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16. Abstract

This research project was established by TxDOT's Research and Technology Implementation Office to address special studies required by the department's Administration during FY 2014. One task was undertaken, and is documented in this report.

17. Key Words Air Transportation in Texas, Autonomous Vehicles in Texas, North Carolina's Strategic Mobility Formula, Oregon's Voluntary Road User Charge Program, Potential Use of Highway Rights-of-Way for Oil and Natural Gas Pipelines, State Energy Severance Taxes and Comparative Tax Revenues, U.S.-Mexico Transportation and Logistics	18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161; www.ntis.gov.

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CENTER FOR TRANSPORTATION RESEARCH

RTI Special Studies for TxDOT Administration in FY 2014

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Acknowledgments

This is the last report for this project, which spanned six years and addressed a wide variety of topics, as documented each year in an annual report. The authors would like to express their thanks to Rick Collins, former Director of TxDOT's Research and Technology Implementation Office, and his staff, for developing and supporting this innovative research project. The authors would also like to acknowledge the inputs provided by staff from several TxDOT districts and divisions, who always responded promptly to requests for data as each work task evolved each year.

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Introduction

Background

This research project was established by the Texas Department of Transportation's (TxDOT) Research and Technology Implementation Office (RTI) in fiscal year (FY) 2009 and renewed in FYs 2011–2014 to evaluate transportation issues as requested by TxDOT's Administration, and develop findings and/or recommendations. The project was structured as a *rapid response* contract for two reasons:

1) Transportation research needs are sometimes identified in a manner necessitating a quick response that does not fit into the normal research program planning cycle, and
2) Individual transportation research needs are not always sufficiently large enough to justify funding as stand-alone research projects, even though the issue may be an important one.

The Center for Transportation Research (CTR) contracted with RTI to provide rapid response teams when work requests came from TxDOT's administration. Task teams were assembled based on the technical requirements in each case, and worked independently of other task teams. Each team coordinated directly with the administration member requesting the study, submitting technical memorandums for the task to provide TxDOT with implementation information in a timely manner. This report combines the various technical memoranda completed in FY 2014 for easy reference, and is a follow-up to Reports 0-6581-1, -2, -3, -4, and -6, which documented the work completed in FYs 2009, 2010, 2011, 2012, and 2013, respectively, and a special report 0-6581-5 compiled in December 2012 to comprehensively document Task 12. This is the last report for this project, which terminated in August 2014.

Innovative Research Project

The traditional TxDOT research program planning cycle requires about a year to plan a research project and at least a year to conduct and report the results. With respect to some transportation issues, this type of program is best suited to addressing large, longer-range issues where an implementation decision can wait for 2 or more years for the research results. In recent years, the need for quick response to district engineers, TxDOT administration, elected officials, and public concerns has become more pressing, as information regarding ordinances, legislation, revenue forecasting, mobility, traffic control devices, intermodal systems, material performance, safety, and every aspect of transportation has become more critical to decision-making. When these initiatives are initially proposed, TxDOT has a very limited time in which to respond to the concept. While the advantages and disadvantages of a specific initiative may be apparent, there may not be specific data upon which to base the response. Due to the limited available time, such data cannot be developed within the traditional research program planning cycle.

As a result of these factors (smaller scope, shorter service life, lower capital costs, and the typical research program planning cycle), some transportation research needs are not addressed in the traditional research program because they do not justify being addressed in a stand-alone project that addresses only one issue. This research project was developed to address these types of research needs.

This type of research contract is important because it provides TxDOT with capabilities to accomplish the following:

1. Address important issues that are not sufficiently large enough (either funding- or duration-wise) to justify research funding as a stand-alone project.
2. Respond to issues in a timely manner by modifying the research work plan at any time to add or delete activities (subject to standard contract modification procedures).
3. Effectively respond to legislative initiatives.
4. Address numerous issues within the scope of a single project.
5. Address many research needs.
6. Conduct preliminary evaluations of performance issues to determine the need for a full-scale (or stand-alone) research effort.

Research Tasks

The following task was undertaken in the period September 2013 to August 2014:

Task 19 (FY 2014): Examining the Merits of Various State Initiatives to Ascertain Their Relevance and Applicability to the State of Texas

The objective of this task was to support a Policy Research Project (PRP) to be conducted by the Lyndon B. Johnson School of Public Affairs at The University of Texas at Austin (LBJ). LBJ has established interdisciplinary research on policy problems as the core of its educational program. A major part of this program is the nine-month policy research project (PRP), in the course of which two or more faculty members from different disciplines direct the research of 10 to 20 graduate students of diverse backgrounds on a policy issue of concern to a government or nonprofit agency.

During the 2013–2014 academic year, under this research project TxDOT funded, through the Center for Transportation Research (CTR), a PRP addressing seven key policy issues. This task was requested by Mr. Phil Wilson, at that time TxDOT Executive Director. The sub-tasks outlined below were based on a discussion on June 3, 2013 between Mr. Wilson and Leigh Boske of LBJ and Rob Harrison of CTR. This work plan was subject to change upon Mr. Wilson's direction as the work proceeded.

The following initiatives were agreed with Mr. Wilson:

Sub-task 19.1. Evaluate the following topics, brief Mr. Wilson, and follow up on the priorities he identified:

a. Road User Maintenance Agreements (RUMAs)
   Update developments in the implementation of RUMAs in other energy shale plays, capture any changes to make them more effective or efficient, and identify any economic analysis undertaken to measure the fiscal impacts.
b. Prioritization of Projects for Tiered Maintenance – Rural vs. Urban
   Review the literature on ranking the wide variety of maintenance strategies facing those regions impacted by energy exploration. The amount of additional funding, its allocation

between urban and rural areas, or perhaps the on- and off-systems—TxDOT vs. counties/cities—and the basis for project selection need to be described.

c. Impacts of Air Cargo Transport on Local Economic Development and Surface Transport Infrastructure
   Air cargo represents a significant portion of U.S. domestic and international freight by value yet it is not featured in TxDOT freight planning. This may be because planes generally land in metropolitan areas and impact urban flows. Nevertheless, it deserves a place in strategic analysis considering constrained budgets. As an example, air freight forms services clustered near the airport, which allows infrastructure improvements to be targeted on small, but critical, links in the highway system.
d. Innovative State Strategic Planning Approaches, such as that launched by the Connecticut DOT, called Transform CT, to address issues related to transport policies, programs, and projects. It is intended to improve economic growth and state competitiveness, build sustainability, and provide a blue print for a world-class transport system.
e. Innovative State Funding Distribution Methods for State and Federal Transport Dollars, such as North Carolina's "Strategic Mobility Formula." North Carolina Governor Pat McCrory signed a bill into law that creates a new distribution method for state and federal revenues that is designed to relieve traffic congestion and create jobs. It would allocate 40 percent of construction monies on projects of state-wide significance, 30 percent divided regionally on the basis of population, and would prioritize projects on economic merit.

Sub-task 19.2: Conduct research according to the guidance provided by Mr. Wilson in Sub-Task 19.1.

Collect the level of detail requested by TxDOT senior administration regarding implementation effectiveness and improvements needed. The research team interacted with TxDOT officials throughout the course of the academic year. Overall direction and guidance was provided by Mr. Wilson. Mr. Wilson participated in an October 2013 workshop to determine the scope of the study. As a consequence, the following policy issues were selected for study:

- Air transportation in Texas
- Autonomous vehicles in Texas
- North Carolina's Strategic Mobility Formula
- Oregon's Voluntary Road User Charge Program
- Potential use of highway rights-of-way for oil and natural gas pipelines
- State energy severance taxes and comparative tax revenues
- U.S.-Mexico transportation and logistics

Sub-task 19.3: Complete PRP briefs and final report.

Brief the TxDOT Administration and submit a final report. TxDOT personnel were invited as guest speakers to the Policy Research Project (PRP) course conducted at the LBJ School of Public Affairs during the 2013–14 academic year to discuss the issues under study.

The research team completed and documented the results of this work. The findings of each policy issue were presented within the context of separate transportation policy briefs.

The following template was approved for each of the briefs:

- Executive Summary

- Background
- Key Issues
- Lessons Learned
- Relevance to Texas
- Appendices

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TxDOT Participants

This policy research project would not have been possible without the generous contributions of assistance from numerous individuals and organizations. As previously mentioned, overall direction and guidance was provided by Mr. Phil Wilson, former Executive Director of TxDOT. The research team is also indebted to the following TxDOT officials for participating in weekly class presentations or scheduled interviews, sharing information and data, and suggesting useful contacts:

- John Barton, P.E., Deputy Executive Director/Chief Engineer
- James Bass, Chief Financial Officer
- Oliver "Jay" Bond, Legislative Liaison, State Legislative Affairs Office
- Jessica Butler, Unified Transportation Program Coordinator
- Shannon Crum, Ph.D., Director, Research and Technology Implementation Office
- Will Etheredge, Financial Analyst, Finance Division
- David Fulton, Director, Aviation Division
- Jerry Haddican, J.D., Director, State Legislative Affairs Office
- Caroline Mays, Freight Planning Branch Manager
- Peggy Thurin, Systems Planning Branch Manager
- Lanny Wadle, Deputy Director, Finance Division
- Marc Williams, P.E., Director of Planning

Organization of This Report

This section presented the background and justification for this research effort, and summarized the research undertaken. At different stages of the work the research team submitted technical memoranda and presentations to TxDOT.

Seven policy briefs were completed under Task 19, and were presented to TxDOT Administration and the new Executive Director. This report combines the policy briefs for easy reference. The seven policy briefs are presented individually in Volumes 1 through 7 of this report. Conclusions and recommendations are contained within each volume.

Transportation Policy Brief #1

Air Transportation in Texas

kut.org

infrastructure-intelligence.com

TxDOT 0-6581-Task 19-1

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Center for Transportation Research

Volume 1. Transportation Policy Brief #1: Air Transportation in Texas

1.1 Introduction

This particular policy brief, "Air Transportation in Texas," was researched and written by Paul Gainey, Miranda Hoff, Kevin Merrill, and Vance Roper. The authors are particularly indebted to Mr. Phil Ritter, former Executive Vice President of the Dallas/Ft. Worth International Airport and current Chief Operating Officer of Meadows Mental Health Policy Institute, for providing contacts, class lectures, background information, and insight about air transportation in Texas.

1.2 Executive Summary

Aviation in Texas is a multi-billion dollar industry that includes both general and commercial air transportation. We examined both for this report and identified the following:

- **Economic impact of general aviation airports**: Texas has approximately 270 general aviation (GA) airports spread across the state. This network of airports works to meet the needs of businesses, commercial cargo transporters, and leisure travelers; the GA industry creates approximately $14 billion in economic impact and generates 60,000 jobs.[1]
- **Global hubs**: Continuing to provide an environment that encourages expansion of the commercial aviation industry will benefit the state through economic development and job creation.
- **Industry best practices**: To grow and expand their service offerings, GA airports could benefit from implementing industry best practices, including diversifying revenue streams, employing onsite management, building terminal space, providing hangar space, and offering fuel services.
- **Coordinated marketing**: By developing coordinated marketing and outreach efforts, GA airports and communities can work together to draw in new travelers and businesses. Increasing traffic to the communities may help to spur economic development.
- **Aligning stakeholders**: Aligning stakeholders is a crucial step towards long-term planning and sustainability for GA airports.
- **Airport Visit Reward Program:** Developing a program that encourages and incentivizes travel to GA airports has the potential to increases revenue for the GA airports.

TxDOT is uniquely positioned to help influence the aviation industry in Texas. With its strong focus on GA, TxDOT can work to promote the industry to help it maintain its positive economic impacts on the state. Additionally, TxDOT can advocate on behalf of the commercial airports to bring attention to policies that are negatively impacting the state.

[1] Fulton, 2013.

1.3 Background

General aviation (GA) includes all non-commercial air transportation and operations. Texas is home to one of the largest GA systems in the country with nearly 270 non-commercial airports.[2] In general, there are two types of GA airports: those located in more densely populated urban areas and those in less populated rural areas. Traffic at urban airports primarily includes business travel, cargo, and tourism. Whether transporting people or cargo, urban GA airports provide flexibility that is not afforded by commercial travel. This flexibility helps to increase productivity and drive positive economic growth. Rural GA airports, on the other hand, primarily provide critical access to basic services for residents. These services include access for law enforcement, emergency medical personnel, air charters, essential air cargo, and tourism. Together, urban and rural airports provide much-needed access for businesses and residents all across Texas.

In order to provide this access, the State of Texas currently invests $16 million annually in GA activities. Through a cost-sharing program, Texas receives an additional $55 million in federal dollars and $8 million in local dollars. These funds are pooled and distributed through grant programs administered by TxDOT's Aviation Division.[3] The grant programs help local communities build and enhance their GA airports. Whether through building new hangars or towers, repaving runways, or enhancing the automated weather observation system, these grants help to improve the operations and activities at GA airports across the state.

This report will explore the economic impact of these investments, identify industry best practices, and provide an outline for TxDOT's evolving role with aviation.

1.4 Key Policy Issues

The following sections outline the positive economic impacts generated by GA and provide insight into the potential role for state transportation agencies in working with commercial airports and global hubs. TxDOT plays a direct and significant role in GA, and thus should be aware of the policy issues associated with Texas' consumer aviation airports.

1.4.1 Economic Impact from General Aviation

State air transportation officials often face misperceptions of the GA industry and services. The image of a corporate executive flying in a private plane from meeting to meeting does not typically evoke positive reactions from the general public. As a result, GA airports are often minimally funded in comparison to other modes of transportation and the issues facing these entities are frequently placed on the backburner for policymakers. As this report will show, however, both urban and rural GA airports produce significant economic value for the communities (and states) in which they reside and this positive value can be increased through implementation of industry best practices.

The impact of GA airports is not limited to the operations and activities of the airport alone. GA airports have both direct and indirect effects on a state's economy by increasing jobs, facilitating

[2] Texas Department of Transportation, 2010.
[3] TxDOT Aviation Division, 2013.

commerce, and fostering tourism activities. During a December 2013 U.S. House of Representatives hearing, Representative Frank LoBiondo, chairman of the House Subcommittee on Aviation, highlighted the positive effects of GA:

> It is an understatement to say that aviation is a key sector of the U.S. economy. Commercial aviation represents five percent of our gross domestic product and roughly ten million American jobs. General aviation (GA) contributes about $150 billion to the economy and supports roughly 1.2 million jobs.[4]

In Texas, GA generates $14 billion annually and produces nearly 60,000 jobs.[5] Texans are "affected daily, in some way, by general aviation," and it will continue to play a "significant role in the future health, well-being, and economic prosperity of our state."[6] The following subsections examine the economic impacts of GA through business aviation, commercial cargo, and tourism.

Business Aviation

For purposes of this report, business aviation refers to using GA airports (as opposed to commercial airports) for business purposes. According to the National Business Aviation Association, business aviation accounts for 80% of the economic impacts generated by GA.[7] Providing ready access to aircraft gives businesses the flexibility that they need to be more efficient and effective, which in turn can lead to higher profits and greater economic impact in the states and communities in which these businesses reside.

A study conducted by Andersen Consulting found that it is the flexibility provided by GA that produces the greatest value for businesses. "Being able to control the aircraft's schedule and routes" enables employees to travel to "their own facilities or those of customers/suppliers" at a greater rate than those businesses that do not use GA.[8] Using GA provides greater control over the aircraft's schedule, which helps keep businesses moving. The effects of the 2013–2014 winter evince the value of being able to control the schedules: the more than 1 million cancelled or delayed commercial flights this past winter are estimated to have resulted in nearly "$5.3 billion in lost productivity" nationwide.[9]

In Texas, businesses like Valero Energy have come to rely on GA and GA airports to keep their businesses moving forward. In February 2013, John White, Vice President of Aviation for Valero Energy and the president of Texans for General Aviation, helped to showcase GA for Texas legislators.[10] Businesses of all sizes can benefit from the service offerings provided by GA. These benefits often translate to increased productivity, which in turn can lead to increased opportunities and economic growth for communities and states.

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[4] LoBiondo, 2013.
[5] Fulton, 2013.
[6] Ibid.
[7] National Business Aviation Association, 2014.
[8] Andersen Consulting, 2001.
[9] Isidore, 2014.
[10] Texans for General Aviation, 2013.

Commercial Cargo

In Texas and across the country, noncommercial airports play a role in facilitating commerce through the transport of commercial cargo. As defined by the Federal Aviation Administration (FAA), non-commercial airports include cargo service only airports, reliever airports, and GA airports. The FAA's definition for each of these airports is included in Appendix 7. In addition to defining airports, the FAA also tracks passenger boarding and all-cargo data. The data show the Fort Worth Alliance Airport ranks 36th nationally in total weight landed in 2012.[11] Additionally, according to the data, U.S. non-commercial airports handled more than 157 billion pounds of cargo weight in 2012.[12]

The transport of cargo represents a vital revenue source for non-commercial airports. Typically, urban GA airports see greater cargo traffic. As shown in Figure 1.1, most of the top-performing non-commercial airports are located in or near large metropolitan areas.[13] These population centers tend to have strong multi-modal transportation infrastructure, including roads and access to rail that helps to move cargo efficiently and effectively to other population centers across the country.

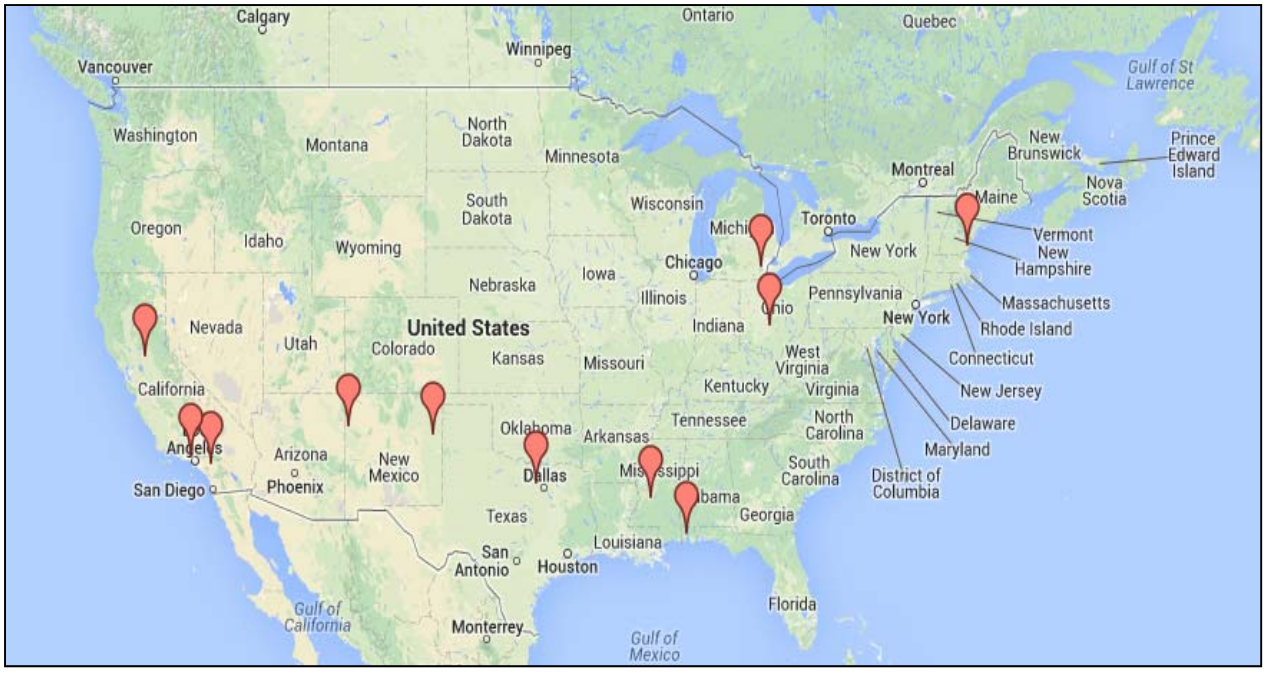

Figure 1.1: Map of Top Cargo Transporting Non-Commercial Airports

[11] Federal Aviation Administration, 2013.
[12] Ibid.
[13] Ibid.

Tourism

In addition to business and cargo traffic, GA airports in urban and rural communities serve the needs of private pilots and hobbyists. This air tourism can be seen as an evolution of the leisurely Sunday drive. Private pilots and hobbyists take short trips to cities and towns to see local attractions and take advantage of offerings at local GA airports.

In order to attract this type of tourism, urban and rural GA airports focus on providing wide-ranging amenities typically including free Wi-Fi, meeting spaces, and coffee. Many airports also provide more elaborate amenities such as red carpet entrances and courtesy cars.[14] The airports also host events such as air shows and seminars that are designed to draw in more travelers who are willing to spend time and money at the airport and in the community. In Texas, a 2011 study shows that the average GA airport visitor spends $190 per day per visit to a GA airport.[15] This helps to contribute to the positive economic impact of GA airports across the state as well as nationwide.

In the past, one of the more difficult tasks for urban and rural GA airports was to market themselves and advertise the amenities and events that they offer. But with the rise of social media and smartphone applications, spreading information has become a much easier task. For example, the introduction of the smartphone application SocialFlight, which is available on iTunes and Google Play, provides real-time schedules to pilots outlining the "aircraft fly-ins, air shows, pancake breakfasts, conventions, [and] FAA safety seminars" that are held exclusively at GA airports.[16] Users are also able to update the application's database with new events and reviews and provide a new method for GA airports and their communities and states to market them.

1.5 Texas Global Hubs

Texas' commercial aviation and global hub airports can directly affect Texans' lives every day by providing access to new destinations or through the direct spending of travelers visiting Texas destinations. The international hubs, in particular, help to facilitate substantial economic benefit for the state. These global hubs also provide the U.S. with a critical component to the national air network by providing a key gateway to destinations around the world.

This section will address the importance of Texas global hubs to the national and international air network, the economic benefit and potential that global hubs offer, and the potential pilot projects that TxDOT could endorse to bolster the success of aviation across the state.

1.5.1 Texas' Position in the National and Global Air Network

Texas' global hubs are involved in more than 150 domestic non-stop routes and host an extensive international route network spanning six continents.[17] As a southern border state with

[14] Preusch, 2007.
[15] Center for Economic Development and Research, 2011.
[16] Where2Interactive, 2014.
[17] Dallas/Fort Worth International Airport, 2013a.

strong ties to international business, international air traffic is a top priority and key economic driver for Texas. As a result, international hubs within the state have increased and expanded travel into and out of the state. For example, the Dallas/Fort Worth International Airport (DFW) provides the domestic air transit system with a critical port in the south-central region of the country. Additionally, Bush Intercontinental Airport in Houston provides the most non-stop flights to Mexico at any time and serves as the "primary gateway to Latin America" for U.S. citizens and international travelers.[18] The Houston airport system provides passengers with 116 domestic routes and over 70 international routes.[19]

1.5.2 Economic Benefit and Potential for Future Growth

Texas' global hubs have generated billions of dollars for the state economy through international air service. The economic impact of new international air service not only boosts revenues for the state's global hubs, but it can also provide a positive economic impact to local businesses and industry. Passenger spending and international freight services increase with every expansion of Texas' international air service.[20] In the Dallas-Fort Worth metroplex, international air service into and out of DFW generated about $1.21 billion in 2010.[21] The economic impact from international air service into and out of Bush Intercontinental saw an even greater impact for the Houston area generating $3.4 billion 2011.[22]

Texas' global hubs will continue to compete for this significant economic impact due to the increased demand for international air service. As noted by the Metropolitan Policy Program at Brookings, "Since 2003, international air travel grew between the United States and every global region, with the strongest growth coming from emerging markets."[23]

TxDOT can encourage both global hubs and smaller commercial airports within the state to expand into international air service market. Any expansion would bring an increased economic benefit to the region and to the state. In fact, each additional route added to Texas' international air service network is projected to be "worth $40–$140 million annually without local spending."[24] The high economic benefits coupled with the competitiveness of the aviation industry indicate the importance of Texas maintaining its status a global leader in aviation.

1.5.3 Recapturing Lost Markets: Automation

Due to security concerns prompted after 9/11, the Department of Homeland Security suspended the Transit without Visa and International-to-International programs. The purpose of these programs was to grant foreign nationals the ability to transit through a U.S. airport on a foreign-to-foreign itinerary without the need for a non-immigrant U.S. visa.[25] Since the suspension in

[18] Houston Visitors Bureau, 2013.
[19] Ibid.
[20] Dallas/Fort Worth International Airport, 2010.
[21] Dallas/Fort Worth International Airport, 2013a.
[22] GRA, Incorporated, 2011.
[23] Tomer et al., 2012.
[24] Dallas/Fort Worth International Airport, 2010.
[25] Dallas/Fort Worth International Airport, 2013b.

2003, U.S. airports have lost an estimated 1 million passengers per year.[26] These lost passengers choose to transit through foreign airports despite higher costs. New businesses have popped up that are dedicated to helping international passengers avoid traveling through the U.S. because of the now-required security measurements.[27] Under the current regulations, international travelers, even those from Visa Waiver Program (VWP) countries, are required to pass through U.S. Customs and Border Protection upon U.S. arrival, regardless of final destination. Non-VWP countries must go a step further and secure a U.S. Visa to transit through a U.S. airport.[28] These policies deter potential customers from using Texas' global hubs, and are unnecessarily burdensome for Texas' business partners in countries like Brazil, China, and the Middle East.

International travel is the fastest-growing and highest-value segment of U.S. air travel. Texas, because of its global hub infrastructure and central location, is being held back by federal customs and immigration regulations. While a tenuous connection exists between TxDOT and the agencies responsible for these policies, TxDOT could work as a unified voice for aviation transportation interests in the state.

Since the federal level security adjustments, some pilot programs have been launched to ease the burden of transiting through U.S. global hubs. One such program at DFW allows travelers from VWP countries to have their checked baggage transferred directly to their final destination flight without an inspection from U.S. Customs and Border Protection.[29] These pilot programs could be pushed beyond just baggage—VWP and trusted traveler programs could be explored for some of Texas' most trusted business partners. With the availability of new automated technology and more personnel, Texas' global hubs have the capability to process international travelers faster without sacrificing security. TxDOT could advocate for this positive change by highlighting the positive economic impact that can be generated without sacrificing security for the country.

1.6 Lessons Learned

This section provides an overview of the key lessons learned related to improving and strengthening the aviation industry in Texas. These lessons examine the effectiveness of implementing industry best practices, coordinating marketing efforts and aligning stakeholder groups, and developing and implementing travel incentive programs.

1.6.1 Industry Best Practices

In any industry, implementing best practices can help to improve efficiencies and increase productivity. Aviation is no exception. GA airports in both rural and urban settings can look to the established best practices at major airport hubs to identify ways to improve airport functions and efficiency. These best practices include the following:

- Identifying new revenue streams
- Employing onsite management
- Building and maintaining terminal buildings

[26] Dallas/Fort Worth International Airport, 2010.
[27] Ibid.
[28] DFW International Airport, 2013b.
[29] Ibid.

- Providing hangar space
- Offering fuel services

Many of these best practices will help to create new revenue streams to augment the typical airport functions. According to a study by the North Central Texas Council on Governments, "At GA airports, development of landside facilities, such as hangars for aircraft storage and terminal buildings offer significant upside potential for generating revenue…if the market for such space is healthy."[30] These types of revenue streams can help sustain GA airports and facilitate growth.

Identifying New Revenue Streams

For any airport to remain viable, it must have sustainable aviation and non-aviation revenue streams. According to the Transportation Research Board of the National Academies, "Revenue diversification…can also be an effective risk mitigation strategy. Airports can engage directly (or partner with third parties) in non-aeronautical activities…airports can reduce the systemic revenue uncertainty associated with the air travel industry".[31] These revenue streams can include sales of food, merchandise, and professional development services. The diversification of revenue can smooth unexpected fluctuations in business and passenger traffic.

Many GA airports have adopted this with the addition of onsite diners and professional development opportunities through trainings and seminars. Implementing this at GA airports can help to increase revenues and reduce the reliance on state funding for sustainability.

Employing Onsite Management

The seemingly simple act of employing onsite management can be a major draw for businesses that use GA airports. Having onsite management indicates that the airport is ready and prepared to address the needs of businesses and that the airport will be maintained in an appropriate manner. If a business is going to invest in a region long-term, they need to have assurances that the airport can handle the travel and needs of the business well into the future.[32] Onsite management helps to provide this assurance to businesses that use GA airports.

Building and Maintaining Terminal Buildings

GA airports can also explore the use of improved terminal buildings as a way to improve the airport offerings. Terminal buildings not only help to facilitate baggage handling, but also provide passengers with access to merchants and ample, comfortable waiting spaces.[33] Having terminal buildings at GA airports can help to facilitate an increase in passenger and business traffic by providing more spaces for the passengers and business travelers.

When a GA airport is ready to develop and build terminal space, the design is crucial. As outlined by the Transportation Research Board of the National Academies, "Linear terminal

[30] North Central Texas Council of Governments, 2013.
[31] Transportation Research Board of the National Academies, 2012.
[32] Fulton, 2013.
[33] Graf, 2013.

design and centralized processing facilities…Allows the greatest flexibility for airport expansion. It also allows flexibility in the face of changing traffic mix."[34] These guidelines, which are implemented at many major hubs, would allow GA airports the necessary flexibility to respond as the needs of the groups it serves change.

Providing Hangar Space

Hangar space for private and corporate airplanes is a major source of revenue for global hub airports. Hangars are seen in abundance at major airport hubs including the Dallas/Fort Worth International Airport and Bush Intercontinental Airport. As noted by the North Central Texas Council of Governments, "For many airports, hangar leases offer an excellent source of steady revenue generation. Hangar rental rates can vary by size and type of hangar…The more hangars at your airport, the more potential for revenue generation."[35]

Adding hangar space to GA airports could provide increased revenues as it would create an incentive for both businesses and private plane owners. Hangars allow for businesses and private individuals to securely store their planes while not in use. Storing planes outside leaves them susceptible to the elements, to damage from vandalism, and to theft.[36] Secure, covered space helps to reduce the opportunity for damages to the planes.

In addition to storage benefits, hangars also provide a source of employment and economic development for airports. According to a study by the North Central Texas Council of Governments,

> When the employment benefits and the hangar lease aspects of the operation are included, there is a significant potential revenue impact of attracting corporate aircraft to an airport. Direct revenue impacts have been found to provide up to five on-airport jobs and approximately $1 million in annual economic activity.[37]

This represents an important source of revenue for a GA airport, as well as an important source of economic development for the region surrounding the airport.

Offering Fuel Services

Finally, GA airports can also benefit from the addition of onsite fueling services. According to the North Central Texas Council of Governments,

> A popular trend over the past decade has been the installation of self-service fueling. These systems often allow for fuel purchases 24 hours per day…Quick and convenient fueling systems can make an airport more appealing to users, resulting in higher activity

[34] Transportation Research Board of the National Academies, 2012.
[35] North Central Texas Council of Governments, 2013.
[36] Fulton, 2013.
[37] North Central Texas Council of Governments, 2013.

> levels…one corporate jet based at an airport can add up to 5 direct personnel and require between 1,000 and 1,500 gallons of jet fuel per week.[38]

Unfortunately, fuel services can be difficult for some GA airports to capitalize on due to the high costs of implementation. As noted by North Central Texas Council of Governments, "Traditionally, aircraft…services have been dependent on the airport having a staffed F[ixed] B[ase] O[perator]; this was fiscally challenging for lower-activity airports."[39] One workaround for this is to bring in third-party operators to run the fuel services for the airport. This approach places the costs on the private industry while increasing the traffic and revenue at the GA airport.

1.6.2 Coordinated Marketing and Outreach

Both global hub and GA airports in Texas could benefit from a coordinated marketing and outreach program. Marketing and outreach have become a major function in most areas of business and society. It increases business traffic and visibility for the product that is being sold. This concept holds true even when the product is a city or a region.

For airports, the coordinated marketing and outreach effort would work to promote the local area, regional area, and the state as a whole. A strong campaign promotes the activities and sights that make the area unique and worth visiting. Items to focus on may include museums, historical landmarks, unique destinations, and local restaurants.

Manchester, United Kingdom provides a strong example of the positive impact of a coordinated marketing and outreach effort. The city coordinates its outreach through a single agency, Marketing Manchester. This agency developed Manchester as a brand. It uses this marketing to increase the visibility and travel traffic through the city. It also treats tourism as a product and focuses all combined industry activities to highlight this. This was all made possible through aligning the marketing in the region to include businesses, chambers of commerce, the tourism industry, and local government.[40] As a result of these efforts, Manchester is becoming well-known as an example of how best to market a destination. Implementation of similar, coordinated efforts could provide positive results for cities and towns across Texas.

1.6.3 Aligning Stakeholders

For an airport to grow and thrive, it needs support from the surrounding community. Without this support, an airport's ability to obtain funding necessary to sustain operations, to accommodate growth, or to address the needs of its travelers is greatly hindered. When community support is strong, well-coordinated activities and campaigns can enable growth and provide lasting investment in the community. This coordination includes actively encouraging businesses to move to the area through incentivized legislation, eased zoning restrictions, and investments in hangar or warehouse space.

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[38] Ibid.
[39] Ibid.
[40] Marketing Manchester, 2014.

Airports have different methods to pursue increased development, including the development of an airport master plan. An airport master plan includes the ideas and viewpoints of relevant stakeholder groups and provides a long-term approach for growth and sustainability. This approach tends to be more effective for larger, more urban airports; however, smaller, rural airports can use these practices to develop planning documents as well.

The first step in the process is identifying the relevant stakeholders. These include local businesses, local governmental officials, state officials, chambers of commerce, and other community leaders. Uniting these stakeholders around the common goal of economic development for the region helps to facilitate the creation of a master plan for the airport. Aligning stakeholders early is helpful; however, the inherent uncertainty surrounding state-funded transportation projects can make stakeholders hesitant to invest in development projects at and around the airport [41] Therefore, the master plan should include a multi-modal transportation approach (e.g., commuter and material railheads, heavy truck access, adequate terminal parking, and loaner transportation) that uses and improves on existing transportation infrastructure. Allowing for airport growth in the master plan is important to enable continued and encouraged use of the airport.

The expansion of the DFW International provides an example of the positive results from stakeholder alignment. As the region grows, existing public roadways surrounding the airport experience increased congestion from traffic into and out of the airport. In 2007, TxDOT released a request for bids for the development of State Highway 121, a new toll road that would connect DFW International to Bonham, Texas. Jim Gandy, President of the Frisco Economic Development Council, served as the liaison aligning all the stakeholders for meetings with DFW International, the 21 affected communities, TxDOT, and the North Texas Tollway Authority. The completion of the new toll road helped to improve DFW International's capacity to serve an entire region while also enabling the airport to continue to grow and expand.

