Energy Developments in Mexico – Best Practices for Sustainable Transportation Infrastructure

Unconventional Energy Resources in Texas: Lessons Learned, Strategies, and Opportunities
TTI Mission

- To transfer technology and knowledge
- To develop diverse human resources to meet the transportation challenges of tomorrow

Over 60 years of Implementing the U.S. Land-Grant University Mission in Transportation

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Unconventional Energy Resources in Texas: Lessons Learned, Strategies, and Opportunities
San Antonio Office

• Optimization of the project development process
• Energy and transportation sector interactions
• Utility coordination and conflict management
• Planning and operations
• Extensive South Texas coverage
• Support to TxDOT Districts (San Antonio, Laredo, Corpus Christi, Pharr)
• Coordination with local jurisdictions
Oil and Gas Developments in Texas
Unconventional Energy Developments

• Horizontal drilling
  – Late 1980s, Austin Chalk Formation in Texas
  – 1991, Barnett Shale
• Hydraulic fracturing
  – Has been around since the 1940s
• Slickwater fracturing
  – 1996/1997, chemicals added to increase fluid flow
• Horizontal drilling + slickwater fracturing
  – Shale gas extraction became efficient and feasible
Most Productive Oil Regions in the U.S.

[Line graph showing oil production from Dec-06 to Dec-14 for various regions: Permian, Eagle Ford, Bakken, Niobrara, Haynesville, Marcellus, and Utica.]
Completed Oil and Gas Wells by Year

1977-09/2014 (6,550)

Unconventional Energy Resources in Texas:
Lessons Learned, Strategies, and Opportunities
Completed O/G Wells
2002-2007
Karnes County

OG Wells in Karnes County (2002-2007)

- OG Wells in Karnes County 2002-2007
- Other Roads
- Interstate Highways
- State Highways
- Local Roads
- Railroads
- City Limits
- Counties

Unconventional Energy Resources in Texas:
Lessons Learned, Strategies, and Opportunities
OG Wells in Karnes County (2008-2013)

Completed O/G Wells
2008-2013
Karnes County

- OG Wells in Karnes County 2008-2013
- Other Roads
- Interstate Highways
- State Highways
- Local Roads
- Railroads
- City Limits
- Counties
Recent and Current Research and Technology Transfer
0-6498 Research Project

• Completed in 2012

• Impacts
  – Pavement impacts
  – Reduction in pavement life
  – Roadside impacts
  – Operational and safety impacts

• Statewide impact
  – $1 billion per year ($2 billion including local roads)
IH 35W – East Frontage Road

Pavement shoving, loss of surface

Pavement shoving, loss of surface
FM 1611

Drainage problem at driveway

Mud tracking
Current Initiatives

• TxDOT Maintenance Division Interagency Agreement
• Policy Research Center
• Comprehensive Energy and Transportation Sector Initiative
• Pool Fund Study
## Energy Traffic Characterization

### Marcellus Shale

<table>
<thead>
<tr>
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<tr>
<td>Drilling pad and construction equipment</td>
<td>10-45</td>
<td>10-45</td>
<td>45</td>
<td>45</td>
<td>10-45</td>
<td>90</td>
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<tr>
<td>Drilling rig</td>
<td>35-45</td>
<td>60</td>
<td>190</td>
<td>190</td>
<td>95</td>
<td>90</td>
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<td>Drilling fluid and materials</td>
<td>25-50</td>
<td>200-400</td>
<td>360</td>
<td>360</td>
<td>45</td>
<td>45</td>
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<td>Drilling equipment: casing, drilling pipe</td>
<td>25-50</td>
<td>200-400</td>
<td>90</td>
<td>90</td>
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<td>Completion rig</td>
<td>15</td>
<td>30</td>
<td>400</td>
<td>400</td>
<td>30</td>
<td>40</td>
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<tr>
<td>Completion fluid and materials</td>
<td>10-20</td>
<td>80-160</td>
<td>160</td>
<td>160</td>
<td>20</td>
<td>20</td>
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<tr>
<td>Completion equipment: pipe, wellhead</td>
<td>5</td>
<td>10</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>10</td>
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<tr>
<td>Hyd. frac. equipment: pump truck, tanks</td>
<td>150-200</td>
<td>300-400</td>
<td>350</td>
<td>350</td>
<td>150</td>
<td>320</td>
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<tr>
<td>Hydraulic fracturing water</td>
<td>400-600</td>
<td>3200-4800</td>
<td>4000</td>
<td>480</td>
<td>60</td>
<td>100-1000</td>
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<tr>
<td>Hydraulic fracturing sand</td>
<td>20-25</td>
<td>160-200</td>
<td>184</td>
<td>184</td>
<td>23</td>
<td>23</td>
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<tr>
<td>Flowback water removal</td>
<td>200-300</td>
<td>1600-2400</td>
<td>800</td>
<td>136</td>
<td>100</td>
<td>17</td>
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<td>Final pad preparation and miscellaneous</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>895-1355</td>
<td>5850-8905</td>
<td>6634</td>
<td>2450</td>
<td>1148</td>
<td>625</td>
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</tbody>
</table>

### Activity Types

- **Well production equipment**
- **Oil and water removal (per year)**
- **Operations and maintenance (per year)**
- **General maintenance (every 3-5 years)**

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<tbody>
<tr>
<td>Marcellus Shale</td>
<td></td>
<td></td>
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<tr>
<td>Trucks Only</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Trucks &amp; Pipeline</td>
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</tbody>
</table>

