Texas A&M Transportation Institute

Oil and Gas Energy Developments and Changes in Crash Trends in Texas

Final report

PRC 15-35 F

TRANSPORTATION
Policy Research CENTER

Oil and Gas Energy Developments and Changes in Crash Trends in Texas

Texas A&M Transportation Institute

PRC 15-35 F

October 2015

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Executive Summary

In fall 2014, the Texas Legislature asked the Texas A&M Transportation Institute (TTI) to update a study completed in late 2011 documenting locations and trends of oil and gas energy developments in the state. As part of the study, the Texas Legislature asked TTI to correlate oil and gas developments with changes in pavement condition data. TTI summarized the results of this analysis in a report published in March 2015.

To complement the study, the Texas Legislature asked TTI to gather and process crash data at a level of spatial and temporal detail needed to document locations and trends of crashes in relation to oil and gas energy developments in the state. Location and attribute data about crashes and injuries (i.e., number of people who are injured in crashes) that the research team compiled included the following types of crashes:

- All crashes.
- Rural crashes (i.e., crashes that occur outside city limits).
- Crashes in which commercial motor vehicles (CMVs) are involved.
- Rural CMV crashes.
- Crashes on state highways.
- Crashes on rural state highways.
- CMV crashes on state highways.
- CMV crashes on rural state highways.

With this information, the research team examined changes in the number of crashes and the number of injuries from 2006–2009 to 2010–2013. These date ranges were used for consistency with those in the original March 2015 report. The year 2009 was significant because this was when accelerated oil production started in the Eagle Ford Shale region and oil production in the Permian Basin region began to accelerate, making the end of 2009 suitable for use as a baseline for comparison purposes. The last year with reliable Railroad Commission data was 2013 (2014 data were still preliminary). In addition, the economic recession of 2008 caused significant volatility in the oil markets, which resulted in dramatic swings in prices, drilling, and production. In order to reduce the impact of these variations, the research team aggregated and compared data using two four-year blocks: 2006–2009 and 2010–2013.

The total number of crashes decreased by 10 percent in the Barnett Shale region, increased by 1 percent in the Eagle Ford Shale region, and decreased by 4 percent in the Permian Basin region. As a reference, the number of crashes decreased by 7 percent in all other 175 counties in the state. However, these changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. In general:

- Changes were more prominent for rural crashes. In the Barnett Shale region, the number of rural crashes decreased by 25 percent (compared to a 10 percent decrease overall in the region). In the Eagle Ford Shale region, the number of rural crashes increased by 4 percent (compared to a 1 percent increase overall in the region). In the Permian Basin region, the number of crashes increased by 11 percent (compared to a 4 percent decrease overall in the region).

- Changes were even more prominent for crashes that involved CMVs and, in particular, for rural crashes that involved CMVs. For rural crashes that involved CMVs, there was a 34 percent decrease in the Barnett Shale region, a 61 percent increase in the Eagle Ford Shale region, and a 52 percent increase in the Permian Basin region. By comparison, there was a 9 percent decrease in all other 175 counties in the state.

- For rural CMV crashes, changes in the relative number of crashes were larger as the severity of the injuries worsened. For example, in the Eagle Ford Shale region, there was a 77 percent increase in the number of fatal, incapacitating, and non-incapacitating injury crashes (compared to a 61 percent increase for all rural CMV crashes). For fatal crashes, the increase was 76 percent. In the Permian Basin region, there was a 57 percent increase in the number of fatal, incapacitating, and non-incapacitating injury crashes (compared to a 52 percent increase for all rural CMV crashes). For fatal crashes, the increase was 88 percent. The exception to this trend was the Barnett Shale region, where there was a 26 percent decrease in the number of fatal, incapacitating, and non-incapacitating injury crashes (compared to a 34 percent decrease for all crashes). For fatal crashes, the decrease was 37 percent.

- Relative changes in the number of crashes on state highways were similar to those found for all highways. The changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. Overall, the percentage of crashes occurring on state highways increased. For all crashes, the increase was from 54 to 56 percent. For fatal, incapacitating, and non-incapacitating injury crashes, the increase was from 59 to 61 percent. For fatal crashes, the increase was from 74 to 76 percent. These percentages were higher for rural roads. For example, for rural CMV crashes, the percentage of crashes on state highways decreased slightly from 78 to 77 percent. For fatal, incapacitating, and non-incapacitating injury crashes, this percentage increased from 90 to 91 percent. For fatal crashes, it decreased slightly but stayed around 96 percent.

The research team calculated crash rates expressed both as the number of crashes per 100 million vehicle miles traveled (VMT) and number of crashes per 100 lane-miles. The results were similar with both approaches, although rates expressed as the number of crashes per 100 lane-miles were more stable particularly for roadway segments with low traffic volumes. In total, the crash rate decreased by 4 percent in the Barnett Shale region, increased by 7 percent in the Eagle Ford Shale region, and increased by 11 percent in the Permian Basin region. These changes were not uniform either by crash location and type of vehicles involved or by injury severity.

There were also significant differences geographically within each region. The changes were more prominent for rural crashes. The changes were even more prominent for crashes that involved CMVs and, in particular, for rural crashes that involved CMVs. In most cases, as the severity of the injuries worsened, the changes in the corresponding crash rate were more evident.

The research team established correlations by comparing pairs of metrics representing historical data aggregated at the county level (Table 1). In the Barnett Shale region, there was a strong correlation between the number of new horizontal wells and the number of crashes (regardless of location or type of vehicles involved). In the Eagle Ford Shale region, there was a strong correlation between the number of new horizontal wells and the number of rural CMV crashes. In the Permian Basin region, there was a strong correlation between the number of new vertical wells and the number of rural CMV crashes. It is worth noting that In the Permian Basin, although the relative change in the number of horizontal wells was considerably higher than for vertical wells, in absolute terms the number of new vertical wells was much higher than the number of new horizontal wells. Judging from the trends in the Eagle Ford Shale and Barnett Shale regions, as the industry shifts from vertical drilling to horizontal drilling in the Permian Basin, the correlation between new horizontal wells and rural CMV crashes in that part of the state will likely increase.

Table 1. Pearson Correlation Coefficients.

		Number of New Horizontal Wells	Number of New Vertical Wells
Barnett Shale Region	Number of Crashes	0.56	-0.15
	Number of Rural Crashes	0.62	-0.24
	Number of CMV-Involved Crashes	0.52	-0.19
	Number of Rural CMV-Involved Crashes	0.63	-0.10
Eagle Ford Shale Region	Number of Crashes	0.12	0.16
	Number of Rural Crashes	-0.07	-0.22
	Number of CMV-Involved Crashes	0.39	0.09
	Number of Rural CMV-Involved Crashes	0.57	-0.10
Permian Basin Region	Number of Crashes	-0.08	0.07
	Number of Rural Crashes	0.03	0.33
	Number of CMV-Involved Crashes	0.06	0.29
	Number of Rural CMV-Involved Crashes	0.23	0.47
Remaining Counties	Number of Crashes	-0.04	-0.03
	Number of Rural Crashes	-0.03	0.00
	Number of CMV-Involved Crashes	-0.02	-0.02
	Number of Rural CMV-Involved Crashes	0.00	0.06

In the Barnett Shale region, there was a very strong correlation between the *change* in the number of new horizontal wells and the *change* in the number of rural CMV crashes. In the Eagle Ford Shale region, the correlation between these two variables was also very strong. In the Permian Basin region, there was a strong correlation between the change in the number of new vertical wells and that of rural CMV crashes. The research team used this information to develop linear regression models (Figure 1) for county-level data from the Eagle Ford Shale, Barnett Shale, and Permian Basin regions that could be used for forecasting purposes in situations where other factors remain reasonably stable and there is a need for high-level estimates. These models suggest a generalized trend that could be used to estimate positive (or negative) changes in the number of rural CMV crashes in Texas as a function of the positive (or negative) change in the number of new horizontal wells.

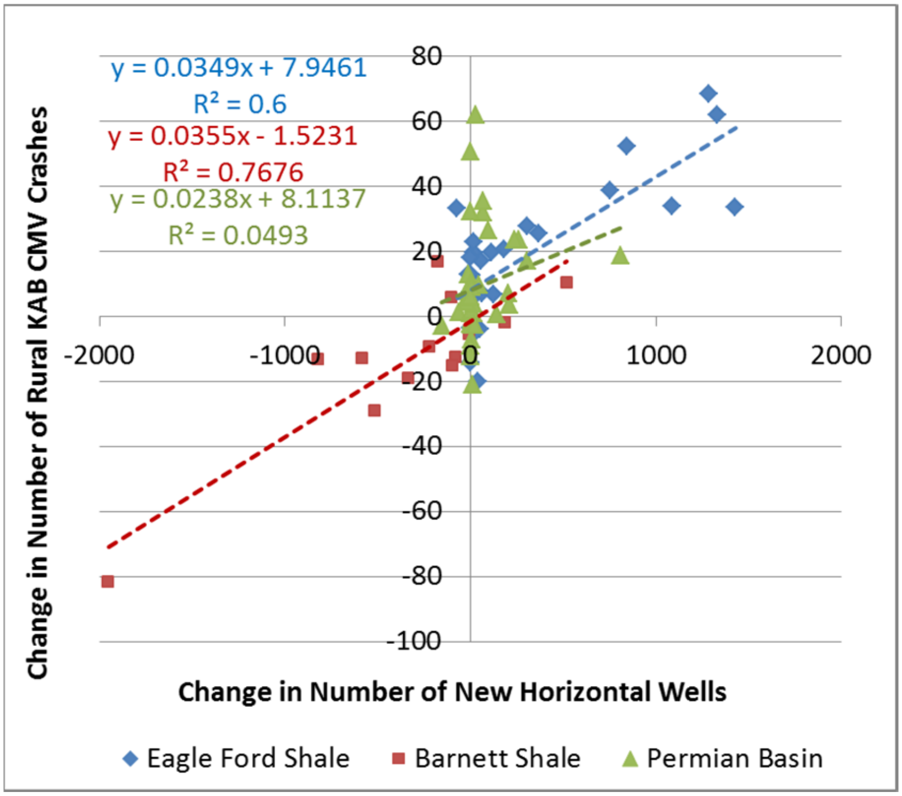


Figure 1. Change in the Number of Rural Fatal, Incapacitating, and Non-Incapacitating CMV Crashes vs. Change in the Number of Horizontal Wells.

The research team developed preliminary estimates of the change in the cost of injuries from 2006–2009 to 2010–2013 using standardized economic and comprehensive crash cost estimates from the National Safety Council (NSC) and comprehensive crash cost estimates from the U.S. Department of Transportation (DOT). Economic costs rely on calculable costs such as wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employers' uninsured costs). Comprehensive costs include economic cost components and a measure of the value of lost quality of life, which makes comprehensive costs appropriate to analyze the anticipated benefit of future improvements (because they provide a measure of what people would be willing to pay for improved safety). In general, the U.S. DOT's methodology for comprehensive cost estimates, which are based on a concept called the value of a statistical life (VSL), are considerably higher than those resulting from the NSC methodology.

Table 2 summarizes the result of the analysis. Because the correlation between new completed wells and rural CMV crashes was stronger than for other types of crashes, the research team only included the number of injuries resulting from rural CMV crashes. Further, the research team only included the number of fatal, incapacitating, non-incapacitating, and possible injuries in the cost calculation. In the Barnett Shale region, there was a 35 percent decrease (i.e., $73 million in economic costs or $425 million in comprehensive costs) in NSC-based costs and a 30 percent decrease (i.e., $763 million) in VSL-based comprehensive costs. The cost reduction was the result of fewer rural CMV crashes and, correspondingly, fewer injuries. In the Eagle Ford Shale region, there was a 52 percent increase (i.e., $139 million in economic costs or $801 million in comprehensive costs) in NSC-based costs and a 68 percent increase (i.e., $2 billion) in VSL-based comprehensive costs. In the Permian Basin region, there was a 103 percent increase (i.e., $176 million in economic costs or $1.03 billion in comprehensive costs) in NSC-based costs and a 97 percent increase (i.e., $2 billion) in VSL-based comprehensive costs.

The huge increase in the cost of injuries resulting from rural CMV crashes in the Eagle Ford Shale and Permian Basin regions (covering 66 counties in total) was largely responsible for the net increase in the cost of injuries resulting from rural CMV crashes in the state from 2006–2009 to 2010–2013. As Table 2 shows, the net increase was 9 percent overall, even though there was a 35 percent reduction in the Barnett Shale region (covering 13 counties) and a 3 percent reduction in 175 other counties around the state.

Table 2. Changes in Economic and Comprehensive Costs for Injuries Resulting from Rural CMV Crashes.

Cost of Rural CMV Injuries (Million)												
Region	Economic Cost (NSC)				Comprehensive Cost (NSC)				Comprehensive Cost (VSL)			
	2006-09	2010-13	Change	Diff.	2006-09	2010-13	Change	Diff.	2006-09	2010-13	Change	Diff.
Barnett Shale	$ 212	$ 138	$ (73)	-35%	$ 1,224	$ 799	$ (425)	-35%	$ 2,510	$ 1,747	$ (763)	-30%
Eagle Ford Shale	$ 269	$ 408	$ 139	52%	$ 1,548	$ 2,349	$ 801	52%	$ 2,931	$ 4,927	$1,996	68%
Permian Basin	$ 171	$ 348	$ 176	103%	$ 981	$ 2,011	$1,030	105%	$ 2,051	$ 4,045	$1,994	97%
Other	$ 1,615	$ 1,567	$ (47)	-3%	$ 9,229	$ 8,988	$ (241)	-3%	$19,796	$19,205	$ (591)	-3%
Grand Total	**$ 2,266**	**$ 2,461**	**$ 194**	**9%**	**$12,981**	**$14,146**	**$1,165**	**9%**	**$27,288**	**$29,924**	**$2,636**	**10%**

In practical terms, the research results mean the following (Figure 2):

- The number of crashes and resulting injuries increased along with oil and gas well development activities, but the changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region.
- The increases in the number of crashes and injuries were more prominent in rural areas where energy developments take place (i.e., Eagle Ford Shale and Permian Basin regions). The highest increase was in the case of rural CMV crashes. Overall, there was a strong correlation between rural CMV crashes and the number of new wells.
- The percentage of crashes on state highways increased. As the severity of the injuries increased, the percentage of crashes on state highways also increased. For rural CMV crashes, the percentage of crashes on state highways increased from 81 to 83 percent. For fatal, incapacitating, and non-incapacitating injury crashes, this percentage increased from 89 to 90 percent. For fatal crashes, it increased slightly but stayed around 95 percent.

- The cost of injuries resulting from rural CMV crashes in energy development regions increased significantly and was largely responsible for the net increase in the cost of injuries resulting from rural CMV crashes in the state from 2006–2009 to 2010–2013. In the Eagle Ford Shale region, the increase was $139 million in economic costs or $801 million–$2 billion in comprehensive costs. In the Permian Basin region, the increase was $176 million in economic costs or $1.03–2.0 billion in comprehensive costs. These costs are of the same order of magnitude as the impact of energy developments on the transportation infrastructure (estimated at $1 billion per year on state highways and an additional $1 billion on county and local roads).

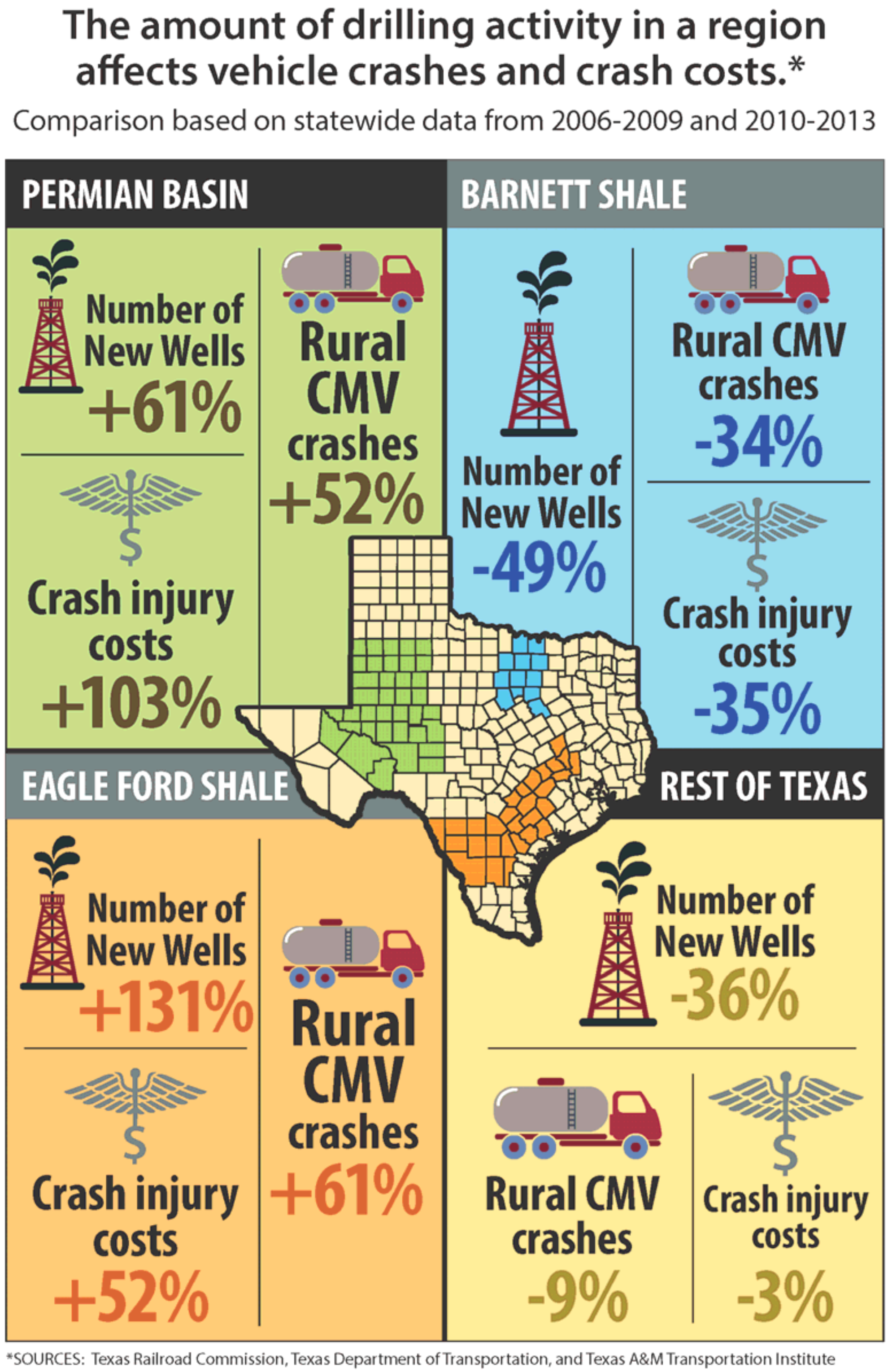


Figure 2. Overall Trends in Well Development, Rural CMV Crashes, and Crash Injury Costs from 2006–2009 to 2010–2013.

Chapter 1. Crash Data Collection and Processing

Introduction

In fall 2014, the Texas Legislature asked TTI to update a study completed in late 2011 documenting locations and trends of oil and gas energy developments in the state (*1*). As part of the study, the Texas Legislature asked TTI to correlate oil and gas developments with changes in pavement condition data. TTI summarized the results of this analysis in a report published in March 2015 (*2*).

To complement the study, the Texas Legislature asked TTI to gather and process crash data at a level of spatial and temporal detail needed to document locations and trends of crashes in relation to oil and gas energy developments in the state. The research team completed the following activities to document trends and changes in crash rates and to correlate this information with changes in oil and gas drilling developments:

- Request and process crash data from the Texas Department of Transportation (TxDOT).
- Analyze and correlate trends with oil and gas drilling developments.
- Prepare deliverables.

Figure 3 shows the location of counties associated with the Barnett Shale region (13 counties), Eagle Ford Shale region (29 counties), and Permian Basin region (37 counties) that were used in the March 2015 report to document changes in oil and gas well developments in the state. Of specific interest was to examine changes with respect to a pre-determined baseline. The research team used the end of 2009 for baseline and comparison purposes because this was when well drilling and oil production in the Eagle Ford Shale region began in earnest and when oil production in the Permian Basin began to accelerate. The last year in which the research team received reliable data from the Railroad Commission was 2013 (2014 data are still preliminary). In addition, the economic recession of 2008 caused significant volatility in the oil markets, which resulted in dramatic swings in prices, drilling, and production. In order to reduce the impact of these variations, the research team aggregated and compared data using two four-year blocks: 2006–2009 and 2010–2013.

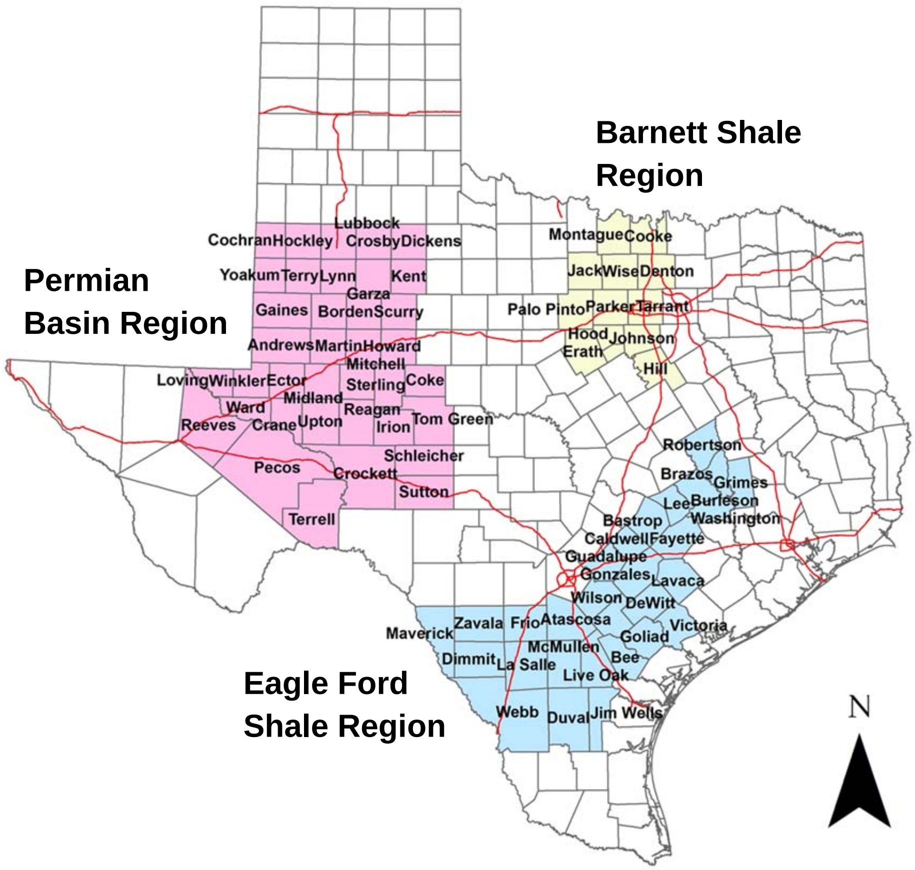


Figure 3. Counties Analyzed in the Eagle Ford Shale, Permian Basin, and Barnett Shale Regions.

Crash Data

The research team gathered and processed data from TxDOT's Crash Record Information System (CRIS) at a level of spatial and temporal detail needed to document locations and trends of crashes in relation to oil and gas energy developments in the state. Available data from CRIS covered the 2010–2014 period. The research team complemented this information with historical crash data from 2003–2009 that TTI had received from TxDOT before the introduction of CRIS.

Consistent with protocols between TTI and TxDOT for the release of historical crash data, the research team worked through a designated official at the TTI Traffic Safety Center to download and furnish relevant crash data. The focus was on crash locations and basic crash attribute data such as severity, number and type of vehicles involved, manner of collision, contributing factors, and type of roadway. The crash data available to the research team included generic information about the vehicles involved in crashes (such as vehicle type and vehicle body type), but not specific vehicle identifiable information. The data included information about the number of people injured in crashes (and the corresponding injury level, e.g., fatal, incapacitating injury, non-incapacitating injury, possible injury, no injury, or unknown), but did not include identifiable information about those people.

Beginning with 2008, crash data records were sufficiently complete to conduct the analysis. Prior to 2008, there were gaps in certain data categories. Specifically, rural crashes, CMV crashes, and injuries (i.e., the number of people who were injured in crashes). The gaps were not uniform. For example, the number of rural crashes in CRIS was practically nonexistent from 2003–2005, but appeared to be reasonable for subsequent years. Likewise, the number of fatal CMV crashes in CRIS for 2006 and 2007 appeared to be reasonable, but the number of CMV crashes for other injury types during the same two years appeared to be much lower than what the historical trend would suggest (based on data from subsequent years). The number of CMV crashes in CRIS from 2003–2005 was also practically nonexistent.

Because it was of interest to compare crash data for two four-year blocks (2006–2009 and 2010–2013) to enable a comparison with oil and gas well developments during the same periods, it was necessary to estimate missing CMV crash and injury data for 2006 and 2007. Fortunately, the CRIS data contained reliable information about vehicles that were involved in crashes. This record appeared reasonably complete for all the years of interest. Based on this information, the process to estimate missing CMV crash and injury data was as follows:

- Determine the number of trucks (i.e., the number of CMVs) that were involved in crashes in 2008. The research team classified the following vehicle types as trucks: truck and trailer, semi-trailer, mobile home, other truck combinations, farm tractor, road machinery, and other machinery.
- Determine the ratio of number of crashes in 2008 to the number of CMVs in 2008. For accuracy, the research team determined a separate ratio for crashes according to severity (i.e., fatal, incapacitating injury, non-incapacitating injury, possible injury, no injury, or unknown) and according to region (i.e., Barnett Shale, Eagle Ford, Permian Basin, and other).
- Estimate the number of CMV crashes in 2006 and 2007 by dividing the number of crashes in 2006 and 2007 by the corresponding ratio of number of crashes in 2008 to the number of CMVs in 2008. This process resulted in four estimated sets of CMV crashes for 2006 and 2007.
- Determine the ratio of number of injuries in CMV-related crashes in 2008 to the number of CMVs in 2008. For accuracy, the research team determined a separate ratio for injuries according to severity (i.e., fatal, incapacitating injury, non-incapacitating injury, possible injury, no injury, or unknown) and according to region (i.e., Barnett Shale, Eagle Ford, Permian Basin, and other).

- Estimate the number of injuries in 2006 and 2007 by dividing the number of injuries in 2006 and 2007 by the corresponding ratio of number of injuries in 2008 to the number of CMVs in 2008. This process resulted in four estimated sets of injuries for 2006 and 2007.

Table 3 through Table 18 summarize the result of the crash data compilation, as follows:

- Number of crashes:
    - Table 3: Number of crashes.
    - Table 4: Number of rural crashes.
    - Table 5: Number of CMV crashes.
    - Table 6: Number of rural CMV crashes.
    - Table 7: Number of crashes on state highways.
    - Table 8: Number of crashes on rural state highways.
    - Table 9: Number of CMV crashes on state highways.
    - Table 10: Number of CMV crashes on rural state highways.
- Number of injuries:
    - Table 11: Number of injuries.
    - Table 12: Number of injuries in rural crashes.
    - Table 13: Number of injuries in CMV crashes.
    - Table 14: Number of injuries in rural CMV crashes.
    - Table 15: Number of injuries in crashes on state highways.
    - Table 16: Number of injuries in crashes on rural state highways.
    - Table 17: Number of injuries in CMV crashes on state highways.
    - Table 18: Number of injuries in CMV crashes on rural state highways.

In these tables, a rural crash is a crash that occurs on a roadway outside city limits. An on-system crash is a crash that occurs on a state highway. A rural on-system crash is a crash that occurs on a state highway outside city limits. Years marked with a '*' (i.e., 2006 and 2007) correspond to CMV crashes or injuries that were estimated following the procedure described above.

Table 3. Number of Crashes.

