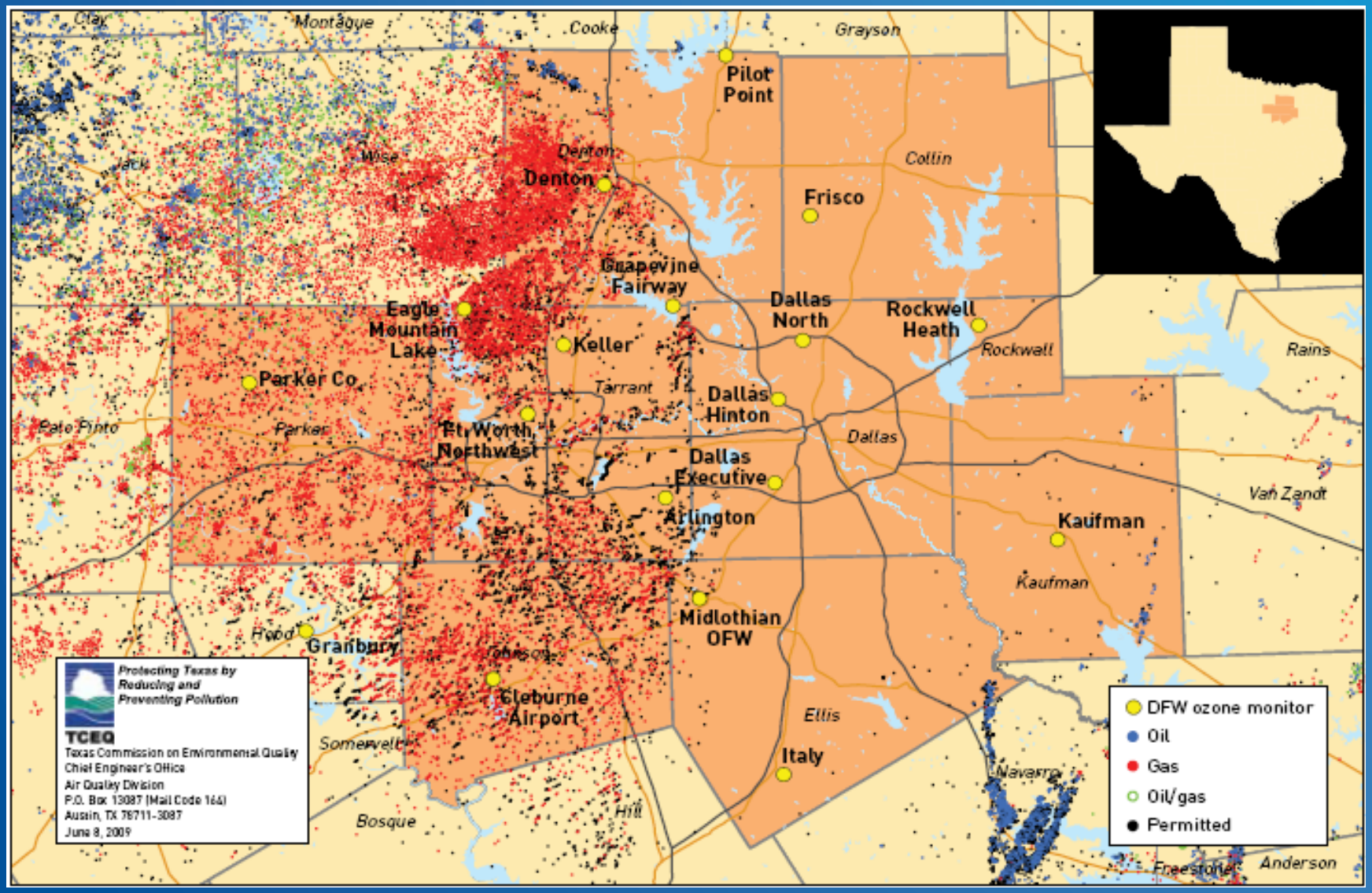
Air Pollutants Linked with Barnett Shale Gas/Oil Production

