TRANSPORTATION RESEARCH DIGEST

JULY-AUGUST 2009

ARIZONA TRANSPORTATION INSTITUTE

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TO: TRANSPORTATION PROFESSIONALS, MANAGERS, & POLICY MAKERS

FROM: ARIZONA TRANSPORTATION INSTITUTE

The volume of information on transportation issues, policies, technologies, and related topics is huge. Not even the most well-read professional can keep up with everything that might be useful to know. The *Transportation Research Digest* series is designed to expedite the transmission of information by condensing and summarizing significant documents. Busy professionals or managers may quickly obtain the gist of new developments and determine whether they need to see the full document.

The *Transportation Research Digest* is not meant to present definitive resolutions of scientific or policy controversies, but contributions to the pursuit of knowledge and the debate of issues. The intent is to be comprehensive rather than conclusive on the multitude of issues and topics of concern to those working in the field of transportation. Readers are encouraged to obtain the original document summarized in the *Transportation Research Digest* and subject the content to their own judgment.

Transportation professionals who would like to recommend documents to be summarized or submit summaries to be considered for inclusion in this publication are invited to do so. To recommend a document please send a copy (or information indicating how a copy can be obtained) of the research report to be summarized. To be considered, the report must meet the following requirements: (1) it is transportation related, (2) it is no more than two years old, (3) there is enough information in the report to warrant a two page summary. To write a summary, insure that the document being summarized meets the above requirements. The summary should be submitted in an electronic format. This summary should be in the 500 to 800 word range and may include tables and/or simple graphics—all of which must fit within the *Transportation Research Digest's* two-page format. Submissions are subject to editing for clarity and length. We do not guarantee that all submissions will be published.

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Transportation Research Digests from December 1995 to November 2003 are available on request.

A "Topic" code in the Table of Contents will help readers more quickly identify items of interest. The topic codes are explained in the table below.

Code	Topic	Code	Topic
ADM	Administration	PLAN	Planning
AIRP	Airports	PRIV	Privatization
AVIA	Aviation	RAIL	Railroads
BIKE	Bicycles	RDSD	Roadside
CON	Construction	ROW	Right-of-Way
ECON	Economics	SAFE	Safety
ENV	Environment	STR	Structures
FIN	Finance	TECH	Technology
INOV	Innovations	TOLL	Toll Roads
MAIN	Maintenance	TRAN	Transit
MISC	Miscellaneous	TRF	Traffic
MVD	Motor Vehicle Dept	TRK	Trucking
PAVE	Pavement	VEH	Vehicles

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Updated Test and Design Methods for Thermoplastic Drainage Pipe, *NCHRP Report 631* by T.J. McGrath, *et al*. (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_631.pdf) (2009)

Highlights

- Complete draft design and construction specifications are provided for design of thermoplastic culvert pipe.

Mechanical tests evaluated tension and compression behavior of polyvinyl chloride (PVC) and high-density polyethylene (HDPE) thermoplastic resins. The tests demonstrated that, in engineering stress, the strength and modulus determined in a compression test are higher than when determined by tension tests. One key finding is that filled PVC resins can use the same compression strain limit as unfilled resins. This substantially increases the burial depths for pipe manufactured with filled PVC resin.

Extensive stub compression tests were conducted. These included extensive tests by the research agencies and round-robin testing by participating laboratories to correlate test results with the calculated compression strength based on local buckling. Test results were used to develop a draft AASHTO specification for the stub compression test and to provide a procedure for using the stub compression test result to compute the compression strength as an alternate to the calculation procedure. Overall, compression strain limits should be set to fixed values for each type of thermoplastic, rather than the current method of using the strain at yield assuming linear behavior.

Structural performance of profile wall pipe was evaluated through a series of soil-structure interaction tests conducted in soil cells and through two- and three-dimensional (2D and 3D) finite element modeling. Tests included hoop compression tests (in which a pipe is surrounded by a ring of soil and compressed axisymmetrically) and biaxial cell tests (in which a pipe is subjected to forces representative of in-ground conditions). These tests have demonstrated local buckling behavior of profile wall pipe and validate the proposals for the simplified design method. Tests and analysis were conducted to evaluate the effects of poor haunch support on bending strains and to support recommendations for the shape factor parameter used in the simplified design method. Overall, the modeling and testing demonstrate a complex stress field in profile wall pipe under earth load further complicated by the occurrence of local buckling. This suggests that even though overall tension stresses in pipe are small or nonexistent when the pipe is installed properly, AASHTO should continue to maintain a minimum tension required strength for resins to ensure that local stresses do not result in long-term failures.

The computer modeling and tests were also used to assist in developing guidelines for comprehensive analysis of thermoplastic pipe installations. In particular, these guidelines provide a more precise method for computing the buckling capacity of thermoplastic pipe relative to the simplified method provided in the draft design specifications. These guidelines will assist designers for unusual projects where computer modeling can be used to provide more cost-effective designs.

A simplified design method was developed for thermoplastic pipe that should be suitable for evaluating thermoplastic pipe for most design conditions. The design method is drawn largely from prior methods, but provides enhancements where necessary. The load factor for earth load is reduced to the same values as rigid pipe; however, to preserve the traditional safety for thermoplastic pipe installations, an "installation factor" is incorporated into the design method. Material modulus values for a 75-year design period have been added. Most pipe designs are controlled by compression capacity. For profile wall pipe, the compression capacity is most often controlled by local buckling of the profile elements. Design for local buckling is largely unchanged except that the compression capacity of a pipe determined through the stub compression test can be used in lieu of the capacity calculated with the design equations. Guidelines for computing bending strain have been improved with the addition of better guidance for the shape factor, which considers non-elliptical deformation due to non-uniform bedding. Tests and computer modeling have shown that the low hoop stiffness of profile wall HDPE can result in reduced bending strains relative to pipe with higher hoop stiffness. Provisions are added to estimate the expected field deflection; however, this is presented as a reasonability check for selecting appropriate backfill and compaction levels. Contractor field control is ultimately responsible for limiting deflection under construction.