Number of Crashes - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	3,118	13,596	50,480	108,914	243,094	17,985	**437,187**	**1,762,497**
2007	3,101	13,250	51,178	107,870	263,334	19,252	**457,985**	
2008	3,126	12,562	49,652	97,538	257,155	18,962	**438,995**	
2009	2,821	11,466	47,425	95,798	251,891	18,929	**428,330**	
2010	2,781	11,813	48,394	81,658	234,050	12,880	**391,576**	**1,637,478**
2011	2,803	11,753	46,570	81,321	228,491	12,706	**383,644**	
2012	3,037	12,870	50,836	88,583	247,674	14,014	**417,014**	
2013	3,054	13,436	52,205	88,799	272,579	15,171	**445,244**	

Number of Crashes - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	224	732	2,678	4,098	12,642	707	**21,081**	**85,964**
2007	211	690	2,770	4,118	13,533	778	**22,100**	
2008	218	695	2,754	3,788	13,660	832	**21,947**	
2009	198	686	2,526	3,698	13,044	684	**20,836**	
2010	188	693	2,595	3,432	12,737	538	**20,183**	**86,744**
2011	204	741	2,826	3,756	13,051	579	**21,157**	
2012	274	804	2,866	4,089	13,820	619	**22,472**	
2013	236	840	2,997	4,031	14,201	627	**22,932**	

Number of Crashes - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	311	1,738	6,003	11,126	24,324	1,879	**45,381**	**184,735**
2007	320	1,769	6,429	10,935	27,132	2,067	**48,652**	
2008	294	1,667	5,891	9,821	26,063	2,090	**45,826**	
2009	277	1,500	5,540	9,515	25,954	2,090	**44,876**	
2010	251	1,598	5,705	8,309	23,128	1,359	**40,350**	**166,474**
2011	257	1,552	5,471	8,166	22,351	1,312	**39,109**	
2012	263	1,658	5,923	8,534	24,185	1,241	**41,804**	
2013	259	1,650	6,141	8,742	26,967	1,452	**45,211**	

Number of Crashes - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	171	499	2,144	4,166	11,710	836	**19,526**	**80,891**
2007	152	532	2,326	4,185	12,945	725	**20,865**	
2008	174	476	2,292	4,161	12,149	1,059	**20,311**	
2009	151	410	2,193	4,036	12,198	1,201	**20,189**	
2010	167	410	2,090	3,478	11,099	443	**17,687**	**77,511**
2011	169	478	2,238	3,662	10,821	651	**18,019**	
2012	205	525	2,408	4,066	12,198	889	**20,291**	
2013	248	602	2,479	4,204	13,059	922	**21,514**	

Number of Crashes - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	2,412	10,627	39,655	89,524	194,418	14,563	**351,199**	**1,410,907**
2007	2,418	10,259	39,653	88,632	209,724	15,682	**366,368**	
2008	2,440	9,724	38,715	79,768	205,283	14,981	**350,911**	
2009	2,195	8,870	37,166	78,549	200,695	14,954	**342,429**	
2010	2,175	9,112	38,004	66,439	187,086	10,540	**313,356**	**1,306,749**
2011	2,173	8,982	36,035	65,737	182,268	10,164	**305,359**	
2012	2,295	9,883	39,639	71,894	197,471	11,265	**332,447**	
2013	2,311	10,344	40,588	71,822	218,352	12,170	**355,587**	

Table 4. Number of Rural Crashes.

Number of Rural Crashes - Statewide								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	1,642	4,798	12,831	15,938	51,326	2,744	**89,279**	**356,636**
2007	1,610	4,529	12,773	16,079	55,654	2,968	**93,613**	
2008	1,542	4,212	12,654	14,658	52,876	3,192	**89,134**	
2009	1,397	3,887	11,497	13,782	51,124	2,923	**84,610**	
2010	1,358	3,895	11,878	12,273	51,719	2,263	**83,386**	**349,182**
2011	1,390	3,978	11,242	12,430	50,202	1,936	**81,178**	
2012	1,543	4,188	11,863	13,850	54,614	2,209	**88,267**	
2013	1,539	4,661	12,225	14,034	61,377	2,515	**96,351**	

Number of Rural Crashes - Eagle Ford Shale Region								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	162	447	1,230	1,058	4,084	208	**7,189**	**27,660**
2007	165	392	1,228	1,068	4,308	212	**7,373**	
2008	161	378	1,173	918	4,003	250	**6,883**	
2009	141	383	1,029	936	3,549	177	**6,215**	
2010	138	363	964	885	3,752	158	**6,260**	**28,804**
2011	162	423	1,105	946	3,854	151	**6,641**	
2012	217	477	1,176	1,182	4,575	187	**7,814**	
2013	177	530	1,216	1,170	4,814	182	**8,089**	

Number of Rural Crashes - Barnett Shale Region								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	119	405	880	877	3,622	181	**6,084**	**24,572**
2007	118	383	883	898	4,326	214	**6,822**	
2008	126	378	924	867	3,928	233	**6,456**	
2009	96	292	742	658	3,247	175	**5,210**	
2010	83	243	699	565	2,925	125	**4,640**	**18,521**
2011	70	281	682	519	2,837	98	**4,487**	
2012	91	271	695	542	2,872	113	**4,584**	
2013	81	260	709	482	3,167	111	**4,810**	

Number of Rural Crashes - Permian Basin Region								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	120	226	633	577	2,202	100	**3,858**	**15,689**
2007	110	216	707	609	2,607	80	**4,329**	
2008	103	214	663	523	2,328	105	**3,936**	
2009	97	168	584	500	2,129	88	**3,566**	
2010	96	152	670	360	2,104	65	**3,447**	**17,426**
2011	115	215	657	515	2,329	49	**3,880**	
2012	139	253	780	610	2,813	65	**4,660**	
2013	168	357	922	561	3,339	92	**5,439**	

Number of Rural Crashes - Remaining Counties								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	1,241	3,720	10,088	13,426	41,418	2,255	**72,148**	**288,715**
2007	1,217	3,538	9,955	13,504	44,413	2,462	**75,089**	
2008	1,152	3,242	9,894	12,350	42,617	2,604	**71,859**	
2009	1,063	3,044	9,142	11,688	42,199	2,483	**69,619**	
2010	1,041	3,137	9,545	10,463	42,938	1,915	**69,039**	**284,431**
2011	1,043	3,059	8,798	10,450	41,182	1,638	**66,170**	
2012	1,096	3,187	9,212	11,516	44,354	1,844	**71,209**	
2013	1,113	3,514	9,378	11,821	50,057	2,130	**78,013**	

Table 5. Number of CMV Crashes.

Number of CMV Crashes - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	409	976	2,927	5,553	18,624	483	**28,972**	**115,582**
2007*	440	998	3,076	5,754	21,120	443	**31,831**	
2008	432	925	3,005	5,088	20,021	304	**29,775**	
2009	301	743	2,439	4,367	16,900	254	**25,004**	
2010	393	891	2,731	4,097	16,653	133	**24,898**	**105,198**
2011	381	825	2,584	3,883	16,451	144	**24,268**	
2012	462	922	2,831	4,207	17,972	163	**26,557**	
2013	456	1,073	3,063	4,279	20,402	202	**29,475**	

Number of CMV Crashes - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	33	38	209	197	1,122	40	**1,639**	**6,607**
2007*	28	43	220	228	1,322	28	**1,870**	
2008	34	73	177	213	1,236	17	**1,750**	
2009	34	46	160	169	923	16	**1,348**	
2010	27	82	202	209	1,114	7	**1,641**	**8,708**
2011	40	86	227	263	1,290	17	**1,923**	
2012	73	105	275	320	1,670	17	**2,460**	
2013	64	127	333	368	1,778	14	**2,684**	

Number of CMV Crashes - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	38	132	343	596	2,149	66	**3,323**	**14,119**
2007*	55	127	408	621	2,732	47	**3,989**	
2008	49	145	387	559	2,675	47	**3,862**	
2009	39	120	282	429	2,043	32	**2,945**	
2010	40	107	329	418	2,065	17	**2,976**	**12,367**
2011	31	103	285	409	2,090	13	**2,931**	
2012	33	129	301	401	2,156	15	**3,035**	
2013	31	105	352	431	2,486	20	**3,425**	

Number of CMV Crashes - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	27	39	132	149	704	19	**1,069**	**4,775**
2007*	28	52	170	202	912	8	**1,372**	
2008	23	48	165	194	849	14	**1,293**	
2009	16	34	149	140	692	10	**1,041**	
2010	26	38	156	136	846	6	**1,208**	**6,368**
2011	40	63	193	179	908	10	**1,393**	
2012	57	83	217	223	1,145	4	**1,729**	
2013	60	117	283	221	1,346	11	**2,038**	

Number of CMV Crashes - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	311	766	2,244	4,611	14,649	360	**22,941**	**90,081**
2007*	328	776	2,279	4,703	16,154	360	**24,600**	
2008	326	659	2,276	4,122	15,261	226	**22,870**	
2009	212	543	1,848	3,629	13,242	196	**19,670**	
2010	300	664	2,044	3,334	12,628	103	**19,073**	**77,755**
2011	270	573	1,879	3,032	12,163	104	**18,021**	
2012	299	605	2,038	3,263	13,001	127	**19,333**	
2013	301	724	2,095	3,259	14,792	157	**21,328**	

Table 6. Number of Rural CMV Crashes.

Number of Rural CMV Crashes - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	250	415	1,069	1,130	5,437	85	**8,387**	**34,635**
2007*	263	420	1,226	1,349	6,380	109	**9,747**	
2008	262	421	1,189	1,233	6,020	50	**9,175**	
2009	171	305	927	1,021	4,865	37	**7,326**	
2010	223	412	1,032	937	5,014	22	**7,640**	**34,288**
2011	235	396	1,032	944	5,257	31	**7,895**	
2012	300	443	1,106	1,096	5,756	23	**8,724**	
2013	319	558	1,313	1,179	6,636	24	**10,029**	

Number of Rural CMV Crashes - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	27	22	115	77	423	16	**679**	**2,820**
2007*	24	26	123	103	528	12	**816**	
2008	25	54	106	71	482	2	**740**	
2009	26	29	85	77	368	-	**585**	
2010	22	55	114	87	439	2	**719**	**4,542**
2011	37	64	163	111	578	6	**959**	
2012	64	85	186	173	823	7	**1,338**	
2013	56	95	232	217	921	5	**1,526**	

Number of Rural CMV Crashes - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	24	51	87	85	490	5	**742**	**3,130**
2007*	24	41	109	102	638	11	**925**	
2008	35	57	108	103	650	3	**956**	
2009	17	27	61	54	347	1	**507**	
2010	18	28	73	38	324	-	**481**	**2,061**
2011	11	34	66	41	352	2	**506**	
2012	14	37	63	38	364	-	**516**	
2013	20	22	88	47	380	1	**558**	

Number of Rural CMV Crashes - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	21	24	103	74	348	6	**576**	**2,464**
2007*	25	31	125	89	451	1	**722**	
2008	20	31	101	83	426	3	**664**	
2009	14	27	94	51	314	2	**502**	
2010	21	25	98	56	408	1	**609**	**3,743**
2011	33	48	135	94	513	1	**824**	
2012	45	62	154	118	663	1	**1,043**	
2013	52	96	202	106	809	2	**1,267**	

Number of Rural CMV Crashes - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	178	319	764	895	4,177	58	**6,390**	**26,221**
2007*	190	323	868	1,056	4,763	85	**7,284**	
2008	182	279	874	976	4,462	42	**6,815**	
2009	114	222	687	839	3,836	34	**5,732**	
2010	162	304	747	756	3,843	19	**5,831**	**23,942**
2011	154	250	668	698	3,814	22	**5,606**	
2012	177	259	703	767	3,906	15	**5,827**	
2013	191	345	791	809	4,526	16	**6,678**	

Table 7. Number of Crashes on State Highways.

Number of On-System Crashes - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	2,277	8,112	27,954	56,602	128,073	4,371	**227,389**	**921,379**
2007	2,285	7,828	28,554	56,382	139,734	4,686	**239,469**	
2008	2,267	7,491	27,257	51,376	135,906	4,192	**228,489**	
2009	2,037	6,921	26,496	51,213	135,191	4,174	**226,032**	
2010	2,068	7,396	28,007	45,509	129,438	2,864	**215,282**	**897,671**
2011	2,077	7,306	26,960	45,062	125,877	2,740	**210,022**	
2012	2,244	7,972	29,020	49,141	136,608	3,060	**228,045**	
2013	2,303	8,485	30,096	48,968	151,109	3,361	**244,322**	

Number of On-System Crashes - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	196	559	1,859	2,643	7,914	222	**13,393**	**54,020**
2007	182	520	1,860	2,623	8,313	232	**13,730**	
2008	179	523	1,842	2,428	8,459	234	**13,665**	
2009	165	511	1,726	2,537	8,125	168	**13,232**	
2010	160	529	1,792	2,315	8,245	138	**13,179**	**58,201**
2011	184	595	1,980	2,547	8,563	160	**14,029**	
2012	241	646	2,025	2,818	9,286	169	**15,185**	
2013	207	678	2,171	2,767	9,809	176	**15,808**	

Number of On-System Crashes - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	232	1,060	3,435	6,158	13,562	445	**24,892**	**101,789**
2007	243	1,033	3,711	6,055	15,206	493	**26,741**	
2008	214	1,026	3,352	5,503	14,565	467	**25,127**	
2009	198	917	3,215	5,467	14,797	435	**25,029**	
2010	190	964	3,442	5,002	13,844	277	**23,719**	**97,528**
2011	196	980	3,311	4,822	13,364	241	**22,914**	
2012	190	1,025	3,520	5,166	14,395	241	**24,537**	
2013	185	1,034	3,729	5,161	15,955	294	**26,358**	

Number of On-System Crashes - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	132	295	1,158	2,070	5,584	149	**9,388**	**38,703**
2007	109	315	1,299	2,075	6,410	106	**10,314**	
2008	121	299	1,241	2,027	5,684	172	**9,544**	
2009	120	254	1,142	1,933	5,845	163	**9,457**	
2010	131	272	1,271	1,780	5,774	71	**9,299**	**43,040**
2011	139	344	1,350	2,030	5,973	90	**9,926**	
2012	173	362	1,474	2,326	6,822	128	**11,285**	
2013	204	449	1,630	2,400	7,699	148	**12,530**	

Number of On-System Crashes - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	1,717	6,198	21,502	45,731	101,013	3,555	**179,716**	**726,867**
2007	1,751	5,960	21,684	45,629	109,805	3,855	**188,684**	
2008	1,753	5,643	20,822	41,418	107,198	3,319	**180,153**	
2009	1,554	5,239	20,413	41,276	106,424	3,408	**178,314**	
2010	1,587	5,631	21,502	36,412	101,575	2,378	**169,085**	**698,902**
2011	1,558	5,387	20,319	35,663	97,977	2,249	**163,153**	
2012	1,640	5,939	22,001	38,831	106,105	2,522	**177,038**	
2013	1,707	6,324	22,566	38,640	117,646	2,743	**189,626**	

Table 8. Number of Crashes on Rural State Highways.

Number of Rural On-System Crashes - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	1,333	3,494	8,973	10,405	33,306	969	**58,480**	**231,933**
2007	1,327	3,321	9,058	10,593	36,406	1,086	**61,791**	
2008	1,249	3,045	8,715	9,558	33,859	1,106	**57,532**	
2009	1,125	2,754	7,956	8,873	32,467	955	**54,130**	
2010	1,098	2,873	8,200	7,857	32,360	692	**53,080**	**222,457**
2011	1,122	2,846	7,786	7,843	31,492	584	**51,673**	
2012	1,260	3,152	8,231	8,774	34,330	729	**56,476**	
2013	1,268	3,564	8,541	8,733	38,310	812	**61,228**	

Number of Rural On-System Crashes - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	145	376	1,013	859	3,228	129	**5,750**	**21,974**
2007	153	328	996	873	3,371	124	**5,845**	
2008	140	321	926	738	3,163	133	**5,421**	
2009	126	317	843	777	2,811	84	**4,958**	
2010	121	313	799	730	3,014	78	**5,055**	**23,975**
2011	150	371	938	811	3,195	85	**5,550**	
2012	196	416	1,004	997	3,793	112	**6,518**	
2013	160	474	1,044	998	4,065	111	**6,852**	

Number of Rural On-System Crashes - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	92	296	606	611	2,418	59	**4,082**	**16,179**
2007	97	273	630	597	2,850	80	**4,527**	
2008	104	283	636	579	2,551	82	**4,235**	
2009	76	194	511	451	2,061	42	**3,335**	
2010	71	171	482	376	1,935	35	**3,070**	**12,523**
2011	59	195	481	373	1,874	29	**3,011**	
2012	75	227	459	377	1,922	38	**3,098**	
2013	63	205	510	339	2,186	41	**3,344**	

Number of Rural On-System Crashes - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	98	173	523	455	1,695	36	**2,980**	**12,046**
2007	90	165	565	478	2,064	30	**3,392**	
2008	81	173	521	411	1,704	46	**2,936**	
2009	86	132	452	384	1,643	41	**2,738**	
2010	78	131	524	281	1,633	23	**2,670**	**14,114**
2011	103	190	537	404	1,871	20	**3,125**	
2012	125	220	631	501	2,302	28	**3,807**	
2013	148	311	777	473	2,756	47	**4,512**	

Number of Rural On-System Crashes - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	998	2,649	6,831	8,480	25,965	745	**45,668**	**181,734**
2007	987	2,555	6,867	8,645	28,121	852	**48,027**	
2008	924	2,268	6,632	7,830	26,441	845	**44,940**	
2009	837	2,111	6,150	7,261	25,952	788	**43,099**	
2010	828	2,258	6,395	6,470	25,778	556	**42,285**	**171,845**
2011	810	2,090	5,830	6,255	24,552	450	**39,987**	
2012	864	2,289	6,137	6,899	26,313	551	**43,053**	
2013	897	2,574	6,210	6,923	29,303	613	**46,520**	

Table 9. Number of CMV Crashes on State Highways.

Number of CMV On-System Crashes - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	373	786	2,185	3,625	12,282	215	**19,465**	**79,132**
2007*	394	804	2,341	3,849	14,017	198	**21,603**	
2008	385	737	2,283	3,503	13,549	131	**20,588**	
2009	276	580	1,902	3,076	11,553	89	**17,476**	
2010	348	746	2,157	2,943	11,736	50	**17,980**	**77,270**
2011	356	691	2,063	2,776	11,740	65	**17,691**	
2012	414	764	2,290	3,086	13,011	70	**19,635**	
2013	421	920	2,524	3,269	14,747	83	**21,964**	

Number of CMV On-System Crashes - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	33	32	183	160	809	10	**1,226**	**4,979**
2007*	28	39	198	175	942	9	**1,391**	
2008	30	69	156	159	882	1	**1,297**	
2009	33	40	134	149	705	4	**1,065**	
2010	26	75	168	175	838	5	**1,287**	**7,186**
2011	40	78	206	226	1,000	10	**1,560**	
2012	71	100	249	286	1,351	8	**2,065**	
2013	62	119	309	325	1,455	4	**2,274**	

Number of CMV On-System Crashes - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	36	112	259	437	1,466	36	**2,346**	**10,010**
2007*	50	101	324	432	1,840	20	**2,768**	
2008	46	114	296	413	1,882	23	**2,774**	
2009	35	89	213	328	1,444	13	**2,122**	
2010	35	83	257	334	1,486	7	**2,202**	**9,278**
2011	30	83	234	304	1,539	4	**2,194**	
2012	28	110	236	310	1,605	4	**2,293**	
2013	29	87	291	339	1,834	9	**2,589**	

Number of CMV On-System Crashes - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	29	33	113	122	511	9	**816**	**3,645**
2007*	29	45	143	163	687	1	**1,068**	
2008	21	45	132	149	636	6	**989**	
2009	15	28	120	109	495	5	**772**	
2010	24	36	126	107	645	1	**939**	**5,189**
2011	39	56	168	139	721	5	**1,128**	
2012	54	74	178	176	918	3	**1,403**	
2013	55	108	248	177	1,125	6	**1,719**	

Number of CMV On-System Crashes - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	277	609	1,629	2,906	9,496	161	**15,077**	**60,499**
2007*	288	618	1,676	3,078	10,548	168	**16,376**	
2008	288	509	1,699	2,782	10,149	101	**15,528**	
2009	193	423	1,435	2,490	8,909	67	**13,517**	
2010	263	552	1,606	2,327	8,767	37	**13,552**	**55,617**
2011	247	474	1,455	2,107	8,480	46	**12,809**	
2012	261	480	1,627	2,314	9,137	55	**13,874**	
2013	275	606	1,676	2,428	10,333	64	**15,382**	

Table 10. Number of CMV Crashes on Rural State Highways.

Number of Rural CMV On-System Crashes - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	240	366	930	891	4,281	49	**6,757**	
2007*	252	380	1,074	1,091	5,086	71	**7,955**	**28,178**
2008	241	383	1,032	986	4,843	29	**7,514**	
2009	164	267	832	830	3,846	12	**5,951**	
2010	208	377	911	767	4,039	12	**6,314**	
2011	230	357	911	760	4,291	16	**6,565**	**28,598**
2012	286	397	981	901	4,694	16	**7,275**	
2013	304	523	1,178	1,001	5,425	13	**8,444**	

Number of Rural CMV On-System Crashes - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	26	19	112	67	370	7	**601**	
2007*	24	25	122	92	472	6	**740**	**2,556**
2008	23	52	103	59	435	-	**672**	
2009	26	27	80	74	336	-	**543**	
2010	22	52	105	83	409	2	**673**	
2011	37	58	155	106	531	4	**891**	**4,259**
2012	62	81	173	168	759	6	**1,249**	
2013	55	95	227	207	858	4	**1,446**	

Number of Rural CMV On-System Crashes - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	22	49	71	69	394	2	**607**	
2007*	24	35	102	81	501	6	**750**	**2,525**
2008	33	51	97	80	510	1	**772**	
2009	16	21	53	43	263	-	**396**	
2010	15	28	61	33	251	-	**388**	
2011	11	28	60	37	294	1	**431**	**1,745**
2012	13	37	55	32	305	-	**442**	
2013	19	21	80	38	325	1	**484**	

Number of Rural CMV On-System Crashes - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	23	20	94	68	291	2	**498**	
2007*	26	28	110	76	408	1	**649**	**2,189**
2008	18	30	87	74	380	2	**591**	
2009	14	25	86	46	280	1	**452**	
2010	20	24	91	50	366	1	**552**	
2011	32	43	119	85	458	1	**738**	**3,384**
2012	43	56	133	106	599	1	**938**	
2013	47	90	183	97	738	1	**1,156**	

Number of Rural CMV On-System Crashes - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	169	278	652	687	3,227	38	**5,052**	
2007*	178	293	740	842	3,705	58	**5,816**	**20,907**
2008	167	250	745	773	3,518	26	**5,479**	
2009	108	194	613	667	2,967	11	**4,560**	
2010	151	273	654	601	3,013	9	**4,701**	
2011	150	228	577	532	3,008	10	**4,505**	**19,210**
2012	168	223	620	595	3,031	9	**4,646**	
2013	183	317	688	659	3,504	7	**5,358**	

Table 11. Number of Injuries.

Number of Injuries - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	3,521	17,554	71,621	181,886	842,887	135,295	**1,252,764**	**4,991,605**
2007	3,466	17,070	71,995	176,948	888,654	139,775	**1,297,908**	
2008	3,487	15,901	68,940	158,689	860,395	127,651	**1,235,063**	
2009	3,122	14,569	65,648	154,502	844,813	123,216	**1,205,870**	
2010	3,060	15,275	68,212	134,417	795,341	49,512	**1,065,817**	**4,426,286**
2011	3,067	14,787	65,386	132,509	772,926	48,029	**1,036,704**	
2012	3,417	16,196	71,067	143,678	841,395	53,947	**1,129,700**	
2013	3,396	16,807	72,622	143,143	897,798	60,299	**1,194,065**	

Number of Injuries - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	271	1,030	3,987	7,055	41,736	5,920	**59,999**	**241,484**
2007	247	956	4,149	6,715	43,775	6,316	**62,158**	
2008	258	917	4,088	6,209	44,203	5,720	**61,395**	
2009	226	887	3,621	6,090	42,084	5,024	**57,932**	
2010	219	953	3,802	5,612	42,313	1,540	**54,439**	**230,497**
2011	235	981	4,156	6,233	43,101	1,596	**56,302**	
2012	329	1,104	4,285	6,882	45,204	1,687	**59,491**	
2013	264	1,137	4,480	6,731	45,933	1,720	**60,265**	

Number of Injuries - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	332	2,163	8,356	18,280	85,891	14,446	**129,468**	**521,304**
2007	350	2,213	8,848	17,797	92,987	15,394	**137,589**	
2008	314	2,061	7,988	15,708	88,461	14,389	**128,921**	
2009	298	1,840	7,582	14,932	87,049	13,625	**125,326**	
2010	276	2,021	7,888	13,651	79,987	5,432	**109,255**	**446,866**
2011	285	1,923	7,578	13,294	76,437	5,118	**104,635**	
2012	278	2,047	7,923	13,243	84,158	5,235	**112,884**	
2013	286	2,056	8,358	13,583	89,964	5,845	**120,092**	

Number of Injuries - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	199	654	3,053	6,918	39,239	5,279	**55,342**	**225,483**
2007	175	680	3,275	6,883	42,197	5,549	**58,759**	
2008	192	628	3,182	6,684	39,632	5,980	**56,298**	
2009	172	501	2,993	6,559	38,813	6,046	**55,084**	
2010	190	550	2,982	5,774	36,766	1,119	**47,381**	**202,170**
2011	193	607	3,070	5,892	35,391	1,680	**46,833**	
2012	250	696	3,352	6,626	39,545	2,281	**52,750**	
2013	281	776	3,568	6,842	41,261	2,478	**55,206**	

Number of Injuries - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	2,719	13,707	56,225	149,633	676,021	109,650	**1,007,955**	**4,003,334**
2007	2,694	13,221	55,723	145,553	709,695	112,516	**1,039,402**	
2008	2,723	12,295	53,682	130,088	688,099	101,562	**988,449**	
2009	2,426	11,341	51,452	126,921	676,867	98,521	**967,528**	
2010	2,375	11,751	53,540	109,380	636,275	41,421	**854,742**	**3,546,753**
2011	2,354	11,276	50,582	107,090	617,997	39,635	**828,934**	
2012	2,560	12,349	55,507	116,927	672,488	44,744	**904,575**	
2013	2,565	12,838	56,216	115,987	720,640	50,256	**958,502**	

Table 12. Number of Injuries in Rural Crashes.

