Mr. Chairman, distinguished members of the Subcommittee, I would like to thank you for the opportunity to testify today. It is indeed an honor. I would also like to commend you all for your efforts to address the environmental impact of our nation's transportation infrastructure through H.R. 5161, The Green Transportation Infrastructure Research and Technology Transfer Act. I believe this legislation will help address many of the issues this Subcommittee is examining today, such as the need for improved coordination among federal, state, and local governments; the private sector and university-based research organizations, as well as the need to shorten the time to find and implement solutions.

The Texas Transportation Institute's (TTI's) environmental research encompasses air, water and soil studies, as well as roadway landscaping issues, environmental design and other aspects of the field. TTI is nationally recognized for its state-of-the-art testing facilities, experts in transportation-related environmental concerns and an interdisciplinary approach to environmental research.

TTI's Environmental Management program conducts landmark transportation research in areas such as storm water quality and erosion-control materials, housing a full-scale evaluation facility. Research from the Air Quality Studies Program expands analytical approaches to transportation air quality analysis and provides results that help to more effectively evaluate air quality policies and emission reduction measures. The University Transportation Center for Mobility focuses on infrastructure congestion, which is a major cause of wasted fuel each day.

Offices housed in several of the state's air quality non-attainment areas provide TTI with awareness of local concerns and targeted solutions. Personnel throughout the agency conduct research on wide-ranging environmentally related topics such as public transit, urban planning and traffic patterns.

We consider Green Transportation Infrastructure as the design, construction, operation, and maintenance of transportation infrastructure to mitigate air pollution, ground water contamination, and surface water contamination with an end result of reducing congestion, flooding, erosion, and impacts to ecosystems.

First, let me summarize my key points.

- Green Transportation Infrastructure includes a diverse group of stakeholders that must act together to fully address the impact of transportation on the environment. I would like to commend the Committee for its efforts to elevate the topic through a University Transportation Center.
- Congestion problems will continue to challenge our metropolitan regions in the future. Travel delays and unpredictable travel times for people and freight will be a problem leading to increased emissions and fuel consumption. With the increase in gas prices, the impact will only become more costly to the average citizen.
- Research is needed to quantify the benefits of green transportation strategies. The transportation industry needs solid evidence on the impact of technologies, strategies, and materials.
- There are design, operational strategies, technologies, materials, and construction techniques that will reduce transportation's impact on the environment. Technology

transfer of research and best practices is needed to increase implementation of green transportation.

I would like to expand on these ideas in five key elements: the congestion problem, improvements in design and operations, improvements in pavements, improvements in construction materials, and future research needs and the federal role.

The Congestion Problem

Most, if not all of you, have driven through the District during rush hour, so I need not point out that congestion is a major problem, not only in our nation's capital but in cities across the nation. Technically we might use words that describe elements of problems or solutions like accessibility, mobility, reliability, connectivity, and seamless productivity. These are all useful distinctions and point to viable and important solutions, but the meaning of these various words may be lost on people and freight shippers who understand their congestion problem, but do not parse it in the way that experts do. People are concerned when it takes them longer to get where they want to go than they think it should. I think it is important to recognize this difference between what people call the problem and how we attack it.

Our research suggests that no matter what you call it, we've got several problems. A quick summary:

- We waste quite a lot of time – 3.7 billion hours in 85 cities in 2005
- We use more fuel than we should – 2.3 billion gallons in those 85 cities
- This has value - $63 billion in 85 cities in 2005
- We cannot reliably predict travel time very accurately due to several factors such as crashes, vehicle breakdowns, weather, special events and road work.
- Jobs, shops and homes are spread out for a variety of understandable reasons, many of which make transportation service more difficult to provide.
- There are fewer travel options than people say they want, but many of the existing options are underutilized.
- We have to plan around congestion during most daylight hours and on weekends.

A 2003 study for the Texas Governor's Business Council used information developed by the state's metropolitan planning organizations and the Texas DOT to estimate the benefits of improving mobility. To keep the relatively high level of congestion experienced in major Texas cities from getting worse will require an increase in spending from $108 billion to $123 billion between now and 2030. The more desirable outcome of eliminating serious congestion will increase spending to $174 billion. That $66 billion increase generates $540 billion in savings from lower travel delay, reduced fuel consumption and business efficiency, an 8 to 1 return ratio. Reductions in fuel purchases that would result from less stop-and-go driving were estimated at $37 billion alone, more than half of the cost of the program.

Addressing the congestion problems can provide substantial benefits and provide improvements in many sectors of society and the economy. The costs involved in eliminating serious congestion problems are large and the projects, programs and policies that are implemented will

require the cooperation of the public, agencies at all levels of government and, in many states, the private sector as well.