Extensive testing was performed to evaluate slow crack growth resistance (SCR) of HDPE used in profile wall pipe. The notched constant ligament stress (NCLS) test is the primary tool to evaluate SCR. Tests included pipe manufactured from 100% virgin resin and with virgin resin +10% and +20% regrind. Regrind is reprocessed waste material from the manufacturer's own production. The tests demonstrate the need to evaluate SCR based on the finished pipe, as the addition of carbon black and the manufacturing process can have a significant effect on the NCLS failure time. An NCLS failure time for pipe specimens removed from the liner of profile wall pipe is recommended at 18 h. This will require virgin resins to have a failure time of approximately 33 h. Testing the finished pipe will reward manufacturers who have good processes, as the necessary NCLS of the virgin resin can be lower.

Material testing also included evaluation of the oxidation induction time (OIT), which measures the quantity of antioxidants present in a polymer. The testing found widely varying results for the various materials tested. The work conducted in this study was preliminary in nature and no firm recommendation is made at this time.

Several changes are recommended to the AASHTO product standards for HDPE and PVC culverts:

- Modification of the crosshead speed for the parallel plate test to 2% per min for pipe larger than 600 mm (24 in.) in diameter.
- Inclusion of a stub compression test to evaluate the compression strength of profile wall pipe.
- Inclusion of a strength limit for PVC pipes in the parallel plate test.
- Addition of the new SCR test on finished HDPE pipe.
- Addition of recordkeeping provisions.
- Addition of the heat reversion test to the PVC standard as a better test to evaluate extrusion quality.

Complete draft design and construction specifications are provided for design of thermoplastic culvert pipe. These include the changes proposed for the simplified design method. For construction, emphasis is placed on post-construction inspection to confirm that deflection levels are within specified limits, and line and grade and joints are all as specified.

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Life-cycle Energy and Emissions Inventories for Motorcycles, Diesel Automobiles, School Buses, Electric Buses, Chicago Rail, and New York City Rail by Mikhail Chester and Arpad Horvath (Institute of Transportation Studies, University of California, Berkeley, CA 80222; http://repositories.cdlib.org/cgi/viewcontent.cgi?article=1024&context=its/future_urban_transport) (May 2009)

Highlights

- Transit does not necessarily result in lower emissions or less air pollution.

The total life-cycle energy consumption and emissions are often dominated by a few critical processes for each mode. For energy and emissions, the on-road modes are heavily influenced by vehicle manufacturing and maintenance, infrastructure construction, and fuel production. The electricity use in vehicle and parts production as well as the fuels needed to transport parts and materials are the primary energy and greenhouse gas (GHG) contributors to vehicle manufacturing and maintenance. The dominating share of light duty vehicle travel on roadways increases the allocation of roadway energy and GHG emissions to the infrastructure construction phase. The energy requirements and resulting GHG emissions needed to extract, refine, and transport fuels is significant. This is not the case for just conventional gasoline and diesel vehicles, but also for electric vehicles. The energy required to produce primary fuels for fossil-based electricity generation facilities results in large contributions for this mode. School buses show large contributions from infrastructure maintenance components. School buses are estimated at around 70% of the bus fleet and although they average fewer vehicle miles of travel (VMT) than urban passenger buses, their impact on local roadways in particular is significant. Attributing this maintenance to buses results in more energy and GHG emissions required to maintain roads due to buses than the actual bus creates itself. The large non-operational shares for motorcycles are due to the large process requirements and relatively few passenger miles of travel (PMT) served. For example, it takes roughly the same amount of energy to produce a motorcycle as it does an automobile (this may be because of economies of scale or the extra requirements to produce specialty parts), but motorcycles service roughly one-third the PMT as the automobile modes over the vehicle's lifetime. The sulfur dioxide (SO2), nitrous oxides (NOX), volatile organic compounds (VOC), particulates (PM10), and carbon monoxide (CO) emissions are produced from several different processes across life-cycle components. SO2 is produced primarily in electricity generation. The SO2 emitted from electricity generation in life-cycle components dominates total emissions due to low fuel sulfur contents in direct combustion. The SO2 emissions from electricity requirements in aggregate production for infrastructure construction, vehicle manufacturing, and fuel production are strong contributors across all modes. NOX emissions are mostly attributable to diesel truck and equipment use, often in material or parts transport. While VOCs are dominated by the vehicle operation phase, the releases during asphalt placement during roadway construction are non-negligible.

The vehicle manufacturing and roadway construction phases show dominating

contributions to total PM10 emissions. Additionally, parking construction has significant contributions for automobiles as does infrastructure maintenance for buses. While CO emissions for autos are mostly from vehicle operation, the emissions from truck transportation in vehicle manufacturing contribute heavily to bus modes.

The infrastructure construction, infrastructure operation, and fuel production components are the strongest influence on rail energy consumption and GHG emissions. The massive material requirements (particularly concrete) results in significant energy consumption for building rail stations and tracks.

