

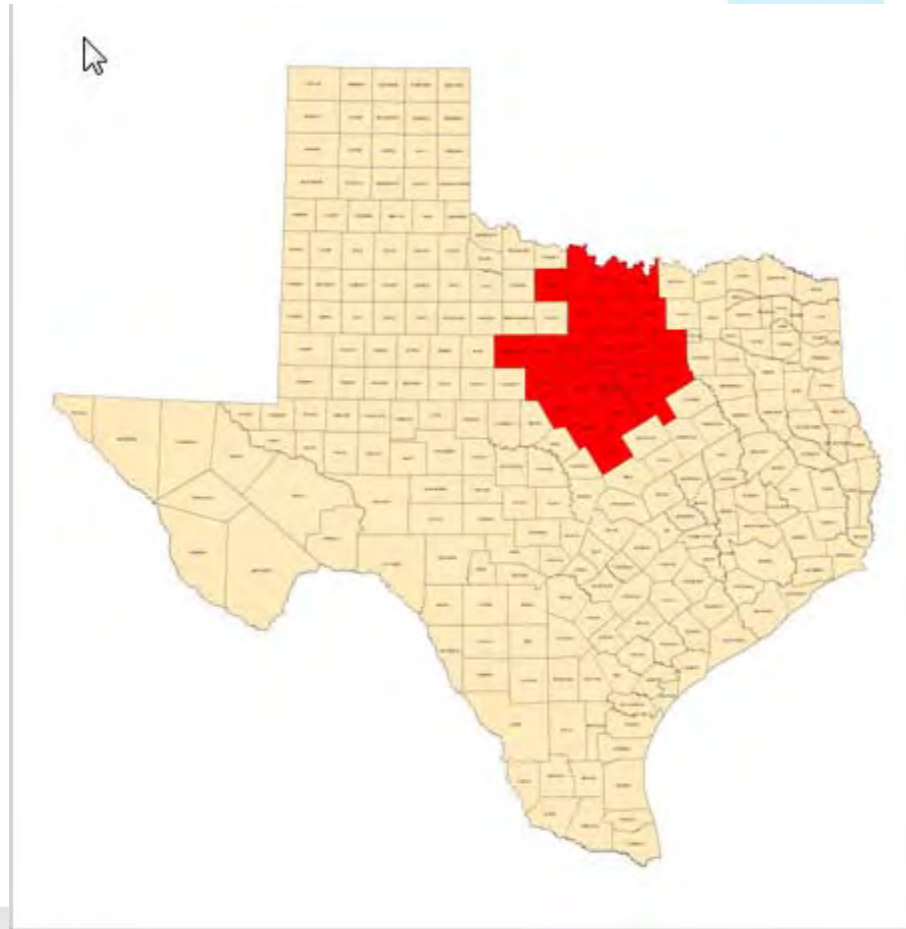
History and Development of the Barnett Shale: Lessons Learned

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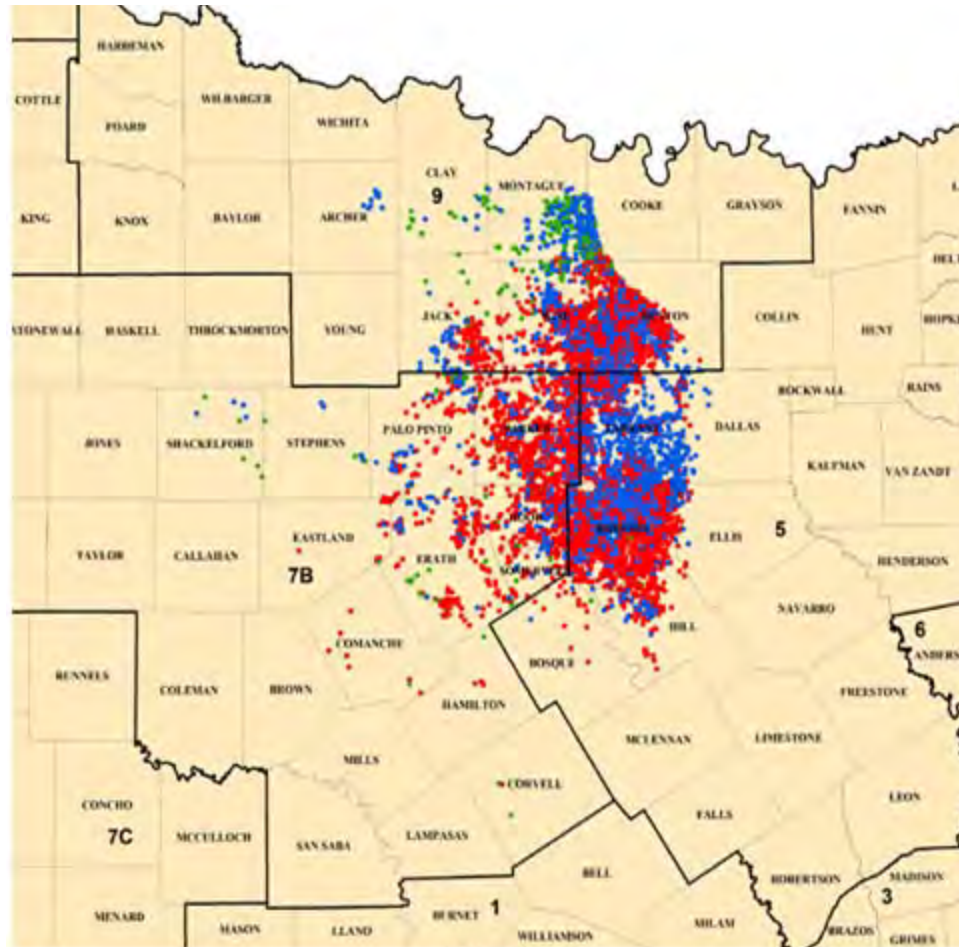