The case builds for emissions controls

October 2009

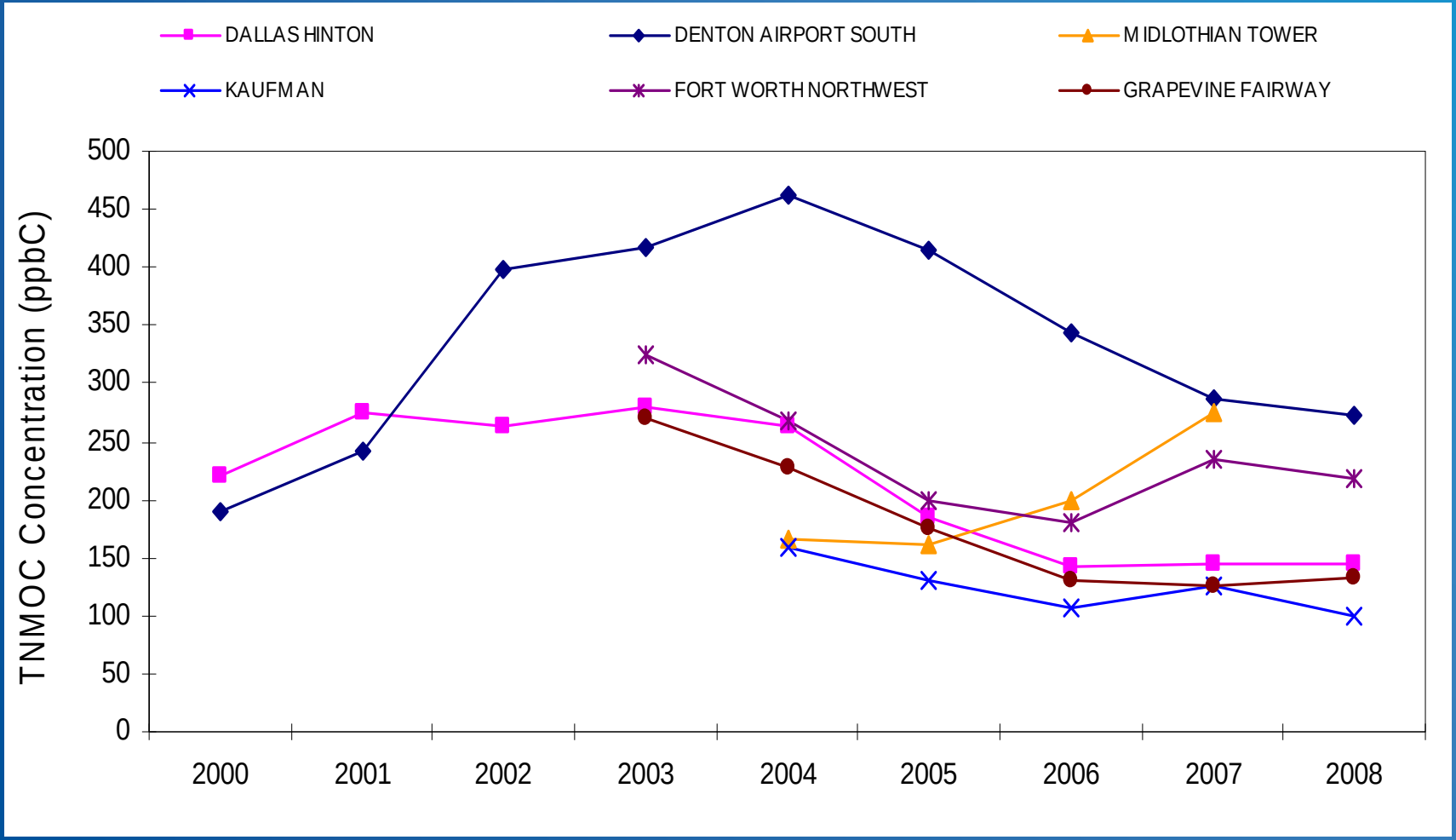
Barnett Shale Area Wells



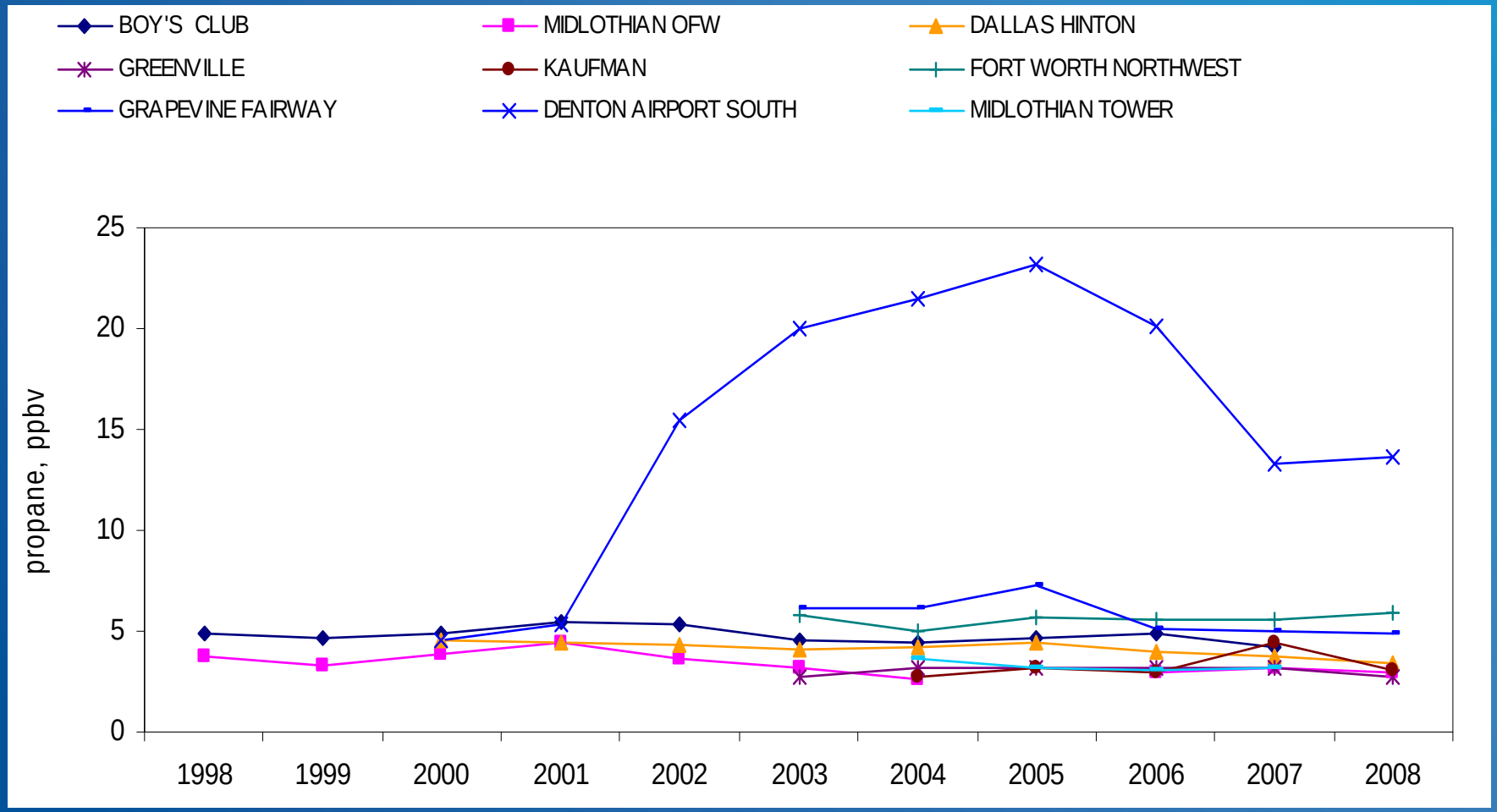
Summary

- Test hypothesis: oil/gas production in Barnett Shale affects the area's air quality
  - Analysis of TCEQ's air pollution monitoring data
  - Comparison to trends in county-level drilling and production activity
  - No one has looked at ozone effects yet
- Encourage the use of cost-effective emission controls