In addition to aligning stakeholders for the development of a master plan, aligning stakeholders is helpful when pursuing funding opportunities. TxDOT administers cost-sharing grant programs that provide funding to GA airports across the state. The program requires that the community apply for funds from TxDOT's Aviation Division; depending on the purpose for the funds, TxDOT will match the local dollars at varying levels. For example, TxDOT matches 100% of local funds provided up to $1 million for terminal buildings and matches at a rate of 90/10 up to $600,000 for hangars and control towers. To date, TxDOT has awarded funds for 42 general terminals and 15 air traffic control towers. The majority of the grants issued by TxDOT are for projects that focus on improving airport safety features, including: deer resistant fencing, security systems, automated fueling stations, automated weather systems, improving runway conditions, signage, and nighttime lighting.[42] These projects have helped to transform previously unsafe airports into vital transportation centers for communities to invest in into the future.

[41] Krikorian, 2013.
[42] Texas Department of Transportation, 2010.

1.6.4 Airport Visit Reward Program

GA airports are located all across the country in both urban and rural areas. The uses for urban and rural GA airports differ quite significantly, with the exception of tourism and recreational travel. Tourism and recreational travel represent a potential revenue-enhancing opportunity for communities and for GA airports.

Providing a properly equipped airport with automated weather service, 24-hour fuel, maintenance, transient parking, and other amenities allows for a safe and enjoyable experience for amateur and veteran pilots alike. Pilots routinely choose destination airports based on unique amenities such as a diner with unique menu offerings, discounted fuel, red carpet welcoming, and other special events. This atmosphere creates an opportunity for GA airports to compete with each other to attract more travelers. Incentivizing travel to all airports across Texas provides adventure and freedom to the pilot, which in turn brings new revenue to communities.

Currently in its ninth year, Virginia has experienced sustained success with its "Aviation Ambassador" program.[43] The program is funded both through state general funds and private donations, with no additional cost to the pilot.[44] The Virginia Department of Transportation encourages recreational pilots to travel to all 66 public airports in exchange for leveled rewards, as denoted in the Participation Levels Table in Appendix 8.[45]

Newly registered pilots receive an Aviation Ambassador Program passport in which they can collect stamps from an airport's fixed base operator when purchasing fuel. Additionally, pilots receive stamps for attending public airshows, completing safety training, visiting aviation-related museums, and attending Virginia's annual aviation conference. This process rewards a pilot for traveling to new airports, advancing their professional development, and joining a community of aviators. Additionally, the program helps airports increase revenue in fuel sales and increases spending in local communities. The program has been a success for Virginia and its 15,000 registered pilots. To date, approximately 2.5% of registered participants have completed the entire program, bringing new business and revenue to each airport. As Virginia's Division of Aviation Public Relations Manager, Betty Wilson, notes,

> Pilots tell us that it has given them a reason to go flying, encouragement to expand the airports they fly to (and to visit those areas for vacations later), a reason to improve their proficiency (short runways, mountainous terrain, low visibility high density altitude conditions, Special Flight Rules Area, etc.), provides an opening to talk with locals at the various airports, and a sense of camaraderie with other Ambassadors.[46]

A similar program could be enacted in Texas, which has more than 270 airports and 49,886 registered pilots as of 2012.[47] If a similar 2.5% participated in the program, over 1,200 pilots would visit all participating airports, with a many visiting new airports for the first time. If Texas

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[43] Virginia Department of Aviation, n.d.
[44] Wilson, 2014.
[45] Virginia Department of Aviation, n.d.
[46] Wilson, 2014.
[47] Federal Aviation Admission, 2012b.

were to use the Virginia program's fee schedule as a model, this program could potentially bring participating airports nearly a quarter of a million dollars in new revenue. Texas could also explore implementing a sustainable funding model that would charge airports for their participation in the program. These annual fees would be designed to cover the cost of program materials, advertising, and administration. Much like the Virginia program, this program has tremendous potential to successfully drive the economic growth of Texas GA airports and their communities.

1.7 Relevance to Texas

With a gross domestic product (GDP) of $8.4 billion and more than 153,000 aviation and aerospace-related workers, the Texas air transportation industry ranked first in the nation GDP and employment.[48] These numbers include commercial air travel, cargo, and GA. As discussed in this report, the key role for GA has been to facilitate commerce and provide basic services to citizens across the state. However, the industry still has significant potential and opportunity to grow further and drive the GDP and employment numbers even higher.

Texas has one of the largest air transportation systems in the country. A robust air transportation system is a draw for businesses, local travelers, and international travelers. Thus, air transportation is a major economic driver for state, regional, and local communities. TxDOT has a role in supporting and highlighting the relevance of Texas air transportation in Texas.

1.7.1 TxDOT's Evolving Role

TxDOT has the opportunity to shape and mold the direction of the aviation industry within the state. Included below are four target areas for TxDOT to explore. Each area provides an opportunity to effect meaningful change across the state.

1.7.2 Economic Impact and Growth

As outlined in this report, aviation (both general and commercial) has significant, positive economic impacts that are felt across the state. From job creation to infrastructure development, aviation is a key component to Texas' continued economic success story.

TxDOT can outline success stories during legislative sessions, enabling legislators to connect with real examples of the positive impact that aviation is having on the state. The record of success also helps to solidify the importance and effectiveness of state funding for aviation. As noted previously, Texas invests $16 million in state dollars annually for GA. That $16 million, combined with additional federal and local dollars, yields $14 billion annual in economic impact.[49]

Additionally, TxDOT can work to implement a travel incentive program for GA airports. This incentive program will help to bring new travelers to GA airports, which will result in more dollars being spent at the airports and their communities. By creating a partnership with GA

[48] Office of the Governor, 2014.
[49] Fulton, 2013.

airports, TxDOT can shift some of the costs to the participating airports, which will reduce the funding liability for the state, but still create a mechanism for the program to be sustainable.

1.7.3 Improved Coordination Efforts

TxDOT also has an opportunity to develop and implement a coordinated marketing effort that showcases GA airports and the communities in which they are located. By leveraging the expertise of other state agencies, like the Governor's Office of Economic Development and Tourism as well as representatives from local communities, TxDOT can develop a strong campaign that will help to draw in businesses and tourists alike.

1.7.4 Funding and Promoting the GA Industry

TxDOT should continue its efforts in the planning, designing, and construction of terminal buildings and hangar spaces at GA airports. Doing so enables these airports to grow and better serve business and leisure travelers. Additionally, by building off the relationships developed during the coordinated marketing and outreach campaigns, TxDOT can work to promote the GA industry across the state, the country, and even internationally. Increasing awareness about the GA system in Texas will help to increase traffic, which in turn will increase the positive economic impact that the industry has on the state.

1.7.5 Infrastructure Development

Finally, TxDOT should continue to work with local communities and businesses on long-term planning efforts to address the infrastructure needs of the state. Texas' population is increasing rapidly, and as a result TxDOT must continue to be prepared to address the changing transportation needs of the state. By working with the local communities and other stakeholder groups, TxDOT can identify gaps within the current infrastructure and develop plans to help alleviate those gaps.

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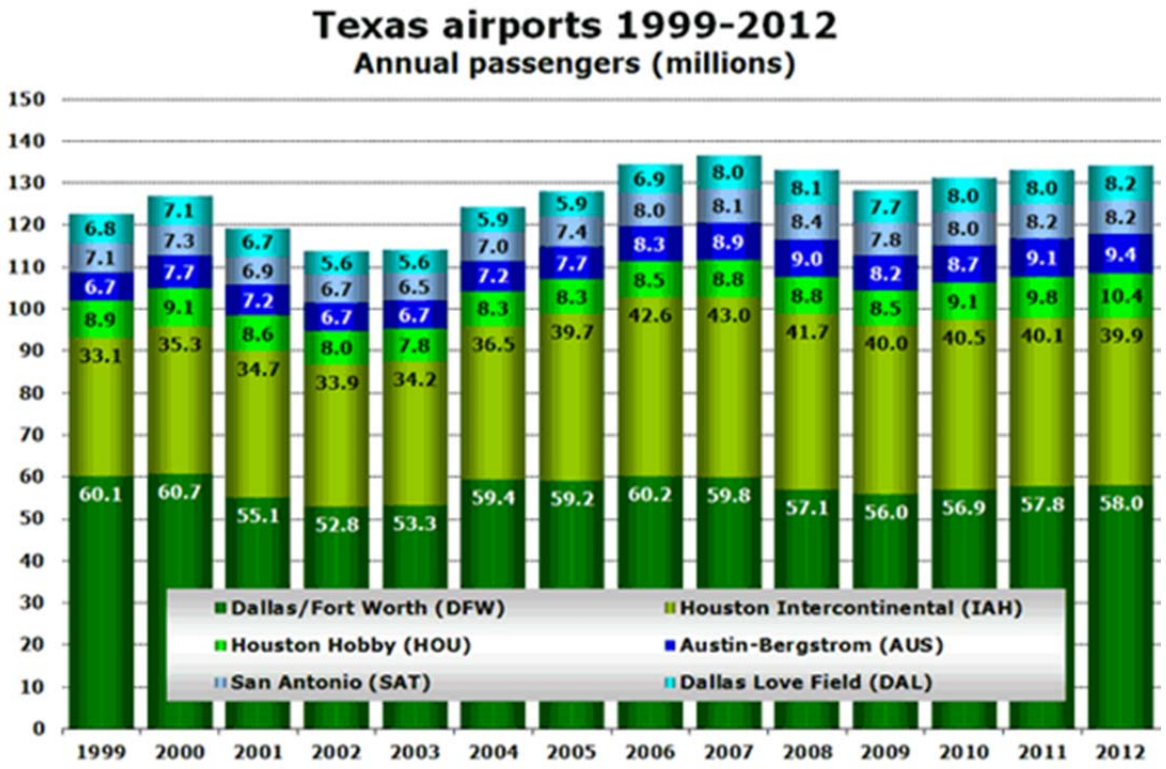
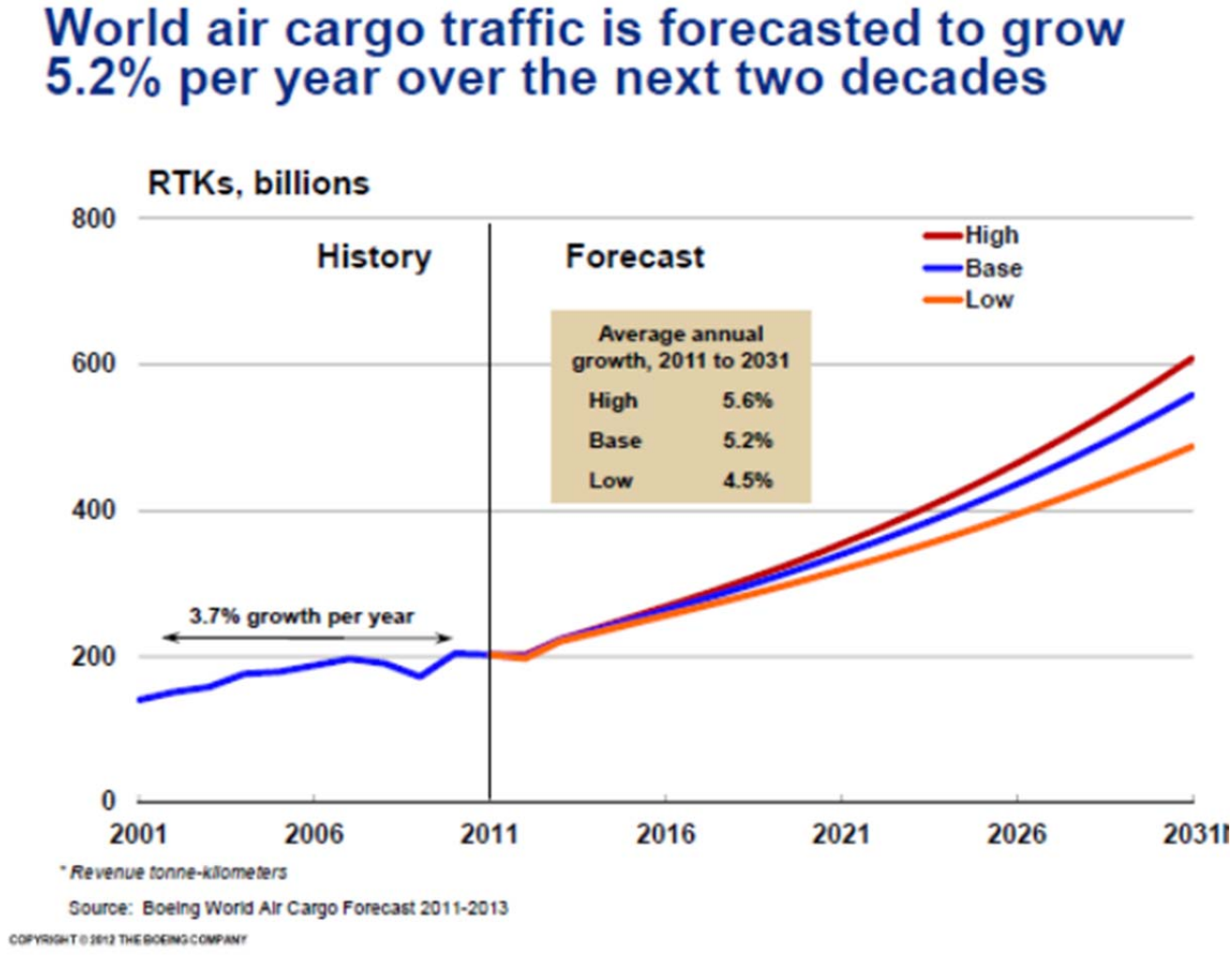
Volume 1 Appendix 2: Number of Passengers Moved by Six Largest Texas Airports



Number of Passengers Moved by Six Largest Texas Airports

Source: Anna Aero: Airline News and Network Analysis

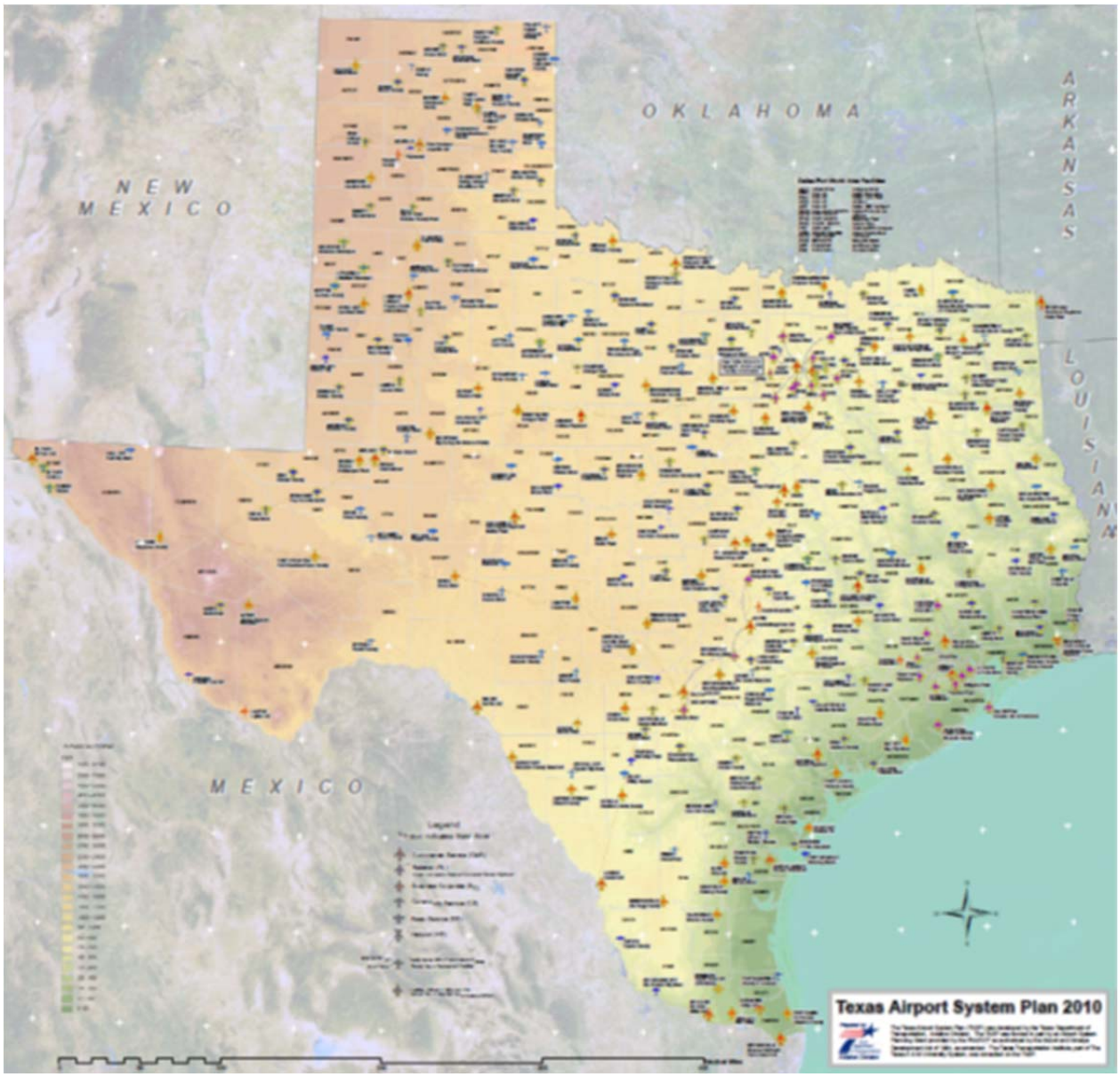
Volume 1 Appendix 3: Air Cargo Economic Forecast



Air Cargo Economic Forecast

Source: Boeing World Air Cargo Forecast 2013-2014

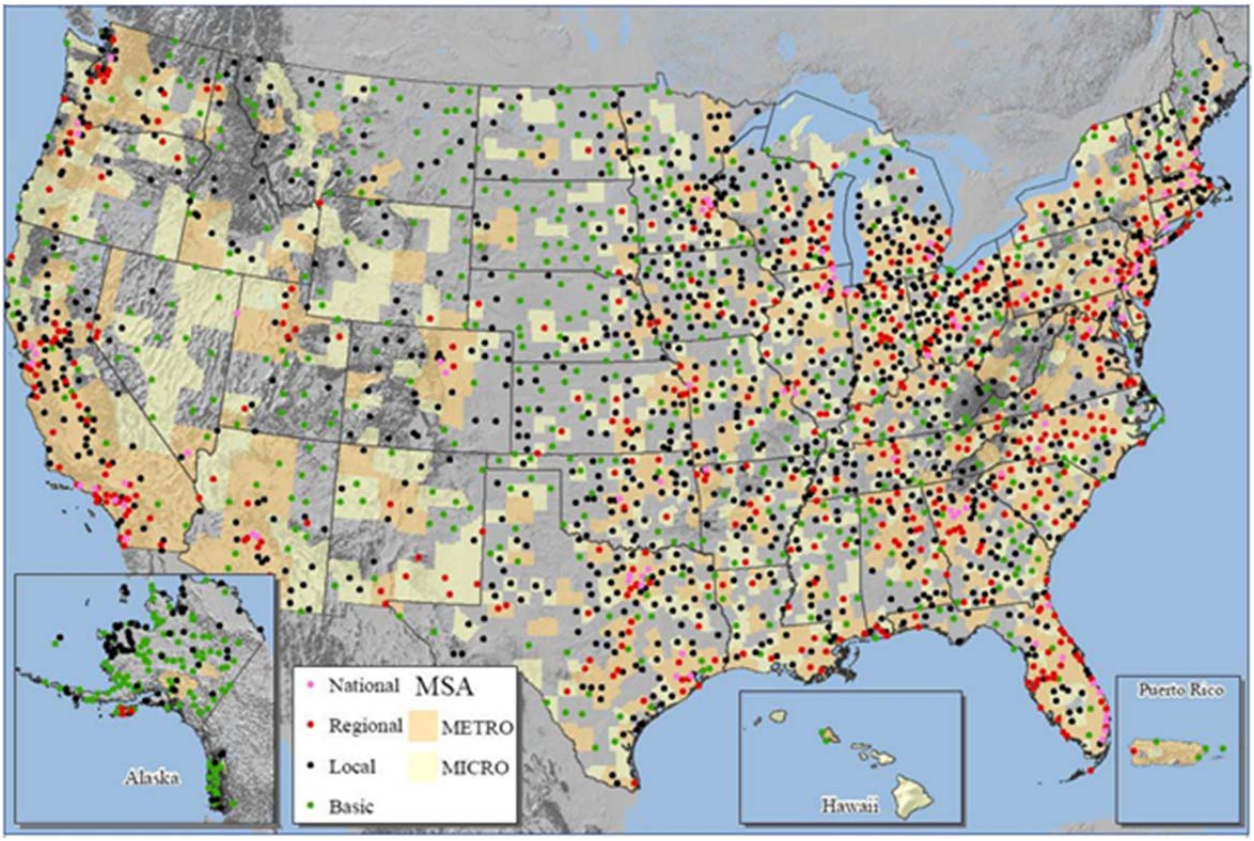
Volume 1 Appendix 4: Airports under TxDOT Aviation System Plan 2010



Airports Under TxDOT Aviation System Plan 2010

Source: TxDOT Aviation Division, 2013

Volume 1 Appendix 5: Map of General Aviation Airports in Four Categories



Map of General Aviation Airports in Four Categories

Source: Federal Aviation Administration: *General Aviation Airports Reports*.

Volume 1 Appendix 6: Uses of General Aviation Airports

Emergency Preparedness and Response	▪ Aeromedical Flights ▪ Law Enforcement/National Security/Border Security ▪ Emergency Response ▪ Aerial Fire Fighting Support ▪ Emergency Diversionary Airport ▪ Disaster Relief and Search and Rescue ▪ Critical Federal Functions	
Critical Community Access	▪ Remote Population/Island Access ▪ Air Taxi/Charter Services ▪ Essential Scheduled Air Service Cargo	
Other Aviation Specific Functions	▪ Self-Piloted Business Flights ▪ Corporate ▪ Flight Instruction ▪ Personal Flying ▪ Charter Passenger Services ▪ Aircraft/Avionics Manufacturing/Maintenance ▪ Aircraft Storage ▪ Aerospace Engineering/Research	
Commercial, Industrial, and Economic Activities	▪ Agricultural Support ▪ Aerial Surveying and Observation ▪ Low-Orbit Space Launch and Landing ▪ Oil and Mineral Exploration/Survey ▪ Utility/Pipeline Control and Inspection ▪ Business Executive Flight Service ▪ Manufacturing and Distribution ▪ Express Delivery Service ▪ Air Cargo	
Destination and Special Events	▪ Tourism and Access to Special Events ▪ Intermodal Connections (rail/ship) ▪ Special Aeronautical (skydiving/airshows)	

Uses of General Aviation Airports

Source: Federal Aviation Administration: *General Aviation Airports Reports*.

Volume 1 Appendix 7: Definition of Airport Categories

1. **Commercial Service Airports** are publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service. Passenger boardings refer to revenue passenger boardings on an aircraft in service in air commerce whether or not in scheduled service. The definition also includes passengers who continue on an aircraft in international flight that stops at an airport in any of the 50 States for a non-traffic purpose, such as refueling or aircraft maintenance rather than passenger activity. Passenger boardings at airports that receive scheduled passenger service are also referred to as Enplanements.

    A. **Nonprimary Commercial Service Airports** are Commercial Service Airports that have at least 2,500 and no more than 10,000 passenger boardings each year.
    B. **Primary Airports** are Commercial Service Airports that have more than 10,000 passenger boardings each year. Hub categories for Primary Airports are defined as a percentage of total passenger boardings within the United States in the most current calendar year ending before the start of the current fiscal year. For example, calendar year 2001 data are used for fiscal year 2003 since the fiscal year began 9 months after the end of that calendar year. The table below depicts the formulae used for the definition of airport categories based on statutory provisions cited within the table, including Hub Type described in 49 USC 47102.

2. **Cargo Service Airports** are airports that, in addition to any other air transportation services that may be available, are served by aircraft providing air transportation of only cargo with a total annual landed weight of more than 100 million pounds. “Landed weight” means the weight of aircraft transporting only cargo in intrastate, interstate, and foreign air transportation. An airport may be both a commercial service and a cargo service airport.

3. **Reliever Airports** are airports designated by the FAA to relieve congestion at Commercial Service Airports and to provide improved general aviation access to the overall community. These may be publicly or privately-owned.

4. The remaining airports, while not specifically defined in Title 49 USC, are commonly described as **General Aviation Airports**. This airport type is the largest single group of airports in the US system. The category also includes privately owned, public use airports that enplane 2500 or more passengers annually and receive scheduled airline service. The airport privatization pilot program authorized under Title 49 U.S.C., Section 47134, may affect individual general aviation airports. Under this program, some private rather than public ownership provisions are allowed, and questions on it should be directed to the Airport Compliance Division.

Source: Federal Aviation Administration. *“Airport Categories.”* 2012

Volume 1 Appendix 8: Aviation Ambassador Participation Award Levels

Virginia's Aviation Ambassador Program Participation Award Levels

Participation Levels
Gold Level: Flight Jacket
1. Visit all 66 of Virginia's Public-Use Airports
2. Visit four (4) aviation museums in Virginia
3. Attend one (1) safety seminar in Virginia
4. Attend the Regional Festival of Flight
Silver Level: Flight Bag
1. Visit 50 of Virginia's Public-Use Airports
2. Visit four (4) aviation museums in Virginia
3. Attend one (1) safety seminar in Virginia
4. Attend the Regional Festival of Flight
Bronze Level: Ambassadors Cap and Lapel Pin
1. Visit 25 of Virginia's Public-Use Airports
2. Visit four (4) aviation museums in Virginia
3. Attend one (1) safety seminar in Virginia
4. Attend the Regional Festival of Flight

Source: Virginia Department of Aviation. "Virginia Aviation Ambassadors Program."

Transportation Policy Brief #2

Autonomous Vehicles in Texas

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TxDOT 0-6581-Task 19-2

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Volume 2. Transportation Policy Brief #2: Autonomous Vehicles in Texas

2.1 Introduction

This particular policy brief, "Autonomous Vehicles in Texas," was researched and written by John Montgomery and Vivek Nath.

2.2 Executive Summary

The Texas highway and road systems have reached a turning point. Capacity limitations, pervasive safety concerns, and limited public capital are creating strain. Technological breakthroughs in sensors and autonomy seek to solve these problems by reinventing the automobile itself. This paper examines autonomous vehicle (AV) technology, and the potential it offers to TxDOT.

The examination of AV's usefulness for TxDOT begins with brief background section. Great advances in wireless communications, as well as ongoing deployment research, demonstrate the usefulness of AV systems. The scope of this analysis is also presented in the report which envisions an Intelligent Transportation System (ITS) which is fully executing AV operations.

While offering significant safety improvements over traditional drivers, AVs also present a wide range of challenges. The economic and capacity benefits associated with autonomous driving are not readily known due to the currently limited deployment of these vehicles. In addition to these uncertainties, the technological complication of deploying AVs will require TxDOT to develop new capabilities. However, as with all new technologies, the up-front risks can be mitigated with measured and thoughtful action.

Important lessons have been gleaned from other states to establish some best practices in deploying AV technologies. Other states have been too specific in establishing technology requirements for testing AVs on their roads. TxDOT would be wise to avoid such prescriptive policies, and use the information in this brief to better educate the lawmakers ahead of the 2015 session. In addition, international transportation agencies in countries such as the United Kingdom and Canada offer examples of how ITS can be utilized to create a more efficient highway driving experience. These ITS lessons are invaluable in the deployment of AV technology.

While the previous lessons learned will be compared for best practices, in certain areas Texas can take the lead in establishing AV technology. Specifically, autonomous freight vehicles (AFVs) are at a stage in development where the technology is well tested, but still requires wider deployment to be commercially validated. Situated on the largest freight corridor in North America, Texas has a unique position in America's freight system, which can be a huge advantage when deploying AFV technologies. In addition, the federal government is deploying AFV technology for testing on Texas military bases. This report will examine the sorts of

services Texas can offer freight companies using AFVs, and the particular requirements of introducing autonomous freight services.

Taking all of the aforementioned into consideration, this paper then demonstrates the steps needed to establish a full autonomous AV system, where drivers, vehicles, and the transportation network all interrelate through a dedicated short-range communications (DSRC) network administered by TxDOT. In such a set-up, drivers can enter vehicles which will automatically ferry them to a destination of their choice by using ITS. The technological, regulatory, and administrative requirements of such a Vehicle-to-Infrastructure (V2I) system will be detailed. Finally, a timetable based on industry-wide assumptions will be presented that offers a basic path toward full implementation.

2.3 Background

This section provides context for why AVs are needed on Texas roads. Automobile travel in Texas is becoming more time consuming, expensive, and dangerous. Commuters spend more time in traffic each year, with increasingly erratic travel times.[50]According to the Annual Urban Mobility Report 2012, an average commuter in Austin spends 44 hours a year to travel to work. The increase in commute time results in associated economic impacts that affect the economy (e.g., 44 hours per year in Austin traffic costs society approximately $930 for each commuter).[51] Limited capacity and societal reliance on automobiles exacerbate these outcomes.

Increasing travel time is one of the major consequences of higher automobile use. Automobile accidents and fatalities represent a major ongoing problem not only for Texas but also for American society at large. In 2012 alone, there were almost 3,400 traffic deaths on Texas roads, which represented a 10% increase over the previous year.[3] This unfortunate loss of life also impacted the state's economy to the tune of $26 billion. [52] What can be done about these negative impacts on Texans' lives and economic prosperity?

Failure to control speed, driver inattention, and tailgating are the most common causes for automobile accidents in Texas.[53] These problems are inherent to human drivers, and represent major behavioral issues that can only partially be overcome through training and licensing. Technological solutions offer new and effective methods for addressing much of the unsafe driving on Texas roads, along with the associated negative economic impacts.

2.3.1 Automating the Driving Experience

AVs and Autonomous Freight Vehicles (AFVs) utilize technology to improve the driving experience along with safety. These technologies seek to automate many of the functions controlled by drivers, such as speed maintenance, following distance, and device control (headlights, radios, phones, etc.). A majority of automobiles made today include some level of

[50]Schrank, 2012.
[51]Ibid.
[52]Texas Department of Transportation, 2013b.
[53]Texas Department of Transportation, 2013a.

automation, and car manufacturers are seeking to increase these services in new production vehicles.[54]

AV technology is always evolving as new discoveries are being tested and deployed. Because of this fluid process, AV technology can be broadly categorized into five main categories, or levels of sophistication.[55] This report assumes that TxDOT's deployment of AV infrastructure will be focused on supporting a fully autonomous Level 4 vehicle throughout its travel on Texas roads. A Level 4 system "anticipates that the driver will provide destination of navigation input, but is not expected to be available for control at any time during the trip."[56] By operating under this expectation, TxDOT would be able to roll out its AV support in a timely manner based on clear technical goals.

AFV technology is less developed than its AV counterpart, but is evolving in new ways that will change the commercial freight industry around the world. These developments include electronic platooning of driverless trucks[57], and the deployment of modular sensor packages for retrofitting on any existing freight vehicle.[58]AFVs operate along similar lines to standard passenger AVs, but additional safety requirements limit the extent of automation for these vehicles. Therefore, any system that seeks to integrate AFV operations must make several additional considerations.

The most vital infrastructure required to support AV and AFV operations is a robust wireless communications system.[59]AV communication can occur through Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) means, and is based on the concept of a mesh wireless network.[60] This report will focus primarily on V2I networking capabilities since these are the most applicable to TxDOT.

The overall implication of connected AVs in a V2I system is an Intelligent Transportation System (ITS) that integrates system information and vehicular information into a synchronized command and control structure. An ITS facilitates interaction between drivers, their vehicles, and infrastructure. ITS capabilities already exist in Texas' major metropolitan areas, but this report will examine how other transportation authorities implement larger-scale ITS deployments.

2.3.2 Key Policy Advantages

Safety

The primary advantage of an AV use is the prevention of road accidents. Over 30,000 people die each year in the U.S. in automobile collisions, with 2.2 million crashes resulting in injury. [12] The annual economic cost to the United States of these crashes is estimated to be $300 billion.[12]

[54]Eno Center for Transportation, 2013.
[55]National Highway Transportation Safety Administration, 2013.
[56]Ibid.
[57]Davila and Nombela, 2010.
[58]Lockheed Martin, 2014
[59]National Highway Transportation Safety Administration, 2013.
[60]Naranjo, 2012.

Traffic accidents remain the primary reason for the death of Americans between 15 and 24 years of age. Several safety pilot tests of AVs indicate a high degree of success in preventing road accidents.[61]

Congestion

The annual economic cost associated with road congestion in the U.S. is estimated at $100 billion, based on a 2009 estimate. AVs can sense and possibly anticipate lead vehicles' braking and acceleration decisions, leading to reductions in traffic-destabilizing shockwave propagation. AVs can use existing lanes and intersections more efficiently, which could increase congested traffic speeds by 8 to 13%.[62] However, because of lack of large-scale deployments, field testing of these theories have not been conducted. The most urgent AV research moving forward will test theories of congestion mitigation.

Increased Mobility

Theoretically, the elderly, visually impaired and other disabled individuals could take advantage of autonomous vehicle technology to navigate roads safely.

2.3.3 Key Policy Disadvantages

Technological Investment

The adoption of a full Level 4 automated system will require significant technological investments that go beyond traditional transportation systems. The technologies needed for AVs include the addition of new sensors, communication and guidance technology as well as software for each automobile. KPMG and the Center for Automotive Research note that the Light Detection and Ranging (LIDAR) systems on top of Google's AVs cost $70,000. Author Dellenback estimates that majority of the current civilian and military AV applications cost over $100,000, and at least for ten years, these costs will most likely not fall to $10,000 with mass production. Additional investment would be needed to upgrade the ITS to facilitate communication between vehicles and transportation infrastructure.[63]

Uncertain Economic Benefits

The lack of deployed Level 4 automated systems and the imprecise business model of selling AV technology in the current market reveal an uncertain picture of the associated economic benefits. Despite the current enthusiasm for AV technology and the amount of research among automakers and other institutions, this technology might not be widely adopted due to high expense and/or consumer uncertainty in the safety benefits of the technology. Some of the expected economic benefits associated with congestion may not materialize. When drivers can use the time in the vehicle for other tasks, such as checking email and videoconferencing, the

[61]Eno Center for Transportation, 2013.
[62]Ibid.
[63]Eno Center for Transportation, 2013.

cost of congestion is effectively reduced for vehicle operations. This cost reduction may lead to additional vehicle miles travelled resulting in a negative externality and higher economic costs.[64]

Lag Time

As with any new paradigm, the deployment of AVs will take time. TxDOT may therefore experience higher short-term costs (in terms of technological and infrastructure upgrades) than short-term benefits to safety and congestion. A phased approach may need to be laid out for a smooth transition to the regular use of AVs on the road. The infrastructure requirements for a phased rollout are discussed in the "Relevance to Texas" section of this report.