Infrastructure operation includes station lighting, escalators, and train control, all of which consume large quantities of electricity considering continuously draw electricity for a large part of the day. The energy and corresponding GHG emissions of primary fuels extraction and processing for electricity generation results in significant contributions from the fuel production phase. For the other emissions, similar processes are responsible for large life-cycle contributions but the large physical size of rail infrastructure given the PMT served pronounces the contributions from infrastructure components. SO2 in electricity generation again shows in the infrastructure operation component for station power. The electricity required in concrete production results in a non-negligible contribution for the infrastructure construction component of some modes. While NOX in diesel trucks and equipment use dominates some rail modes, for commuter rail systems, vehicle operation factors dominate. This is due to direct combustion of diesel fuel by these vehicles and produces much larger vehicle operation emissions than electric modes. VOC and PM10 emissions are relatively small for rail modes but can be dominated by the release of organic components in cement production and fugitive emissions in aggregate production for infrastructure construction.

These life-cycle inventories highlight the importance of energy and emissions inventories for transportation modes that include components beyond vehicle direct energy use. The energy and GHG emissions in vehicle operation are between 10% and 70% of the total inventory showing that even at its largest contribution, non-operational components have significant contributions. For SO2, NOX, VOCs, PM10, and CO emissions, the results are even stronger. It is often the case that the vast majority of emissions of these pollutants occur outside of the vehicle operation phase. While the life-cycle inventories presented are valuable, they do not delve into impact assessment (with the exception of GHG emissions). These inventories should provide an improved dataset for evaluating GHG, human health, ecologic, and other impact categories. The importance of proper attribution of energy consumption and emissions is critical in well-formed policy and decision making.

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Out of Gas: Congress Raids the Highway Trust Fund for Pet Projects While Bridges and Roads Crumble by Senators Tom Coburn and John McCain (United States Senate, 111th Congress; http://coburn.senate.gov/public/_files/OutofGas730Final0.pdf) (Jul 2009)

Highlights

- States should be given the flexibility to opt out of the federal Transportation Enhancement funding requirement.
- Congress should implement a moratorium on all transportation-related earmarks.

Our country is literally running on empty. Future generations of Americans will inherit a multi-trillion dollar debt because Washington politicians have long relied on reckless borrowing to finance their wish lists of pet projects and programs. There seems to be no crisis facing our nation that Washington politicians believe borrowing or bailouts cannot solve.

Now the politicians want to be trusted with yet another bailout, this time of The Highway Trust Fund. Politicians will not make tough choices, so taxpayers must begin demanding them.

The choices faced today with the Highway Trust Fund are:

- What is the best way to spend Highway Trust Funds: Is it to make roadways and bridges more scenic, or more safe?
- What is the best way to pay for our nation's infrastructure needs: Is it to raise taxes on gasoline, borrow more money for yet another government bailout, or reduce spending on non-essential projects that do not strengthen roads or bridges?

GAO reports our nation obligated $78 billion over five years to projects other than crucial bridge and highway maintenance and repair. Now, Congress is being asked to borrow $7 billion from general tax revenues to only temporarily refill the Highway Trust Fund.

No one is saying our nation should be without flowers and ferries or bike paths and boat museums. But today's choices must be about priorities. Should those priorities include spending millions on programs that tell bikers to smile and making states use funds for the safety of their turtles instead of the safety of their citizens?

At a minimum, states should be given the flexibility to opt out of the federal Transportation Enhancement funding requirement.

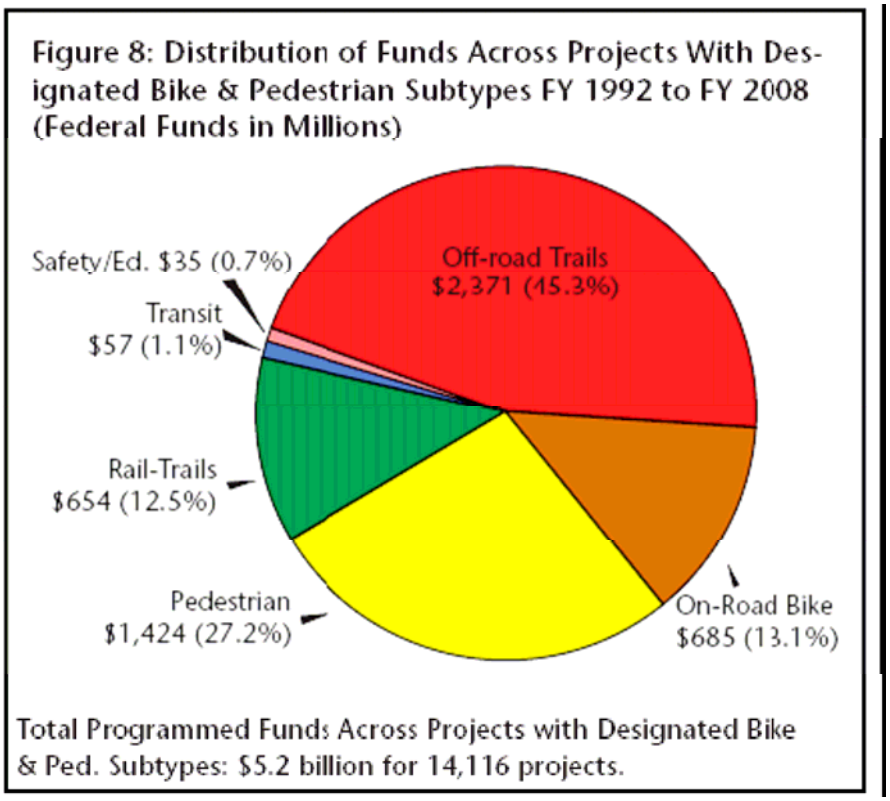
The shortfall in the Highway Trust Fund could also be addressed without further deficit spending by shifting unused funds from the American Recovery and Reinvestment Act of 2009.

