EMISSIONS FROM LONG-HAUL MEXICAN DIESEL TRUCKS IN THE LAREDO-SAN ANTONIO CORRIDOR

FINAL REPORT

by

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DISCLAIMER

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EXECUTIVE SUMMARY

This project investigates the potential air quality impact of changes in long-haul truck activity along the I-35 corridor between Laredo, TX, and San Antonio, TX. This corridor has been identified as an area of concern in Texas, because of the volume of freight movement at the Laredo port of entry (POE), coupled with the existing air quality concerns in the region, including the impacts of drilling activities in the Eagle Ford Shale region.

Changes in long-haul truck activity along the corridor are anticipated as a result of a new federal law that allows Mexican-domiciled trucks to engage in long-haul operations across the border. Historically, goods have crossed the southern border using drayage trucks that are limited to operating within a small commercial zone adjacent to the border. The new rule will allow Mexican-domiciled trucks to long-haul goods directly from the interior of the Mexico to a final destination in the United States, and vice versa. This has led to concerns that emissions from Mexican trucks could impact the air quality along the corridor.

To address these air quality concerns, researchers developed a quantitative analysis of projected corridor emissions between 2015 and 2025 based on projections of Mexican truck activities. The analyses incorporated the following information:

- The estimated long-term trends in total combination truck traffic along the corridor.
- Estimated changes in the composition of Mexican- and U.S.-domiciled trucks on the corridor.
- Estimated emission rates of U.S.- and Mexican-domiciled trucks using the highway.

The results suggest a small increase in emissions is likely to result from Mexican trucks displacing U.S. trucks on the corridor. This impact is driven by higher emission rates of Mexican compared to U.S. trucks. In turn, these emission rates are driven by existing differences in current Mexican and U.S. truck emission standards. However, the Mexican government plans to adopt U.S. equivalent emission standards in 2018. If this occurs, it will result in a gradual decrease in the emission impact of each Mexican truck that displaces a U.S. truck on the corridor.

Despite direct impacts to emissions on the corridor, results also suggest that total emissions on the corridor will decrease over time, driven by reductions in the average emission rates of both U.S. and Mexican trucks. Over the long term, extra emissions from Mexican-domiciled trucks are unlikely to result in increases in total emissions along the corridor.

CHAPTER 1 – INTRODUCTION

Following the implementation of the North American Free Trade Agreement (NAFTA) in 1994, trade between the United States and Mexico increased substantially. Total surface trade (rail and truck) between the two countries has increased at an annual average rate of approximately 5–10 percent in the 20-year period since NAFTA's inception (*1*; *2*). In 2013, an estimated \$507 billion of goods were traded (imports and exports) between the two countries, making Mexico the United States' third most important trading partner by dollar value.

Much of the trade between Mexico and the United States occurs via ground freight, of which approximately 80 percent is carried by trucks. POEs occur in all U.S. states bordering Mexico (Texas, New Mexico, Arizona, and California), but Texas accounts for 69 percent of truck freight crossings. The Laredo POE is the busiest inland port in North America, accounting for 27 percent of total U.S.-Mexico trade. Most of the freight entering the country through Laredo is constrained to travel along an approximately 150-mile section of I-35 to major interstate junctions in San Antonio.

Currently, most Mexican trucks are only allowed to operate within commercial zones that typically extend to about 25 miles inside the United States. Consequently, most truck freight is currently transported across the border via a drayage system. Here, long-haul trucks deliver freight to a facility close to the Mexican side of the POE. This freight is then carried across the border by short haul (drayage) trucks to another facility on the U.S. side, from where it is once again loaded onto long-haul trucks to be transported to its final destination.

The original intent of NAFTA was to allow Mexican trucks to operate within the United States (and vice versa), similar to cross-border trucking between Canada and the United States. However, the implementation of this provision had stalled because of a number of factors, including political issues and concerns from labor and environmental groups. In order to address these concerns, two pilot programs (2007–2009 and 2011–2014) were undertaken that allowed Mexican long-haul trucks to operate within the United States. These programs culminated in a January 2015 decision to open the U.S.-Mexico border to Mexican trucks, allowing eligible firms to apply for permits to make deliveries in the United States.

From an environmental perspective, the major concern raised in relation to Mexican trucks undertaking long-haul operations in the United States are the potential air quality impacts. The Texas Commission on Environmental Quality (TCEQ) identified the Laredo–San Antonio corridor as an area of concern in Texas, due to the volume of freight movement at the Laredo POE, coupled with the existing air quality concerns in the region, including the impacts of drilling activities in the Eagle Ford Shale region. This study, titled *Emissions from Long-Haul Mexican Diesel Trucks in the Laredo-San Antonio Corridor*, was performed by the Texas A&M Transportation Institute (TTI) for TCEQ.

This project assesses potential emissions and air quality impacts of long-haul Mexican truck activity in the Laredo–San Antonio corridor and the region's airshed. As part of this project, the TTI research team conducted a literature review and state-of-practice assessment, gathered information from stakeholders through interviews, and conducted an assessment of potential air quality impacts. Chapter 2 of this report contains the literature review and state-of-practice assessment. Chapter 3 discusses findings from the assessment of potential impacts (including interviews with Mexican trucking firms), and Chapter 4 discusses the major findings and conclusions.

CHAPTER 2 – STATE-OF-THE-PRACTICE AND LITERATURE REVIEW

This section provides an overview of information relevant to potential air quality impacts of changes in long-haul truck activity in the Laredo–San Antonio corridor. This review of current data and literature is designed to cover a wide range of issues that are relevant for understanding current and potential changes in truck activity in the region, and the likely drivers and impacts of these changes on emissions and air quality.

The broad scale review includes information on the status of trade between the United States, and Mexico, and Texas' role as a gateway for a majority of this trade. Because much of this trade has been driven by, and is dependent on rules and regulations outlined by NAFTA, researchers present a comprehensive review of the history of the agreement's impact on cross-border trucking and freight movement. This historical review provides insight into the status of U.S.-Mexico cross-border trucking that is currently dominated by a drayage system. However, the review also highlights that recent, NAFTA-driven changes in long-haul, cross-border trucking regulations could impact the volume and type of trucks that operate within the United States. In line with the objectives of this section, researchers provide an interpretive overview of political, legal, economic, and technological factors that may affect future cross-border trucking activity.

This review also discusses the data available for assessing how changes in trucking activity (including truck types and volumes) may impact emissions and air quality. Specifically, the objective is to understand the differences in emissions characteristics between three categories of trucks operating across the U.S. border: drayage trucks, Mexican-domiciled long-haul trucks, and U.S.-domiciled long-haul trucks. Each of these truck categories has the potential to impact emissions and air quality along the corridor of interest. Because of the impending nature of the new long-haul regulations, information on the emission characteristics of Mexican-domiciled long-haul trucks is sparse. As such, researchers also present information that could be used to infer the emission standards of trucks under the prevailing rules, regulations, and enforcements.

Finally, the area of interest is the Laredo–San Antonio I-35 corridor, which also passes through one of the nation's most productive oil and gas fields—the Eagle Ford Shale. Researchers present information on the nature of oil and gas drilling activities in this region, and the activity and emissions of trucks and non-mobile emission sources associated with this industry.

The information from this review is presented and documented with the objective to:

- Identify core factors likely to impact truck activity and emissions.
- Highlight information and data sources currently available for a qualitative and/or quantitative impact assessment.
- Highlight missing information and data important for an impact assessment.

The findings from this review of available information were used to develop a quantitative impact assessment (Chapter 3).

U.S.-MEXICO TRADE

Mexico is currently the United States' third most important trading partner measured by the value of imported and exported goods (Figure 1). U.S.-Mexico trade has grown at an average annual rate of approximately 8 percent between 2004 and 2013, reaching a record high of almost \$507 billion in 2013 (*3*). Approximately half (\$280.5 million or 55 percent) of the total traded value in 2013 was from imports. Of its top four trade partners, this balance of trade is most similar to that of Canada (52 percent from imports) and contrasts with more import dominated trade with China and Japan (78 percent and 68 percent, respectively).

Trucks are the most common mode of freight transport between the United States and Mexico. On average, more than 80 percent of the U.S.-Mexico trade is transported by surface modes (4). Approximately 80 percent of the total value of surface freight is transported by trucks and 16 percent by rail (4).



Figure 1 – Top U.S. trading partners between the years 2004 and 2013. Source: (3).

U.S.-TEXAS TRADE

Texas plays a large role in the trade of goods between the United States and Mexico. On average approximately 60 percent of the value of total U.S.-Mexico trade goods crossed at a Texas POE between 2004 and 2012. In line with the national trend, approximately 83 percent of this freight was transported by truck (*4*). Consequently, 69 percent of all Mexico- U.S. truck crossings, representing approximately 48 percent of the total value of U.S.-Mexico trade, occur at Texas POEs (*5*).

NAFTA

NAFTA is a comprehensive trade agreement that sets the rules of trade and investment between the United States, Canada, and Mexico. NAFTA was designed to foster trade among the three member countries by eliminating tariffs on traded goods, reducing trade restrictions, and protecting intellectual property and foreign investment. Since the agreement entered into force on January 1, 1994, NAFTA has systematically eliminated most tariff and non-tariff barriers to free trade and investment between the three NAFTA countries. NAFTA created the world's largest free trade area, resulting in a total trade value of \$705.6 billion by the end of August 2012 (4). NAFTA has fostered economic growth, created jobs, lowered prices, and provided increased selection for consumer goods in all three member countries. Since the inception of the agreement, trade among the three member countries has grown significantly. Since 1994, U.S.-Canada trades have more than doubled, while U.S.-Mexico trades have more than quadrupled (6).

NAFTA and Cross-Border Trucking

The United States has used two different trucking policies for Canadian and Mexican-domiciled carriers. Since 1982, the United States had allowed Canadian cargo trucks to enter through its borders, largely because of a reciprocal agreement where U.S. truckers were allowed to deliver cargo to Canada (Canada's Brock-Gotlieb Understanding and a memorandum from President Reagan). In contrast, until very recently, Mexican truckers have been prevented from obtaining licenses to operate throughout the United States. Instead, Mexican-domiciled trucks have been constrained to operate within officially designated commercial zones that typically extend only 25 miles of the border. In line with NAFTA's goal of improving the efficiency of trade between member countries, part of the original agreement was to implement a single, reciprocal trucking policy for all member countries. Under NAFTA's original timeline, the United States and Mexico agreed to permit access to each other's border states by December 17, 1995 (7). This first stage of integration would allow Mexican trucks into the four bordering U.S. states (Texas, New Mexico, Arizona, and California) and U.S. trucks into Mexico's six border states (Baja California, Sonora, Chihuahua, Coahuila, Nuevo León, and Tamaulipas). A second stage of integration involving reciprocal access beyond the border-states was promised by January 1, 2000.

NAFTA failed to deliver a unified trucking policy among its member countries by the agreed timelines largely because the planned changes in cross-border trucking laws led to concerns over the safety of Mexican trucks and operators compared to U.S. operators; transport of illegal drugs and immigrants; and from the U.S. trucking industry over pay and job losses. On the day before the first stage of cross-border Mexican-U.S. trucking was to be implemented, President Bill Clinton placed a moratorium that blocked the movement of Mexican trucks within U.S. border states (*8*) and instead restricted their operation to commercial zones.

The U.S.-driven change to the original NAFTA cross-border trucking plan was intended to allow research into the impacts of these policy changes. Although there was considerable opposition to change on the grounds of protecting the livelihood of U.S. truck workers, official reasons for the delay focused on safety issues surrounding Mexican trucks and drivers. The Mexican government, frustrated by the delays, responded by imposing a similar and reciprocal commercial zone restriction on U.S. truckers crossing into Mexico, and by submitting the dispute to the NAFTA resolution panel in 2000. In 2001, the NAFTA resolution panel unanimously determined that the U.S. refusal to process any applications for Mexican truckers was in violation of the original agreement. The panel also authorized Mexico to issue retaliatory tariffs on U.S. imports as long as compliance was not met (9). However, the NAFTA resolution panel did determine that, although it could not refuse operating licenses to Mexican truckers completely, it could apply more stringent standards to Mexican truckers than are applied to Canadian or domestic truckers, as long as each application for a license was reviewed on a case by case basis. The U.S. Congress mandated 22 conditions for Mexican cross-border truck operators that were in addition to those required for domestic and Canadian operators (FY 2002 Department of Transportation Appropriations Act) (7). In November 2002, the U.S. Department of Transportation (DOT) announced that the Federal Motor Carrier Safety Administration (FMCSA) would begin accepting applications for licenses to allow Mexican operators to longhaul cargo across the border to destinations in the United States.

Less than 3 months after FMCSA began accepting licenses, NAFTAs goals were once again halted, this time on the basis of environmental concerns. A government watchdog group called Public Citizen argued that because FMCSA knew that a large number of Mexican trucks would be admitted to the United States once it issued its regulations, it should have considered the environmental impact of the proposed changes in addition to safety considerations (*7*; *10*). The National Environmental Policy Act of 1969 requires that federal agencies perform an Environmental Impact Study (EIS) of policies that are likely to have significant environmental effects. In January 2003, the 9th Court of Appeals delayed implementation of the FMCSA permit process amended DOT plan pending completion of a National Environment Policy Act, EIS, and a Clean Air Act conformity determination. FMCSA responded by beginning the EIS process but also filed a petition asking the Supreme Court to review the 9th Circuit Court's decision. On June 7, 2004, the Supreme Court unanimously reversed the decision, once again paving the way for cross-border long-haul trucking (*11*).

NAFTA Cross-Border Pilot Programs

Demonstration Project: September 2007–March 2009 (Project 1)

In February 2007, the United States and Mexican Secretaries of Transportation announced a demonstration program to implement the previously agreed NAFTA trucking provisions (i.e., those outlined in section 350 of FY 2002 DOT). The goal of the program was to demonstrate the ability of Mexico-based carriers to operate safely in the United States beyond the commercial zones (Federal Register Vol. 72, No. 159). The demonstration program would allow up to 100 Mexican-domiciled motor carriers to operate throughout the United States for one year.