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Barnett Shale Region of North Texas



Barnett Shale Area



Legend:

Oil wells - green
Gas Wells - red
Drilling Permits - blue



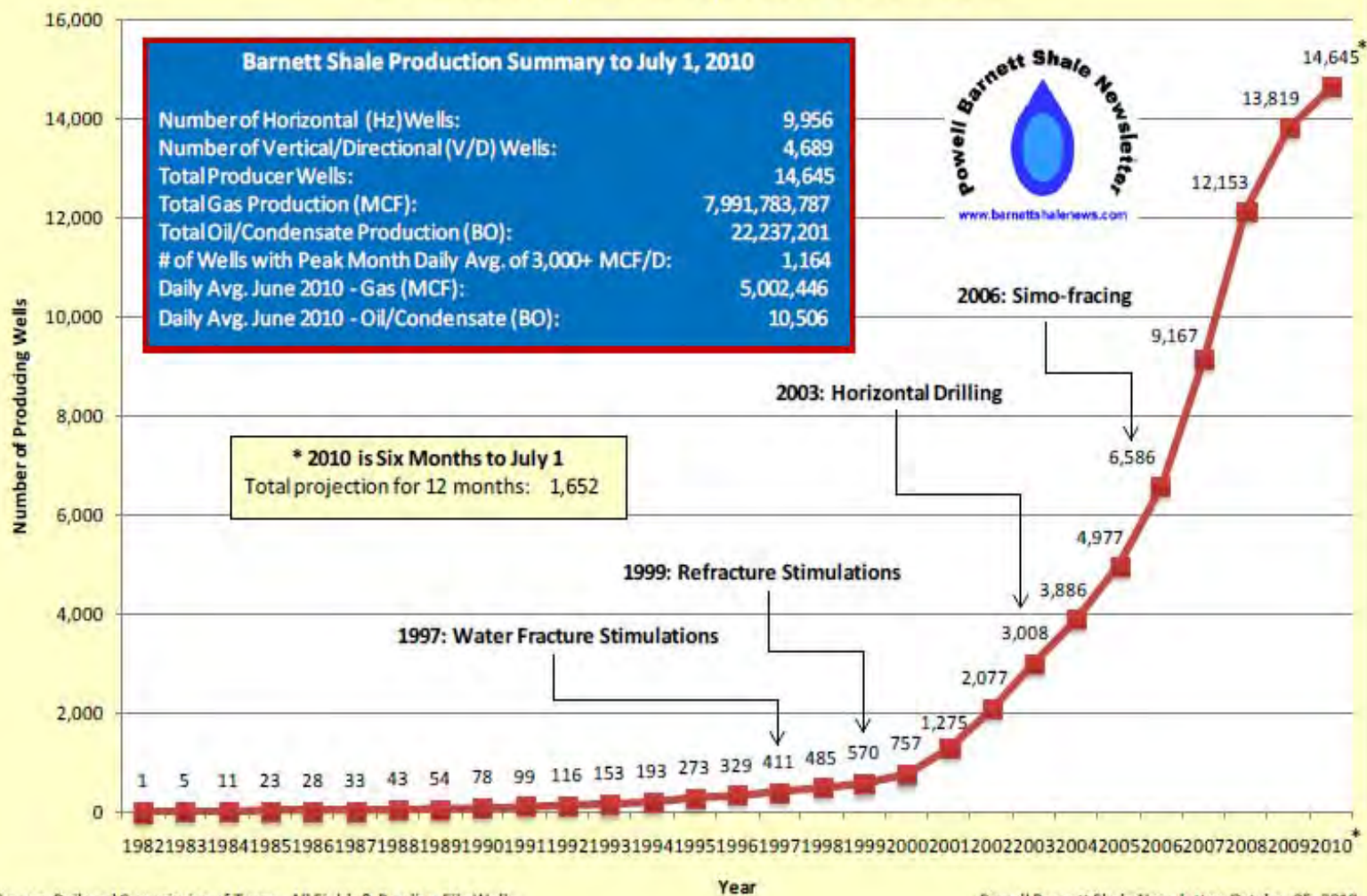
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What is the Barnett Shale?

- A layer of rock 7,000 feet below the surface that contains natural gas, making it the largest natural field in Texas and one of the largest in the United States
- Covers 8,000 square kilometers
- First well was drilled in 1981 by Mitchell Energy which was acquired by Devon Energy in 2002. Production only became economically feasible in 2002 due to improvements in recovery methods.
- Urban concentration: Over 1,000 producing natural gas wells are within the city limits of Fort Worth, Texas which has a population of 750,000



Number of Producing Barnett Shale Wells Over Time as of July 1, 2010 All Counties/Fields in the Fort Worth Basin



Shale Gas Plays, Lower 48 States



Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

Lessons Learned in the Barnett Shale

- Natural gas companies must reach out to the public.



Barnett Shale Energy Education Council

- Established to provide fact-based information on natural gas production in North Texas
- Comprised of leading energy companies in the region
- Non-profit organization
- www.bseec.org



Founding Members

- Chesapeake Energy
- Dale Resources
- Devon Energy
- EnCana Oil & Gas
- EOG Resources
- Four Sevens Resources
- XTO Energy



Accomplishing Our Mission

- Web site – www.bseec.org
- Printed materials distributed through community centers and public libraries
- Speaking to interested groups
- Central point for media inquiries



Lessons Learned in the Barnett Shale

- Natural gas companies must reach out to the public.
- The economic benefits of shale gas development must be emphasized



Why Natural Gas?



Daniel Yergin: “It’s simply the most significant energy innovation so far this century.”