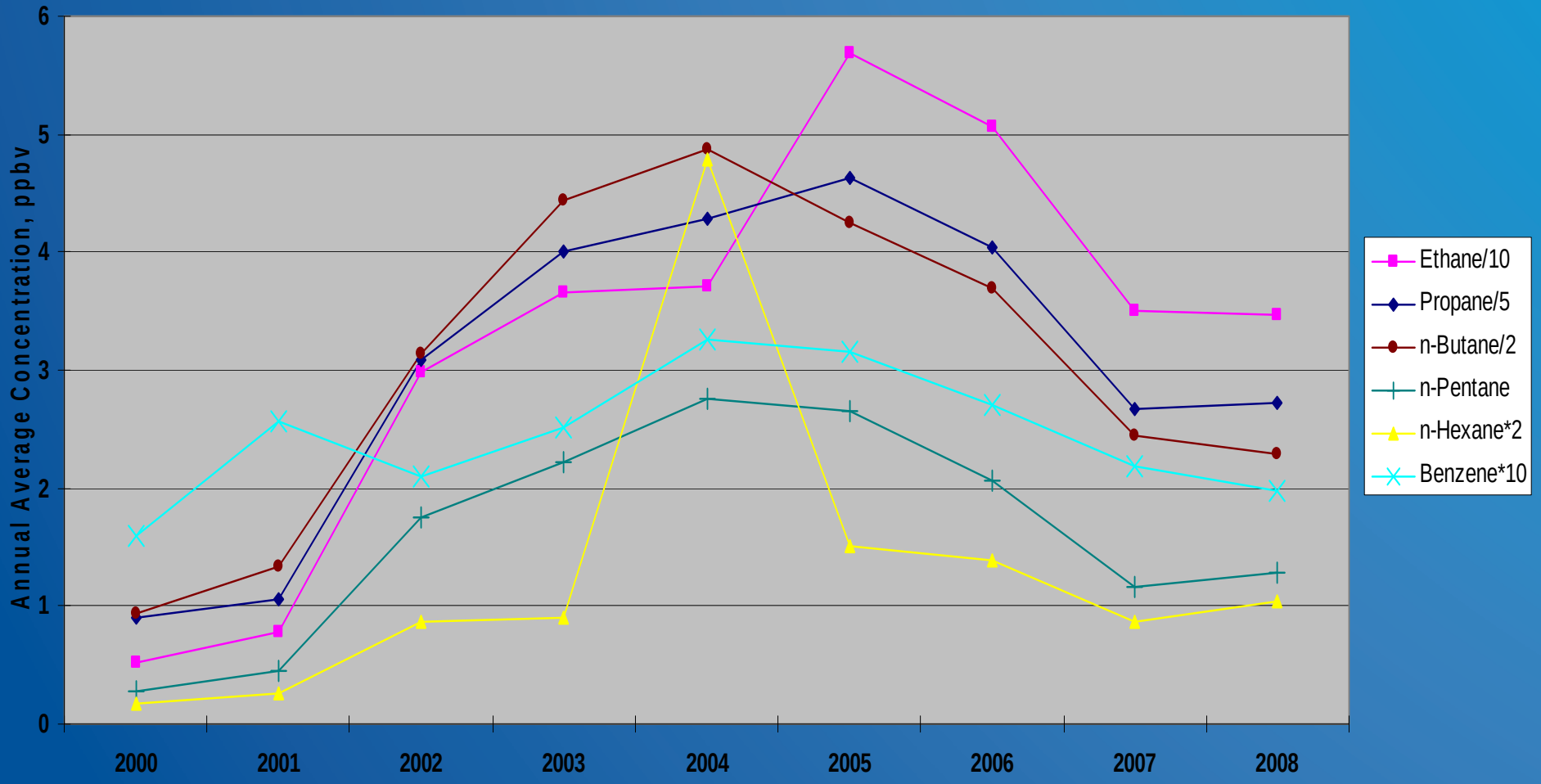
Denton County Has Region's Highest Levels of Non-Methane Hydrocarbons