On May 24, 2007, Congress approved funds for the demonstration project subject to a number of additional mandates:

- 1. A reciprocal project would allow up to 100 U.S.-domiciled vehicles to operate in Mexico.
- 2. It would exclude buses and transportation of hazardous materials.
- 3. The project must meet the minimum requirements of a pilot program under 49 U.S.C. 31315(c).

Under the third condition, a pilot program must include safety measures designed to achieve a level of safety equivalent to or higher than that would otherwise be achieved with compliance with the Federal Motor Carrier Safety Regulations and must have the following six elements:

- 1. A scheduled life of less than three years.
- 2. A specific data collection plan.
- 3. A reasonable number of participants to yield statistically significant findings.
- 4. An oversight plan to ensure that participants comply with the program.
- 5. Adequate countermeasures to protect the public health and safety of participants and the general public.
- 6. A plan to inform state partners and the public about the pilot program and to identify approved participants to safety compliance and to the public.

The demonstration program began on September 2007. By October 2008, GPS units had been installed in trucks participating in the program and these reported the location of the trucks at 30-minute intervals (designed to warn border officials of approach and to prevent cabotage [i.e., shipping between two locations within the United States]) (*12*). In March 2008, U.S. DOT testified that FMCSA was checking the prerequisite safety items for 100 percent of long-haul Mexican carriers as they crossed the border. U.S. DOT also reported that since 1995, FMCSA

had spent more than \$500 million to improve border inspection stations in preparation for the new regulations (7). In 2008, U.S. DOT announced a two-year extension to the project because only 29 carriers had participated to that point. In December 2007, Congress passed the FY2008 Consolidated Appropriations Act (P.L. 110-161), which included a provision prohibiting any funding from being used to establish a cross-border trucking program, but that allowed funds to be used in the continuation of the demonstration project. However, in 2009, Congress (FY2009 Omnibus Appropriations Act) forced the termination of the project. In line with the law concerning pilot programs, U.S. DOT was required to provide a report of the pilot program. Table 1 presents the main findings (*13*). Ten U.S. carriers also took part in the reciprocal program in Mexico. Following the abrupt end of the pilot project, the Mexican authorities continued to honor this authority to U.S. trucks and also granted permits to two new companies (*14*).

Pilot Project: October 14, 2011–October 10, 2014 (Project 2)

In March 2009, in response to the termination of the first pilot program, and in line with the NAFTA Arbitration panel ruling, the Mexican government increased tariffs on a list of 89 products imported from the United States. These tariffs, valued at \$2.4 billion covered a variety of products including paper, home appliances, vegetables, and other consumer goods. In August 2010, additional tariffs were applied (and some removed from the list) resulting in a list of 99 products from 43 states, with a total export value of \$2.6 billion (9). To increase the effect of these tariffs on American producers, the Mexican government randomly changed the products that would be tariffed; making it difficult for exporters and producers to develop effective business plans (8).

These tariffs were designed to pressure U.S. lawmakers into a settlement of the trucking dispute. As such, the FY2010 Appropriations Act allowed (or at least did not prohibit) the use of funds for cross-border trucking, and in March 2011, President Obama unveiled a new initiative to resolve the dispute. The proposal for this second pilot or demonstration project was developed following 12 months of consultation with a working group. The proposal was also published by FMCSA on April 13, 2011, to obtain feedback from stakeholders (*14*).

The pilot program was designed to test the effectiveness of FMCSA in upholding the regulations governing the registration of Mexican-domiciled motor carriers (*15*). Principally, these regulations were designed to ensure that the motor carriers participating in the pilot program had adequate safety management programs. Table 2 lists the requirements for carriers wishing to participate in the second pilot program. Once these requirements had been met, FMCSA issued a certificate of registration that granted operating authority for transportation beyond the commercial zones on the U.S. border. The certificates of registration explicitly stated that motor carriers were prohibited from:

- 1. Point-to-point transportation services, including express delivery services, for goods other than international cargo.
- 2. Transportation of hazardous materials.
- 3. Transportation of passengers.
- 4. Transportation by vehicles or drivers not approved by FMCSA.
- 5. Transporting oversized or overweight goods.
- 6. Transporting industrial cranes or vehicle towing equipment.
- 7. Transportation by packaging and courier services.
- 8. Operating a vehicle without an operational DOT electronic monitoring device.

Violation of these terms could result in suspension of drivers, vehicles, or carriers from the program.

Finding	Details					
Demonstration	FMCSA projected 100 carriers would take part in the pilot resulting in					
project lacks an	approximately 540 participating trucks and 9 million to 18 million vehicle miles					
adequate number	traveled (VMT).					
of carriers	FMCSA estimated that a total of 989 total carriers would apply for long-haul					
participants are not	licenses should the border be opened.					
representative of	At the end of the first year of the project, only 29 carriers (companies) and 118					
Mexican carriers	trucks had participated.					
	There were an estimated 12,516 border crossings (12,516 inspections @ 100%					
	inspection rate).					
	Two carriers withdrew from the project.					
	Only 1 carrier joined the project after July 17, 2008.					
	Only between 8.5 and 11.5 percent of trips went beyond the commercial zone.					
	Driver out of service rates (0.46%) and truck out of service rates (8.29%) were					
	lower in the pilot program than U.S. averages, but the sample size prevents					
	statistically significant conclusions.					
	After analyzing 775 carrier applications provided by FMCSA, it was found that					
	project participants were not representative of the carrier population in terms of					
	business activity and prior safety records. Specifically, service rates were					
	significantly lower in the 4 years prior to the study in the participating carrier					
	group compared to non-participating carriers.					
The department	An independent panel was set up to monitor program performance.					
will no longer rely	Because this was not a specific requirement by law, the panel was not used in the					
on the independent	extended 2 years of the project.					
evaluation panel	A first year report from the independent panel was found to be similar to the					
	official DOT report.					
	Disengagement of the independent panel was detrimental to demonstrating the					
	success of the project.					
Actions were taken	The project was designed to check every participating truck crossing the border					
to ensure safety	FMCSA QA could not guarantee that all trucks at all crossings were checked.					
compliance	Adequate outreach to state and local law enforcement was performed.					
but quality control	The GPS systems fitted to trucks had limited capabilities that did not provide the					
process did not	data needed to fully assess safety, particularly vehicle miles.					
check every truck	Adequate steps were made to ensure Mexican driver convictions were recorded					
	FMCSA's licensing and insurance monitoring systems were working well to					
	ensure project participants complied with insurance regulations for the project.					
One carrier	Trinity Industries de Mexico withdrew from the program because the inspection					
withdrew from the	process was disrupting business.					
program	It had been claimed that Trinity had a poor safety record prior to the project and					
	should not have been admitted.					
	Trinity's withdrawal did not have significant effects on the project results.					
	Trinity was not found to have a poor safety record.					

Table 1 – Findings from the Report to Congress for the First Demonstration Project (2007–2009).

In addition to stipulating the requirements of program participants, FMCSA developed a set of protocols designed to monitor adherence to these requirements. Vehicles from each licensed carrier were fitted with GPS systems. The GPS devices tracked trips and were capable of

identifying hours of service and route and pick up violations (including cabotage), and provided alerts to FMCSA staff of the arrival of approved vehicles to the border. The level of monitoring of the carriers taking part in the pilot program varied depending on the experience and safety record of the carrier. Stage 1 of the program required all trucks and drivers to be inspected at each northbound border crossing. A carrier progressed to Stage 2 after three months of monitoring and a minimum of three inspections, and if the past inspection history met safety thresholds. After the carrier successfully completed 18 months of operations with provisional operating authority, it was granted permanent operating authority under the pilot program (stage 3). In Stages 2 and 3, border inspections were conducted randomly at a rate similar to non-pilot program vehicles operating within the commercial zone. FMCSA also formed an independent monitoring committee to provide further oversight and monitoring of the program via a subcommittee of the Motor Carrier Safety Advisory Council. As in the previous study, findings from the pilot study were required to be summarized and published by the Office of the Inspector General (OIG).

Table 2 – Program Requirements for Participation in the 2011-2014 Pilot Project. Source:(16).

Program Requirement	Comments			
Application forms and	Reasons that a driver could fail a Department of Homeland Security			
Security background	background check included: Providing false information, criminal record or			
checks	under federal investigation, violation of custom laws, driver inadmissible to			
	United States on immigration laws.			
	Three carriers were rejected from the process on these grounds.			
Preliminary Safety	Applicants with existing operations in the United States were reviewed			
Vetting	using inspection data and safety and compliance information already			
	existing in FMCSA databases.			
	Two applicants were rejected			
Pre-Authorization	PASA is a review of carriers safety management system, including written			
Safety Audits (PASA)	procedures and reports.			
	Vehicles designated for cross-border long-haul were inspected, and			
	Commercial Vehicle Safety Alliance (CVSA) decals affixed on successful			
	completion.			
	Results of each carrier's PASA were posted on a website for public			
	comment.			
Drivers	Carriers designated drivers who would perform cross-border long hauls.			
	Drivers licenses were validated and checked for U.S. and Mexican			
	violations.			
	Drivers were assessed on ability to read and speak the English language to			
	understand highway signs, respond to official enquiries and to document			
	their activities.			
Emission Control Label	All diesel powered vehicles used in the program was required to conform to			
	EPA regulations applicable to vehicles manufactured after 1998 (either by			
	label or other form of evidence).			
Federal Motor Vehicle	Vehicles must display a FMVSS or Canadian Motor Vehicle Safety			
Safety Standards	Standards certification label or the vehicle was newer than 1998 and			
(FMVSS)	equipped with safety features required by the FMVSS.			
Safety Decals	All participating vehicles must display a CVSA Decal.			
FMCSA Register	Upon completion of all steps above, a notice of intent for a carrier license			
	was published, with interested parties invited to submit a protest.			
	FMCSA received five protests, all of which were dismissed.			
Liability Insurance and	Maintenance of a certificate of insurance or surety bond underwritten by a			
Process Agents	U.S. company.			
-	Designation of process agents to represent them in the United States.			

During the second pilot program 15 Mexican-domiciled carriers were approved to operate across the border. Upon completion of the 2011–2014 pilot project, nine Mexico-domiciled motor carriers had permanent certificates of registration and four had provisional certificates. This translated to 55 specifically nominated vehicles, 53 drivers and a total of 28,225 crossings at the conclusion of the project. During the project, one carrier withdrew from the pilot program and another was dismissed because of a poor safety rating. In an interim review of the project, the OIG indicated a lack of adequate and representative samples to make confident projections

regarding long-haul operations by Mexican-domiciled carriers. Originally, OIG estimated 46 carriers would be needed to achieve the target of 4,100 inspections per year (a total of 5,545 were actually performed). They suggested that the participation of 15 carriers from 37 applicants was not adequate to confidently predict safety performance for an unknown number of potential future applicants (i.e., the sample of participants could not be shown to be representative of all potential carriers). Table 3 provides a summary of quantitative data from the second pilot program. Even with only 15 carriers, the program surpassed the inspection target. However, OIG concludes that the sample size was still too small to draw significant inference between the operational safety of Mexican versus U.S. or Canadian trucks and drivers (*16*).

Statistic	Quantity
Total Carriers	15
Total Designated Vehicles	55
Total Designated Drivers	53
Total Crossings	28,225
Stage 1 inspections	2,358
Stage 2 and 3 Inspections	3,187
Total Inspections	5,545
Roadside Inspection Results	Pilot Project
Inspections per power unit	53.3
Driver Out of Service (OOS) Rate (number inspected)	0.2% (2671)
Vehicle OOS rate (number inspected)	8.9 (1080)
Driver Fitness Violation Rate	< 1%
Hours of Service Violation	1%
Brake Violation Rate	20.8%
Reported Crashes	1
VMT	1.5 million
Crashes per million miles	0.65

Table 3 – Overview of Pilot Program Results. Source: (16).

Post Pilot Project: October 2014 Onward

Upon completion of the pilot program, the nine participants that had been granted permanent Certificates of Registration (Stage 3) were eligible for standard motor operating authority, similar to that of U.S.-domiciled carriers, but with significant restrictions and requirements (similar to those outlined in the pilot programs, see Table 2). The four pilot program participants that had attained provisional status (Stage 2) were eligible to be converted to Provisional Motor Carrier Operating Authority. These carriers must undergo a compliance review, receive a satisfactory rating, and have no pending enforcement or safety improvement actions before being considered eligible for a Standard Motor Carrier Authority. On October 10, 2014, U.S. DOT verbally advised Congress of the completion of the pilot program. On January 9, 2015, U.S. DOT submitted a report titled, "United States-Mexico Cross-Border Long-Haul Trucking Pilot Program Report to Congress" to the House and Senate Committees on Appropriations and the Senate Committee on Commerce, Science and Transportation and the House of Representatives Committee on Transportation and Infrastructure (*12*). On October 10, 2014, FMCSA issued new certificates of operating authority registration to 13 of the pilot program participants. U.S. DOT and FMCSA are currently taking applications for Mexican-domiciled long-haul licenses for companies not originally part of the pilot program.

Current Truck Activity at the U.S.-Mexico Border

Currently, Mexican-domiciled trucks crossing the Mexico-U.S. border operate under a number of different licenses. Some of these licenses date back to 1989 when the Interstate Commerce Commission (ICC) issued operating authority licenses (the ICC was dissolved in 1996; FMCSA was formed in 2000). The four types of operating license are outlined below, and a summary of the number of granted licenses and active operators is provided in Table 4 (*14*):

- Certificate: These were issued by ICC as a result of the Truck and Bus Safety and Regulatory Reform Act of 1988 (Pub.L. No. 100-690). These operating licenses (certificates of registration) allow Mexican-domiciled carriers to transport nonexempt commodities beyond commercial zones. They also allow private motor carriers to operate beyond the commercial zones in some specific, limiting capacity. Private carriers are those that transport their own goods. Each certificates of operation specifically outlines the limits of operation (for example, to a specific state). FMCSA stopped issuing new certificates in 2002.
- 2. Enterprise: Under NAFTA and presidential orders, U.S.-domiciled motor carriers (i.e., with places of business in the United States) owned by "persons of Mexico" are allowed to obtain authority to operate beyond the commercial zones. These Enterprise motor carriers are allowed to operate beyond the commercial zones, but must transport international cargo only. Most of these carriers have sister companies in Mexico.
- 3. Commercial Zone: These Mexican-domiciled carriers can operate solely within commercial zones along the border. The granting of this authority passed from the ICC to FMCSA.
- 4. Mexico-based carriers for motor carrier authority to operate beyond U.S. municipalities and commercial zones on the U.S.-Mexico border: This operating authority is the result of negotiations between United States and Mexico to facilitate reciprocal cross-border long-haul trucking agreement. FMCSA has issued permanent licenses to carriers who have taken part in pilot programs and are currently accepting applications from all for-hire long-haul, Mexican-domiciled carriers.