Transferring unspent stimulus funds to ensure the Highway Trust Fund remains solvent would be consistent with a stated purpose of the Act to improve our transportation infrastructure to support job growth.

Congress should walk the fiscally responsible path. Each chamber should implement a moratorium on all transportation-related earmarks for the remainder of the 111th Congress.

Washington politicians should be required to sit down with the new GAO report, the transportation bailout request, and our red pens. From there, crossing out extraneous

transportation spending should be our first priority. Lives depend on it.



A graph compiled with federal funds and published by the National Transportation Enhancements Clearinghouse tracks the different kinds (subtypes) of federally funded bike and pedestrian projects.

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Alternate Mitigation Materials for Alkali-Silica Reaction (ASR) in Concrete by Zachoria J. Ballard, William S. Caires, Stanley R. Peters, J.A. Cesare & Associates, Inc./Construction Technical Services, 7108 S. Alton Way Bldg. B, Centennial, CO 80112 (Colorado Department of Transportation – Research, 4201 E. Arkansas Ave., Denver, CO 80222; http://www.dot.state.co.us/Publications/PDFFiles/asr.pdf) (Nov 2008)

Highlights
- All materials tested were able to mitigate ASR expansions.

Due to recent changes in the Environmental Protection Agency's regulations, the production of Class F fly ash that is acceptable for use in concrete pavement will be more limited in the future. This has led to a difficulty in obtaining Class F fly ash for Colorado Department of Transportation (CDOT) projects. Class N fly ash is not on CDOT's list of approved products, and until recently this was not a problem; Class F fly ash was more abundant and cheaper to acquire than Class N fly ash.

Research was conducted to evaluate the performance of Class N fly ash and other materials to mitigate Alkali Silica Reaction (ASR). The American Standard for Testing Materials (ASTM) test C 1260 was used to create a baseline for testing the expansion of reactive aggregates. C 1567 testing was conducted using a blend of reactive aggregates and various mitigating materials. Baseline mitigation testing was conducted with varying replacement levels of cement with supplementary cementitious materials (SCMs). These SCMs included one source of Class F fly ash and one source of metakaolin chosen by CDOT. Once the effectiveness of the various materials to mitigate 14-day expansion to 0.10% was determined using the above test methods, concrete mixes were prepared using the various materials. From these mix designs, slump and air entrainment on the plastic concrete was performed; compressive strength cylinders were cast and tested at 7, 28 and 56 days. Rapid chloride permeability test, in accordance with ASTM C 1202 was performed. Restrained cracking tendency testing (AASHTO PP 34) will be performed by CDOT on select mixtures in the future.

All materials tested were able to mitigate ASR expansions to below 0.10 at certain dosage rates. The metakaolin products mitigated ASR at dosages of approximately 10% replacement, as compared to an average replacement with fly ash of 24%.

This replacement reduction could either be used to maintain higher early strengths of concrete or to mitigate ASR with less cementitious materials (less costly).

Materials other than either Class N or F fly ash also successfully mitigated ASR, and can have applications in Colorado. Lithium can mitigate ASR without any cement replacement, although blends with fly ash tend to be more economical.

Lightweight sands can mitigate ASR by replacing reactive sands and giving a pore structure for gel from the coarse aggregate to grow in safely.

ASR mitigation with lightweight sand also brings the benefits of "internal curing" to dense, low water to cement (w/c) ratio concrete that can be difficult to cure in the field.

Implementation Statement

CDOT should modify the concrete specifications to allow the use of alternate materials, pending compliance to the new specifications and successful testing before being placed on the CDOT Approved Products List APL). A review of specifications in other states and this report should be helpful.

Implementation into concrete construction (after specifications allow alternate materials) will involve economic evaluations by the contractors. Potential Class F shortages will likely promote mix designs with alternate materials as a backup, or if strength gain (with less cement replacement) is beneficial to the project schedule.

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An Asset-Management Framework for the Interstate Highway System, *NCHRP Report 632* by Cambridge Systematics, Inc. (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_632.pdf) (2008)

Highlights
- Asset management is a developing field that provides a set of tools and techniques for managing infrastructure assets.
- A recommended outline for an Interstate Asset Management Plan is presented.

It is impossible to overstate the importance of the Interstate Highway System (IHS) to global, national, regional, and local area movements of people and goods. On a global scale, the competitiveness of the United States in international trade and the need to surmount the challenges of moving goods over long distances has benefited immensely from this far-reaching network of roads that for a generation had no equal. This report is intended to supplement other work on the past and future of the IHS with tools and approaches for better managing the system in the present.

Part of the challenge of managing the IHS lies in developing cost-effective investment strategies for managing the various assets on the system. The assets need to be managed collectively by asset type, as well as by segment, by corridor, by region, and for the system in its entirety. The challenges only will grow greater as the system ages, and there are further increases in passenger and freight traffic.

Transportation asset management is a developing field that provides a set of tools and techniques for managing infrastructure assets. Asset management is, at its core, a set of guiding principles and best practice methods for making informed transportation resource allocation decisions, and for improving the accountability for these decisions. Asset management principles and processes apply to all types of investments in transportation infrastructure assets. Conceptually asset management is not limited to a preservation focus, but considers the full range of potential investments, as well as factors related to safety, operations, environmental management, corridor management, and project/program delivery.