Number of Rural Injuries - Statewide								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	1,908	6,585	19,028	27,065	149,280	24,442	**228,308**	**897,571**
2007	1,855	6,214	19,010	26,758	157,998	25,570	**237,405**	
2008	1,759	5,710	18,359	24,251	149,636	22,899	**222,614**	
2009	1,586	5,293	16,739	22,343	143,096	20,187	**209,244**	
2010	1,531	5,318	17,378	20,065	147,016	6,288	**197,596**	**830,063**
2011	1,563	5,311	16,460	19,984	142,575	5,630	**191,523**	
2012	1,785	5,676	17,489	22,634	157,466	6,201	**211,251**	
2013	1,766	6,190	17,988	22,677	173,598	7,474	**229,693**	

Number of Rural Injuries - Eagle Ford Shale Region								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	204	649	1,906	1,942	10,460	1,754	**16,915**	**63,650**
2007	198	586	1,921	1,823	10,693	1,851	**17,072**	
2008	198	525	1,796	1,601	10,036	1,684	**15,840**	
2009	163	511	1,550	1,602	8,731	1,266	**13,823**	
2010	167	541	1,502	1,450	9,641	356	**13,657**	**61,679**
2011	188	577	1,685	1,509	9,632	335	**13,926**	
2012	269	684	1,820	2,037	11,496	463	**16,769**	
2013	201	748	1,875	2,028	12,007	468	**17,327**	

Number of Rural Injuries - Barnett Shale Region								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	125	504	1,252	1,400	9,595	1,782	**14,658**	**58,038**
2007	134	499	1,294	1,387	11,047	1,984	**16,345**	
2008	136	498	1,319	1,277	10,446	1,806	**15,482**	
2009	104	382	1,038	1,028	7,877	1,124	**11,553**	
2010	92	313	940	854	7,041	273	**9,513**	**38,861**
2011	81	362	955	835	6,842	220	**9,295**	
2012	98	356	963	832	7,473	247	**9,969**	
2013	93	351	1,005	747	7,664	224	**10,084**	

Number of Rural Injuries - Permian Basin Region								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	144	334	996	1,062	5,777	1,097	**9,410**	**37,286**
2007	131	299	1,085	1,109	6,573	1,305	**10,502**	
2008	111	301	983	886	5,826	1,143	**9,250**	
2009	113	223	871	871	5,126	920	**8,124**	
2010	110	227	1,028	647	5,211	154	**7,377**	**37,788**
2011	137	292	976	798	5,924	133	**8,260**	
2012	174	367	1,154	1,094	7,227	171	**10,187**	
2013	198	484	1,485	979	8,560	258	**11,964**	

Number of Rural Injuries - Remaining Counties								
Year	**Fatal**	**Incapacit.**	**Non-Incap.**	**Possible Inj.**	**No Injury**	**Unknown**	**Total**	
2006	1,435	5,098	14,874	22,661	123,448	19,809	**187,325**	**738,597**
2007	1,392	4,830	14,710	22,439	129,685	20,430	**193,486**	
2008	1,314	4,386	14,261	20,487	123,328	18,266	**182,042**	
2009	1,206	4,177	13,280	18,842	121,362	16,877	**175,744**	
2010	1,162	4,237	13,908	17,114	125,123	5,505	**167,049**	**691,735**
2011	1,157	4,080	12,844	16,842	120,177	4,942	**160,042**	
2012	1,244	4,269	13,552	18,671	131,270	5,320	**174,326**	
2013	1,274	4,607	13,623	18,923	145,367	6,524	**190,318**	

Table 13. Number of Injuries in CMV Crashes.

Number of CMV Injuries - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	497	1,304	4,241	9,572	69,644	41,090	**126,347**	**472,946**
2007*	532	1,333	4,448	9,913	78,876	37,751	**132,854**	
2008	525	1,235	4,341	8,765	74,778	25,711	**115,355**	
2009	352	966	3,453	7,176	65,273	21,169	**98,389**	
2010	453	1,164	4,065	7,171	66,079	1,877	**80,809**	**332,759**
2011	422	1,052	3,738	6,653	63,438	1,946	**77,249**	
2012	528	1,193	4,119	7,232	69,283	1,926	**84,281**	
2013	534	1,418	4,404	7,249	74,396	2,419	**90,420**	

Number of CMV Injuries - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	44	55	334	371	3,884	3,729	**8,417**	**28,518**
2007*	37	62	352	429	4,578	2,663	**8,121**	
2008	45	105	283	401	4,279	1,598	**6,711**	
2009	43	62	232	277	3,424	1,231	**5,269**	
2010	33	101	342	359	4,087	68	**4,990**	**24,812**
2011	46	115	364	428	4,528	83	**5,564**	
2012	86	139	444	551	5,402	107	**6,729**	
2013	72	169	474	643	6,049	122	**7,529**	

Number of CMV Injuries - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	42	162	473	989	7,980	4,948	**14,595**	**56,707**
2007*	61	156	563	1,030	10,144	3,550	**15,504**	
2008	54	179	534	928	9,933	3,550	**15,178**	
2009	45	150	404	676	7,615	2,540	**11,430**	
2010	49	151	481	691	7,607	231	**9,210**	**37,827**
2011	33	123	403	669	7,219	244	**8,691**	
2012	35	159	387	644	8,059	208	**9,492**	
2013	33	136	462	684	8,815	304	**10,434**	

Number of CMV Injuries - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	30	48	169	232	2,274	1,556	**4,309**	**16,734**
2007*	31	64	218	316	2,947	681	**4,256**	
2008	25	59	212	303	2,743	1,167	**4,509**	
2009	18	42	200	261	2,244	895	**3,660**	
2010	34	60	224	223	2,462	31	**3,034**	**16,109**
2011	47	81	267	289	2,782	42	**3,508**	
2012	74	128	306	408	3,522	41	**4,479**	
2013	69	157	421	368	3,980	93	**5,088**	

Number of CMV Injuries - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	382	1,037	3,265	7,979	55,506	30,857	**99,027**	**370,987**
2007*	404	1,050	3,316	8,138	61,207	30,857	**104,973**	
2008	401	892	3,312	7,133	57,823	19,396	**88,957**	
2009	246	712	2,617	5,962	51,990	16,503	**78,030**	
2010	337	852	3,018	5,898	51,923	1,547	**63,575**	**254,011**
2011	296	733	2,704	5,267	48,909	1,577	**59,486**	
2012	333	767	2,982	5,629	52,300	1,570	**63,581**	
2013	360	956	3,047	5,554	55,552	1,900	**67,369**	

Table 14. Number of Injuries in Rural CMV Crashes.

Number of Rural CMV Injuries - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	306	558	1,526	2,051	18,708	18,017	**41,166**	
2007*	321	566	1,746	2,458	21,894	21,540	**48,526**	**152,258**
2008	319	568	1,695	2,223	20,661	8,959	**34,425**	
2009	209	426	1,311	1,716	17,405	7,074	**28,141**	
2010	269	544	1,577	1,630	18,194	309	**22,523**	
2011	266	534	1,605	1,595	18,162	302	**22,464**	**97,923**
2012	351	622	1,675	2,002	20,081	296	**25,027**	
2013	377	763	1,957	2,084	22,263	465	**27,909**	

Number of Rural CMV Injuries - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	38	32	182	201	1,332	6,176	**7,961**	
2007*	35	37	194	270	1,664	4,632	**6,833**	**19,625**
2008	36	79	167	186	1,519	772	**2,759**	
2009	34	42	129	130	1,163	574	**2,072**	
2010	28	73	235	162	1,550	26	**2,074**	
2011	43	85	273	177	1,834	29	**2,441**	**11,395**
2012	77	116	309	314	2,345	52	**3,213**	
2013	63	131	322	367	2,719	65	**3,667**	

Number of Rural CMV Injuries - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	26	63	122	118	1,698	1,448	**3,475**	
2007*	26	50	153	142	2,212	3,378	**5,961**	**14,923**
2008	38	70	151	144	2,253	965	**3,621**	
2009	20	34	87	78	1,164	483	**1,866**	
2010	24	36	101	65	929	18	**1,173**	
2011	12	42	112	74	1,124	24	**1,388**	**5,518**
2012	15	45	75	68	1,238	11	**1,452**	
2013	20	36	109	71	1,246	23	**1,505**	

Number of Rural CMV Injuries - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	23	30	133	121	901	1,328	**2,536**	
2007*	28	40	161	145	1,167	221	**1,762**	**7,992**
2008	22	40	130	136	1,103	664	**2,095**	
2009	15	35	128	90	819	511	**1,598**	
2010	28	43	138	85	1,033	10	**1,337**	
2011	40	64	191	147	1,415	14	**1,871**	**8,580**
2012	56	98	216	239	1,785	16	**2,410**	
2013	60	132	313	182	2,241	34	**2,962**	

Number of Rural CMV Injuries - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	218	433	1,089	1,611	14,778	9,065	**27,194**	
2007*	232	439	1,238	1,901	16,851	13,309	**33,970**	**109,719**
2008	223	379	1,247	1,757	15,786	6,558	**25,950**	
2009	140	315	967	1,418	14,259	5,506	**22,605**	
2010	189	392	1,103	1,318	14,682	255	**17,939**	
2011	171	343	1,029	1,197	13,789	235	**16,764**	**72,430**
2012	203	363	1,075	1,381	14,713	217	**17,952**	
2013	234	464	1,213	1,464	16,057	343	**19,775**	

Table 15. Number of Injuries in Crashes on State Highways.

Number of On-System Injuries - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	2,620	10,840	40,891	95,881	454,513	61,576	**666,321**	**2,670,807**
2007	2,585	10,499	41,387	93,962	480,608	64,219	**693,260**	
2008	2,575	9,873	39,145	85,086	465,722	56,885	**659,286**	
2009	2,280	9,097	37,962	83,911	464,696	53,994	**651,940**	
2010	2,306	9,950	40,651	76,503	451,060	22,282	**602,752**	**2,497,866**
2011	2,303	9,518	39,030	74,782	437,621	21,508	**584,762**	
2012	2,565	10,414	41,844	81,168	476,549	24,159	**636,699**	
2013	2,597	10,985	43,250	80,495	509,153	27,173	**673,653**	

Number of On-System Injuries - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	243	817	2,867	4,667	26,455	3,250	**38,299**	**153,606**
2007	215	748	2,891	4,385	27,372	3,330	**38,941**	
2008	213	703	2,831	4,126	28,223	2,938	**39,034**	
2009	191	686	2,537	4,306	27,126	2,486	**37,332**	
2010	189	755	2,717	3,895	28,309	721	**36,586**	**157,978**
2011	215	814	2,995	4,243	29,069	794	**38,130**	
2012	293	913	3,130	4,782	31,009	872	**40,999**	
2013	234	949	3,304	4,769	32,113	894	**42,263**	

Number of On-System Injuries - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	246	1,345	4,890	10,195	49,664	6,990	**73,330**	**297,381**
2007	269	1,321	5,241	10,021	53,626	7,719	**78,197**	
2008	230	1,298	4,670	8,910	50,959	6,910	**72,977**	
2009	216	1,121	4,480	8,704	51,911	6,445	**72,877**	
2010	212	1,254	4,817	8,332	49,920	2,593	**67,128**	**272,618**
2011	215	1,235	4,722	7,964	46,977	2,496	**63,609**	
2012	203	1,286	4,783	8,204	51,784	2,682	**68,942**	
2013	207	1,310	5,172	8,111	55,209	2,930	**72,939**	

Number of On-System Injuries - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	157	391	1,747	3,524	18,977	2,083	**26,879**	**109,201**
2007	130	417	1,903	3,492	21,037	2,290	**29,269**	
2008	135	423	1,778	3,316	19,153	2,162	**26,967**	
2009	139	327	1,638	3,171	18,804	2,007	**26,086**	
2010	152	387	1,886	3,103	19,533	403	**25,464**	**115,161**
2011	161	448	1,952	3,331	20,047	635	**26,574**	
2012	215	510	2,169	3,950	22,660	854	**30,358**	
2013	235	601	2,443	4,028	24,495	963	**32,765**	

Number of On-System Injuries - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	1,974	8,287	31,387	77,495	359,417	49,253	**527,813**	**2,110,619**
2007	1,971	8,013	31,352	76,064	378,573	50,880	**546,853**	
2008	1,997	7,449	29,866	68,734	367,387	44,875	**520,308**	
2009	1,734	6,963	29,307	67,730	366,855	43,056	**515,645**	
2010	1,753	7,554	31,231	61,173	353,298	18,565	**473,574**	**1,952,109**
2011	1,712	7,021	29,361	59,244	341,528	17,583	**456,449**	
2012	1,854	7,705	31,762	64,232	371,096	19,751	**496,400**	
2013	1,921	8,125	32,331	63,587	397,336	22,386	**525,686**	

Table 16. Number of Injuries in Crashes on Rural State Highways.

Number of Rural On-System Injuries - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	1,573	4,963	13,674	18,113	97,888	15,728	**151,939**	**592,775**
2007	1,546	4,705	13,912	18,105	103,908	17,023	**159,199**	
2008	1,451	4,281	13,037	16,246	96,403	14,821	**146,239**	
2009	1,293	3,868	11,931	14,802	91,030	12,474	**135,398**	
2010	1,256	4,059	12,362	13,286	91,464	2,905	**125,332**	**527,166**
2011	1,279	3,899	11,742	13,009	89,583	2,681	**122,193**	
2012	1,483	4,404	12,479	14,929	98,449	2,964	**134,708**	
2013	1,477	4,873	12,972	14,714	107,378	3,519	**144,933**	

Number of Rural On-System Injuries - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	187	568	1,609	1,620	8,439	1,479	**13,902**	**52,369**
2007	185	510	1,601	1,533	8,593	1,541	**13,963**	
2008	173	453	1,464	1,293	8,257	1,352	**12,992**	
2009	148	433	1,279	1,371	7,243	1,038	**11,512**	
2010	148	479	1,278	1,236	8,028	214	**11,383**	**52,884**
2011	176	516	1,464	1,332	8,341	240	**12,069**	
2012	246	605	1,591	1,781	9,830	342	**14,395**	
2013	183	676	1,642	1,782	10,405	349	**15,037**	

Number of Rural On-System Injuries - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	95	380	885	1,004	6,791	1,267	**10,422**	**40,622**
2007	111	373	951	968	7,697	1,485	**11,585**	
2008	114	379	940	904	7,074	1,272	**10,683**	
2009	84	262	754	731	5,366	735	**7,932**	
2010	79	224	666	588	4,951	112	**6,620**	**27,573**
2011	69	257	708	597	4,759	103	**6,493**	
2012	81	301	658	616	5,354	127	**7,137**	
2013	72	286	757	555	5,541	112	**7,323**	

Number of Rural On-System Injuries - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	120	251	838	839	4,549	874	**7,471**	**29,389**
2007	110	228	881	886	5,168	1,084	**8,357**	
2008	88	257	778	701	4,375	906	**7,105**	
2009	102	184	697	690	4,044	739	**6,456**	
2010	92	199	815	517	4,021	83	**5,727**	**30,944**
2011	124	260	810	629	4,801	79	**6,703**	
2012	160	328	958	925	5,999	113	**8,483**	
2013	177	429	1,269	836	7,141	179	**10,031**	

Number of Rural On-System Injuries - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006	1,171	3,764	10,342	14,650	78,109	12,108	**120,144**	**470,395**
2007	1,140	3,594	10,479	14,718	82,450	12,913	**125,294**	
2008	1,076	3,192	9,855	13,348	76,697	11,291	**115,459**	
2009	959	2,989	9,201	12,010	74,377	9,962	**109,498**	
2010	937	3,157	9,603	10,945	74,464	2,496	**101,602**	**415,765**
2011	910	2,866	8,760	10,451	71,682	2,259	**96,928**	
2012	996	3,170	9,272	11,607	77,266	2,382	**104,693**	
2013	1,045	3,482	9,304	11,541	84,291	2,879	**112,542**	

Table 17. Number of Injuries in CMV Crashes on State Highways.

Number of CMV On-System Injuries - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	459	1,087	3,223	6,166	43,337	40,369	**94,641**	**337,132**
2007*	482	1,113	3,445	6,547	49,377	37,172	**98,136**	
2008	472	1,018	3,357	5,956	47,722	19,342	**77,867**	
2009	327	773	2,678	4,961	41,495	16,255	**66,489**	
2010	405	990	3,261	5,113	42,887	1,312	**53,968**	**226,684**
2011	396	898	2,997	4,709	41,937	1,329	**52,266**	
2012	479	1,016	3,381	5,375	46,080	1,438	**57,769**	
2013	499	1,230	3,703	5,563	49,946	1,740	**62,681**	

Number of CMV On-System Injuries - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	44	46	304	283	2,852	11,704	**15,233**	**38,725**
2007*	38	57	328	310	3,322	10,472	**14,527**	
2008	41	100	259	281	3,109	1,232	**5,022**	
2009	42	56	191	249	2,410	996	**3,944**	
2010	32	94	294	307	3,000	56	**3,783**	**19,802**
2011	46	104	335	378	3,524	55	**4,442**	
2012	84	134	414	500	4,195	84	**5,411**	
2013	70	161	439	544	4,855	97	**6,166**	

Number of CMV On-System Injuries - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	38	141	359	696	4,947	4,037	**10,217**	**38,333**
2007*	53	128	449	687	6,208	2,307	**9,832**	
2008	49	144	410	657	6,349	2,595	**10,204**	
2009	41	113	295	508	5,178	1,945	**8,080**	
2010	43	121	371	560	5,356	157	**6,608**	**26,804**
2011	32	101	335	481	4,934	163	**6,046**	
2012	30	137	303	510	5,459	171	**6,610**	
2013	31	112	384	555	6,255	203	**7,540**	

Number of CMV On-System Injuries - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	31	41	147	193	1,585	1,409	**3,406**	**12,259**
2007*	31	56	186	259	2,132	157	**2,821**	
2008	23	56	172	236	1,974	939	**3,400**	
2009	17	36	162	172	1,515	731	**2,633**	
2010	32	55	188	175	1,862	16	**2,328**	**12,886**
2011	46	74	235	224	2,164	28	**2,771**	
2012	71	118	263	347	2,792	32	**3,623**	
2013	64	146	375	291	3,216	72	**4,164**	

Number of CMV On-System Injuries - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	345	859	2,413	4,995	33,953	23,220	**65,785**	**247,815**
2007*	359	872	2,482	5,291	37,715	24,237	**70,956**	
2008	359	718	2,516	4,782	36,290	14,576	**59,241**	
2009	227	568	2,030	4,032	32,392	12,583	**51,832**	
2010	298	720	2,408	4,071	32,669	1,083	**41,249**	**167,192**
2011	272	619	2,092	3,626	31,315	1,083	**39,007**	
2012	294	627	2,401	4,018	33,634	1,151	**42,125**	
2013	334	811	2,505	4,173	35,620	1,368	**44,811**	

Table 18. Number of Injuries in CMV Crashes on Rural State Highways.

Number of Rural CMV On-System Injuries - Statewide								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	299	501	1,353	1,612	13,614	12,694	**30,073**	**119,198**
2007*	312	523	1,559	1,983	16,121	19,620	**40,118**	
2008	298	527	1,499	1,777	15,358	7,772	**27,231**	
2009	202	383	1,179	1,373	12,579	6,060	**21,776**	
2010	252	500	1,417	1,368	13,099	246	**16,882**	**75,248**
2011	261	489	1,416	1,294	13,799	244	**17,503**	
2012	337	570	1,517	1,675	14,784	238	**19,121**	
2013	362	723	1,788	1,776	16,705	388	**21,742**	

Number of Rural CMV On-System Injuries - Eagle Ford Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	39	28	179	151	1,156	2,132	**3,684**	**11,854**
2007*	35	36	193	208	1,475	1,827	**3,776**	
2008	34	77	164	134	1,359	707	**2,475**	
2009	34	40	119	126	1,053	547	**1,919**	
2010	28	70	218	157	1,355	26	**1,854**	**10,472**
2011	43	76	263	172	1,714	24	**2,292**	
2012	75	112	295	308	2,057	45	**2,892**	
2013	62	131	317	353	2,510	61	**3,434**	

Number of Rural CMV On-System Injuries - Barnett Shale Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	24	61	100	101	1,266	1,616	**3,169**	**14,214**
2007*	27	44	143	120	1,610	4,848	**6,792**	
2008	36	64	136	118	1,639	808	**2,801**	
2009	19	28	78	55	877	395	**1,452**	
2010	20	36	85	59	722	10	**932**	**4,326**
2011	12	36	106	55	816	20	**1,045**	
2012	14	45	67	60	963	10	**1,159**	
2013	19	35	100	56	959	21	**1,190**	

Number of Rural CMV On-System Injuries - Permian Basin Region								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	25	26	123	113	720	609	**1,615**	**6,580**
2007*	29	36	143	126	1,010	305	**1,649**	
2008	20	39	113	122	942	609	**1,845**	
2009	15	33	119	82	749	473	**1,471**	
2010	27	42	130	77	902	9	**1,187**	**7,858**
2011	39	59	170	133	1,284	12	**1,697**	
2012	54	91	192	223	1,635	16	**2,211**	
2013	55	124	287	167	2,098	32	**2,763**	

Number of Rural CMV On-System Injuries - Remaining Counties								
Year	Fatal	Incapacit.	Non-Incap.	Possible Inj.	No Injury	Unknown	Total	
2006*	211	386	951	1,247	10,473	8,338	**21,605**	**86,551**
2007*	221	406	1,079	1,529	12,026	12,641	**27,902**	
2008	208	347	1,086	1,403	11,418	5,648	**20,110**	
2009	134	282	863	1,110	9,900	4,645	**16,934**	
2010	177	352	984	1,075	10,120	201	**12,909**	**52,592**
2011	167	318	877	934	9,985	188	**12,469**	
2012	194	322	963	1,084	10,129	167	**12,859**	
2013	226	433	1,084	1,200	11,138	274	**14,355**	

General Trends

With the data compiled in Table 3 through Table 18, as well as basic crash attribute data such as severity, number and type of vehicles involved, manner of collision, contributing factors and type of roadway, the research team prepared a series of figures and charts to develop a high-level understanding of crash locations and trends. This section includes a small sample of charts and figures to illustrate general highlights. Additional materials could be prepared as needed.

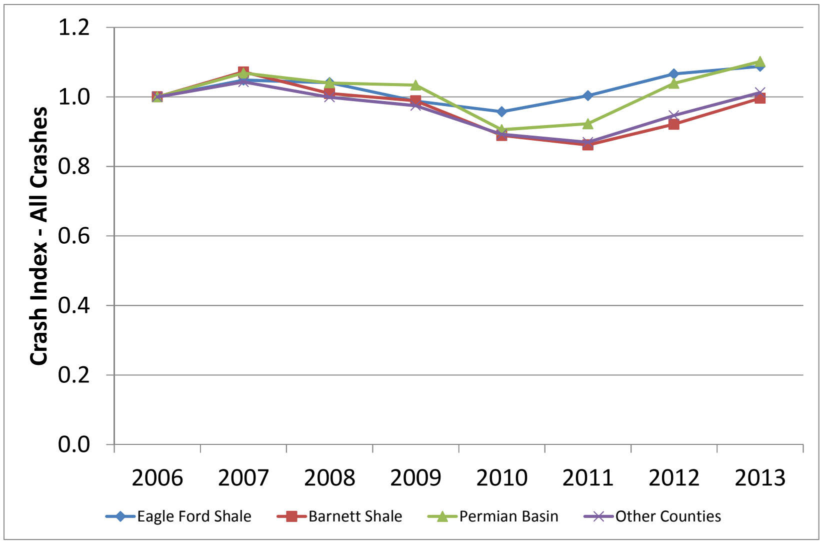
Figure 4 shows the annual relative variation in the number of crashes using year 2006 as the reference point. In the figure, an index value of 1.0 means that the number of crashes for any given year was the same as the number of crashes in 2006. The figure shows aggregated changes for the Barnet Shale region (13 counties), Eagle Ford Shale region (29 counties), and Permian Basin region (37 counties), as well as all other 175 counties in the state. Figure 4 shows values for all crashes; fatal, incapacitating injuries, and non-incapacitating (KAB) injury crashes; and fatal crashes. Overall, the figure shows that both crashes in energy sector counties and non-energy sector counties decreased from 2006 through 2009, then increased from 2010 through 2013. Crashes in the Eagle Ford Shale and Permian Basin regions increased faster than in other regions in the state. The relative growth in crashes in those two regions increased faster as the severity of the crashes increased.

The decrease in the number of fatal crashes in the Eagle Ford Shale region in 2013 was an interesting observation, but the research team could not identify a clear reason as to why this happened. It is possible that enhanced safety campaigns by the Department of Public Safety in the region had an impact. However, more research would be necessary to isolate and quantify this effect. In any case, even with this decrease, the number of fatal crashes in the Eagle Ford Shale region in 2013 was slightly higher than in 2006.

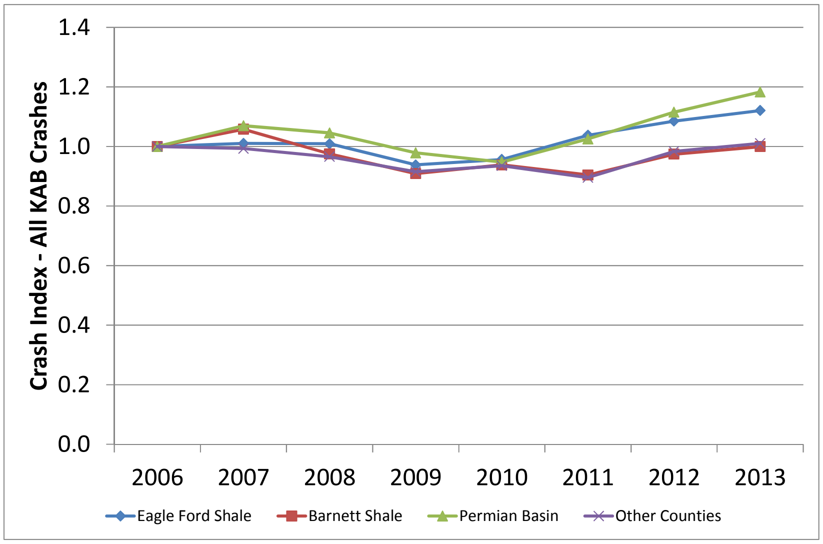
Figure 5 shows a similar figure for rural crashes. As in the previous figure, Figure 5 shows all rural crashes, rural KAB crashes, and rural fatal crashes. The trends are somewhat similar as in Figure 4, but the differences among regions are more clearly defined. In particular, the number of KAB crashes and fatal crashes in rural areas in the Eagle Ford Shale and Permian Basin regions began to increase in 2010 and 2011, and by 2012 they were higher than in 2006.

As described in Chapter 2, there was a very strong correlation between the change in the number of new wells and rural CMV crashes. Figure 6 shows all rural CMV crashes, rural KAB CMV crashes, and rural fatal CMV crashes. In this case, the trends in Figure 5 were even more clearly defined. In particular, not only did rural CMV crashes in the Eagle Ford Shale and Permian Basin regions begin to increase in 2010, they were already higher that year than in 2006. Notice also that, despite the decrease in rural fatal CMV crashes in the Eagle Ford Shale region in 2013, the number of rural CMV crashes in that region was still more than twice the number in 2006.

All crashes



All KAB crashes



All fatal crashes

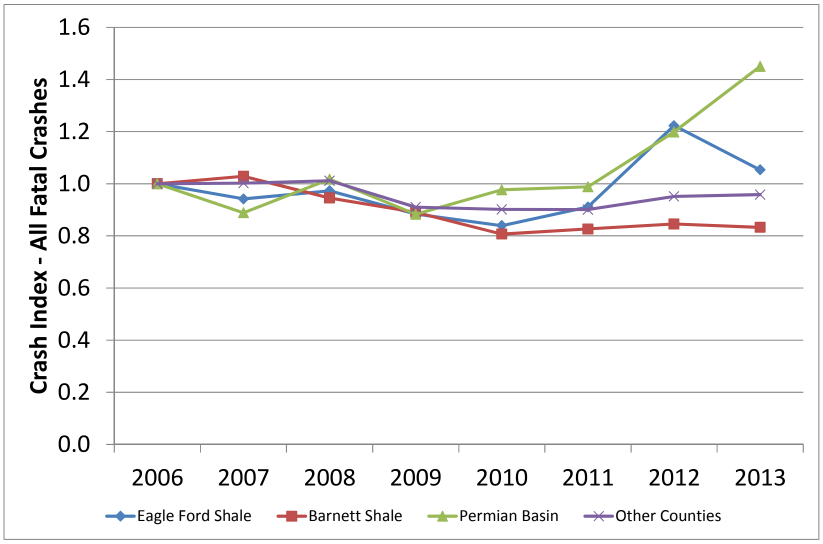
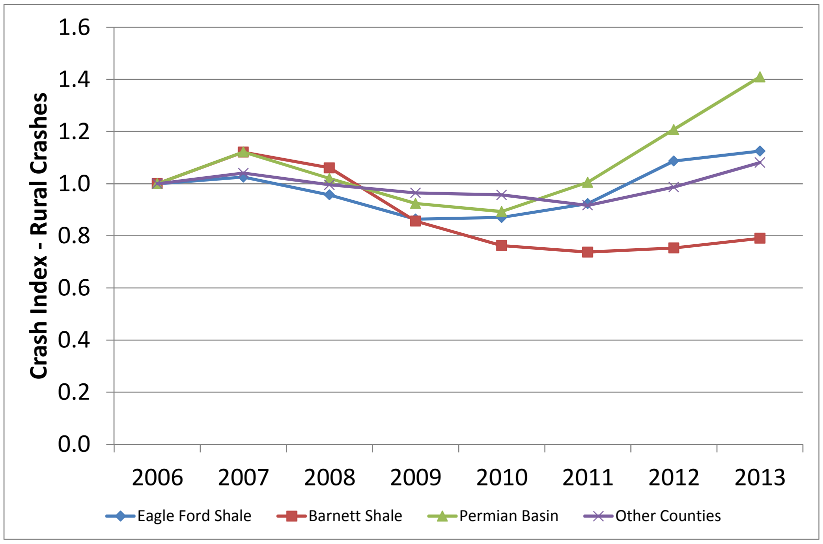
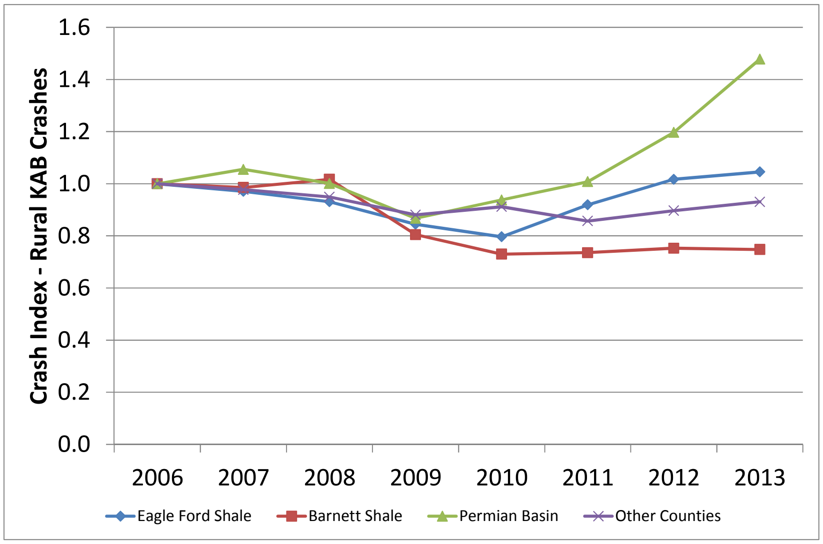


Figure 4. Crash Index – All Crashes.