Type of authority	Number of carriers with authority	Approximate number of carriers operating
Certificate	900	260
Enterprise	760	692
Commercial Zones	7586	4191
Long-haul Operation beyond commercial zone	15	unknown

 Table 4 – Summary of Operator Licenses, and Number of Mexican-Domiciled Carriers.

 Source: (14).

FACTORS AFFECTING LONG-HAUL CROSS-BORDER TRUCKING

Restrictions placed on operating authorities for haulage companies have greatly influenced the logistics of cross-border cargo movement into the United States. Specifically, crossings at the Canada-U.S. border are very different to those at the Mexico-U.S. border. Long-haul trucks crossing the U.S.-Canada border simply cross the border by presenting their documents to Canadian and U.S. customs officers, who may or may not request additional safety or cargo inspections. However, until now, the majority of operating permits for Mexican-domiciled carriers only allow them to operate trucks within designated commercial zones on the U.S. side of the border. This has led to the development of a large drayage industry at the Mexico-U.S. border. In the drayage process, cargo from Mexican manufacturers, warehouses, and other points of origin are transported to the drop off points close to the Mexico side of the border. Containers and other cargo are then transported across the border using short haul trucks, and dropped off at warehousing locations within the commercial zone of the United States. U.S.-domiciled longhaul carriers then transport this freight to their final destinations within the United States. A description of the main activities that occur in the northbound border crossing process is illustrated in Figure 2 and details presented in Table 5 (2). The time required for a shipment to make the complete trip from the yard or the manufacturing plant in Mexico to the exit of the state inspection facility is dependent on the number of secondary inspections required, the number of inspection booths in service, and traffic volume at that specific time-of-day.

Although NAFTA has been the primary driver of change to cross-border truck policies, a number of other factors have been involved in the recent policy changes and may have considerable influence on future border activity. These include: labor and union concerns; economic factors; operational safety of vehicles; security concerns (terrorism, transport of illicit cargo); environmental and public health concerns; and cross-border differences in technology or infrastructure. Together, these factors are likely to influence the short and long term changes in cross-border truck activities across the U.S.-Mexico border. They are discussed in the sections below.



Figure 2 – Schematic of north bound drayage operations at the Mexico-U.S. border. A description is given in Table 5. Source: (2)

Table 5 – Processes and Physical Location of Cargo Moving North across the Mexico-U.S.
Border under Drayage System. Source: (2)

Location	Processes
Mexican Export Lot	The driver of the drayage vehicle proceeds into the Mexican export customs compound. Mexican Customs conduct inspections consisting of a physical review of the cargo of randomly selected outbound freight prior to its export for audit and interdiction purposes. Those not selected proceed to the exit gate, cross the border, and continue to the U.S. POE.
U.S. Federal Compound	At the primary inspection booth, the truck driver presents identification (proof of citizenship or a valid visa or laser card), a copy of the Inward Cargo Manifest, and the commercial invoice to the processing agent. The U.S. Customs and Border Protection (CBP) inspector cross-checks the basic information about the driver, vehicle, and load with information sent previously by the U.S. customs broker. The inspector then makes a decision to refer the truck, driver, or load for a more detailed secondary inspection, or releases the truck to the exit gate.
State Safety Inspection Facility	At the majority of POEs, stations are located adjacent to the federal compounds. State police interview drivers and inspect conveyances to determine whether they are in compliance with U.S. safety standards. After leaving the state inspection facility, the driver typically drives to the freight forwarder or customs broker yard to drop off the trailer for pickup by a long-haul tractor bound for the final destination. The time required for a shipment to make the complete trip from the yard or the manufacturing plant in Mexico to the exit of the state inspection facility is dependent on the number of secondary inspections required, the number of inspection booths in service, and traffic volume at that specific time-of-day.

Labor and Union Concerns

The official intent of the transportation operator provision of NAFTA is to allow the free movement of goods across the border, but not to facilitate access to the domestic labor market. The balance between permitting free movement of goods across the border, while at the same time protecting the livelihood of U.S. workers has led to the following rules that relate to the operation of all international long-haul trucks (*17*):

- Drivers may deliver a shipment from Canada/Mexico to one or more U.S. locations.
- Drivers may then pick up a return shipment from one or more U.S. locations for delivery to Canada/Mexico (generally must be pre-arranged).
- Drivers may deliver a shipment from Canada/Mexico to a U.S. location, deadhead (i.e., move between two locations while carrying no freight) with the same trailer to another U.S. location, and load that trailer for delivery to Canada/Mexico.
- Drivers may deliver a shipment from Canada/Mexico to a U.S. location, deadhead with the same trailer to another location, drop the empty trailer, and pick up a second loaded trailer for delivery to Canada/Mexico.
- Drivers may deliver a shipment from Canada to a U.S. location, pick up the empty trailer and deadhead that trailer to another U.S. location where the trailer is live loaded for delivery to Canada/Mexico.
- Drivers may also drop a loaded trailer from Canada/Mexico at one location in the United States, and drive an empty tractor to another location to pick up a loaded trailer for transport to Canada/Mexico.
- Relay drivers may drive entirely domestic segments of an international delivery if the driver meets two conditions: 1) the driver must be employed by the same company as the delivery; and 2) the domestic portion of the trip is a necessary incident to the international nature of the trip. Relaying is permitted in order for drivers to comply with Federal regulations regarding the number of consecutive hours an individual is permitted to drive. They need not enter with the vehicle, but must enter within a reasonable period.
- Drivers may perform activities that are "necessary incidents" of international commerce, such as loading and unloading international cargo.
- In each situation above, each trailer must be used only in delivering goods either to or from the United States. Non-permissible movements are:
 - Drivers may not pick up a shipment at one U.S. location and deliver that shipment to another U.S. location.
 - Drivers may not reposition an empty trailer between two points in the United States when the driver did not either enter with or depart with that trailer.
 - Drivers may not "top up" an international shipment with U.S. domestic shipments.
 - Drivers may not solicit shipments for domestic deliveries while in the United States.

Economic Factors

The \$2.4 billion of tariffs imposed on U.S. goods imported into Mexico, appears to have been a significant driver in the implementation of the second pilot project. Since Mexico is the third largest trading partner of the United States, the new tariffs were seen to potentially jeopardize over 12,000 agricultural 14,000 manufacturing jobs (*9; 18*). In April 2009, 150 U.S. businesses including General Electric, Wal-Mart, and Proctor and Gamble collaborated to warn President Obama that the tariffs were having a large effect on the ability of U.S. goods to compete in the Mexican market and called for immediate action to resolve the dispute. If the United States had failed to provide open access by 2015, Mexico would have been allowed to reinforce the tariffs. Presumably, given the current state of affairs, if the United States were to withdraw the new rules, Mexico will also be allowed to reinstate trade sanctions. The suspension of the first pilot project also resulted in a lawsuit, filed by Mexico's National Cargo Transportation Association seeking \$6 billion in compensation for losses they have allegedly suffered since the U.S. government first imposed restrictions on long-haul trucking post NAFTA (*9*).

In addition to the economic costs of tariffs, loss of trade, and lawsuits, the current system of drayage is thought to substantially increase the direct costs of transporting goods across the border. The U.S. DOT estimated that off-loading and warehousing associated with drayage costs the nation \$400 million annually (9). The Mexican DOT estimated total delay costs at the U.S.-Mexico border at \$77.4 million in 1999 dollars (19). In a 2003 study, researchers conducted an analysis of the costs of moving freight across the U.S. border under the current drayage system compared with a long-haul system (20). Using freight movement from Chicago, IL, to Monterey, Mexico, monetary savings of between 15 and 30 percent were estimated for south bound long-haul crossings versus drayage, and between 26 and 55 percent savings in time. The researchers also simulated changes in commodity movement between the United States and Mexico, as a result of changes in border friction, and concluded that NAFTA agreement truck crossings could result in over an 8 percent increase in northbound trade, and over a 1 percent increase in southbound trade. It is also possible that changes in the cost of moving freight across the border by truck will affect other cross-border shipping methods (rail and sea).

In spite of the estimated inefficiencies of drayage, significant costs have been involved with implementing the new cross-border procedures. In 2008, U.S. DOT reported that since 1995 FMCSA had spent more than \$500 million on developing border infrastructure to accommodate the NAFTA rules. A number of stakeholders have commented that these costs have been at the expense of U.S. rather than Mexican taxpayers. There also appears to be some confusion concerning whether the NAFTA crossing rules will increase or decrease border wait times. A counter argument to the overall inefficiency of drayage is that it offers a potential advantage for operators to time cross-border trips during quieter border conditions.

The final economic factor relevant to the nature of future cross-border truck movement involves the costs that individual companies bear in adapting to the new policies. Particularly relevant are

costs associated with Mexican carriers upgrading equipment, applying for a DOT operating license, maintaining records, and maintaining compliance with rules and regulations. Both pilot studies were hampered by low uptake rates by Mexican carriers. Although this could be interpreted as Mexican carriers having low intrinsic interest in long-haul cross-border movements, the lack of uptake reflects the fact that return trips (with freight) are required to make long-haul cost effective. NAFTA rules prevent drivers from picking up a load in the United States and delivering that same load within the United States (i.e., cabotage). However, the driver can deliver a northbound load in the United States, then deadhead any number of miles to another U.S. location for a pick up as long as the load will be delivered to a destination in Mexico. These logistics will most likely require business connections in the United States that do not yet exist (*16*; *19*).

Operational Safety and Law Enforcement

Much of the formal reluctance to allow Mexican-domiciled trucks to operate in the United States has surrounded the operational safety of Mexican registered trucks and their operators. The current safety requirements that Mexican truck companies must achieve before they are granted a long-haul operating license by FMCSA are more stringent than for Canadian or U.S. truck drivers. Moreover, as the legal issues surrounding the pilot programs have suggested, there is a considerable burden on FMCSA and U.S. DOT to demonstrate to U.S. stakeholders that these regulations can be and are being effectively enforced by border officials and by federal, state, and local authorities away from the border. Currently, it is unclear the range of punishments that will be available to prosecute violators of the new rules. One possible issue for law enforcement is that the new rules will increase the presence of Mexican registered trucks past the commercial zones, which could make it more difficult for law enforcers to identify properly registered vehicles and drivers.

Security Concerns

The current Mexico-U.S. drayage system represents a considerable security risk to the United States (21). The principal objection surrounds the fact that drayage operators have minimum information about the freight they carry and can bear little responsibility for the goods they are transporting across the border. The process of exporting a U.S. cargo by truck begins when a Mexican shipper contacts the Mexican long-haul carrier to pick-up cargo destined for the United States. The long-haul carrier is not responsible for customs documentation, so all shipping and any customs documentation is sent to a Mexican customs broker before the carrier even arrives. The long-haul truck then leaves the cargo in a yard or warehouse on the Mexican side of the border. After the goods have been delivered by the long-haul company, the Mexican customs broker handles all the documentation to release the goods and U.S. documentation to allow entry of the goods). The customs broker then contracts a drayage carrier to transport the cargo across the border. The drayage carrier knows the least of any of the goods into the united states of any of the goods.

about the contents of the trailer or container. However, it is their responsibility to file documentation into U.S. CBP Automated Commercial Environment portal about the nature of the cargo, and usually this is done through an authorized third party rather than the drayage driver themselves. The result is a convoluted system for tracking the movement of goods across the border, which given current heightened interest in homeland security could be a major driver in popularizing long-haul trucking.

In additional to national safety, the personal safety of U.S. drivers across the border may present a barrier to U.S. firms widely supporting and taking advantage of the new regulations. The reciprocal nature of the new NAFTA rules will allow U.S. trucks to move freely within Mexico and vice-versa. Since the new rules allow for return loads to be transported across the border (as long as their destination is across the border), theoretically it does not matter how the demand for cross-border trucking is shared between U.S. and Mexico carriers. It follows that any reluctance of U.S. truckers to operate in Mexico may have the effect of increasing the proportion of Mexican-domiciled (versus U.S.-domiciled) trucks that actually transport freight across the border.

Technology, Regulations, and Infrastructure

Much of the delay in developing a NAFTA trucking agreement has involved differences in safety standards and technology between the United States and Mexico. Over 5 million trucks currently operate in the United States compared to approximately 289,000 in Mexico. Almost half of these Mexican trucks are owner operated, which usually means that the trucks are older. The average age of the Mexican truck fleet is 16 years old (circa 1998), which makes them less efficient and cost effective during long hauls (*19*). Specifically, the new DOT rules stipulate that carriers must be able to demonstrate that trucks were manufactured on or after 1998. Differences also exist between maximum loads, heights, and weights for U.S. versus Mexican trucks (*19*).

Another aspect that is partially dependent on technology, regulations, and infrastructure is the differences in emissions of U.S. and Mexican trucks. This is governed by the overall fleet age, prevailing emissions standards, and other factors influencing vehicle emissions such as the vehicle loading, maintenance practices, and fuel use. Few studies have measured and reported Mexican heavy-duty truck emissions; Rafael et al. (22) tested a 1985 model year Mexican truck and found that the truck's emissions were significantly higher than corresponding U.S. emissions standard for nitrogen oxides (NOx) and hydrocarbons (HC).

Differences in the U.S. and Mexican emissions standards for heavy-duty diesel engine in United States and Mexico can potentially lead to differences in the actual emissions from these vehicles. Between 1979 and 1993, a large fraction of Mexican heavy-duty trucks were not equipped with emission control devices and Mexico did not have emissions standards (22-24). Table 6 shows differences in emission standards for Mexican and U.S. trucks from 1974. From 1994 to 2006, Mexican truck standards have been similar to those in the United States. However, Mexico has

not revised its emission standards to changes U.S. standards after 2004. A significant deviation may be expected in model year 2007 and newer trucks. The U.S. EPA 2007 emission standard requires a 70 percent reduction on HC and 90 percent reduction on NOx and particulate matter (PM) produced from heavy duty diesel trucks; these trucks rely on devices such as diesel particulate filters and selective catalytic reduction to achieve emissions reductions, and also require the use of ultra-low sulfur diesel (ULSD) fuel (< 15 parts per million sulfur).