Liability Complexity

As AVs take on more of the driving functions that were historically the responsibility of the driver, new questions arise regarding accident responsibility. Risk is introduced for manufacturers as they may be held liable for AV-involved road accidents. This, in turn, may introduce a reluctance to adopt new AV technology despite the associated safety improvements. AV technology may lead to lower car insurance costs for consumers, but the new complexities for processing insurance claims after accidents, and the possible shift of liability costs to manufacturers, are notable disadvantages of AV technology.[65]

2.4 Lessons Learned

This section evaluates lessons from AV deployments in other states and countries. These initiatives provide examples of the policy and technological challenges associated with AV technology.

2.4.1 Technology: United Kingdom

The ITS plan in the United Kingdom highlights the advantages associated with a well-functioning information system working in tandem with V2Iand V2V communication.[66] Apart from the safety benefits of AVs, the associated ITS system may also serve several other functions. Road-side vehicle detectors add reliability and accuracy to traffic management. Real-time analysis of traffic flow can be used to vary electronic speed limit signs to maximize traffic throughput. Cameras and sensors on motorways can help detect accidents and accordingly relay routing and traffic information to the central ITS server as well as to drivers. The system also has the ability to charge tolling fees of varying amounts based on vehicle identity.

2.4.2 Technology: Canada

The ITS plan for Alberta, Canada suggests several of the advantages mentioned in the 'United Kingdom' section. In addition, the Alberta plan also suggests using ITS applications that include changeable message signs to display real-time information collected by sensors and warn motorists of collisions and road-weather conditions. It provides a thorough template for how ITS

[64] Anderson et al., 2014.
[65] Anderson et al., 2014.
[66] Walsh, 2011.

systems may be managed and seamlessly integrated into a knowledge-based economy.[67]This flexibility will allow for easier integration of AVs in future road operations.

2.4.3 Technology: Germany

A project called KONVOI, which stands for the "Development and Examination of the Application of Electronically Coupled Truck Convoys on Highways" in German, was conducted in Germany to evaluate the performance of automated truck platoons. During test runs of these experimental vehicles on motorways, data were collected to analyze the traffic flow, road safety, economic efficiency and environmental effects as well as the acceptance and stress levels of the truck drivers. The KONVOI test concluded that traffic flow and road safety could be increased through autonomous truck platoons which would lead to a more effective use of existing resources. The study also concluded that further advancement in V2V and V2I communication would be required to incorporate truck platoons in road traffic.[68]

2.4.4 Technology: United States

To understand the effectiveness of AV technology in addressing road safety issues, the U.S. Department of Transportation (USDOT) ITS Joint Program Office created a test and evaluation effort called the Connected Vehicle Safety Pilot.[69] Close to 3,000 vehicles were deployed in the largest-ever road test of V2V technology. The National Highway Traffic Safety Administration (NHTSA) issued a statement in February 2014 stating that the DOT testing indicated interoperability of V2V technology among products from different vehicle manufacturers and suppliers and that they work in real-world environments.[70]

In the private-sector, as of March 2013, Google AV fleet had logged more than 500,000 miles of autonomous driving on public roads without incurring a crash attributable to AV technology.[71]

2.4.5 Policy: Federal

Since 2001, the Federal Government has pursued standards to facilitate nationwide ITS projects. In 1999, the Federal Communications Commission (FCC) allocated a frequency spectrum known as Dedicated Short Range Communications (DSRC) in the 5.9 GHz band for communication between vehicles. In 2003, the FCC issued corresponding licensing and service rules. The Moving Ahead for Progress in the 21stCentury Act of 2012 called for an assessment and evaluation of V2V and V2I communication, including DSRC.[72]

2.4.6 Policy: California

California has enacted prescriptive laws that specify the ideal technologies that an AV should have. For instance, AVs need a manufacturer certification of a mechanism to engage and disengage the autonomous technology. Manufacturers must provide privacy notifications to

[67] Alberta Infrastructure, 2000.
[68] Ramakers et al., 2009.
[69] Research and Innovative Technology Administration, 2014.
[70] National Highway Traffic Safety Administration, 2014.
[71] Anderson et al., 2014.
[72] US Congressional Report, 2012.

purchasers of autonomous vehicles, and obtain a form of insurance in the amount of $5 million before starting the testing of AVs in the state.[73] California has come under criticism for enacting legislation that is too prescriptive of technology safety requirements, and therefore stifles the development of AV technology.

2.4.7 Policy: Nevada

Nevada has promulgated regulation requiring AVs to possess a certificate of compliance stating that the AV is capable of being operated in autonomous mode without the physical presence of the operator in the vehicle. Licensed dealers may only sell AVs with certifications issued by the manufacturer or an authorized certification facility. The regulation requires an endorsement on the driver's license to operate it. In addition, Nevada has regulation that creates a privately operated technology certification facility market.

2.4.8 Policy: Florida

Florida does not have as many prescriptive laws as California and Nevada. Florida's laws provide liability protection for original equipment manufacturers whose vehicles are converted to AVs.

2.4.9 Commonalities of State Legislation

Florida, Nevada, and Washington D.C provide liability protection for original equipment manufacturers whose vehicles are converted to AVs. California, however, has no explicit mention of such liability protection. Apart from California, Florida, Nevada, and Washington, D.C., there are ongoing legislations regarding AVs in Arizona, Colorado, Hawaii, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Oklahoma, Oregon, South Carolina, Washington, and Wisconsin. Most states, including Texas, have passed laws that define *Autonomous Vehicle*, *Autonomous Technology*, and *Operator*. They also engage in setting up a bonding system to test upcoming vehicle technology. The states also provide protections for manufacturers against claims due to third party AV conversions, and most of these states establish clear lines of accountability for the testing and certification of prototypes.

2.5 Relevance to Texas

This section explores how AV technology can be facilitated on Texas roads by exploring the technology and timing issues for an effective TxDOT AV rollout. TxDOT will need to address the AV issue comprehensively for a successful implementation. This section proposes a timeline formed around benchmarks to guide AV rollout in Texas. The rollout efforts should aim on having an ITS that can support V2I communications between Level 4 AVs, which will give Texas the technological flexibility to facilitate a variety of AV systems well into the future.

2.5.1 Communications infrastructure

As previously mentioned, communications technology will be the largest component of any state-wide AV rollout. International case studies have shown that effective wireless

[73] State of California, 2012.

communications is critical for traffic management and information dissemination.[74] This is also true for the operation of AVs, which will rely on wireless communications for safe operations. Since AV technologies rely so heavily on wireless communications, it is important to understand the standards that will be in place during TxDOT's AV rollout. These standards for wireless communication will control how wireless information is exchanged between AVs over V2I networks.

Since 2003, the federal government has DSRC standards for automobile use in place. This system envisions a microwave communications network operating at 5.9 GHz, and automobile manufacturers are seeking to conform to these requirements with their AV deployments. Therefore these DSRC standards in turn set the industry-wide standard, and represent the mode of compatibility that TxDOT's wireless communications system must meet.

Note that this wireless communications format is not intended to cover all the possible communications with AVs, but only those strictly related to safety. However, despite this limited use, DSRC represents the most likely medium for wireless communication between AVs and infrastructure.[75] There is no uniform agreement on the usefulness of DSRC, and many are examining how this wireless standard can be improved to allow for cross compatibility with wireless and cell phone services.[76] Many complaints about DSRC, however, are based on this lack of flexibility, which can be justified via its role in protecting motorists' lives. There are developments to utilize hybrid systems to operate on multiple frequencies, which would separate out safety critical functions from other wireless operations.[77] Therefore, even in the face of industry scrutiny, DSRC offers the best path forward for vehicular wireless safety communications.

In conjunction with the USDOT, AASHTO released a field guide in 2011 outlining some major obstacles to and recommendations for AV implementation.[78] Most notable is the deployment flexibility that many DSRC technologies permit. Existing camera masts, traffic control boxes, and road sign installations can be adapted to use the wireless communications technology prescribed by the FCC. Thus, TxDOT's existing networking infrastructure can be modified to facilitate greater V2I coverage for AVs.

2.5.2 V2I Services Infrastructure

TxDOT can build upon its robust ITS system to create more unified statewide services for AV drivers. The advancement of AV technology will change a driver's relationship with the roads they travel on, and TxDOT will need to determine how much they want to provide to users of Texas' ITS. V2V and V2I technologies mean that a continuous two-way exchange of information between driver, car, and road will occur. The ability to interface directly with infrastructure users, either through information dissemination or traffic control, will have major impacts on AV deployment.

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[74] Walsh, 2011.
[75] KPMG, 2012.
[76] Li, 2012.
[77] Samuel, 2013.
[78] Intelligent Transportation Systems Joint Program Office, 2011.

Some V2I applications in other countries provide a wide range of information and safety services to customers as a part of their national transportation plans.[79] These applications can include (but are not limited to) traffic information, routing options, hazard warning, platooning services, and user feedback. TxDOT can provide these services either in-house, or by hiring outside contractors. Failing to provide these services, however, would be missing a unique opportunity to advance road infrastructure into a useful information age. TxDOT, AVs, and drivers would be able to interact in real-time, which will revolutionize TxDOT's customer service capacity. TxDOT must decide how far to take this new relationship:

- Should TxDOT supply AV motorists with traffic information?
- Can there be automatic rerouting of vehicles around congestion areas?
- Should TxDOT help facilitate platooning for AV and AFV motorists?
- Should AV motorists be able to interact with TxDOT to submit complaints?

An important starting point for building these capabilities within TxDOT would be the enhancement of the state's ITS. Establishing a statewide ITS center can facilitate the dissemination of real-time traffic data along major interregional transport routes, which would improve Texas' traffic management capabilities.[80] Not only this, but interregional traffic could be automatically rerouted around major congestion areas.[81] TxDOT could establish alternative routes for interregional traffic, and provide variable tolling to motorists who are willing to circumvent congested areas at a discount. Alternatively, the state could offer to "do the driving" for AV users and facilitate platoons of vehicles for interregional travel.

Establishing the parameters of TxDOT's V2I program is beyond the scope of this report, but one thing is clear: the massive amount of information and connectivity between the cars and the road will change TxDOT's interaction with its users. A more unified statewide ITS would place TxDOT in a better position to capitalize on this evolution.

2.5.3 Traditional Infrastructure

TxDOT will not only need to address the communications infrastructure requirements, but also several traditional infrastructure requirements that AVs present. Only a handful of large-scale AV deployments have occurred, and hence this area of research lacks examples and data. Traditional infrastructure recommendations fall into two major categories: signage and pavement.

As mentioned previously, the dissemination of information to AV users will be one of the most important developments in AV rollouts. TxDOT's ITS will be able to send information directly to the dashboard of participating AV users, increasing the visibility of this information to drivers. Other countries have incorporated electronic signage to inform motorists about impending changes to road conditions.[82] Therefore one of the primary tasks in maintaining modern signage is to establish how TxDOT wants to disseminate information directly to AV motorists.

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[79] Walsh, 2011.
[80] Ibid.
[81] Alberta Infrastructure, 2000.
[82] Walsh, 2011.

Due to the lack of AV deployments, the benefits of reduced congestion can only be modeled at this point. While many advocates of AVs propose that these vehicles will reduce congestion, some have noticed that there is a chance for increased traffic when AVs and traditional vehicles are mixed due to the uncertain nature of their interaction.[83] TxDOT may consider allowing AV motorists to utilize high-occupancy-vehicle (HOV) lanes or other designated rights-of-way.[84] This approach could have two important impacts: limiting the interaction of AVs with traditional vehicles, and establishing an additional incentive for the adoption of this technology. These designated rights-of-way for AVs would need to have additional pavement reinforcement due to increased wear caused by shorter following distances. A policy of allowing AV users into HOV lanes would ease the transition into AV use, and help increase utilization of those special lanes.

2.5.4 Autonomous Freight Vehicles

While a great deal of research has been conducted on passenger AV deployment, AFVs remain fertile ground for progress. The main focus for AFV use is through road trains, which are extended convoys of platooning freight vehicles led by a single human driver. TxDOT has the opportunity to not only offer resources for the testing of AFV equipment on public roads, but also to partner with the freight industry to collaborate on future freight routing services.

Most testing on AFVs has been done in Europe, where a consortium of universities led by automaker Volvo is seeking to better understand the safety requirements of this technology.[85] This research is ongoing, and will produce data on the extent to which road surfaces are worn, the economic savings produced, and the safety considerations that arise from the deployment of road trains that involve not only AFV but also traditional passenger vehicles. Another project, headed by Daimler Chrysler, focused on "electronic tow bars" which link AFVs to follow a lead driver. Simulations of road conditions from this project indicate many unique safety requirements for the eventual deployment of AFVs in platoons.[86] In addition to these deployment studies, Lockheed Martin and the US Department of Defense have collaborated to test AFV technologies on military vehicles at Fort Hood.[87] The unique nature of this project is that the sensor and control equipment was an aftermarket kit that could be deployed on any freight vehicle.

Taken together, these efforts show that AFV technology is on the cusp of widespread deployment. TxDOT will need to actively partner with research organizations to permit the testing of AFVs on Texas roads. Moving beyond testing, TxDOT can employ an improved state-wide ITS system to motivate companies to adopt AFV technologies. One recommendation from international ITS applications is the classification of vehicle traffic into different categories, and TxDOT could do the same with interregional AFV traffic. This would allow TxDOT's state-wide ITS to route commercial freight around congestion areas. In addition to these routing services, TxDOT could facilitate platooning services for AFVs which would permit commercial freight

[83] House Transportation and Infrastructure Committee, 2013.
[84] Kurman and Lipson, 2013.
[85] Davila and Nombela, 2010.
[86] Liang et al., 2003.
[87] Lockheed Martin, 2014.

operators to reduce the number of drivers they require. A wide variety of services can be offered to freight operators,[88] and as with the standard AV operations, TxDOT will need to establish the scope of its operations.

Whether or not TxDOT decides to go into AFV services, important infrastructure and safety considerations must be taken into account to accommodate AFVs on the road. First, road trains will make a considerable impact on road surfaces because of the concentration of wheels into a smaller space.[89] This means that any designated AFV routes will need to have reinforced road surfaces to increase operating life. In addition, grave safety concerns arise when operating mile-long road trains around traditional motorists.[90] Therefore, TxDOT should seek designated AFV routes away from major thoroughfares to prevent accidents. A good example of such a route would be State Highway 130 around Austin. Separating motorists from AFVs can ensure safe and economic operations.

2.5.5 Roadmap For Implementation

This section provides one potential timetable for the upgrade of infrastructure and other deployment and development activities over the next ten years. The goal is to enable Level 4 AV/AFV use on Texas roads, based on deployment scenarios anticipated by the AASHTO. The ten-year deployment schedule is set up in two-year time frames to coincide with the state biennial budgeting cycle.

2013–2014

This phase is mainly devoted to research, evaluation and planning. A study of the technology implementation requirements should be conducted, with special attention to any updates on using DSRC as a communication standard and possible technological requirements for ITS. This is also the phase where state legislation on AVs may be planned with the help of the lessons learned from other states such as California and Nevada. Some of the initial steps, such as legally defining an AV, have already taken place in Texas. There are still details on liability and licensing that will need clarification, especially establishing clear responsibility for the Department of Motor Vehicles (DMV) and Department of Public Safety (DPS).

TxDOT would benefit from outreach to the trucking and auto manufacturing industries, which can enable a smoother transition to AFV and consumer AV use. During this period, it should also conduct an internal organization evaluation to comprehend how to deal with the current silos within metro area traffic management systems. An important area of planning and budgeting would be to estimate the extent of V2I services that would be offered. Budgeting may be conducted for a full-scale AV technology rollout with a 2023 time frame.[91]

2015–2017

The year 2015 may mark the beginning of the establishment of wireless communication networks in Texas for AVs rollout which can be done in four stages:

- Stage 1: Major Metro Areas (2015–2017)

[88] Intelligent Transportation Systems Joint Program Office, 2011.
[89] Liang et al., 2003.
[90] Davila and Nombela, 2010.
[91] Intelligent Transportation Systems Joint Program Office, 2011.

- Stage 2: All Interregional/ Interstate traffic routes (2017–2019)
- Stage 3: Secondary roads/ State Highways (2019–2021)
- Stage 4: All TxDOT rights-of-way (2021-2023)

TxDOT may consider upgrading its existing infrastructure of traffic signal controllers to facilitate V2I communication with AVs. Controller cabinets, for instance, may be used for deploying DSRC roadside equipment, as the cabinets provide secure environmentally-protected enclosures with electric power and backhaul communications. In many cases, integration of DSRC capabilities for AVs with signal controllers may require an upgrade or replacement of the existing controllers. The benefit of using existing controller cabinets would have to, therefore, be weighed against the use of new stand-alone cabinets that are equipped with the required controller.

This phase may also involve the development of a unified protocol for traffic management between metro areas. Traffic management issues include those to do with information dissemination, traffic routing and incident management (e.g., weather or accidents). TxDOT may conduct a study to plot acceptable AFV routes in Texas. The outreach to trucking companies and AV manufacturers would help TxDOT to determine the V2I services and infrastructure that would be useful.[92]

2017–2019
Stage 2 of the communications network rollout may start in 2017. TxDOT might consider expanding electronic road signage along major corridors as well as identifying less populated areas to receive communication networks in Stage 3.[93]

2019–2021
The year 2019 would set forth Stage 3 of the communications network rollout. This year may be designated as "year zero" for estimating the number of equipped vehicles in the fleet for subsequent years. Widespread 4G and possibly 5G commercial services as well as increasingly available DSRC installations would make it easier to gather and share data with AFV and AV users. Thus, 2019 would mark the beginning of the provision of TxDOT V2I data services to these users. Data exchange may include routing and weather information.[94]

2021–2023
2021 would mark the beginning of Stage 4 of the communications network rollout.

[92] Intelligent Transportation Systems Joint Program Office, 2011.
[93] Ibid.
[94] Ibid.

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Volume 2 Appendix 2: Levels of Automation

The following text was taken from a National Highway Traffic Safety Administration statement entitled "Preliminary Statement of Policy Concerning Automated Vehicles."

Definitions – Levels of Vehicle Automation

The definitions below cover the complete range of vehicle automation, ranging from vehicles that do not have any of their control systems automated (level 0) through fully automated vehicles (Level 4). The agency has segmented vehicle automation into these five levels to allow for clarity in discussing this topic with other stakeholders and to clarify the level(s) of automation on which the agency is currently focusing its efforts.

• Level 0 – No-Automation. The driver is in complete and sole control of the primary vehicle controls (brake, steering, throttle, and motive power) at all times, and is solely responsible for monitoring the roadway and for safe operation of all vehicle controls. Vehicles that have certain driver support/convenience systems but do not have control authority over steering, braking, or throttle would still be considered "level 0" vehicles. Examples include systems that provide only warnings (e.g., forward collision warning, lane departure warning, blind spot monitoring) as well as systems providing automated secondary controls such as wipers, headlights, turn signals, hazard lights, etc. Although a vehicle with V2V warning technology alone would be at this level, that technology could significantly augment, and could be necessary to fully implement, many of the technologies described below, and is capable of providing warnings in several scenarios where sensors and cameras cannot (e.g., vehicles approaching each other at intersections).

• Level 1 – Function-specific Automation: Automation at this level involves one or more specific control functions; if multiple functions are automated, they operate independently from each other. The driver has overall control, and is solely responsible for safe operation, but can choose to cede limited authority over a primary control (as in adaptive cruise control), the vehicle can automatically assume limited authority over a primary control (as in electronic stability control), or the automated system can provide added control to aid the driver in certain normal driving or crash-imminent situations (e.g., dynamic brake support in emergencies). The vehicle may have multiple capabilities combining individual driver support and crash avoidance technologies, but does not replace driver vigilance and does not assume driving responsibility from the driver. The vehicle's automated system may assist or augment the driver in operating one of the primary controls – either steering or braking/throttle controls (but not both). As a result, there is no combination of vehicle control systems working in unison that enables the driver to be disengaged from physically operating the vehicle by having his or her hands off the steering wheel AND feet off the pedals at the same time. Examples of function-specific automation systems include: cruise control, automatic braking, and lane keeping.

•Level 2 - Combined Function Automation: This level involves automation of at least two primary control functions designed to work in unison to relieve the driver of control of those functions. Vehicles at this level of automation can utilize shared authority when the driver cedes active primary control in certain limited driving situations. The driver is still responsible for monitoring the roadway and safe operation and is expected to be available for control at all times

and on short notice. The system can relinquish control with no advance warning and the driver must be ready to control the vehicle safely. An example of combined functions enabling a Level 2 system is adaptive cruise control in combination with lane centering. The major distinction between level 1 and level 2 is that, at level 2 in the specific operating conditions for which the system is designed, an automated operating mode is enabled such that the driver is disengaged from physically operating the vehicle by having his or her hands off the steering wheel and foot off pedal at the same time.

• Level 3 - Limited Self-Driving Automation: Vehicles at this level of automation enable the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control. The driver is expected to be available for occasional control, but with sufficiently comfortable transition time. The vehicle is designed to ensure safe operation during the automated driving mode. An example would be an automated or self-driving car that can determine when the system is no longer able to support automation, such as from an oncoming construction area, and then signals to the driver to reengage in the driving task, providing the driver with an appropriate amount of transition time to safely regain manual control. The major distinction between level 2 and level 3 is that at level 3, the vehicle is designed so that the driver is not expected to constantly monitor the roadway while driving.

• Level 4 - Full Self-Driving Automation (Level 4): The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any time during the trip. This includes both occupied and unoccupied vehicles. By design, safe operation rests solely on the automated vehicle system.

Volume 2 Appendix 3: Economic Benefits from AVS

The following table is from the October 2013 report of the Eno Center for Transportation entitled "Preparing a Nation for Autonomous Vehicles: Opportunities, Barriers and Policy Recommendations."

Economic Benefits from AVS

	10%	50%	90%
Crash Cost Savings from AVs			
Lives Saved (per year)	1,100	9,600	21,700
Fewer Crashes	211,000	1,880,000	4,220,000
Economic Cost Savings	$5.5 B	$48.8 B	$109.7 B
Comprehensive Cost Savings	$17.7 B	$158.1 B	$355.4 B
Economic Cost Savings per AV	$430	$770	$960
Comprehensive Cost Savings per AV	$1,390	$2,480	$3,100
Congestion Benefits			
Travel Time Savings (M Hours)	756	1680	2772
Fuel Savings (M Gallons)	102	224	724
Total Savings	$16.8 B	$37.4 B	$63.0 B
Savings per AV	$1,320	$590	$550
Other AV Impacts			
Parking Savings	$3.2	$15.9	$28.7
Savings per AV	$250	$250	$250
VMT Increase	2.0%	7.5%	9.0%
Change in Total # Vehicles	-4.7%	-23.7%	-42.6%
Annual Savings: Economic Costs Only	$25.5 B	$102.2 B	$201.4 B
Annual Savings: Comprehensive Costs	$37.7 B	$211.5 B	$447.1 B
Annual Savings Per AV: Economic Costs Only	$2,000	$1,610	$1,670
Annual Savings Per AV: Comprehensive Costs	$2,960	$3,320	$3,900
Net Present Value of AV Benefits minus Added Purchase Price: Economic Costs Only	$5,210	$7,250	$10,390
Net Present Value of AV Benefits minus Added Purchase Price: Comprehensive Costs	$12,510	$20,250	$26,660
Assumptions			
Number of AVs Operating in U.S.	12.7 M	63.7 M	114.7 M
Crash Reduction Fraction per AV	0.5	0.75	0.9
Freeway Congestion Benefit (delay reduction)	15%	35%	60%
Arterial Congestion Benefit	5%	10%	15%
Fuel Savings	13%	18%	25%
Non-AV Following-Vehicle Fuel Efficiency Benefit (Freeway)	8%	13%	13%
VMT Increase per AV	20%	15%	10%
% of AVs Shared across Users	10%	10%	10%
Added Purchase Price for AV Capabilities	$10,000	$5,000	$3,000
Discount Rate	10%	10%	10%
Vehicle Lifetime (years)	15	15	15

Transportation Policy Brief #3

North Carolina's Strategic Mobility Plan

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TxDOT 0-6581-Task 19-3

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Volume 3. Transportation Policy Brief #3: North Carolina's Strategic Mobility Formula

3.1 Introduction

This particular policy brief, "North Carolina's Strategic Mobility Formula," was researched and written by Jacob Thayer and Tiffany Wu.

3.2 Executive Summary

In 2013, the North Carolina Department of Transportation (NCDOT), in partnership with the North Carolina General Assembly, took a unique and innovative approach to prioritization. NCDOT structured the Strategic Mobility Formula (SMF) with the end goal that all modes of transportation would compete for the same pool of money. NCDOT defines these modes of transportation as highway, passenger rail, freight rail, ferry, aviation, public transportation, and pedestrian/bicycle. NCDOT has worked with the North Carolina General Assembly since 2009 to base their prioritization on quantitative data rather than qualitative measures. They produced prioritization methods P1.0 and P2.0 in 2009 and 2011, respectively, and are currently on the third iteration of the prioritization methodology, P3.0, which contains the SMF. The SMF is projected to increase the number of new projects NCDOT can work on in a ten-year period from 175 to 260 (which is an increase of 175,000 jobs to 240,000) and will go into full effect in 2015.

Each potential NCDOT project receives a score based on criteria created by a work group set up by NCDOT, and then NCDOT ranks the projects based on these scores. NCDOT funds these projects in accordance with House Bill 817, also known as the Strategic Transportation Investment Bill. This law states that the SMF will receive funding via the state Highway Trust Fund and federal funds with exceptions and conditions. The amount of funds available to the SMF is approximately 6% of NCDOT's total funds. The concept for the next stage of prioritization, or P4.0, is to have all modes under one formula competing for funding, rather than using the separate formulas they will use under P3.0. Since both Texas and North Carolina are facing growing population and decreasing revenue, TxDOT should identify any lessons that can be learned from NCDOT's innovative approach to prioritization.

3.3 Background

The North Carolina Department of Transportation (NCDOT) originated with the State Highway Commission, formed in 1915. Today's NCDOT came into being in 1979. North Carolina has one of the largest state highway systems in the United States with over 80,214 miles in the system.[95] The State of North Carolina owns and maintains that mileage, while cities maintain the other roads. The state has only one county road. NCDOT geographically administers its system through seven geographic regions. Each region is then subdivided into two divisions.

This massive road system places a burden on the state, especially in tough economic times, such as the recession from which the nation is currently emerging. In some respects, North Carolina's

[95] Hartgen et al., 2013.

political climate is similar to that of Texas. The state legislature tends to be conservative and, therefore, is hesitant to raise or implement new taxes.

North Carolina is also rapidly growing. CNNMoney compiled a list of the ten-fastest-growing U.S. cities in the decade from 2000 to 2010.[96] Charlotte and Raleigh were number one and two on the list, respectively. Charlotte, a transportation hub, experienced a population growth of 65% in that decade. The city is now the second-largest financial hub in the country, after New York City. Raleigh, an anchor city of the "Research Triangle" along with Durham and Chapel Hill, grew 63%; the technology sector is important in this part of the state. In addition, both cities have enjoyed growth as burgeoning retirement communities.

Considering the need to provide transit options to support the growth while reducing expenses (given the lack of political will to increase tax- or fee-based revenue), NCDOT created the Strategic Mobility Formula (SMF). It replaces two previous prioritization methods (P1.0 from 2009 and P2.0 from 2011) which initiated the shift to prioritizing specific types of projects or modes of transportation based on congestion relief and other factors. While funding constraints exist for highway and non-highway projects, this is the first attempt at including other modes of transportation into NCDOT's prioritization method. NCDOT hopes to prove that data-driven prioritization is the optimal way to fund capital projects.[97] In the future, they seek to finalize good index rubrics for allocating funds to projects by 2015, and then create a multivariable formula that encapsulates all modes of transportation into one funding scheme by 2017. Additionally, they seek to have the General Assembly free up the restrictions even more, so that an even greater percentage of funds can flow through the formula.

3.4 Key Policy Issues

NCDOT publishes and implements a new project prioritization methodology every two years. The most recent is the SMF, also known as the Strategic Transportation Initiative (STI). The Strategic Transportation Investments Bill (House Bill 817) details the scoring criteria and available funding for the SMF. NCDOT assisted the Assembly in creating House Bill 817 in order to elevate the use of the criteria.[98]

3.4.1 Development of Prioritization Method

As stated earlier, prioritization began in North Carolina in 2009 with their P1.0 structure. Newly inaugurated Governor Beverly Purdue's Executive Order Number 2 prompted the effort to move toward data-driven decisions.[99] NCDOT's first prioritization scheme focused primarily on highway projects. Index scoring led the decision-making process; however, at the time this process relied on qualitative methods, rather than quantitative.

The highway projects were chosen based on a mix of these three attributes: quantitative (volume-to-capacity ratios, crash rates, and pavement condition ratings, etc.), qualitative (top-25 priorities of each metropolitan planning organization [MPO], rural transportation planning organization

[96] Christie, 2012.
[97] Patel et al., 2013.
[98] Patel et al., 2013.
[99] North Carolina Department of Transportation, 2010.

[RPO], and division), and multimodal characteristic (e.g., a hub that allowed more than one transportation option).[100] Statewide, regional, and sub-regional stakeholders contributed input; NCDOT also took its stated goals of Safety, Mobility, and Infrastructure Health into account.

The second stage of prioritization, or P2.0, began in 2011. Senate Bill 890 codified the Governor's Executive Order and made prioritization a North Carolina state law. The prioritization process had the added benefit of cubing citizens' desire to lower the gas tax, enabling NCDOT to keep funds that might have been lost. Bicycle and pedestrian routes were assigned data-driven formulas, and NCDOT modified other formulas as needed after seeking input from the various stakeholders at the state, regional, and sub-regional levels.[101]

The current stage of prioritization, P3.0, includes the SMF. In April of 2013, House Bill 817 introduced this form of prioritization. Governor Patrick McCrory signed the Bill into law on June 26, 2013 with overwhelming bipartisan support.[102] This law required NCDOT to report to the Joint Legislative Transportation Oversight Committee and the Fiscal Research Division no later than August 15, 2013 on NCDOTs recommended formulas.[103] Additionally, as has been discussed, quantitative methods were extended to every capital project possible, albeit with safety nets included to ensure funding is still secured for highway funding.

3.4.2 Method of Prioritization

NCDOT prioritizes and implements projects based on data-driven scores, local inputs, project delivery times, and available funds. Some 70% of the regional project scores come from similar criteria as statewide projects, and the remaining 30% of the regional project scores are based on local input from NCDOT's transportation division engineers, MPOs, and RPOs. The division projects are prioritized based on quantitative scores and local inputs similar to the regional projects, but are divided equally between the two criteria. Each division and region receives 1,300 points, which each can allocate in their local input score. The maximum score any one project can receive is 100 points. The divisions and regions can share and transfer points with other divisions and regions. NCDOT checks the qualitative and quantitative rubrics assigned by the regions and divisions.[104]

The scoring criteria vary for statewide, regional, and division projects. Statewide highway projects, as defined by House Bill 817, include benefit-cost, congestion, safety, economic competitiveness, freight, multimodal, pavement condition, land width, and shoulder width data.[105] Development of this scoring criteria occurred during P2.0, and the lack of change in criteria signals this scoring method's level of acceptance.[106] Region and division quantitative criteria also include a score for accessibility and connectivity to employment centers, tourist

[100] Ibid.
[101] Wasserman, 2012.
[102] North Carolina Department of Transportation, 2013b.
[103] Ibid.
[104] Patel et al., 2013.
[105] General Assembly of North Carolina, 2013.
[106] North Carolina Department of Transportation, 2013b.

destinations, or military installations.[107] NCDOT added this last criterion for P3.0.[108] Legislation does not dictate non-highway project scoring criteria. Instead, the legislation allows NCDOT to create the prioritization method contingent on the requirement that the scores are based on at least four quantitative criteria. Appendix 3 shows the scoring weights for each mode of transportation.

While the method of prioritization of projects is based heavily on the priority ranking, the rankings are not the only requirement for inclusion in the State Transportation Improvement Program (STIP). Figure 3.1 illustrates the four criteria for inclusion in the STIP.

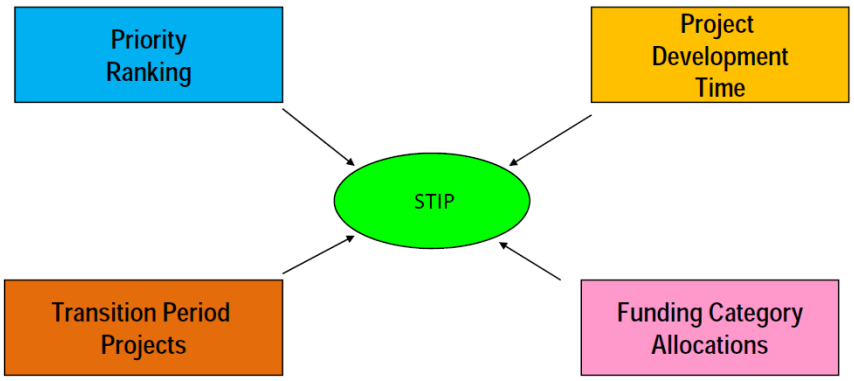

Figure 3.1: Criteria for Project Inclusion in the State Transportation Improvement Program

NCDOT gives some weight to the project delivery time since funding cannot be allocated until required planning activities are completed. Additionally, some state and federal statutes could constrain the funding for certain projects. NCDOT also needs to consider transition period projects that are scheduled to be obligated for construction prior to July 1, 2015.[109] Projects are, therefore, included in the STIP after consideration of priority ranking, project development time, funding category allocations, and transition period projects.

3.4.3 Method of Funding

Highway revenues fund the North Carolina State Highway Trust Fund. Those revenues combined with federal aid funds support the SMF. State, regional, and division projects will each receive a portion of the funds: 40% of the funds will be used for statewide projects; 30% for regional projects; and 30% for division projects. The total funding of NCDOT is $4.4 billion of which $1.8 billion (41%) will be available for the SMF.[110] Appendix 4 provides the funding sources and uses for all NCDOT funds.

A number of funds are excluded from the SMF, including the following:

- Federal Congestion Mitigation and Air Quality Improvement Funds

[107] General Assembly of North Carolina, 2013.
[108] North Carolina Department of Transportation, 2013b.
[109] North Carolina Department of Transportation, 2013a.
[110] Ibid.