Rural crashes



Rural KAB crashes



Rural fatal crashes

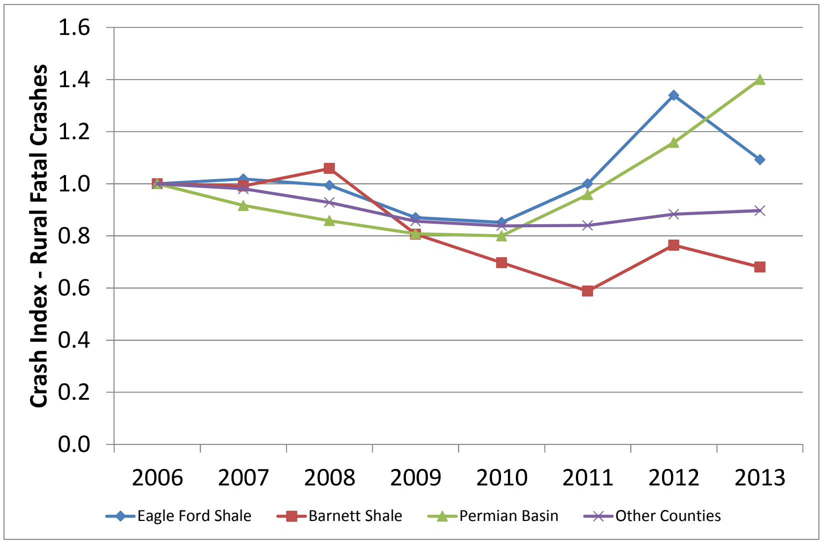
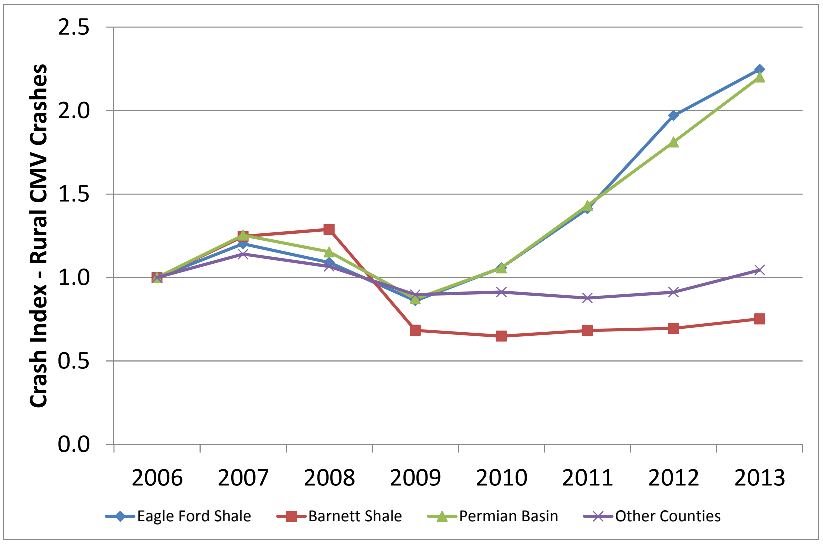
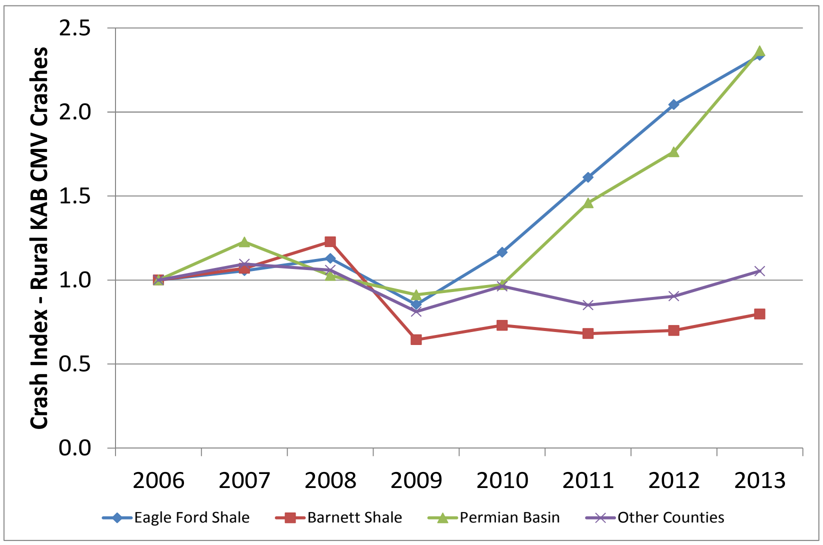


Figure 5. Crash Index – Rural Crashes.

Rural CMV crashes



Rural KAB CMV crashes



Rural fatal CMV crashes

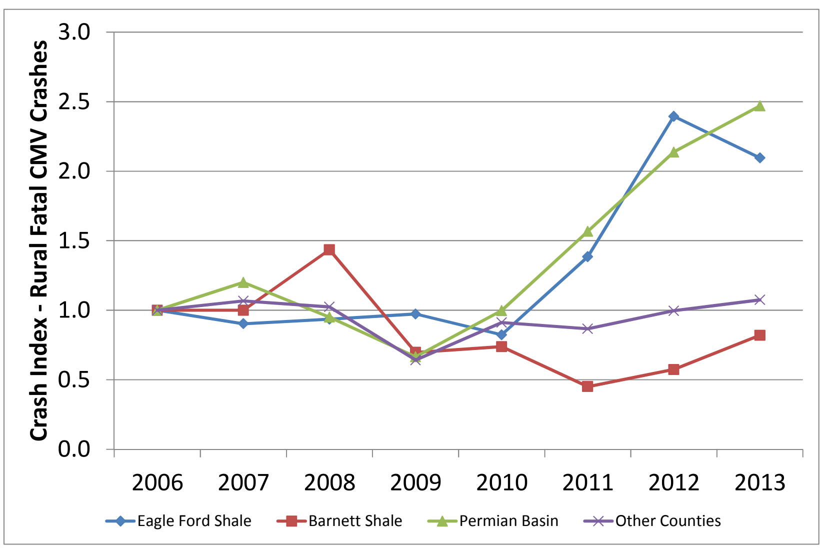


Figure 6. Crash Index – Rural CMV Crashes.

CRIS contains data regarding manners of collision and crash contributing factors for individual crashes, according to information included in the crash reports. This information is based on police officers' interpretation of what happened at the crash sites, not based on forensic or engineering analyses. Despite these caveats, a high-level review of the data offers insight as to potential crash causes.

Figure 7 shows the top 10 manners of collision in CRIS. There were some differences among regions, but for the most part, the trends were similar throughout the state. By far, the most common manner of collision was a single motor vehicle going straight. The second and third most common manners of collision were two vehicles going straight either in opposite or same directions. Readers should note that a vehicle going straight does not mean that the road alignment was straight. It just means the vehicle was not making a turn. A more detailed analysis would be necessary to clarify the impact of roadway characteristics, such as horizontal and vertical alignments, curvature, cross section characteristics, visibility restrictions, and pavement conditions.

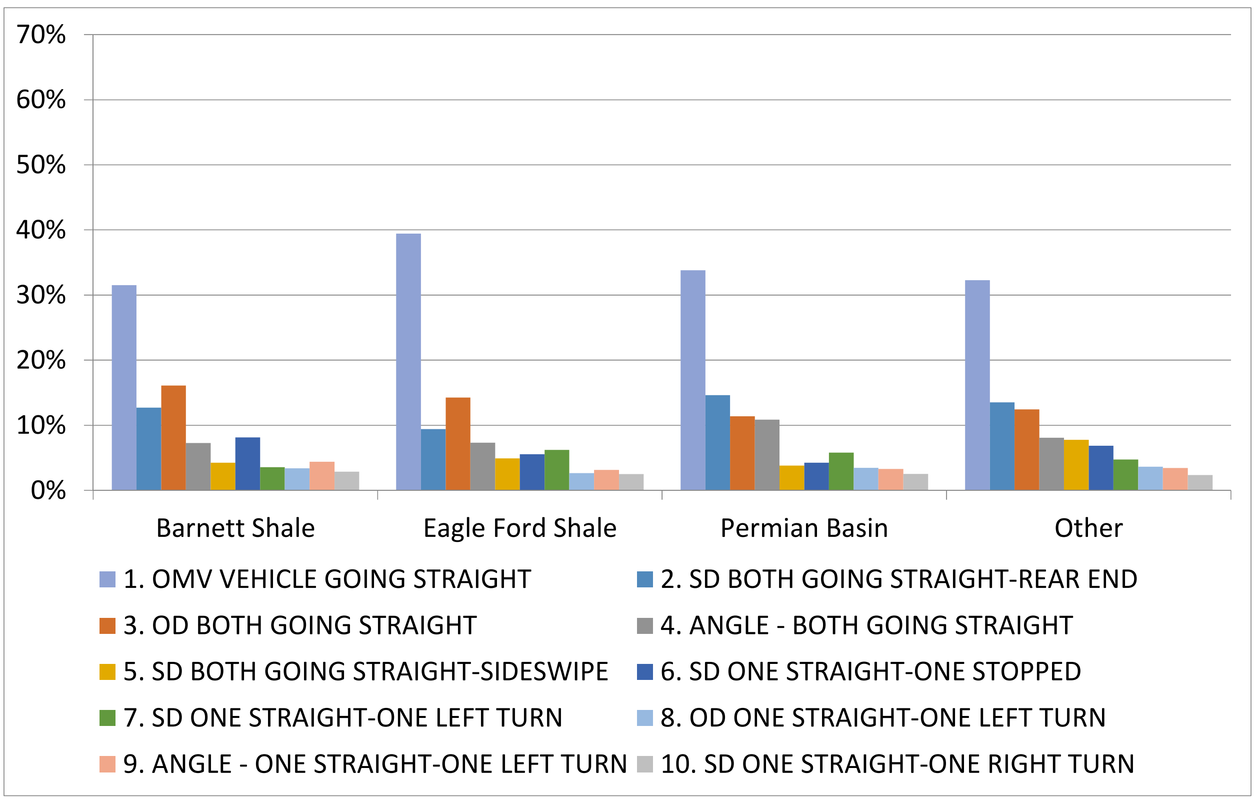


Figure 7. Top 10 Manners of Collision (2010–2013 Crash Data).

Figure 8 shows the top 10 vehicle contributing factors in CRIS. There were some differences among regions, but for the most part, the trends were similar throughout the state. By far, the most common vehicle contributing factor category was "not applicable," which is an indication of the police officer’s inability to identify what vehicle factor may have contributed to the crash based on information that was readily available at the crash site. In many cases, it is possible that the interaction between the roadway environment and the vehicle was a contribution factor to a crash. However, this information is normally not included in crash reports. Most other vehicle contributing factors in Figure 8 are factors that could be considered driver factors (i.e., factors that might suggest lack of control by the driver as a contributing factor to the crash).

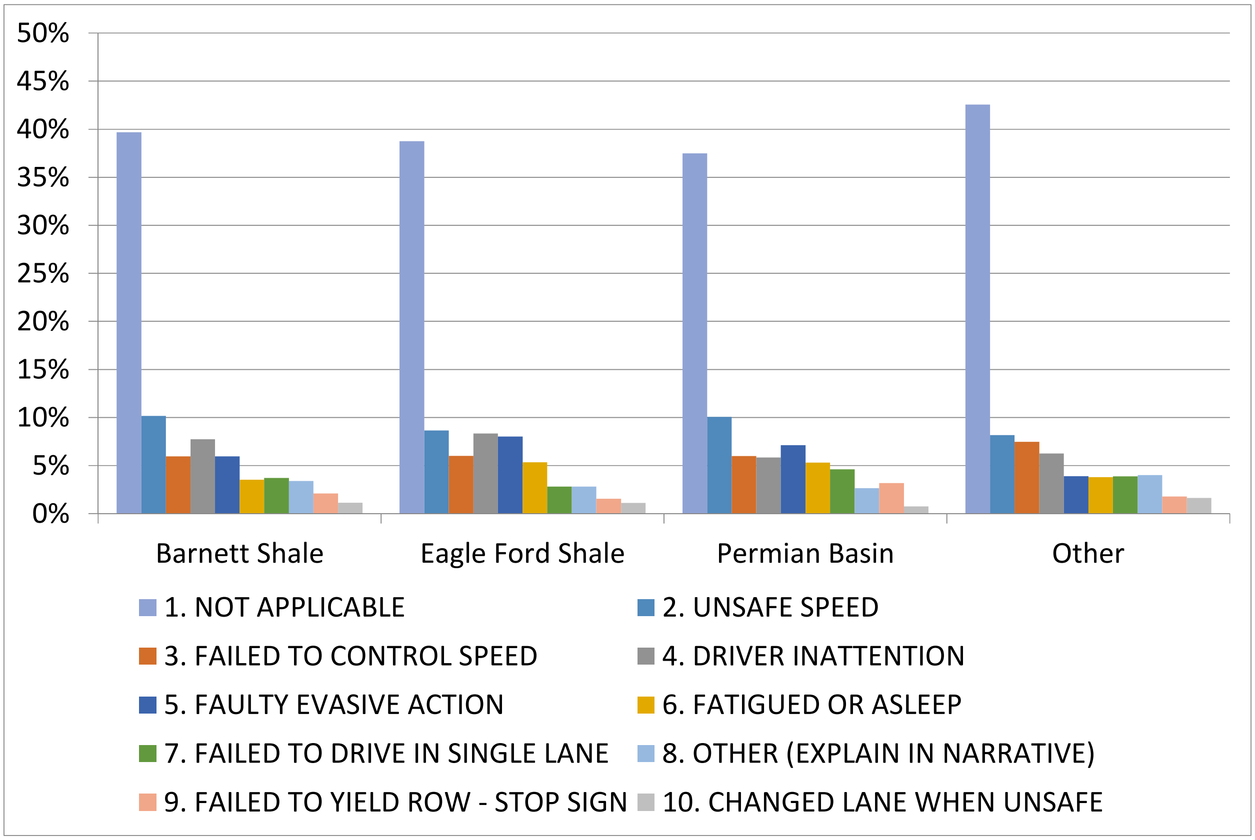


Figure 8. Top 10 Vehicle Contributing Factors (2010–2013 Crash Data).

Chapter 2. Analysis and Trends

Oil and Gas Well Developments

The March 2015 report provides information on the methodology to extract and analyze oil and gas energy developments in the state (*2*). In summary, the research team aggregated and compared data using two four-year blocks: 2006–2009 and 2010–2013. Table 19 summarizes changes in the number of new completed wells in the Barnett Shale, Eagle Ford Shale, and Permian Basin regions from 2006–2009 to 2010–2013. The table also shows the total number of wells completed in other areas and throughout the state.

The total number of new wells increased from 51,393 during the four-year period from 2006–2009 to 55,398 from 2010–2013 (i.e., the total number of wells drilled increased by 8 percent). This growth was not uniform. For example, in the Barnett Shale region, the number of new horizontal wells decreased by 48 percent and the number of new vertical wells decreased by 53 percent. In the Eagle Ford Shale region, the number of new horizontal wells increased by 941 percent but the number of new vertical wells decreased by 20 percent. In the Permian Basin region, the number of new horizontal wells increased by 240 percent and the number of new vertical wells increased by 49 percent.

Table 19. Changes in the Number of New Completed Wells.

Region	Number of Horizontal Wells			Number of Vertical Wells			Total Number of Wells		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	8,663	4,490	-48%	1,482	698	-53%	10,145	5,188	-49%
Eagle Ford Shale	854	8,886	941%	4,595	3,689	-20%	5,449	12,575	131%
Permian Basin	951	3,230	240%	14,381	21,396	49%	15,332	24,626	61%
Other	1,761	3,356	91%	18,706	9,653	-48%	20,467	13,009	-36%
Grand Total	**12,229**	**19,962**	**63%**	**39,164**	**35,436**	**-10%**	**51,393**	**55,398**	**8%**
Karnes County	28	1,312	4586%	38	50	32%	66	1,362	1964%

Changes in the Number of Crashes and Injuries

With the data compiled in Table 3 through Table 18, the research team examined changes in the number of crashes and the number of injuries from 2006–2009 to 2010–2013. Table 20 through Table 23 summarize the results, as follows:

- Table 20 shows changes in the number of crashes on all highways.
- Table 21 shows changes in the number of crashes on state highways.
- Table 22 shows changes in the number of injuries on all highways.
- Table 23 shows changes in the number of injuries on state highways.

Table 20. Changes in the Number of Crashes on All Highways.

Note: Green dots correspond to decreases in the number of crashes (desirable trend). Red dots correspond to increases in the number of crashes (undesirable trend).

(a) All crashes

Region	Number of Crashes (Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown)											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	184,735	166,474	-10%	24,572	18,521	-25%	14,119	12,367	-12%	3,130	2,061	-34%
Eagle Ford Shale	85,964	86,744	1%	27,660	28,804	4%	6,607	8,708	32%	2,820	4,542	61%
Permian Basin	80,891	77,511	-4%	15,689	17,426	11%	4,775	6,368	33%	2,464	3,743	52%
Other	1,410,907	1,306,749	-7%	288,715	284,431	-1%	90,081	77,755	-14%	26,221	23,942	-9%
Grand Total	**1,762,497**	**1,637,478**	**-7%**	**356,636**	**349,182**	**-2%**	**115,582**	**105,198**	**-9%**	**34,635**	**34,288**	**-1%**

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Number of Fatal, Incapacitating, Non-Incapacitating Crashes											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	31,739	30,728	-3%	5,346	4,165	-22%	2,124	1,846	-13%	642	474	-26%
Eagle Ford Shale	14,382	15,264	6%	6,889	6,948	1%	1,096	1,641	50%	662	1,173	77%
Permian Basin	11,520	12,019	4%	3,841	4,524	18%	883	1,333	51%	617	971	57%
Other	204,134	201,541	-1%	57,296	54,123	-6%	12,568	11,792	-6%	4,998	4,751	-5%
Grand Total	**261,775**	**259,552**	**-1%**	**73,372**	**69,760**	**-5%**	**16,671**	**16,612**	**0%**	**6,919**	**7,369**	**7%**

(c) Fatal injury crashes

Region	Number of Fatal Crashes											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	1,202	1,030	-14%	459	325	-29%	181	135	-25%	101	63	-37%
Eagle Ford Shale	851	902	6%	629	694	10%	129	204	58%	102	179	76%
Permian Basin	648	789	22%	430	518	20%	94	183	94%	80	151	88%
Other	9,465	8,954	-5%	4,673	4,293	-8%	1,177	1,170	-1%	663	684	3%
Grand Total	**12,166**	**11,675**	**-4%**	**6,191**	**5,830**	**-6%**	**1,582**	**1,692**	**7%**	**946**	**1,077**	**14%**

Table 21. Changes in the Number of Crashes on State Highways.

Note: Green dots correspond to decreases in the number of crashes (desirable trend). Red dots correspond to increases in the number of crashes (undesirable trend).

(a) All crashes

Region	Number of Crashes (Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown)											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	101,789	97,528	-4%	16,179	12,523	-23%	10,010	9,278	-7%	2,525	1,745	-31%
Eagle Ford Shale	54,020	58,201	8%	21,974	23,975	9%	4,979	7,186	44%	2,556	4,259	67%
Permian Basin	38,703	43,040	11%	12,046	14,114	17%	3,645	5,189	42%	2,189	3,384	55%
Other	726,867	698,902	-4%	181,734	171,845	-5%	60,499	55,617	-8%	20,907	19,210	-8%
Grand Total	**921,379**	**897,671**	**-3%**	**231,933**	**222,457**	**-4%**	**79,132**	**77,270**	**-2%**	**28,178**	**28,598**	**1%**

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Number of Fatal, Incapacitating, Non-Incapacitating Crashes											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	18,636	18,766	1%	3,798	2,998	-21%	1,675	1,503	-10%	575	428	-26%
Eagle Ford Shale	10,122	11,208	11%	5,684	5,986	5%	974	1,503	54%	639	1,122	76%
Permian Basin	6,485	7,799	20%	3,059	3,775	23%	752	1,166	55%	561	881	57%
Other	114,236	116,161	2%	39,809	37,182	-7%	9,645	9,522	-1%	4,387	4,232	-4%
Grand Total	**149,479**	**153,934**	**3%**	**52,350**	**49,941**	**-5%**	**13,046**	**13,694**	**5%**	**6,162**	**6,663**	**8%**

(c) Fatal injury crashes

Region	Number of Fatal Crashes											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	887	761	-14%	369	268	-27%	167	122	-27%	96	58	-39%
Eagle Ford Shale	722	792	10%	564	627	11%	123	199	62%	99	176	77%
Permian Basin	482	647	34%	355	454	28%	93	172	84%	80	142	77%
Other	6,775	6,492	-4%	3,746	3,399	-9%	1,046	1,046	0%	622	652	5%
Grand Total	**8,866**	**8,692**	**-2%**	**5,034**	**4,748**	**-6%**	**1,429**	**1,539**	**8%**	**897**	**1,028**	**15%**

Table 22. Changes in the Number of Injuries on All Highways.

Note: Green dots correspond to decreases in the number of injuries (desirable trend). Red dots correspond to increases in the number of injuries (undesirable trend).

(a) All crashes

Region	Number of Injuries (Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown)											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	521,304	446,866	-14%	58,038	38,861	-33%	56,707	37,827	-33%	14,923	5,518	-63%
Eagle Ford Shale	241,484	230,497	-5%	63,650	61,679	-3%	28,518	24,812	-13%	19,625	11,395	-42%
Permian Basin	225,483	202,170	-10%	37,286	37,788	1%	16,734	16,109	-4%	7,992	8,580	7%
Other	4,003,334	3,546,753	-11%	738,597	691,735	-6%	370,987	254,011	-32%	109,719	72,430	-34%
Grand Total	**4,991,605**	**4,426,286**	**-11%**	**897,571**	**830,063**	**-8%**	**472,946**	**332,759**	**-30%**	**152,258**	**97,923**	**-36%**

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Number of Fatal, Incapacitating, Non-Incapacitating Injuries											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	42,345	40,919	-3%	7,285	5,609	-23%	2,823	2,452	-13%	840	627	-25%
Eagle Ford Shale	20,637	21,945	6%	10,207	10,257	0%	1,654	2,385	44%	1,006	1,755	75%
Permian Basin	15,704	16,515	5%	5,591	6,632	19%	1,115	1,868	67%	786	1,379	76%
Other	278,208	273,913	-2%	80,963	75,957	-6%	17,635	16,385	-7%	6,920	6,779	-2%
Grand Total	**356,894**	**353,292**	**-1%**	**104,046**	**98,455**	**-5%**	**23,228**	**23,090**	**-1%**	**9,552**	**10,540**	**10%**

(c) Fatal injury crashes

Region	Number of Fatal Injuries											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	1,294	1,125	-13%	499	364	-27%	201	150	-26%	111	71	-36%
Eagle Ford Shale	1,002	1,047	4%	763	825	8%	169	237	40%	143	211	47%
Permian Basin	738	914	24%	499	619	24%	103	224	117%	88	184	109%
Other	10,562	9,854	-7%	5,347	4,837	-10%	1,433	1,326	-7%	813	797	-2%
Grand Total	**13,596**	**12,940**	**-5%**	**7,108**	**6,645**	**-7%**	**1,907**	**1,937**	**2%**	**1,155**	**1,263**	**9%**

Table 23. Changes in the Number of Injuries on State Highways.

Note: Green dots correspond to decreases in the number of injuries (desirable trend). Red dots correspond to increases in the number of injuries (undesirable trend).

(a) All crashes

Region	Number of Injuries (Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown)											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	297,381	272,618	-8%	40,622	27,573	-32%	38,333	26,804	-30%	14,214	4,326	-70%
Eagle Ford Shale	153,606	157,978	3%	52,369	52,884	1%	38,725	19,802	-49%	11,854	10,472	-12%
Permian Basin	109,201	115,161	5%	29,389	30,944	5%	12,259	12,886	5%	6,580	7,858	19%
Other	2,110,619	1,952,109	-8%	470,395	415,765	-12%	247,815	167,192	-33%	86,551	52,592	-39%
Grand Total	**2,670,807**	**2,497,866**	**-6%**	**592,775**	**527,166**	**-11%**	**337,132**	**226,684**	**-33%**	**119,198**	**75,248**	**-37%**

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Number of Fatal, Incapacitating, Non-Incapacitating Injuries											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	25,327	25,416	0%	5,328	4,158	-22%	2,220	2,000	-10%	761	575	-24%
Eagle Ford Shale	14,942	16,508	10%	8,610	9,004	5%	1,506	2,207	47%	979	1,690	73%
Permian Basin	9,185	11,159	21%	4,534	5,621	24%	959	1,667	74%	720	1,270	76%
Other	160,300	162,330	1%	57,762	53,502	-7%	13,748	13,381	-3%	6,175	6,097	-1%
Grand Total	**209,754**	**215,413**	**3%**	**76,234**	**72,285**	**-5%**	**18,434**	**19,255**	**4%**	**8,635**	**9,632**	**12%**

(c) Fatal injury crashes

Region	Number of Fatal Injuries											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	961	837	-13%	404	301	-25%	181	136	-25%	106	65	-39%
Eagle Ford Shale	862	931	8%	693	753	9%	165	232	41%	142	208	46%
Permian Basin	561	763	36%	420	553	32%	103	213	107%	89	175	97%
Other	7,676	7,240	-6%	4,346	3,888	-11%	1,290	1,198	-7%	774	764	-1%
Grand Total	**10,060**	**9,771**	**-3%**	**5,863**	**5,495**	**-6%**	**1,739**	**1,779**	**2%**	**1,111**	**1,212**	**9%**

Table 20 shows changes in the number of crashes on all highways from 2006–2009 to 2010–2013. In total, the number of crashes decreased by 10 percent in the Barnett Shale region, increased by 1 percent in the Eagle Ford Shale region, and decreased by 4 percent in the Permian Basin region. As a reference, the number of crashes decreased by 7 percent in all other 175 counties in the state.