Fuel in Mexico is supplied by a state owned company Petróleos Mexicanos (Pemex). Pemex should have supplied Mexico with ULSD by 2009, but the supply remains limited to the northern border and the metropolitan areas of Monterrey, Guadalajara, and Mexico City. In contrast, ULSD is mandatory in the United States. U.S. exports of ULSD to Mexico have more than quadrupled from 25,000 barrels per day in 2009 to 109,000 per day in 2012. The availability of ULSD fuel within Mexico may be problematic in two ways. First, it may affect the emissions from cross-border Mexican-domiciled vehicles. Second, confusion over compatibility of fuel types (especially if damage to engines or emission reduction devices could occur) could affect the efficiency with which either U.S. or Mexican truckers can conduct business across the border.

		НС	C Mono	arbon xide (CO)]	NOx		PM
Year	US	Mexico	US	Mexico	US	Mexico	US	Mexico
1974–78 ^a	_	_	40	—	—	—	—	—
1979–83 ^b	1.5	_	25	—	—	—	—	—
1984–87	1.3	_	15.5	—	10.7	—	_	—
1988–89	1.3	_	15.5	—	10.7	—	0.6	—
1990	1.3	-	15.5	—	6.0	—	0.6	—
1992–93	1.3	_	15.5	—	5.0	—	0.25	—
1994–97	1.3	1.3	15.5	15.5	5.0	5.0	0.1	0.1
1998–2003	1.3	1.3	15.5	15.5	4.0	4.0	0.1	0.1
2004–2006 ^{c,d,e}	0.5	1.3	15.5	15.5	2.0	4.0	0.1	0.1
2007+	0.14	1.3	15.5	15.5	0.2	4.0	0.01	0.1

Table 6 – Comparison of U.S. and Mexico Heavy-Duty Diesel Vehicle Emission Standards (in Grams per Brake Horsepower-Hour). Sources: (25; 26).

a: United States had combined HC+NOx standard of 16 g/bhp-hr.

b: United States had combined HC+NOx standard of 10 g/bhp-hr.

c: Under a consent decree with U.S. EPA, engine makers implemented the 2004 standards in October 2002.

d: Standards allow the option of 2.4 g/bhp-hr NMHC+NOx, or 2.5 g/bhp-hr NMHC+NOx and 0.5 NMHC.

e: Assumes no future change in Mexican emission standards.

Environmental and Public Health Concerns

The potential emissions impacts (as described in the previous section) are one of the main environmental and public health concerns related to the operation of Mexican trucks in the United States; Public Citizen versus DOT (*10*) resulted in a significant delay to FMCSA plans to issue long-haul licenses. Using the National Environmental Policy Act of 1969, Public Citizen argued that because FMCSA knew that changes to its truck licensing policy would affect the environment, it should have performed an environmental impact assessment. This lawsuit directly caused a delay of at least a year, but may have also indirectly facilitated other delays that were argued on safety grounds. At issue was the prospect that Mexican-domiciled trucks driving throughout the United States would exacerbate air pollution, since the Mexican truck fleet is older and emits greater quantities of pollutants, including NOx and PM.

In response to proposed changes in cross-border processes, California created a law that requires, to the extent permissible by federal law, owners/operators of all commercial vehicles greater than 1000 pounds entering California to demonstrate that the vehicle's engine met appropriate emission standards when the engine was manufactured. The bill also directs the California Highway Patrol to adopt and implement regulations to establish inspection protocols for ensuring compliance with these requirements. They also commissioned a study to assess the impacts of cross-border traffic on air quality (27). The study concludes that a lack of data for both cross border activity under NAFTA rules and for the profile of trucks that may undertake that activity prevents any meaningful emission projections.

In a 2002 study, researchers estimated the impact of cross-border freight emissions on the air quality of selected trade corridors (including freight passing through the San Antonio, TX– Monterrey, Mexico, corridor that uses the Laredo POE). Their approach used freight volume forecasts and emission models to estimate total emissions for 1999 and 2020. For the 2020 estimates, they assumed that the older drayage fleet would have been phased out and replaced with the long-haul trucks (although they did assume that ULSD would not be available in Mexico, and instead used 500 ppm sulfur diesel for their models). They conclude that with a forecasted 398 percent increase in trade flow along the San Antonio–Monterrey corridor, NOx, VOC, CO, PM₁₀, and carbon dioxide emissions would increase by 96 percent, 215 percent, 370 percent, 83 percent, and 407 percent, respectively (28).

OPERATIONS AND FLEET CHARACTERISTICS OF MEXICAN TRUCKS IN THE UNITED STATES

There are 46 land POEs on the southern border of the United States and 24 process commercial truck traffic. Figure 3 shows the 28 POEs in Texas with non-commercial POEs in orange and the 13 commercial POEs in green (29). In 2013, 69 percent of all trucks truck crossing the southern border entered through Texas (5). Major Texas POEs are in Brownsville, Pharr, Laredo, and El Paso. Table 7 shows the six busiest southern border POEs in the United States in 2013 by

number of truck crossings. Laredo is the busiest POE with over 1.8 million truck crossings in 2013 and represented 33.5 percent of all southern border truck crossings.¹ Laredo accounted for twice the number of truck crossings than the second busiest POE at Otay Mesa, CA. El Paso is the third busiest southern border crossing for trucks, with similar traffic to Otay Mesa. Border crossing processes vary by POE in Texas. In El Paso and the Lower Rio Grande Valley, significant amounts of goods are shipped from local maquiladoras near the border with the United States. However, at Laredo and Eagle Pass, most crossings are of freight destined for long-haul destinations in Texas and the interior United States.

Much of the delay in implementing NAFTA truck crossings has been driven by the concerns of U.S. stakeholders over the safety of Mexican trucks. However, the perceived operational and environmental safety of Mexican trucks may be biased because the only Mexican trucks authorized to operate in the United States are those used in drayage operations. Drayage trucks that operate across the southern border have very different drive cycles than long-haul trucks. A number of researchers speculate that this intrinsically drives differences in the types and ages of trucks used in drayage versus long-haul operations and their impact on emissions and safety (30). Figure 4 shows the age distribution of a sample of U.S. registered trucks used for drayage versus U.S. registered trucks used for long-haul operations (31). Relative to long-haul trucks, drayage trucks move relatively short distances; spend considerable amounts of time with idling engines (while in traffic jams, at border inspection locations and during offloading and unloading); and undertake frequent acceleration and deceleration cycles. These drive cycles place considerable wear and tear on the mechanics of a truck. As a result, trucks used for drayage operations tend to be older, less expensive vehicles that offer a cost effective solution to this particular haulage problem. On the other hand, carriers tend to use newer models for long-hauling because they need to be cost effective when transporting goods over long distances and are required to have low fuel consumption rates and high mechanical reliability.

¹ While the Laredo POE is the site of the largest number of truck crossings on the southern border, results from the FMCSA pilot (Table 3) indicate that the number of crossings by Mexican long-haul trucks were significantly higher at the Otay Mesa crossing compared to the Laredo crossing.



Figure 3 – Map of U.S. commercial zones across the U.S.-Mexico border. The size of the commercial zone is usually determined by the population of the municipality. Exceptions are commercial zones at border crossings in south Texas, (defined by Cameron, Hidalgo, Starr, and Willacy Counties, Texas) and in New Mexico (defined by Dona Ana and Luna Counties). Source: (32).

POE Name	Number of Truck Crossings	% of U.S. Total
Laredo, TX	1,846,282	33.5%
Otay Mesa, CA	769,886	14.8%
El Paso, TX	738,914	14.2%
Hidalgo, TX	510,706	9.8%
Calexico East, CA	325,690	6.3%
Nogales, AZ	311,669	6%

Table 7 – Southern Border POEs by Number of Truck Crossings 2013.



Figure 4 – Age distribution of a sample of U.S. registered trucks used for domestic longhaul (top) versus cross-border drayage (bottom) operations. Source: (31).

Although the actual characteristics of the Mexican long-haul fleet are unknown, a 2008 TTI study collected data on the fleets and operations of potential Mexican long-haul carriers using telephone interviews (*30*). The companies were selected from lists of Mexican companies that applied for permits through FMCSA (application to register Mexican carriers for motor carrier authority to operate beyond U.S. municipalities and commercial zones on the U.S.-Mexico border). These companies represented a sample of trucks that could have been used for cross border operations, subject to successful registration with U.S. DOT. Almost half of the study respondents reported that their truck fleet are less than 5 years old (N=35), while only 6 reported trucks older than 10 years old. In the same study, information was recorded about the location of each company, the types of vehicles and the number of tractors and trailers they operate, and the estimated number of cross-border trips they will take per week. Their key results are presented in Figure 5 and Figure 6. Figure 7 provides an overview of Mexican truck types and specifications.



Figure 5 – Types of vehicles and expected number of cross-border trips sampled from Mexican-domiciled truck companies that applied for operating authority within the United States. Source: (30).

In contrast to the paucity of information detailing Mexican long-haul fleets, a number of studies have investigated fleet profiles of drayage trucks employed in cross-border shipment. A study conducted by TTI (2) estimated that 90 percent of truck traffic between the United States and Mexico at the El Paso POE were drayage trucks with the primary purpose of short-haul operations and that 20 percent of the trucks crossing the border were over 15 years old. Other research also supports the fact that drayage is the dominant form of cross border transport in

Laredo (*33*). Drayage vehicles in Texas are almost entirely retired long-haul trucks (*34*). Another study conducted by California Air Resource Board in 2005 found that 66 percent of the Mexican drayage fleet were 1993 model year and older and 25 percent of the Mexican truck fleet were pre-1980 model year. Using investigative interviews in Laredo and across the border in Mexico, Harrison et al. (*33*) found evidence that most border crossings use Mexican-domiciled trucks and drivers. They attribute this to the comparative economic advantage of using Mexican drivers and trucks (\$85 versus \$125 for a U.S.-domiciled company on identical trips). Specifically, northbound Mexican tractors can easily compete for return loads, especially because some of their costs are lower. Because drayage trucks are somewhat older than long-haul tractors, both U.S. and Mexican owners will experience generally higher parts and maintenance costs. However, these costs—particularly those related to mechanic's labor—are lower in Mexico, which lowers the Mexican-domiciled ton-mile costs. Additionally, they suggest that broker-drayage company relationships might also favor Mexican truckers.



Figure 6 – Location of long-haul trucking companies interviewed about expected long-haul operations and equipment types. Source: (30).

UNITARY TRUCK Nomenclature	Number of Axles	Number of Tires	Vehicle Configuration
C2	2	6	
C3	3	8-10	
TRACTOR TRAILE Nomenclature	R Number of Axles	Number of Tires	Vehicle Configuration
C2-R2	4	14	
C3-R2	5	18	
C3-R3	6	22	
C2-R3	5	18	
ARTICULATED TR Nomenclature	ACTOR TRUCK Number of Axles	Number of Tires	Vehicle Configuration
T2-S1	3	10	<mark>ي. ب بي</mark>
T2-S2	4	14	
T3-S2	5	18	
T3-S3	6	22	
DOUBLE ARTICU Nomenclature	LATED TRACTOR TRUG	CK Number of Tires	Vehicle Configuration
T2-S1-R2	5	18	╔╶╶┙╼<mark>┙╔</mark>╴╺┙╤┛╸
T3-S1-R2	6	22	<mark>⋳⋰⋳[,] ⋳</mark>
T3-S2-R2	7	26	⋳⋰┙╶<mark>┙</mark>╘╛╶┙╶⋻⋻ ╸
T3-S2-R4	9	34	
T3-S2-R3	8	30	<mark>∞∻ -æ-</mark> 60∻ - 30 ->
T3-S3-S2	8	30	

Figure 7 – Types and specification of trucks defined by Mexican authorities. Source: (30)

TRUCKING ACTIVITY IN THE LAREDO-SAN ANTONIO CORRIDOR

Current Trucking Activity

Current truck traffic on I-35 between Laredo and San Antonio is estimated at approximately 3625 to 7250 vehicles per day (Figure 8). Because there are no major urban or commercial areas on this stretch of road (between Laredo and San Antonio), much of this traffic is from cross-border activities and is heading for major road intersections at San Antonio. However, in
addition to cross border trucks, the I-35 corridor passes through the Eagle Ford Shale, one of the United States' most important oil and natural gas field the Eagle Ford Shale is currently heavily exploited for oil and gas, and operations are expected to grow in line with improvements in extraction technology and increased demand for oil and gas. Truck traffic and emissions in the I-35 corridor and the road network adjacent to it can be characterized by trends in truck activity from two distinct sources: 1) long-haul cross-border traffic and 2) Eagle Ford Shale oil and gas traffic. Understanding the factors that drive truck activity from these distinct sources is essential in understanding their potential impacts on air quality in the region, and for understanding how the amount and type of truck traffic may change in the future. Currently none of the counties adjacent to the to the I-35 corridor between Laredo and San Antonio have a non-attainment status. However a number are classified as near-non-attainment (i.e., Bexar, Bastrop, Caldwell, Comal, Guadalupe, Hays, Travis, Williamson, and Wilson Counties).

Potential Changes in Trucking Activity Resulting from NAFTA Cross-Border Trucking

The Laredo POE is an important component of a trans-continental transport corridor that has been called the NAFTA superhighway. This highway links the Mexican port of Lázaro Cárdenas through the major Mexican cities of Mexico City and Monterrey to major U.S. cities (San Antonio, Dallas, Kansas City) along US I-35 and I-29, to northern crossings on the Alberta, Canada border (Figure 9). The Port of Lázaro Cárdenas is the largest Mexican seaport and one of the largest seaports in the Pacific Ocean basin linking to major trade partners in the East (e.g., China and Japan). Improved transportation along the NAFTA superhighway has the potential to ease congestion in existing U.S. eastern seaports (most notably Los Angeles). Additionally, Mexico City and Monterrey have a combined GDP of nearly US\$500 billion, and relatively affluent populations with increasing demand for exported goods from Canada and the United States. Potentially, the new NAFTA truck crossing regulations will allow freight to be moved non-stop between Mexico and the United States (or Canada). This may even have the affect the movement of goods into the United States from its major import partners such as China and Japan via Mexican sea ports.