“bridge fuel”

- 1.3 million jobs in Texas
- 12% of total employment
- Cleanest fossil fuel
- Highly efficient
- Helps improve our country’s energy security

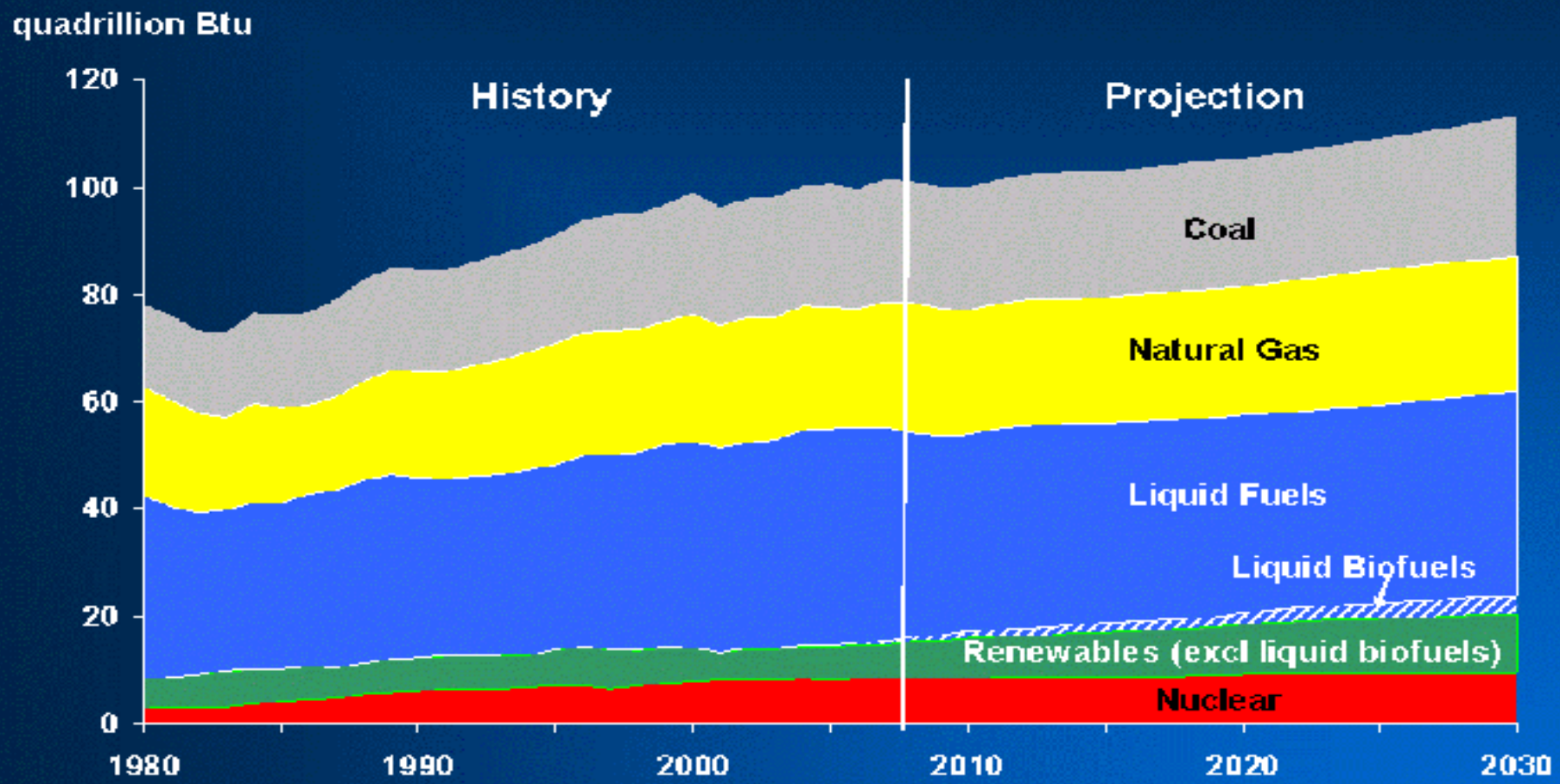
Colorado Gov.

Bill Ritter:
“mission critical.”



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Non-fossil energy use grows rapidly, but fossil fuels still provide 79 percent of total energy use in 2030



EIA Annual Energy Outlook 2009 Reference Case Presentation -- December 17, 2008



Natural Gas is the Bridge Fuel to the Future

- Natural gas is the only domestic fuel that can be scaled up over the next decade in order to achieve significant reductions in the use of foreign oil and in carbon emissions.
- The shale fields in the U.S. are the key to future natural gas supplies in the U.S., Canada and the world



Annual U.S. Dry Natural Gas Proved Reserves



Source: U.S. Energy Information Administration



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Lessons Learned in the Barnett Shale