In applying asset management to the IHS, one must first ask what, if anything, is unique about the IHS that demands a targeted approach. The answer to this most fundamental question is that the IHS is uniquely important because it represents the most critical set of highway assets in the United States. Keeping its portion of the IHS in operation is a critical concern for every IHS owner, and asset management promises an approach for helping accomplish this objective. Applying asset management to IHS assets is not an objective unto itself, but a means for achieving a larger, national goal, that of helping keep the IHS network in operation using the most effective means. This objective is in one respect very targeted, in that it applies to a single portion of the U.S. transportation network. In another respect, the objective is quite broad, as it implies consideration of the full range of factors that might impact operation of the IHS, and introduces the concept of a national interest in IHS asset performance. This approach provides a consistent asset management framework and, therefore performance

expectations for the IHS, by leveraging existing agency-to-agency institutions and relationships in managing the connection points of the system.

The basic strategy recommended for integrating decision making for IHS assets with the broader decision-making scope is for each IHS owner to develop an Interstate Asset Management Plan on a periodic basis. The plan should summarize conditions of IHS assets, establish performance measures for those assets considering available funds, and describe the plan for future investments in the IHS. The plan, once developed, will help support the agency's ongoing resource allocation process for its IHS network across investment categories and decision-making horizons. It also should provide consistent information about the system that can be shared among the many agencies managing the network. A recommended outline for an Interstate Asset Management Plan is presented in Chapter 2.

Chapter 6 of this report provides guidance on implementing an asset management approach for the IHS. The approach to implementing asset management will depend on the basic motivation for implementation, the focus area of the effort, the approach taken to leading the effort, and the set of internal and external stakeholders involved in implementation. An Interstate Asset Management Framework may focus on areas that vary according to function (preservation, mobility, safety, and environment), or level within the organization (policy level issues, program and project prioritization issues, management and operational issues), or any combination of these.

Each and every agency and entity responsible for a portion of the IHS must reach its own conclusions, for its own reasons, on whether and how to undertake all or parts of the Interstate Asset Management Framework. Motivating factors will vary, as will areas of emphasis, specific approaches, sources of leadership, background expertise, and organizational characteristics. What does not vary is the simple fact that the potential consequences of deterioration or disruption to the nation's most important arteries will be severe in terms of impacts upon the economic well being and quality of lives of our citizens. By taking advantage of best practices in asset management and risk management, system owners and operators can most effectively identify and combat the effects of deteriorating infrastructure, minimize costly system disruptions, and ensure that our national highway system continues to serve as an engine for helping drive our economy forward.

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The Tipping Point: The Transportation-Housing Trade-Offs of Suburban, Urban and Rural Living by Alan E. Pisarski (Heritage Foundation, 214 Massachusetts Ave NE, Washington DC 20002-4999; ph 202.546.4400; http://www.heritage.org/Research/SmartGrowth/upload/The_Tipping_Point_Pisarski_090522.pdf) (May 2009)

Highlights

- America is reaching a stage that no other nation has ever achieved, in which people can live where they want and work where they want.
- An array of density options ought to exist to serve the various choices and preferences of the society.

In March 2009, the Secretaries of the Departments of Transportation and Housing and Urban Development issued a joint press release announcing a new interagency partnership and task force to create "affordable, sustainable communities." Among the several projects this partnership and its task forces will take on is the development of a new cost index that combines housing and transportation costs by "redefining affordability and making it transparent."

Efforts to "redefine" and "make transparent" housing and transportation costs have been the subject of a growing debate over the past decade as opposing sides of the cities versus suburbs debate and the cars versus trolleys debate have offered up conflicting data on the relative costs of these choices. How the new DOT/HUD partnership will address these issues and competing contentions is unknown, but many recent state and local trends on these issues suggest a narrowing of opportunity for the average household is the chief risk.

The recent jump in gasoline prices has heightened interest in these issues as Americans have cut back on their driving, while transit has captured at most about 3 percent of this decline. Some wonder if these Hummer-loving, McMansion-living families are finally getting what's coming to them. And will they all come crawling back to the city to live in apartments and bicycle to work?

Many issues have been raised as the call increases for policy intercession, which basically take offense at the public's choices:

- The public spends too much on transportation.
- The low-income population is "transportation poor."
- The transportation trade-off with housing costs has created losses for households.
- The sprawling of jobs to the suburbs is a problem that needs to be solved.

Do these things happen because the public is coerced by circumstances, or are they just making really dumb choices? Somehow the sense is that these mistaken choices can be resolved by everyone coming back to the cities and the jobs returning with them.

This paper works its way through the morass of conflicting claims and provides some factual outlines for a sensible policy structure. The presentation focuses in particular on two issues in this debate:

1) The transportation–housing trade-offs of suburban, urban, and rural living, and

2) the massive importance of access to skilled workers in our future economy.

We have no choice but to care greatly about transportation. Transportation is all about reducing the time and cost penalties of distance on our economic and social interactions. To the extent that nations succeed in that function they enable tremendous forces of economic opportunity, social cohesion, and national unity.

Peering into the future as various legislative options move forward. One can see strong threats in the offing as well as tremendous opportunities.

Among the threats:

- The enactment of policies to penalize current life style preferences such as: Dispersed housing & Dispersed job locations
- The enactment of policies to promote Higher density & "Organized" society
- The utilization of subsidies to Recentralize populations and jobs Promote density

Among the opportunities:

- Market forces are naturally moving jobs closer to skilled workers.
- Increases in mobility, especially among minorities, has been growing and should continue absent contravening policies.
- Better long distance transportation promotes greater/broader job access,
- America is reaching a stage that no other nation has ever achieved, in which people can live where they want and work where they want. Hard to believe the government—much less the society—would decide that that is a bad thing.