Because reverse trade is essential for cost effective long-haul trucking, this may also stimulate southbound exports—either back to Lázaro Cárdenas or to major metropolitan areas of Mexico. While changes in the long-haul trucking rules have the potential to change the characteristics of trucks and emissions of cross-border freight (most notably the inclusion of Mexican long-haul trucks), they may also have long-term impacts on the amount of traffic along trade corridors that are more difficult to forecast



Figure 8 – Flowband map showing truck activity (2012) along the I-35 corridor between Laredo and San Antonio. Data from the Texas Department of Transportation (TxDOT).



Figure 9 – The NAFTA superhighway could potentially provide a link between ports on the Pacific coast of Mexico to major commercial cities in Mexico, United States, and Canada.

Emissions Associated with Eagle Ford Shale Drilling Activities

The Eagle Ford Formation (also called the Eagle Ford Shale) is a sedimentary rock formation from the Late Cretaceous age underlying much of South Texas. The shale formation slopes from North Texas to South Texas, with the deeper, oil and gas producing areas at the deeper, southern end of the formation (Figure 10). The first well to produce oil and gas from the Eagle Ford was drilled in in 2008, in LaSalle County, Texas. The current area of production now extends from the Texas-Mexico border in Webb and Maverick Counties, 400 miles toward East Texas. The play is 50 miles wide and an average of 250 feet thick at a depth between 4000 and 12,000 feet. The oil contained within the Eagle Ford Shale is termed tight oil (also known as shale oil or light tight oil, defined as petroleum that consists of light crude oil contained in petroleum-bearing formations of low permeability). The shale contains a high amount of carbonate that makes it brittle and easier to use hydraulic fracturing. The methods for extracting oil and gas from these deposits are often similar and require technologically advanced drilling methods (horizontal drilling and hydraulic fracturing). Improvements in drilling technologies are largely responsible for driving the recent expansion of oil and gas production in this area. An economic assessment of the Eagle Ford Shale estimated that it currently contributes \$61 billion to the Texas economy and supported about 116,000 jobs across a 20-county region in central and southern Texas. The region is projected to support more than 127,000 jobs and contribute \$89 billion to Texas's

economy by 2022 (*35*). According to data from the Texas Railroad Commission, approximately 8350 gas and 10600 oil wells produce petroleum products within the area of the Eagle Ford Shale defined by counties adjacent to the stretch of I-35 between Laredo and San Antonio.

Extraction of oil and gas can be characterized by three phases: exploration, well development, and production. The exploration process (seismic exploration, exploratory drilling) requires a relatively small amount of truck traffic to perform on site explorations. Once a well site is considered economically viable, truck activity increases during the well development phase. This phase involves: site preparation; rigging up, drilling, hydraulic fracturing, and rigging down (36; 37). Well development requires the construction of access roads and a workable platform around the well, and the delivery of drilling machinery and drilling and fracturing materials to the site using trucks. Typically, a number of wells are drilled at a single site. Although oil and gas products are typically transported away from the site using pipelines, all the machinery and products required to develop a site must be brought in by truck along with machinery and pipeline infrastructure required to transport the petroleum products away from the site. The site development phase may last between 2–6 months. The production phase of the process requires constant delivery of materials to maintain the site and drilling operations, but also to dispose of water that comes up the wellbore during the extraction of the shale oil and gas. The duration of the production phase of a well is very variable, requiring considerable analysis of the ongoing economic viability of the well, which itself is largely driven by the availability of petroleum resources and the future demand for and price of oil and gas products.



Figure 10 – Map of the Eagle Ford Shale area showing the different oil, wet gas, and dry gas production areas. However, the map does not show the extent to which the formation extends into Mexico. Source: (38).

Two studies have estimated the amount of truck traffic required to develop a well site and extract gas and oil: North Central Texas Council of Governments (NCTCOG) Barnett Shale inventory, referred to as the NCTCOG study (*39*), and the Center for Transportation Research's (CTR) study on energy developments and impacts on Texas infrastructure (referred to as the CTR study) (*40*). Table 9 shows a comparison of truck trips frequency estimates for two phases based on the CTR and NCTCOG studies. NCTCOG divided construction phase further into drilling and completion phase, but to enable comparison between the studies, data for these two sub-phases are combined in the table. Table 10 shows more detailed estimates of overall truck trips from the CTR study, while Table 11 shows the duration and trip estimates (along with data sources/assumptions) for the NCTCOG study. The results indicate similar truck trip patterns from the two studies for construction phase. For the production phase, NCTCOG's estimates of trip frequency are seen to be 3~10 times higher than CTR's study. These studies show that the development of a single gas well may require 295 to 455 truck visits (one way), while a multi-well pad may require between 4,250 to 6,505.

Most of the trucks that develop and service well sites travel relatively short distances and presumably usually transport one-way loads. Trip distance is most dependent on the ongoing phase of the shale gas extraction. The first phase (i.e., the construction phase) consists of the trips aimed at bringing equipment and material to the site for setting up of the well site including: sand, cement, drilling, and rig equipment. For the production phase the truck trips are mainly to dispose of water produced at the wellbore (during the extraction shale of the oil and gas) to a saltwater disposal site. Pipeline or onsite water disposal sites may also be used to dispose of water, but some portion is always transferred by truck. Because of differences in the goods being carried, the trip lengths for the two phases are also different. Table 8 and Table 9 list the data sources and assumptions used to estimate trip distance from the two studies.

In 2014, the Alamo Area Council of Governments published a report on the impact of increased oil and gas production in the Eagle Ford Shale region (*41*). They used existing oil and gas production inventories in Texas and data from the Railroad Commission of Texas to estimate the total emission impact of the petroleum industry in the region, including mobile and non-mobile sources. Non-mobile sources mainly comprise of drilling equipment, and other engines used to support oil and gas extraction. To estimate mobile emissions (i.e., those produced by trucks that support drilling operations), they used a number of sources including the NCTCOG and CTR studies mentioned previously. In addition to calculating past and current emissions, they used three different development scenarios (low, moderate, and high) to project emissions to 2018.

Phase	Well Pad Traffic	Minimum Truck Trips	Maximum Truck Trips
Construction	Drilling Pad and Road Construction Equipment	10	45
	Drilling Rig	35	45
	Drilling Fluids and Materials	25	50
	Drilling Equipment (casing, drill pipe, etc.)	25	50
	Completion Rig	15	15
	Completion Fluids and Materials	10	20
	Completion Equipment (casing, drill pipe, etc.)	5	5
	Hydraulic Fracturing Equipment (pump trucks and tanks)	150	200
	Hydraulic Fracturing Sand Trucks	20	25
	Phase 1 Total	295	455
Production	Phase 2 total	400	600
	Total	695	1055

Table 8 – Truck Trip Estimates from CTR Study.

Phase		Source	Duration	Number of Trips	Final
					Assumption
Construction	Drilling	Chesapeake	17–24	62 for equipment	187 based on
			days		TxDOT (more
		TxDOT	25 days	187 (for site	detailed) data
				preparation, for	
				equipment, for	
				mud/water/cement)	
	Completion	Chesapeake	3–5 days	Up to 400 water trucks,	420 truckloads,
				another 20 truckloads	based on
				for other items	Chesapeake
		City of Fort	Approx.	Ranges from 150–400	information,
		Worth	1 month	truckloads	which is a
		TxDOT	Approx.	997 truckloads; can be	moderate
			14 days	reduced to 655	assumption
				truckloads if half of	compared to
				freshwater needed for	other sources
				hydraulic fracturing is	
D 1 (<u> </u>		piped in	0.22 / 1
Production		Chesapeake		13–1 / trips on the first	0.33 trips/day
				day of production	per well
				during the second week	
				of production around A	
				trips/day after 60 days	
				Less than on trip/day	
				after 90 days/ or Less	
				than 1 per day for	
				lifetime of well	
		City of Fort	1	219–2,847 lifetime	
		Worth		trips or 0.03-0.39 per	
				day	
		TTI		88 trips/year or 0.24	
				per day	
		TxDOT		353 trips/year or 0.97	
				per day	

 Table 9 – Duration and Trips Estimates from the NCTCOG Study.

	Phase	Source	Final Assumptions
Miles per Trip	Construction	TxDOT oversize/overweight database, which was collected for years 2007 and 2009 for the oil based industry	32.88 miles
	Production	For this study they used the Rail Road Commission of Texas data to locate the 3756 gas wells and 57 disposal sites in the Barnett Shale region	Approximately 10 miles with high standard deviation

Table 10 –	Summarv	of Data	Sources and	l Assum	ptions for	VMTs from	CTR Sf	udv.
						1 1 1 2 2 0 2 0 0 1 0	N	

Table 11 – Summary of Data Sources and Assumptions for VMTs from NCTCOG Study.

	Phase	Source	Estimate	Final
				Assumptions
Miles Per Trip	Construction	L&R Tank Trucks	Water hauler; travel approximately 30 miles for freshwater, 50 miles for produced water; trucks travel approximately 200–	50 miles
		Thuram Transportation	Water hauler; travels less than 60 miles	
		Mr. Troy Rockey, Trucking Contractor	Rock and equipment hauler; travel anywhere from 100– 500 miles per day	
	Production	A synthetic module of the Dallas-Fort Worth Regional Travel Model for the Expanded Area	Associated traffic is recurring and repetitive	26 miles for 2006; 22 miles for the year 2012 and 2018

Interaction between Cross Border Trucking and Oil and Gas Activities

The truck traffic associated with the oil and gas industry will use the I-35 corridor and many of the adjacent arterial roads to transport the substantial goods and services required for economically viable oil and gas extraction. However, an additional legislative factor may also have an effect on truck traffic in the region. On December 20, 2013, Mexican President Enrique Peña Nieto signed historic constitutional reforms related to Mexico's energy sector aimed at reversing oil and gas production declines. On August 11, 2014, secondary laws to implement those reforms officially opened Mexico's oil, natural gas, and power sectors to private investment. As a result, Pemex can now partner with international companies that have the

experience and capital required for exploring Mexico's deep water and shale resources (42). Although, the Eagle Ford Shale most likely extends into Northern Mexico, viable production has been limited by infrastructure and technology requirements for economically viable extraction. It is possible then that recent changes in both cross border trucking regulations and Mexico's energy investment reforms will lead to economic and infrastructural conditions that greatly facilitate the development of the Mexican portion of the Eagle Ford Shale. If such changes occur, this may have an impact on the types of traffic using the I-35 corridor and the movement of freight across the border.

CONCLUDING REMARKS

This section provides an overview of information relevant to potential air quality impacts of changes in long-haul truck activity in the Laredo–San Antonio corridor. This corridor has been identified as an area of concern in Texas because of the volume of freight movement at the Laredo POE, coupled with the existing air quality concerns in the region, including the impacts of drilling activities in the Eagle Ford Shale region.

The introduction of new rules for Mexican and U.S. long-haul trucking has the potential to both increase the amount of trucking activity in the region, change the characteristics, and emissions profiles of trucks that use this corridor. As this review illustrates, a complex and often turbulent series of political factors have driven the introduction of these new cross-border trucking rules. A variety of other socio-economic factors are likely to determine the extent to which the new rules will change the volume of freight movement across the border and within the study region. To a large extent, this complexity suggests that it is difficult to accurately forecast changes in truck activity along the corridor.

However, the detailed legislation associated with the new long-haul regulations does provide a starting point for estimating the likely change in the emission profiles of trucks that use the region. Here, the biggest drivers affecting changes in emissions are likely to surround the fleet characteristics of potential long-haul trucks. These characteristics include vehicle age, vehicle type, engine characteristics, maintenance schedules, and the availability of ULSD fuel.

CHAPTER 3 – IMPACT ASSESSMENT

In the previous section, researchers provide an overview of the factors that have influenced the decision to allow long-haul trucking across the U.S.-Mexico border. Researchers also identified a number of other factors important for predicting whether the new regulations will significantly affect the adoption of cross border long-haul trucking by U.S. and Mexican companies.

This section uses quantitative and qualitative methods to explore the likely impact of the new cross-border trucking rules on truck emissions along the I-35 corridor. In this section, researchers:

- Describe information collected from Mexico as part of a more detailed qualitative data collection program.
- Define the problem as a quantitative impact assessment including providing a conceptual model of the methods used to develop a quantitative impact assessment, and highlight the information needed.
- Describe the data collection procedures used for the quantitative impact assessment.
- Detail the methods of the quantitative impact assessment.
- Present and interpret the results.

QUALITATIVE APPROACH – INTERVIEWS AND INFORMATION COLLECTION

The previous findings highlighted two categories of information that would benefit from qualitative survey methods:

- Information from Mexican truck companies on their plans for underling long-haul operations within the United States.
- The availability of ULSD in Mexico and its effect on Mexican emissions and emission standards.

Interviews with Mexican Truck Companies and Trade Organizations

Mexican truck companies were interviewed by phone to assess their plans for adopting the new cross-border long-haul regulations. The companies were briefly introduced to the research problem and instructed that their responses will be used to evaluate possible environmental impacts of the new rules and are anonymous. The interviewees were asked two questions:

- Does your company have plans to operate in the United States in the near future?
- If the response is yes, what model, year, and type of trucks are you planning to use in the United States?

Eight companies were successfully contacted and interviewed. Table 12 presents the detailed results of these interviews. All of the companies reported that they are not looking to take advantage of the new crossing rules in the near future, for reasons mainly involving costs and changing business practices:

- **Costs**: The cost for Mexican carriers to comply with U.S. regulations is too high. The other concern discussed frequently by the interviewees is that to be cost effective, each truck would require a backhaul load. It is not cost effective for them to enter the U.S. market, preferring to continue using the drayage cross border business models than to travel far into the United States and return with an empty tuck while complying with U.S. regulations.
- **Changing business practices**: The second problem that was mentioned is the business model would need to change and there is no experience of operating in the United States. These include new regulations (i.e., hours of operation that is not enforced in Mexico).

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Table 12 – Responses from Eight Mexican Long-Haul Truck Companies v	vnen Askea
Their Plans for Using the New Long-Haul Cross-Border Trucking Reg	ulations.