The Texas Governor's Business Council study estimated that solving the serious congestion problems in the state's eight largest metropolitan regions would generate $540 billion in economic benefits—including $37 billion in reduced fuel consumption and $104 billion in travel time savings (Figure 1). The analysis estimated almost $80 billion in business efficiencies and operating savings would result from lower congestion levels. More than $320 billion in construction benefits, which include more than 110,000 jobs that would be created, were also identified.

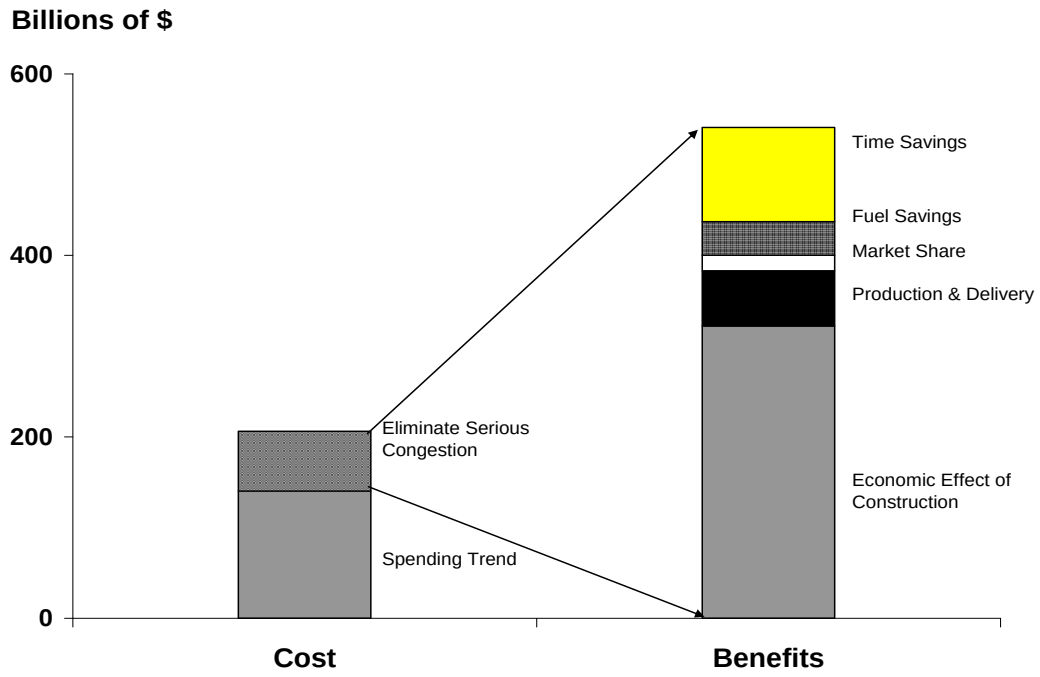

Figure 1. 25-Year Costs and Benefits of Implementing Texas Metropolitan Mobility Plan
Source: TTI Mobility Study, 2007

Design and Operation of Transportation Infrastructure

Some may say congestion is a by-product of success and economic development. However, accommodating the growth does not have to produce the same past results. Public agencies need to find new ways of designing and operating the transportation system to accommodate the growth. An example of this in the Dallas area is the Integrated Corridor Management project

jointly funded by the US DOT and Dallas Area Rapid Transit and in cooperation with the North Central Texas Council of Governments, North Texas Tollway Authority, Texas Department of Transportation and the cities of Dallas, Richardson, Plano Highland Park, and University Park. The goal of this project is to operate the US 75 corridor in a collaborative manner among all agencies to save the traveler from congestion. For the first time, all agencies will have comparative travel data for freeways, toll roads, arterials streets, and transit. By knowing the fastest way to travel and sharing this with the public, travelers will be able to avoid congestion by traveling on different routes, traveling at different times, or traveling by transit.

Improvements in New Pavement Surfaces

New pavement surfaces can improve safety and improve the environment. Porous friction courses (PFC) are special asphalt mixtures characterized by high air-voids content (i.e., air gaps between the asphalt material) as compared to the most commonly used dense-graded hot mix asphalt. Placed as a surface layer, the PFC mixture reduces the risk of hydroplaning and wet skidding, decreases splash and spray, and improves the visibility of pavement markings in wet weather. These safety benefits (as evident in Figure 2) are realized as water travels through the connected air voids within the pavement layer instead of over the surface.