Hydrocarbon Trends in Denton County Are Distinct from Rest of Region



Several Hydrocarbons Follow Similar Trends at Denton Monitor

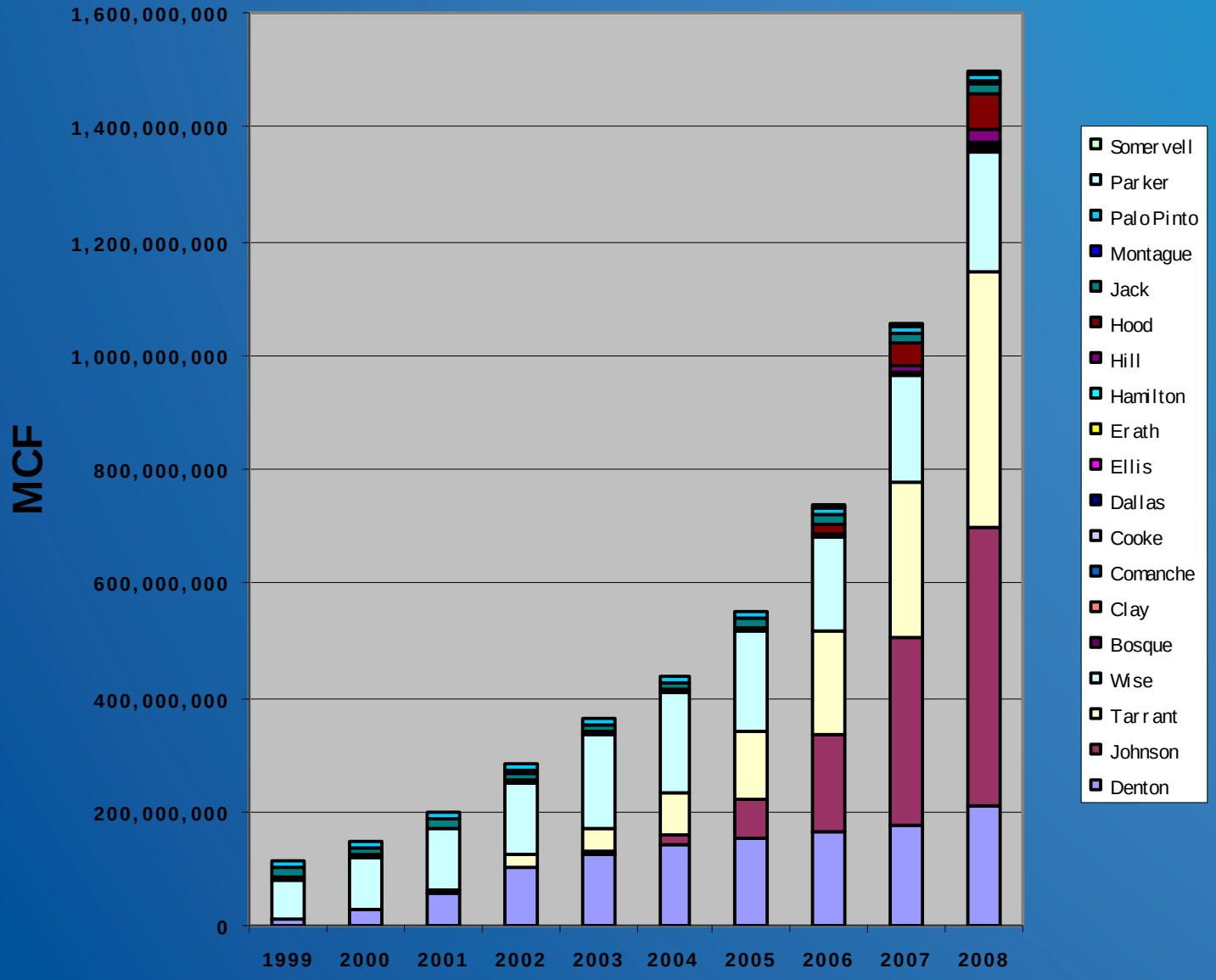


Note: Scaling factors applied as indicated in legend

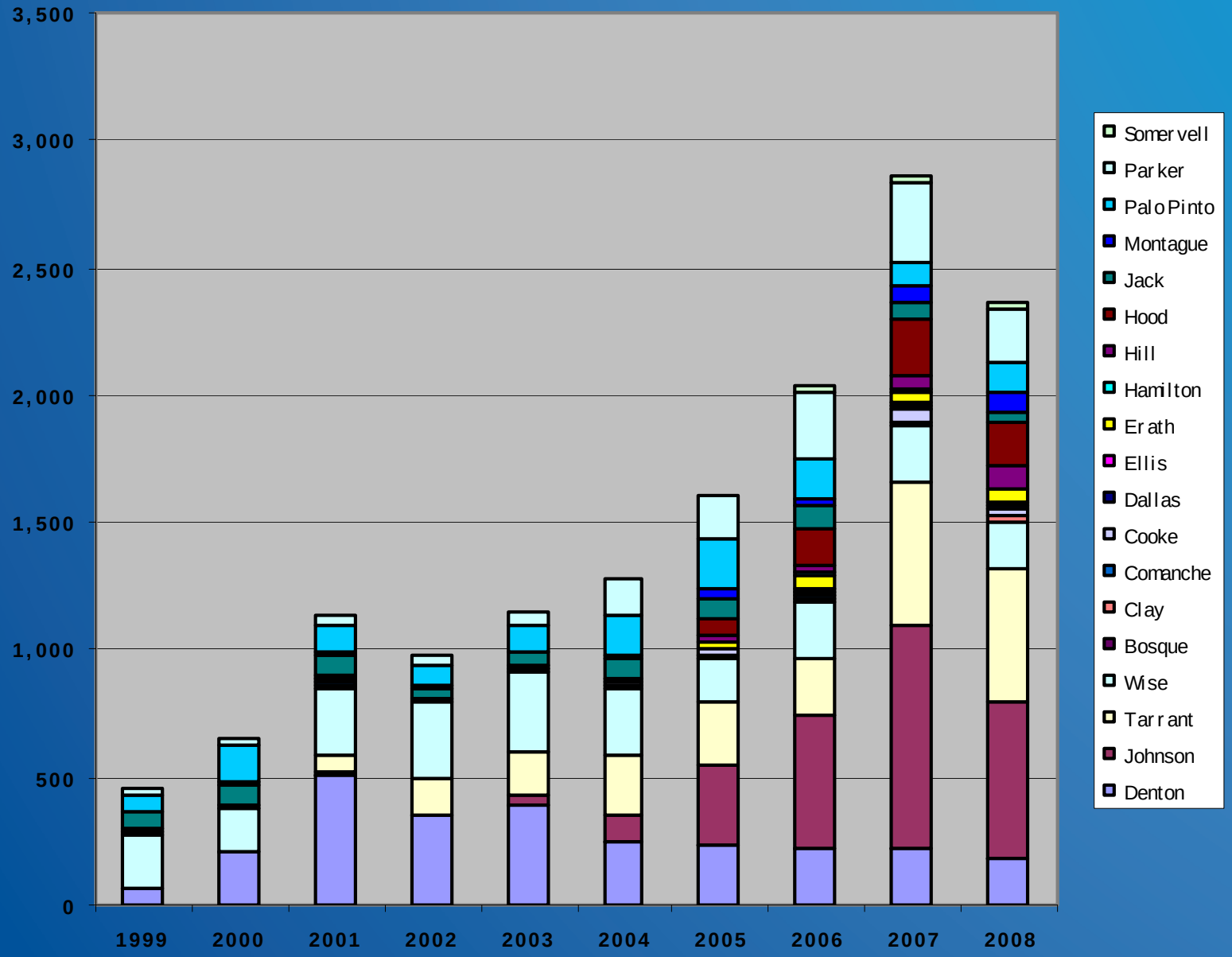
Q: Can the hydrocarbon trends observed at the Denton County monitor be explained by oil and gas activity?