These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. For example:

- Changes were more prominent for rural crashes. In the Barnett Shale region, the number of rural crashes decreased by 25 percent (compared to a 10 percent decrease overall in the region). In the Eagle Ford Shale region, the number of rural crashes increased by 4 percent (compared to a 1 percent increase overall in the region). In the Permian Basin region, the number of crashes increased by 11 percent (compared to a 4 percent decrease overall in the region).

  The changes were even more noticeable for crashes that involved CMVs and, in particular, for rural crashes that involved CMVs. Overall, for rural crashes that involved CMVs, there was a 34 percent decrease in the Barnett Shale region, a 61 percent increase in the Eagle Ford Shale region, and a 52 percent increase in the Permian Basin region. By comparison, there was a 9 percent decrease in all other 175 counties in the state.

- In most cases, as the severity of the injuries worsened, the changes in the corresponding number of crashes were more evident. For example, for rural crashes that involved CMVs in the Barnett Shale region, there was a 26 percent decrease in the number of fatal, incapacitating, and non-incapacitating injury crashes (compared to a 34 percent decrease for all crashes). For fatal crashes, the decrease was 37 percent. In the Eagle Ford Shale region, there was a 77 percent increase in the number of fatal, incapacitating, and non-incapacitating injury crashes (compared to a 61 percent increase for all crashes). For fatal crashes, the increase was 76 percent. In the Permian Basin region, there was a 57 percent increase in the number of fatal, incapacitating, and non-incapacitating injury crashes (compared to a 52 percent increase for all crashes). For fatal crashes, the increase was 88 percent.

Table 21 shows changes in the number of crashes on state highways from 2006–2009 to 2010–2013. In total, the number of crashes decreased by 4 percent in the Barnett Shale region, increased by 8 percent in the Eagle Ford Shale region, and increased by 11 percent in the Permian Basin region. As a reference, the number of crashes decreased by 3 percent in all other 175 counties in the state. These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. The relative changes in the number of crashes on state highways (Table 21) were similar to those found for all highways (Table 20).

From 2006–2009 to 2010–2013, the percentage of crashes occurring on state highways increased by about 2 percent. For all crashes, this percentage increased from 52.2 to 54.8 percent. For fatal, incapacitating, and non-incapacitating injury crashes, it increased from 57.1 to 59.3 percent. For fatal crashes, it increased from 72.8 to 74.4 percent. These percentages were higher for rural roads. For example, for CMV crashes on rural roadways, the percentage of crashes on state highways increased from 81.4 to 83.4 percent. For fatal, incapacitating, and non-incapacitating injury crashes, this percentage increased from 89.1 to 90.4 percent. For fatal crashes, it increased from 94.8 to 95.4 percent.

Table 22 shows changes in the number of injuries in crashes on all highways from 2006–2009 to 2010–2013. In total, the number of injuries decreased by 14 percent in the Barnett Shale region, decreased by 5 percent in the Eagle Ford Shale region, and decreased by 10 percent in the Permian Basin region. As a reference, the number of injuries decreased by 11 percent in all other 175 counties in the state.

These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. For example:

- The changes were more prominent in the case of rural crashes. In the Barnett Shale region, the number of injuries in rural crashes decreased by 33 percent (compared to a 14 percent decrease overall in the region). In the Eagle Ford Shale region, the number of injuries in rural crashes decreased by 3 percent (compared to a 5 percent decrease overall in the region). In the Permian Basin region, the number of injuries in crashes increased by 1 percent (compared to a 10 percent decrease overall in the region).

  The changes were even more noticeable for crashes that involved CMVs and, particularly, for rural crashes that involved CMVs. Overall, for rural crashes that involved CMVs, there was a 63 percent decrease in the Barnett Shale region, a 41 percent decrease in the Eagle Ford Shale region, and a 7 percent increase in the Permian Basin region. By comparison, there was a 34 percent decrease in all other 175 counties in the state.

- In most cases, as the severity of the injuries worsened, the changes in the corresponding number of crashes were more evident. For example, for rural crashes that involved CMVs in the Barnett Shale region, there was a 25 percent decrease in the number of injuries resulting from fatal, incapacitating, and non-incapacitating injury crashes (compared to a 63 percent decrease for all crashes). For fatal crashes, the decrease was 36 percent. In the Eagle Ford Shale region, there was a 75 percent increase in the number of injuries resulting from fatal, incapacitating, and non-incapacitating injury crashes (compared to a 42 percent decrease for all crashes). For fatal crashes, the increase was 47 percent. In the Permian Basin region, there was a 76 percent increase in the number of fatal, incapacitating, and non-incapacitating injury crashes (compared to a 7 percent increase for all crashes). For fatal crashes, the increase was 109 percent.

Table 23 shows changes in the number of injuries from crashes on state highways from 2006–2009 to 2010–2013. In total, the number of crashes decreased by 8 percent in the Barnett Shale region, increased by 3 percent in the Eagle Ford Shale region, and increased by 5 percent in the Permian Basin region. As a reference, the number of crashes decreased by 8 percent in all other 175 counties in the state. These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. The relative changes in the number of injuries from crashes on state highways (Table 23) were similar to those found for all highways (Table 22).

From 2006–2009 to 2010–2013, the percentage of injuries from crashes occurring on state highways increased by about 2 percent. For all crashes, this percentage increased from 53.5 to 56.4 percent. For fatal, incapacitating, and non-incapacitating injury crashes, it increased from 58.8 to 61.0 percent. For fatal crashes, it increased from 74.0 to 75.5 percent. These percentages were higher for rural roads. For example, for rural CMV crashes, the percentage of injuries from crashes on state highways decreased from 78.3 to 76.8 percent. For fatal, incapacitating, and non-incapacitating injury crashes, this percentage increased from 90.4 to 91.4 percent. For fatal crashes, it decreased from 96.2 to 96.0 percent.

Changes in Crash Rates

As part of the 0-6498 research project completed in 2011, the researchers conducted an evaluation of crash rates in the north and northwest regions of the state, with a focus on areas within the jurisdiction of the TxDOT Abilene, Lubbock, and Fort Worth Districts (*1*). For the analysis, the researchers calculated crash rates by dividing the number of crashes found by the number of VMT based on traffic information in the TxDOT Pavement Management Information System (PMIS). Because of concerns about the reliability of average annual daily traffic (AADT) data in the PMIS database (as well as the low frequency of crashes and relatively low traffic volumes that characterize most rural highways), the researchers also used distance (more specifically 100 miles) to estimate crash rates. Although this approach did not explicitly consider exposure, at least it eliminated the issue of traffic volume uncertainty.

Overall, the 0-6498 analysis indicated higher crash rates along corridors where energy developments took place than crash rates along control corridors. The trends also indicated higher crash rates along corridors with higher traffic volumes. In the Lubbock District, crash rates along energy development corridors were similar to those along control corridors. However, traffic volumes were low in general. In the Abilene District (which exhibited higher traffic volumes than those in the Lubbock District), crash rates along energy development corridors were higher than (a) crash rates along control corridors in the same district and (b) crash rates along energy development corridors in the Lubbock District. In the Fort Worth District (which exhibited higher traffic volumes than those in the Abilene District), crash rates along energy development corridors were higher than (a) crash rates along control corridors in the same district and (b) crash rates along energy development corridors in the Abilene District.

For the 2006–2013 crash data compiled as described in the previous chapter, the research team calculated crash rates expressed both as the number of crashes per 100 million VMTs and number of crashes per 100 lane-miles. Table 24 shows the changes in the number of crashes over four years per 100 million VMTs from 2006–2009 to 2010–2013. Table 25 shows the changes in the number of crashes over four years per 100 lane-miles from 2006–2009 to 2010–2013.

Table 24 shows changes in the number of crashes over four years per 100 million VMTs from 2006–2009 to 2010–2013. In total, the crash rate decreased by 2 percent in the Barnett Shale region, increased by 4 percent in the Eagle Ford Shale region, and increased by 7 percent in the Permian Basin region. As a reference, the crash rate decreased by 2 percent in all other 175 counties in the state.

These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. For example:

- The changes were more prominent for rural crashes. In the Barnett Shale region, the rural crash rate decreased by 18 percent (compared to a 2 percent decrease overall in the region). In the Eagle Ford Shale region, the rural crash rate increased by 3 percent (compared to a 4 percent increase overall in the region). In the Permian Basin region, the rural crash rate increased by 13 percent (compared to a 7 percent increase overall in the region).

  The changes were even more noticeable for crashes that involved CMVs and, particularly, for rural crashes that involved CMVs. For rural crashes that involved CMVs, there was a 26 percent decrease in the Barnett Shale region, a 57 percent increase in the Eagle Ford Shale region, and a 49 percent increase in the Permian Basin region. By comparison, there was a 6 percent decrease in all other 175 counties in the state.

- In most cases, as the severity of the injuries worsened, the changes in the corresponding crash rate were more evident. For example, for rural crashes that involved CMVs in the Barnett Shale region, there was a 21 percent decrease in the crash rate for fatal, incapacitating, and non-incapacitating injury crashes (compared to a 26 percent decrease for all crashes). For fatal crashes, the decrease was 36 percent. In the Eagle Ford Shale region, there was a 65 percent increase in the crash rate for fatal, incapacitating, and non-incapacitating injury crashes (compared to a 57 percent increase for all crashes). For fatal crashes, the increase was 67 percent. In the Permian Basin region, there was a 51 percent increase in the crash rate for fatal, incapacitating, and non-incapacitating injury crashes (compared to a 49 percent increase for all crashes). For fatal crashes, the increase was 70 percent.

Table 24. Number of Crashes over Four Years per 100 Million VMTs.

Note: Green dots correspond to decreases in crash rates (desirable trend). Red dots correspond to increases in crash rates (undesirable trend).

(a) All crashes

Region	Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	121.8	119.7	-2%	95.1	78.4	-18%	12.0	11.4	-5%	14.8	10.9	-26%
Eagle Ford Shale	115.1	119.5	4%	69.6	71.4	3%	10.6	14.8	39%	8.1	12.7	57%
Permian Basin	126.5	135.9	7%	59.2	66.7	13%	11.9	16.4	37%	10.8	16.0	49%
Other	130.6	127.9	-2%	88.7	85.9	-3%	10.9	10.2	-6%	10.2	9.6	-6%

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Fatal, Incapacitating, Non-Incapacitating Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	22.3	23.0	3%	22.3	18.8	-16%	2.0	1.8	-8%	3.4	2.7	-21%
Eagle Ford Shale	21.6	23.0	7%	18.0	17.8	-1%	2.1	3.1	49%	2.0	3.3	65%
Permian Basin	21.2	24.6	16%	15.0	17.8	19%	2.5	3.7	50%	2.8	4.2	51%
Other	20.5	21.3	4%	19.4	18.6	-4%	1.7	1.7	1%	2.1	2.1	-1%

(c) Fatal injury crashes

Region	Fatal Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	1.1	0.9	-12%	2.2	1.7	-23%	0.2	0.1	-25%	0.6	0.4	-36%
Eagle Ford Shale	1.5	1.6	6%	1.8	1.9	4%	0.3	0.4	56%	0.3	0.5	67%
Permian Basin	1.6	2.0	30%	1.7	2.1	23%	0.3	0.5	78%	0.4	0.7	70%
Other	1.2	1.2	-2%	1.8	1.7	-7%	0.2	0.2	2%	0.3	0.3	7%

Table 25. Number of Crashes over Four Years per 100 Lane-Miles.

Note: Green dots correspond to decreases in crash rates (desirable trend). Red dots correspond to increases in crash rates (undesirable trend).

(a) All crashes

Region	Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	777.9	743.7	-4%	230.2	177.9	-23%	76.5	70.8	-8%	35.9	24.8	-31%
Eagle Ford Shale	261.2	278.4	7%	123.4	133.2	8%	24.1	34.4	43%	14.4	23.7	65%
Permian Basin	169.2	187.5	11%	59.8	69.9	17%	15.9	22.6	42%	10.9	16.8	54%
Other	532.2	505.5	-5%	184.7	173.2	-6%	44.3	40.2	-9%	21.2	19.4	-9%

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Fatal, Incapacitating, Non-Incapacitating Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	142.4	143.1	0%	54.0	42.6	-21%	12.8	11.5	-10%	8.2	6.1	-26%
Eagle Ford Shale	48.9	53.6	10%	31.9	33.3	4%	4.7	7.2	53%	3.6	6.2	74%
Permian Basin	28.3	34.0	20%	15.2	18.7	23%	3.3	5.1	54%	2.8	4.4	57%
Other	83.6	84.0	0%	40.5	37.5	-7%	7.1	6.9	-2%	4.5	4.3	-4%

(c) Fatal injury crashes

Region	Fatal Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	6.8	5.8	-14%	5.2	3.8	-27%	1.3	0.9	-27%	1.4	0.8	-40%
Eagle Ford Shale	3.5	3.8	9%	3.2	3.5	10%	0.6	1.0	60%	0.6	1.0	75%
Permian Basin	2.1	2.8	34%	1.8	2.2	28%	0.4	0.7	83%	0.4	0.7	76%
Other	5.0	4.7	-5%	3.8	3.4	-10%	0.8	0.8	-1%	0.6	0.7	4%

Table 25 shows changes in the number of crashes over four years per 100 lane-miles from 2006–2009 to 2010–2013. In total, the crash rate decreased by 4 percent in the Barnett Shale region, increased by 7 percent in the Eagle Ford Shale region, and increased by 11 percent in the Permian Basin region. As a reference, the crash rate decreased by 5 percent in all other 175 counties in the state.

These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences within each region. For example:

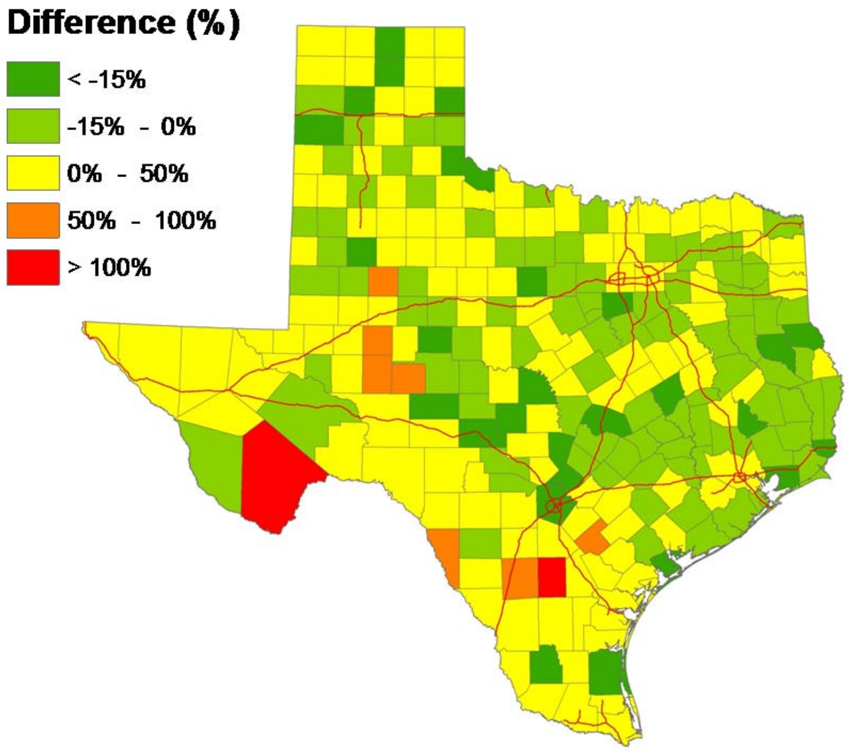
- The changes were more pronounced for rural crashes. In the Barnett Shale region, the rural crash rate decreased by 23 percent (compared to a 4 percent decrease overall in the region). In the Eagle Ford Shale region, the rural crash rate increased by 8 percent (compared to a 7 percent increase overall in the region). In the Permian Basin region, the rural crash rate increased by 17 percent (compared to an 11 percent increase overall in the region).

  The changes were even more pronounced for crashes that involved CMVs and, particularly, for rural crashes that involved CMVs. For rural crashes that involved CMVs, there was a 31 percent decrease in the Barnett Shale region, a 65 percent increase in the Eagle Ford Shale region, and a 54 percent increase in the Permian Basin region. By comparison, there was a 9 percent decrease in all other 175 counties in the state.

- In most cases, as the severity of the injuries worsened, the changes in the corresponding crash rate were more pronounced. For example, for rural crashes that involved CMVs in the Barnett Shale region, there was a 26 percent decrease in the crash rate for fatal, incapacitating, and non-incapacitating injury crashes (compared to a 31 percent decrease for all crashes). For fatal crashes, the decrease was 40 percent. In the Eagle Ford Shale region, there was a 74 percent increase in the crash rate for fatal, incapacitating, and non-incapacitating injury crashes (compared to a 65 percent increase for all crashes). For fatal crashes, the increase was 75 percent. In the Permian Basin region, there was a 57 percent increase in the crash rate for fatal, incapacitating, and non-incapacitating injury crashes (compared to a 54 percent increase for all crashes). For fatal crashes, the increase was 76 percent.

Although the changes in Table 24 and Table 25 are similar, it is worth noting that the basis for the analysis was slightly different, making a comparison between the tables difficult. The reason is that Table 24 relied on AADT data, which were only available for state highways (both rural and urban). By comparison, Table 25 relied on lane-miles, which were only available for rural roads (both state highways and county roads). It is also worth noting that the uncertainty in crash rates (when expressed as the number of crashes per 100 million VMT) increases as traffic volumes decrease, and becomes particularly evident in the case of highway segments with very low AADT values. Figure 9 and Figure 10 illustrate this situation. The uncertainty in crash rates is lower when expressing crash rates per 100 lane-miles (see Figure 11 and Figure 12).

All crashes



Rural crashes

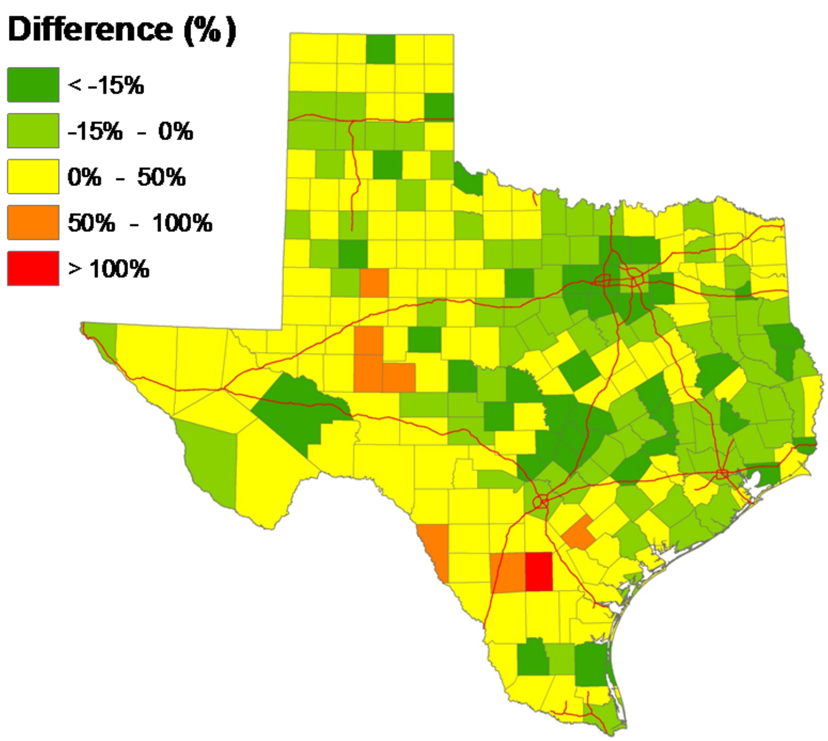
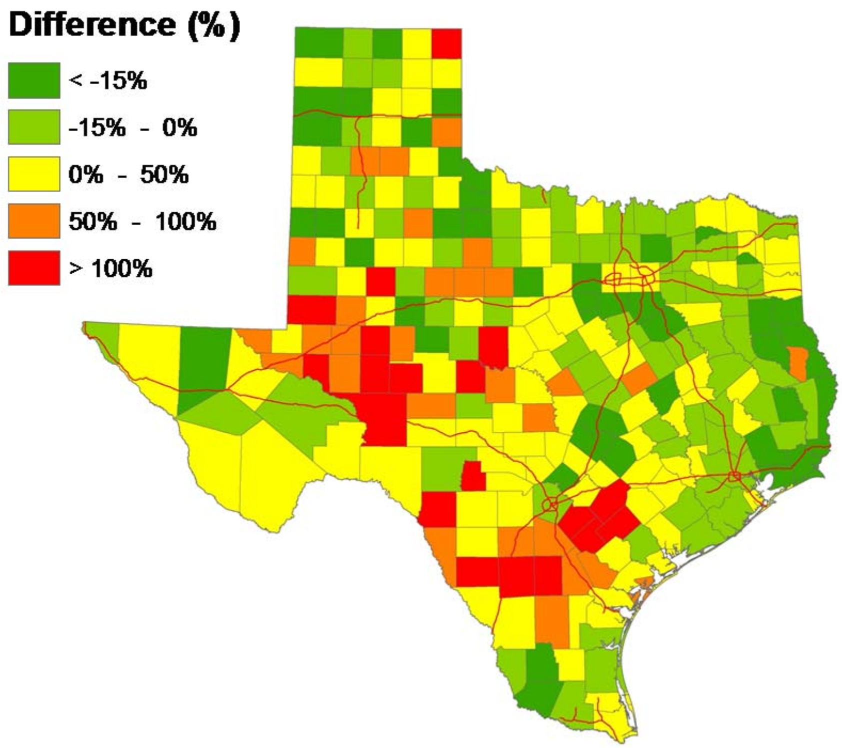


Figure 9. Changes in Crash Rate (per 100 Million VMTs) from 2006–2009 to 2010–2013 – All Crashes and Rural Crashes.

CMV crashes



Rural CMV crashes

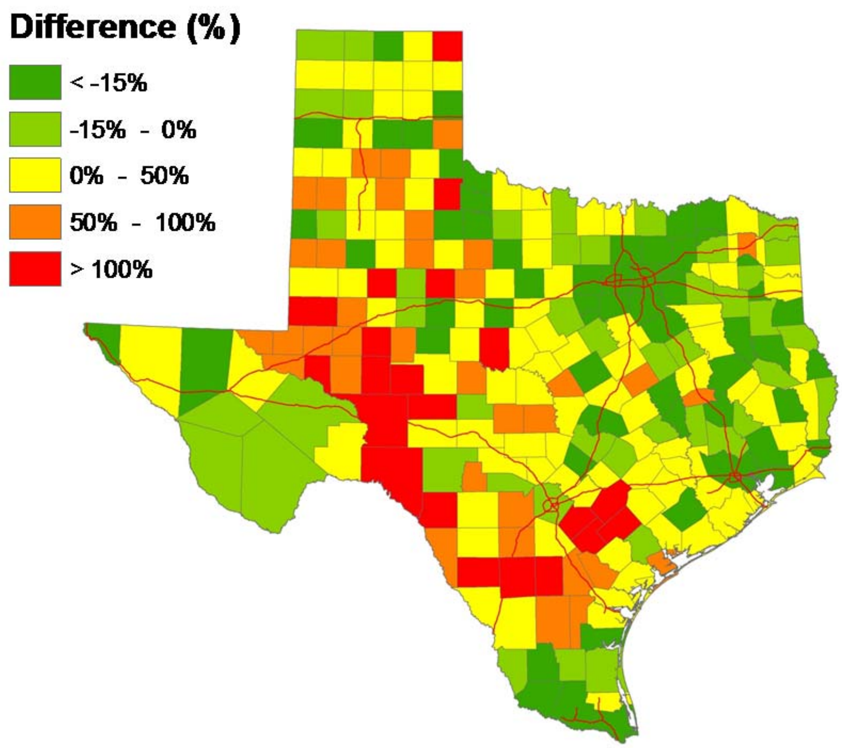
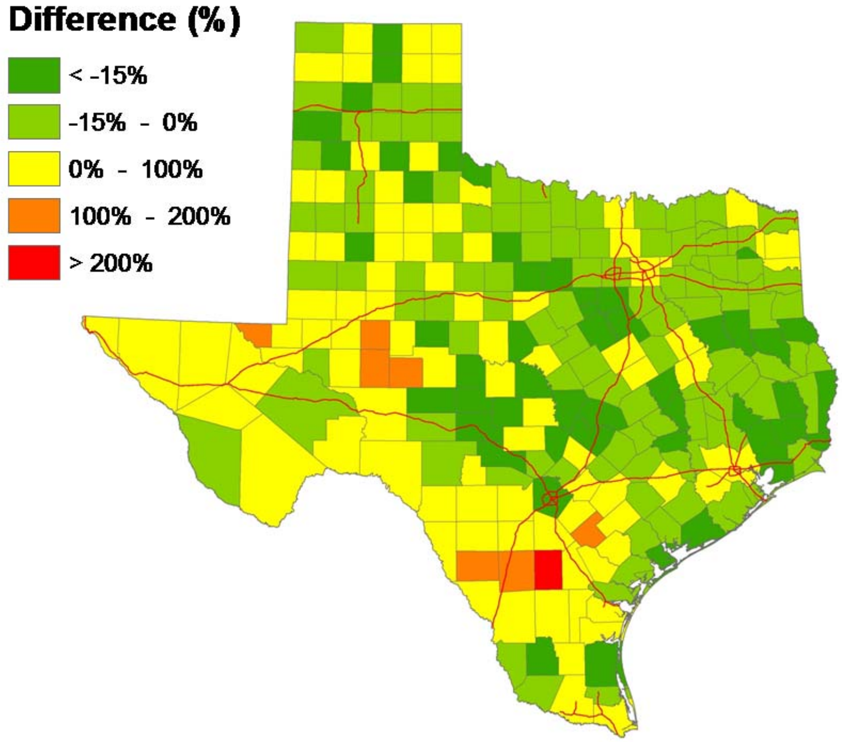


Figure 10. Changes in Crash Rate (per 100 Million VMTs) from 2006–2009 to 2010–2013 – CMV Crashes and Rural CMV Crashes.