### Activities

- **Oil and water removal**: 580
- **Operations and maintenance**: 150
- **General maintenance**: 25-40
## Relative Pavement Impact

<table>
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<tr>
<th>Total Weight (lb)</th>
<th>Weight Ratio</th>
<th>EALF Ratio</th>
<th>Weight Ratio</th>
<th>EALF Ratio</th>
<th>Weight Ratio</th>
<th>EALF Ratio</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>WRT 4,000 lb</td>
<td>WRT 35,000 lb</td>
<td>WRT 80,000 lb</td>
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<tr>
<td>4,000</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>10,000</td>
<td>2.5</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>35,000</td>
<td>8.8</td>
<td>583</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>80,000</td>
<td>20</td>
<td>18,009</td>
<td>2.3</td>
<td>31</td>
<td>1</td>
<td>1</td>
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<tr>
<td>84,000</td>
<td>21</td>
<td>22,210</td>
<td>2.4</td>
<td>38</td>
<td>1.05</td>
<td>1.2</td>
</tr>
<tr>
<td>90,000</td>
<td>22</td>
<td>28,511</td>
<td>2.6</td>
<td>49</td>
<td>1.1</td>
<td>1.6</td>
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<tr>
<td>100,000</td>
<td>25</td>
<td>42,753</td>
<td>2.9</td>
<td>73</td>
<td>1.2</td>
<td>2.4</td>
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</tbody>
</table>
Adjusted 18-kip ESALs: Station 531, All Axles

Axle Group Weight, lbs

18-kip ESALs

- 2010
- 2012
- 2010 Cumulative
- 2012 Cumulative

Texas A&M Transportation Institute
Tools for Selecting Maintenance and Rehabilitation Alternatives - Traffic Topics
Adjusted 18-kip ESALs: Station 533, All Axles

Axes:
- **Y-axis**: 18-kip ESALs (Millions)
- **X-axis**: Axle Group Weight, lbs

Graph Data Points:
- 2010: 139,546
- 2012: 118,699
- 2010 Cumulative: 151,513
- 2012 Cumulative: 108,538

Legend:
- **Green Line**: 2010 Cumulative
- **Red Line**: 2012 Cumulative

**Note:** The graph illustrates the adjusted 18-kip Equivalent Single Axle Loads (ESALs) for Station 533, categorized by axle group weight and differentiated by the years 2010 and 2012.
## Vehicle Crash Statistics

<table>
<thead>
<tr>
<th>Region</th>
<th>Category</th>
<th>2009</th>
<th>2013</th>
<th>Change</th>
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</thead>
<tbody>
<tr>
<td>Eagle Ford</td>
<td>Total crashes</td>
<td>15,016</td>
<td>16,643</td>
<td>11%</td>
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<tr>
<td></td>
<td>Crashes involving CMVs</td>
<td>987</td>
<td>2,023</td>
<td>105%</td>
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<tr>
<td></td>
<td>Fatal crashes</td>
<td>140</td>
<td>170</td>
<td>21%</td>
</tr>
<tr>
<td></td>
<td>Fatal crashes involving CMVs</td>
<td>15</td>
<td>52</td>
<td>247%</td>
</tr>
<tr>
<td>Permian Basin</td>
<td>Total crashes</td>
<td>21,141</td>
<td>22,074</td>
<td>4%</td>
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<tr>
<td></td>
<td>Crashes involving CMVs</td>
<td>1,145</td>
<td>2,125</td>
<td>86%</td>
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<tr>
<td></td>
<td>Fatal crashes</td>
<td>162</td>
<td>252</td>
<td>56%</td>
</tr>
<tr>
<td></td>
<td>Fatal crashes involving CMVs</td>
<td>18</td>
<td>62</td>
<td>244%</td>
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<tr>
<td>Statewide</td>
<td>Total crashes</td>
<td>428,310</td>
<td>441,682</td>
<td>3%</td>
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<tr>
<td></td>
<td>Crashes involving CMVs</td>
<td>25,000</td>
<td>20,198</td>
<td>17%</td>
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<tr>
<td></td>
<td>Fatal crashes</td>
<td>2,821</td>
<td>3,038</td>
<td>8%</td>
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<tr>
<td></td>
<td>Fatal crashes involving CMVs</td>
<td>301</td>
<td>452</td>
<td>50%</td>
</tr>
</tbody>
</table>
Water and Environmental Issues

• Water management
  – Amount of water used for fracking
    • Vertical well fracking: 20,000–80,000 gallons
    • Horizontal well fracking: 2–9 million gallons
  – Disposal
    • Water is a byproduct in hydrocarbon production
    • Transportation and disposal for produced water
  – Best practices
Comprehensive Transportation and Energy Systems (CTES) Initiative
Strategic Research Roadmap Framework

Comprehensive Transportation and Energy Systems (CTES)

- Communication, Coordination, and Cooperation
- Transportation and Energy Development Data
- Policy and Economics
- Planning and Multimodal
- Operations and Safety
- Environment and Sustainability
- Roadside Management
- Pavement and Bridge Structures

Texas A&M Transportation Institute
Workshop Locations and Dates

- San Antonio (TAMU-SA): 04/03/2015
- Odessa: 04/07/2015 (tentative)
- Fort Worth: 04/14/2015 (tentative)
Thank You!

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