T 11 10 D

Company ID	Response
1	Not in the near future but maybe when some "procedures" change.
2	Currently we just cross the border but does not plan to go beyond the commercial zone, and we don't expect this to change.
3	No, we won't operate in the US it's very complicated.
4	We have some plans to develop a new base of operations in the US but not right now.
5	No, I already have an established business here and have an established relationship with people in the United States. Developing new business by myself is not feasible.
6	No, currently we operate sending freight to Nuevo Laredo and if needed, it crosses the border with a drayage truck.
7	No, we continue with operations in Mexico and it was easier to open a new company in the US It's based in Dallas.
8	No, it is too complicated and not cost effective for us to operate in the US. Insurance and driver costs are much lower in Mexico and hours of operation rules are not enforced.

Information on Mexico's Energy Reform, the Availability of ULSD, and the Convergence of U.S. and Mexican Emission Standards

Toward the end of 2014, the Mexican government proposed a reform to Norm 44 (NOR44), which is the legal framework for emissions guidelines. The new proposal is to update Mexico's emissions guidelines to match the EPA 10 and Euro VI emissions regulations (43).

The Mexican government published a proposed modification to Norm 44 in the federal diary on December 17, 2014. The modification requires diesel engines or fully loaded vehicles with a gross vehicle weight above 3,857 kg to follow EPA 10 or Euro VI emissions standards from January 1, 2018. The reform has passed through the required 60-day comment period, and final publication is expected in 2015.

If the reform is adopted, it will apply to engines that are manufactured and sold on or after January 1, 2018. Manufacturers will be allowed to sell engines that were produced before January 1, 2018, for six months into the new regulation, after which only engines that conform to the new regulations will be allowed on the market.

Part of the proposed reform states that the Department of Environment and Natural Resources (SEMARNAT) will review the country's ULSD production and availability in order to determine whether there will be enough fuel to uphold the new emissions standards. If SEMARNAT determines that the country does not have the capacity to produce or purchase enough ULSD, the new regulations will be pushed back 12 months to January 1, 2019.

Mexico currently does not have the capacity to refine its own crude oil into ULSD. However, Pemex recently announced that it would begin modernization projects at the Lazaro Cardenas refinery in order to produce ULSD by 2017, but the project has already been postponed due to financial constraints.

The proposed emissions standards follow Mexico's large-scale energy reform. The energy reform, which was passed in 2013, opened up Mexico's energy sector to private investment, allowing private companies to build and operate independent oil refineries in Mexico. This foreign investment should greatly increase the availability of ULSD, making Mexico's emissions reforms possible.

PROBLEM FORMULATION

Assessing the air quality impacts of Mexican long-haul trucks is made difficult because, with the exception of pilot programs, there are no historical data to assess how the new cross-border trucking rules will influence the total volume of trucks on the Laredo–San Antonio I-35 corridor, or the proportion of Mexican trucks that make up this volume (corridor share). This long-term truck activity will be driven by a complex mix of factors such as the efficiency and cost advantages of bypassing the current drayage system, and the ability of Mexican haulers to develop business relationships in the United States. Additionally, Mexican haulers that wish to adopt long-haul operations across the border can also do so by creating partner companies in the United States, with fleets of U.S.-domiciled trucks (conforming to U.S. emission standards).

Another long-term trend that will impact the emissions impact of the NAFTA rule is the convergence of Mexican emission standards to the current U.S. standards. The Mexican

government has already laid out these plans, with an anticipated implementation date of January 2018. However, in practice the implementation of these standards will depend on the availability of ULSD fuels by this date.

To account for these long-term forecasting uncertainties, researchers focused the quantitative analysis on two complementary scenarios: worst case and most likely case. For the worst case scenario, researchers developed an analysis using the minimal set of information on emission rates of Mexican-domiciled long-haul trucks. In the most likely case scenario, researchers developed an analysis that makes realistic assumptions about the age distribution of long-haul trucks that are likely to operate in the United States and the plans outlined by the Mexican government to converge Mexican truck emissions to U.S. standards.

For each of these scenarios, it is possible to interpret the potential impacts of long-haul crossborder trucking in a number of ways:

- Primary Impact The most direct impact involves an assessment of emissions produced by additional Mexican trucks on the corridor relative to a situation that assumes only U.S. trucks will use the corridor. In other words, Mexican trucks displace U.S. trucks longhauling loads to/from Mexico, leading to an emission impact for each truck replaced.
- Secondary Impact Researchers defined a secondary impact as long-term changes to the total emissions on the corridor. These long-term changes could be driven by changes in the volume of cross border truck activities as a result of changes in border regulations or long-term changes in the emission rates of trucks using the corridor. Theoretically, the new NAFTA crossing rule is designed to improve the efficiency and cost with which goods can be transported across the border. As such, increases in trans-border trade might be expected to increase volumes of trucks on the I-35 corridor above the current growth rates.
- Tertiary Impact A third impact potentially occurs because trucks from long-haul cross border trucking may displace drayage truck volumes. Many of these drayage trucks are older, high emitting models. If the new regulations lead to drayage trucks to be replaced by long-haul, the emission impacts could be positive. However, in practice the displacement drayage by long-haul trucks is difficult to quantify for a number of reasons. First, the drayage system uses border warehouses that reconsolidate cross-border goods ready for long-haul destinations within the United States. This makes it difficult to estimate how many drayage truck loads a single long-haul truck is likely to replace. Second, there may be considerable differences in drive cycles for long-haul versus drayage trucks that are influenced by differences in waiting times at the POE.

For the quantitative analyses, researchers focused on the primary and secondary emission impacts of Mexican trucks replacing U.S. trucks on the I-35 corridor. Specifically, researchers

focused the analysis on the corridor between Laredo and the outskirts of San Antonio, and on long-haul trucks that use this corridor.

In this case study, researchers defined long-haul trucks as combination trucks moving freight greater than 150 miles (i.e., the approximate length of the corridor between Laredo and San Antonio), and that are directly involved in carrying goods to and from the border. This distinction excludes other trucks using the corridor (e.g., single unit trucks, and combination trucks that service local oil and gas industry) that are not a direct component of border traffic. Finally, researchers modeled the emission impacts of four pollutants—CO, PM, NOx, and HC. To account for planned implementation of new Mexican truck emission standards, researchers performed the analysis for the years 2015–2025.

QUANTITATIVE IMPACT ASSESSMENT

Study Area and Traffic Activity Data

The study area involves a segment of I-35 between Laredo and San Antonio. To provide a detailed understanding of the long-haul truck activity in this region, researchers used TxDOT's online traffic data management system, STARS II. This database provides detailed traffic activity data from temporary and permanent traffic count stations across the state. Unlike the federal Highway Performance Management System (to which STARS II contributes data), the database can be used to specifically determine the activity of combination truck activities (rather than all trucks including single unit vehicles) on the network. The rationale is that combination trucks are most likely to be used for long-haul operations. Researchers used STARS II to find annual average daily traffic counts of long-haul trucks on the corridor of interest and on other roads in the region to develop a spatial overview of truck activity in the region (Figure 11). In Figure 11, the station labels illustrate the station ID and the average daily number of trucks measured at that station during 2014 (for trucks traveling in both directions). For reference, Figure 12 shows the same spatial overview but for all traffic, illustrating that combination trucks comprise a large proportion of vehicles on the corridor. Figure 11 suggests that a large number of combination trucks that cross the Laredo POE are destined for the I-35 corridor at station ID S219. The strong relationship among combination truck volumes at station ID S219 on the outskirts of Laredo, station ID W531 roughly half way along the corridor, and station S210 on the outskirts of San Antonio suggest that once on the I-35 corridor, most of the trucks will remain in the corridor to San Antonio. The extra combination truck volumes on the outskirts of Laredo and San Antonio can be attributed to extra traffic near the urban areas of San Antonio and Laredo.

Figure 13 illustrates a simplified view of the I-35 corridor and shows the temporal change in combination truck counts at the three stations. The figure also shows the temporal pattern of trucks crossing the POE (in both directions) using data from the U.S. DOT Bureau of

Transportation statistics website (5) and the Texas Center for Border economic and Enterprise Development (44). Researchers used these data to develop simple linear models for the change in daily truck volumes (per day) at each site, with the baseline volume set to January 1, 2013 (Table 13). The long-term trends in truck activity between the sites were similar. This again suggests a high degree of correlation between combination truck activities among these sites. From this information, researchers assessed that station W531 provides the best insight of current and future long-haul combination truck volumes along the corridor of interest.



Figure 11 – Truck activity data on and around the I-35 corridor. The blue dots show the location of TxDOT traffic count stations that provide volume counts classified by vehicle type. The station labels illustrate the station ID and the average daily number of trucks measured at that station during the year 2014. Because the focus of this study is long-haul trucks, the truck volumes are based on TxDOT vehicle classes 8 and above (combination trucks). The I-35 corridor (highlighted red) is monitored by three permanent traffic monitoring sites (large blue markers) that provide classification data (S219, W531, and S210). Note the significant increase in I-35 truck activity close to San Antonio, but the similarity of truck counts at W531 and S219. Data were obtained from STARS II (45).

Counts include vehicles traveling in both directions.



Figure 12 – Total traffic activity on and around the I-35 corridor. The blue dots are locations of TxDOT traffic count stations that provide volume counts classified by vehicle type. The station labels illustrate the station ID and the average daily traffic (all vehicle classes) measured at that station during the year 2014. Cross referencing with the data presented in Figure 11, the map shows that a high proportion (c.a. 50 percent in the case of station W531) of traffic on the section of the interstate between Laredo and San Antonio is comprised of combination trucks. Data were obtained from STARS II (45). Counts include vehicles traveling in both directions.



Figure 13 – Simplified representation of truck activity along the I-35 corridor. The graphs on the left hand side of the diagram show detailed temporal traffic counts at the three
TxDOT monitoring stations (S210, W531, S219) and truck crossings at the Laredo border. South to north border crossing data were obtained from the U.S. DOT Bureau of Transportation statistics website (5). Crossings for both directions were estimated as double the south-north estimate based on more limited information on north to south crossings from Texas Center for Border Economic and Enterprise Development (44). The border crossing data are provided as monthly crossings. At I-35 stations, truck counts are daily, illustrating a strong daily (weekday) component to truck volumes. The trend lines fitted to each graph illustrate long-term trends in traffic volume.

Table 13 – Summary of Baseline (Jan. 1, 2013) Traffic Volume and Long-Term Growth Rates at Each Traffic Monitoring Station and the Border. Linear regression (least squares) was used to obtain the baseline truck volumes and the linear growth rate in trucks per day. The single-year growth rate and the 10-year growth rate are based on the same assumption of linear (versus exponential) volume growth.

Location	Baseline Truck Volume (Jan. 1, 2013)	Growth Rate (Trucks per Day)	1-Year Growth Rate (%)	10-Year Growth Rate (%)
Border (Laredo, TX)	9941	1.26	5%	46%
S219 (I-35 near Laredo, TX)	7384	0.66	3%	33%
W531 (I-35 between Laredo and San Antonio, TX)	5822	1.37	9%	86%
S210 (I-35 near San Antonio, TX)	7000	1.35	7%	70%

Emission Rates of U.S. and Mexican Trucks

The Motor Vehicle Emissions Simulator (MOVES) is the most recent on-road emission factor model developed by the U.S. EPA. MOVES 2014 is the most recent MOVES model and is widely used to estimate mobile source emission rates for national-, state-, and regional-level air quality analyses.

MOVES 2014 was used to create a database of emissions for long-haul combination truck types using input parameters for Laredo. MOVES 2014 provides emission rates (per vehicle) for each pollutant (CO, NOx, PM, HC) and requires a number of specific inputs for local meteorology, fuel supply, and inspection/maintenance. These inputs were obtained for Laredo from the Texas Statewide Emission Inventory (*46*). Emission rates were calculated for a rural Interstate highway under winter temperature and humidity conditions (50.6°F, and 72.7 percent relative humidity) representing worst case emissions (i.e., the environmental conditions under which emission rates are highest for this vehicle type and road type). The emission rates are specific to vehicle speed, analysis year, and truck model year. Table 14 lists the input parameters used to extract emission rates from MOVES 2014.

MOVES 2014 provides emissions estimates for U.S. trucks only. For emissions from Mexican trucks, two emission rate scenarios were assumed. In the worst case scenario, Mexican trucks are assumed to follow the emission standards of U.S. 1998 model trucks throughout the analysis (2015–2025). The rationale for this worst case is that under the new NAFTA regulations, all trucks with the long-haul operating license must be model 1998 or younger. The second, most likely case scenario incorporates the Mexican government's plans to adopt emission standards equivalent to the current U.S. standards by 2018. Under this scenario, between 2015–2018, the emission rates of Mexican trucks are assumed equivalent to a U.S. model year 1998 truck. Post

2018, a Mexican truck with a model years of 2018 or greater is assumed to have emissions equivalent to U.S. trucks of the same model year. Figure 14 illustrates the emission rates for each pollutant estimated for U.S., Mexican (worst case), and Mexican (most likely case) trucks.

Parameters	Range/Source
Time Span (Analysis Year)	2015–2025 at 1-year increment
Geographic Boundary	Texas, Webb County
Vehicle Type	Combination Long-Haul Truck (Vehicle Type ID 62)
Fuel Type	Diesel Fuel
Road Types	Urban Restricted Access
Pollutants	CO, NO_X, THC, PM_{10}
Meteorology Data	Local Inputs from Texas Statewide Emission Inventory
Age	0 to 30 years at 1 year increment
Inspection/Maintenance	MOVES default
Speed	65 mph (Speed Bin ID 14)
Season	Winter

Table 14 –Input Parameters of MOVES Model to Extract Emission Rates



Figure 14 – Emission rates per truck for the U.S., worst case Mexican trucks, and most likely case Mexican trucks. Emissions are calculated using MOVES 2014 for a single analysis year (2015). The figures illustrate the changes in emissions for a truck of a given model year, assuming the truck is new (i.e., 0–1 years old). In MOVES 2014, emission rates per truck change through time in response to engine wear and other factors. Although the analysis period is between 2015–2015, emissions of older truck models are important because fleets may contain older model trucks.