A: To answer this, we looked at county-level data on oil/gas production and well completions from the Railroad Commission

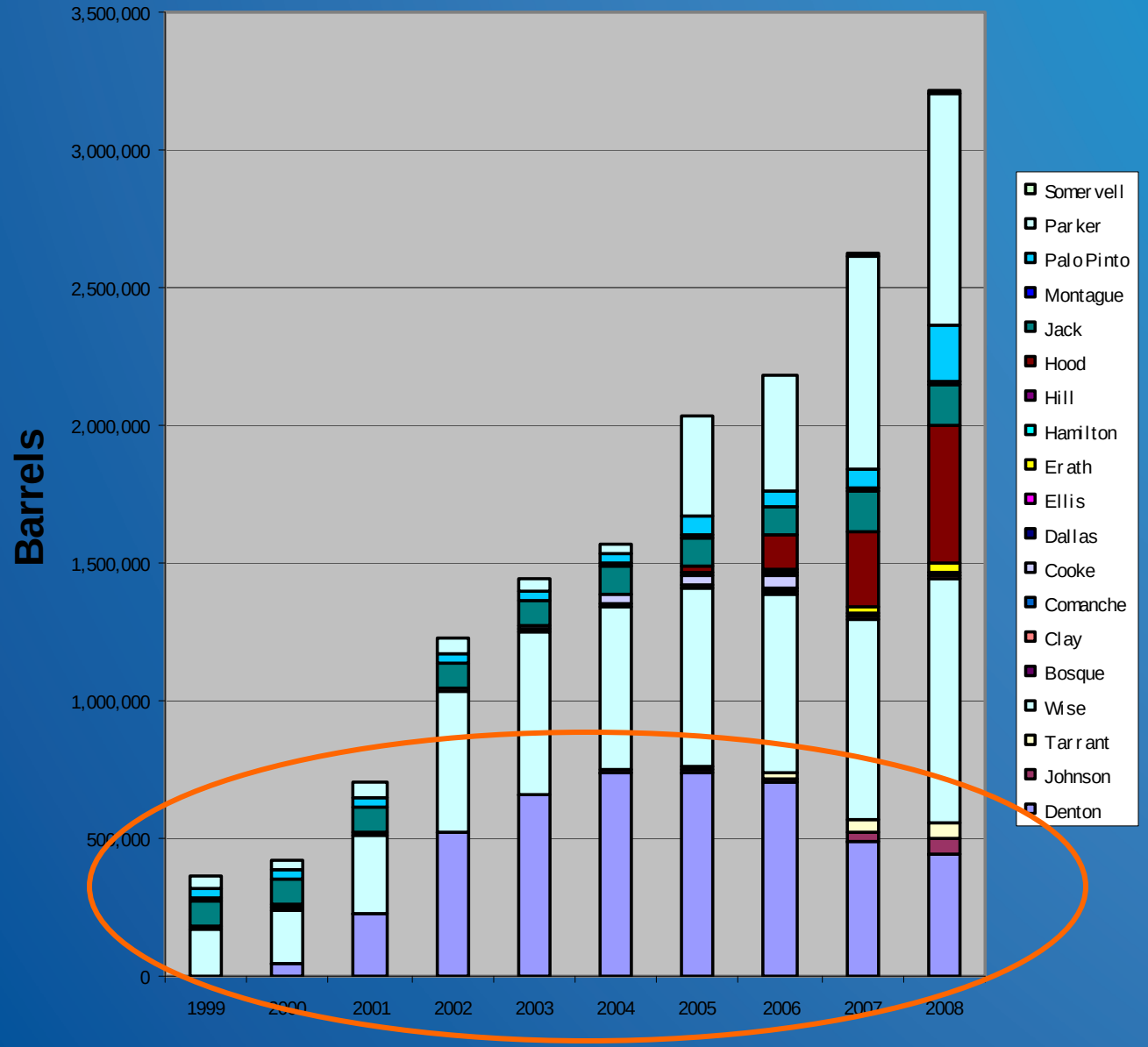
Natural Gas Production



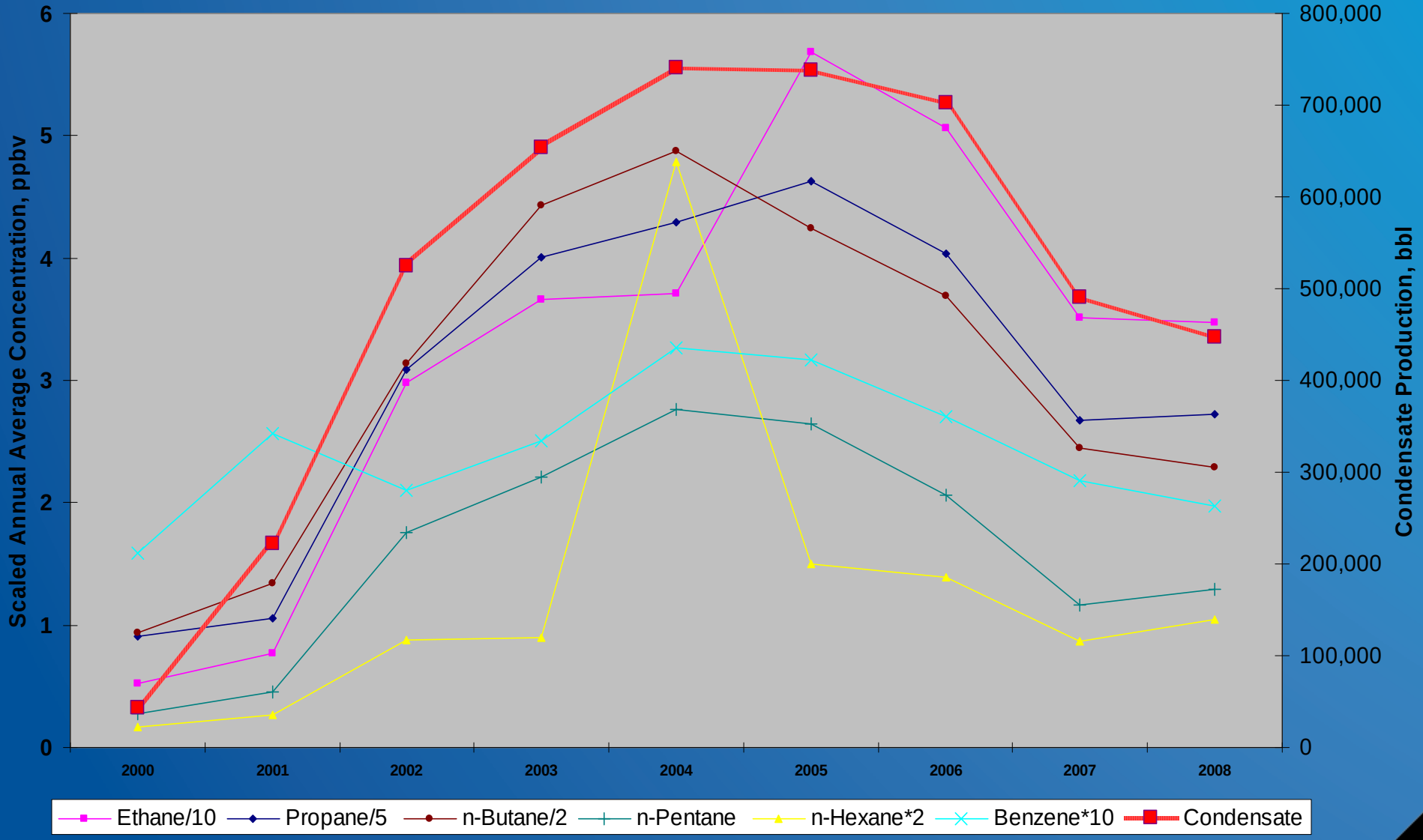
Well Completions



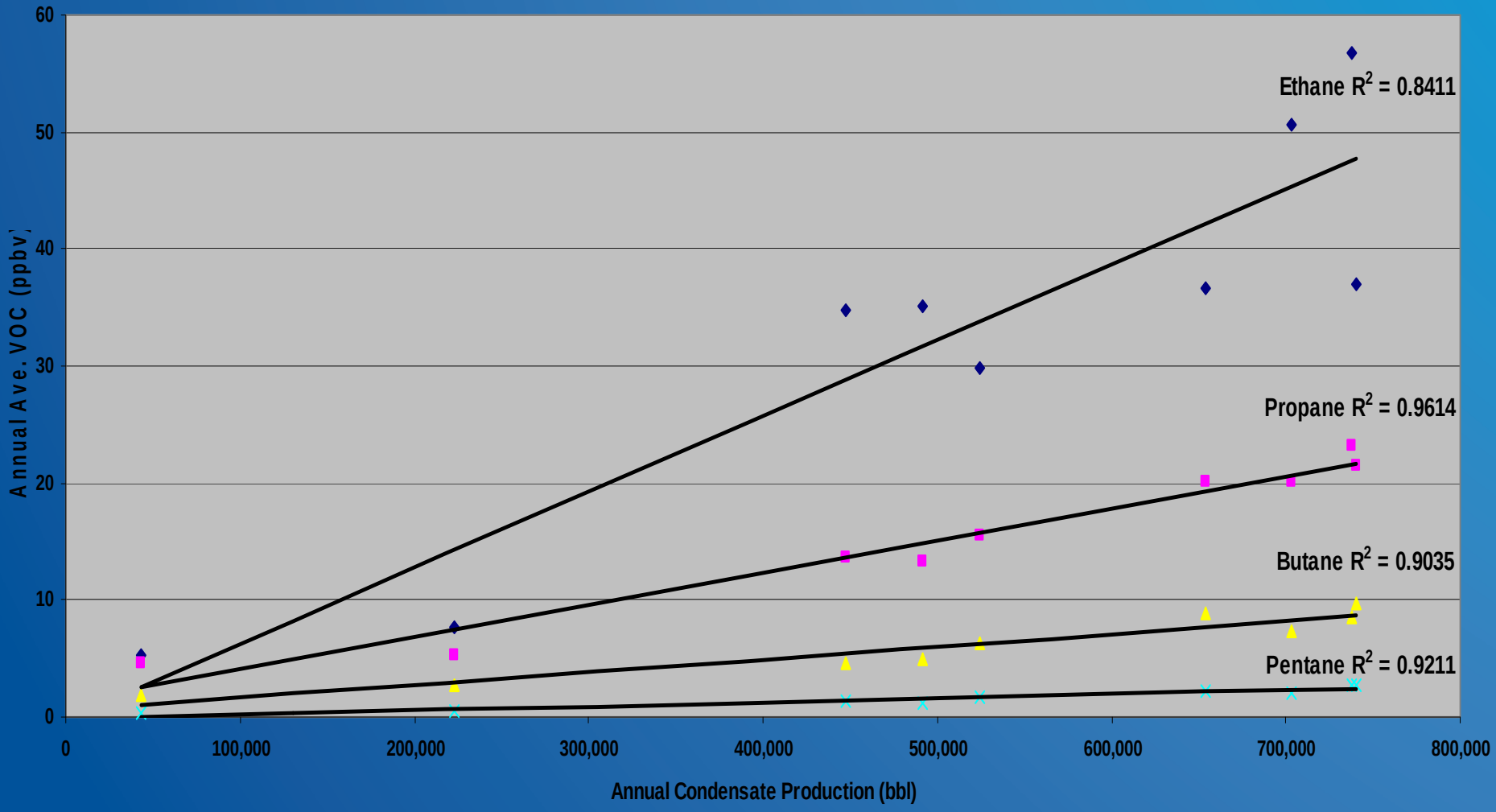
Condensate Production



Denton VOC vs. Condensate Production



Linear Regression Gives Good Fit for C2-C5 Hydrocarbons



2005 Oil and Gas Emissions in Barnett Shale Counties

	Annual VOC (tons)
Bosque	2
Clay	1,403
Comanche	140
Cooke	2,683
Dallas	N/A
Denton	13,538
Ellis	7
Eastland	1,237
Erath	209
Hamilton	17
Hill	43