- Competitive awards or discretionary grants
- Funds dedicated to the Appalachian Development Highway System projects
- Repayment of Grant Anticipation Revenue Vehicle Bonds
- Funds already obligated for projects that are scheduled for construction as of April 1, 2013

Additionally, a number of projects that rely on federal programs or have alternative prioritization criteria are not included in the quantitative criteria detailed in the SMF but compete for the same funds. These projects fall under the following federal programs or conditions:

- Federal Surface Transportation Program
- Federal Transportation Alternatives
- Federal Railway-Highway Crossings Program
- Federal funds for municipal roads
- Time-critical job creation opportunities[111]

Projects with alternate prioritization criteria include the following:

- Bridge replacement
- Interstate maintenance
- Highway safety improvement projects

The bridge replacement program already has another prioritization methodology in place and dedicated funds. The interstate maintenance program also has dedicated funds and touches every highway in a ten-year period. Spot safety is defined by federally-approved safety spot programs.[112]

As previously mentioned, a large portion of the funds are dedicated to transition period projects. Figure 3.2 shows the amount of funds available to the SMF following exclusion of the transition period projects.

[111] General Assembly of North Carolina, 2013.
[112] Patel et al., 2013.

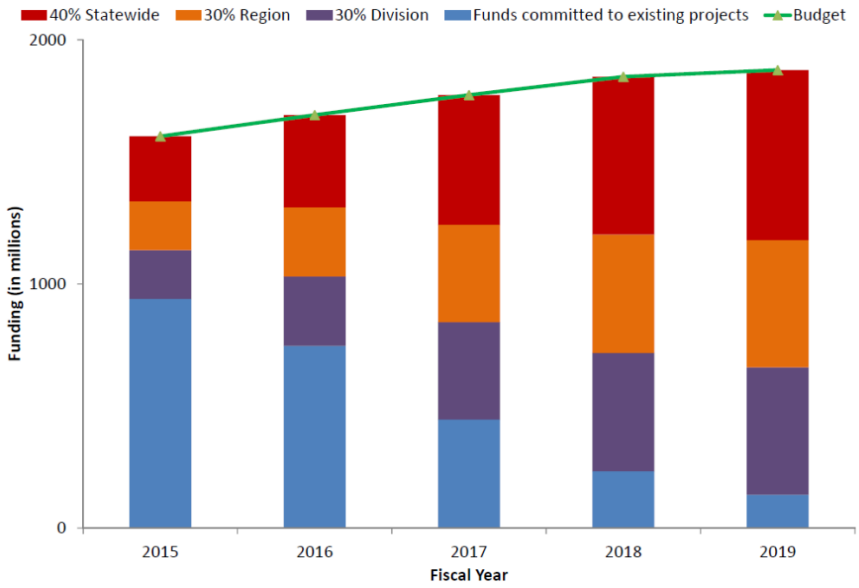

Figure 3.2: Funding for the Strategic Mobility Formula and Transition Period Projects

Committed funds will slowly dissipate through the years, allowing more projects to enter prioritization according to the new ranking scheme.

House Bill 817 dictates funding caps for individual projects and variance caps for funding groups. One cap requires funds for any one statewide project shall not exceed 10% of projected funds over a five-year period.[113] The variance of funding distribution is dictated as follows:

- State, region, and division fund percentage variance must be less than 5% over a five-year period
- Among each region or division, variance must be less than 10% over a five-year period[114]

The purpose of these caps is to prevent unfair and drastic changes of the allocation of funds.

3.5 Lessons Learned

Through the implementation of the strategic prioritization process, NCDOT has accumulated knowledge to successfully and continually improve their prioritization process. This portion of the paper focuses on the lessons learned for encouraging participation, comparing all modes of transportation, and including economic development in the prioritization process.

3.5.1 Participation by All Related Parties

NCDOT attributes the success of the introduction of P3.0 to its work group, whose main purpose was to develop methods for project submittal and scoring. The original work group included local planners, but slowly grew to 25 members with representatives from MPOs, RPOs, advocacy groups, NCDOT staff, the Federal Highway Administration, and legislative research

[113] General Assembly of North Carolina, 2013.
[114] Ibid.

staff.[115] The frequency of meetings increased from monthly (starting in May 2012) to weekly as more interests and responsibilities grew as well.[116] The work group used a consensus approach, rather than a voting approach, to balance its members' various interests and issued a memorandum of understanding (MOU) after each meeting. Despite differences of opinion, the work group was satisfied overall with the meetings and their results.

One potential pitfall that NCDOT is conscious of is the possible attack on the data collected and used for its scoring criteria. NCDOT officials believe the best way to combat the possible criticism of its data is to be as transparent as possible.[117] The work group has published each of its MOUs, and NCDOT will publish the final scores for each of the projects.

Competing Modes of Transportation

One major goal of the SMF is for all modes of transportation to compete based on one prioritization method. However, the work group quickly discovered a lack of precedent for this approach and had to consider options that allow all modes to compete for funding fairly. Thus, the SMF separates the modes into six separate formulas with varying scoring criteria. NCDOT plans to incorporate all modes of transportation into one formula in the future.[118]

One option originally considered was to require no normalization and to prioritize based solely on the scores produced by the formulas. On the state level, the work group decided this was adequate since very few modes of transportation actually compete. On the regional and division levels, relying solely on the scores was a weak form of comparison since many more modes of transportation were competing for funds, all with separate scoring criteria.[119]

For the region and division projects, the work groups considered comparing projects based on benefit-cost analysis, statistical analysis, and historical spending and expenditures. The work group decided to pursue the last option and have a minimum of 90% of funds allocated for highway projects and a minimum of 4% of funds allocated for non-highway projects. Table 3.1 shows the proposed minimums along with historical budgeted and actual expenditures.[120]

Table 3.1: Proposed Minimum Funding Allocation for Regional and Division Projects

Mode	Proposed Minimums for Regional Impact and Division Needs Categories	Historical Budgeted	Historical Expenditures
Highway	90% (minimum)	93%	96%
Non-Highway	4% (minimum)	7%	4%

[115] North Carolina Department of Transportation, 2014.
[116] North Carolina Department of Transportation, 2013b.
[117] Patel et al., 2013.
[118] Ibid.
[119] North Carolina Department of Transportation, 2013b.
[120] Ibid.

The scores from the SMF will then inform the prioritization of the projects within highway and non-highway modes of transportations.

The work group suggested NCDOT pursue statistical analysis for implementation into P4.0. NCDOT plans to request an independent consultant to help them implement the normalization procedure based on statistical analysis.[121]

3.5.2 Economic Development

NCDOT incorporates economic development into the SMF through an economic competitiveness criterion that is included in the highway project scoring. The economic competitiveness score is based on expected economic outcomes (not on current data). These economic outcomes are determined from Transportation Research Economic Development Impact System (TREDIS), which is an economic impact model. While TREDIS cannot predict the exact outcome, the industry recognizes TREDIS nationally as a reliable model. The work group did not increase the weight of economic competitiveness above 10% since it is based on predictive analysis. However, they are willing to increase it to 20% should NCDOT require it.[122]

NCDOT equally considers the change in gross domestic product (GDP) and job creation in its final score for economic competitiveness. The baseline GDP is calculated using Bureau of Labor Statistics data and is compared with Moody's economic model, which projects the economy 30 years out by inputting expected travel-time savings, project location, and freight traffic. NCDOT only considers long-term employment effects in the scoring criteria although TREDIS measures both short-term and long-term employment impacts. [123]

3.6 Relevance to Texas

Considering other states' initiatives and policies, the foremost question to ask throughout the process is "Can that work here?" While Texas and North Carolina differ in some ways, they do share many similarities.

3.6.1 Physical Similarities

Both states have large state-controlled highway systems to operate and interstates that are major thoroughfares for long-distance travel and freight movement (north and south movement along the Eastern Seaboard in North Carolina, and transnational movement in Texas). Both also have coastlines with significant port operations, and hub airports for major airlines. NCDOT maintains 80,214 miles of highway (as of 2008).[124] TxDOT oversees and maintains 80,212 miles of highway (as of 2008).[125]

[121] Ibid.
[122] North Carolina Department of Transportation, n.d.
[123] Ibid.
[124] Hartgen, et al., 2013.
[125] Ibid.

3.6.2 Political Similarities

The governors of both states are Republican, and in both state legislatures, the Republican Party has a strong majority in both houses. Hence, both tend to be conservative and hesitant to raise taxes and fees, or create new ones, which can have a detrimental impact on the construction and maintenance of the state highway systems. With rates held in place for years, while operating costs rise, there is a strain on the highway system.

While the heads of the respective transportation departments are chosen differently, they both report to multiple bodies: the TxDOT Executive Director reports to the Texas Transportation Commission and the Legislature; the NCDOT director reports to the Governor, Board of Transportation, and Assembly (Table 3.2). In North Carolina, the Assembly passes a budget for NCDOT, but generally does not get involved in project selection. The Texas Legislature tends to be more involved in the project selection process.

Table 3.2: Governing Bodies of Transportation Departments

Texas	North Carolina
Governor appoints 5-member Transportation Commission	Governor appoints 19-member Board of Transportation (1 member from each of 14 geographic Divisions, and function-specific positions)
Transportation Commission appoints Executive Director of TxDOT	The Governor also directly appoints the Secretary of Transportation who serves in the North Carolina Cabinet.
Executive Director reports to Transportation Commission and State Legislature (150 Representatives, 31 Senators)	The Secretary of Transportation reports to the Governor, the Board of Transportation, and to the General Assembly (50 Senators, 120 Representatives in single member districts)
Legislature meets regularly every other year	Assembly meets for six months in odd-numbered years, and six weeks in even-numbered years

3.6.3 Economic Similarities

Both states have a burgeoning economy. Two North Carolina cities (Charlotte and Raleigh) held the first two positions in CNN's top-ten list of cities that grew over 30% from 2000 to 2010.[126] Three Texas cities are on the list (Austin, McAllen, and San Antonio).[127] The technology sector is an important part of the economy in both Raleigh and Austin. Transportation agencies can tap into the talent provided by the companies, universities, and other locally based organizations to find creative ways to improve transportation planning and make the implementation process most efficient.

[126] Christie, 2012.
[127] Ibid.

The diversity of economies is also similar in both states. North Carolina and Texas both have metropolitan areas with more than one million residents, but also have very rural areas, and consequently must create transportation plans that can encompass urban, suburban, and rural needs.

3.6.4 What Texas is Doing Now

TxDOT funds its projects through 12 categories (included in Volume 3 Appendix 6: Texas Department of Transportation Funding Streams).[128] Unlike NCDOT's direct funding into modes of transportation, TxDOT funds through topical categories. The Texas Legislature also directly funds projects as witnessed by Rider 42, whereas the North Carolina General Assembly leaves project selection to NCDOT.[129]

TxDOT structures its prioritization in five tiers:

- 2-Year Letting Schedule
- Statewide Transportation Improvement Program (4 years)
- Unified Transportation Plan (10 years)
- Metropolitan Transportation & Rural Transportation Plans (20 years)
- Statewide Long-Range Transportation Plan (24 years)

Within this prioritization scheme, the Unified Transportation Plan (UTP) most closely resembles North Carolina's SMF. The UTP contains some prioritization via a point system to assign points to projects. The scoring is based on three broad categories: Project Need, Funding Availability, and Project Readiness (with a slight advantage given to Project Need).

Texas could benefit from learning about the SMF, though the lessons learned will not be fully realized until the new SMF reaches full implementation in 2015. Once the method is implemented and feedback is provided from a variety of stakeholders, the SMF can be better analyzed for its ability to successfully achieve the desired goals.

[128] Texas Department of Transportation, 2013.
[129] Lomax, 2013.

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Volume 3 Appendix 2: NCDOT Transportation Modes and Tiers

THE TRANSPORTATION MODES AND TIERS

Mode	Statewide Tier	Regional Tier	Sub-regional Tier
Highway—*Projects where the primary purpose is to improve the highway system.*	The Strategic Highway Corridors (SHC) as approved by the Board of Transportation	All primary routes (US and NC) not on the Statewide Tier	All secondary routes (SR) not on the Statewide Tier
Rail (Passenger & Commuter)—*Projects where the primary purpose is to improve passenger rail service. Rail safety projects may be classified as a rail project or a highway project, depending how they are classified in the State Transportation Improvement Program.*	All intercity (including out-of-state) passenger rail service and station facilities associated with intercity services	Commuter rail service and associated station facilities which serve commuters between two or more counties	Commuter and light rail service and associated station facilities which serve commuters *within* a county
Rail (Freight)—*Projects where the primary purpose is to improve freight rail service. Rail safety projects may be classified as a rail project or a highway project, depending how they are classified in the State Transportation Improvement Program.*	Rail lines of strategic importance as determined by the Rail Division	All remaining rail lines not included on the Statewide Tier	N/A
Ferry—*Projects where the primary purpose is to improve the ferry system.*	Ferry routes connecting Statewide Tier Highway facilities	Ferry routes connecting Regional Tier Highway facilities	Ferry routes connecting Subregional Tier Highway facilities
Aviation—*Projects where the primary purpose is to improve the publicly-owned airports.*	Commercial service airports with at least 100,000 annual enplanements	Commercial service airports (Part 139 Certificated) with less than 100,000 annual enplanements *OR* General aviation airports with at least 25 based aircraft	General Aviation airports with fewer than 25 based aircraft
Public Transportation—*Projects where the primary purpose is to improve the public transportation system and regional/urban/rural transit systems.*	Bus service and associated station facilities which serve out-of-state travel	Bus and vanpool service and associated stations facilities and passenger amenities which serve commuters *between* two or more counties	Bus and vanpool service and associated stations facilities and passenger amenities which serve commuters within a county
Bicycle & Pedestrian—*Projects where the primary purpose is to enhance the Bicycle and Pedestrian system. Projects that include improving a roadway facility and enhancing bicycle access (such as a resurfacing project which includes adding wide outside shoulders) are classified as highway projects. Stand-alone projects that add wide outside shoulders are classified as bicycle and pedestrian projects.*	NC bicycling highways (on-road)	NCDOT designated multi-county regional routes (on-road) *OR* Off-road facilities spanning multiple jurisdictions with a length of at least 20 miles	Off-road facilities with a length shorter than 20 miles *OR* Town, city, or county on-road bicycle networks *OR* All sidewalks
Ports & GTP—*N/A*	All facilities		

Note: If a project is located at the intersection of more than one tier, the project is classified by the higher tier. An exception is an intersection, interchange or grade separation where the project improves only one of the facilities. In this case, the project is classified according to the facility in which the improvement is located. For example, a project that converts a grade separation to an interchange (on a freeway) is classified by the tier of facility which currently does not have access to the freeway.

For more information on the North Carolina Multimodal Investment Network tier system, please visit http://www.ncdot.gov/performance/reform/NCMINmaps/default.html

Source: North Carolina Department of Transportation, *Policy to Projects*, 2012.

Volume 3 Appendix 3: NCDOT Modes of Transportation Scoring Criteria

The following is an excerpt from the "Report to the Joint Legislative Transportation Oversight Committee."

Appendix A – Highway and Non-Highway Scoring Criteria

Scoring Overview – Development of Criteria and Approach

Scoring criteria, measures, and weights for each transportation mode were developed as a result of reviewing the requirements introduced in the draft Strategic Transportation Investments bill. Department staff and P3.0 workgroup members drew upon their professional expertise and experience in evaluating proposed approaches in a time sensitive manner. Workgroup members took a deliberative approach and scrutinized proposed criteria to ensure a quantitative methodology was used for scoring projects. Criteria scoring approaches for each transportation mode are outlined and additional descriptions of each criteria are found in each respective subsection in this Appendix.

Highway – Appendix A1

The workgroup recognized nearly all the eligible highway criteria in the draft bill were already in use in the Department's existing strategic prioritization process. This was an indication that previous highway scoring models have gained a level of acceptance and the criteria are considered to be consistently and fairly used throughout the state. The only new criteria were accessibility and connectivity to employment centers, tourist destinations, or military installations. With the exception of the economic competitiveness factor, the selected criteria were quantitatively measurable today. The economic competitiveness criterion was an output of an economic model that measured anticipated future benefits. However, the inputs to the model were travel time savings and construction costs which are provided by today's available data. The highway approach was built to score projects on a 100 point scale.

Aviation – Appendix A2

The NC Division of Aviation (NCDOA) developed the NC General Aviation Airport Development Plan in 2003. This plan provides eligible airports the guidance to determine what projects are eligible for funding as well as the projects that are needed to meet minimum and recommended FAA criteria to protect safety, preserve infrastructure health, and enhance mobility. The NCDOA Project Rating utilizes the core of this criterion to evaluate each airport project request independently based on the need and purpose of the project. The criteria produced a prioritized list of projects ranging from the highest ranking project, receiving 75 points, to the lowest, receiving one point. Federal Aviation Regulation (FAR) Order 5100.39, Airport Capital Improvement Plan (ACIP), is FAA's primary tool for prioritizing projects. Recognizing this, the division synchronized their point system with the NCDOA Rating seventy-five point rating scale. This criterion is appropriately named FAA ACIP. The next two criteria, Local Investment Index and Federal Investment Index, deal with ratios of the local funds or federal funds going toward the proposed project as compared to the total state investment. The

intent is to award higher points toward projects that have lower percent state participation, therefore, leveraging the State's investment. Lastly, the Volume/Demand Index provides higher points toward projects where there is more aircraft traffic and higher number of jobs located near the site.

The Division of Aviation researched several national publications, other state's criteria, met with current and former airport directors, and multiple lead aviation planners from across the country while developing these criteria.

Data sources required to score projects include the airport's FAA approved Airport Layout Plan (ALP), FAA Master Record Data (which is based aircraft, aircraft operations, and recorded Instrument Flight Rule (IFR) operations). US Census data is also used to synthesize the number of jobs near the airport project site.

Bicycle and Pedestrian – Appendix A3

The Bicycle and Pedestrian Division began with the methodologies used during Prioritization 1.0/2.0 processes and began developing a methodology for P3.0 prior to the introduction of House Bill 817. The previous workgroup discussions had already produced a good framework for quantifying and ranking bicycle and pedestrian projects. Most of these concepts for scoring projects were identified through a survey of NC MPO/RPO and national methodologies (FHWA research) for ranking bicycle and pedestrian projects.

Bicycle and pedestrian division staff took the concepts developed by the workgroup and created the specific measures and found more reliable data sources to match. Data sources to be used largely come from the US Census (population/employment data), the NCDOT bicycle and pedestrian crash database, NCDOT roadway data containing posted speeds, and local inputs (destination types, ROW acquisition, project costs, etc.).

Similar to highway projects, quantitative scores for bicycle and pedestrian projects will be generated through a geographic information system. The scoring range is 0-100 scale per criteria as the user uploads data per project. Therefore, normalizing a set of scores after input is not an option for bicycle and pedestrian projects. The study of a range of historic or estimated project scores caused staff to improve the methodology to keep the bulk of project scores within a reasonable range of a 50% score.

Ferry – Appendix A4

As a result of Session Law 2013-183 Ferry Division personnel worked vigorously with SPOT and other experts to develop a data centric methodology for evaluating projects and establishing a scoring system to rank these projects on a 100 point scale. The initial efforts included, but were not limited to the following:

- Extensive review of existing data that has been historically collected.
- Development of new review and rating methodologies to better define traits and characteristics related to the Ferry Division assets and operations (of which there was no pre-existing assessment system in place).

- Extensive analysis of this data to understand its true meaning and to use that understanding to better develop scoring methodologies that fairly treat all ferry routes even though they have differing characteristics (i.e. commuter, tourist, & mix).

Based on the input of numerous parties and the Prioritization 3.0 workgroup the Ferry staff continued to improve the *quantitative* aspects associated with the scoring methodologies including the following adjustments:

- Banded scoring ranges were abandoned. This resulted in improved quantitative results in 3 different criteria (Safety, Connectivity/Accessibility, & Capacity/Congestion).
- A modified point system for Benefit Cost criteria was produced which resulted in more evenly distributed scoring based on real world conditions.
- Direct ratio approach (based on real world costs) was implemented with Asset Efficiency criteria.

Public Transportation – Appendix A5

Public Transportation Division's (PTD) overall approach to develop criteria and set up formulas/measures utilized Federal Transit Administration (FTA), National Transit Database (NTD), Federal Highway Administration (FHWA) , Institute for Transportation Research and Education (ITRE), Ernst & Young, and Operating Statistics (OPSTATS) collected from transit systems. PTD coordinated and collaborated with community transportation systems, urban transit systems (i.e. CATS and TTA), Metropolitan Planning Organizations (MPOs), Rural Planning Organizations (RPOs), and FTA. PTD will rely on data from the National Transit Database and operating statistics (OPSTATS) from the Institute for Transportation Research and Education (ITRE). The methodology used to stay within the 100 point scale reflected calculations based on quantitative data produced by the criteria formulas.

Rail – Appendix A6

Rail Division staff worked toward a 100 point scale and researched proposed Rail criteria and solicited input from the railroad industry and other rail planning experts. Research of project appraisal frameworks was also conducted on an international basis. Limited data and data driven measure were located. Available nonproprietary data elements and economic models that could be used were identified and selected for utilization. The TREDIS model was selected for benefit/cost and economics competitive scoring to be consistent with model used for highway scoring.

Capacity/congestion, mobility, safety, accessibility and connectivity criteria were selected in addition to those scored through TREDIS. Those criteria were developed using railroad track charts, the NC Statewide Authoritative Railway and Highway (SARAH) database, ridership & other studies, track capacity studies and facility design standards. The objective was to evaluate projects based on their total and relative benefits to the state. To maintain consistency and maximize use of raw data, only daily volume data was used and logarithmic functions were employed to scale criteria scores as required by the law.

Following the August 7, 2013, BOT meeting, the Department published an expanded version of its recommended scoring criteria, measures, and weights. The following table provides abbreviated definitions/descriptions of scoring criteria for highways and non-highway modes.

Highway Scoring

Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Statewide Mobility	**[Travel Time] Benefit/Cost = 30%** Travel time savings the project is expected to provide over 30 years divided by the cost of the project to NCDOT **Congestion = 30%** Comparison of the existing traffic volume to the existing capacity of the roadway (depending on data availability, Congestion may be measured by comparing congested travel speeds to uncongested speeds) **Economic Competitiveness = 10%** Estimate of the number of long-term jobs and the % change in economic activity within the NCDOT Division the project is expected to provide over 30 years **Safety = 10%** Evaluation of the number, severity, and frequency of crashes along the roadway **Multimodal [& Freight + Military] = 20%** Measure of existing congestion along key military and truck routes, and routes that provide connections to transp. terminals **Total = 100%**	--	--
Regional Impact	**[Travel Time] Benefit/Cost = 30%** Travel time savings the project is expected to provide over 30 years divided by the cost of the project to NCDOT **Congestion = 30%** Comparison of the existing traffic volume to the existing capacity of the roadway (depending on data availability, Congestion may be measured by comparing congested travel speeds to uncongested speeds) **Safety = 10%** Evaluation of the number, severity, and frequency of crashes along the roadway **Total = 70%**	**15%**	**15%**

Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Division Needs	**[Travel Time] Benefit/Cost = 20%** Travel time savings the project is expected to provide over 30 years divided by the cost of the project to NCDOT **Congestion = 20%** Comparison of the existing traffic volume to the existing capacity of the roadway **Safety = 10%** Evaluation of the number, severity, and frequency of crashes along the roadway **Total = 50%**	**25%**	**25%**

Note: Divisions 1, 2, 3, 4 have approved different criteria and weights for their respective areas (refer to Appendix A1, Highway Scoring Slides).

Aviation Scoring

Funding Category	Quantitative Data (75-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Statewide Mobility	**NCDOA Project Rating = 40%** Projects prioritized and classified within NC Division of Aviation (NCDOA) established project categories. Assigns point values based on priority of the project and need of the project **FAA Airport Capital Improvement Plan = 40%** Federal Aviation Administration Airport Capital Improvement Plan (ACIP) Rating. Ratings based on critical airport development and capital needs within National Airspace System (NAS) **Local Investment Index = 10%** A measurement of the project's local funds compared to state funds and provides greater points for projects that have a higher % of local funding sources (i.e. local or public-private funds) **Federal Investment Index = 10%** A measurement of the project's federal funds compared to state funds and provides greater points for projects with higher % of federal funds verses state funds **Total = 100%**	--	--
Regional Impact	**NCDOA Project Rating = 40%** Projects prioritized and classified within NC Division of Aviation (NCDOA) established project categories. Assigns point values based on priority of the project and need of the project **FAA Airport Capital Improvement Plan = 20%** Federal Aviation Administration Airport Capital Improvement Plan (ACIP) Rating. Ratings based on critical airport development and capital needs within National Airspace System (NAS) **Local Investment Index = 5%** A measurement of the project's local funds compared to state funds and provides greater points for projects that have a higher % of local funding sources (i.e. local or public-private funds) **Federal Investment Index = 5%** A measurement of the project's federal funds compared to state funds and provides greater points for projects with higher % of federal funds verses state funds **Total = 70%**	**15%**	**15%**

Funding Category	Quantitative Data (75-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Division Needs	**NCDOA Project Rating = 30%** Projects prioritized and classified within NC Division of Aviation (NCDOA) established project categories. Assigns point values based on priority of the project and need of the project **FAA Airport Capital Improvement Plan = 10%** Federal Aviation Administration Airport Capital Improvement Plan (ACIP) Rating **Local Investment Index = 5%** A measurement of the project's local funds compared to state funds and provides greater points for projects that have a higher % of local funding sources (i.e. local or public-private funds) **Volume/Demand Index = 5%** Index representing traffic (aircraft operations) plus employment density (jobs near the airport). Identifies projects where there is more traffic and in areas with more user demand **Total = 50%**	**25%**	**25%**

Bicycle & Pedestrian Scoring

Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Division Needs	**Access = 10%** This criterion measures community benefit as a result of constructing the proposed project, and is measured by the quantity and significance of destinations associated with the proposed project. Access benefit is also measured by the proximity of the proposed project to the most important end destination **Constructability = 5%** This criterion measures the readiness of a project to be constructed in the near term. Factors such as secured right-of-way, environmental impact, and preliminary engineering work complete are used to calculate this score **Safety = 15%** This criterion uses bicycle and pedestrian crash data and speed limit information along project corridors to determine the existing safety need **Demand Density = 10%** This criterion measures user benefit as a result of constructing the proposed project, and it is measured by the density of population and employment within a walkable or bike-able distance of the proposed project **Benefit/Cost = 10%** This criterion adds the Access and Demand scores together to create a combined benefit score, and then the benefit is divided into the cost of the project to NCDOT **Total = 50%**	**25%**	**25%**

Ferry Scoring

Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Regional Impact *(Note: all vessels are excluded from this category)*	**Safety [Route Health Index] = 15%** The safety analysis of the ferry route based an Asset Health Index that is determined based on the condition ratings of the vessels and the ramps & gantries **Benefit/Cost [Travel Time] = 15%** Travel time savings determined by comparing the travel hours saved by utilizing the various ferry routes instead of taking the shortest available alternative route **Accessibility/Connectivity = 10%** A measurement of the accessibility and connectivity provided by the various routes based on the number of points of interest within travel radii of 10, 20, & 30 miles **Asset Efficiency = 10%** An evaluation of the cost effectiveness of asset operations in respect to continued maintenance on an asset versus the replacement costs of the subject asset **Capacity/Congestion = 20%** A measure of the capacity/congestion by an evaluation of the vehicles that are left behind each time a ferry vessel departs compared to the total numbers of vehicles carried by the route in a year **Total = 70%**	**15%**	**15%**
Division Needs	**Safety [Route Health Index] = 15%** The safety analysis of the ferry route based an Asset Health Index that is determined based on the condition ratings of the vessels and the ramps & gantries **Benefit/Cost [Travel Time] = 15%** Travel time savings determined by comparing the travel hours saved by utilizing the various ferry routes instead of taking the shortest available alternative route **Accessibility/Connectivity = 10%** A measurement of the accessibility and connectivity provided by the various routes based on the number of points of interest within travel radii of 10, 20, & 30 miles **Asset Efficiency = 10%** An evaluation of the cost effectiveness of asset operations in respect to continued maintenance on an asset versus the replacement costs of the subject asset **Total = 50%**	**25%**	**25%**

Public Transit Scoring (Expansion)

Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Regional Impact	**Benefit/Cost = 45%** • Assesses the projected ridership for the life of the expansion vehicle relative to the cost of the vehicle to the state **Vehicle Utilization Data = 5%** • Examines how systems are maximizing current fleet **System Safety = 5%** • Compares system safety statistics to the national average **Connectivity = 5%** • Measures the connectivity of the proposed expansion of service to destinations (education, medical, employment, retail, other transfers) **System Operational Efficiency = 10%** • Compares the number of trips to revenue hours reported **Total = 70%**	**15%**	**15%**
Division Needs	**Benefit/Cost = 25%** • Assesses the projected ridership for the life of the expansion vehicle relative to the cost of the vehicle to the state **Vehicle Utilization Data = 5%** • Examines how systems are maximizing current fleet **System Safety = 5%** • Compares system safety statistics to the national average **Connectivity = 5%** • Measures the connectivity of the proposed expansion of service to vital destinations **System Operational Efficiency = 10%** • Compares the number of trips to revenue hours reported **Total = 50%**	**25%**	**25%**

Public Transit Scoring (Facilities)

Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Regional Impact	**Age of Facility, Facility Demand, Park & Ride, Bus Shelter = 40%** Age: examines the age of the facility compared to the useful life of the facility Facility Demand: measures the demand for new or expanded maintenance and operations facilities Park & Ride: compares utilization to cost to state to construct Bus Shelter: examines current demand (boardings and alightings) at the proposed shelter location **Benefit-Cost = 5%** Examines the benefit (trips) relative to the cost of the project to the state **System Operational Efficiency = 5%** Compares the number of trips to revenue hours reported **Facility Capacity = 20%** Identifies the need for additional capacity by comparing proposed capacity, current usage, and current capacity **Total = 70%**	**15%**	**15%**
Division Needs	**Age of Facility, Facility Demand, Park & Ride, Bus Shelter = 30%** Age: examines the age of the facility compared to the useful life of the facility Facility Demand: measures the demand for new or expanded maintenance and operations facilities Park & Ride: compares utilization to cost to state to construct Bus Shelter: examines current demand (boardings and alightings) at the proposed shelter location **Benefit-Cost = 5%** Examines the benefit (trips) relative to the cost of the project to the state **System Operational Efficiency = 5%** Compares the number of trips to revenue hours reported **Facility Capacity = 10%** Identifies the need for additional capacity by comparing proposed capacity, current usage, and current capacity **Total = 50%**	**25%**	**25%**

Public Transit Scoring (Fixed Guideway)

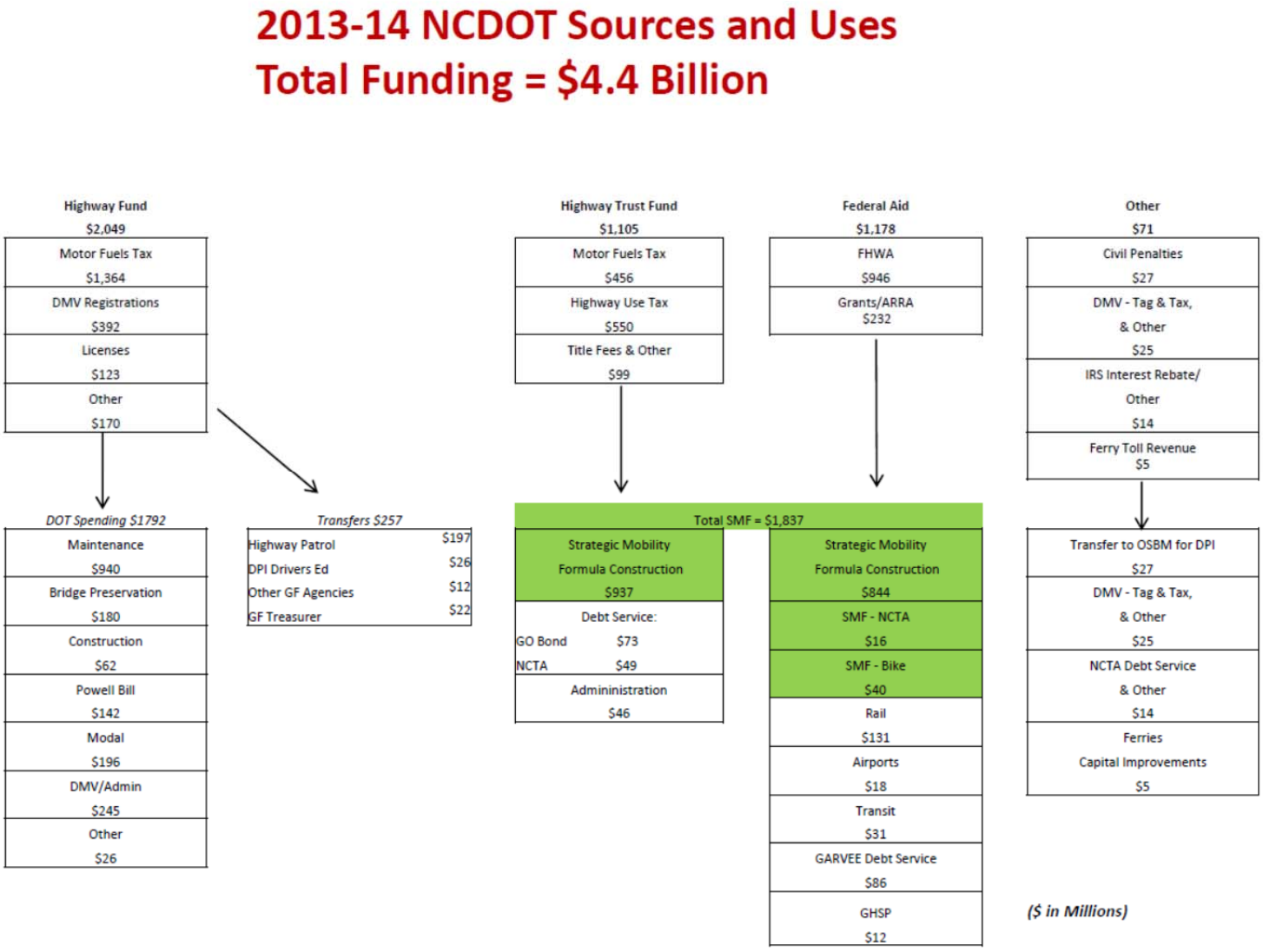
Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Regional Impact	**Mobility = 20%** Measures the project usage (annual trips) **Cost Effectiveness = 15%** Measures the cost effectiveness of the project per trip over the life of the project **Economic Development = 20%** Measures the new employment and population growth in the fixed guideway corridor over 20 years **Congestion Relief = 15%** Travel time savings the project is expected to provide over 30 years divided by the cost of the project **Total = 70%**	**15%**	**15%**
Division Needs	**Mobility = 15%** Measures the project usage (annual trips) **Cost Effectiveness = 15%** Measures the cost effectiveness of the project per trip over the life of the project **Economic Development = 10%** Measures the new employment and population growth in the fixed guideway corridor over 20 years **Congestion Relief = 10%** Travel time savings the project is expected to provide over 30 years divided by the cost of the project **Total = 50%**	**25%**	**25%**