PFC also serves as a filtering mechanism for storm water runoff. The quality of storm water runoff monitored before and after installation of PFC on a highway in Austin showed a much lower concentration of total suspended solids and pollutants associated with particulate material after installation of the PFC. PFC pavements also provide a significant reduction in traffic noise that is readily and reliably measurable at the roadside and is the primary reason for their increasing use in Europe.

The safety and environmental benefits associated with PFC result from the high-air voids in the pavement layer which allow for water and air to infiltrate and move through this layer. These same characteristics also have the potential to reduce the life of the pavement surface by causing oxidative aging of the asphalt binder (causing brittleness and stone loss in the surface) or by the action of water with traffic destroying the bond between the asphalt binder and the stone (leading to potholes) or destroying the bond of the PFC layer to the underlying surface (causing delamination or separation of the pavement material). TTI has an extensive, ongoing research effort aimed at optimizing the mix design and construction practices for PFC, as well as characterizing the properties of the asphalt binder and stone which are needed to guarantee the safety and environmental functionality without sacrificing durability.

Figure 2. Porous Friction Course Surface (left) Compared to Conventional Surface (right) After a Rain Storm.

Improvement in Pavement Construction

Warm mix asphalt pavement technology can reduce air pollution and save energy. Traditional hot-mix asphalt is typically produced in either batch or drum mix plants at temperatures ranging from 280°F to 325°F. It has been necessary to use these elevated temperatures to dry the aggregates, coat them with the asphalt binder, achieve the desired workability, and provide sufficient time to compact the HMA mat. A new technology, warm mix asphalt can reduce the production temperature to as low as 200°F. This reduction in both production (mixing) and paving (compaction) temperatures yields beneficial environmental effects:

- decreased fuel or energy consumption at the plant;
- reduced emissions and odors from plants; and
- improved working conditions at the paving site.

While preliminary field trials (Figure 3) have indicated that these mixtures perform as well as conventional mixes, the technology is in its infancy and some of the laboratory tests that engineers use to predict performance indicate a cause for concern. The warm mix asphalt tends to exhibit lower strength and a propensity for moisture susceptibility in laboratory tests. TTI is conducting a comprehensive field and laboratory study to ensure that the improved benefits of warm mix asphalt do not cause a sacrifice in pavement performance.

Figure 3. WMA Field Trials in Lufkin, Texas.

Environmental Management in Construction

When examining the impact of our surface transportation infrastructure on water quality, one should keep these numbers in mind:

- *1 soil* – is the number one pollutant of receiving waters
- *2 acres* – the size of a stormwater runoff oil slick created by a quart of motor oil
- *3 million dollars* – the largest stormwater fine ever assessed by EPA was levied on Wal-Mart for runoff violations at construction sites across the country
- *4 metals* – lead, mercury, iron, manganese can be found in runoff
- *5 pollution prevention benefits of vegetation* – includes protecting soil from the impact of raindrops, slowing down storm water runoff, anchoring soil in place, intercepting soil before it runs off, increasing filtration rate of soil

Roadway Grasses: A Marriage of Function and Beauty

Grass. It isn't just for mowing anymore.

In fact, the sometimes lush and pretty patches along roadways are an important frontline defense in the battle to improve water quality. But which varieties work best? For example, which seed mix of grasses will stand up to brutal Texas weather and regimented mowing heights? And just how much grass is needed to effectively filter roadway stormwater runoff?

The Texas Department of Transportation (TxDOT) sponsored a study conducted by the Texas Transportation Institute (TTI) studying these very questions.

The native alternative

While the concept of using native seed sounds great, two things need to be considered in its use, however. Number one, when a contractor goes in and strips off the soil, gets it down to subgrade, pours concrete and does everything else you have to do to build a road—you no longer have a native environment. Number two, in their natural environment, native seeds are left alone and

allowed to grow. But highway rights-of-way are mowed 3 or 4 times per year. This changes the development of the native vegetation.

In a research project which concluded in August of 2005, researchers studied native seed species along with the standard, TxDOT-approved seed mix. Using soil samples taken from Austin, Abilene, Lufkin and Corpus Christi, TTI researchers tested the different seed mixes at greenhouse facilities and outdoor laboratories.

In addition, test plots were planted in Georgetown, north of Austin, using both commercially available native seed mixes and the standard TxDOT seed mix. Researchers also monitored a second set of test plots at TTI's Erosion Control Laboratory on the Riverside campus.

The laboratory at TTI is a unique testing facility that helps us cut down on research costs and yet still conduct accurate testing. One section of the test plots was mowed according to TxDOT specifications and the typical mowing schedule. This ensured that the performance of the seed mixes is evaluated under the normal conditions grasses would encounter along roadways.