Nothing is more fundamental to ways of living preferences than the density at which people live. An array of density options ought to exist to serve the various choices and preferences of the society. Nothing that has been said here precludes the opportunities for higher density clusters in suburban areas as portions of society—perhaps younger people and retirees—opt for that life style. But it is clear that the American people have no obligation to life in ways that make it convenient for governments to serve them.

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Annual Privatization Report 2009 by Leonard C. Gilroy (Reason Foundation, 3415 S. Sepulveda Blvd. Suite 400 Los Angeles, CA 90034; ph. (310) 391-2245; http://reason.org/files/annual_privatization_report_2009.pdf) (2009)

Highlights
- Several ongoing projects are outlined in this digest summary.

A number of the Public-Private Partnership (PPP) toll projects discussed previously involve managed lanes, including I-595 in Florida, I-495 and the subsequent I-95/395 project in Virginia and the LBJ (I-635) and North Tarrant Express projects in Texas. There are a number of other managed lanes projects in various stages of planning and implementation in large metro areas, some of which have PPP potential. Here is a brief recap.

California is the site of considerable managed lanes activity. In August 2008 the Metropolitan Transportation Commission for the entire San Francisco Bay Area approved a $4.8 billion plan to convert existing high-occupancy-vehicle (HOV) lanes to high-occupancy free, others toll (HOT) lanes and build new lanes to close many gaps, making a relatively seamless network. The bill to permit this plan to move forward, AB 744, was approved 12-1 by the Assembly Transportation Committee in April 2009. The 800-mile network will consist mostly of a single lane in each direction, like the current HOV system. It will involve converting 500 miles of existing HOV lanes and building another 300 miles of new HOT lanes, plus direct connector flyover ramps at six major interchanges. Under most scenarios in the feasibility study, the network would be self-supporting from toll revenues. San Diego is under way on a more modest network, beginning with widening and lengthening the reversible I-15 HOT lanes and going on in future years to add HOT lanes to several other major freeways, including I-5 and I-805. Los Angeles won a federal grant in 2008 to convert HOV lanes on two freeways, I-10 and I-110, to HOT lanes and it has a feasibility study under way on a network of HOT lanes. Riverside County received legislative permission in 2008 to extend the HOT lanes on SR 91 from the Orange County line eastward to I-15.

In Florida, the I-95 Express Lanes project opened its first phase in December 2008, providing two variably priced managed lanes from near downtown Miami northward to the Golden Glades interchange in northern Miami-Dade County. The southbound portion is under construction and slated for a late 2009 opening. A subsequent phase will extend the Express Lanes to Broward Blvd. in Ft. Lauderdale and at that point there will be nonstop express bus service between Miami and Ft. Lauderdale. This project, an Urban Partnership Agreement winner, permits registered carpools of three or more to use the Express Lanes at no charge; all others pay a variable toll via the SunPass transponder that is standard statewide in Florida. The Florida Department of Transportation (FDOT) has feasibility studies under way on adding managed lanes to I-75 in Broward County and portions of SR 826 (the Palmetto Expressway) in Miami-Dade County. Reversible managed lanes are also being implemented on I-595 in Broward County. FDOT's winning Urban Partnership proposal suggested that these and

possibly other variable pricing projects could become a network of managed lanes.

Georgia won a competitive Federal Highway Administration (FHWA) grant in 2008 to convert the existing HOV lanes on I-85 to managed lanes, as the potential first step in developing a managed lanes network spanning most of the metro area's freeway system (replacing the previous plan of building a large network of HOV lanes). The initial project will extend 14 miles on I-85 outside the I-285 Perimeter.

In Texas, both Dallas and Houston have outlined networks of managed lanes based on feasibility studies done several years ago. The Dallas/Ft. Worth metro area has adopted a region-wide managed lanes policy, which will be adhered to by all such projects, whether developed by the local toll agency (NTTA), TxDOT or companies operating under toll concession agreements. The map on the region's long-range transportation plan, Mobility 2030, shows an extensive set of toll roads and managed lanes on freeways. In March 2009, Houston Metro announced plans to convert 83 miles of HOV lanes on five freeways into HOT lanes, using federal stimulus funds. This will complement the four new managed lanes on the Katy Freeway (I-10), which began charging tolls in early 2009. A HOT network study for the Houston metro area was completed in 2008, funded largely by the FHWA's Value Pricing Program.

The Washington, DC metro area is another one that has done fairly extensive studies of a HOT or managed lanes network, with a comprehensive feasibility study completed in 2008. This region has a number of elements already in place or under way that could be incorporated into such a network, including the under-construction HOT lanes on the I-495 Beltway in Virginia, the existing Dulles Greenway toll road, the planned HOT lanes on I-95/395, the variably priced InterCounty Connector toll road under construction in Maryland and the express toll lanes under construction on I-95 in the Baltimore area. The Metropolitan Washington Council of Governments is developing a staging plan for the HOT/Priority Bus network.

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Reducing Litter on Roadsides, *NCHRP Synthesis 394* by Gerry J. Forbes (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_394.pdf) (2009)

Highlights

- Facilities with Adopt-a-Highway (AAH) programs have 13% to 31% less litter.
- The cost of roadside litter collection and disposal is about $430 to $505 per centerline-mile.

One of the primary tenets in litter prevention is that litter begets litter. Research has shown repeatedly that keeping an area litter-free will greatly reduce the incidence of new litter. This suggests that prevention and collection efforts need to be maintained or bolstered.