Characterizing Age Distributions and Emission Rates of Mexican and U.S. Long-Haul Trucks

In MOVES 2014, emission rates of individual trucks are dependent on its age and model year. However, the average emission rate of a fleet of trucks is also dependent on the age distribution of trucks in a fleet (where age is the age in years relative to a specific calendar year). MOVES 2014 provides a default age distribution for U.S. long-haul trucks (Figure 15). In practice, this age distribution changes through time as trucking companies respond to changes in economic conditions (e.g., by purchasing new trucks when economic conditions are favorable or relying on older trucks during economically unfavorable periods). For the purposes of this analysis, researchers assumed that the age distribution of the U.S. fleet is constant.

The best information for the age distribution of Mexican trucks is FMCSA data detailing the age and VIN of each truck that took part in the pilot study, and were subsequently registered for long-haul operations (the federal regulations require that each unit is registered). Because the original data provide the model year of participating trucks, researchers calculated relative age of each truck assuming a base year of 2014 (the end of the second pilot study). Researchers developed a continuous age distribution from the data (preferable for the quantitative analysis), assuming the truck ages followed a log-normal distribution. Figure 16 shows the fitted age distributions with the empirical distribution inset. As for the U.S. age distribution, researchers assumed a constant age distribution over the long term.



Figure 15 – Age distribution of U.S. long-haul combination trucks based on MOVES 2014 default values. The analysis assumes the same age distribution for all analysis years.



Figure 16 – Age distribution of Mexican long-haul trucks. The inset graph shows the age distribution of trucks registered to take part in the second pilot program (2012–2014). The main graph shows the age distribution of Mexican-domiciled trucks modeled using a log-normal distribution (μ =4.17, σ = 0.77) fitted to the pilot program data.

Impact Assessment Methods

The previous section illustrates key data required to perform a quantitative assessment of the emission impacts of Mexican trucks on the I-35 corridor. In this section, researchers describe the methods used to quantitatively assess these impacts for the period 2015 to 2025. The methods are used to model two complementary scenarios: one based on minimal information (worst case) and another based on a full interpretation of the available data (most likely case scenario).

The first step in calculating total emissions is to project the total daily truck volumes for the I-35 corridor for each day between 2015 and 2015:

$Trucks_{total} = day \times Growth + Volume_{base}$ Equation 1

Where:

day is the model day that is equal to the number of days since January 1, 2013 (the base date used for traffic analysis).

Trucks_{total} is the total number of truck volume estimated on the corridor each day.

Growth is the growth rate in trucks along the corridor in units of truck per day.

Volume_{base} is the estimated volume of trucks on 1st January 2013 (the base date used for traffic analysis).

The forecast of Trucks_{total} for each day is then further disaggregated into forecasts of the number of U.S. (Trucks_{US}) versus Mexican-domiciled trucks (Trucks_{Mex}) using a factor Proportion_{Mex}:

$Trucks_{mexican} = Trucks_{total} \times Proportion_{Mex}$	Equation 2
$Trucks_{US} = Trucks_{total} \times (1 - Proportion_{Mex})$	Equation 3

Given truck volumes attributable to U.S. and Mexican trucks, total emissions are calculated by multiplying these country specific volumes by the average emissions of trucks from the two fleets. Average emission rates per U.S. and Mexican truck are the weighted average of the truck age distribution and the age specific emission rates for each country, for a specific analysis year:

$AvEmissions_{US} = \sum_{age=0}^{age=max} ER_{us,age} x Fleet_{us,age}$	Equation 4
$AvEmissions_{Mex} = \sum_{age=0}^{age=max} ER_{Mex,age} x Fleet_{Mex,age}$	Equation 5

Where:

AvEmissions_{US, year} = Average emissions from U.S. trucks for a specific analysis year.

AvEmissions_{Mex, year} = Average emissions from U.S. trucks for a specific analysis year.

 $ER_{US, age}$ = the age specific emission rates for U.S. trucks.

 $ER_{mex, age}$ = the age specific emission rates for Mexican trucks.

 $Fleet_{US,age}$ = the proportion of trucks of a given age in the U.S. truck fleet.

 $Fleet_{Mex,age}$ = the proportion of trucks of a given age in the Mexican truck fleet.

Finally, the total emissions per mile attributable to U.S. or Mexican trucks are calculated as:

$Emissions_{Mex} = Trucks_{Mex} \times AvEmissions_{Mex}$ Equation 6

And

$Emissions_{US} = Trucks_{US} \times AvEmissions_{US}$ Equation 7

The total emissions per mile are the sum of $Emissions_{Mex}$ and $Emissions_{US}$. Similarly, the total emissions for the corridor can be calculated by multiplying these values by the corridor length.

As outlined in the problem definition section, the primary impact of Mexican long-haul trucks is calculated as the emissions that would occur with Mexican trucks using the corridor minus the emission rates that occur with only U.S. trucks using the corridor. This impact is obtained by performing two simulations in each scenario. The first simulation calculates the emission rates with Mexican trucks on the corridor (i.e., assuming new NAFTA regulations). The second is performed by setting the Proportion_{Mex} parameter to 0, assuming that only U.S. trucks will use the corridor as would be the case if the border remained closed to cross-border long-haul trucks. The secondary impact is assessed through the long term trends in total emissions generated by trucks on the corridor.

Worst Case Scenario

Table 15 outlines the assumptions for the worst case scenario. The scenario assumes that the emission rates of all Mexican-domiciled trucks will be equal to 1998 U.S. emission rates, and does not incorporate the current plans for Mexican truck emission standards to converge to U.S. standards. As a result of this worst case assumption, it requires minimal information about the age distribution of the Mexican-domiciled truck fleet and instead assumes that all Mexican trucks (irrespective of age) will generate emissions per mile equivalent to a 1998 model U.S. truck. In contrast, the scenario assumes that the emission rates of U.S.-domiciled trucks will follow those outlined in Figure 14 (based on MOVES age specific emission rates), and the U.S. fleet will follow the age distribution outlined in Figure 15.

Following the rationale outlined in the problem definition section, the worst case impact of Mexican long-haul truck emissions involves simulating total emissions (per mile or for the corridor) assuming two situations. The first assumes that no Mexican trucks will use the corridor, while the second assumes that a specified proportion of Mexican trucks (Proportion_{Mex}) will use the corridor as a result of the new NAFTA rules. Because the likely uptake of this new opportunity is so difficult to gauge (especially over a 10-year horizon), researchers calculated the worst case scenario emissions for three different values of Proportion_{Mex}—1 percent, 5 percent, and 20 percent.

Most Likely Scenario

Table 15 outlines the assumptions for the most likely impact scenario. As in the worst case scenario, it assumes age specific emission rates of U.S. trucks outlined in Figure 14, and age distribution of trucks shown in Figure 15. However, the most-likely case scenario incorporates an assumption that Mexican truck emission standards will converge to U.S. standards by 2018 (shown in Figure 14), and information for the age distribution of Mexican trucks likely to take part in cross-border long-haul activities (Figure 16). Again, following the rationale outlined in the problem definition section, the worst case impact of Mexican long-haul truck emissions involves simulating total emissions (per mile or for the corridor) assuming two situations. The first assumes that no Mexican trucks will use the corridor, while the second assumes that a

specified proportion of Mexican-domiciled trucks will use the corridor as a result of the new NAFTA rules. Because the likely uptake of this new opportunity is so difficult to gauge (especially over a 10-year horizon), researchers calculated the worst case scenario emissions for three different values of Proportion_{Mex} percent, 5 percent, and 20 percent.

Parameter/Data	Worst Case	Most Likely Case
Volume _{base}	5822 (Table 13)	5822 (Table 13)
Growth	1.37 (Table 13)	1.37 (Table 13)
Proportion _{Mex}	1%, 5% and 20%	1%, 5% and 20%
Emissions _{US,age}	Figure 14	Figure 14
Emissions _{Mex,age}	Figure 14(1998 standards)	Figure 14
Fleet _{US,age}	Figure 15	Figure 15
Fleet _{Mex,age}	Figure 16	Figure 16

Table 15 – Summary of Parameters and Data Sources Used in the Two Emission Impac	ct
Scenarios.	

Quantitative Impact Assessment Results and Interpretation

Figure 17 illustrates changes in emission rates for U.S. and Mexico truck fleets. The blue line illustrates average emission rates through time for the U.S. fleet. These average emissions per truck are a product of emission rates of different truck ages and model years using the corridor. Although there are no planned changes in emission standards for U.S. trucks (at least none built into this analysis), average emissions per U.S. truck decrease through time because older, higher emitting trucks are removed from the fleet and replaced by newer lower emitting trucks.

Figure 17 also displays the average emissions per Mexican truck for each scenario (worst case and most likely case). Each scenario incorporates different assumptions about the long-term emission rates of Mexican cross-border trucks. The worst case scenario (red line in Figure 17) assumes that the emission rates of all Mexican trucks participating in the program are equivalent to U.S. trucks of 1998 model year. This scenario was developed because by law, 1998 is the oldest truck that can be registered for long-haul, cross-border operations. As a result, the average emissions of Mexican trucks under the worst case scenario remain constant throughout the scenario projections. In contrast, the average emissions per Mexican truck from the most likely scenario change considerably through time (green line in Figure 17). In the most likely case scenario, the average emissions per truck are a product of planned changes in Mexican emission standards (beginning 2018), and the age distribution of Mexican long-haul trucks using the corridor (Figure 16). As might be expected, under the most likely scenario the average emissions



per Mexican truck begin to converge to the average emissions per U.S. truck.

Figure 17Figure 17 can be interpreted as the likely emission impact that occurs by replacing a single U.S. truck on the corridor with a single Mexican truck (either worst case or most likely case scenario). Between 2005 and 2018, these impacts are the same for both scenarios. But post-2018 (initiation of new emission standards), the impacts of replacing a U.S. truck with a Mexican truck are greatly reduced. The analysis suggests that around the year 2025, displacement of U.S.-domiciled trucks by Mexican trucks will result in a minimal direct emission impact.

Figure 18, Figure 19, and Figure 20 illustrate the total emissions impact (per mile) of Mexican long-haul cross-border trucks. The results are a function of a number of assumptions about changes in the volume and composition trucks using the corridor. These figures show total emissions assuming the same growth in truck volume along the corridor but with different compositions (proportions) of U.S. and Mexican trucks sharing the corridor. In each graph, the blue line illustrates a baseline scenario that assumes that all trucks on the highway are U.S. domiciled (i.e., representing the situation if there was no new cross-border regulation); the red

and green lines illustrate the total emissions when Mexican trucks share the corridor under worst case and most likely emission scenarios, respectively.

Figure 18 shows emission totals assuming Mexican trucks will make up 1 percent of the corridor volume (i.e., a low uptake of the new cross-border trucking rules by Mexico truck companies). Figure 18 shows emission totals under the assumption that 5 percent of the volume will comprise Mexican trucks. Figure 19 shows emission totals under the assumption that 20 percent of the volume will comprise Mexican trucks.

Previously, researchers defined the primary impact of Mexican cross-haul trucks as the difference between the baseline truck emissions (all U.S. trucks) and the total emissions that occur as a result of Mexican trucks replacing some of this baseline U.S. traffic. Figure 18 shows emission totals assuming Mexican trucks will make up 1 percent of the corridor volume (i.e., a low uptake of the new cross-border trucking rules by Mexico truck companies). The total primary impacts are low, for both the worst case and most likely case scenarios. Although a primary impact does occur, over the long term the total emissions on the corridor actually decrease through time. This is in spite of the fact that the analyses include long-term growth in total truck traffic activity along the corridor. This long-term reduction in emissions for baseline, worst case, and most-likely scenarios can be explained by the gradual reduction in U.S. emission rates over time (illustrated in Figure 17). In turn, this is caused by the replacement of older trucks in the U.S. fleet with newer ones (under an assumption of a constant age distribution). As a result, the emission impacts caused by a 1 percent highway share by Mexican trucks are not large enough to offset the improvements in average emissions from the remaining 99 percent of U.S. trucks on the highway.

Figure 19 illustrates the total emissions assuming that 5 percent of the truck volume will be Mexican domiciled. As is the case for the 1 percent corridor share analysis, some primary emission impacts occur as a result of the Mexican truck activity. However, although an emission impact occurs for each U.S. truck displaced by a Mexican truck, these impacts are not large enough to cause total corridor emissions to increase over the long term.

Figure 20 illustrates total emissions per mile assuming a 20 percent share of the corridor by Mexican-domiciled trucks. In this case, the impact of the worst case scenario is particularly pronounced. In contrast to the previous cases (1 percent and 5 percent share), the emission impacts of a 20 percent corridor share by Mexican trucks (worst case) are large enough to offset the gradual reduction in emissions from the U.S. fleet. In the most-likely case scenario, the short-term impacts of a 20 percent corridor share by Mexican trucks are relatively large, but these impacts decrease dramatically when the proposed changes in Mexican emission standards are implemented (2018).



Figure 17 – Average emissions of Mexican and U.S. trucks used in the analyses under worst case and most likely case scenarios. The red line shows the average emission rates of Mexican trucks through time assuming the worst case assumption that all trucks will produce emissions equivalent to a 1998 U.S. truck. The green line shows average emission rates per truck for the most likely case scenario. The blue line illustrates the emission rates per truck for the U.S. fleet. The emission rates are a calculated using MOVES 2018 emission rates and the age distribution of trucks in each fleet.



Figure 18 – Total emission rates (per mile of corridor per day) using the I-35 corridor between Laredo–San Antonio, and assuming that 1 percent of the current and projected truck activity comprises Mexican-domiciled trucks. The red line shows the total emission per mile of highway assuming the worst case assumptions (all Mexican trucks are equivalent to 1998 U.S. standard). The green line shows total emission per mile for the most likely case scenario. The blue line illustrates the total emission per mile assuming that no Mexican trucks use the corridor. Note that because the differences in total emissions are small, the lines overlap considerably. The total emissions are calculated using temporal changes in average truck emission rates, and the modeled changes in traffic activity along the corridor.