Vegetation along roadways plays an essential role in stabilizing soil banks, stemming erosion and protecting habitats and waterways from too much sediment. Beyond beauty, this is ultimately grass' most important function.

Grass filters

Most environmental researchers agree that sediment is the number one pollutant of receiving waters. While some techniques, like construction sequencing, can help minimize sediment runoff during construction, establishing vegetation is the single most important step toward protecting waterways from harmful runoff.

Water streaming off the hard-packed surface of roads can grab sediment and pick up heavy metals and organic compounds (like motor oil), and would eventually deposit such sediment in pipes, drainage systems and water bodies were it not for one potent defense mechanism along roads: grassy filters.

The premise of this research was to study how vegetative buffer strips affect runoff from highways. Preliminary findings show that the more grass water runs through, the cleaner it gets. Leaving vegetation buffer strips near roads is a good management practice.

To study how effective grassy strips are at filtering runoff, researchers buried 30-foot lengths of 8-inch PVC pipe at 2, 4, and 8 meters from roadway pavement edges along Hwy 6 in College Station, Texas, and Hwy 360 in Austin. Rainwater is collected during test periods and is then sent to the Lower Colorado River Authority in Austin for chemical analysis.

Research into how vegetated roadside swales (shallow depressions that carry water mainly during rainstorms) can function to filter storm water runoff, reduce the need for end-of-channel water quality structures, and improve the overall quality of runoff from the highway system is important. Understanding the properties of and having good documentation of roadside water

quality performance can potentially reduce the cost and size of end-of-channel water quality structures on the highway system. The results of this project showed that up to a certain distance, grass can be quite effective at trapping and filtering sediment.

Introducing Native Plant Life to Roadsides

Traveling down the highway can be tedious—miles and miles of road, tens of thousands of lane markers and traffic signs. Sometimes the scenery is the only thing that keeps you awake. But the Texas Department of Transportation (TxDOT) sponsored a study conducted by the Texas Transportation Institute (TTI) to use native plants to recreate the visual character of the regional native landscape. Prior to this time, the typical approach to interchange landscape design was to create a park-like setting dominated by canopy trees. Maintenance required mowing the area at the same frequency as other sections of corridor.

This project explored the use of local plants in landscaping the roadside rather than using a one-size-fits-all approach. This would not only give the roadside a 'local look,' but would also facilitate the growth and maintenance of the landscaped area by using plant life native to the area.

An interchange in Austin was used as the test case. A context-sensitive design was used to enhance both the local community and the natural environment. Located in an urban area amid office buildings and shopping centers, the interchange presented some design challenges. TxDOT wanted to reduce maintenance while developing a publicly acceptable landscape aesthetic. The first three goals of the design plan were established as eliminating the need for hand maintenance wherever possible, especially near travel lanes, preventing erosion on slopes and improving the appearance and maintainability of the detention ponds.

Researchers worked with various stakeholders—City of Austin Parks Department representatives, representatives of the Lady Bird Johnson Wildflower Research Center, the Texas Parks and Wildlife Department, and representatives of local, grassroots environmental programs—to finalize the site design.

Water quality was identified as the key environmental issue since so much water flowed through the site. The plan called for enhancing the siltation function of the ponds by installing a rock filter dam and reducing mowing. The aesthetic goal was to recreate the visual character and, as much as possible, the ecological character of the Texas Hill Country live oak savanna.

Aesthetically, the site today resembles some commonly seen rural landscapes of native plant communities. The new maintenance schedule reduces the frequency of mowing, which, in turn, reduces management costs to TxDOT and taxpayers.

This project demonstrated that we can improve maintenance, make the roadside look better, reduce erosion, and improve the environment for native plants and wildlife, even in urban areas.

Future Research Needs and Federal Role

The Green Transportation Infrastructure initiative is bold idea that will impact how surface transportation is designed, built, and operated. Thus, it is imperative that the industry fully understand the benefits of "going Green." There is significant research needed to fully explore the impact and benefit that will result from Green Transportation implementation. The research must take a holistic approach to ensure direct benefits and secondary benefits are fully analyzed.

Furthermore, once the relationships between Green Transportation strategies and the resultant impact are known, this information must get into the hands of transportation design and construction industry. Research is only as good as the ones implementing it. The university transportation center network has well established processes and delivery methods to disseminate and train the transportation industry.

The research and academic community has not always had direct input into setting the research agenda at the federal and state level. To ensure that Green Transportation Infrastructure builds on successful past research and truly addresses gaps in research going forward it is imperative that the academic community has input. The University Transportation Centers have successfully created the environment where academia and industry can collaboratively set research agendas.