The effectiveness of individual litter prevention strategies is largely undetermined. The literature is replete with research on the effects of messaging, trash can design and placement, and penalties on litter reduction. However, the majority of these studies are not measures of success as it applies to roadside litter. It is uncertain whether the results from a cafeteria or a campground are directly transferable to a highway roadside. Still, some programs that have been studied have been found to be effective. Specifically, facilities with Adopt-a-Highway (AAH) programs have 13% to 31% less litter than similar non-AAH facilities, and litter collection before roadside mowing is an effective method of reducing visible litter. Other measures such as passing container deposit laws and establishing local Keep America Beautiful affiliates have documented successes, but are perhaps outside of the mandate of the department of transportation (DOT).

Advertising and education material reflect a social norm that littering is not commonplace (i.e., visual messages would show a clean environment as opposed to a littered environment). Displaying a littered environment in advertisements and promotional material lessens the effect of the message, yet this is a common mistake made in roadside litter prevention efforts.

The enforcement community has a promising opportunity with closed circuit television to monitor high litter roadsides and reduce litter. Privacy issues that arise would be similar to those already considered by speed cameras and red light cameras that have been deployed in some states.

The survey of state DOTs reveals that the cost of roadside litter collection and disposal is about $430 to $505 per centerline-mile. Furthermore, although a variety of education programs and encouragement strategies are available for roadside litter prevention, no distinct trends or patterns have emerged in the use of these strategies.

The case studies clearly support the need for a multi-stakeholder approach that uses solid research on the who, what, when, where, and why of roadside littering to select and implement multiple, targeted antilitter strategies. Furthermore, it seems less important who leads the multi-stakeholder effort as long as a lead agency champions the cause. Finally, the case studies strongly suggest that advertising campaigns (for education and encouragement) be comparable to traditional private sector commercial advertising. It is

important that slogans and other advertising material be attention-grabbing and memorable, delivering a straightforward, unapologetic message concerning the unacceptability of roadside littering.

Roadside litter prevention efforts are hampered, however, because nationally the attempts to address the roadside litter problem are largely fragmented and under researched. Existing efforts lack the synergy that might be created by a national coordination of roadside litter prevention efforts. The individual states are in various stages of program development, using different organizational structures and strategies. In some cases, the DOT is the lead agency; in others, the DOT is a supporting agency to other state departments. The successes of the various programs in reducing roadside litter have been documented only by some of the well-developed state programs.

This is not to say that roadside litter prevention efforts have not enjoyed some success. The findings from the Institute for Applied Research demonstrate a drop in overall litter rates over time, which may indicate that litter prevention programs in the United States are working. Furthermore, the shift from intentional to accidental litter is significant, and is a strong indicator that campaign efforts might now be better directed toward accidental litter prevention efforts. On that note, the litter prevention community has adopted the term “accidental litter” to describe litter that was not deliberately or knowingly deposited on a road. The term “accidental” may imply that this litter is random and not culpable. It may be an effective strategy to use the term “negligent litter” because willful acts, such as securing cargo, and being more diligent about the potential for litter may further reduce litter.

Overall, however, quality effectiveness evaluations concerning roadside litter are rare, and road authorities and government agencies may be hesitant to invest in litter programs that have not been proven effective. Only a few roadside litter prevention programs produce evaluations. Moreover, currently documented evaluations typically use the frequency or density of visible roadside litter as the sole measure of success. Other performance measures could be considered, such as injuries to workers and volunteers, motor vehicle crashes, roadside fires, and so on. Standard data collection methods and templates will allow state and municipal road authorities to pool collected data and obtain a better understanding of causative factors in roadside litter and appropriate target audiences for education and enforcement programs.

One of the primary obstacles in developing effective litter prevention campaigns, and in attracting funding for these programs, is the lack of reliable data on the roadside litter problem. The state survey clearly demonstrates that state DOTs do not have a consistent metric for roadside litter collection (e.g., weight, volume, and so on). The costs and impacts of roadside litter need to be better documented and widely publicized. The cost of roadside litter and litter collection in the United States is staggering and likely would be surprising to the general public and decision makers.

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Light Rail Vehicle Collisions with Vehicles at Signalized Intersections, *TCRP Synthesis 79* by Kelley Klaver Pecheux and Harry Saporta (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_79.pdf) (2009)

Highlights

- The objective of this study was to report on the mitigation methods tested and used by transit agencies to reduce collisions.
- This synthesis report describes 34 countermeasures.

At their start-up, new light rail transit (LRT) operating systems typically experience undesirable frequencies of light rail vehicle (LRV)–motor vehicle collisions, particularly where motor vehicles cross LRT tracks located in or adjacent to highway intersections that are controlled by conventional traffic signals (i.e., street-running operations). Over time, as agencies have gained experience with LRT operations, they have addressed the problems through engineering, education, and enforcement efforts. This report is a synthesis of today's state of the practice with regard to mitigating collisions between LRVs and motor vehicles at signalized intersections. This synthesis will help transit agencies to better understand, and to learn from, the experiences of other agencies facing similar challenges.

The objective of this study was to report on the mitigation methods tested and used by transit agencies to reduce collisions between LRVs and motor vehicles where LRT runs through or adjacent to highway intersections controlled by conventional traffic signals, with a particular focus on collisions occurring between LRVs and vehicles making left turns at intersections. This synthesis includes success stories and specific actions taken to achieve positive results, as well as examples of unsuccessful actions. The issues addressed include a range of LRT operations and environments (median-running, side-running, contra-flow, and mixed-use LRT alignments), urban and suburban settings, and a variety of U.S. geographic regions.