All crashes



Rural crashes

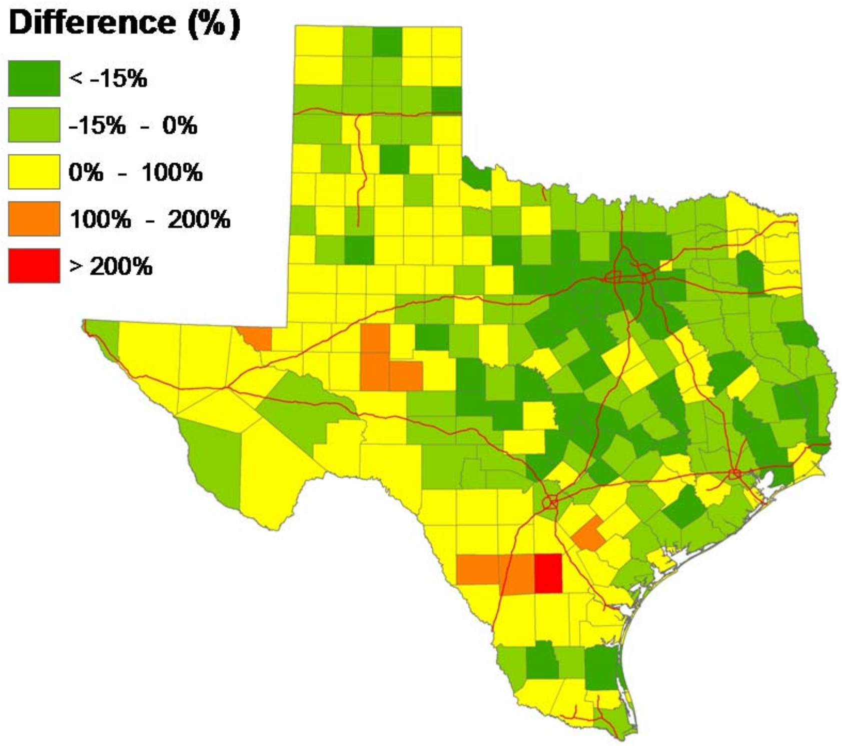
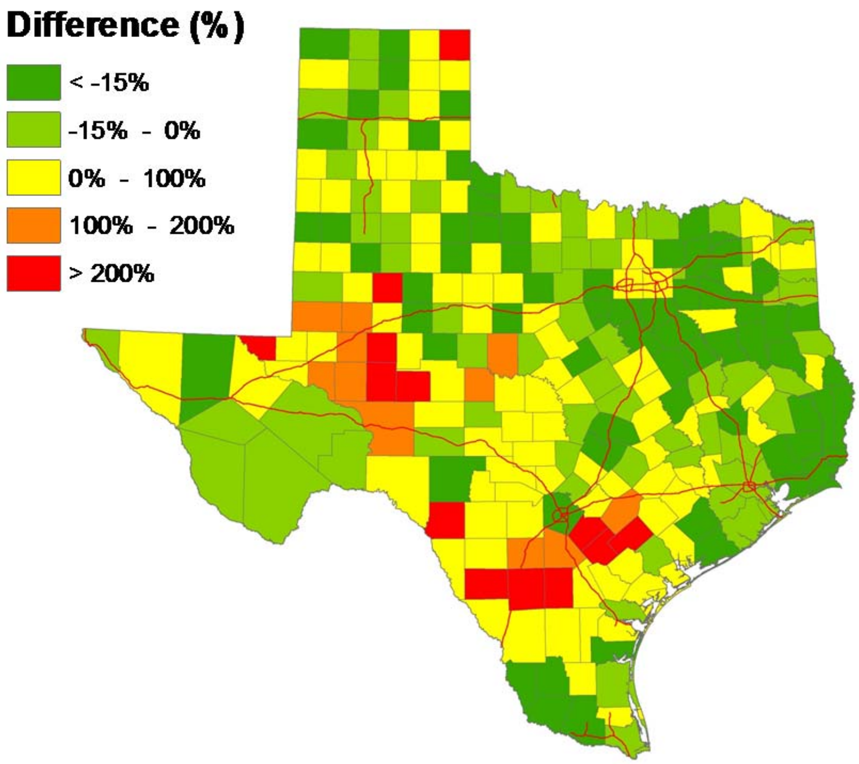


Figure 11. Changes in Crash Rate (per 100 Lane-Miles) from 2006–2009 to 2010–2013 – All Crashes and Rural Crashes.

CMV crashes



Rural CMV crashes

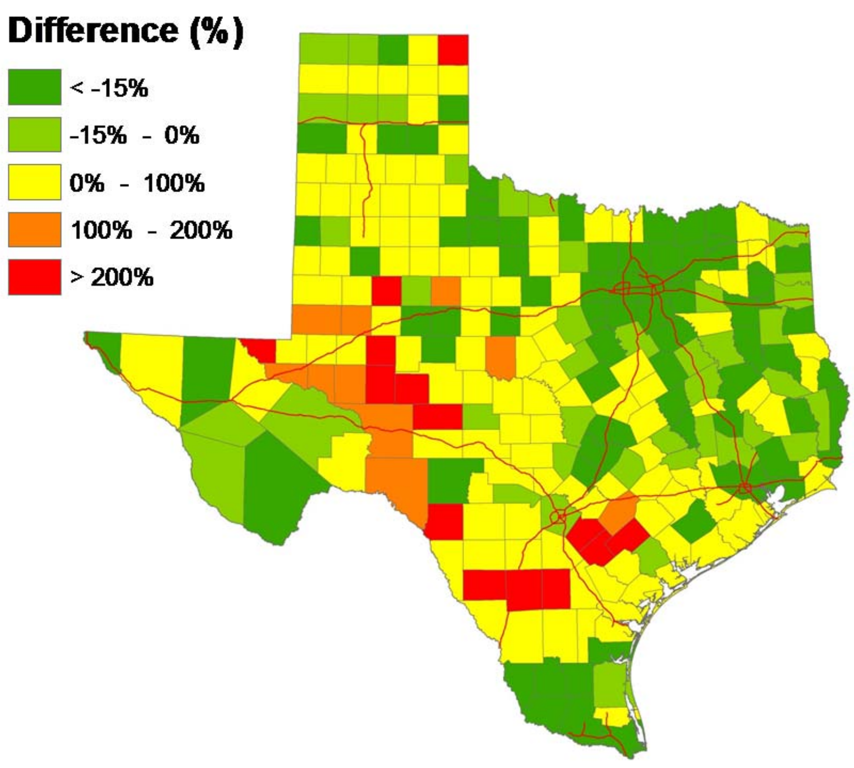


Figure 12. Changes in Crash Rate (per 100 Lane-Miles) from 2006–2009 to 2010–2013 – CMV Crashes and Rural CMV Crashes.

Correlations

The research team used the Pearson product-moment correlation coefficient to compare pairs of metrics using historical data aggregated at the county level. As a reference, a Pearson coefficient of −1 between any two variables indicates total negative correlation, 0 indicates no correlation, and +1 indicates total positive correlation. As the absolute value of the Pearson coefficient increases, the linear correlation between the two variables increases. Table 26 provides a rudimentary way to interpret Pearson correlation coefficients. The literature contains a variety of threshold alternatives and statistical procedures to measure the significance of the Pearson coefficient.

Table 26. Rudimentary Thresholds to Interpret Pearson Correlation Coefficients.

From/To (Positive)	From/To (Negative)	Correlation Strength
+0.70 to +1.00	−0.70 to −1.00	Very strong
+0.40 to +0.69	−0.40 to −0.69	Strong
+0.30 to +0.39	−0.30 to −0.39	Moderate
+0.20 to +0.29	−0.20 to −0.29	Weak
0.00 to +0.19	0.00 to −0.19	No or negligible

Table 27 summarizes the results of the analysis, using eight years of data from 2006 through 2013. In the Barnett Shale region, there was a strong correlation between the number of new horizontal wells and the number of crashes (regardless of location or type of vehicles involved). The correlation between the number of new vertical wells and the number of crashes was weak to negligible.

Table 27. Pearson Correlation Coefficients.

		Number of New Horizontal Wells	Number of New Vertical Wells
Barnett Shale Region	Number of Crashes	0.56	-0.15
	Number of Rural Crashes	0.62	-0.24
	Number of CMV Crashes	0.52	-0.19
	Number of Rural CMV Crashes	0.63	-0.10
Eagle Ford Shale Region	Number of Crashes	0.12	0.16
	Number of Rural Crashes	-0.07	-0.22
	Number of CMV Crashes	0.39	0.09
	Number of Rural CMV Crashes	0.57	-0.10
Permian Basin Region	Number of Crashes	-0.08	0.07
	Number of Rural Crashes	0.03	0.33
	Number of CMV Crashes	0.06	0.29
	Number of Rural CMV Crashes	0.23	0.47
Remaining 175 Counties	Number of Crashes	-0.04	-0.03
	Number of Rural Crashes	-0.03	0.00
	Number of CMV Crashes	-0.02	-0.02
	Number of Rural CMV Crashes	0.00	0.06

In the Eagle Ford Shale region, there was a strong correlation between the number of new horizontal wells and the number of rural CMV crashes. There was also a moderate correlation between the number of horizontal wells and the number of CMV crashes. All other correlations were weak to negligible.

In the Permian Basin region, there was a strong correlation between the number of new vertical wells and the number of rural CMV crashes. There was also a moderate correlation between the number of new vertical wells and the number of rural crashes and the number of CMV crashes. All other correlations were weak to negligible.

Based on these results, the research team focused further on rural CMV-related crashes, more specifically, to establish potential correlations between changes in the number of rural CMV crashes from 2006–2009 to 2010–2013 at the county level and the corresponding changes in the number of new horizontal and vertical wells. Because of some uncertainties regarding the number of crashes resulting in unknown and possible injuries, the research team decided to focus on fatal, incapacitating, and non-incapacitating injury crashes. Table 28 shows the corresponding Pearson correlation coefficients.

Table 28. Pearson Correlation Coefficients – Change in the Number of Rural KAB CMV Crashes vs. Change in the Number of New Wells from 2006–2009 to 2010–2013.

		Change in Number of New Horizontal Wells	Change in Number of New Vertical Wells
Barnett Shale Region	Change in Numbe of Rural KAB CMV Crashes	0.88	-0.25
Eagle Ford Shale Region		0.77	0.03
Permian Basin Region		0.22	0.72
Remaining 175 Counties		-0.04	0.31

In the Barnett Shale region, there was a very strong correlation between the change in the number of new horizontal wells and that of rural CMV crashes. In the Eagle Ford Shale region, the correlation between these two variables was also very strong. In the Permian Basin region, there was a strong correlation between the change in the number of new vertical wells and that of rural CMV crashes. Other correlations were weak to negligible.

Figure 13 shows a scatter plot of the change in the number of rural KAB CMV crashes versus the change in the number of new horizontal wells. Each point on the scatter plot corresponds to one county. Figure 13 also shows linear regression lines for county-level data from the Eagle Ford Shale, Barnett Shale, and Permian Basin regions. These regression models could be used for forecasting purposes in situations where other factors remain reasonably stable, and there is a need for high-level estimates.

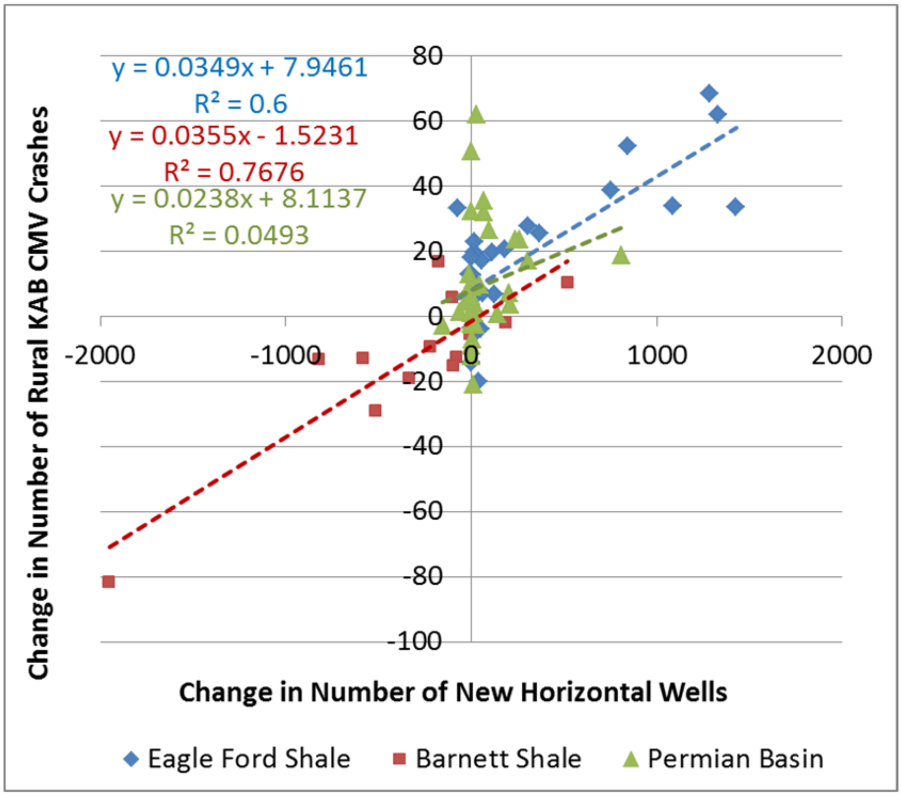


Figure 13. Change in the Number of Rural KAB CMV Crashes vs. Change in the Number of Horizontal Wells.

Overall, the predictive power of the regression models is much higher for the Eagle Ford Shale and Barnett Shale regions than for the Permian Basin region. Nevertheless, the similarity between the trends for the Eagle Ford Shale and the Barnett Shale regions in Figure 13 suggests a generalized trend that could be used to estimate positive (or negative) changes in the number of rural KAB CMV crashes in Texas as a function of the positive (or negative) change in the number of new completed horizontal wells. For example, for a county with 1,000 new horizontal wells over four years, the anticipated increase in the number of rural KAB CMV crashes could be 40. Similarly, for a county with 2,000 fewer new horizontal wells over four years, the anticipated decrease in the number of rural KAB CMV crashes could be about 70.

The research team also developed statistical models to account for differences at the individual county level. The initial dataset included 2,032 records (one record per year per county) from 2006–2013. The research team used 2006–2012 data for model calibration and 2013 data for model validation. Initially, the research team explored several combinations of independent variables and variable selection methods, and used Bayesian analysis to improve model accuracy. After noticing that the corresponding improvement was negligible (compared to simpler non-Bayesian models), the research team developed three models that met an expectation of simplicity for potential implementation:

Model 1 (ordinary least squares regression model):

$$Y_i = 0.0281 \times H_i + 0.0155 \times V_i + 7.34 \times 10^{-6} \times VMT_i + \varepsilon_i$$

Model 2 (ordinary least squares regression model):

$$Y_i = \beta_i + 0.0349 \times H_i + 0.0156 \times V_i + \varepsilon_i$$

Model 3 (analysis of covariance (ANCOVA) model):

$$E(Transformed\ Y_i) = -10.6 + \beta_i + 0.00428 \times H_i + 0.00219 \times V_i + 2.26 \times \log(VMT_i) + \varepsilon_i$$

or

$$Y_i = \left(-10.6 + \ \beta_i + 0.00428 \times H_i + 0.00219 \times V_i + 2.26 \times log(VMT_i)\right)^2 - \frac{3}{8} + \varepsilon_i$$

where

i	= County of interest (1 through 254)
Y_i	= Number of rural KAB CMV crashes on state and county roads per year in county i
$Transformed\ Y_i$	= $(Y_i + \frac{3}{8})^{1/2}$
$E(Transformed\ Y_i)$	= Mean value of $Transformed\ Y_i$
H_i	= Number of new horizontal wells per year in county i
V_i	= Number of new vertical wells per year in county i
VMT_i	= VMT on state roads per year in county i
β_i	= Coefficient for county i
ε_i	= Random error for county i

The appendix provides a list of all the coefficients and other relevant data related to the statistical analysis conducted to develop Models 1,2, and 3.

All independent variables used in the models are statistically significant at the 95 percent confidence interval. In all three models, the beta coefficient for H_i was larger than the beta coefficient for V_i, suggesting that an increase in the number of new horizontal wells is likely to yield more crashes, compared to the same increase in the number of new vertical wells. This is consistent with field observations, which point to a significantly larger number of trucks needed to develop horizontal wells compared to the number of trucks needed to develop vertical wells.

Figure 14 shows a comparison between the observed number of rural KAB CMV crashes in 2013 and the predicted values using the three models. Overall, the predictive power (R^2) of Model 1 was similar to that of Model 2, but Model 3 outperformed the other two models. Nevertheless, F-test and two-sample t-test results showed that the means of the predicted values and the variances of the predicted values were not statistically different.

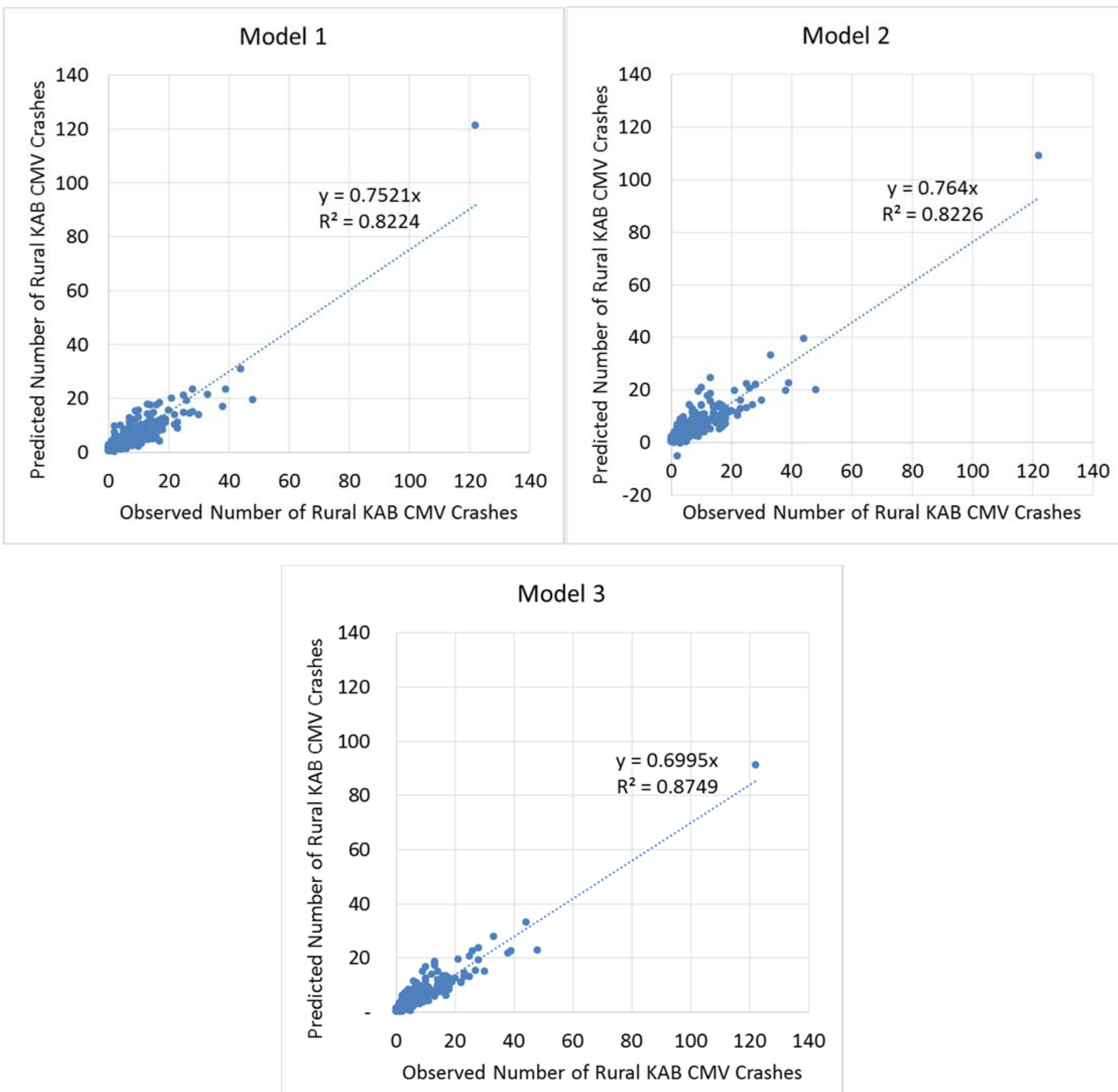


Figure 14. Observed versus Predicted Number of Rural KAB CMV Crashes in 2013.

To understand the similarities and differences between models further, the research team classified counties into three groups based on the 33rd and the 66th percentiles of the observed number of rural KAB CMV crashes in 2013: low (0–3), medium (4–9), and high (>10). Then, the research team estimated the average coefficient of variation (ACV) for every group within each region, as follows:

$$ACV_i = \frac{1}{n} \times \sum_{i=1}^{n} \frac{\sqrt{\left(Y_{i,predicted} - \overline{Y_i}\right)^2 + \left(Y_{i,observed} - \overline{Y_i}\right)^2}}{\overline{Y_i}} \times 100$$

where

n	= Number of counties in Texas (254)
$Y_{i,predicted}$	= Predicted number of crashes in county i
$Y_{i,observed}$	= Observed number of crashes in county i
$\overline{Y_i}$	= Average of $Y_{i,predicted}$ and $Y_{i,observed}$

Table 29 shows ACV values for all three models. In general, ACVs were higher for groups of counties with the lowest number of rural KAB CMV crashes, and decreased as the number of rural KAB CMV crashes increased. With a few exceptions, there were not significant differences between the models within each group, indicating that any of the models would perform adequately in most cases.

Table 29. Average Coefficient of Variation.

Region	Number of Rural KAB CMV Crashes per County (2013)	Number of Counties	ACV (Model 1)	ACV (Model 2)	ACV (Model 3)
Barnett Shale	Low: 0-3	4	53.5%	117.1%	29.3%
	Medium: 4-9	5	14.9%	17.9%	18.8%
	High: >10	4	44.0%	39.0%	40.7%
Eagle Ford Shale	Low: 0-3	0	-	-	-
	Medium: 4-9	14	30.1%	33.0%	27.0%
	High: >10	15	27.5%	28.5%	27.2%
Permian Basin	Low: 0-3	13	77.2%	76.2%	76.7%
	Medium: 4-9	11	27.8%	36.3%	27.0%
	High: >10	13	38.7%	46.7%	40.3%
Remaining 175 Counties	Low: 0-3	70	48.8%	55.2%	51.3%
	Medium: 4-9	68	34.0%	30.5%	29.5%
	High: >10	37	36.1%	26.2%	29.8%
	Low: 0-3		53.3%	61.2%	54.1%
	Medium: 4-9		40.1%	30.8%	28.3%
	High: >10		35.2%	31.3%	31.8%

Economic Impact of Crashes

The research team developed preliminary estimates of the change in the cost of injuries from 2006–2009 to 2010–2013 using standardized economic and comprehensive crash cost estimates from NSC and comprehensive crash cost estimates from U.S. DOT (*3*, *4*).

Economic costs rely on calculable costs such as wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employers' uninsured costs. Comprehensive costs include economic cost components and a measure of the value of lost quality of life, which makes comprehensive costs appropriate to analyze the anticipated benefit of future improvements (because they provide a measure of what people would be willing to pay for improved safety). In general, the U.S. DOT's methodology for comprehensive cost estimates, which are based on a concept called the value of a statistical life, are considerably higher than those resulting from the NSC methodology.

Economic costs in 2013 dollars, according to the NSC methodology, are as follows:

- Death: $1,500,000
- Incapacitating injury (i.e., Class A): $74,900
- Non-incapacitating injury (i.e., Class B): $24,000

- Possible injury (i.e., Class C): $13,600

Comprehensive costs include both the economic cost components above and a measure of the value of lost quality of life, and are therefore appropriate to use as a reference to analyze the anticipated benefit of future improvements (because they provide a measure of what people would be willing to pay for improved safety). In 2013 dollars, comprehensive costs of motor vehicle crashes are as follows:

- Death $4,628,000
- Incapacitating injury $235,400
- Non-incapacitating evident injury $60,000
- Possible injury $28,600

These dollar amounts do not include property damage-only crashes.

According to the U.S. DOT methodology, VSL was $9.1 million in 2012 dollars. For subsequent years, the methodology recommends adjusting this value using a 1.07 percent annual growth rate. In 2014 dollars, adjusted VSL was $9,295,782. The guidance also includes six injury severity levels, each one with a factor to estimate the corresponding comprehensive cost, as shown in Table 30.

Table 30. Injury Severity Levels and Estimated Comprehensive Costs (Adapted from *4*).

Severity Level	Fraction of VSL	Comprehensive Cost Adjusted for 2014	Corresponding Type of Injury Used in the Analysis	Estimated Comprehensive Cost
Minor	0.003	$27,887	Possible Injury	$232,395
Moderate	0.047	$436,902		
Serious	0.105	$976,057	Non-Incapacitating	$976,057
Severe	0.266	$2,472,678	Incapacitating	$3,992,538
Critical	0.593	$5,512,399		
Un-survivable	1.000	$9,295,782	Fatal	$9,295,782

The severity levels in Table 30 provide a measure of survivability using the abbreviated injury scale, which is different from the system of classification of injuries in CRIS. This is a common problem reflecting different practices between police agencies (which normally complete crash reports) and health providers (which care for the injured). Information on how to map injury levels from one system to the other is not available. For simplicity, the research team assumed that possible injuries in CRIS captured a large percentage of minor and moderate injuries, non-incapacitating injuries in CRIS captured serious injuries, incapacitating injuries in CRIS included severe and critical injuries, and fatal injuries in CRIS corresponded to un-survivable injuries.

Table 30 shows the result of this mapping process, along with the corresponding comprehensive costs for each injury level in CRIS.

Table 31 summarizes the result of the analysis. Because the correlation between new completed wells and rural CMV crashes was stronger than for other types of crashes, the research team only included the number of injuries resulting from rural CMV crashes. Further, the research team only included the number of fatal, incapacitating, non-incapacitating, and possible injuries in the cost calculation. In the Barnett Shale region, there was a 35 percent decrease (i.e., $73 million in economic costs or $425 million in comprehensive costs) in NSC-based costs and a 30 percent decrease (i.e., $763 million) in VSL-based comprehensive costs. The cost reduction was the result of fewer rural CMV crashes and, correspondingly, fewer injuries. In the Eagle Ford Shale region, there was a 52 percent increase (i.e., $139 million in economic costs or $801 million in comprehensive costs) in NSC-based costs and a 68 percent increase (i.e., $2 billion) in VSL-based comprehensive costs. In the Permian Basin region, there was a 103 percent increase (i.e., $176 million in economic costs or $1.03 billion in comprehensive costs) in NSC-based costs and a 97 percent increase (i.e., $2 billion) in VSL-based comprehensive costs.

Table 31. Changes in Economic and Comprehensive Costs for Injuries Occurred in Rural CMV Crashes.

Cost of Rural CMV Injuries (Million)												
Region	Economic Cost (NSC)				Comprehensive Cost (NSC)				Comprehensive Cost (VSL)			
	2006-09	2010-13	Change	Diff.	2006-09	2010-13	Change	Diff.	2006-09	2010-13	Change	Diff.
Barnett Shale	$ 212	$ 138	$ (73)	-35%	$ 1,224	$ 799	$ (425)	-35%	$ 2,510	$ 1,747	$ (763)	-30%
Eagle Ford Shale	$ 269	$ 408	$ 139	52%	$ 1,548	$ 2,349	$ 801	52%	$ 2,931	$ 4,927	$1,996	68%
Permian Basin	$ 171	$ 348	$ 176	103%	$ 981	$ 2,011	$1,030	105%	$ 2,051	$ 4,045	$1,994	97%
Other	$ 1,615	$ 1,567	$ (47)	-3%	$ 9,229	$ 8,988	$ (241)	-3%	$19,796	$19,205	$ (591)	-3%
Grand Total	**$ 2,266**	**$ 2,461**	**$ 194**	**9%**	**$12,981**	**$14,146**	**$1,165**	**9%**	**$27,288**	**$29,924**	**$2,636**	**10%**

The huge increase in the cost of injuries resulting from rural CMV crashes in the Eagle Ford Shale and Permian Basin regions (covering 66 counties in total) was largely responsible for the net increase in the cost of injuries resulting from rural CMV crashes in the state from 2006–2009 to 2010–2013. As Table 31 shows, the net increase was 9 percent overall, even though there was a 35 percent reduction in the Barnett Shale region (covering 13 counties) and a 3 percent reduction in 175 other counties around the state.

Chapter 3. Findings

In fall 2014, the Texas Legislature asked TTI to update a study completed in late 2011 documenting locations and trends of oil and gas energy developments in the state (*1*). As part of the study, the Texas Legislature asked TTI to correlate oil and gas developments with changes in pavement condition data. TTI summarized the results of this analysis in a report published in March 2015 (*2*).

To complement the study, the Texas Legislature asked TTI to gather and process crash data at a level of spatial and temporal detail needed to document locations and trends of crashes in relation to oil and gas energy developments in the state. To accomplish this goal, the research team gathered and processed data from TxDOT's Crash Record Information System. Available data from CRIS covered the 2010–2014 period. The research team complemented this information with historical crash data from 2003–2009 that TTI had received from TxDOT before the introduction of CRIS.

Location and attribute data about crashes and injuries (i.e., number of people who are injured in crashes) that the research team compiled included the following types of crashes:

- All crashes.
- Rural crashes (i.e., crashes that occur outside city limits).
- CMV crashes (i.e., crashes in which CMVs are involved).
- Rural CMV crashes.
- Crashes on state highways.
- Crashes on rural state highways.
- CMV crashes on state highways.
- CMV crashes on rural state highways.