Rail Scoring (Track and Structures)

Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Statewide Mobility (Class I Freight Only)	**Benefit/Cost = 20%** Benefits associated with emissions savings, fuel savings, travel time savings divided by the project cost to the state **Economic Competitiveness = 10%** High-level relative measure of the anticipated statewide benefits of project improvements in numbers of jobs **Capacity/Congestion = 15%** Percentage that the existing track segment is over- capacity **Safety = 15%** Crash potential for railroad/highway at-grade crossings **Accessibility = 10%** Measures the potential for new or improved accessibility to rail service for industries by a freight rail project **Connectivity = 10%** Values projects on strategic corridors, carrying military, ports, intermodal and transload traffic **Mobility = 20%** Measures either the change in percentage of available capacity or travel time savings provided by project **Total = 100%**	--	--

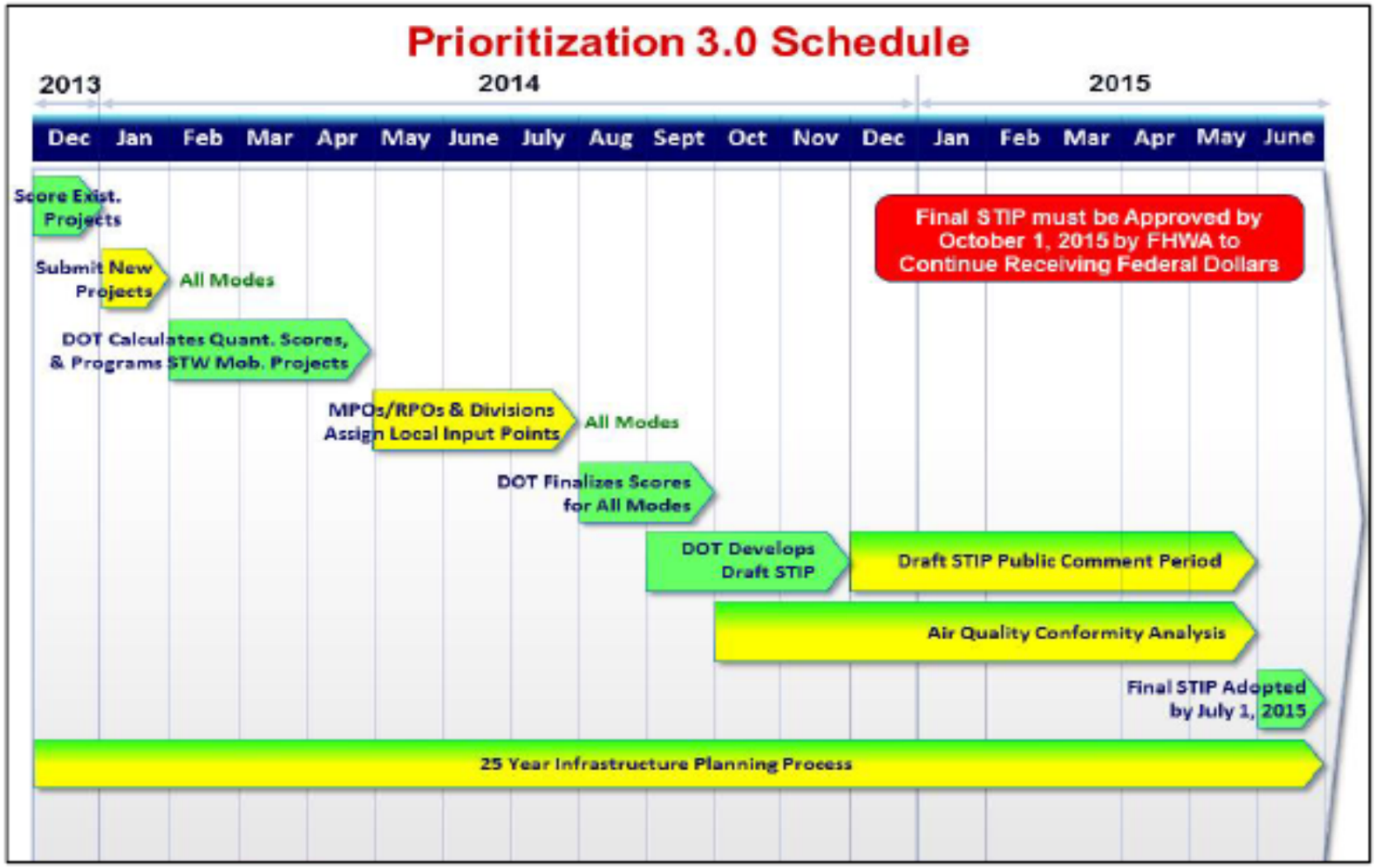
Funding Category	Quantitative Data (100-point scale)	Local Input	
		Division Rank	**MPO/RPO Rank**
Regional Impact (Freight / Passenger)	**Benefit/Cost = 10% (freight) / 10% (passenger)** Benefits associated with emissions savings, fuel savings, travel time savings divided by the project cost to the state **Capacity/Congestion = 15% (freight) / 25% (passenger)** Percentage that the existing track segment is over- capacity **Safety = 15% (freight) / 15% (passenger)** Crash potential for railroad/highway at-grade crossings **Accessibility = 10% (freight only)** Measures the potential for new or improved accessibility to rail service for industries by a freight rail project **Connectivity = 5% (freight only)** Values projects on strategic corridors, carrying military, ports, intermodal and transload traffic **Mobility = 15% (freight) / 20% (passenger)** Measures either the change in percentage of available capacity or travel time savings provided by project **Total = 70%**	**15%**	**15%**

Volume 3 Appendix 4: NCDOT Funding Breakdown



Source: North Carolina Department of Transportation, *2013-2014 NCDOT Sources and Uses*, 2013.

Volume 3 Appendix 5: Prioritization 3.0 Schedule



Source: North Carolina Department of Transportation, "Report to the JLTOC," 2013.

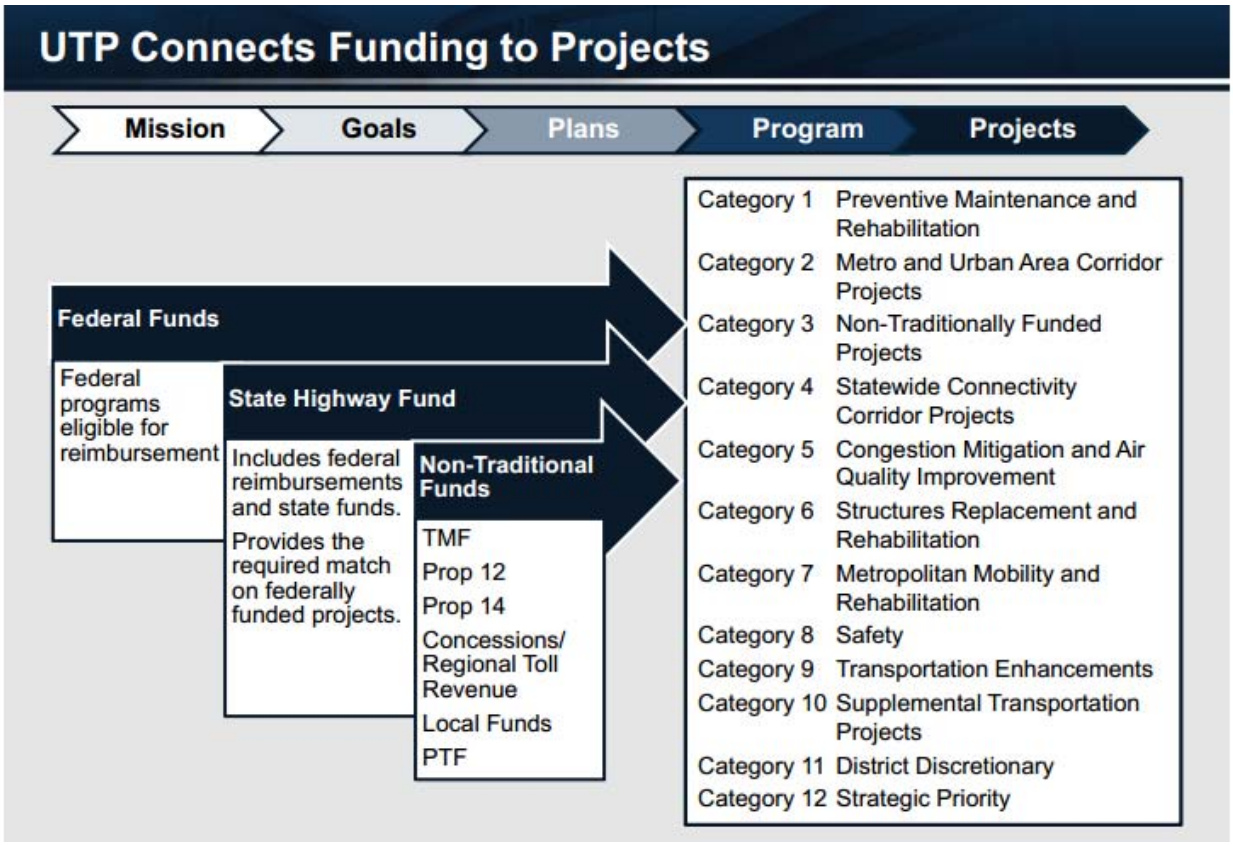
Volume 3 Appendix 6: Texas Department of Transportation Funding Streams

FUNDING AT A GLANCE

FUNDING CATEGORY	PROJECT SELECTION	USUAL FUNDING
1 - Preventive Maintenance and Rehabilitation	Projects selected by districts. Commission allocates funds through Allocation Program.	Federal 90% State 10% or Federal 80% State 20% or State 100%
2 - Metropolitan and Urban Area Corridor Projects	Projects selected by Metropolitan Planning Organizations (MPOs) in consultation with TxDOT. Commission allocates funds through Allocation Program.	Federal 80% State 20% or State 100%
3 - Non-Traditionally Funded Transportation Projects	Project selection varies based on the funding source, such as Proposition 12, Proposition 14, Pass-Through Toll Finance, Regional Toll Revenue and Local Participation.	Federal 80% State 20% or State 100% or Local 100% Varies by agreement and rules
4 - Statewide Connectivity Corridor Projects	Projects selected by commission based on corridor ranking. Project total costs cannot exceed commission-approved statewide allocation.	Federal 80% State 20% or State 100%
5 - Congestion Mitigation and Air Quality Improvement	Projects selected by MPOs in consultation with TxDOT and funded by district's Allocation Program. Commission allocates funds based on population percentages within areas failing to meet air quality standards.	Federal 80% State 20% or Federal 80% Local 20% or Federal 90% State 10%
6 - Bridges Federal Highway Bridge Program; Federal Railroad Grade Separation Program	Projects selected by the Bridge Division as a statewide program based on the Federal Highway Bridge Program and the Federal Railroad Grade Separation Program eligibility and ranking. Commission allocates funds through Statewide Allocation Program.	Federal 90% State 10% or Federal 80% State 20% or Federal 80% State 10% Local 10%
7 - Metropolitan Mobility/ Rehabilitation	Projects selected by MPOs in consultation with TxDOT. Funded by district's Allocation Program. Commission allocates funds according to the federal formula.	Federal 80% State 20% or Federal 80% Local 20% or State 100%
8 - Safety Federal Highway Safety Improvement Program, Federal Railway-Highway Crossing Program, Safety Bond Program, Federal Safe Routes to School Program and Federal High Risk Rural Roads	Projects selected statewide by federally mandated safety indices and prioritized listing. Commission allocates funds through Statewide Allocation Program. Projects selected and approved by commission on a per-project basis for Federal Safe Routes to School Program.	Federal 90% State 10% or Federal 90% Local 10% or Federal 100% or State 100%
9 - Transportation Enhancements	Local entities nominate projects and TxDOT, in consultation with FHWA, reviews them. Projects selected and approved by commission on a per-project basis. Projects in the Safety Rest Area Program are selected by the Maintenance Division.	Federal 80% State 20% or Federal 80% Local 20%
10 - Supplemental Transportation Projects State Park Roads, Railroad Grade Crossing Replanking, Railroad Signal Maintenance, Landscape Incentive Awards, Green Ribbon Landscape Improvement, Curb Ramp Program, Coordinated Border Infrastructure Program, Comprehensive Development Agreements and Congressional High Priority Projects	Projects selected statewide by Traffic Operations Division or Texas Parks and Wildlife Department or district. Commission allocates funds to districts or approves participation in federal programs with allocation formulas. Coordinated Border Infrastructure Program funds are allocated to districts according to the federal formula.	State 100% or Federal 80% State 20% or Federal 100%
11 - District Discretionary	Projects selected by districts. Commission allocates funds through Allocation Program.	Federal 80% State 20% or Federal 80% Local 20% or State 100%
12 - Strategic Priority	Commission selects projects which generally promote economic opportunity, increase efficiency on military deployment routes or to retain military assets in response to the federal military base realignment and closure report, or maintain the ability to respond to both man-made and natural emergencies. Also, the commission approves pass-through financing projects in order to help local communities address their transportation needs.	Federal 80% State 20% or State 100%

Source: Texas Department of Transportation, *Project Selection Process*, 2013.

Volume 3 Appendix 7: Unified Transportation Plan Funding/Project Relationships



Source: Texas Department of Transportation, *2014 UTP Public Meeting.* Presentation, 2013.

Transportation Policy Brief #4

Oregon's Voluntary Road User Charge Program

kut.org

infrastructure-intelligence.com

TxDOT 0-6581-Task 19-4

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Volume 4. Transportation Policy Brief #4: Oregon's Voluntary Road User Charge Program

4.1 Introduction

This particular policy brief, "Oregon's Voluntary Road User Charge Program," was researched and written by Gregory Conte and Jane Santa Cruz.

4.2 Executive Summary

State governments, along with the U.S. Department of Transportation, have relied on motor fuel taxes for close to a century as a means to fund highway construction and maintenance, as well as other transportation projects. As an excise tax imposed on the sale of fuel for motor engines, the fuel tax was considered the most convenient and effective method of collecting revenues to fund transportation infrastructure. Today, that perception has changed as highly fuel-efficient or entirely electric vehicles enter road systems, and more rigorous standards for fuel efficiency in vehicles become the norm. While more vehicles today are on the roads than ever before, greater fuel efficiency means these vehicles are consuming less gas. This situation creates the need for both more roads and more maintenance for existing roads, yet also results in a dwindling revenue stream that fails to meet those demands.

The State of Oregon has undergone extensive policy implementation to remedy this inefficiency and identify an alternative method of tax collection that could replace the dwindling revenues that have been traditionally derived from fuel taxes. After much research, the Oregon Department of Transportation (ODOT) conducted two pilot programs, and recently received both legislative and executive approval to begin charging volunteer road users not by the amount of fuel they consume, but rather by the distance they travel through a flat per-mile rate. ODOT officials are currently conducting procurement processes and public relations initiatives to establish a larger pool of volunteers for their Road User Charge (RUC) Program set to begin on July 1, 2015.

The purpose of this report is to identify important lessons learned by ODOT throughout their process of implementing the RUC as an alternative source of funding, and determine how those lessons could be applied in Texas, if such an initiative is to be considered. ODOT's initiative has undergone years of extensive research, technical collaboration, public outreach, and significant legislative attention. While other states have recognized the dire need to remedy their revenue collections and have considered an alternative method focused on road user fees, they have failed to successfully address the issue. Oregon has taken the lead on this issue by undertaking multiple pilot programs and passing legislation. Other states have much to learn from Oregon in terms of how drivers can equitably pay for the roads they use, regardless of the type of vehicle they drive.

The main lessons learned by Oregon can be summarized as the following:

- Consumer choice, in the form of an open market system, is essential in implementing a policy centered on collecting revenues on behalf of the state.
- RUC messaging significantly depends on the audience, as urban, rural, and mixed communities have different concerns.

- Promoting the RUC not as a "new" tax, but as greater fairness in taxation, is essential to the program's success.

These lessons can provide insight and guidance should TxDOT consider a RUC Program for Texas.

4.3 Background

Oregon has been at the forefront of highway funding in the United States and has set the precedent for how revenues are collected to finance construction, operation, and maintenance of state highways. In 1919, Oregon was the first state in the nation to introduce the current procedure of collecting taxes based on gas consumption. This tax has since increased 18 times to meet the cost of sustaining and improving roadways. Oregon is also the nation's first state to introduce the weight-mile tax for heavy vehicles, enacted in 1933.[130]

From 1970 to 2003, the gasoline tax revenue in Oregon had declined by half in "cents per vehicle mile traveled" (after adjusting for inflation).[131] This drop in revenue is attributed to one factor: the popularity of increasingly fuel-efficient and electric vehicles. For almost a century, the motor fuel tax has been the mainstay of highway finance for state governments. This method has the advantage of being roughly proportional to the distance traveled and thus has the desirable attribute of being a pay-as-you-go form of user charge. However, as consumers seek greater fuel-efficiency for their vehicles, the motor fuel taxes will become increasingly insufficient (see Appendix D2).

Like many other states, Oregon now recognizes, for political and economic reasons, that fuel tax revenues will not keep pace with improvements in vehicle fuel efficiency. The Oregon Legislature mandated the development of a new design for revenue collection for Oregon's roads and highways to replace the current system for revenue collection.[132] In 2001, House Bill (HB) 3456 was passed, assigning the Oregon Department of Transportation (ODOT) the task of administering a Road User Fee Task Force (RUFTF) and directing ODOT to develop and implement pilot programs based on RUFTF's policy recommendations (see Appendix D6). After considerable research and exploration of options, RUFTF spearheaded two pilot programs; the first was a 12-month pilot program in 2006–2007 and the second was a 4-month pilot program in 2012–2013.

The pilot programs allowed ODOT officials and policymakers to gauge public perception of and logistical concerns involved in a program centered on road usage fees in Oregon. Key policy issues arose, including the future of the state's fuel tax, data collection, reporting methods, technology matters, operations, and billing.[133] The pilot programs succeeded at providing a better understanding of how a successful statewide program would be rolled out.

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[130] Whitty, 2013a.
[131] Virginia Department of Transportation Research Library, 2008.
[132] Whitty, 2012.
[133] Ibid.

In 2013, Senate Bill (SB) 810 was signed into law, authorizing ODOT to set up a mileage collection system, or a road user charge (RUC), for 5,000 volunteer motorists beginning July 1, 2015. ODOT may assess a charge of 1.5¢ per mile for the volunteer drivers and issue a gas tax refund to those participants. ODOT officials like James Whitty, Manager of ODOT's Office of Innovative Partnerships and Alternative Funding, explains that SB 810 will not setup another pilot program but rather establish the beginning of an alternate, lasting statewide method of generating revenue from personal vehicles to pay for Oregon highways.[134]

4.4 Key Policy Issues

Issues arising from this program include public concerns about privacy, public acceptance of the program, partnerships with external industries, and the statewide RUC implementation process. While many challenges exist when carrying out a statewide program based on fee collection, these four issues were identified as the most significant to evaluate. If the State of Texas were to consider undertaking a mileage-based fee system to recapture revenues lost on fuel efficiency, these issues would correspondingly be applicable.

4.4.1 Privacy Concerns

Following the first pilot program, which mandated a global positioning system (GPS) device for each participating vehicle and provided a single billing system through the state government, ODOT officials recognized significant privacy concerns amongst the public. Aside from any design flaws, the RUC program attracted both public enmity and national scrutiny due to required GPS technology. Many members of the general public strongly objected to a state mandate for a "GPS box" in their cars as a violation of privacy. [135] A GPS tracker is not anymore of a violation of privacy than a cell phone or E-ZPass, which both have GPS technology; citizens are still concerned about their personal privacy when discussing a RUC system.

ODOT has identified that the biggest flaw about the 2007 Road User Fee Pilot Project (RUFPP) was that it centered on a closed system, or a system that was internally assimilated and organized by a single, public body with mechanisms that cannot be exchanged by other external, private components, which could perform the same functions.[136] The RUFPP was a "pay-at-the-pump" model (see Appendix D3) that required participants to pay the road user fee at gas pumps, similar to the current gas tax. However, the RUFPP required a GPS device in each vehicle and a wireless reader attached to the pump to transmit data, such as the vehicle identification number (VIN), vehicle miles traveled (VMT) data, and fuel purchase amount every time a participating vehicle purchased gas at a service station. These data were transmitted to the service station's point of sale computer, which conveyed the data to a central database controlled by ODOT for the appropriate VMT charge.[137]

Aside from privacy concerns, this closed system simultaneously prevented advancement in consumer technology and modifications in consumer behavior. The model was also flawed since

[134] Tanya, 2013
[135] Whitty, 2011.
[136] Whitty, 2012.
[137] Whitty and Svadlenak, 2009.

it partially relied on automakers to develop and employ a pre-market mileage counting device embedded into new vehicles. Thus, the ability for ODOT to improve the capability of system technology was significantly limited. Moreover, it obstructed swift execution of a new system because of the constraint of relying on the equipment development processes of various automakers, which could take several years.[138]

To address these issues, ODOT refashioned its RUC model as an open system platform for the second pilot program that allowed the marketplace to play a larger role in data collection and account management (see Appendix D4). The state removed the GPS mandate and tapped into market forces to allow greater public choice. Participants could choose the means by which they reported their mileage (from ODOT-approved methods), the on-board technology to suit their needs, and a private-sector administration option as an alternative to ODOT administration for invoicing and payment.[139]

When considering how to motivate motorists to opt into paying the per-mile road tax as authorized by SB 810, ODOT officials understood that a GPS obligation would be a potential deal breaker for statewide acceptance. To mitigate privacy concerns, ODOT preserved the policy of not mandating the GPS for RUC program participants of the RUC. Instead, drivers will be allowed to select a mileage reporting device from the marketplace, or report mileage manually. Combining reporting options with invoicing and payment choices allows users to interact directly with the marketplace, completely separating them from government involvement, if they so choose. Whitty explicitly wanted to offer motorists a range of options for fee collection so that no one could accuse the system of being an invasion of privacy.[140] Table 4.1 presents the three categories offered for the upcoming program.

Table 4.1: Categories of Mileage Reporting

Basic	Report all miles driven: Manual or electronic reporting without GPS. Does not distinguish the type of roads was used.
Advanced	Report miles by location: Electronic mileage reporting with GPS. Distinguishes usage of private/public and in-state/out-of-state road usage.
Switchable	Changeable reporting of miles: Switching between basic and advanced by preference

Removing the GPS mandate and creating an open market were not the only successes ODOT accomplished when it came to addressing privacy concerns. When considering a program that would soon become a statewide initiative, ODOT officials collaborated with the American Civil Liberties Union (ACLU) on proper procedures to protect privacy. Together, both groups were able to agree upon a way to meet the ACLU's privacy requirements while also meeting ODOT's operability requirements. They acknowledged that personal data would only be collected through

[138] Ibid.
[139] Ibid.
[140] Holeywell, 2012.

certain methods and legal language was created to protect the personally identifiable information (PII) of users. This collaboration eventually became Section 9 of the final version of SB 810 (see Appendix D7).

The ACLU negotiated amendments to ensure that PII collected could only be disclosed when necessary for particular entities to carry out their duties in administering the program. Other amendments required that location data collected by corresponding GPS devices be destroyed when no longer needed to enforce tax compliance, and that location data be provided to a law enforcement agency only when pursuant to a warrant based on probable cause. Private details of a driver's travel cannot be handed over without cause to law enforcement and cannot be held indefinitely to enable opportunities for abuse. The ACLU believed these amendments were positive steps to guard against these perceived threats.[141]

The privacy issue was recognized as the most challenging obstacle to a successful RUC program in Oregon, and legislative as well as ODOT officials understood that overcoming this problem would be their primary mission. They discarded the idea of requiring any kind of GPS tracker and established an open system. By allowing drivers more choice through an open market and collaborating with the ACLU, ODOT eased privacy apprehensions greatly, but not completely.

4.4.2 Public Acceptance

When considering the implementation of any public program, especially one that involves the collection of taxes, the approach must include navigating a path to public acceptance. Although it is important to implement a well-designed program, gaining approval from those affected by the tax should be more important than any other factor. Simply because some aspect may work well for a program's functionality does not necessarily mean it will work for the public. In this respect, public program designers must establish an informational feedback loop with the public that informs policy choices as public attitudes shift and become apparent. Policymakers and program designers can then adjust their perspectives and goals accordingly, continuing to gather public feedback as they move forward. ODOT recognizes this need for public support and has carried out three important steps to stimulate public approval while ensuring that the program is received positively.[142] These steps include publicizing the critical need for a RUC program, navigating public sensitivities, and tackling the wide range of program logistics and legislative details when bringing a RUC system into reality.

The first step is to make certain that the public recognizes the problem that the RUC program is designed to address. Through focus group studies, ODOT officials learned that transportation funding was not well understood by the public. For example, most drivers do not know how much the gas tax is or how much gas tax they contribute per month. ODOT acknowledged that participants did not have thorough knowledge of the funding source for transportation improvements in Oregon. They concluded that the disconnect in understanding between the current fuel tax and the RUC may be the biggest barrier to public support, as it is difficult for people to see the similarities of these two taxes.[143]

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[141] ACLU of Oregon, 2013.
[142] Whitty and Svadlenak, 2009.
[143] Focus Group Report, 2013.

The approach to educating Oregonians and striving for a greater participation pool in the upcoming volunteer program will involve local outreach and personalizing the program to potential users, i.e. "getting local and specific."[144] Creating interest and helping drivers understand why they should care has become a key task for ODOT. ODOT approaches their messaging campaign for the RUC program by conveying the message that the current fuel tax will be incapable of meeting local transportation needs and that the RUC will improve local communities directly by generating this much-needed revenue. Additionally, ODOT is designing a public relations and education campaign to occur throughout 2014 and up until the July 2015 implementation date. The campaign will focus on educating the public about the current fuel tax's inability to meet the state's revenue needs for transportation purposes. Details about the campaign are currently unavailable as the solicitation and bidding process is being conducted as of the time of publication.[145]

The second step is to adapt the RUC program so that it considers public receptivity and sensitivities. ODOT has done extensive research to identify concerns regarding public apprehensions and has sought to remedy these concerns through various channels, including a more open system with greater options, regional messaging, and dedication to protecting privacy. To further calm anxieties and promote acceptance, officials understand that achieving greater acceptance will require drivers to hear positive stories about the program from others (rather than state officials). ODOT is establishing an interest group through email and social media. Officials will use this group to talk about the program, discuss the nuances of it, facilitate positive experiences, debunk myths, and overcome the barriers on a more personal level. The interest group will be a means of greater communication to Oregonians for the purpose of education and clarification about the program.[146]

Another crucial aspect in generating public acceptance was including eight state legislators as volunteer participants in the second pilot program's newly designed platform. Whitty defined this as an important step, as the legislators would then discuss the program in great detail—specifically how easy the program is—with their colleagues behind doors closed to ODOT officials. Whitty believes some of the strongest political, bipartisan support for SB 810 sprang from testimonies based on backroom discussions, and in turn these state legislators were able to convey a positive message based on personal experience about the program to their constituents.[147] Public acceptance and positive peer-to-peer conversations are fundamental but cultivating legislator approval provides a different level of public acceptance that is likewise important for implementing a successful RUC program.

The third step is to introduce a real RUC program that completely addresses safeguards to privacy, system controls, cost estimates, and a detailed rate structure. Regarding all of these issues, ODOT has done extensive research, buildup, and promotion to address each concern effectively. The privacy issue—the biggest obstacle—was given significant attention. System

[144] Godfrey and Averbeck, 2014.
[145] Godfrey, 2014.
[146] Ibid.
[147] Whitty, 2014.

controls have been moved from a closed system, controlled exclusively by the State of Oregon, to an open system administered by various private market operators, granting greater choice to fee payers, and thus ultimately garnering greater approval by fee payers.

Members of the state legislature also played an important role in constructing a bill designed with the primary mission of statewide public acceptance. House Minority Whip Vikki Berger, a proclaimed "champion" of SB 810, acknowledged the difficulty of constructing a practical bill that simultaneously met the financial needs of the state and maintained respect towards the sensitivities of state drivers. Representative Berger explains,

> Taxes and cars: something that Americans hate and something they love. If you tie them together, you will have their full attention […] Generally, your legislators get it, with some that would say 'I wouldn't vote for this, I won't get reelected' and there's a certain group who will consider it. But at some level you need to get the public to understand. You first have to be able to say 'the public understands it' and that's where we are now. We are getting the public to say 'Yeah, this works. Yeah, this doesn't hurt [our] cars or [our] taxes' at some level.[148]

Representative Berger, along with House Majority Whip Tobias Read, garnered bipartisan support to achieve the 3/5 vote needed to pass a new tax bill. Another RUC-related bill during the same session, HB 2453, was unable to endure the scrutiny it received through the legislative process as it was perceived as vindictive towards drivers of fuel-efficient vehicles. SB 810 is all encompassing, and was viewed as being in the best interest of the state and the public. This sense of fairness and practicality ultimately paved the way for the bill to be signed into law.

4.4.3 Implementation: Internal Operations & External Partnerships

As of July 2015, ODOT will have multiple program aspects to manage in addition to creating short- and long-term plans of action for the ultimate goal of statewide RUC implementation in the future. Currently, the cost estimates for the road user charge are locked in at 1.5¢ per mile, but are subject to change in the future with legislative approval. One strategy of a road user fee is to reduce congestion and grow efficient roadway usage by increasing the fee during high-volume times in certain regions. Oregon officials have stated they do not intend to use the RUC as a tool to combat congestion. The cost estimates of the system, procedures, and staff functions will fall under the operational metrics and evaluations of the taxing authority internally and externally.

Oregon's aim will be greater cost efficiency and operational effectiveness. A decrease in operating costs and transactional fees are both expected and part of the yearly metrics for the taxing authority.[149] For the moment, these are considerations that will need to be worked out over time and through regular use of RUC system.

In regards to RUC system management, ODOT is currently delineating internal and external roles and responsibilities to ensure smooth delivery of the RUC program. As mentioned previously, ODOT will not be managing all RUC program aspects, but they will be discussing their organizational capacity to leverage ODOT staff and resources towards various aspects of

[148] Berger and Read, 2014.
[149] Whitty, 2011b.

program management.[150] In terms of responsibilities, ODOT will likely lead operations in account management, compliance, and enforcement of RUC payment from citizens.[151] The RUC program will still be a state-led program and, therefore, ODOT will also serve as the primary liaison to the legislature and public.[152] ODOT and external partners will share the responsibility of providing consumer choices. Finally, external partners will be responsible for their respective technology elements, account management, and data transfers, as outlined in their contracts.[153] Throughout this planning and role designation, the goal is to maintain an open system that is flexible with account management and mileage reporting so that all operations do not hinge on ODOT leadership.[154]

In order to provide consumer options and expand overall program capacity, ODOT will continue contracting with commercial entities to support RUC implementation.[155] ODOT has already worked with private companies during the most recent pilot program (completed in February 2013). Through a competitive contracting process, ODOT finalized private-sector partnerships with Raytheon and Sanef for mileage-reporting devices and services.[156] Raytheon created a mileage-reporting device for the smartphone-based plan while Sanef created another mileage-reporting device along with providing billing and account services.[157] The recently completed pilot program underscored the importance of an open system that allows for interoperable and changeable program pieces so that ODOT does not manage all components of mileage-reporting and collecting RUCs.[158]

Contracting with commercial partners is crucial for providing additional capacity to implement a RUC program. According to Carly Francis, the Program Manager for the Road User Charger Program at ODOT, implementing the RUC system should be easy and functional both now and in the future, especially because changes will come as technology advances and program needs shift.[159] ODOT is currently in the process of finalizing expectations and drafting procurement documents to establish commercial partners.[160] This high degree of operational flexibility also lends itself towards providing a template for other states to easily replicate a RUC program and tailor it to their department of transportation's needs, capacity, and preferred commercial partnerships.[161]

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[150] Capps, 2014.
[151] Capps and Atkins, 2014.
[152] Capps, 2014.
[153] Ibid.
[154] Atkins et al., 2014.
[155] Atkins, 2014.
[156] ODOT Office of Innovative Partnerships & Alternative Funding, 2013b.
[157] Ibid.
[158] Larson, 2014.
[159] Francis, 2014.
[160] Atkins, 2014.
[161] Larson, 2014.

4.4.4 Implementation: Participant Recruitment and Public Relations

In order for the July 2015 RUC program to be successful, ODOT needs to engage the public to recruit volunteers along with communicating a strong, coherent message around why a RUC is important. As previously discussed, the recruitment goal is to find a diverse group of interested Oregonians, get them on board with the program, and support them with great customer service.[162] Lynn Averbeck, Senior Project Executive for the Office of Innovative Partnerships and Funding, explains that if participants understand the transparency and logistics behind the RUC, they will be more likely to support the program and communicate that support to others.[163] In this way, the July 2015 program has a unique opportunity to not only solidify RUC implementation, but also generate massive statewide support.

There are already many RUC advocates, but ODOT needs greater statewide acceptance if the program will be legally accepted as a fully implementable program for all Oregonians.[164] The Public Relations component will be valuable in spreading RUC system information and debunking myths. Michelle Godfrey, the Office's Public Information Officer, notes that drivers have concerns around privacy, additional taxation, expected unfairness for rural drivers, and the potential to punish drivers with fuel-efficient vehicles when it comes to a RUC.[165] Each of these concerns has either a solution (such as ODOT providing multiple choices to address privacy concerns) or is simply untrue (such as the fact that the RUC is not an additional tax but replaces the gas tax).[166] ODOT's proactive approach to generate public acceptance through their program volunteers and through concentrated outreach will serve as a "tipping point" for future RUC legislation.

4.5 Lessons Learned

ODOT has accumulated substantial RUC implementation knowledge through multiple pilot programs and three key lessons emerge: provide consumer choice, tailor proper RUC messaging by region, and emphasize fairness in taxation.

4.5.1 Consumer Choice

James Whitty and his team found that consumer choice is fundamental to a successful RUC program. In the recent 2012-2013 pilot program, ODOT provided participants with multiple options for mileage reporting and billing.[167] Individual consumers prefer to choose their method of mileage reporting rather than having the government mandate one expectation for all drivers. In fact, choice generates greater public acceptance: "Almost all participants [in the second pilot] said that having a choice of road usage charging plans improved their perception of a road usage charging program and made them more comfortable with it."[168] Providing a blend of both ODOT-led and private partner-led account management options also alleviates privacy

[162] Godfrey and Averbeck, 2014.
[163] Averbeck, 2014.
[164] Godfrey, 2014.
[165] Ibid.
[166] Ibid.
[167] ODOT Office of Innovative Partnerships & Alternative Funding, 2013b.
[168] Ibid.

concerns.[169] If hoping to implement a RUC system, TxDOT must ensure that consumers have choices in mileage reporting and billing in order to gain their support and ease privacy concerns.