	Annual VOC (tons)
Hood	614
Jack	3,420
Johnson	4,669
Montague	2,760
Palo Pinto	1,931
Parker	2,070
Somervell	10
Stephens	2,902
Tarrant	7,789
Wise	15,582

Source: Eastern Research Group, “Emissions From Oil And Gas Production Facilities,” August, 2007

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Emissions from Condensate Tanks

- Two state-funded projects measured significant emissions being routinely vented from storage tanks
- URS study measured an average of 1,600 scf gas vented daily at 9 tank batteries in Denton county, with calculated VOC emissions between 26 to 304 pounds per day
- ERG estimates 2005 VOC emissions from condensate tanks in Denton County are 3,312 tons (about 25% of total VOC emissions from oil and gas exploration and production in the county).

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Conclusions (I)

- Canister samples taken in Denton County show elevated of hydrocarbons compared to other monitors in the DFW area
- The observed trends in ambient concentrations of key hydrocarbons (ethane, propane, butane and pentane) are well predicted by the annual production of condensate in Denton County
- There is no hydrocarbon monitoring data from other counties with high condensate production (Wise, Parker and Hood) to allow similar analyses to be performed

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Conclusions (II)

- Emissions associated with condensate production, such as venting from storage tanks, appear to measurably affect ambient air quality in surrounding areas
- The effect of the observed VOC levels in Denton County on human health or regional ozone production have not been investigated

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Recommendations

- Expand VOC monitoring to include other Barnett Shale counties with significant condensate production (Wise, Hood, Parker)
- Assess impacts of oil and gas emissions on health and regional ozone levels
- Adopt cost-effective oil/gas emission controls, beginning with condensate tanks
- Deploy an ozone monitor in Wise County and re-consider its inclusion in DFW nonattainment area

Background Slides

Definitions

- Hydrocarbons - compounds made up of carbon and hydrogen. Includes methane and many other chemicals that comprise natural gas, as well as many components found in petroleum (oil)
- VOC – volatile organic compounds, defined as compounds of carbon that participate in atmospheric photochemical reactions. VOC, a mostly regulatory construct, excludes specific chemicals that have been determined to have negligible photochemical reactivity, including methane and ethane
- Condensate - The gasoline-like hydrocarbon liquid that is sometimes produced by natural gas wells

Cost-effective methane reduction opportunities

Technology/practice	Volume of natural gas reductions (Mcf/yr)	Value of annual gas savings (dollars/yr)	Implementation costs	Payback time (months)
Change from high to low-bleed pneumatic device	50 to 260, depending on age of device at time of replacement	$350–1,820, depending on age of device at time of replacement	$210–1,850 depending on age of device at time of replacement	3–13, depending on age of device at time of replacement
Retrofitting high-bleed devices	230	$1,610	$675	6
Replace gas with air in pneumatic device (per facility)	20,000	$140,000	$60,000	6
Green completions	25.2 billion cubic feet annually	$176 million	$1,000–10,000	1–3
Plunger lift systems	4,700–18,250 per well	$32,900–127,750	$2,591–10,363 per well	2–14
Well automation devices	500 per well	$35,000 per well	$11,000 per well	3
Reducing glycol circulation rates on glycol dehydrators	N/A. In general, EPA found circulation rates to be two or more times higher than necessary.	$2,758–275,940	Negligible	Immediate
Replacing glycol dehydrator with desiccant dehydrator	1,063	$7,441	$15,787	21
Using pipeline pump-down techniques to lower gas line pressure before maintenance	200,000	$1,400,000	$98,757 or zero if using in-line compressors	1 or immediate if using in-line compressors
Directed inspection and maintenance at compressor stations	29,412 per compressor station	$88,239 per compressor station	$26,248 per compressor station	N/A. Potential average first year savings equal $61,991
Vapor recovery units on crude oil storage tanks	4,900-96,000	$30,300-606,800	$35,738–103-959	3–19
Replace compressor rod packing systems	865	$6,055	$540	2
Install BASO valves	Varies. One partner reported savings of 222 Mcf per year for a single installation	$1554 per valve	< $1000 per valve	Less than one year
Replacement of wet seals with dry seals on wet seal centrifugal compressors	45,120 per seal	$315,000 per seal	$324,000 per seal	1[illegible] per seal

Area	Monitoring Site	POC	Fourth Highest Average (ppb)			Current Three-Year Average (ppb)
			2007	2008	2009 as of 3:21 pm CDT 10/14/2009	
Dallas-Fort Worth						
	Ft. Worth Northwest C13/AH302	2	81	73	83	**79**
	Keller C17	2	84	85	90	**86**
	Frisco C31/C680	1	80	79	79	**79**
	Midlothian OFW C52/A137	1	76	72	72	**73**
	Denton Airport South C56/A163/X157	1	89	84	82	**85**
	Arlington Municipal Airport C61	1	75	78	80	**77**
	Dallas North No.2 C63/C679	1	79	76	88	**81**
	Rockwall Heath C69	1	74	73	78	**75**
	Grapevine Fairway C70/A301/X182	1	89	77	86	**84**
	Kaufman C71/A304/X071	1	74	69	68	**70**
	Granbury C73/C681	1	81	73	77	**77**
	Eagle Mountain Lake C75	1	84	85	91	**86**
	Parker County C76	1	88	77	80	**81**
	Cleburne Airport C77/C682	1	87	83	80	**83**
	Midlothian Tower C94/A305/X158 (Deactivated Aug 22, 2007)	1	72 *			
	Dallas Hinton St. C401/C60/AH161	3	76	64	62	**67**
	Dallas Executive Airport C402	1	80	77	79	**78**
	Greenville C1006/A198	1	69	63	67	**66**
	Pilot Point C1032	1	75	80	78	**77**
	Italy C1044/A323	1	66 *	72	70	**69**
	Corsicana Airport C1051	1			66 **	