Figure 19 – Total emission rates (per mile of corridor per day) using the I-35 corridor between Laredo–San Antonio and assuming that 5 percent of the current and projected truck activity comprises Mexican-domiciled trucks. The red line shows the total emission per mile of highway assuming the worst case assumptions (all Mexican trucks are equivalent to 1998 U.S. standard). The green line shows total emission per mile for the most likely case scenario. The blue line illustrates the total emission per mile assuming that no Mexican trucks use the corridor. Note that because the differences in total emissions are small, the lines overlap considerably. The total emissions are calculated using temporal changes in average truck emission rates, and the modeled changes in traffic activity along the corridor.



Figure 20 – Total emission rates (per mile of corridor per day) using the I-35 corridor between Laredo–San Antonio and assuming that 20 percent of the current and projected truck activity comprises Mexican-domiciled trucks. The red line shows the total emission per mile of highway assuming the worst case assumptions (all Mexican trucks are equivalent to 1998 U.S. standard). The green line shows total emission per mile for the most likely case scenario. The blue line illustrates the total emission per mile assuming that no Mexican trucks use the corridor. Note that because the differences in total emissions are small, the lines overlap considerably. The total emissions are calculated using temporal changes in average truck emission rates, and the modeled changes in traffic activity along the corridor.

CHAPTER 4 – CONCLUSIONS

This project addresses the potential air quality impact of changes in long-haul truck activity along the I-35 corridor between Laredo and San Antonio. The Laredo–San Antonio corridor is an area of air quality concern in Texas for a number of reasons:

- Laredo is the busiest POE for truck crossings along the southern border, and most of the freight imported and exported through this POE is transported by truck along the I-35 corridor between Laredo and San Antonio.
- San Antonio already has underlying air quality concerns driven by traffic in and around the city. A number of counties adjacent to the corridor are near non-attainment for 8 hour ozone: Bexar, Bastrop, Caldwell, Comal, Guadalupe, Hays, Travis, Williamson, and Wilson. Increases or changes in truck activity along the corridor may lead to additional emissions.
- The Laredo–San Antonio corridor runs through the Eagle Ford Shale, a major oil and gas field. These oil and gas activities cause additional air quality concerns as a result of emissions from drilling activities and trucks that service the oil field.

Changes in long-haul truck activity along the corridor are anticipated as a result of a new federal law that allows Mexican-domiciled trucks to engage in long-haul operations across the border. Historically, goods have crossed the southern border using drayage trucks that are limited to operating within a small commercial zone adjacent to the border. The new NAFTA driven rule will allow Mexican-domiciled trucks to engage in long-haul operations that will allow goods to be transported directly from the interior of the Mexico to a final destination in the United States, and vice versa. This has led to concerns that emissions from Mexican trucks will impact the air quality along the corridor.

To address the project goals, researchers conducted a broad review of literature on Mexico-U.S. cross-border trucking, truck emissions, the strategic importance of the I-35 corridor, and the factors that may influence Mexican truck companies to engage in cross-border operations. The main findings are as follows:

• The implementation of the recent NAFTA cross-border rule has a long and turbulent history driven by safety, environmental, and political factors. Additionally, there are a broad range of factors that are likely to influence Mexican truck companies to take part in long-haul cross-border trucking. These include the cost of applying for operating licenses (and maintaining records), the need to establishing business connections that allow backhaul of freight into Mexico, the adoption of new operating procedures (longer trips, language issues, different hours of service laws for U.S. and Mexico drivers), and the fact that an established drayage system already allows cross-border trucking. This interaction

of these factors makes it difficult to predict with any certainty the effect that the new rule will have on the Laredo–San Antonio corridor.

- Only a few truck companies took part in a pilot project that immediately preceded the new NAFTA rule. Border crossings of Mexican-domiciled long-haul trucks at the Laredo POE were less than 1 truck per day (estimated to be less than 0.05 percent of the total number of combination trucks on the corridor).
- Although the new NAFTA rules only allow Mexican trucks of 1998 model year or newer, there are likely to be significant differences in the emission rates of Mexican and U.S. long-haul trucks. This is primarily driven by different truck emission standards between the two countries and the limited availability of ULSD fuel in Mexico.

In the second phase of this research, researchers developed a framework for assessing the impacts of Mexican trucks on the corridor between 1995 and 2025. This quantitative framework was based around the following information:

- Anticipated changes in the emission rates of Mexican trucks: A detailed review of SEMARNAT activities highlighted the Mexican government's plans to implement new emission standards for long-haul trucks by 2018 that are equivalent to U.S. standards. These standards are expected to be implemented as a result of increased availability of ULSD fuel, driven by recent reforms in Mexico's energy laws.
- The proportion of Mexican trucks likely to use the corridor: This information was obtained by asking a sample of truck companies and organizations whether they intended to take advantage of the new cross-border rules and information from the second pilot program. Both information sources suggest that Mexican companies' interests in long-haul operations are low.
- The age distribution of Mexican trucks that might use the corridor for cross-border activities: A detailed review of the 2012–2014 pilot project resulted in the ages (and other details) of nearly 50 trucks licensed through the program.
- **Current and future truck traffic volumes along the corridor:** TxDOT's STARS II was used to estimate current and future long-haul truck traffic on the corridor.

Researchers based the quantitative impact assessment around two scenarios for the emissions of Mexican trucks: a worst case emissions scenario and a most likely case emissions scenario. In the worst case scenario, researchers assumed that the emission rates of all Mexican trucks on the corridor would be equivalent to a 1998 standard U.S. truck for the duration of the scenario timeline (2015–2025). The most likely case scenario was developed to account for planned changes in Mexican truck emission standards.

Although interviews suggested that Mexican companies have very little interest in long-haul cross-border trucking, the long-term effects of the new rule on Mexican truck activity are

uncertain. To account for this uncertainty, and because the new NAFTA rule is a principal focus of this study, researchers explored the emission impacts that might occur assuming different proportions (1 percent, 5 percent, and 20 percent) of Mexican trucks using the corridor and displacing U.S. trucks.

SUMMARY

All scenarios resulted in an emission impact caused by Mexican trucks displacing U.S. trucks on the corridor. This impact is driven by higher emission rates of an average Mexican long-haul trucks compared to an average U.S. long-haul truck (Figure 17). However, over a 10-year time frame, the emission rates of both U.S. and Mexican trucks are expected to decrease.

The reduction in Mexican truck emission rates estimated using the most likely case scenario is caused by the Mexican government's plans to introduce new truck emission standards in 2018. After this occurs, the emission rates of Mexican trucks are expected to gradually converge to those of U.S. trucks. The speed of convergence is dependent on the age distribution of both the U.S. and Mexican fleet. The convergence will occur relatively quickly if Mexican truck companies use newer model trucks for cross-border long-haul. Cost, efficiency, and maintenance issues are likely to naturally drive Mexican truck companies to use newer trucks for long-haul operations. The pilot program also suggests that Mexican trucks engaging in long haul are relatively young (compared to the U.S. long-haul fleet).

In the most likely case emission scenarios, total (per mile) emissions along the corridor are expected to decrease through time. This occurs even with forecasted increases in total truck volumes. These long-term emissions reductions are primarily caused by a decrease in the average emissions from the U.S. fleet, which occurs as older trucks are replaced with newer, lower emitting trucks. Under the assumptions of the most likely case scenario, average Mexican truck emissions also decrease after 2018. As such, over the long term, even a 20 percent corridor share by Mexican trucks, will lead to a long-term reduction in total emission rates along the corridor. In other words, the primary emission impacts of Mexican trucks are unlikely to be large enough to offset the long-term emissions reductions that occur from a reduction in average emissions of trucks from both fleets.

The largest unknown factor in this case study is the long-term trends in truck activity especially the proportion of Mexican trucks that will use the corridor over the next 10 years. The pilot study and the qualitative interviews both suggest that the number of Mexican trucks on the corridor will be small. In the pilot program, Mexican trucks comprised less than 0.05 percent of all combination trucks on the corridor. However, to be cost effective, cross-border long haul will require significant restructuring of current business practices, and this is likely to take some time. If and when this occurs, the number of Mexican-domiciled trucks on the corridor could increase dramatically. The most likely case scenario results suggest that corridor emissions will be resilient to even large increases in Mexican truck activity, especially if these volumes occur after

2018 (i.e., after Mexican emission standards are implemented). If the corridor share by Mexican trucks remains below approximately 20 percent, total corridor emissions are unlikely to increase from 2015–2018. It is unlikely that the trucking industry will restructure significantly within this time.

The worst case scenario does not account for planned changes in Mexican truck emission standards. To some extent it represents a naïve view of the impacts of Mexican trucks on the corridor - i.e., one that might be formed without the information provided by the qualitative review and quantitative impact assessment. It also emphasizes the importance of planned changes in Mexican truck emission standards for this corridor.

FUTURE WORK

The results of this study suggest that the emissions impact of Mexican domiciled long haul trucks on the San Antonio-Laredo corridor are likely to be small. However, over the long term it is difficult to forecast the long term volume and composition of Mexican and US trucks on the corridor. The new regulations essentially provide additional options for haulage companies involved in cross border trucking: continue using the drayage system, or adapt to take advantage of the new long haul regulations. To keep the quantitative analyses tractable, rather than explicitly modelling how corridor share by Mexican trucks will change over time, simple scenarios were used to represent possible corridor share (i.e., assumptions of 1%, 5%, and 20%). The following areas for future research are suggested:

Ongoing monitoring of long-haul truck volume, composition and emissions along the corridor: The unpredictability of future truck volumes and composition could be alleviated through a follow up study or ongoing monitoring of the corridor. A monitoring/follow up project could use combination truck volumes from TxDOTs STARS II database, coupled with more detailed observations of Mexican truck activities at border crossings. The Onroad Heavy Duty Measurement System (OHMS) could also be used to unobtrusively measure emissions from all trucks on the corridor. OHMS is a semi-portable, drive through emissions testing facility that can be used to rapidly measure combination truck emissions. The system allows emissions to be measured from large samples of trucks, with minimal inconvenience to drivers. This inconvenience may be important considering the sensitive nature of the law changes to both US and Mexican stakeholders.

The impacts of Mexican long-haul trucks on border drayage: In the problem formulation section we suggested that new cross border trucking rules may result in a positive emission impact if newer, cleaner long-haul trucks replacing older drayage trucks operating at the border. The extent of this impact will be related to the number of long-haul crossings, but also to factors such as differences in drive cycles caused by different border crossing procedures, and because it a single long-haul truck load may not exactly replace a single drayage load. More specific research into the fine scale haulage activities at the border and within the commercial zones
would also develop insights into the restructuring of the cross border truck industry, and therefore long term trends in border crossing, and corridor share.

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APPENDIX – TRUCKS REGISTERED DURING SECOND PILOT PROGRAM

Company	Туре	Make	Year	VIN	GVWR
Fletes Morales	TT	FRHT	2002	3AKJAHCG62DJ90317	80,000
	TT	FRHT	2002	3AKJAHCG62DJ90317	80,000
GCC Transporte	TT	KW	2004	3WKAD40X55F618468	59,129
	TT	INTL	2007	3HSCEAHR07N513202	52,000
	TT	INTL	2008	3HSCEAHR18N670223	52,000
	TT	INTL	2006	3HSCEAHR47N513204	52,000
	TT	INTL	2008	3HSCEAHR68N670220	52,000
	TT	INTL	2008	3HSCEAHR88N670221	52,000
	TT	INTL	2008	3HSCEAHRX8N670222	52,000
	TT	INTL	2007	3HSCEAHR27N513203	52,000
Grupo Behr	TT	PTRB	1998	1XP5DR9X2WN444103	80,000
	TT	STRG	2003	2FWJA3AS13AK38886	80,000
Higienicos y Desechables	TT	INTL	2008	3HSCNAPT08N673594	80,000
Servicio de Transporte Local y	TT	INTL	2011	1HSHXSHR4BJ432897	52,000
	TT	INTL	2011	1HSHXSHR0BJ432895	52,000
	TT	INTL	2011	1HSHXSHR1BJ432887	52,000
	TT	INTL	2011	1HSHXSHR2BJ432896	52,000
	TT	INTL	2011	1HSHXSHR3BJ432888	52,000
	TT	INTL	2011	1HSHXSHR3BJ432891	52,000
	TT	INTL	2011	1HSHXSHR5BJ432889	52,000
	TT	INTL	2011	1HSHXSHR5BJ432892	52,000
	TT	INTL	2011	1HSHXSHR7BJ432893	52,000
	TT	INTL	2011	1HSHXSHR8BJ432885	52,000
	TT	INTL	2011	1HSHXSHR9BJ432894	52,000
	TT	INTL	2011	1HSHXSHRXBJ432886	52,000
	TT	FRHT	2008	3AKJA6CK18DAB6283	52,000
	TT	FRHT	2008	3AKJA6CK38DAB6284	52.000
	TT	FRHT	2008	3AKJA6CK58DAB6285	52,000
	TT	FRHT	2008	3AKJA6CK78DAB6286	52,000
	TT	FRHT	2008	3AKJA6CK88DAB6281	52,000
	TT	FRHT	2008	3AKJA6CK98DAB6287	52.000
	TT	FRHT	2008	3AKJA6CKX8DAB6282	52.000
	TT	INTL	2011	1HSHXSHR1BJA32890	52.000
Servicios Refrigerados Internac	TT	KW	2008	3WKAD40X88F810746	80.000
Transportation and Cargo Soluti	TT	KW	2013	3WKAD49X0DF845021	52.246
	TT	KW	2013	3WKAD49X9DF845020	52.246
	TT	KW	2013	3WKAD49X2DF845019	52.241
	TT	KW	2013	3WKAD49X7DF845016	52.000
	TT	KW	2013	3WKAD49X9DF845017	52,000
	TT	KW	2013	3WKAD49X0DF845018	52.000
	TT	INTL	2013	3HSDJAPR9DN358453	46,000
Transportes del Valle de Guad	TT	KW	2003	3WKADR0X83F609323	80.000
	TT	KW	2003	3WKADR0X83F609323	58,400
Transportes Monteblanco	TT	INTL	2011	3HSCWAPT3BN371432	57,750
	TT	INTL	2011	3HSCWAPT7BN371434	52,000
Transportes Olympic	TT	FRHT	2005	1FUJA6CG15DP00731	52.000
	TT	FRHT	2007	1FUJA6CG47LX84133	52,000

Table 16 – Summary of Mexican Trucks with Cross-Border Operating Authority (15).