4.5.2 RUC Messaging by Region

Oregon and Texas are geographically similar with combinations of urban, rural, and mixed communities; therefore, messaging is significant depending on the audience. Understanding that messaging must be tailored to the audience, ODOT has adapted RUC messaging by region, especially to address the concern around unfairness to rural residents. There may be some opposition from rural residents out of concern that a RUC targets them and the fact that they typically drive longer distances per trip than urban drivers. In reality, ODOT's research "reveal[s] that rural residents, on average, will not be affected adversely in any significant way by a road usage charge—financially, behaviorally, or technologically."[170] Rural drivers will not be paying an unfair proportion of the tax and in fact, many may already been paying their fair share through the gas tax. Michelle Godfrey emphasizes that it is crucial for ODOT to be sensitive to these concerns and differing lifestyles throughout the state.[171] The greater message is not about rural versus urban drivers but about all Oregonians maintaining their investment in roads through a RUC program.[172]

4.5.3 Fairness in Taxation

The most important lesson from Oregon's RUC pilot programs is that ODOT needs to emphasize fairness in taxation. A RUC is not an additional tax but rather a supplementary tax to fill in revenue gaps that the fuel tax no longer covers. All drivers, regardless of the fuel efficiency of their cars, utilize and devalue roads through consistent use. Because of this, roads need revenue to pay for ongoing maintenance. As Representative Berger explained, quality roads are a government service that all citizens, regardless of political affiliation, want and expect.[173] Using the RUC system to supplement waning fuel tax revenues is a fair, consistent way to maintain road infrastructure. This idea of a fair tax is closely linked with the previous lesson learned around messaging and public relations. Public support can likewise be generated when the RUC message becomes tangible through the example of well-maintained roads versus poor ones.[174] Representative Berger finds a "perfect tax" in the RUC program because it meets revenue goals, makes sense, and truly is a user fee for roads.[175] The RUC, as a neutral fee, negates concerns about over-taxation and generates public acceptance when citizens choose to maintain their long-term transportation investments.

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[169] Ibid.
[170] ODOT Office of Innovative Partnerships & Alternative Funding, 2013a.
[171] Godfrey, 2014.
[172] Ibid.
[173] Berger, 2014.
[174] Ibid.
[175] Ibid.

4.6 Relevance to Texas

A RUC system based on miles driven, rather than fuel consumed, is extremely relevant to Texas because such a program generates additional revenue for TxDOT and provides a fair, transparent means to fund the maintenance of Texas roads. Currently, TxDOT has to contend with declining gas tax revenues while still trying to find resources to address growing road congestion and ongoing road consumption due to more drivers across the state. The bottom line is that maintaining and building statewide road infrastructure requires money. The Texas Legislature likewise understands the need for greater transportation revenue and, during the summer of 2013—after several consecutive special sessions—the legislature controversially appropriated up to $1.2 billion to TxDOT for road maintenance and future projects.[176] Regardless of this additional funding, TxDOT needs to find a long-term funding solution in the face of declining revenues so that TxDOT has a plan for funding roads. With a RUC system, drivers will pay a flat rate per mile and be charged for the actual number of road miles they drive during a given time. A RUC program is worthwhile for TxDOT to implement because it generates revenue in a way that the gas tax does not, especially for fuel-efficient vehicles, and would provide an ongoing revenue stream that TxDOT could depend on for road maintenance.

Because of ODOT's work through multiple pilot programs, TxDOT will not need to create an entirely new RUC system, but can instead adapt and build on Oregon's experience. Texas, along with Oregon and other states, is part of the Western Road User Consortium, which researches RUC implementation and encourages cross-state collaboration through ongoing feedback, new ideas, and continued research.[177] Because Oregon has laid the foundation for implementation and public acceptance, TxDOT will be able to move forward without encountering many of ODOT's early obstacles and concerns. Investing in a RUC system will provide TxDOT with much-needed revenue and Texans will make a long-term commitment to maintaining good roads and continued transportation growth throughout the state.

[176] Ward, 2013.
[177] Whitty, 2013d.

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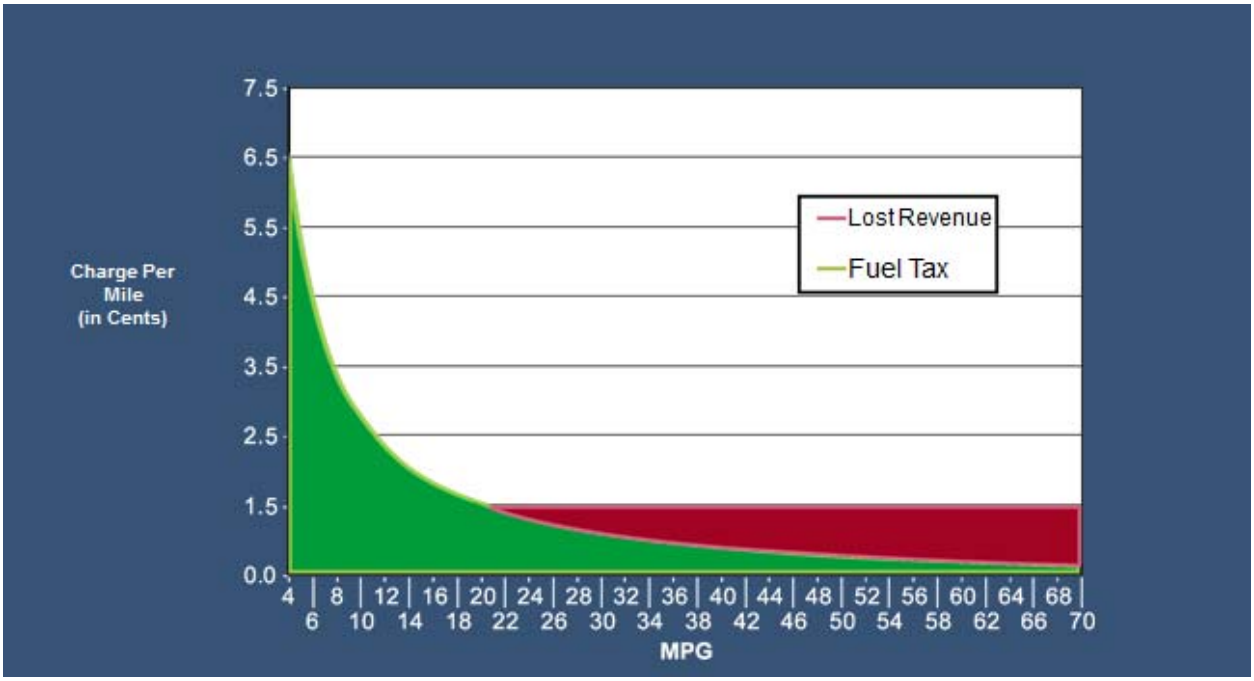
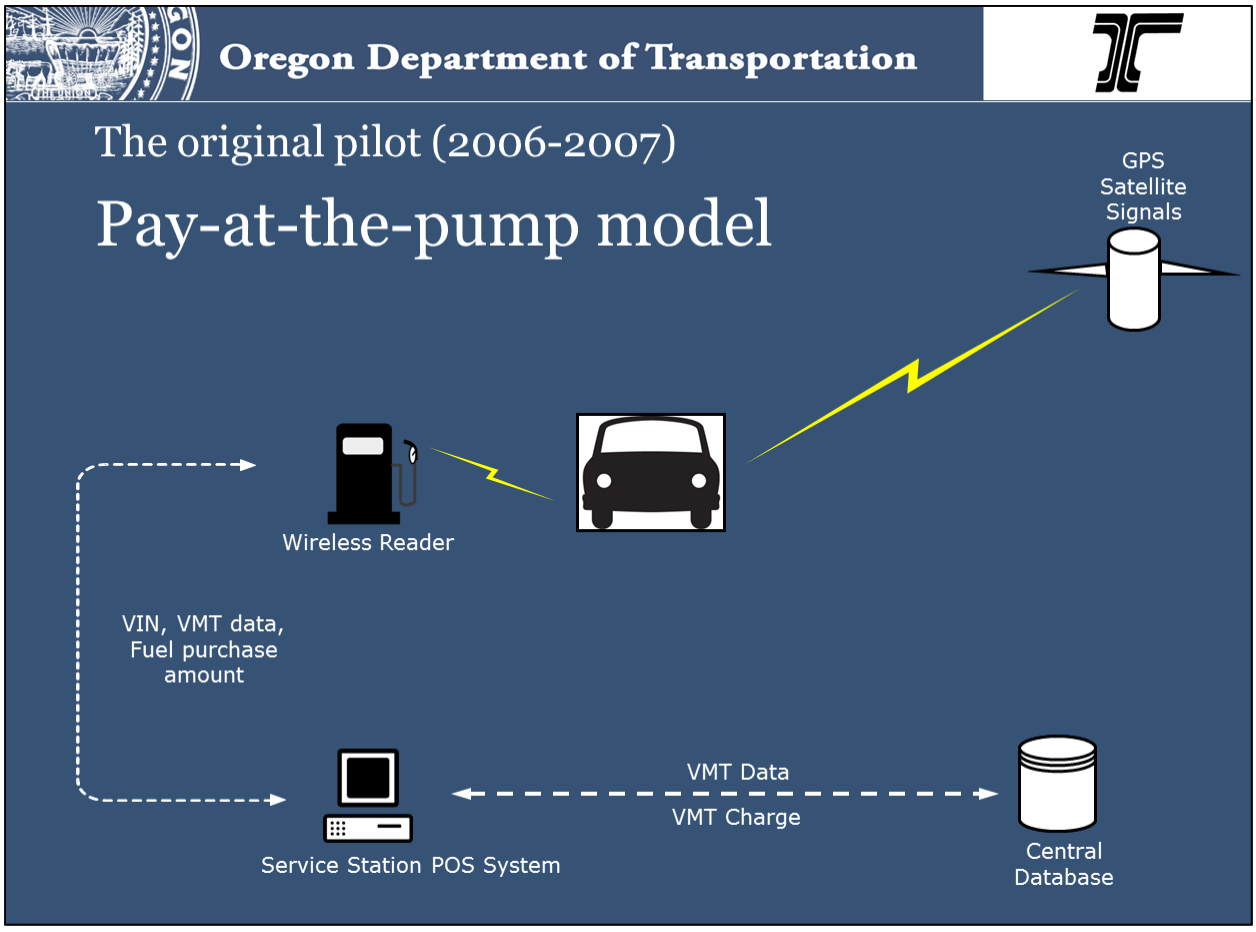
Volume 4 Appendix 2: Fuel Tax and Lost Revenues[178]



This graph demonstrates that when vehicles achieve less than 20 MPG, they actually pay more than 1.5¢ per mile. Also, more fuel-efficient vehicles that get greater than 20 MPG are contributing to a revenue loss if they are not on the RUC program.

[178] Whitty, 2013a.

Volume 4 Appendix 3: Pilot #1: Pay-at-the-pump Model[179]



[179] Whitty, 2013a.

Volume 4 Appendix 4: Pilot #2: Road User Charge Model[180]

Oregon's second Road Usage Charge Pilot Program (RUCPP):

- Duration: November 1, 2012–February 28, 2013
- 44 volunteer participants from Oregon
    - 8 state legislators
    - Washington DOT and Nevada DOT managed 44 additional participants
- Paid road usage charge, received fuel tax credit
- Private sector firms provide
    - Mileage reporting technologies
    - Tax processing and account management

Plan options for RUCPP are presented in the following table.

[180] Whitty, 2013a.

Oregon RUCPP Plan Options

Plan Option	Provider	Miles Reported?	Invoice	Payment	Online Account Management?	GPS?
#1 (The Basic Plan)	Sanef	All	Emailed Monthly	Credit/Debit Card	Yes	No
#2 (The Smartphone Plan)	Sanef/Raytheon	With app running, only roads in Oregon; without app running, all roads	Emailed Monthly	Credit/Debit Card	Yes	Yes, when app is running
#3 (The Advanced Plan)	Sanef	Public roads in Oregon only	Emailed Monthly	Credit/Debit Card	Yes	Yes, device installed in vehicle
#4 (The Basic Plan)	ODOT	All	Mailed Monthly	Check	No	No
#5 (Flat Rate Plan)	ODOT	N/A	Once, at start	Check	No	No

Volume 4 Appendix 5: Road Usage Charge Program Documents[181]

Sequence	Document Title	Description
1	Open System Architecture Model (2012)	This report addresses a market based method to achieve a comprehensive approach to electronic road usage charging in the State of Oregon and interoperability within the State and the surrounding region. It explains the difference between open and closed IT systems in the context of various types of road charging such as tolling, per mile, and congestion pricing, and presents the case for an open system for road usage charging. It defines the functional system components, the various "actors" and their roles, and explains how an open system encourages private sector competition and promotes interoperability. Six (6) principles for an open system architecture model are provided, as well as some state and federal policy background.
2	Strategic Program Plan (2011)	This is the "plan of plans" of the Oregon RUC Program, providing a vision for a full roll out of a mandatory RUC system over an eight year timeframe. The document is based on policy directives made by the statutory Road Use Fee Task Force in 2010 and 2011. A two-phased approach is proposed but also broken down further into five detailed schedule phases, along with detailed information about twelve critical work streams.
3	Preliminary Concept of Operations (2011)	This document provided a user-friendly view of the mileage-based taxation system designed for highly fuel-efficient vehicles, with special focus on electric and plug-in electric hybrid vehicles that were entering the market at the time ODOT was preparing to implement the 2012 Road Usage Charge Pilot Project. This document was updated after the pilot was completed (Please see Pre-Legislative Concept of Operations below).
4	System Requirements Specifications (2012)	The SRS, a technical document, was designed for the successful 2012 RUC pilot project, but with a future mandatory system in mind. It contains an overview of the system and its requirements including context, security, performance, assumptions, dependencies and facilities. Mileage Collection, RUC Processing and Accounting subsystems are described in detail that covers data, hardware, trained personnel and process requirements.

[181] Road Usage Charge Program, ODOT, 2014.

Sequence	Document Title	Description
5	Interface Control Document (2012)	The ICD, a technical document, covers the interface between the Mileage Collection subsystem, RUC Processing subsystem, and the mileage message. It also explains the interface between the RUC Processing and RUC Accounting subsystems.
6	Road Usage Charge Pilot Project Evaluation Report (2013)	This document picks up where ODOT's first RUC pilot project in 2007 left off. It provides a complete overview of the more recent and successful second pilot project (RUCPP) that demonstrated the viability of an open system architecture using the latest technology including the use of a smartphone app. The document provides the policy strategy used to design and operate the project and recommends next steps towards implementation of the first mandated RUC system in the nation as set forth by Senate Bill 810.
7	Financial and Economic Cost Model (2013)	This is a planning tool that consists of Excel spreadsheets that can be used to estimate operations and transactional costs of the RUC system under a wide range of possible combinations of assumptions, or scenarios.
8	Impacts of Road Usage Charging in Rural, Urban and Mixed Counties (2013)	This report explains the study of impacts of RUC in rural, urban and mixed counties in Oregon. The analysis describes various impacts a mileage tax policy will have on the various county characteristics in Oregon. It includes total cost impact relative to current cost burden of the existing gas tax system. The document also discusses the expected behavioral impacts on users who would have to adapt to new technological features of the proposed RUC system.
9	Focus Group Report (2013)	This report describes the results of work with six focus groups of Oregon voters to test attitudes and perceptions toward a proposal for a mileage fee on new highly fuel efficient vehicles. The research probed participants' views about existing and ideal methods of funding transportation improvements and explored several possible approaches, include a specific proposal to charge fees on miles driven on new highly fuel efficient vehicles.
10	Economic Viability of Road Usage Charging in Oregon (2013)	The economic viability analysis identifies and analyzes stakeholder interests for "Day One" and "Mature" scenarios. It also provides market analysis for RUC, explaining various business cases, key observations, scenarios for private market involvement, and cost and revenue categories. A summary of costs and revenues is included, along with information about the ODOT financial model.

Sequence	Document Title	Description
11	Pre-Legislative Concept of Operations (2013)	The Pre-Legislative "ConOps" is ODOT's best guess as to how to move the RUC program forward using the latest information from the 2012 pilot project results combined with pending legislative direction. "Pre-Legislative" means prior to the passing of Senate Bill 810 while House Bill 2453 (which did not pass) was under consideration. The voluntary aspect of the Senate Bill was included in HB 2453 and is thus examined in this report. The document includes background RUC and Road Use Fee Task Force history in Oregon, explains the visioning process and program goals, and provides operational details and scenarios.
12	Road Usage Charge Program Implementation Plan (2013)	This is a bar chart schedule showing all the activities and milestones that must be accomplished and in place to initiate RUC operations by the actual state date set in Senate Bill 810 (July 1, 2015). It includes supporting text and explanatory notes about what is involved and lists the major tasks for each activity/milestone, the responsible entity, required resources, rough order-of-magnitude cost estimate and milestone current status.
13	Help Desk Operations Guide (2013)	This explains the "Help Desk" system designed and used for the 2012 Road Usage Charge Pilot Project (RUCPP). It includes an overview of the three-pronged customer support team structure, Help Desk operations procedures, and instructions for handling specific issue scenarios.

Volume 4 Appendix 6: Oregon Statutes – Chapter 184

Chapter 184 — Administrative Services and Transportation Departments
2013 EDITION
(Road User Fee Task Force and Program)

184.841 Legislative findings. The Legislative Assembly finds that:
(1) An efficient transportation system is critical for Oregon's economy and quality of life.
(2) The revenues currently available for highways and local roads are inadequate to preserve and maintain existing infrastructure and to provide funds for improvements that would reduce congestion and improve service.
(3) The gas tax will become a less effective mechanism for meeting Oregon's long-term revenue needs because:
(a) It will steadily generate less revenue as cars become more fuel-efficient and alternative sources of fuel are identified; and
(b) Bundling fees for roads and highways into the gas tax makes it difficult for users to understand the amount they are paying for roads and highways. [2001 c.862 §1]

184.843 Road User Fee Task Force; members; duties; terms; reports. (1) There is created the Road User Fee Task Force.
(2) The purpose of the task force is to develop a design for revenue collection for Oregon's roads and highways that will replace the current system for revenue collection. The task force shall consider all potential revenue sources.
(3) The task force shall consist of 12 members, as follows:

(a) Two members shall be members of the House of Representatives, appointed by the Speaker of the House of Representatives.
(b) Two members shall be members of the Senate, appointed by the President of the Senate.
(c) Four members shall be appointed by the Governor, the Speaker and the President acting jointly. In making appointments under this paragraph, the appointing authorities shall consider individuals who are representative of the telecommunications industry, of highway user groups, of the Oregon transportation research community and of national research and policy-making bodies such as the Transportation Research Board and the American Association of State Highway and Transportation Officials.
(d) One member shall be an elected city official, appointed by the Governor, the Speaker and the President acting jointly.
(e) One member shall be an elected county official, appointed by the Governor, the Speaker and the President acting jointly.
(f) Two members shall be members of the Oregon Transportation Commission, appointed by the chairperson of the commission.

(4)(a) The term of a legislator appointed to the task force is four years except that the legislator ceases to be a member of the task force when the legislator ceases to be a legislator. A legislator may be reappointed to the task force.

(b) The term of a member of the task force appointed under subsection (3)(c) of this section is four years and the member may be reappointed.

(c) The term of a member of the task force appointed under subsection (3)(d) or (e) of this section is four years except that the member ceases to be a member of the task force when the member ceases to be a city or county elected official. A city or county elected official may be reappointed to the task force.

(d) The term of a member of the Oregon Transportation Commission appointed to the task force is four years except that the member ceases to be a member of the task force when the member ceases to be a member of the commission. A member of the commission may be reappointed to the task force.

(5) A legislator appointed to the task force is entitled to per diem and other expense payments as authorized by ORS 171.072 from funds appropriated to the Legislative Assembly. Other members of the task force are entitled to compensation and expenses as provided in ORS 292.495.

(6) The Department of Transportation shall provide staff to the task force.

(7) The task force shall study alternatives to the current system of taxing highway use through motor vehicle fuel taxes. The task force shall gather public comment on alternative approaches and shall make recommendations to the Department of Transportation and the Oregon Transportation Commission on the design of pilot programs to be used to test alternative approaches. The task force may also make recommendations to the department and the commission on criteria to be used to evaluate pilot programs. The task force may evaluate any pilot program implemented by the department and report the results of the evaluation to the Legislative Assembly, the department and the commission.

(8) When the task force is studying alternatives to the current system of taxing highway use through motor vehicle fuel taxes and developing recommendations on the design of pilot programs to test alternative approaches under subsection (7) of this section, the task force shall:

(a) Take into consideration the availability, adaptability, reliability and security of methods that might be used in recording and reporting highway use.

(b) Take into consideration the protection of any personally identifiable information used in reporting highway use.

(c) Take into consideration the ease and cost of recording and reporting highway use.

(d) Take into consideration the ease and cost of administering the collection of taxes and fees as an alternative to the current system of taxing highway use through motor vehicle fuel taxes.

(e) Take into consideration effective methods of maintaining compliance.

(f) Consult with highway users and transportation stakeholders, including representatives of vehicle users, vehicle manufacturers and fuel distributors.

(9) The task force shall report to each odd-numbered year regular session of the Legislative Assembly on the work of the task force, the department and the commission in designing, implementing and evaluating pilot programs.

(10) Official action by the task force requires the approval of a majority of the members of the task force.

(11) Notwithstanding ORS 171.130 and 171.133, the task force by official action may recommend legislation. Legislation recommended by the task force must indicate that it is introduced at the request of the task force. Legislative measures proposed by the task force shall be prepared in time for presession filing with the Legislative Counsel by December 15 of an even-numbered year. [2001 c.862 §2; 2011 c.470 §7; 2011 c.545 §2; 2011 c.629 §1]

184.846 Pilot programs; fees; rules. (1) The Department of Transportation may develop one or more pilot programs to test alternatives to the current system of taxing highway use through motor vehicle fuel taxes. Pilot programs may include, but need not be limited to, programs testing technology and methods for:

(a) Identifying vehicles;

(b) Collecting and reporting the number of miles traveled by a particular vehicle; and

(c) Receiving payments from participants in pilot projects.

(2) Technology and methods tested under subsection (1) of this section shall be tested for:

(a) Reliability;

(b) Ease of use;

(c) Public acceptance;

(d) Cost of implementation and administration; and

(e) Potential for evasion of accurate reporting.

(3) The department may solicit volunteers for participation in pilot programs developed under this section. A participant must:

(a) Report the participant's use of the highway system in Oregon as required by the program;

(b) Pay the fee established for the program for use of the highway system; and

(c) Display in the participant's vehicle an emblem issued under subsection (6) of this section.

(4) The department shall establish a fee for each pilot program the department undertakes. The fee shall be a highway use fee and shall be paid by each participant in the program. The program may be designed so that the fee is imposed in lieu of any tax on motor vehicle fuel imposed under ORS 319.020 or any tax on the use of fuel in a vehicle under ORS 319.530 that would otherwise be paid by the participant.

(5) If a person who participates in a pilot program under this section pays the motor vehicle fuel tax under ORS 319.020, the department may refund the taxes paid.

(6) The department shall issue an emblem for each vehicle that will be used by a participant as part of a pilot program under this section. A seller of fuel for use in a motor vehicle may not collect the tax that would otherwise be due under ORS 319.530 from a person operating a vehicle for which an emblem has been issued under this subsection.

(7) If a person participating in a pilot program under this section ends the person's participation in the program prior to termination of the program, the person shall pay to the department any amount of the highway use fee established for the program under

subsection (4) of this section that the person has not yet paid. The person shall return to the department any emblem issued to the person under subsection (6) of this section.

(8) The department may terminate a pilot program at any time and may terminate participation by any particular person at any time. When a program is terminated or a person's participation is terminated by the department, the department shall collect any unpaid highway use fees established for the program under subsection (4) of this section.

(9) The department may adopt any rules the department deems necessary for the implementation of this section, including but not limited to rules establishing methods of collecting highway use fees from program participants and rules establishing reporting requirements for participants.

(10) The department may compensate participants in pilot programs established under this section.

(11) In designing, implementing and evaluating pilot programs under this section, the department shall consider the recommendations of the task force created by ORS 184.843. [2001 c.862 §3]

184.850 Variable pilot program fees. The Department of Transportation may vary any fee established under ORS 184.846 to facilitate the maximum use of road capacity. [2003 c.618 §43]

184.853 Moneys for task force and programs. (1) The department may use moneys in the State Highway Fund for financing activities required to support the task force created by ORS 184.843 and the pilot programs established under ORS 184.846.

(2) The department may solicit and accept grants and assistance from the United States Government and its agencies and from any other source, public or private.

(3) The department may accept gifts or donations of equipment necessary to carry out research and pilot programs under ORS 184.843 and 184.846. [2001 c.862 §4]

Volume 4 Appendix 7: SB 810 § 9

SECTION 9. (1) As used in this section:

(a) "Certified service provider" means an entity that has entered into an agreement with the Department of Transportation under ORS 367.806 for reporting metered use by a subject vehicle or for administrative services related to the collection of per-mile road usage charges and authorized employees of the entity.

(b) "Personally identifiable information" means any information that identifies or describes a person, including, but not limited to, the person's travel pattern data, per-mile road usage charge account number, address, telephone number, electronic mail address, driver license or identification card number, registration plate number, photograph, recorded images, bank account information and credit card number.

(c) "VIN summary report" means a monthly report by the department or a certified service provider that includes a summary of all vehicle identification numbers of subject vehicles and associated total metered use during the month. The report may not include location information.

(2) Except as provided in subsections (3) and (4) of this section, personally identifiable information used for reporting metered use or for administrative services related to the collection of the per-mile road usage charge imposed under section 3 of this 2013 Act is confidential within the meaning of ORS 192.502 (9)(a) and is a public record exempt from disclosure under ORS 192.410 to 192.505.

(3)(a) The department, a certified service provider or a contractor for a certified service provider may not disclose personally identifiable information used or developed for reporting metered use by a subject vehicle or for administrative services related to the collection of per-mile road usage charges to any person except:

(A) The registered owner or lessee;

(B) A financial institution, for the purpose of collecting per-mile road usage charges owed;

(C) Employees of the department;

(D) A certified service provider;

(E) A contractor for a certified service provider, but only to the extent the contractor provides services directly related to the certified service provider's agreement with the department;

(F) An entity expressly approved to receive the information by the registered owner or lessee of the subject vehicle; or

(G) A police officer pursuant to a valid court order based on probable cause and issued at the request of a federal, state or local law enforcement agency in an authorized criminal investigation involving a person to whom the requested information pertains.

(b) Disclosure under paragraph (a) of this subsection is limited to personally identifiable information necessary to the respective recipient's function under sections 2 to 15 of this 2013 Act.

(4)(a) Not later than 30 days after completion of payment processing, dispute resolution for a single reporting period or a noncompliance investigation, whichever is latest, the department and certified service providers shall destroy records of the location and daily metered use of subject vehicles.

(b) Notwithstanding paragraph (a) of this subsection:

(A) For purposes of traffic management and research, the department and certified service providers may retain, aggregate and use information in the records after removing personally identifiable information.

(B) A certified service provider may retain the records if the registered owner or lessee consents to the retention. Consent under this subparagraph does not entitle the department to obtain or use the records or the information contained in the records.

(C) Monthly summaries of metered use by subject vehicles may be retained in VIN summary reports by the department and certified service providers.

(5) The department, in any agreement with a certified service provider, shall provide for penalties if the certified service provider violates this section.

Transportation Policy Brief #5

Potential Use of Highway Rights-of-Way for Oil and Natural Gas Pipelines

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TxDOT 0-6581-Task 19-5

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Volume 5. Transportation Policy Brief #5: Potential Use of Highway Rights-of-Way for Oil and Gas Pipelines

5.1 Introduction

This particular policy brief, "Potential Use of Highway Rights-of-Way for Oil and Natural Gas Pipelines," was researched and written by Benjamin Moriarty and Kyle McNew.

5.2 Executive Summary

Hydraulic fracturing (fracking) and horizontal drilling have led to a successful expansion in energy production in Texas. Increased oil and gas extraction has created net economic gains statewide, and job growth has risen accordingly. Projections indicate that fracking will continue to play a large role in the Texas energy industry, especially as natural gas slowly displaces coal in national energy standards. The effects, both positive and negative, of hydrocarbons production will be felt throughout the state for decades to come.

An unintended side effect of fracking has been the reliance on trucks to transport water and wastewater from oil and gas production sites to disposal injection wells. Truck traffic related to the energy boom causes billions of dollars per year in damage to both the Texas highway system and to county and municipal roads.[182] Many of these county roads were built in the 1950s and were not designed to handle the weight and frequency of the wastewater trucks. Moreover, as maintenance costs have risen to the point where proper maintenance is unsustainable, road safety has also become a major concern. According to TxDOT data, traffic fatalities have increased over 10% across the state. In areas such as the Eagle Ford shale, they are up 40%.[183]

In order to control maintenance costs and alleviate the need for trucks on the road, TxDOT can support and help fully implement several policy mechanisms. Senate Bill 514 grants right-of-way (ROW) access to saltwater pipelines that could drastically reduce road deterioration if used in place of trucks. This outcome can be achieved both through the use of above- and below-ground pipelines. House Bill 2767 encourages private firms to recycle fracking wastewater used in the production process, further reducing the reliance on trucks. Achieving similar legislation by creating incentives to encourage on-site recycling of water would be even more beneficial for road preservation. By working with both energy firms and regulatory agencies like the Railroad Commission of Texas, TxDOT can take positive steps to lower the prohibitive costs of maintaining state and local highways. Promoting innovative legislation in tandem with private sector cooperation will help TxDOT to preserve both roads and roadway users' lives.

[182] Henry, 2013.
[183] Ibid.

5.3 Background

While the oil and gas industry has always been important and influential in Texas, over the past decade exploration and production (E&P) have expanded tremendously. Technological developments have increased the number of viable shale plays all across the state. This growth has led to a rapid development in E&P. Industry experts estimate that current production levels will continue for several decades, if not longer.[184]

As Texas has seen, technological advancements in hydraulic fracturing (fracking) have allowed companies to extract more oil than was once previously possible. Fracking is the process of using hydraulic fracturing fluid (under high pressure) to promote fracturing in the earth's geological formations.[185] Initially consisting of just primary and secondary recoveries of oil for production companies, enhanced oil recovery as a result of fracking has allowed exploration and production (E&P) companies to extract more oil using tertiary and even quaternary recoveries, increasing the extraction and production of oil across the state (Figure 5.1).

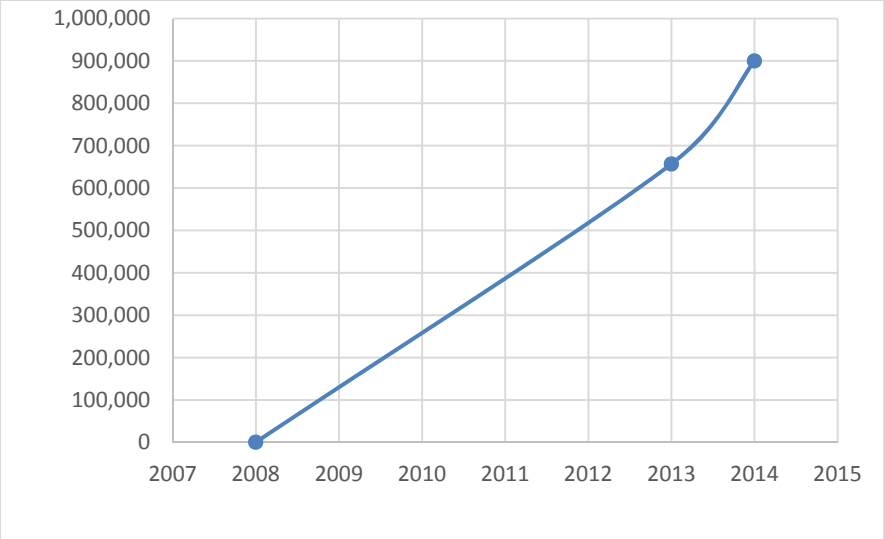

Figure 5.1: Daily Texas Oil Production (barrels per day) [186]

The Eagle Ford Shale formation in particular has grown exponentially since 2008. As seen in the following graphs, both natural gas and oil production in Eagle Ford Shale are increasing at rates never before experienced in that area (Figures 5.2–3).

[184] Campoy, 2012.
[185] Railroad Commission of Texas, 2014a.
[186] Shauk, 2013.

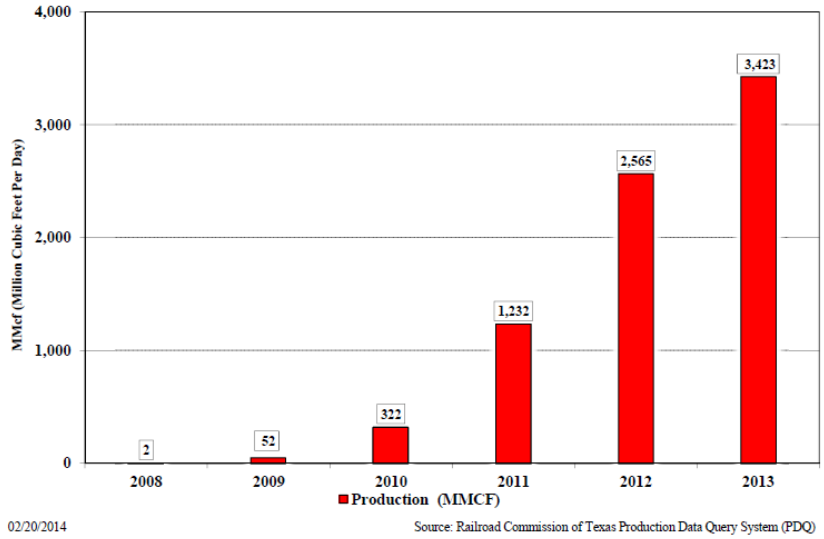

Figure 5.2: Texas Eagle Ford Shale Total Natural Gas Production (2008–2013)[187]

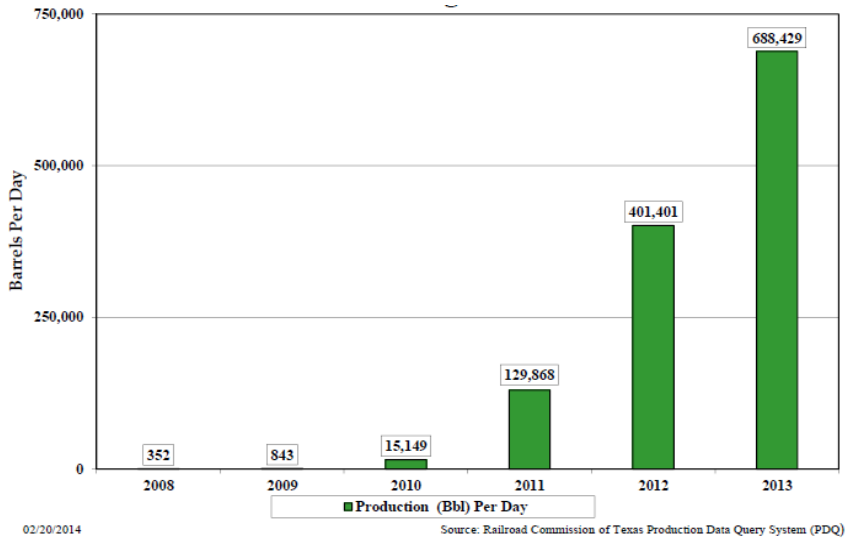

Figure 5.3: Texas Eagle Ford Shale Oil Production (2008–2013)[188]

Increased E&P requires increased trucking and use of the state's roadways. This increased usage has caused the breakdown of roadway far faster than TxDOT's models had previously predicted. In late 2012, TxDOT formed the Texas' Energy Sector Roadway Needs task force to address this problem and to identify possible solutions. This task force concluded that trucking from the energy sectors was causing $2 billion dollars in damage to the state's highway system, as well as an equal amount of monetary damage on county roads.[189]

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[187] Railroad Commission of Texas. 2014c.
[188] Railroad Commission of Texas, 2014b.
[189] Texas Department of Transportation, 2012.