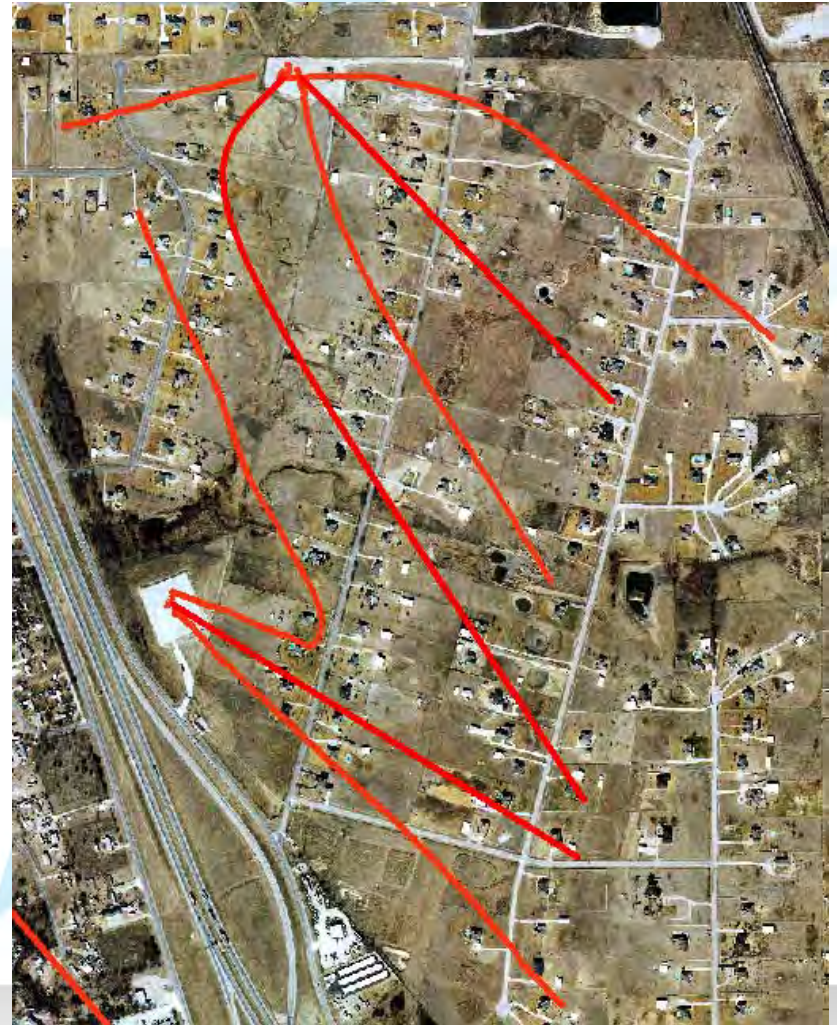
- Natural gas companies must reach out to the public.
- The economic benefits of shale gas development must be emphasized
- Natural gas companies must adapt to new situations.





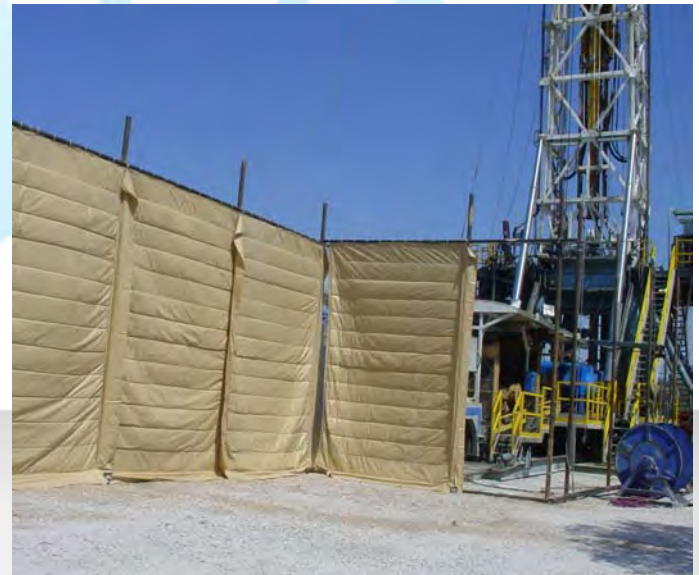
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Urban Drilling





SOUND ABATEMENT



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Lessons Learned

- The natural gas companies must reach out to the public with proactive educational efforts.
- The economic benefits of shale gas development must be emphasized
- Natural gas companies must adapt to new situations.
- **Regulators and industry must develop a cooperative relationship.**



City of Fort Worth Natural Gas Task Force

- 18 people including City Council, citizens and 4 industry representatives
- Developed recommendations to the City Council that resulted in many revisions to the City's Gas Drilling Ordinances



Charge to the 2008 Gas Drilling Task Force

- Noise
- Compressors
- Protected Use Definitions
- Setbacks
- Environmental Impacts
- Pipelines
- Public Notice
- Roads



Examples of Recommendations Regarding Noise Ordinances

- Require a **noise management plan** be submitted with the permit application
- Adopt new regulations regarding **pure tones** and **low frequency**
- Require a **continuous 72-hour** pre-drilling Ambient Noise Level test
- Require **72-hour monitoring** of the noise if a complaint is received from any Protected Use within 1,000 feet
- Limit **associated fracturing activities** noise levels to **3 dBA** at night with no fracturing allowed at night
- Allow **issuance of immediate citations** for violations unless the operator is in compliance with their submitted noise mitigation plan



Lessons Learned

- The natural gas companies must reach out to the public with proactive educational efforts.
- The economic benefits of shale gas development must be emphasized
- Natural gas companies must adapt to new situations.
- Regulators and industry must develop a cooperative relationship.
- Natural gas companies must stay ahead of the issues



Issues in the Barnett Shale

- Early Issues: noise, lighting, safety, truck traffic, water use, water disposal
- Later issues: earthquakes, contribution to ozone levels
- Latest issue: air emissions and hydraulic fracturing



BSEEC Study Background

- BSEEC wanted to provide the public with data about air quality in the Barnett Shale
- Study focused on Fort Worth/Arlington urban area
- Engaged a licensed professional engineering firm to conduct the study and a 3rd party lab to test the air samples
- Goal of study was to test natural gas sites for VOCs, sulfur compounds and formaldehyde



Study Findings

- **Study Results Accurately Represent Normal Site Air Quality**

- *Air sampling implemented according to protocols and plan*
- *Site conditions were normal: production and winds*
- *Lab data met quality objectives*

- **VOC Sampling (81 compounds including benzene)**

- *1 exceedance in 7,533 tests (93 samples x 81 compounds)*
- *None of the one-hour samples exceeded the short-term AMCV*
- *1 of the 24-hour samples (benzene 1.96 ppbv) slightly exceeded the 24-hour long-term benzene AMCV (1.4 ppbv) but was still significantly under the applicable ATSDR minimum risk level (9 ppbv)*