- Highest ozone readings are near highest density of oil and gas activity
- No modeling of ozone air impacts from oil/gas has been done to date

Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements

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Version 1.1
January 26, 2009

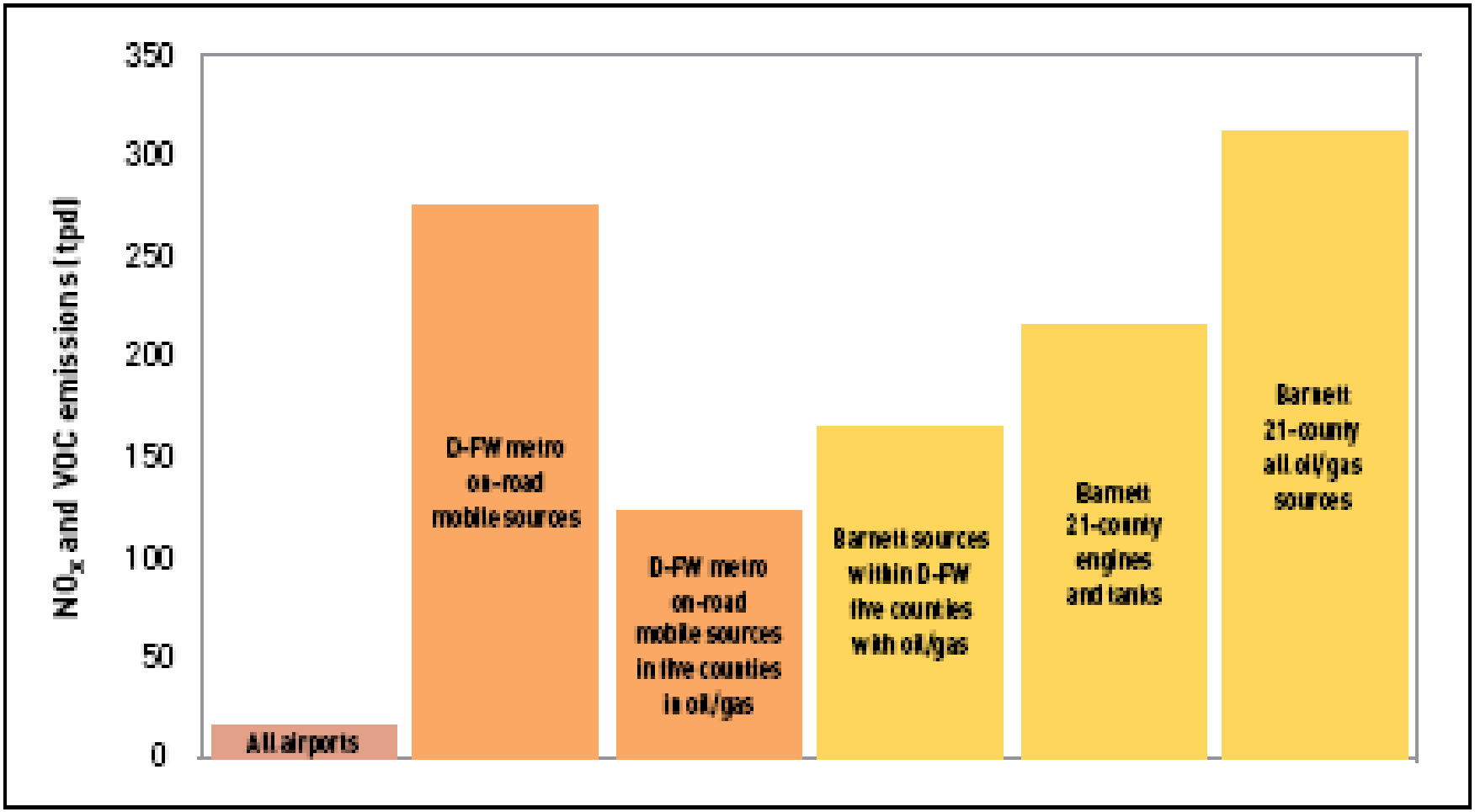
- Dr. Armendariz's report concluded that emissions from oil and gas activity in Barnett area are significant
- Despite industry criticism, estimated emissions found to be in line with TCEQ's own estimates

Peak summertime daily emissions (tons per day) from Barnett Shale area oil and gas production

	2009				
	Pollutant (tpd)				
	NO_x	VOC	HAPs	CH_4	CO_2e
Compressor engine exhausts	46	19	3.6	61	13877
Condensate and oil tanks	0	146	11	23	483
Production fugitives	0	26	0.62	232	4884
Well drilling and completions	5.5	21	0.49	183	4061
Gas processing	0	15	0.37	50	1056
Transmission fugitives	0	28	0.67	411	8643
Total daily emissions (tpd)	**51**	**255**	**17**	**961**	**33004**

Source: Al Armendariz, Ph.D., Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements, 6, (January 26, 2009).

NO_x and VOC 2009 summer emissions



Emissions of NO_x and VOC in the summer of 2009 from all oil and gas sources in the Barnett Shale 20-county area will exceed emissions from on-road mobile sources in the D-FW metropolitan area by more than 30 tpd (307 vs. 273 tpd). Source: Al Armendariz, Ph.D., Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements, 6, (January 26, 2009).