Another effect of widespread heavy trucking associated with energy production is the increase in crashes and fatalities on roadways. While statewide fatalities on Texas roads increased by 10.82% from 2011 to 2012,[190] in the Eagle Ford region, fatalities have increased by over 40%.[191] In light of these statistics, it is clear that fracking-related trucking creates a safety hazard in rural areas.

While there are many proactive and reactive ways to address this issue, the main focus of this report is to address how TxDOT can use highway ROWs in order to alleviate two of the significant negative effects from trucking as a result of the energy boom (specifically, roadway damage and increased fatalities). In particular, this policy brief looks at how TxDOT can help facilitate an increase of oil and saltwater pipelines on their ROWs in order to combat the negative effects resulting from the increased occurrence of fracking and its parallel increase in trucking.

Fracking can be either horizontal or vertical, with each requiring different amounts of hydraulic fracturing fluid in the process of building and completing the well. As seen in the graph, depending on the type of well, the amount of water used in the process can greatly vary.

Hydraulic fracturing fluid is around 99 % water, with specific additives that are decided upon in the engineering process (salt being the most common additive).[192] These additive combinations are seldom the same and are chosen depending upon the nature of the geological formations which are being fractured. The process requires millions of gallons of water per well, with horizontal wells using roughly 3.5 million gallons and vertical wells using one to 1.5 million.[193] The primary means of transporting the water have been trucks. Once the wells are drilled, much of the water returns to the surface and is known as flowback water. While some of this waste water is recycled, the majority of flowback and waste water is disposed of in disposal injection wells. This once again requires trucks to move water from one site to another, further exacerbating road deterioration.

On June 14, 2013, Senate Bill (SB) 514 was signed into law. This bill amended Chapter 91 of the Natural Resources Code and gave companies the right and ability to install and operate pipelines on ROWs[194]. Senator Wendy Davis introduced the bill on the grounds that allowing companies to install and operate these pipelines on state ROWs would reduce the trucking of flowback water from wells to disposal and injection wells.

House Bill (HB) 2767, enacted into law on May 28, 2013, clarifies the ownership of the waste produced as a result of fracking.[195] This bill encourages companies to be proactive in their attempt to recycle waste water by clarifying the "ownership" of the waste and

[190] Texas Department of Transportation, 2013.
[191] Gordon, 2013.
[192] Railroad Commission of Texas, 2014a.
[193] Railroad Commission of Texas, 2014a.
[194] U.S. Senate, 2014.
[195] Texas House of Representatives, 2013.

defining waste as follows: "containing salt or other mineralized substances, brine, hydraulic fracturing fluid, flowback water, produced water, or other fluid that arises out of or is incidental to the drilling for or production of oil or gas."[196] By clarifying the ownership and establishing a legal basis for the point at which this transfer of ownership occurs, companies may be more willing to sell and give their waste water to private companies that will then recycle that water.

5.4 Key Policy Issues

One of the key policy issues regarding the increased trucking on TxDOT highways is that TxDOT has limited policy options. It also lacks the authority in policy areas that could directly reduce the amount of trucking traffic on its roads.

For the most part, energy firms have two options in regards for transporting waste water: using pipelines or transporting it by trucks. Both options have advantages and disadvantages in price and risk, as outlined in Table 5.1.

Table 5.1: Industry Costs for Transporting Water[197]

	Trucking	**Pipelines**
Capital Cost	Low	High
Maintenance Costs	High	Low

The method of transportation that an energy firm chooses is often based primarily on profit maximization, which is variable but ultimately dependent on well water usage and its respective transportation costs. The cost factors of transportation include:

- Initial water purchase
- Cost of transportation to well
- Cost of transportation to disposal site
- Disposal costs
- Additional taxes[198]

Companies run estimates of potential water usage and potential disposal amounts, and based on these figures can and will decide if building a pipeline or trucking the water will be cheaper.

As an example, in the Eagle Ford Shale , estimates of using a third-party fees for disposal has fees of $.80+/barrel (42 gallons) with hauling costs of $3.00–$6.00/barrel.[199] The estimated water usage in the Eagle Ford Shale for one well, in the process of drilling and fracturing, is 116,000 barrels.[200] Thus, average costs run approximately $500,000 and

[196] Ibid.
[197] MuleShoe Engineering, 2006.
[198] Ibid.
[199] Schaefer, 2012.
[200] Railroad Commission of Texas, 2013a.

higher solely to remove and dispose of the water from a single well. In contrast, installing pipeline costs $35,000 per inch of diameter per mile.[201] As such, the number of wells, and location of and distance to transfer stations, factor into this highly variable equation.

Since the goal of TxDOT is to alleviate road deterioration, TxDOT needs to alter the "cost formula" to have companies favor pipelines over trucking. This alteration can be done in several ways: increase disposal costs, increase costs associated with road usage, or reduce the high capital costs of implementing pipelines. Unfortunately, many of these solutions are beyond the scope of TxDOT's authority. Without working in conjunction with other state agencies that have authority over oil, gas, drilling, and water disposal, or enacting new legislation, incentivizing companies to install pipelines is difficult to achieve.

One potential fix is to allow the use of temporary above-ground salt water lines on ROW. This approach was used in Florida as a temporary fix to address a saltwater leak that was spilling into wetlands.[202] While this is not a permanent fix because well water production changes over time, making ROW available may be a possible solution in incentivizing companies to use pipelines over trucking.

Above-ground temporary water lines are a lower-cost alternative to the relatively permanent underground pipelines. This is due to cheaper installation and operating costs. Moreover, when pipelines are placed above-ground, firms do not need to vie for space in ROWs with other utility companies such as telecommunication firms. The competition for ROW space among utilities, which is known as co-mingling, is a reason why underground pipelines are expensive.

Just as TxDOT lacks authority over certain policy areas that affect the amount of trucking on state-maintained roads, another policy concern is that trucking affects county and municipal roads as well. Because oil wells and injection wells are spread throughout the state and occur mostly in rural areas, rarely do trucking patterns and routes occur only on TxDOT-maintained roads. Instead, trucks transporting water and waste water drive on both state and local roads. As a result, in order for TxDOT to fully maximize ROWs in order to reduce truck traffic, TxDOT would need to work in conjunction with counties and towns to create and install saltwater pipelines. By working with counties, towns and E&P companies, pipelines could be networked in a way which would reduce trucking. This would be beneficial for TxDOT, counties, and municipalities.

Several local governments have also begun attempting to ban fracking within municipal and county boundaries. The reasons for these limits or bans vary from region to region. Some believe fracking to be environmentally harmful, while some have political, social, and economic reasons. Regardless, attempted fracking bans have become more common throughout the country.

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[201] MuleShoe Engineering, 2006.
[202] Andres, 2009.

Organizers in Colorado have begun the process of trying to implement a proposal entitled "Community Rights Amendment," which would alter the state constitution to grant them "the inherent and inalienable right to local self-government."[203] This amendment grants residents the right and ability to "enact local laws protecting health, safety, and welfare by recognizing the fundamental rights of people, communities, and the natural environment…and the power to enact local laws establishing, defining, altering, or eliminating the rights, powers, and duties of for-profit business entities."[204]

This amendment would essentially allow local municipalities to ban fracking or other E&P they deem harmful to their residents or to the environment. Thus, these communities would be able to protect themselves from the negative externalities of this industry, such as road deterioration, decreased air quality, etc.

This type of policy regulation could be a viable option in some Texas communities. Denton, which is located above the Barnett Shale, has already tried to initiate a similar process. In February 2012, the Denton city council approved a moratorium on new permits for drilling, and in January 2013 the city banned fracking within 1,200 feet of homes.[205] However, the legality of this policy has been called into question as companies have a right to use their property as they wish, per land ownership and mineral rights in Texas [206] Despite this ongoing legal battle, the Denton Drilling Awareness Group announced that it received enough signatures on its petition to put to vote in November 2014 a ban on fracking within Denton city limits.[207]

Attempts by local governments to completely ban fracking and production in Texas, one of the biggest oil producing regions in the world, will be difficult. However, this policy issue will most likely recur, especially if municipalities and counties seek protection from the costs resulting from fracking and trucking traffic.

5.5 Lessons Learned

By allowing companies to install and operate pipelines for salt water, waste water, and oil/natural gas on ROW, TxDOT should see a decrease in maintenance and repair costs. Allowing and aiding companies to install new pipelines for salt water as a result of the recently passed SB 514 will help to diminish trucking traffic. Both above-ground and below-ground pipelines have specific challenges to their installation and operation, yet both would yield results in the area of trucking reduction.

The use of pipelines on ROWs, however, is not the sole solution to the trucking and road deterioration issue. As TxDOT's Task Force on Texas' Energy Sector Roadway Needs noted, there are many possible additional fixes need to be deployed in concert, including

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[203] Community Environmental Legal Defense Fund, 2014.
[204] Ibid.
[205] Lewis, 2014.
[206] Ibid.
[207] Malewitz, 2014.

road user maintenance agreements, private-public roadway partnerships, overweight/oversize truck fees, severance taxes, and temporary water lines.[208]

TxDOT also needs to work more with municipalities in shale play areas to determine the most effective way to plan and install these pipelines. Working with companies to develop a plan to form a hybrid system of trucking and pipelines (thus reducing the total amount of trucking), would be beneficial to all parties.

Lastly, enacting more legislation in conjunction with other agencies that have regulatory authority over the industry, such as the Railroad Commission of Texas and the Texas Commission on Environmental Quality, would be beneficial. A collaboration between TxDOT and regulatory commissions could motivate E&P companies to start recycling more water in order to reduce trucking. HB 2767 will likely aid in this process. However, several bills that could have provided additional benefit to TxDOT were introduced and never passed. These bills encouraged recycling of fracking water (SB 1779) and regulated the use of recycled water (HB 3315).

Creating legislation that would enable and incentivize companies to perform on-site recycling is one of the key policy points for Texas. In the last legislative session, HBs 2992 and 3537 sought to require firms to treat wastewater to a degree that would allow the fluid to be reused on another oil or gas well, or for another beneficial purpose. As mentioned, these initiatives did not pass. As a result, any mandate on recycling will have to wait until the next legislative session starting in January 2015. However, other state agencies are seeking alternative means to encourage wastewater recycling.

The Railroad Commission of Texas is currently amending its water recycling rules. Existing rules define two types of commercial recycling facilities: mobile and stationary. Since 2006, however, an increasing number of applications for permits have failed to meet the specifications for either category. To meet this growing demand, Railroad Commission staff have begun changing the rules to include five additional categories of commercial recycling activities. The overall goal is to encourage water recycling, streamline the permitting process, and support technological advancements. [209]

Apache Corp has been one of the pioneers in recycling both flowback and produced water on-site. Based primarily in the Permian Basin, Apache recycles 100% of its water at $.29/barrel, as compared to the $2.50/barrel for disposal using a third-party.[210] As with pipelines, the capital cost of implementing water recycling treatment facilities is high, which inhibits their construction. Since a well's production life is finite, the amount of water decreases over time. As such, the cost building permanent water recycling plants is not only prohibitive, but unlikely to amortize over the life of the well. Portable water treatment facilities, which are not ubiquitous in the industry but are being closely looked at now, would ease introductory implementation costs.

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[208] Texas Department of Transportation, 2012.
[209] Railroad Commission of Texas, 2013a.
[210] Driver and Wade, 2013.

Using legislation to create proper funding to combat road deterioration is essential. By enacting new legislation during the 2015 session, TxDOT could create solutions now to address the developments of the next few decades as E&P increases, road maintenance costs increase, and the repair of these roads becomes more costly. The main area of concern regarding policy implementation is encouraging on-site water recycling. If on-site water recycling is available, the need for pipelines on TxDOT ROWs decreases exponentially as flowback and waste water would not be trucked out for disposal, nor would millions of gallons of fresh water be trucked in for use.

5.6 Relevance to Texas

Texas is a major oil and gas producing state and will be for decades to come. As such, the expansion and creation of saltwater pipelines through ROW acquisition is a relevant topic of exploration for TxDOT. Pipeline expansion in TxDOT ROWs presents three possibilities: encourage above-ground pipelines, encourage below-ground pipelines, or do nothing. Each scenario entails costs and benefits. If TxDOT does nothing, road deterioration on the scale of billions of dollars a year will continue and will likely increase over time. This deterioration will result in an increase of traffic fatalities as well as overwhelming road damage. If TxDOT encourages the use of underground pipelines, pipeline implementation needs to be made cheaper and easier. The fragmented underground mapping of utilities increases the risk of spills or leaks. Furthermore, because the wells' output of water decreases over time, companies are reluctant to invest in high-cost capital projects like pipelines. Lastly, above-ground pipelines pose their own set of concerns. Unlike underground pipelines, they are cheaper to install, operate, and move. However, they pose an increased safety risk of crashes and spills.

A more extensive pipeline network on ROWs can help alleviate the reliance on heavy trucks in the energy industry. TxDOT's revenue stream is not sufficient to spend billions of dollars' annually repairing roads that will then be destroyed the next year. Whichever methods the Texas government decides to employ, they must be used in conjunction with other policy mechanisms such as road user maintenance agreements and severance taxes. This perennial need for maintenance exacerbates the need for more pipelines.

Texas is now producing more than twice the oil that it did three years ago, and more than one-third of all U.S. production.[211] This unprecedented growth indicates that TxDOT must immediately recommend positive legislation and infrastructure solutions. Economic growth stemming from oil and gas production does not have to be at the expense of the Texas highway infrastructure. Ultimately, the increased construction of saltwater pipelines, coupled with the recycling of fracking fluids, can help to ease maintenance costs.

As a major hydrocarbons producer, Texas is in a unique position to create efficient policies that could be copied by other mineral-rich states. ROW acquisition is just one

[211] U.S. Energy Information Administration, 2014.

lever among many that TxDOT can pull to ease the burden on its highways. In light of helpful legislation such as SB 514, and with the assistance of private firms mindful of corporate social responsibility, TxDOT can reduce maintenance costs and improve driver safety.

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Transportation Policy Brief #6

State Energy Severance Taxes and Comparative Tax Revenues

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Volume 6. Transportation Policy Brief #6: State Energy Severance Taxes and Comparative Tax Revenues

6.1 Introduction

This particular policy brief, "State Energy Severance Taxes and Comparative Tax Revenues," was researched and written by Corey Howell and Wu Zheng.

6.2 Executive Summary

The shale gas industry in the U.S. accounted for over 600,000 jobs in 2012.[212] States' revenue from the severance tax, which is a tax imposed on the production of oil and gas resources, has increased from $5 billion in 1993 to $20 billion in 2012.[213] This spike in oil and gas production has accelerated the consumption of state and local transportation infrastructure due to the volume of heavy trucks and equipment needed for well sites; these heavy trucks are traveling over roads not built to support their weight. This increase in heavy traffic has created additional road maintenance needs not easily funded by traditional highway user fee mechanisms. This policy brief will address the issue of whether the current severance tax rates justify road use for well sites, or if there is a need for additional fees, by comparing the tax structure on oil and gas production in Texas to that of other producing states.

The tax structure in each state is different and complicated. Several factors must be considered when comparing tax structures among states. First, while most states have a severance tax, some do not because other taxes and fees serve the same revenue-generating purpose, such as the conservation tax and clean-up fees. This inconsistency can complicate interstate comparison of taxes. Second, while the overall tax structure tends to be more static, various exemptions and fees are commonly used as policy levers, or measures to incentivize or discourage certain activities. These exemptions and fees can significantly influence the outcome of interstate comparisons. Third, some states collect property tax on oil and gas, while others collect property tax on equipment. Finally, some states' severance tax is a fixed amount that is based on volume, while others use a percentage of market value.

Several studies have attempted to compare the overall tax burden on oil and gas production between states. The states chosen and taxes included in these studies are inconsistent and, therefore, policymakers cannot readily make comparisons and draw conclusions. However, each study provides a valuable view into the complicated tax system. This brief will analyze three different methodologies for comparison. In an attempt to provide a face-value comparison of tax rates, this brief describes the oil and gas tax structures for selected states and highlights the key differences between the states. Additionally, the brief presents a methodology used to compare effective taxes, including severance tax and property tax. Furthermore, the brief assesses the benchmark

[212] Petroff, 2014.
[213] O'Sullivan et al., 2013.

comparison, which compares the tax obligations of an artificially defined benchmark oil and gas company in different states.

The main lessons learned are that a variety of taxes and fees have been and can be used to collect tax from oil and gas companies. Moreover, fees, incentives and exemptions are effective levers that are easier to change than are the tax rates. Tax rates and types used by states tend to be similar within a geographical region, but differ across geographical regions. Finally, Texas has a relatively low severance tax rate when compared to other states and has a low effective tax rate.

6.3 Background

6.3.1 The Severance Tax in Texas

Texas uses the Crude Oil Production Tax and the Natural Gas Production Tax as severance taxes for oil and gas production. The Crude Oil Production Tax is imposed on the production of crude oil at a rate of 4.6% of market value.[214] The Natural Gas Production Tax is imposed on the production of natural gas at a rate of 7.5% of market value.[215] In 2013, Texas collected close to $3 billion—up 42.2% from the previous year—from the Crude Oil Production Tax, which is about 3% of the state's total revenue.[216] Texas also collected about $1.5 billion—down 2.6% from the previous year—from its Natural Gas Production Tax, which is about 1.5% of its total revenue.[217]

Texas has several incentives and exemptions in place for companies, which reduce the tax burden associated with the oil and gas severance taxes. These include the enhanced oil recovery incentive, the high-cost gas incentive, the incentive to market previously flared or vented casinghead gas, the two-year inactive well incentive, severance tax relief for marginal wells, the enhanced efficiency equipment severance tax credit, the orphaned well reduction program, the incentive for reuse/recycling of hydraulic fracturing water, and advanced clean energy-enhanced oil recovery tax reduction.[218] For example, the enhanced oil recovery exemption reduces the oil severance tax rate to 2.3% from 4.6%. The exemptions come with qualifications and certain formulas for reduction calculations. Consider the example of low-producing oil leases receiving severance tax relief for marginal wells. In order to qualify, a well has to produce fewer than 15 barrels of oil per day, or less than 5% recoverable oil per barrel of produced water. Oil prices at a given time determine the exemption amount (as Table 6.1 shows).

[214] Texas Comptroller of Public Accounts, 2013a.
[215] Texas Comptroller of Public Accounts, 2013b.
[216] Texas Comptroller of Public Accounts, n.d.(a)
[217] Ibid.
[218] Railroad Commission of Texas, 2014.

Table 6.1: Severance Tax Relief for Marginal Wells[219]

Average Taxable Oil Price	Exemption
More than $30	No Exemption
$25 – $30	25% Credit
$22 – $25	50% Credit
$22 or less	100% Credit

Oil and gas production are also subject to the regulatory tax and fee, which is $0.008125 per barrel for oil and $0.000333 per thousand cubic feet of gas produced. This tax is negligible when compared to the severance tax on oil and gas, which, varies from $1 to $6 per barrel depending on oil prices.[220]

Oil and gas production companies either own land and mineral rights or lease land from property owners. If a company owns land, then it will pay property taxes on an annual basis. Property tax rates vary greatly between states. According to a survey conducted in 2007, Texas has the highest average property tax rate (2.57%) and Hawaii has the lowest average property tax rate (0.44%).[221] In a more recent survey, Texas ranks third in terms of highest average property tax rate (1.81%).[222]

Furthermore, oil that is in the ground contributes to property taxes in Texas in the form of higher appraised value of land. The tax rate itself is set locally, because, like any other real property, the rate depends on the local taxing authorities such as school districts, hospital districts, and other districts. Moreover, state law governs the appraisal and assessment of property to provide uniformity across counties.[223] However, the assessed value of a property includes the net present value of the oil and gas calculated with the discount rate, which includes both the risk-free rate and the risk premium.[224]

Texas also has a franchise tax, which is a tax on business revenue. The franchise tax rate is 1% of total revenues for all industry groups. This tax has two major exemptions available. First, the retail and wholesale industries pay a reduced rate of 0.5%. The oil and gas industry does not enjoy this special rate. Also, companies whose franchise tax is less than $1,000 or have revenue less than $600,000 do not have to pay franchise tax.

6.3.2 Selection of Compared States

When selecting states to compare tax structures to Texas, it is important to consider several factors. Comparing high production states to low production states might create discrepancies due to differences in the need for a robust oil and gas tax policy. Therefore,

[219] Texas Comptroller of Public Accounts, n.d.(b)
[220] Texas Comptroller of Public Accounts, 2013a.
[221] Moody's Analytics, 2007.
[222] Moreno, n.d.
[223] Peppard, 2010.
[224] Texas Comptroller of Public Accounts, 2012.

such a comparison requires knowledge of production levels relative to other states. Table 6.2 shows several states inside major productive shale plays, which is based on Figure 6.1.

Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

Figure 6.1: Lower 48 Shale Plays

Table 6.2: Shale Plays and States Covered

Shale Play	State Selected
Bakken	North Dakota
Barnett and Eagle Ford	Texas
Haynesville-Bossier	Louisiana
Marcellus/Utica	Ohio & West Virginia
Monterey	California

6.3.3 Raw Tax Comparison

States impose different taxes and fees and use varying formulas to determine tax rates on the production of oil and natural gas. The most direct mechanism to analyze these taxes is to simply compare each state's tax structure at face value. Table 6.3 (next) compares the different taxes and rates of major energy-producing states.

The information in Table 6.3 is based on a study of oil and gas severance taxes conducted in 2012 by Jacquelyn Pless.[225] The Pless study indicates that 36 states collect some sort of severance tax and 31 states levy taxes specifically on the extraction of oil and gas. The list in the Pless study is extensive but not without issues. First, the Pless study includes conservation taxes as part of the severance tax list in California and other states. In a different study by the Covenant Group, the conservation tax is not included in California's severance tax, so the Covenant Group claims California does not collect a severance tax from the oil and gas industry, making the property tax the main tax.[226] Second, the list in the Pless study is incomplete, which is evidenced by the omission of the 4.6% Crude Oil Production Tax on oil production in Texas.

This method of simply listing the rate of severance tax does not include exemptions and incentives and does not allow for an easy comparison of tax rates based on market value versus fixed rates for volume of production. Therefore, the Pless study does not allow for a comparison of the relative rates of tax and, ultimately, the ability to determine which states have higher taxes.

[225] Ibid.
[226] Covenant Consulting Group, 2012.

Table 6.3: Oil and Gas State Severance Taxes as of 2012[227]

State	Type of Tax	Description of Tax Rates
California	Oil and Gas Production Assessment	Rate determined annually by Department of Conservation
	Oil and Gas Conservation Levy	Maximum 1.5 mills/$1 of market value at wellhead
Louisiana	Natural Resources Severance Tax	Varies according to substance
	Oil Field Restoration Fee	Varies according to type of well and production
North Dakota	Oil Gross Production Tax	5% of gross value at the well
	Gas Gross Production Tax	$0.04 per 1,000 cubic feet of gas produced. The rate is subject to a gas rate adjustment each fiscal year.
	Oil Extraction Tax	6.5% of gross value at the well. Exceptions exist for certain production volumes and incentives for enhanced recovery projects.
Ohio	Resource Severance Tax	$0.10/barrel of oil
		$0.025/1,000 cubic feet of natural gas
Texas	Natural Gas Production Tax	7.5% of market value of gas
		Condensate Production Tax is 4.6% of market value of gas
	Oil-Field Cleanup Regulatory Fees	5/8 of $0.01/barrel
		1/15 of $0.01/1,000 cubic feet of gas
West Virginia	Natural Resource Severance Taxes	5% of gross value for natural gas; 10% of net tax is distributed to local governments
		5% of gross value for oil; 10% of net tax is distributed to local governments
		Additional tax for workers' compensation debt reduction rate of $0.047/mcf of natural gas produced

6.3.4 Effective Tax Comparison

An effective tax is defined as the ratio of tax collected over the market value of the production. The North Dakota Legislature requested a report comparing the tax obligations of oil and gas firms in several comparable high energy-producing states, which the Covenant Group produced. The comparison uses eight states: California, Oklahoma, Texas, North Dakota, Montana, Louisiana, West Virginia, and Alaska. The effective tax is used in the Covenant study, as well as an emphasis on the importance of

[227] Pless, 2012.

including property tax. Three of the eight states used in the study do not have property taxes.

Therefore, there are relatively significant changes in effective tax rankings of the states when property taxes are included in the comparison, as is shown in Figures 6.2 and 6.3.

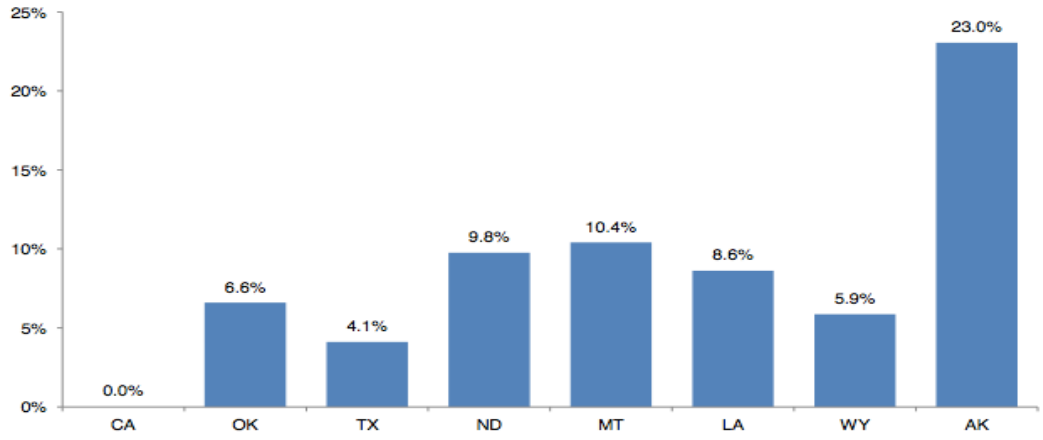

Figure 6.2: Effective Severance Tax Rates[228]

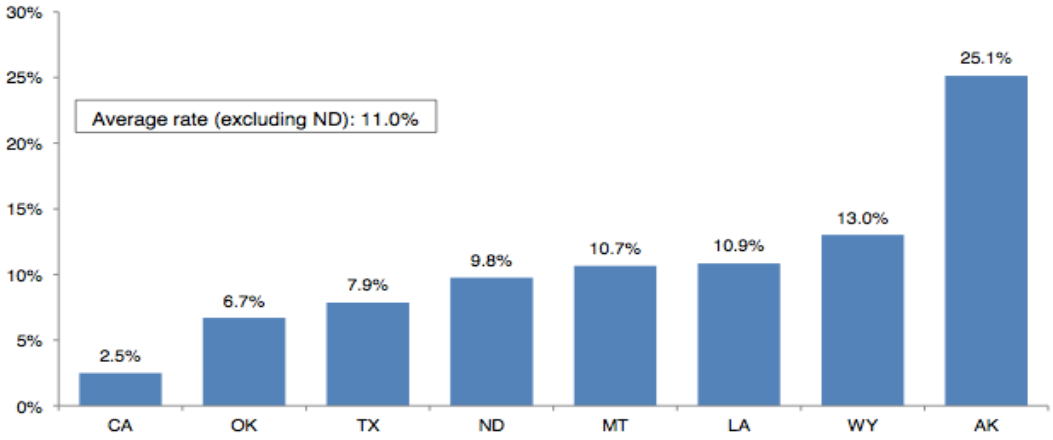

Figure 6.3: Effective Severance and Property Tax Rates[229]

The outlier states are California and Alaska. In the Covenant study, California does not have a severance tax, but rather a conservation tax, which the study does not include. The conservation tax is low enough that inclusion of the tax in the comparison would not

[228] Ibid.
[229] Ibid.

change the rankings. When the two outlier states are removed, then the average effective tax is 9.8% compared to Texas' 7.9%.[230]

6.3.5 Benchmark Comparison

Another applicable method of comparing taxes is the benchmark comparison, which calculates the tax liabilities of a benchmark firm. The benchmark firm is an artificial construct based on the economic activity of a typical firm. Dr. Jose Luis Alberro used this methodology to create an interstate comparison of taxes on oil and gas production. His study poses the same argument as the Covenant study, which is that severance taxes alone are not a good enough measure.[231] Alberro also accounts for unique tax circumstances, such as Colorado allowing firms to deduct property tax from severance tax; otherwise, Colorado's severance would be 137% higher. In addition to severance and property tax, the Alberro study also includes corporate/franchise tax and retail tax.

Since most severance taxes are based on or related to oil and gas prices, results based on different market prices are charted in Figures 6.4 and 6.5. The tax burden for the benchmark oil and gas firm in Texas is at the median amount relative to the states studied. However, the study used data from 2007, so the results may have changed.

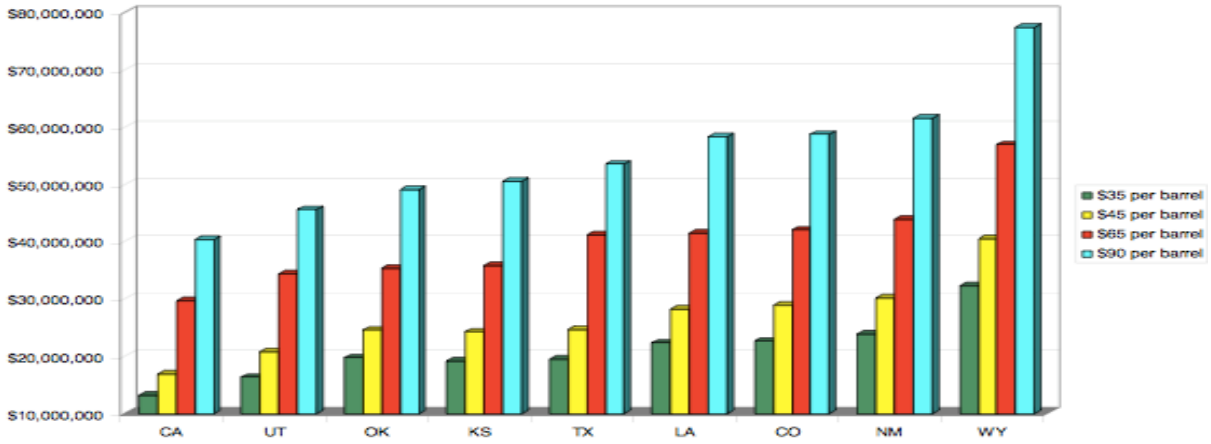

Figure 6.4: Total Tax Collections Based on Benchmark Oil Firm[232]

[230] Ibid.
[231] Alberro, 2013.
[232] Ibid.

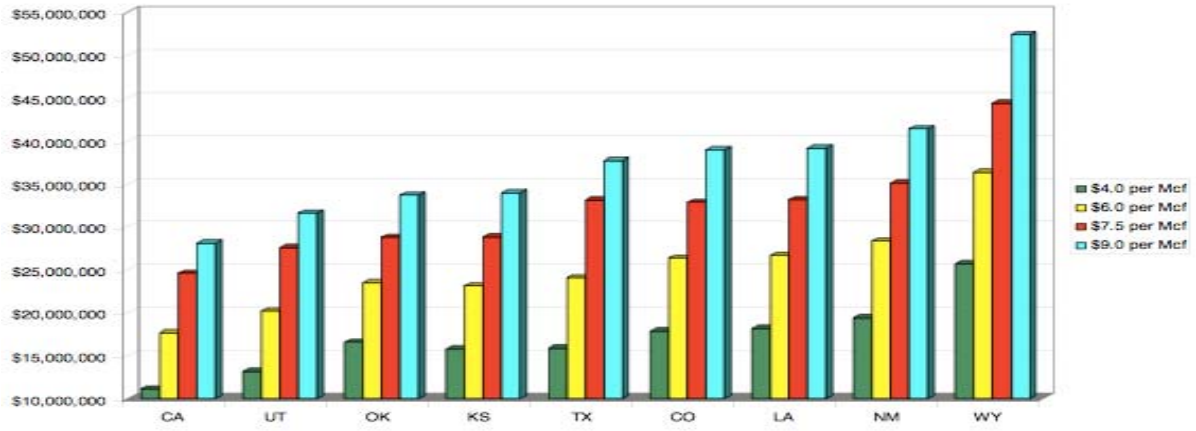

Figure 6.5: Total Tax Collections Based on Benchmark Gas Firm[233]

6.4 Key Policy Issues

Revenue from the severance tax has been rising since advancements in drilling technologies and extraction methods have made oil and natural gas resources more accessible. This surge is evidenced in Figure 6.6 as total severance tax collections have significantly increased across the United States in recent years.