- **Sulfur Compound Sampling (20 compounds)**

- *7 odor-based AMCV exceedances in 420 tests (21 samples x 20 compounds)*
- *5 H₂S attributed to off-site sources and 2 COS at industrial area sites where exceedances were slightly above odor-based AMCV (< 30 x health-based AMCV)*

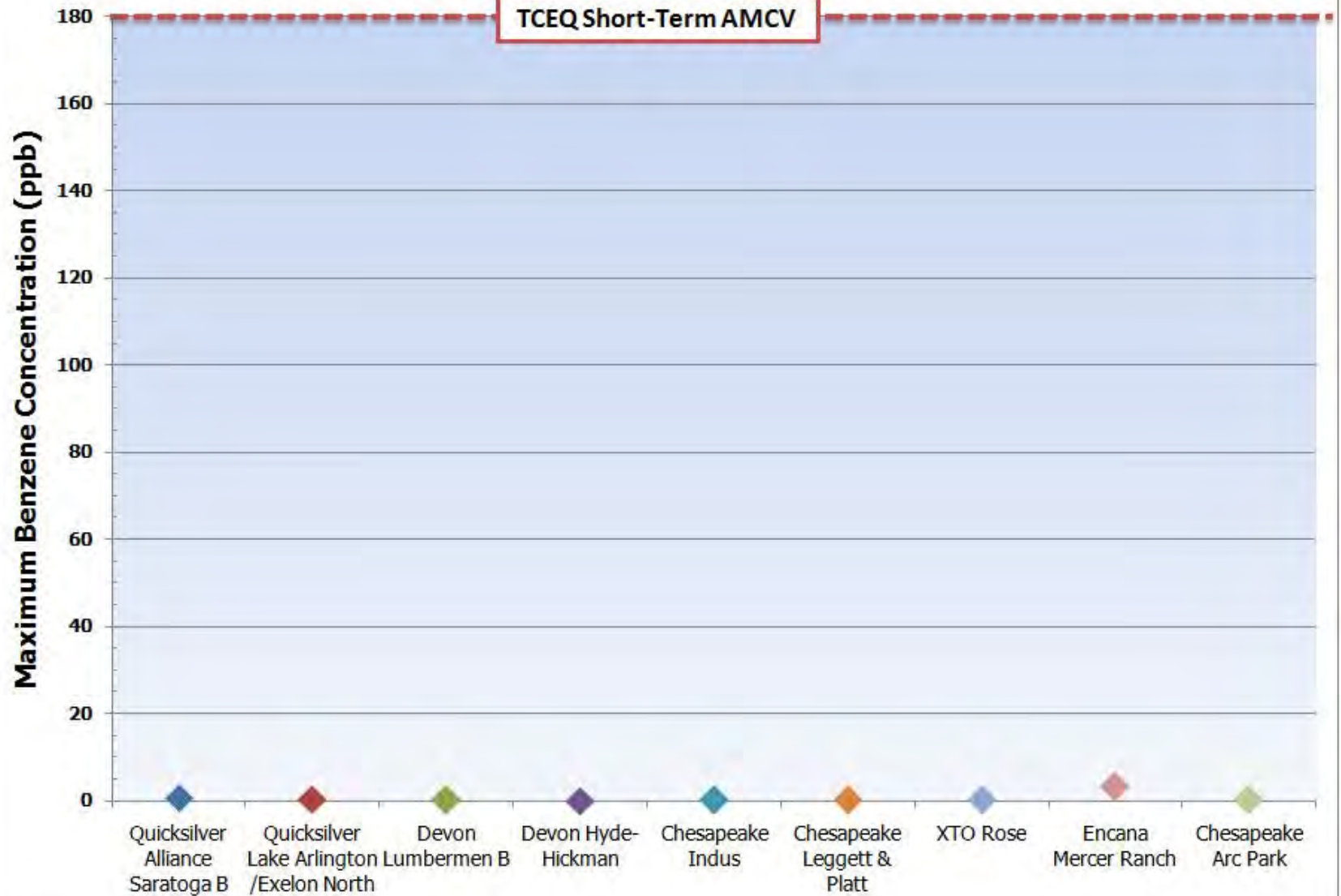
- **Formaldehyde Sampling**

- *5 exceedances in 17 samples - all 5 attributed to off-site sources*



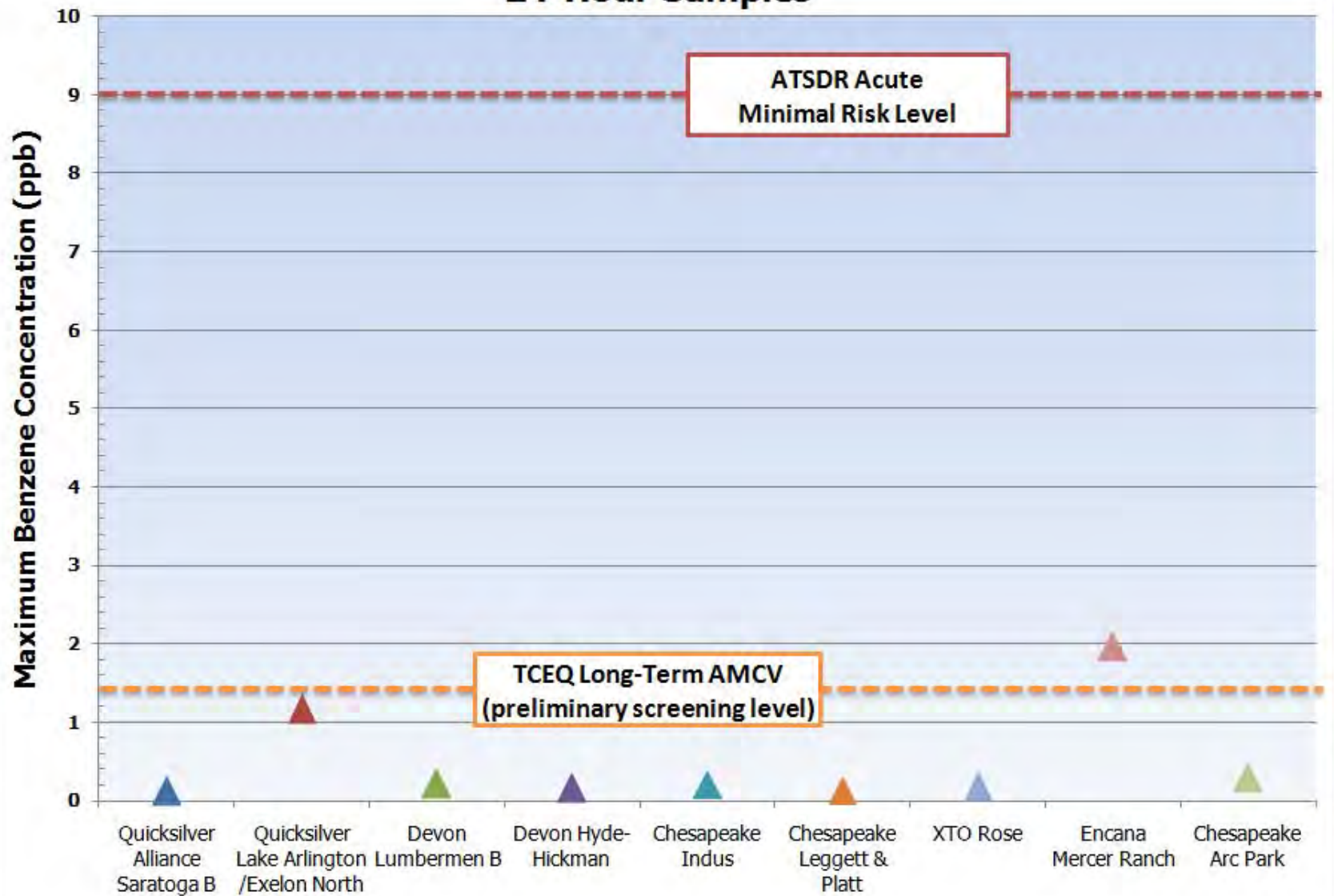