As directed by the topic panel, the technical approach for this synthesis project included a review of recent relevant literature as well as structured telephone interviews with the following transit agencies:

- Tri-County Metropolitan Transportation District of Oregon (TriMet)—Portland, Oregon;
- Denver Regional Transportation District (RTD);
- Metropolitan Transit Authority of Harris County (METRO)—Houston, Texas;
- Los Angeles County Metropolitan Transportation Authority (LACMTA);
- New Jersey Transit—Hudson–Bergen Light Rail;
- Sacramento Regional Transit District (RT); and
- Dallas Area Rapid Transit (DART).

A review of the most recent literature and structured interviews with these transit agencies revealed that collision types and circumstances vary between agencies, depending on a variety of factors. However, transit agencies with LRT systems consistently reported that most collisions between LRVs

and motor vehicles are caused by motorists making illegal or improper turns or running red lights. The most common scenarios of left-turn and right-angle collisions at signalized intersections have been categorized as the following:

- Motorists in left-turn pocket lanes violate the red left-turn signal indication and collide with LRVs approaching from behind.
- Motorists make illegal left turns against static no left-turn signs (at locations where turns are prohibited) and collide with LRVs approaching from behind.
- Motorists violate active turn-prohibition signs and train-approaching warning signs in conflict with LRV operation (at locations where turns are permitted or prohibited).
- Motorists make left turns from adjacent through-only lanes instead of from the lanes shared with the LRVs (mixed-use alignment).
- Drivers encroach on or stop on the tracks and are struck by an LRV (coming from either direction) at a right angle (side-running alignment only).
- Drivers run a red signal indication and collide with an LRV (coming from either direction) at a right angle.

Transit agencies have taken a number of approaches and have implemented a variety of countermeasures to mitigate collisions between LRVs and motor vehicles at signalized intersections. These countermeasures include physical barriers, traffic signs, signal displays, traffic signal phasing, pavement markings and/or treatments, public outreach and/or education, police and photo enforcement, and others such as lower train speeds, standardized crossings, and LRV operator defensive driving. This synthesis report describes 34 countermeasures and presents case studies of recent applications of many of the countermeasures by transit agencies. Although some of these countermeasures have been more effective than others, there have been few empirical studies conducted to examine the effectiveness of the countermeasures in terms of reducing the frequency and severity of collisions.

Despite the efforts put forth by transit agencies and city and county traffic engineering departments, collisions between LRVs and motor vehicles at signalized intersections continue to occur, and agencies continue to seek out innovative countermeasures in an effort to further reduce the frequency and severity of these collisions.

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Real-Time Traveler Information Systems, *NCHRP Synthesis 399* by Dean Deeter (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_399.pdf) (2009)

Highlights

- The primary purpose of this synthesis is to gather and report on the state of the practice for real-time traveler information delivery.

Travelers (as consumers) have certain levels of expectations for traveler information. Simply put, they need quick, simple, safe access to accurate, timely, reliable, route-specific information. The agencies providing traveler information face challenges of their own in attempting to meet the needs of travelers while operating within limited budgets and with available resources. This project identified the following three key challenges that traveler information providers face:

- Challenge 1: The use of some aspects of the traveler information that is being delivered is limited.
- Challenge 2: A gap exists between what is possible in the state of the art in data collection, information generation, and delivery and what occurs in today's state of practice.
- Challenge 3: Both public and private traveler information providers face funding and budget challenges.

As a result of this synthesis, six suggestions are presented (in no specific order) to the traveler information industry:

The first suggestion is that more formal discussions occur between experts in information accessibility and the traveler information system operators and developers to increase awareness and understanding of best practices and approaches. The results of this projects' survey showed that many public agencies either have been successful at making their traveler information systems accessible to all travelers, including those with disabilities, or are working diligently to do so. However, based on feedback and input, it appears that most agencies are unclear about the steps to achieve an accessible system and also have received little feedback from the traveling public.

The second suggestion is that a nationwide effort be considered to achieve consistency in the use of icons on traveler information system websites. The results of this projects' observations and surveys showed that there is little consistency in the use of icons and nomenclature of event descriptions among traveler information websites.

The third suggestion is that the performance measures for 511 phone systems be reconsidered to include consideration of the information content delivered per call, the information missing per call, and the travelers' reactions based on the 511 call. Traditionally, call volume statistics have been a major performance measure used to assess the success of 511 phone systems. However, the study suggests that volume of use tells only a small portion about the success and value of the system.

The fourth suggestion is that more detailed and focused user feedback surveys be conducted to understand the true reactions of travelers. Feedback suggests there are three

related and somewhat conflicting issues regarding 511 phone system feedback:

- Feedback from transportation professionals who have tested 511 • phone systems typically cite many frustrations with the systems and describe both the need for improvements and the technical ability to accomplish such improvements.
- Contradicting the negative feedback from transportation professionals, the feedback obtained from surveys of 511 users expresses satisfaction with 511 systems and often describes how useful and beneficial the systems are.
- With very few exceptions, the usage statistics for 511 do not reinforce the positive feedback expressed by surveyed users; instead, usage spikes at certain times during major events and is very low at other times, suggesting that the value of the system varies greatly depending on the situations facing travelers.

The fifth suggestion is that public agencies consider VoIP (Voice over Internet Protocol) technologies to reduce "per minute" phone costs, and that the 511 industry research the feasibility of centralizing (either regionally or nationally) portions of the call-handling processes (while leaving content development and call dialogs to continue to be locally controlled). Such an approach might better meet the peaks in demand, while reducing overall operations costs.

The sixth suggestion is to research the apparent "gap" between the availability and use of weather information. Although a great deal of weather information is offered by traveler information systems, the weather reports often are general and do not represent the highly detailed and accurate capabilities of the weather forecasting industries.