With this information, the research team examined changes in the number of crashes and the number of injuries from 2006–2009 to 2010–2013. These date ranges were used for consistency with those in the original March 2015 report. The year 2009 was significant because this was when accelerated oil production started in the Eagle Ford Shale region and oil production in the Permian Basin region began to accelerate, making the end of 2009 suitable for use as a baseline for comparison purposes. The last year with reliable Railroad Commission data was 2013 (2014 data were still preliminary). In addition, the economic recession of 2008 caused significant volatility in the oil markets, which resulted in dramatic swings in prices, drilling, and production. In order to reduce the impact of these variations, the research team aggregated and compared data using two four-year blocks: 2006–2009 and 2010–2013.

This chapter replicates tables from Chapter 2, which illustrate the changes. In particular, Table 32 shows changes in the number of crashes on all highways, and Table 33 shows changes in the number of injuries on all highways. Table 32 shows changes in the number of crashes on all highways from 2006–2009 to 2010–2013. In total, the number of crashes decreased by 10 percent in the Barnett Shale region, increased by 1 percent in the Eagle Ford Shale region, and decreased by 4 percent in the Permian Basin region. As a reference, the number of crashes decreased by 7 percent in all other 175 counties in the state.

These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. The changes were more prominent for rural crashes. The changes were even more noticeable for crashes that involved CMVs and, particularly, for rural crashes that involved CMVs. In most cases, as the severity of the injuries worsened, the changes in the corresponding number of crashes were more evident.

Relative changes in the number of crashes on state highways were similar to those found for all highways. The changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. Overall, the percentage of crashes occurring on state highways increased. For all crashes, the increase was from 54 to 56 percent. For fatal, incapacitating, and non-incapacitating injury crashes, the increase was from 59 to 61 percent. For fatal crashes, the increase was from 74 to 76 percent. These percentages were higher for rural roads. For example, for rural CMV crashes, the percentage of crashes on state highways decreased slightly from 78 to 77 percent. For fatal, incapacitating, and non-incapacitating injury crashes, this percentage increased from 90 to 91 percent. For fatal crashes, it decreased slightly but stayed around 96 percent.

The research team calculated crash rates expressed both as the number of crashes per 100 million VMT and number of crashes per 100 lane-miles. The results were similar with both approaches, although rates expressed as number of crashes per 100 lane-miles were more stable particularly for roadway segments with low traffic volumes. Table 34 shows the changes in the number of crashes over four years per 100 lane-miles from 2006–2009 to 2010–2013. In total, the crash rate decreased by 4 percent in the Barnett Shale region, increased by 7 percent in the Eagle Ford Shale region, and increased by 11 percent in the Permian Basin region. These changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region. The changes were more prominent for rural crashes. The changes were even more evident for crashes that involved CMVs and, in particular, for rural CMV crashes. In most cases, as the severity of the injuries worsened, the changes in the corresponding crash rate were more evident.

Table 32. Changes in the Number of Crashes on All Highways.

Note: Green dots correspond to decreases in the number of crashes (desirable trend). Red dots correspond to increases in the number of crashes (undesirable trend).

(a) All crashes

Region	Number of Crashes (Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown)											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	184,735	166,474	-10%	24,572	18,521	-25%	14,119	12,367	-12%	3,130	2,061	-34%
Eagle Ford Shale	85,964	86,744	1%	27,660	28,804	4%	6,607	8,708	32%	2,820	4,542	61%
Permian Basin	80,891	77,511	-4%	15,689	17,426	11%	4,775	6,368	33%	2,464	3,743	52%
Other	1,410,907	1,306,749	-7%	288,715	284,431	-1%	90,081	77,755	-14%	26,221	23,942	-9%
Grand Total	**1,762,497**	**1,637,478**	**-7%**	**356,636**	**349,182**	**-2%**	**115,582**	**105,198**	**-9%**	**34,635**	**34,288**	**-1%**

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Number of Fatal, Incapacitating, Non-Incapacitating Crashes											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	31,739	30,728	-3%	5,346	4,165	-22%	2,124	1,846	-13%	642	474	-26%
Eagle Ford Shale	14,382	15,264	6%	6,889	6,948	1%	1,096	1,641	50%	662	1,173	77%
Permian Basin	11,520	12,019	4%	3,841	4,524	18%	883	1,333	51%	617	971	57%
Other	204,134	201,541	-1%	57,296	54,123	-6%	12,568	11,792	-6%	4,998	4,751	-5%
Grand Total	**261,775**	**259,552**	**-1%**	**73,372**	**69,760**	**-5%**	**16,671**	**16,612**	**0%**	**6,919**	**7,369**	**7%**

(c) Fatal injury crashes

Region	Number of Fatal Crashes											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	1,202	1,030	-14%	459	325	-29%	181	135	-25%	101	63	-37%
Eagle Ford Shale	851	902	6%	629	694	10%	129	204	58%	102	179	76%
Permian Basin	648	789	22%	430	518	20%	94	183	94%	80	151	88%
Other	9,465	8,954	-5%	4,673	4,293	-8%	1,177	1,170	-1%	663	684	3%
Grand Total	**12,166**	**11,675**	**-4%**	**6,191**	**5,830**	**-6%**	**1,582**	**1,692**	**7%**	**946**	**1,077**	**14%**

Table 33. Changes in the Number of Injuries on All Highways.

Note: Green dots correspond to decreases in the number of injuries (desirable trend). Red dots correspond to increases in the number of injuries (undesirable trend).

(a) All crashes

Region	Number of Injuries (Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown)											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	521,304	446,866	-14%	58,038	38,861	-33%	56,707	37,827	-33%	14,923	5,518	-63%
Eagle Ford Shale	241,484	230,497	-5%	63,650	61,679	-3%	28,518	24,812	-13%	19,625	11,395	-42%
Permian Basin	225,483	202,170	-10%	37,286	37,788	1%	16,734	16,109	-4%	7,992	8,580	7%
Other	4,003,334	3,546,753	-11%	738,597	691,735	-6%	370,987	254,011	-32%	109,719	72,430	-34%
Grand Total	**4,991,605**	**4,426,286**	**-11%**	**897,571**	**830,063**	**-8%**	**472,946**	**332,759**	**-30%**	**152,258**	**97,923**	**-36%**

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Number of Fatal, Incapacitating, Non-Incapacitating Injuries											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	42,345	40,919	-3%	7,285	5,609	-23%	2,823	2,452	-13%	840	627	-25%
Eagle Ford Shale	20,637	21,945	6%	10,207	10,257	0%	1,654	2,385	44%	1,006	1,755	75%
Permian Basin	15,704	16,515	5%	5,591	6,632	19%	1,115	1,868	67%	786	1,379	76%
Other	278,208	273,913	-2%	80,963	75,957	-6%	17,635	16,385	-7%	6,920	6,779	-2%
Grand Total	**356,894**	**353,292**	**-1%**	**104,046**	**98,455**	**-5%**	**23,228**	**23,090**	**-1%**	**9,552**	**10,540**	**10%**

(c) Fatal injury crashes

Region	Number of Fatal Injuries											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	1,294	1,125	-13%	499	364	-27%	201	150	-26%	111	71	-36%
Eagle Ford Shale	1,002	1,047	4%	763	825	8%	169	237	40%	143	211	47%
Permian Basin	738	914	24%	499	619	24%	103	224	117%	88	184	109%
Other	10,562	9,854	-7%	5,347	4,837	-10%	1,433	1,326	-7%	813	797	-2%
Grand Total	**13,596**	**12,940**	**-5%**	**7,108**	**6,645**	**-7%**	**1,907**	**1,937**	**2%**	**1,155**	**1,263**	**9%**

Table 34. Number of Crashes over Four Years per 100 Lane-Miles.

Note: Green dots correspond to decreases in crash rates (desirable trend). Red dots correspond to increases in crash rates (undesirable trend).

(a) All crashes

Region	Fatal, Incapacitating, Non-Incapacitating, Possible Injury, No-Injury, Unknown Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	777.9	743.7	-4%	230.2	177.9	-23%	76.5	70.8	-8%	35.9	24.8	-31%
Eagle Ford Shale	261.2	278.4	7%	123.4	133.2	8%	24.1	34.4	43%	14.4	23.7	65%
Permian Basin	169.2	187.5	11%	59.8	69.9	17%	15.9	22.6	42%	10.9	16.8	54%
Other	532.2	505.5	-5%	184.7	173.2	-6%	44.3	40.2	-9%	21.2	19.4	-9%

(b) Fatal, incapacitating, and non-incapacitating injury crashes

Region	Fatal, Incapacitating, Non-Incapacitating Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	142.4	143.1	0%	54.0	42.6	-21%	12.8	11.5	-10%	8.2	6.1	-26%
Eagle Ford Shale	48.9	53.6	10%	31.9	33.3	4%	4.7	7.2	53%	3.6	6.2	74%
Permian Basin	28.3	34.0	20%	15.2	18.7	23%	3.3	5.1	54%	2.8	4.4	57%
Other	83.6	84.0	0%	40.5	37.5	-7%	7.1	6.9	-2%	4.5	4.3	-4%

(c) Fatal injury crashes

Region	Fatal Crash Rates											
	All			Rural			CMV-Involved			Rural & CMV-Involved		
	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.	2006-09	2010-13	Diff.
Barnett Shale	6.8	5.8	-14%	5.2	3.8	-27%	1.3	0.9	-27%	1.4	0.8	-40%
Eagle Ford Shale	3.5	3.8	9%	3.2	3.5	10%	0.6	1.0	60%	0.6	1.0	75%
Permian Basin	2.1	2.8	34%	1.8	2.2	28%	0.4	0.7	83%	0.4	0.7	76%
Other	5.0	4.7	-5%	3.8	3.4	-10%	0.8	0.8	-1%	0.6	0.7	4%

The research team established correlations by comparing pairs of metrics representing historical data aggregated at the county level. In the Barnett Shale region, there was a strong correlation between the number of new horizontal wells and the number of crashes (regardless of location or type of vehicles involved). In the Eagle Ford Shale region, there was a strong correlation between the number of new horizontal wells and the number of rural CMV crashes. In the Permian Basin region, there was a strong correlation between the number of new vertical wells and the number of rural CMV crashes. It is worth noting that in the Permian Basin, although the relative change in the number of horizontal wells was considerably higher than for vertical wells, in absolute terms the number of new vertical wells was much higher than the number of new horizontal wells. Judging from the trends in the Eagle Ford Shale and Barnett Shale regions, as the industry shifts from vertical drilling to horizontal drilling in the Permian Basin, the correlation between new horizontal wells and rural CMV crashes in that part of the state will likely increase.

In the Barnett Shale region, there was a very strong correlation between the *change* in the number of new horizontal wells and the *change* in the number of rural CMV crashes. In the Eagle Ford Shale region, the correlation between these two variables was also very strong. In the Permian Basin region, there was a strong correlation between the change in the number of new vertical wells and that of rural CMV crashes.

The research team used this information to develop regression models for county-level data from the Eagle Ford Shale, Barnett Shale, and Permian Basin regions that could be used for forecasting purposes in situations where other factors remain reasonably stable and there is a need for high-level estimates. These models suggest a generalized trend that could be used to estimate positive (or negative) changes in the number of rural CMV crashes in Texas as a function of the positive (or negative) change in the number of new horizontal wells.

The research team also developed statistical models to account for differences at the individual county level. The result of the modeling effort was three models: two least squares regression models and an analysis of covariance model with a transformed independent variable. The models were calibrated using data from 2006–2012 and validated using data from 2013.

The research team developed preliminary estimates of the change in the cost of injuries from 2006–2009 to 2010–2013 using standardized economic and comprehensive crash cost estimates from NSC and comprehensive crash cost estimates from U.S. DOT. Because the correlation between new completed wells and rural CMV crashes was stronger than for other types of crashes, the research team only included the number of injuries in rural CMV crashes. Further, the research team only included the number of fatal, incapacitating, non-incapacitating, and possible injuries in the calculation.

Table 35 summarizes the result of the analysis. In the Barnett Shale region, there was a 35 percent decrease (i.e., $73 million in economic costs or $425 million in comprehensive costs) in NSC-based costs and a 30 percent decrease (i.e., $763 million) in VSL-based comprehensive costs. The cost reduction was the result of fewer rural CMV crashes and, correspondingly, fewer injuries. In the Eagle Ford Shale region, there was a 52 percent increase (i.e., $139 million in economic costs or $801 million in comprehensive costs) in NSC-based costs and a 68 percent increase (i.e., $2 billion) in VSL-based comprehensive costs. In the Permian Basin region, there was a 103 percent increase (i.e., $176 million in economic costs or $1.03 billion in comprehensive costs) in NSC-based costs and a 97 percent increase (i.e., $2 billion) in VSL-based comprehensive costs.

Table 35. Changes in Economic and Comprehensive Costs for Injuries Occurred in Rural CMV Crashes.

Cost of Rural CMV Injuries (Million)												
Region	Economic Cost (NSC)				Comprehensive Cost (NSC)				Comprehensive (VSL)			
	2006-09	2010-13	Change	Diff.	2006-09	2010-13	Change	Diff.	2006-09	2010-13	Change	Diff.
Barnett Shale	$ 212	$ 138	$ (73)	-35%	$ 1,224	$ 799	$ (425)	-35%	$ 2,510	$ 1,747	$ (763)	-30%
Eagle Ford Shale	$ 269	$ 408	$ 139	52%	$ 1,548	$ 2,349	$ 801	52%	$ 2,931	$ 4,927	$1,996	68%
Permian Basin	$ 171	$ 348	$ 176	103%	$ 981	$ 2,011	$1,030	105%	$ 2,051	$ 4,045	$1,994	97%
Other	$ 1,615	$ 1,567	$ (47)	-3%	$ 9,229	$ 8,988	$ (241)	-3%	$19,796	$19,205	$ (591)	-3%
Grand Total	**$ 2,266**	**$ 2,461**	**$ 194**	**9%**	**$12,981**	**$14,146**	**$1,165**	**9%**	**$27,288**	**$29,924**	**$2,636**	**10%**

The huge increase in the cost of injuries resulting from rural CMV crashes in the Eagle Ford Shale and Permian Basin regions (covering 66 counties in total) was largely responsible for the net increase in the cost of injuries resulting from rural CMV crashes in the state from 2006–2009 to 2010–2013. As Table 35 shows, the net increase was 9 percent overall, even though there was a 35 percent reduction in the Barnett Shale region (covering 13 counties) and a 3 percent reduction in 175 other counties around the state.

In practical terms, the research results mean the following:

- The number of crashes and resulting injuries increased along with oil and gas well development activities, but the changes were not uniform either by crash location and type of vehicles involved or by injury severity. There were also significant differences geographically within each region.
- The increases in the number of crashes and injuries were more prominent in rural areas where energy developments take place (i.e., Eagle Ford Shale and Permian Basin regions). The highest increase was in the case of rural CMV crashes. Overall, there was a strong correlation between rural CMV crashes and the number of new wells.
- The percentage of crashes on state highways increased. As the severity of the injuries increased, the percentage of crashes on state highways also increased. For rural CMV crashes, the percentage of crashes on state highways increased from 81 to 83 percent. For fatal, incapacitating, and non-incapacitating injury crashes, this percentage increased from 89 to 90 percent. For fatal crashes, it increased slightly but stayed around 95 percent.

- The cost of injuries resulting from rural CMV crashes in energy development regions increased significantly and was largely responsible for the net increase in the cost of injuries resulting from rural CMV crashes in the state from 2006–2009 to 2010–2013. In the Eagle Ford Shale region, the increase was $139 million in economic costs or $801 million–$2 billion in comprehensive costs. In the Permian Basin region, the increase was $176 million in economic costs or $1.03–2.0 billion in comprehensive costs. These costs are of the same order of magnitude as the impact of energy developments on the transportation infrastructure (estimated at $1 billion per year on state highways and an additional $1 billion on county and local roads).

References

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2. Quiroga, C., Tsapakis, I., Kraus, E., Le, J., and Wimsatt, A. *Oil and Gas Energy Developments and Changes in Pavement Conditions in Texas*. Final Report. Report PRC 14-35F. Transportation Policy Center, Texas A&M Transportation, College Station, Texas, March 2015.
3. Estimating the Cost of Unintentional Injuries, 2013. National Safety Council, Itasca, Illinois, 2015.
4. Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses. Office of the Secretary of Transportation, U.S. Department of Transportation, 2013.

Appendix

This appendix provides relevant data related to the statistical analysis conducted to develop Model 1 (Table 36), Model 2 (Table 37), and Model 3 (Table 38).

Table 36. Summary Results of Statistical Analysis for Model 1.

Parameter	β	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
H_i	0.0281	0.002	18.007	1.02E-66	0.0250	0.0311	0.154
V_i	0.0155	0.001	14.643	6.40E-46	0.0135	0.0176	0.108
VMT_i	7.34E-06	7.51E-08	97.768	1.12E-74	7.19E-06	7.49E-06	0.843

Table 37. Summary Results of Statistical Analysis for Model 2.

Parameter	β	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
H_i	0.0349	0.00232	15.01	1.26E-47	.0303	.0395	0.129
V_i	0.0156	0.00172	9.07	3.67E-19	.0122	.0190	0.0512
Parameter Estimates for Counties in the Barnett Shale Region							
Cooke	3.60	1.30	2.78	5.51E-03	1.06	6.15	5.05E-03
Denton	6.58	1.34	4.91	9.88E-07	3.95	9.20	1.56E-02
Erath	7.45	1.29	5.76	9.98E-09	4.92	9.99	2.14E-02
Hill	9.50	1.29	7.34	3.42E-13	6.96	12.0	3.42E-02
Hood	5.24	1.32	3.98	7.19E-05	2.66	7.82	1.03E-02
Jack	2.20	1.30	1.69	9.05E-02	-0.347	4.74	1.88E-03
Johnson	7.74	1.71	4.54	6.20E-06	4.39	11.1	1.33E-02
Montague	5.66	1.31	4.32	1.70E-05	3.09	8.24	1.21E-02
Palo Pinto	5.87	1.29	4.54	6.11E-06	3.34	8.41	1.34E-02
Parker	11.7	1.35	8.61	1.74E-17	9.01	14.3	4.65E-02
Somervell	3.81	1.29	2.95	3.21E-03	1.28	6.35	5.69E-03
Tarrant	-8.24	1.74	-4.75	2.24E-06	-11.7	-4.84	1.46E-02
Wise	12.0	1.36	8.86	2.20E-18	9.35	14.7	4.90E-02
Parameter Estimates for Counties in the Eagle Ford Shale Region							
Atascosa	8.39	1.29	6.48	1.23E-10	5.85	10.9	2.69E-02
Bastrop	11.3	1.29	8.77	4.80E-18	8.79	13.9	4.81E-02
Bee	2.79	1.29	2.16	3.11E-02	0.254	5.33	3.05E-03
Brazos	4.71	1.29	3.64	2.82E-04	2.17	7.24	8.63E-03
Burleson	4.39	1.29	3.40	7.01E-04	1.85	6.92	7.52E-03

Parameter	β	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Caldwell	3.76	1.29	2.91	3.67E-03	1.23	6.30	5.53E-03
DeWitt	1.74	1.30	1.33	1.82E-01	-.819	4.30	1.17E-03
Dimmit	-0.0300	1.35	-0.021	9.83E-01	-2.67	2.61	2.95E-07
Duval	3.37	1.29	2.60	9.40E-03	0.827	5.90	4.42E-03
Fayette	8.31	1.29	6.43	1.69E-10	5.78	10.8	2.65E-02
Frio	3.26	1.29	2.52	1.17E-02	0.727	5.80	4.17E-03
Goliad	2.88	1.29	2.23	2.59E-02	0.346	5.42	3.25E-03
Gonzales	6.90	1.30	5.30	1.32E-07	4.35	9.46	1.81E-02
Grimes	9.38	1.29	7.26	6.25E-13	6.84	11.9	3.35E-02
Guadalupe	10.1	1.29	7.81	1.07E-14	7.55	12.6	3.85E-02
Jim Wells	7.37	1.29	5.71	1.39E-08	4.84	9.90	2.09E-02
Karnes	3.81	1.32	2.88	4.05E-03	1.21	6.41	5.41E-03
Lampasas	3.29	1.32	2.48	1.31E-02	0.693	5.89	4.04E-03
Lavaca	3.83	1.29	2.96	3.15E-03	1.29	6.37	5.71E-03
Lee	6.20	1.29	4.80	1.72E-06	3.67	8.74	1.49E-02
Live Oak	6.21	1.29	4.80	1.75E-06	3.67	8.75	1.49E-02
Maverick	-2.57	1.43	-1.80	7.19E-02	-5.37	0.23	2.13E-03
McMullen	4.47	1.30	3.45	5.83E-04	1.92	7.01	7.74E-03
Robertson	13.5	1.30	10.4	1.23E-24	11.0	16.1	6.67E-02
Victoria	8.59	1.29	6.64	4.41E-11	6.05	11.1	2.81E-02
Washington	8.05	1.29	6.23	5.88E-10	5.52	10.6	2.49E-02
Webb	6.40	1.38	4.64	3.72E-06	3.70	9.10	1.40E-02
Wilson	3.25	1.29	2.52	1.20E-02	0.715	5.78	4.14E-03
Zavala	3.07	1.29	2.38	1.75E-02	0.539	5.61	3.70E-03
Parameter Estimates for Counties in the Permian Basin Region							
Andrews	-2.07	1.71	-1.21	2.26E-01	-5.41	1.28	9.63E-04
Borden	-0.29	1.29	-0.223	8.24E-01	-2.82	2.25	3.26E-05
Cochran	0.870	1.29	0.672	5.01E-01	-1.67	3.40	2.97E-04
Coke	1.87	1.29	1.45	1.48E-01	-0.663	4.41	1.38E-03
Crane	-0.390	1.31	-0.295	7.68E-01	-2.95	2.18	5.73E-05
Crockett	3.68	1.33	2.77	5.65E-03	1.08	6.29	5.02E-03
Crosby	-0.06	1.29	-0.043	9.65E-01	-2.60	2.48	1.24E-06
Dawson	0.48	1.29	0.373	7.10E-01	-2.06	3.02	9.12E-05
Dickens	0.89	1.29	0.691	4.90E-01	-1.64	3.43	3.14E-04
Ector	11.1	1.43	7.76	1.53E-14	8.29	13.9	3.81E-02
Gaines	-0.31	1.32	-0.234	8.15E-01	-2.91	2.29	3.59E-05
Garza	2.82	1.29	2.18	2.92E-02	0.286	5.36	3.12E-03
Glasscock	0.08	1.37	0.058	9.54E-01	-2.61	2.76	2.20E-06
Hockley	4.83	1.30	3.73	2.00E-04	2.29	7.37	9.05E-03
Howard	7.11	1.31	5.41	7.22E-08	4.53	9.68	1.89E-02

Parameter	β	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Irion	-0.27	1.30	-0.212	8.33E-01	-2.82	2.27	2.94E-05
Kent	0.21	1.29	0.161	8.72E-01	-2.33	2.74	1.71E-05
Loving	0.01	1.29	0.006	9.95E-01	-2.53	2.55	2.24E-08
Lubbock	6.91	1.29	5.35	1.03E-07	4.37	9.44	1.84E-02
Lynn	2.19	1.29	1.70	8.95E-02	-0.339	4.73	1.89E-03
Martin	6.08	1.30	4.66	3.48E-06	3.52	8.63	1.41E-02
Midland	13.1	1.41	9.32	3.95E-20	10.3	15.9	5.40E-02
Mitchell	4.12	1.33	3.10	1.94E-03	1.52	6.72	6.29E-03
Pecos	5.19	1.33	3.91	9.69E-05	2.58	7.79	9.94E-03
Reagan	-1.10	1.38	-0.801	4.23E-01	-3.80	1.60	4.22E-04
Reeves	5.26	1.30	4.03	5.76E-05	2.70	7.81	1.06E-02
Schleicher	0.86	1.29	0.664	5.07E-01	-1.68	3.39	2.89E-04
Scurry	6.16	1.30	4.74	2.28E-06	3.62	8.71	1.46E-02
Sterling	0.30	1.29	0.235	8.14E-01	-2.24	2.84	3.62E-05
Sutton	3.87	1.30	2.98	2.94E-03	1.32	6.41	5.80E-03
Terrell	1.02	1.29	0.786	4.32E-01	-1.52	3.55	4.06E-04
Terry	1.44	1.29	1.11	2.67E-01	-1.10	3.97	8.09E-04
Tom Green	8.31	1.29	6.43	1.75E-10	5.77	10.8	2.64E-02
Upton	-2.73	1.47	-1.86	6.35E-02	-5.61	0.15	2.26E-03
Ward	0.57	1.34	0.421	6.74E-01	-2.07	3.20	1.16E-04
Winkler	0.41	1.30	0.317	7.51E-01	-2.13	2.96	6.62E-05
Yoakum	0.59	1.31	0.452	6.51E-01	-1.98	3.17	1.34E-04
Parameter Estimates for the Remaining 175 Counties							
Anderson	8.40	1.29	6.50	1.07E-10	5.87	10.9	2.70E-02
Angelina	9.02	1.29	6.98	4.43E-12	6.48	11.6	3.10E-02
Aransas	2.03	1.29	1.57	1.16E-01	-0.500	4.57	1.63E-03
Archer	1.65	1.30	1.27	2.04E-01	-0.899	4.20	1.06E-03
Armstrong	2.57	1.29	1.99	4.67E-02	0.038	5.11	2.60E-03
Austin	6.64	1.29	5.14	3.10E-07	4.11	9.18	1.71E-02
Bailey	3.29	1.29	2.54	1.11E-02	0.752	5.82	4.23E-03
Bandera	1.99	1.29	1.54	1.23E-01	-0.540	4.53	1.56E-03
Baylor	2.36	1.29	1.82	6.83E-02	-0.177	4.89	2.18E-03
Bell	9.00	1.29	6.97	4.79E-12	6.47	11.5	3.09E-02
Bexar	21.7	1.29	16.8	3.59E-58	19.2	24.2	1.56E-01
Blanco	1.86	1.29	1.44	1.51E-01	-0.677	4.39	1.36E-03
Bosque	1.77	1.29	1.37	1.71E-01	-0.766	4.30	1.23E-03
Bowie	11.3	1.29	8.73	6.79E-18	8.74	13.8	4.76E-02
Brazoria	13.8	1.29	10.7	1.05E-25	11.3	16.3	6.97E-02
Brewster	1.14	1.29	0.883	3.77E-01	-1.39	3.67	5.12E-04
Briscoe	0.28	1.29	0.219	8.26E-01	-2.25	2.82	3.16E-05