One-Hour Samples

TCEQ Short-Term AMCV



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24-Hour Samples



Study Conclusion

“Based on the results of this study and the health effects criteria employed, TITAN Engineering concludes that harmful levels of benzene and other pollutants are not being emitted from natural gas sites in the study area.”

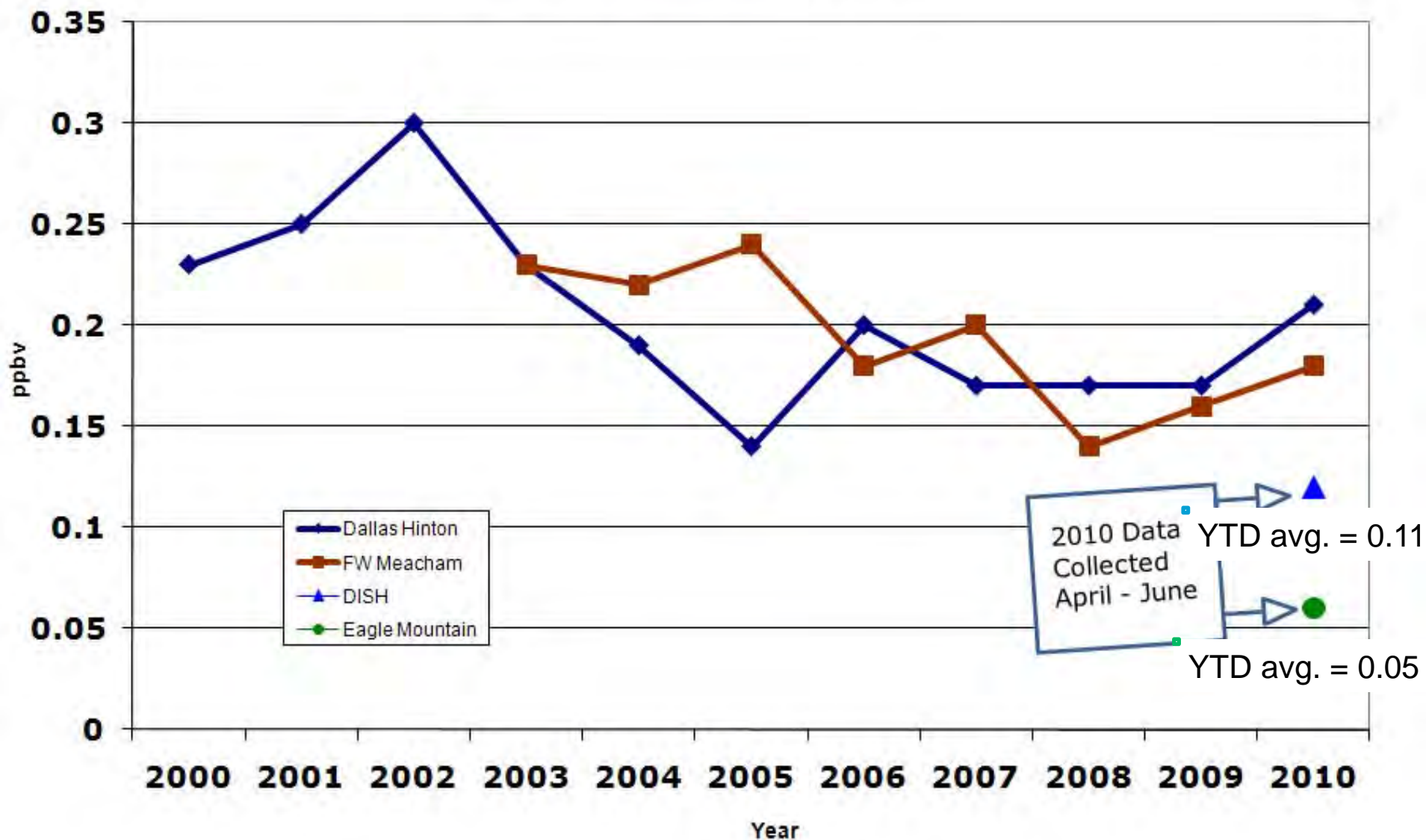


How do these results compare with other study results?