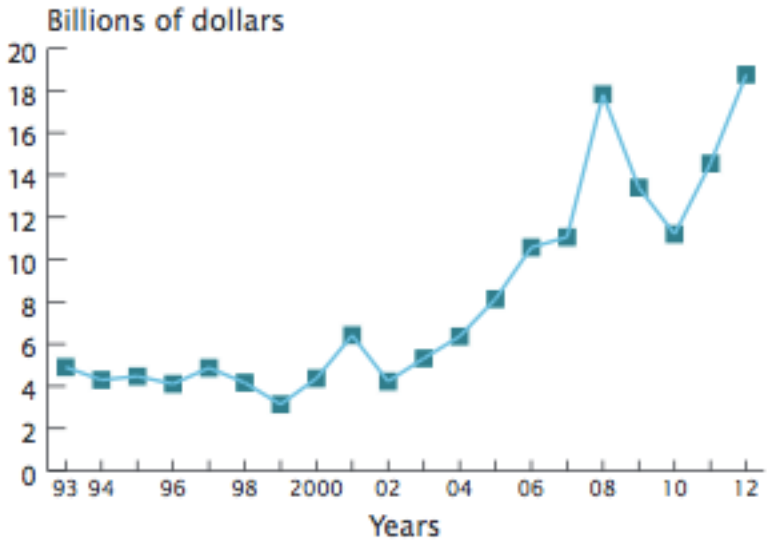

Figure 6.6: Total State Severance Tax Collections (1993–2012)[234]

As oil and gas production and, by extension, severance tax revenues increase, the lack of a severance tax has become costly to states with oil and natural gas resources. Pennsylvania is the largest gas-producing state without a severance tax. According to the

[233] Alberro, 2013.
[234] O'Sullivan et al., 2013.

Pennsylvania Budget and Policy Center, between October 1, 2009, and January 30, 2012, approximately $300 million in revenue was forgone by not having a severance tax in place.[235]

When assessing the various severance taxes, two policy goals are in conflict: 1) raising enough revenue to offset necessary governmental expenditures; and 2) being competitive with other states to attract businesses. Some may argue that adding a new tax or increasing the tax rate can improve revenue, while others argue that higher taxes on oil and gas production will reduce overall business activities and, therefore, decrease the tax base. This brief will not examine the impacts of lowering or raising taxes on overall production activity. Rather, the remaining sections of this brief will assess where Texas stands relative to other states in terms of taxes imposed on oil and gas companies. This information can be useful in the development of certain policies, such as road user maintenance agreements, that aim to ensure proper maintenance of the state and local transportation infrastructure commonly used in drilling activities.

6.5 Lessons Learned

Several important observations and key takeaways arise when comparing tax structures around oil and gas production in various states. These could be helpful to policymakers when analyzing the feasibility of developing policies around new revenue sources for road maintenance in high energy producing areas of the state.

6.5.1 Creative Taxing

The severance tax is not the only mechanism to raise revenue from the production of oil and natural gas. Other taxes and fees can be levied on oil and gas production, such as a conservation tax, franchise tax, property tax, extraction tax, and road impact fees. Different states use various approaches and combinations of taxes and fees. California does not have a severance tax, but instead has a conservation tax for oil and gas production.[236] Pennsylvania is the largest gas-producing state without a severance tax. Instead, Pennsylvania has an oil company franchise tax, an impact fee on each gas well, which goes to the state and local governments (but is not earmarked for infrastructure maintenance), and excess use maintenance agreements, a legal requirement that roads be maintained.[237] Colorado collects property tax based on the nominal oil price and allows for a deduction of the property tax from the severance tax.[238] Nevada imposes an excavation tax, which charges $0.02 for each cubic yard of earth excavated. Additional fees are collected, such as clean-up fees and regulatory fees.

Some states assess more than one tax in the vein of a severance tax. North Dakota has a production tax and oil extraction tax. New Mexico has an Oil and Gas Severance Tax, Oil and Gas Emergency School Tax, and a Natural Gas Processor's Tax.[239]

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[235] Pennsylvania Budget and Policy Center, 2014.
[236] Pless, 2012.
[237] Pennsylvania Department of Revenue, 2013.
[238] Alberro, 2013.
[239] Pless, 2012.

6.5.2 Incentives and Exemptions as Policy Levers

An additional takeaway is that tax rates are relatively stable and tend to be costly to change. In contrast, incentives and exemptions are easy to administer. As a result, incentives and exemptions become policy levers frequently used to adjust taxes. Many incentives and exemptions are created and expire at any given time. When conducting an interstate comparison of tax structures on oil and natural gas production, the fluidity in exemptions becomes an additional obstacle in making an accurate or fair comparison.

6.5.3 Common Severance Tax Rates

Despite the variety of severance tax arrangements, there seems to be a common mechanism by which the tax is imposed in most of the major production states: the percentage of market value. The raw tax rate is not an accurate measure of the effective tax, but this rate holds perception value. From observing the raw rate in Table 6.4, it seems that raw rates tend to be relatively similar by region and/or shale play.

Table 6.4: Severance Tax Rate Comparison

Shale Play(s)	State	Raw Rate
Avalon Bone Spring, Barnett, Eagle Ford, Excello-Mulky	Texas	4.6–7.5%
	New Mexico	7%
	Oklahoma	7%
	Kansas	8%
Marcos	Utah	3–5%
	Wyoming	4–6%
	Colorado	2–5%

The table indicates that states around the Marcos Shale have lower raw rates than the states in the Avalon Bone Spring, Barnett, Eagle Ford, and Excello-Mulky shale areas.

6.6 Relevance to Texas

Shale formations extend beneath many counties in Texas and hydraulic fracturing, a process that requires the transport of large volumes of heavy payload trucks, is growing too quickly to accurately measure the exact number of wells currently operating within these counties.[240] The problem with this booming industry is that Texas currently has no statewide mandate for negotiating road repair payments from energy companies. While severance taxes are collected from the production of oil and natural gas, the collections are not directly allocated to finance the infrastructure needs of the energy companies and public.[241]

[240] Railroad Commission of Texas, 2013.
[241] Lyndon B. Johnson School of Public Affairs, 2013.

Although oil and natural gas tax revenues do contribute a significant amount of money to the Texas Rainy Day Fund, the fund is not earmarked for infrastructure needs, but rather intended to serve as a safety net to cover any unforeseen budget shortfalls.[242] Ultimately, using money from the Rainy Day Fund for road maintenance is unsustainable.[243] The energy industry is predicted to continue to grow in both the Eagle Ford Shale region and West Texas, where new shale plays are being identified.[244] Statewide measures should be implemented to ensure funding for infrastructure repairs on an ongoing basis and funds should be available for TxDOT to repair road damages as they are incurred to ensure roadway safety.[245]

As Texas considers various policy options, such as road user maintenance agreements, to address these infrastructure repair needs, an understanding is necessary of the tax liabilities for the oil and gas industry in Texas as they compare to those of other states. The different methodologies used to compare tax structures lead to varying results in terms of a state's relative tax policies. In the raw tax rate comparison, Texas holds a relatively low tax rate on production of oil and natural gas. Using the effective tax comparison, Texas also falls in the low range relative to other states studied. When a benchmark firm is used to analyze energy-producing states' tax structures, Texas is the median of the sample. This data can inform policymakers in making decisions as they seek to maintain a competitive tax and fee structure while ensuring the appropriate amount of revenues to finance transportation infrastructure maintenance and repair projects.

[242] Texas Tribune, 2013.
[243] Lyndon B. Johnson School of Public Affairs, 2013.
[244] Ibid.
[245] Ibid.

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Volume 6 Appendix 2: Covenant Group Study

OIL TAX STUDY

		Avg Rates	ND	AK	CA	MT	OK	LA	TX	WY
Oil	Prod.		87,668,000	203,816,365	200,821,137	26,211,722	83,169,854	58,540,000	321,305,011	50,493,822
	Value		$5,706,984,000	$14,038,800,000	$14,047,438,533	$1,663,975,228	$5,390,238,238	$3,977,300,000	$22,970,671,438	$2,439,657,555
	Tax		$570,786,588	$3,235,101,557	-	$174,129,888	$377,316,675	$460,700,000	$1,001,971,125	$134,883,093
	Rate	10.3%	10.0%	23.0%	0.0%	10.5%	7.0%	11.6%	4.4%	5.5%
Gas	Prod.		68,165,915		262,884,801	90,315,072	1,642,009,701	1,082,000,000	7,006,058,324	2,365,186,657
	Value		$267,210,387		$1,185,610,452	$305,037,670	$5,714,193,759	$4,652,400,000	$26,436,901,514	$5,861,051,297
	Tax		$11,924,060		-	$30,761,372	$354,834,430	$282,500,000	$1,030,866,620	$351,663,078
	Rate	5.4%	4.5%		0.0%	10.1%	6.2%	6.1%	3.9%	6.0%
Oil & Gas										
	Value		$5,974,194,387	$14,038,800,000	$15,233,048,985	$1,969,012,898	$11,104,431,997	$8,629,700,000	$49,407,572,952	$8,300,708,852
	Tax		$582,710,648	$3,235,101,557	-	$204,891,260	$732,151,105	$743,200,000	$2,032,837,745	$486,546,171
	Rate	9.8%	9.8%	23.0%	0.0%	10.4%	6.6%	8.6%	4.1%	5.9%
Property	Local		No	Yes	Yes	No	No	Yes	Yes	Yes
	State		No	Yes	No	Yes	No	No	No	Yes
	Tax		-	$293,400,000	$380,209,000	$4,874,477	$11,500,000	$193,400,000	$1,851,813,708	$594,408,675
	Rate	3.0%	0.0%	2.1%	2.5%	0.2%	0.1%	2.2%	3.7%	7.2%
Definition	Well Equip./ Tanks		No	Yes	Yes	Yes	No	Yes	Yes	Yes
	Minerals		No	No	Yes	No	No	No	Yes	No
Severance & Property Tax Total	Value		$5,974,194,387	$14,038,800,000	$15,233,048,985	$1,969,012,898	$11,104,431,997	$8,629,700,000	$49,407,572,952	$8,300,708,852
	Tax		$582,710,648	$3,528,501,557	$380,209,000	$209,765,737	$743,651,105	$936,600,000	$3,884,651,453	$1,080,954,486
	Rate	11.0%	9.8%	25.1%	2.5%	10.7%	6.7%	10.9%	7.9%	13.0%
Tax changes since 2010			No	Yes	No	No	No	No	No	No

Notes:

1. *Average rates exclude ND*
2. *Alaska (gas data not segregated from oil)*
3. *Oklahoma adjustment is excise tax*
4. *Alaska audit collections adjusted downward for unusually large collection in FY 2010*

Transportation Policy Brief #7

U.S.-Mexico Transportation and Logistics

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Volume 7. Transportation Policy Brief #7: U.S.-Mexico Transportation and Logistics

7.1 Introduction

This particular policy brief, "U.S.-Mexico Transportation and Logistics," was researched and written by Hector Rojas and Salima Hakim Khan.

7.2 Executive Summary

Trade between the U.S. and Mexico has grown substantially since the North American Free Trade Agreement (NAFTA) took effect in 1994 and Mexico is now the third-largest U.S. trading partner.[246] In 2013, total U.S.–Mexico trade reached $507 billion, of which 66% ($336 billion) was moved by truck through 24 southern border ports of entry (POEs). Some 73% ($246 billion) of that truck traffic passed through 13 Texas ports of entry (POEs)[247] which represent 48% of the total U.S.-Mexico trade moved by truck—$131 billion in imports and $115 billion in exports. Trucks use seven Texas interstate and state highway corridors to move U.S.-Mexico trade to customers either within the state or to other U.S. states and Canadian provinces.

This growth has led to forecasts that Mexico may ultimately replace China as the second-ranked U.S. trading partner due to its proximity to the U.S., abundant supply of natural gas from shale plays, and low cost of labor.[248] Global manufacturers are contemplating locating their factories in Mexico—termed "near-sourcing"—to grow their market share in the U.S. and in other countries that have entered into free trade agreements with Mexico. This is especially true of the automobile sector, which is one of the fastest-growing industries in Mexico.

On July 15, 2013, Mexican President Enrique Pena-Nieto announced the new National Program of Investment in Transportation and Communications Infrastructure (Programa de Inversiones en Infraestructura de Transporte y Comunicaciones 2013-2018) [249], hereafter referred to as the "NIP". This ambitious program includes both government and private-sector investment. The NIP, prepared according to the parameters included in the current National Development Plan (Plan Nacional de Desarrollo 2013-2018), proposes to invest the equivalent of $102.5 billion during the President's stint in new infrastructure and maintenance projects, $46.6 billion of which will primarily benefit road, rail, port, and airport projects. The remainder will be devoted to improving the nation's telecommunications infrastructure.

One project is the construction of the Mazatlán-Matamoros highway corridor, which connects the Atlantic and Pacific oceans. Highways traditionally have followed a north-

[246] U.S. Census Bureau, 2013.
[247] U.S. Department of Tranpsortation, n.d.
[248] Coy, 2013.
[249] Secretaria de Comunicaciones y Transportes, 2013.

south orientation, reflecting the topography of Mexico and this east-west highway opens up agricultural and industrial areas to U.S. markets. The government has also been promoting the development of a national network of logistics hubs on its trade corridors.[250]

The purpose of this brief is to highlight the increasing involvement and interest of private-sector organizations, including inland ports and transportation companies, that are collaborating with each other to make the trading process more efficient. These companies believe that the U.S.-Mexico transportation network will operate more efficiently, if it acts as a single system, rather than two separate systems divided by an international border.

Interpuerto Monterrey, an inland port in Mexico, has been in talks with Alliance Texas, an inland port and global logistics hub in Fort Worth, to promote logistics efficiencies in cross-border trade. These inland ports are planning to cooperate by sharing information and best practices. An example of this initiative is the potential to develop free trade zones within inland ports that would allow faster processing at border ports of entry because the cargo would move "in bond." Interpuerto Monterrey has also started cooperating with other inland ports in Mexico and Spain to share best practices. These developments suggest that U.S.-Mexico truck-based trade, which represents a significant share of truck use and consumption of TxDOT assets, is best addressed by recognizing trade flows that are sensitive to system-wide planning and investments. Rather than simply removing bottlenecks, like congested ports of entry, the private sector is more concerned with the possible integration of the overall transportation and logistics system.

Improving freight flows to maintain economic competitiveness and highway safety is a major TxDOT goal and state planners are aware of bottlenecks at border POEs that have been created by increased trade between the U.S. and Mexico, particularly at peak periods during the working day. This brief suggests that evaluating truck trade flows from a system perspective might more accurately reflect current and future decisions made by highway users. This will enable both countries to support a more efficient supply chain network, which will not only allow timely and safe delivery of goods, but also reduce transportation and inventory costs.

7.3 Background

7.3.1 Mexico's Rise in the Global Economy

Mexico is now one of the largest economies in the world—ranked 14th by the World Bank in 2012 with a gross domestic product (GDP) of $1.18 trillion. Mexico is a member of the G-20, an alliance of the 20-biggest economies of the world, and has entered into a total of 44 free trade agreements (FTAs) with other countries. The alliance and other

[250] Whitfield and Hulse, 2011.

FTAs have given Mexico the opportunity to open its markets to countries outside of the North American Free Trade Agreement (NAFTA).[251]

The U.S., Canada, and Mexico signed NAFTA which was fully implemented on January 1, 1994. In 2008, all trade barriers were eliminated, making it a tariff-free trade zone. This agreement has been instrumental in facilitating trade of goods and services growth, inflow of foreign direct investment, and creation of jobs. Each day, NAFTA creates $3.2 billion worth of trade with its NAFTA partners and produces one-third of the world's total GDP.[252] Mexico has become a major exporter of manufactured goods to the U.S. It has been a major supplier of household appliances, electronics including cell phones, pharmaceuticals, medical devices, power systems, and other consumer goods. According to a study by World Bank, NAFTA not only had a positive impact on the Mexican economy, but it has also enabled the Mexican manufacturers to adopt innovative technologies used in the U.S.[253] There are 52 land crossing ports of entry between the United States and Mexico, comprising 43 highways, 8 rail lines, and 1 ferry. Texas has 29 ports of entry of which 15 process freight trucks. Five Texas ports of entry account for over half of all truck crossings.

From 2012 to 2013, total trade between the U.S. and Mexico increased by 2.6%. In 2013, the top commodity exported between the U.S. and Mexico was electrical machinery at $94.2 billion (see Appendix 3). In the U.S., 23 states consider Mexico as one of its top-three trading partners.[254] Table 7.1 presents the top-ten U.S. states with the highest share of trade with Mexico using all modes of transportation. Texas has the highest volume of trade with Mexico amounting to $195.6 billion in 2013—three times greater than the second state, California.

Table 7.1: Top 10 U.S. States Trading with Mexico255

Value of Trade in 2013 (in millions of dollars)	
State	**Value of Trade ($m)**
Texas	195,636
California	60,174
Michigan	52,431
Illinois	18,987
Arizona	14,113
Ohio	12,642
Louisiana	11,013
Tennessee	10,020
Indiana	7,966
Georgia	7,882

[251]The New Policy Institute, 2013.
[252]U.S. Chamber of Commerce, 2012.
[253] Villarreal and Fergusson, 2013.
[254]The New Policy Institute, 2013.
[255] U.S. Department of Tranpsortation, n.d.

Mexico may supplant China as the second-ranked U.S. trading partner, primarily because the former wide disparity between Mexican and Chinese labor costs (especially in the respective manufacturing sectors) is closing rapidly. The U.S. economy will also benefit because Mexican factories use four times more U.S.-manufactured components as China. Another consideration is the declining cost of energy which will soon be lower in Mexico due to abundant supply of natural gas in Texas. Most manufacturers also prefer to be closer to their largest consumer—the U.S. market—and are, therefore, establishing their manufacturing facilities in Mexico to lower their transportation and inventory costs. In other words, "near-shoring" is economical not only for U.S. consumers, but also for its manufacturers.[256]

One of the fastest-growing industries in Mexico is the automobile sector due to lower costs of production, availability of skilled labor, government support such as tax credits, and job training assistance. Audi, Honda, Nissan, and Mazda are planning to open manufacturing or assembly facilities in Mexico by the end of 2014/15.[257]

7.3.2 Modes of Transportation

There are five primary modes of transportation used in bi-lateral U.S.-Mexico trade: rail, truck, air, ocean vessels, and pipelines. In 2013, surface transportation, which includes truck, rail and pipeline transport, carried 80.8% of the total dollar value of goods or services traded. From 2012 to 2013, freight—in terms of value—on these three modes grew faster than overall trade. That is, transport by pipeline grew by 8.5%, rail by 8.2% and truck by 3.8%. In the same period, air and maritime trade declined by 6.9% and 9.1%, respectively (see Appendix 4). Figure 7.1 shows the percent of total usage by each mode of transportation in the year 2013.

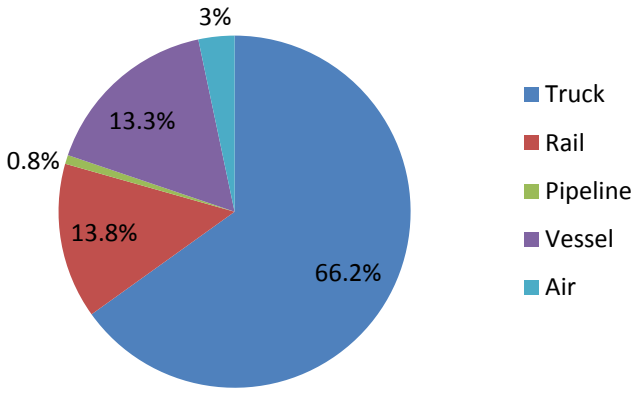

Figure 7.1: Trade Value between U.S.-Mexico by Mode of Transportation in 2013[258]

[256] Coy, 2013.
[257] Ross, 2013.
[258] U.S. Department of Tranpsortation, n.d.

7.3.3 Single Supply Chain Network

NAFTA enabled manufacturing industries in North America to stay globally competitive and focus on establishing strong and efficient supply chains. It reoriented manufacturing and assembly facilities between the U.S. and Mexico to take advantage of economies of scale. Both countries are using production sharing as manufacturers in these countries are working together to create finished goods. In such situations, intermediate goods produced in the U.S. are sent to assembly/value addition facilities in Mexico where the finished goods are produced and transferred to U.S. consumers. Therefore, an efficient supply chain is critical to support this manufacturing and production system.[259]

International supply chains comprise points of production and consumption, multimodal corridors, and ports of entry/export where security inspections, together with legal and tariff compliance, are undertaken. These are conducted at the first entry point for imports—airports, seaports, and border ports of entry for truck and rail imports. International and domestic supply chains may also have load centers at strategic locations along their highway or rail corridors, particularly near large metropolitan markets. These inland ports provide a range of services to shippers and have been most strongly linked to the growth of Class 1 rail carrier intermodal business.

Transportation experts define an inland port as a location where multimodal transportation facilities, along with other services, are offered at a single location. The services include warehousing, freight forwarding, and logistics management. The inland ports provide ways to lower costs by reducing transportation links, delays from customs, and allow shippers to use Just-in-Time (JIT) inventory methods.[260] In light of the growth of such facilities, private investors and public policy makers are focusing on inland ports to strengthen the effectiveness of multimodal corridors. Inland ports can also be linked to industrial parks, which cities promote for industrial development.

7.3.4 Mexico's National Program of Investment in Transportation and Communications Infrastructure 2013–2018

Mexico has four main north-south transportation corridors: the Pacific Corridor, the Chihuahua Corridor, the Central Corridor, and the Gulf Corridor, which link into Mexico City. Of the four corridors, the Gulf Corridor is the least significant in terms of the dollar value of trade between the U.S. and Mexico.[261]

As previously mentioned, the Mexican government launched its most recent NIP on July 15, 2013 to enable the nation to be globally competitive with other developed nations. Some $46.6 billion will be devoted to improving transportation-related infrastructure projects, including modernization and upgrading of the nation's 17,598 km of highways and rural roads.

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[259] Villareal and Fergusson, 2013.
[260] Walter and Poist, 2003.
[261] Eichenauer, 1995.

The Mexican government also plans to construct two new, modern, north-south trade corridors along with two east-west routes. One of the two north-south corridors will be the Pacific Coastline Corridor, which will integrate the country's northwest and western regions. The other corridor is the Gulf Coastline Corridor, which will connect Veracruz, Tampico, and Monterrey to Matamoros. This corridor will not only allow for a smooth flow of goods, but also encourage tourism. It will enable the rest of Mexico's regions to be connected to the oil and gas industries. The first east-west corridor, Manzanillo-Tampico, will connect Mexico's four major north-south trade corridors and will provide easy access to cities at the northern border such as Nuevo Laredo, Reynosa, and Juarez. The second corridor, Mazatlán-Matamoros, will connect the Pacific and Atlantic oceans, linking the U.S. and Mexico with Asia in a well-connected 1,242 km corridor. The superhighway will connect southern U.S. cities to the northern part of Mexico and offer access to the Mazatlán port, which will provide the U.S. with faster access to Asian markets.

In the NIP, the Mexican government acknowledged that the nation has lagged behind in its development of infrastructure. Mexico's infrastructure was rated lower than in previous years, meaning that the country needs to devote more effort to improving its infrastructure to compete with other countries. In the plan, the government includes building its infrastructure to fulfill its mission of uniting North America with Central and South America. Road infrastructure is of special importance to Mexico since it accounts for more than three quarters of its freight flows and over 95% of passenger travel. It is also significant that, compared to similar countries, Mexico relies less on rail transport although that might be changing on key corridors.

Road projects dominate the plan, representing 149 out of the total 210 projects. The Mexican region where most of the budget will be spent is in the southernmost region, followed by the central and northern regions. With Mexico concentrating its resources on road infrastructure, it is closer to accomplishing its goal of connecting North America with the rest of the continent and ultimately, with the world.[262]

7.3.5 Important Private Sector Stakeholders

The Mexican Association of Industrial Parks (AMPIP) was established to encourage foreign direct investment (FDI) in the country. High inflow of FDI was accomplished by assisting and providing investors from other countries with incentives to establish their manufacturing units in Mexico. Currently, AMPIP has 57 corporate members who own more than 200 industrial parks located throughout Mexico.[263]

Other important stakeholders in cross-border trading activities include inland ports and transportation companies. Alliance Texas in Fort Worth is one of the important inland ports in the state. It is termed a "global logistics hub" and is the cornerstone of an 18,000-acre area developed by the Hillwood Group. Alliance offers inland port transportation

[262] Secretaria de Comunicaciones y Transportes, 2013.
[263] AMPIP, n.d.

options via one of the nation's largest intermodal yards, two Class I rail lines, the world's first industrial airport, and connecting state and interstate highways. Stemming from this strong infrastructure system are corporate campuses, office complexes and tech centers, destination retail and entertainment venues, residential housing, apartments, schools, churches and community shopping.[264] Succinctly, it is a master-planned, mixed-use development, not only providing its customers with access to multiple modes of transportation, but also includes an industrial park.[265] Similarly, one of the largest inland ports in Mexico is Interpuerto Monterrey. It is situated in one of the largest industrial cities in Mexico, 200 km from the U.S. border, which makes it an important location for manufacturers and shippers who are also served by two railroads. The government of Mexico has been a strategic partner in terms of both facilitating the development of the infrastructure[266] and meeting with Interpuerto to evaluate the potential of pre-clearance of goods and developing bi-national customs programs.

One of the important private railroad service providers in the U.S. is the Kansas City Southern Railway Company (KCS). KCS owns Kansas City Southern de Mexico (KCSM), which is one of two railroad companies—the other being Ferromex—to offer service between key terminals located in U.S. and Mexican cities.

7.4 Key Policy Issues

Issues arising from a consolidated transportation system between U.S.-Mexico include improvements needed for the logistics system within Mexico, the lack of alliances between the U.S. and Mexican inland ports, and the absence of a deregulated logistics system in Mexico.

7.4.1 Improvements Needed In Infrastructure Development In Mexico

The Secretariat of Communications and Transportation (SCT) and the Secretariat of the Economy (SE) are collaborating with the Inter-American Development Bank to create a National System of Logistics Platforms. In this regard, the April 2013 Mexican National System of Logistics Platforms and Implementation Plan (*Sistema Nacional de Plataformas Logisticas y Plan de Implementacion*) states that primary logistics nodes, secondary nodes, and the cities that unite these nodes form logistics macrospheres that serve to facilitate transport and commerce in Mexico. These logistics macrospheres are strong and overlapped in the central region of the country. This region is the most populous area of Mexico where a significant amount of manufacturing takes place. The logistics macrosphere surrounding Monterrey is very large, but it is separated and distant from other logistics macrospheres. This makes the Monterrey region logistically weak, as it does not have many cities and secondary logistics nodes to facilitate transportation.

Monterrey is part of the most consolidated logistics corridor. This corridor is highly consolidated with good reason—it has the job of transporting goods for export from the

[264] Alliance Texas, n.d.
[265] Dallas logistics Hub, n.d.
[266] Interpuerto Monterrey, n.d.

industrial manufacturing cities in the central region of Mexico into the U.S. through Texas. The other branch of the strongest consolidated logistics corridor starts in the central region of Mexico then makes its way to Chihuahua and across the border through Juarez. Both of the consolidated logistics corridors in Mexico are set up to facilitate trade between Mexico and the rest of North America. Comparatively, the Monterrey branch of the corridor has a stronger network surrounding its region. The Mexican government has singled it out as an area that will receive a significant amount of attention over the next five years because it expects the growth in trade to continue. But, on the other hand, the government also acknowledges that the Chihuahua branch of this corridor is less developed and points out that it is an issue of concern to them.[267]

7.4.2 Lack of Alliances between Inland Ports

Transportation companies in Mexico, such as KCSM, are working in close coordination with some of the inland ports in Mexico. KCSM has established such collaboration by having terminals located within the inland ports to facilitate the transportation of goods. These terminals are located in Puerto Mexico (Taloca), Interpuerto (San Luis Potosi) and Monterrey, which connects the ports to the KCS network in the U.S. to move different goods between the two countries.[268] Partnerships between inland ports or an alliance between inland ports and transportation companies in the U.S. and Mexico can provide immense benefit to both countries by not only ensuring timely delivery of goods, but also reducing transportation and inventory costs. There is a lack of a functioning alliance between inland ports located in the U.S. and Mexico to facilitate cross-border trade. Hence, many inland ports in Mexico are entering into strategic partnerships with industrial parks in other countries. For instance, Interpuerto Monterrey has been working in collaboration with PLAZA (Plataforma logística de Zaragoza) in Zaragoza, Spain.[269]

7.4.3 Regulatory Role of Mexican Government

There is a need for a national logistics platform in Mexico that can lead to more efficiency and competitiveness in all modes of transportation. Success of an efficient transportation system requires a deregulated logistics system. The government needs to support private-sector collaboration and initiatives that will accomplish these ends and spur growth of this sector. [270]

According to recent reports, two of the leading railroad companies—KCSM and Grupo Mexico, operator of the Ferromex and Ferrosur railroads—have been targeted by draft legislation in the Mexican House of Deputies for monopolistic behavior. The proposed legislation would require the companies to share their tracks and disclose their confidential rates associated with private contracts. Ferromex has threatened to withhold a $2.2 billion investment plan if it is forced to disclose rates.[271]

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[267] Secretaria de Comunicaciones y Transportes, Secretaria de Economia, & Banco Interamericano de Desarrollo, 2013.
[268] Délano, 2014.
[269] Hulse, 2014.
[270] Délano, 2014.
[271] Szakonyi, 2014.

7.5 Lessons Learned

Recent reports suggest that, in the future, Mexico will become increasingly competitive with Asia as a manufacturing base. This will also benefit the U.S. economy since global manufacturing in Mexico will enable the U.S. to increase its imports. Typically, Mexican factories use four times as much U.S.-manufactured components as Chinese manufacturers. Such an industrial boost in Mexico will also lead to an increase in the standard of living; hence, Mexicans will be able to buy more U.S. goods.

An analysis of the plans drafted by the Mexican government shows that Mexico has been allocating a significant amount of resources to improve its infrastructure, especially when it comes to the trade corridors used for export and import with other countries. The Mexican government realizes that a strong logistics network is necessary to be competitive in the global market. Similarly, its private sector is working toward finding ways to improve the logistics networks, which will facilitate transport across the U.S.-Mexico border, especially between Texas and Mexico. Mexico passed a Public-Private Partnerships law in 2012, offering much-needed regulatory clarity and legal protection for private investors.

Part of this research was devoted to ascertaining what the private sector is doing to strengthen logistics networks through cooperation. As a result, some of the private-sector stakeholders in the U.S.-Mexico transportation network were interviewed for this project. These included representatives from the North American Strategy for Competitiveness (NASCO), AMPIP, KCSM, and Interpuerto Monterrey. NASCO's work is centered on bringing together the different components of the North American Corridor that unites U.S., Mexico, and Canada.

NASCO, AMPIP, KCSM, and Interpuerto Monterrey all believe that U.S.-Mexico transportation should be treated as a single, continuous logistics network. They believe that companies on both sides of the border should plan their operations as if no border existed. For this reason, the private sector is looking for ways to integrate the transportation system, including encouraging all important stakeholders, especially the inland ports and transportation companies, to cooperate by sharing information and best practices.

Interpuerto Monterrey has been in talks with Alliance Texas in Fort Worth to create a partnership to promote cross-border trade. Interpuerto Monterrey is currently cooperating with inland ports in San Luis Potosi and Spain in order to share best practices. Through cooperation amongst different members of the transportation industry, the private sector is enhancing its ability to facilitate trade.[272]

7.6 Relevance to Texas

The main objective of this policy brief is to provide TxDOT with the information on how the private-sector firms on both sides of the border are working diligently to make the

[272] Hulse, 2014.

supply chain network between U.S.-Mexico more efficient. The private sector has always considered the transportation network between the two countries as a single network, rather than two transportation infrastructure systems situated in different countries. The private sector is developing mutual agreements to form strategic partnerships, which will facilitate a system of sharing best practices and experiences with each other. They want to achieve "integrated" trade corridors through public-private partnerships and cooperative agreements, and need investments in transport logistics, such as telecommunications and warehouses.

The Mexican government is working toward strengthening its transportation network to facilitate the flow of goods with its trading partners. It has realized the importance of logistics hubs to create links between trade corridors and to contribute to the establishment of a national network of logistics hubs. According to the NIP, one of the east-west trade corridors–Mazatlán to Matamoros–will link North America with Asia, which will facilitate global trade. This corridor will make the current two-day journey from the Pacific Ocean to the Gulf of Mexico a reduced, ten-hour voyage on a toll road. As with all toll roads, however, the pricing of the facility will impact truck demand and commercial success. The Mexican government also realizes the need to build logistics hubs at various locations on this trade corridor to facilitate commerce. This will enable Mexico to diversify its trade links by strengthening trade ties with other countries, in addition to the U.S. and Canada. Major industrial and logistics companies are already working in the state of Durango, which will provide services such as industrial parks, foreign trade zones, and intermodal terminals.

In the future, a lack of integrated transportation system between Mexico and the U.S. might begin to adversely impact trade between the two countries. Therefore, TxDOT should focus on helping to facilitate improvements and integration of U.S.-Mexico transportation infrastructure to remedy this potential problem. TxDOT planning should support more efficient supply chain networks, so as to enhance competitive advantages in Mexico-Texas markets.

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Volume 7 Appendix 2: Map of U.S.-Mexico Border

Volume 7 Appendix 3: Top Commodities Traded

Top Commodity Transported Between U.S. and Mexico for each Mode of Transportation (in Millions of Dollars)

Mode	Commodities	Exports	Imports	Total
All Modes	Electrical Machinery; Equipment and Parts	36,774	57,395	94,168
Truck	Electrical Machinery; Equipment and Parts	32,925	52,207	85,131
Rail	Vehicles Other than Railway	6,810	31,832	38,643
Pipeline	Mineral Fuels; Oils and Waxes	3,703	241	3,944
Vessel	Mineral Fuels; Oils and Waxes	16,500	33,825	50,325
Air	Electrical Machinery; Equipment and Parts	2,740	2,462	5,202

Source: U.S. Department of Transportation, n.d.

Volume 7 Appendix 4: Modal Shares of U.S.-Mexico Freight Flow

Modal Shares of U.S.-Mexico Freight Flow (in Millions of Dollars)

Mode		2012	2013	Percentage Change
All Modes	Imports	277,653	280,456	1.0
	Exports	216,331	226,153	4.5
	Total	493,984	506,608	2.6
Share of Total by Mode (% of total value)				**% Point Change 2012-2013**
All Surface Modes*	Imports	79.1	81	2
	Exports	79.5	80.5	1
	Total	79.2	80.8	1.6
Truck	Imports	65.7	65.9	0.3
	Exports	65.1	66.6	1.5
	Total	65.4	66.2	0.8
Rail	Imports	13.3	15	1.7
	Exports	12.8	12.3	-0.5
	Total	13.1	13.8	0.7
Pipeline	Imports	0.1	0.1	0
	Exports	1.6	1.6	0.1
	Total	0.7	0.8	0
Vessel	Imports	16.3	14.3	-2
	Exports	13.2	12	-1.2
	Total	15	13.3	-1.7
Air	Imports	3.1	2.6	-0.5
	Exports	3.4	3.4	0
	Total	3.3	3	-0.3

Source:U.S. Department of Transportation, Bureau of Transportation Statistics, TransBorder Freight Data