Parameter	β	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Brooks	4.57	1.29	3.53	4.23E-04	2.03	7.10	8.14E-03
Brown	2.27	1.29	1.76	7.88E-02	-0.262	4.81	2.03E-03
Burnet	5.00	1.29	3.87	1.13E-04	2.47	7.53	9.75E-03
Calhoun	1.46	1.29	1.13	2.58E-01	-1.07	4.00	8.41E-04
Callahan	6.64	1.29	5.14	3.07E-07	4.11	9.18	1.71E-02
Cameron	3.70	1.29	2.87	4.20E-03	1.17	6.24	5.37E-03
Camp	2.27	1.29	1.76	7.85E-02	-0.260	4.81	2.03E-03
Carson	6.34	1.29	4.91	1.01E-06	3.81	8.88	1.56E-02
Cass	9.67	1.29	7.49	1.17E-13	7.14	12.2	3.55E-02
Castro	4.14	1.29	3.21	1.37E-03	1.61	6.68	6.71E-03
Chambers	21.6	1.29	16.7	6.54E-58	19.1	24.2	1.56E-01
Cherokee	8.40	1.29	6.50	1.08E-10	5.87	10.9	2.70E-02
Childress	1.28	1.29	0.990	3.22E-01	-1.25	3.81	6.44E-04
Clay	5.23	1.29	4.04	5.50E-05	2.69	7.76	1.06E-02
Coleman	0.91	1.29	0.708	4.79E-01	-1.62	3.45	3.29E-04
Collin	6.86	1.29	5.31	1.27E-07	4.32	9.39	1.82E-02
Collingsworth	0.85	1.29	0.657	5.12E-01	-1.69	3.38	2.83E-04
Colorado	11.6	1.29	8.99	7.19E-19	9.08	14.2	5.04E-02
Comal	7.00	1.29	5.42	6.96E-08	4.47	9.53	1.89E-02
Comanche	3.10	1.29	2.40	1.64E-02	0.568	5.64	3.78E-03
Concho	1.21	1.29	0.935	3.50E-01	-1.33	3.74	5.74E-04
Coryell	5.13	1.29	3.97	7.49E-05	2.60	7.66	1.03E-02
Cottle	0.34	1.29	0.263	7.93E-01	-2.19	2.87	4.53E-05
Culberson	3.41	1.29	2.64	8.32E-03	0.879	5.95	4.57E-03
Dallam	4.14	1.29	3.20	1.38E-03	1.60	6.67	6.70E-03
Dallas	2.39	1.29	1.85	6.48E-02	-0.147	4.92	2.24E-03
Deaf Smith	6.00	1.29	4.64	3.70E-06	3.47	8.53	1.40E-02
Delta	0.71	1.29	0.553	5.80E-01	-1.82	3.25	2.01E-04
Donley	5.86	1.29	4.53	6.23E-06	3.32	8.39	1.33E-02
Eastland	9.15	1.29	7.08	2.20E-12	6.61	11.7	3.19E-02
Edwards	0.01	1.29	0.010	9.92E-01	-2.52	2.55	6.32E-08
El Paso	8.43	1.29	6.52	9.24E-11	5.89	11.0	2.72E-02
Ellis	9.26	1.29	7.17	1.17E-12	6.73	11.8	3.27E-02
Falls	5.98	1.29	4.63	3.98E-06	3.45	8.51	1.39E-02
Fannin	4.42	1.29	3.42	6.31E-04	1.89	6.96	7.65E-03
Fisher	0.40	1.29	0.309	7.58E-01	-2.14	2.93	6.26E-05
Floyd	0.70	1.29	0.542	5.88E-01	-1.83	3.23	1.93E-04
Foard	-0.100	1.29	-0.076	9.39E-01	-2.63	2.44	3.79E-06
Fort Bend	13.5	1.29	10.4	1.02E-24	11.0	16.0	6.69E-02
Franklin	2.62	1.29	2.03	4.25E-02	0.088	5.16	2.70E-03

Parameter	β	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Freestone	10.5	1.32	7.96	3.30E-15	7.92	13.1	4.00E-02
Galveston	4.01	1.29	3.10	1.95E-03	1.48	6.54	6.29E-03
Gillespie	3.86	1.29	2.99	2.87E-03	1.32	6.39	5.82E-03
Gray	7.50	1.29	5.80	7.82E-09	4.97	10.0	2.17E-02
Grayson	5.21	1.29	4.03	5.84E-05	2.67	7.74	1.06E-02
Gregg	20.7	1.29	16.0	3.11E-53	18.1	23.2	1.44E-01
Hale	3.98	1.29	3.08	2.10E-03	1.45	6.51	6.20E-03
Hall	2.00	1.29	1.55	1.22E-01	-0.534	4.53	1.57E-03
Hamilton	1.12	1.29	0.870	3.84E-01	-1.41	3.66	4.97E-04
Hansford	1.54	1.29	1.19	2.34E-01	-0.996	4.07	9.31E-04
Hardeman	1.98	1.29	1.53	1.26E-01	-0.558	4.51	1.54E-03
Hardin	8.99	1.29	6.95	5.49E-12	6.45	11.5	3.07E-02
Harris	109.0	1.29	84.4	8.32E-420	106	112	8.24E-01
Harrison	18.6	1.32	14.1	9.09E-43	16.1	21.2	1.16E-01
Hartley	5.48	1.29	4.24	2.36E-05	2.95	8.01	1.17E-02
Haskell	0.96	1.29	0.746	4.56E-01	-1.57	3.50	3.66E-04
Hays	7.43	1.29	5.75	1.07E-08	4.89	9.96	2.13E-02
Hemphill	2.76	1.32	2.09	3.70E-02	0.166	5.35	2.85E-03
Henderson	6.12	1.29	4.74	2.36E-06	3.59	8.65	1.45E-02
Hidalgo	14.2	1.30	10.9	1.00E-26	11.7	16.8	7.25E-02
Hopkins	9.42	1.29	7.29	5.01E-13	6.88	11.9	3.37E-02
Houston	5.84	1.29	4.52	6.58E-06	3.31	8.38	1.33E-02
Hudspeth	12.4	1.29	9.61	2.93E-21	9.88	14.9	5.72E-02
Hunt	11.4	1.29	8.85	2.43E-18	8.89	14.0	4.89E-02
Hutchinson	1.30	1.29	1.01	3.14E-01	-1.23	3.84	6.67E-04
Jackson	4.18	1.29	3.24	1.24E-03	1.65	6.72	6.83E-03
Jasper	6.73	1.29	5.21	2.11E-07	4.20	9.27	1.75E-02
Jeff Davis	1.70	1.29	1.32	1.87E-01	-0.829	4.24	1.14E-03
Jefferson	11.7	1.29	9.08	3.24E-19	9.21	14.3	5.14E-02
Jim Hogg	1.13	1.29	0.875	3.82E-01	-1.40	3.66	5.03E-04
Jones	3.15	1.29	2.44	1.50E-02	0.613	5.69	3.88E-03
Kaufman	8.71	1.29	6.74	2.18E-11	6.18	11.2	2.90E-02
Kendall	4.86	1.29	3.76	1.76E-04	2.32	7.39	9.20E-03
Kenedy	1.52	1.29	1.18	2.40E-01	-1.01	4.06	9.09E-04
Kerr	5.86	1.29	4.53	6.23E-06	3.32	8.39	1.33E-02
Kimble	3.27	1.29	2.53	1.13E-02	0.741	5.81	4.20E-03
King	1.45	1.29	1.12	2.63E-01	-1.09	3.98	8.23E-04
Kinney	1.29	1.29	1.00	3.20E-01	-1.25	3.82	6.50E-04
Kleberg	2.84	1.29	2.19	2.83E-02	.301	5.37	3.15E-03
Knox	0.65	1.29	0.499	6.18E-01	-1.89	3.18	1.64E-04

Parameter	*β*	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
La Salle	3.71	1.29	2.88	4.09E-03	1.18	6.25	5.40E-03
Lamar	2.50	1.29	1.94	5.31E-02	-0.034	5.03	2.46E-03
Lamb	2.11	1.29	1.63	1.03E-01	-0.424	4.64	1.75E-03
Leon	14.1	1.29	10.9	1.66E-26	11.5	16.6	7.19E-02
Liberty	13.2	1.29	10.2	1.20E-23	10.6	15.7	6.39E-02
Limestone	4.83	1.30	3.72	2.06E-04	2.28	7.38	9.01E-03
Lipscomb	-1.44	1.31	-1.10	2.72E-01	-4.00	1.13	7.93E-04
Llano	3.14	1.29	2.43	1.51E-02	0.609	5.68	3.87E-03
Madison	5.13	1.29	3.97	7.44E-05	2.60	7.67	1.03E-02
Marion	2.42	1.29	1.87	6.15E-02	-0.116	4.95	2.30E-03
Mason	-0.15	1.29	-0.118	9.06E-01	-2.69	2.38	9.22E-06
Matagorda	5.02	1.29	3.89	1.07E-04	2.48	7.55	9.82E-03
McCulloch	1.14	1.29	0.885	3.76E-01	-1.39	3.68	5.14E-04
McLennan	11.3	1.29	8.76	5.13E-18	8.79	13.9	4.80E-02
Medina	6.79	1.29	5.26	1.69E-07	4.26	9.33	1.78E-02
Menard	1.83	1.29	1.42	1.57E-01	-0.706	4.36	1.31E-03
Milam	8.23	1.30	6.31	3.64E-10	5.67	10.8	2.55E-02
Mills	1.85	1.29	1.44	1.51E-01	-0.679	4.39	1.35E-03
Montgomery	39.5	1.29	30.6	2.81E-160	36.9	42.0	3.80E-01
Moore	4.62	1.29	3.57	3.68E-04	2.08	7.15	8.31E-03
Morris	4.29	1.29	3.32	9.29E-04	1.75	6.82	7.18E-03
Motley	0.28	1.29	0.219	8.26E-01	-2.25	2.82	3.16E-05
Nacogdoches	10.7	1.31	8.17	6.37E-16	8.12	13.3	4.20E-02
Navarro	7.87	1.29	6.09	1.39E-09	5.34	10.4	2.38E-02
Newton	4.60	1.29	3.56	3.78E-04	2.07	7.14	8.27E-03
Nolan	10.6	1.29	8.16	6.92E-16	8.02	13.1	4.19E-02
Nueces	7.52	1.29	5.81	7.48E-09	4.98	10.1	2.17E-02
Ochiltree	0.24	1.30	0.185	8.53E-01	-2.30	2.78	2.25E-05
Oldham	8.62	1.29	6.67	3.53E-11	6.08	11.2	2.84E-02
Orange	8.00	1.29	6.20	7.43E-10	5.47	10.5	2.46E-02
Panola	20.8	1.35	15.4	4.00E-50	18.1	23.4	1.36E-01
Parmer	5.00	1.29	3.87	1.13E-04	2.47	7.53	9.75E-03
Polk	16.0	1.29	12.4	1.15E-33	13.5	18.5	9.16E-02
Potter	10.2	1.29	7.87	6.55E-15	7.64	12.7	3.91E-02
Presidio	0.57	1.29	0.442	6.58E-01	-1.96	3.11	1.29E-04
Rains	0.28	1.29	0.218	8.28E-01	-2.25	2.82	3.11E-05
Randall	5.29	1.29	4.09	4.50E-05	2.75	7.82	1.09E-02
Real	1.56	1.29	1.21	2.28E-01	-0.977	4.09	9.54E-04
Red River	4.55	1.29	3.53	4.34E-04	2.02	7.09	8.10E-03
Refugio	3.27	1.31	2.50	1.25E-02	0.706	5.83	4.10E-03

Parameter	β	Standard Error	t	Significance	95% Confidence Interval		Partial Eta Squared
					Lower Bound	Upper Bound	
Roberts	0.56	1.30	0.434	6.64E-01	-1.98	3.11	1.24E-04
Rockwall	0.57	1.29	0.442	6.58E-01	-1.96	3.11	1.29E-04
Runnels	3.13	1.29	2.42	1.57E-02	0.590	5.66	3.83E-03
Rusk	16.8	1.33	12.6	1.68E-34	14.1	19.4	9.39E-02
Sabine	3.20	1.29	2.48	1.34E-02	0.664	5.73	4.01E-03
San Augustine	2.18	1.29	1.68	9.31E-02	-0.364	4.71	1.85E-03
San Jacinto	8.80	1.29	6.81	1.38E-11	6.27	11.3	2.96E-02
San Patricio	7.94	1.29	6.14	1.03E-09	5.40	10.5	2.42E-02
San Saba	0.43	1.29	0.332	7.40E-01	-2.11	2.96	7.23E-05
Shackelford	0.71	1.30	0.552	5.81E-01	-1.83	3.25	2.00E-04
Shelby	10.9	1.30	8.44	7.34E-17	8.40	13.5	4.47E-02
Sherman	3.38	1.29	2.62	8.90E-03	0.850	5.92	4.49E-03
Smith	33.0	1.29	25.6	3.69E-120	30.5	35.6	3.00E-01
Starr	3.47	1.30	2.67	7.64E-03	0.923	6.02	4.67E-03
Stephens	1.23	1.29	0.952	3.41E-01	-1.31	3.77	5.95E-04
Stonewall	0.19	1.29	0.147	8.83E-01	-2.35	2.73	1.42E-05
Swisher	2.14	1.29	1.66	9.73E-02	-0.391	4.68	1.80E-03
Taylor	8.88	1.29	6.88	9.00E-12	6.35	11.4	3.01E-02
Throckmorton	0.24	1.29	0.188	8.51E-01	-2.29	2.78	2.31E-05
Titus	6.10	1.29	4.72	2.56E-06	3.56	8.63	1.44E-02
Travis	22.7	1.29	17.6	3.72E-63	20.2	25.2	1.69E-01
Trinity	1.97	1.29	1.53	1.27E-01	-0.562	4.51	1.53E-03
Tyler	5.30	1.29	4.10	4.38E-05	2.76	7.83	1.09E-02
Upshur	6.54	1.29	5.06	4.70E-07	4.00	9.07	1.65E-02
Uvalde	4.43	1.29	3.43	6.27E-04	1.89	6.96	7.66E-03
Val Verde	1.49	1.29	1.16	2.48E-01	-1.04	4.03	8.77E-04
Van Zandt	8.15	1.29	6.31	3.71E-10	5.61	10.7	2.55E-02
Walker	9.68	1.29	7.49	1.12E-13	7.15	12.2	3.56E-02
Waller	7.54	1.29	5.84	6.48E-09	5.01	10.1	2.19E-02
Wharton	13.8	1.30	10.6	1.42E-25	11.3	16.3	6.93E-02
Wheeler	4.14	1.32	3.14	1.75E-03	1.55	6.72	6.42E-03
Wichita	2.50	1.31	1.90	5.72E-02	-0.076	5.07	2.37E-03
Wilbarger	3.66	1.29	2.83	4.77E-03	1.12	6.19	5.22E-03
Willacy	1.90	1.29	1.47	1.41E-01	-0.632	4.44	1.42E-03
Williamson	13.1	1.29	10.2	1.48E-23	10.6	15.7	6.36E-02
Wood	5.20	1.29	4.02	6.04E-05	2.66	7.73	1.05E-02
Young	2.71	1.30	2.09	3.65E-02	0.171	5.25	2.87E-03
Zapata	0.67	1.31	0.511	6.09E-01	-1.90	3.25	1.72E-04

Table 38. Summary Results of Statistical Analysis for Model 3.

Parameter	β	Standard Error	t Ratio	Prob>|t|
Intercept	-10.6	0.490	-21.6	<0.0001
H_i	0.00428	0.00031	13.8	<0.0001
V_i	0.00219	0.00025	8.73	<0.0001
log(*VMT*)	2.26	0.0863	26.2	<0.0001
Parameter Estimates for Counties in the Barnett Shale Region				
Cooke	-0.336	0.201	-1.670	0.095
Denton	-0.045	0.204	-0.220	0.826
Erath	0.120	0.202	0.590	0.553
Hill	-0.116	0.205	-0.570	0.571
Hood	0.018	0.202	0.090	0.930
Jack	-0.178	0.202	-0.880	0.378
Johnson	-0.274	0.228	-1.200	0.231
Montague	-0.053	0.202	-0.260	0.795
Palo Pinto	-0.083	0.202	-0.410	0.680
Parker	0.110	0.207	0.530	0.596
Somervell	0.440	0.203	2.170	0.030
Tarrant	-1.368	0.231	-5.920	<0.0001
Wise	0.169	0.208	0.810	0.417
Parameter Estimates for Counties in the Eagle Ford Shale Region				
Atascosa	-0.216	0.204	-1.060	0.288
Bastrop	0.059	0.205	0.290	0.773
Bee	-0.452	0.201	-2.250	0.025
Brazos	-0.388	0.202	-1.920	0.055
Burleson	-0.160	0.201	-0.790	0.427
Caldwell	-0.269	0.201	-1.340	0.182
DeWitt	-0.444	0.202	-2.190	0.028
Dimmit	-0.357	0.207	-1.730	0.084
Duval	-0.087	0.201	-0.430	0.665
Fayette	-0.168	0.204	-0.820	0.411
Frio	-0.617	0.202	-3.050	0.002
Goliad	0.094	0.202	0.470	0.641
Gonzales	-0.290	0.204	-1.420	0.155
Grimes	0.432	0.202	2.140	0.032
Guadalupe	-0.041	0.204	-0.200	0.839
Jim Wells	-0.233	0.203	-1.150	0.251
Karnes	0.046	0.205	0.220	0.824
Lampasas	-0.465	0.201	-2.310	0.021
Lavaca	-0.035	0.201	-0.170	0.862
Lee	0.177	0.201	0.880	0.380
Live Oak	-0.409	0.203	-2.010	0.045

Parameter	β	Standard Error	t Ratio	Prob>|t|
Maverick	-1.213	0.214	-5.670	<0.0001
McMullen	0.761	0.204	3.730	0.000
Robertson	0.773	0.202	3.840	0.000
Victoria	-0.071	0.204	-0.350	0.728
Washington	-0.019	0.202	-0.090	0.927
Webb	-0.015	0.207	-0.070	0.941
Wilson	-0.617	0.202	-3.060	0.002
Zavala	0.231	0.202	1.140	0.252
Parameter Estimates for Counties in the Permian Basin Region				
Andrews	-0.679	0.239	-2.840	0.005
Borden	0.447	0.212	2.110	0.035
Cochran	0.401	0.208	1.930	0.054
Coke	0.195	0.204	0.960	0.337
Crane	-0.191	0.203	-0.940	0.349
Crockett	0.029	0.203	0.140	0.888
Crosby	-0.305	0.204	-1.500	0.135
Dawson	-0.726	0.201	-3.610	0.000
Dickens	0.384	0.208	1.850	0.065
Ector	0.311	0.216	1.440	0.149
Gaines	-0.689	0.203	-3.390	0.001
Garza	-0.119	0.201	-0.590	0.556
Glasscock	0.113	0.210	0.540	0.592
Hockley	0.048	0.201	0.240	0.810
Howard	0.232	0.203	1.140	0.253
Irion	0.209	0.206	1.010	0.311
Kent	0.662	0.213	3.100	0.002
Loving	1.576	0.223	7.060	<0.0001
Lubbock	-0.248	0.203	-1.230	0.220
Lynn	-0.332	0.201	-1.650	0.099
Martin	0.369	0.202	1.820	0.068
Midland	0.520	0.212	2.450	0.014
Mitchell	-0.049	0.203	-0.240	0.811
Pecos	-0.126	0.203	-0.620	0.537
Reagan	0.284	0.210	1.350	0.177
Reeves	0.003	0.202	0.010	0.989
Schleicher	0.086	0.205	0.420	0.674
Scurry	0.342	0.201	1.700	0.089
Sterling	-0.223	0.203	-1.090	0.274
Sutton	-0.139	0.201	-0.690	0.489
Terrell	0.498	0.208	2.390	0.017
Terry	-0.355	0.201	-1.760	0.078
Tom Green	0.079	0.202	0.390	0.696

Parameter	β	Standard Error	t Ratio	Prob>|t|
Upton	-0.123	0.219	-0.560	0.575
Ward	-0.374	0.204	-1.830	0.068
Winkler	0.083	0.204	0.410	0.684
Yoakum	0.044	0.204	0.210	0.830
Parameter Estimates for the Remaining 175 Counties				
Anderson	0.197	0.202	0.970	0.330
Angelina	0.131	0.202	0.650	0.516
Aransas	-0.157	0.202	-0.780	0.436
Archer	-0.271	0.202	-1.340	0.180
Armstrong	-0.112	0.202	-0.560	0.577
Austin	-0.197	0.202	-0.980	0.329
Bailey	0.430	0.203	2.110	0.035
Bandera	-0.446	0.201	-2.210	0.027
Baylor	0.454	0.204	2.230	0.026
Bell	-0.387	0.206	-1.880	0.060
Bexar	0.650	0.209	3.110	0.002
Blanco	-0.599	0.201	-2.980	0.003
Bosque	-0.620	0.201	-3.080	0.002
Bowie	0.008	0.205	0.040	0.969
Brazoria	-0.038	0.207	-0.190	0.853
Brewster	-0.200	0.203	-0.990	0.325
Briscoe	0.667	0.213	3.130	0.002
Brooks	-0.202	0.201	-1.000	0.316
Brown	-0.560	0.201	-2.780	0.005
Burnet	-0.421	0.202	-2.090	0.037
Calhoun	-0.458	0.202	-2.270	0.023
Callahan	-0.037	0.202	-0.190	0.853
Cameron	-1.000	0.204	-4.910	<0.0001
Camp	0.101	0.203	0.500	0.619
Carson	-0.139	0.202	-0.690	0.490
Cass	0.625	0.201	3.110	0.002
Castro	0.372	0.202	1.840	0.066
Chambers	0.836	0.207	4.040	<0.0001
Cherokee	0.114	0.202	0.560	0.574
Childress	-0.561	0.201	-2.790	0.005
Clay	-0.353	0.201	-1.750	0.080
Coleman	-0.449	0.202	-2.230	0.026
Collin	0.051	0.201	0.250	0.799
Collingsworth	0.331	0.208	1.590	0.112
Colorado	0.148	0.204	0.720	0.470
Comal	-0.609	0.204	-2.990	0.003
Comanche	-0.117	0.201	-0.580	0.562

Parameter	β	Standard Error	t Ratio	Prob>|t|
Concho	-0.237	0.203	-1.170	0.243
Coryell	-0.096	0.201	-0.470	0.635
Cottle	0.423	0.210	2.010	0.044
Culberson	-0.368	0.201	-1.830	0.068
Dallam	0.348	0.202	1.720	0.085
Dallas	0.566	0.206	2.750	0.006
Deaf Smith	0.404	0.201	2.000	0.045
Delta	-0.089	0.204	-0.440	0.663
Donley	0.053	0.201	0.260	0.794
Eastland	0.244	0.202	1.210	0.227
Edwards	0.191	0.208	0.920	0.360
El Paso	-0.461	0.205	-2.250	0.025
Ellis	-0.222	0.204	-1.090	0.276
Falls	0.116	0.201	0.580	0.564
Fannin	-0.276	0.201	-1.370	0.171
Fisher	0.061	0.205	0.300	0.765
Floyd	-0.220	0.204	-1.080	0.281
Foard	0.463	0.213	2.180	0.030
Fort Bend	-0.109	0.208	-0.520	0.600
Franklin	-0.223	0.201	-1.110	0.267
Freestone	-0.072	0.205	-0.350	0.726
Galveston	-0.600	0.202	-2.970	0.003
Gillespie	-0.419	0.201	-2.080	0.038
Gray	0.160	0.201	0.800	0.427
Grayson	-0.461	0.202	-2.280	0.023
Gregg	1.080	0.203	5.320	<0.0001
Hale	-0.483	0.201	-2.400	0.017
Hall	0.065	0.203	0.320	0.749
Hamilton	-0.394	0.202	-1.950	0.051
Hansford	0.417	0.206	2.030	0.043
Hardeman	-0.272	0.202	-1.350	0.178
Hardin	0.073	0.202	0.360	0.717
Harris	4.118	0.231	17.810	<0.0001
Harrison	0.306	0.207	1.480	0.140
Hartley	0.604	0.202	3.000	0.003
Haskell	-0.073	0.203	-0.360	0.720
Hays	-0.213	0.203	-1.050	0.293
Hemphill	0.511	0.204	2.500	0.012
Henderson	-0.273	0.202	-1.350	0.177
Hidalgo	-0.140	0.208	-0.670	0.503
Hopkins	-0.045	0.203	-0.220	0.826
Houston	0.216	0.201	1.080	0.282

Parameter	β	Standard Error	t Ratio	Prob>|t|
Hudspeth	0.417	0.203	2.050	0.040
Hunt	-0.136	0.205	-0.660	0.508
Hutchinson	-0.102	0.202	-0.510	0.613
Jackson	-0.536	0.202	-2.660	0.008
Jasper	-0.322	0.203	-1.590	0.112
Jeff Davis	-0.021	0.203	-0.100	0.917
Jefferson	0.016	0.205	0.080	0.938
Jim Hogg	-0.202	0.203	-1.000	0.319
Jones	-0.002	0.201	-0.010	0.994
Kaufman	-0.553	0.206	-2.690	0.007
Kendall	-0.375	0.202	-1.860	0.063
Kenedy	-0.783	0.201	-3.890	0.000
Kerr	-0.114	0.202	-0.570	0.572
Kimble	-0.279	0.201	-1.390	0.166
King	0.648	0.209	3.090	0.002
Kinney	-0.084	0.204	-0.420	0.678
Kleberg	-0.574	0.201	-2.850	0.004
Knox	0.167	0.206	0.810	0.418
La Salle	-0.424	0.205	-2.060	0.039
Lamar	-0.388	0.201	-1.930	0.054
Lamb	-0.080	0.201	-0.400	0.691
Leon	0.487	0.204	2.390	0.017
Liberty	0.484	0.203	2.380	0.017
Limestone	-0.117	0.201	-0.580	0.561
Lipscomb	0.298	0.208	1.430	0.153
Llano	-0.155	0.201	-0.770	0.440
Madison	-0.308	0.202	-1.520	0.128
Marion	-0.239	0.202	-1.180	0.237
Mason	-0.351	0.204	-1.720	0.085
Matagorda	-0.245	0.201	-1.220	0.224
McCulloch	-0.384	0.202	-1.900	0.058
McLennan	-0.098	0.206	-0.480	0.633
Medina	-0.243	0.202	-1.200	0.229
Menard	0.454	0.205	2.210	0.027
Milam	0.144	0.202	0.710	0.477
Mills	-0.152	0.202	-0.750	0.454
Montgomery	1.558	0.215	7.260	<0.0001
Moore	0.257	0.201	1.280	0.201
Morris	0.050	0.201	0.250	0.803
Motley	0.526	0.212	2.480	0.013
Nacogdoches	0.172	0.203	0.850	0.396
Navarro	-0.234	0.203	-1.160	0.248

Parameter	β	Standard Error	t Ratio	Prob>|t|
Newton	0.161	0.201	0.800	0.424
Nolan	0.416	0.201	2.060	0.039
Nueces	-0.208	0.203	-1.030	0.304
Ochiltree	-0.045	0.203	-0.220	0.824
Oldham	0.430	0.201	2.130	0.033
Orange	0.066	0.202	0.330	0.745
Panola	1.108	0.205	5.410	<0.0001
Parmer	0.294	0.201	1.460	0.145
Polk	0.753	0.204	3.700	0.000
Potter	0.229	0.203	1.130	0.259
Presidio	-0.114	0.205	-0.560	0.578
Rains	-0.518	0.202	-2.560	0.011
Randall	-0.308	0.202	-1.530	0.127
Real	0.494	0.207	2.390	0.017
Red River	0.117	0.201	0.580	0.563
Refugio	-0.521	0.202	-2.580	0.010
Roberts	0.628	0.208	3.020	0.003
Rockwall	-0.519	0.203	-2.560	0.011
Runnels	-0.013	0.202	-0.070	0.947
Rusk	0.702	0.205	3.430	0.001
Sabine	0.136	0.202	0.680	0.499
San Augustine	0.078	0.202	0.390	0.699
San Jacinto	0.272	0.201	1.350	0.177
San Patricio	-0.330	0.204	-1.620	0.106
San Saba	-0.119	0.205	-0.580	0.564
Shackelford	0.000	0.204	0.000	1.000
Shelby	0.668	0.201	3.320	0.001
Sherman	0.531	0.203	2.620	0.009
Smith	1.433	0.210	6.830	<0.0001
Starr	-0.617	0.202	-3.060	0.002
Stephens	-0.019	0.203	-0.090	0.925
Stonewall	0.460	0.209	2.200	0.028
Swisher	-0.222	0.201	-1.100	0.270
Taylor	0.322	0.202	1.600	0.111
Throckmorton	0.518	0.212	2.450	0.015
Titus	-0.262	0.202	-1.300	0.195
Travis	0.820	0.209	3.920	<0.0001
Trinity	-0.319	0.202	-1.580	0.114
Tyler	0.110	0.201	0.550	0.583
Upshur	-0.177	0.202	-0.880	0.381
Uvalde	-0.298	0.201	-1.480	0.139
Val Verde	-0.248	0.202	-1.230	0.220

Parameter	β	Standard Error	t Ratio	Prob>|t|
Van Zandt	-0.423	0.205	-2.060	0.040
Walker	-0.271	0.204	-1.320	0.186
Waller	-0.351	0.204	-1.720	0.085
Wharton	0.341	0.203	1.680	0.093
Wheeler	-0.136	0.202	-0.670	0.500
Wichita	-0.543	0.202	-2.690	0.007
Wilbarger	-0.231	0.201	-1.150	0.250
Willacy	-0.388	0.201	-1.930	0.054
Williamson	0.134	0.206	0.650	0.517
Wood	-0.210	0.202	-1.040	0.297
Young	0.043	0.202	0.220	0.829
Zapata	-0.534	0.202	-2.640	0.008