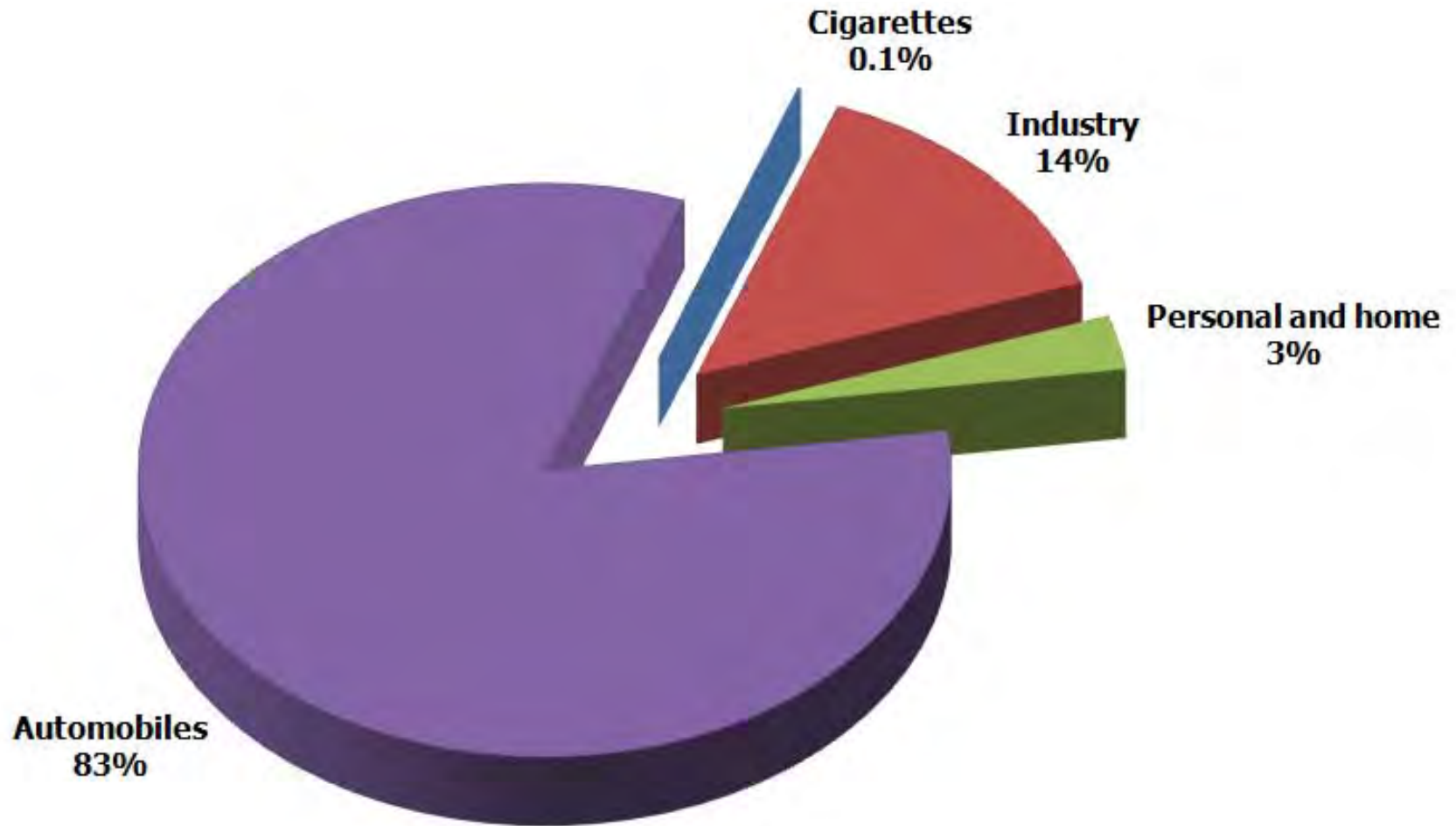
- TCEQ has taken over 450 air samples over the last 12 months and found “only 2 instances of benzene exceeding short-term levels of concern. Subsequent testing at these two locations has shown low levels of benzene.”
- The town of Flower Mound has conducted 2 studies which found normal ambient air.
- The continuous air monitor at Dish, TX reports air quality 24 hours a day and has not shown a single exceedance of any VOC in the 6 months of operation.



Auto GC Benzene Annual Averages
part per billion - by volume (ppbv)



Sources of Benzene Emissions



Sources of Benzene Exposure

Automobile exhaust
18%



Cigarettes
40%



“Even passive exposure to cigarette smoke is responsible for more benzene exposure (about 5% of the total) than the emissions from the entire industrial capacity of the United States (about 3% of the total) (Wilbur *et al.* 2008)

Home sources (paint
and petroleum
products)
16%



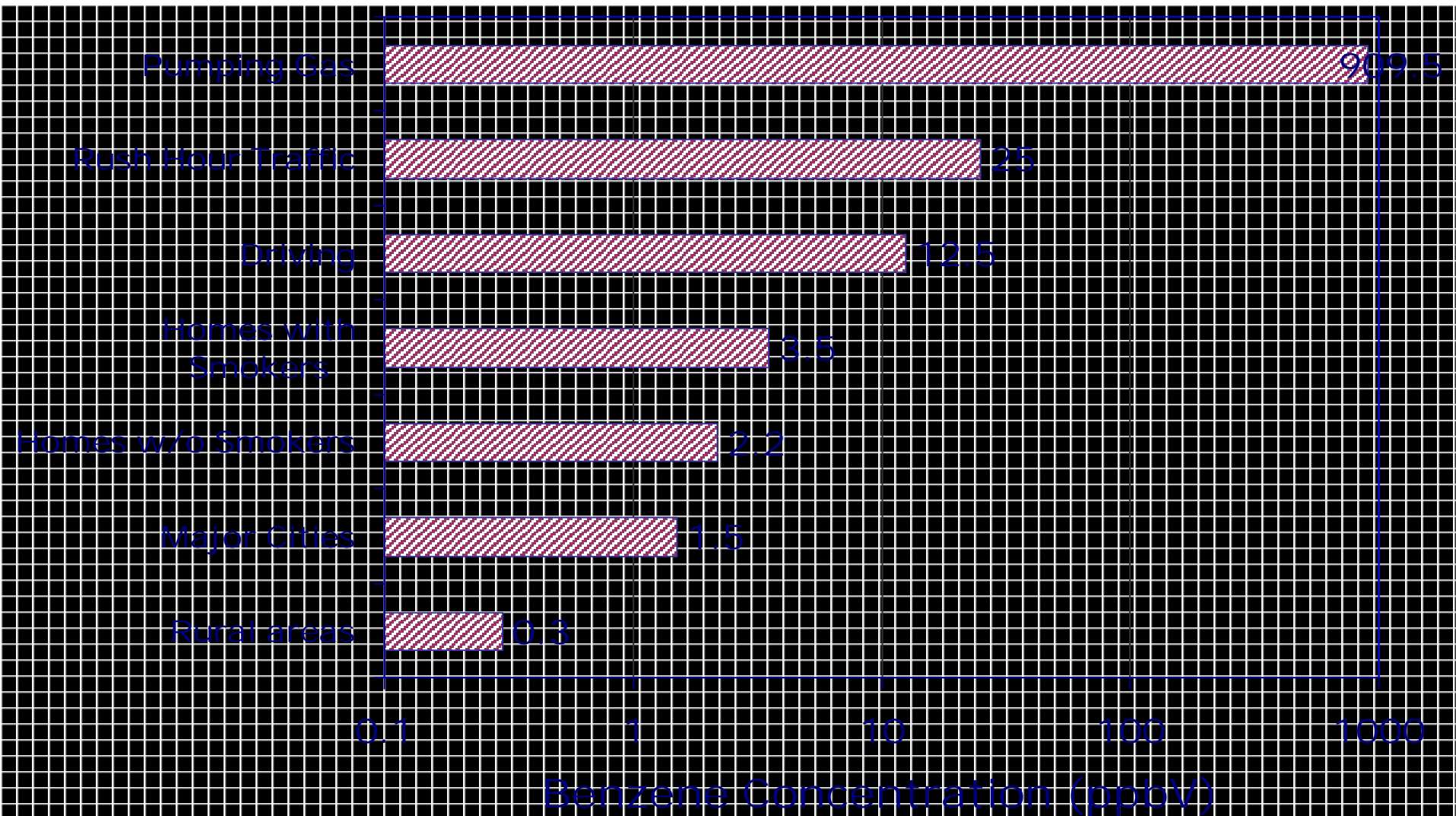
Industry
3%



Environmental tobacco
smoke
5%



Typical Levels of Benzene in the Environment



Concentration of Benzene in Air (ppb)

Short-Term Exposure
{less than 14 days}

Long-Term Exposure
{months to years}

100,000,000

Death

10,000,000

Drowsiness
Headache
Dizziness

1,000,000

100,000

Irritation

EPA 1-hour AEGL

10,000

Aplastic Anemia
Acute Myeloid Leukemia

Odor
Threshold

1,000

OSHA PEL

EPA POD for Increased
Cancer Risk (residential)

TCEQ 1-hour AMCV

100

NIOSH REL

10

ATSDR Acute MRL

EPA Acceptable
Cancer Risk Range

1

TCEQ Long-Term Comparison Value

Typical Environmental Levels in
Texas Cities

0.1

Maximum 1-hour sample (Mercer
Ranch, EnCana)

Maximum 24-hour sample (Mercer
Ranch, EnCana)

Hydraulic Fracturing

- Allegations that fracturing pollutes ground water (“Gasland”)
- Reports of companies refusing to disclose the contents of frac fluids
- The word “fracking” has become an epithet used to describe the entire drilling process



Typical Additives Used in Hydraulic Fracturing*

0.49%
ADDITIVES



Additive	Purpose	Common Use
Nitrogen	gas phase in a foam	79% of the air we breathe
Guar	thickening agent so that the water can carry sand	ice cream, salad dressings
Bentonite	type of clay added to suspend solids in the slurry	cat litter, cosmetics
Borate Crosslinker and Buffer	increase the viscosity of the slickwater fluid	hand soap (borate), baking soda (pH buffer)
Ammonium Persulfate	break up the guar and allow it to flow out of the sand after the fracture treatment	oxidizing agent, hydrogen peroxide
Enzyme Breaker	degrade the guar and clean up the fracture	meat tenderizers, brewing beer
Surfactants	fracture fluid recovery or to create and stabilize a foam	dishwashing soap, household cleaners
Acetic Acid	to lower pH in frac fluid water	vinegar
Triethanolamine (TEA)	iron control, to prevent damage in the formation	fabric softener
Ethylenediaminetetracetic Acid (EDTA)	water mineral deposit control	food preservative

*The specific additives used in a given fracturing operation will vary depending on source water quality, site and specific characteristics of the target formation. The additives listed above are typical components but other additives are also common.



Lessons Learned

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Questions?

Thank You!



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