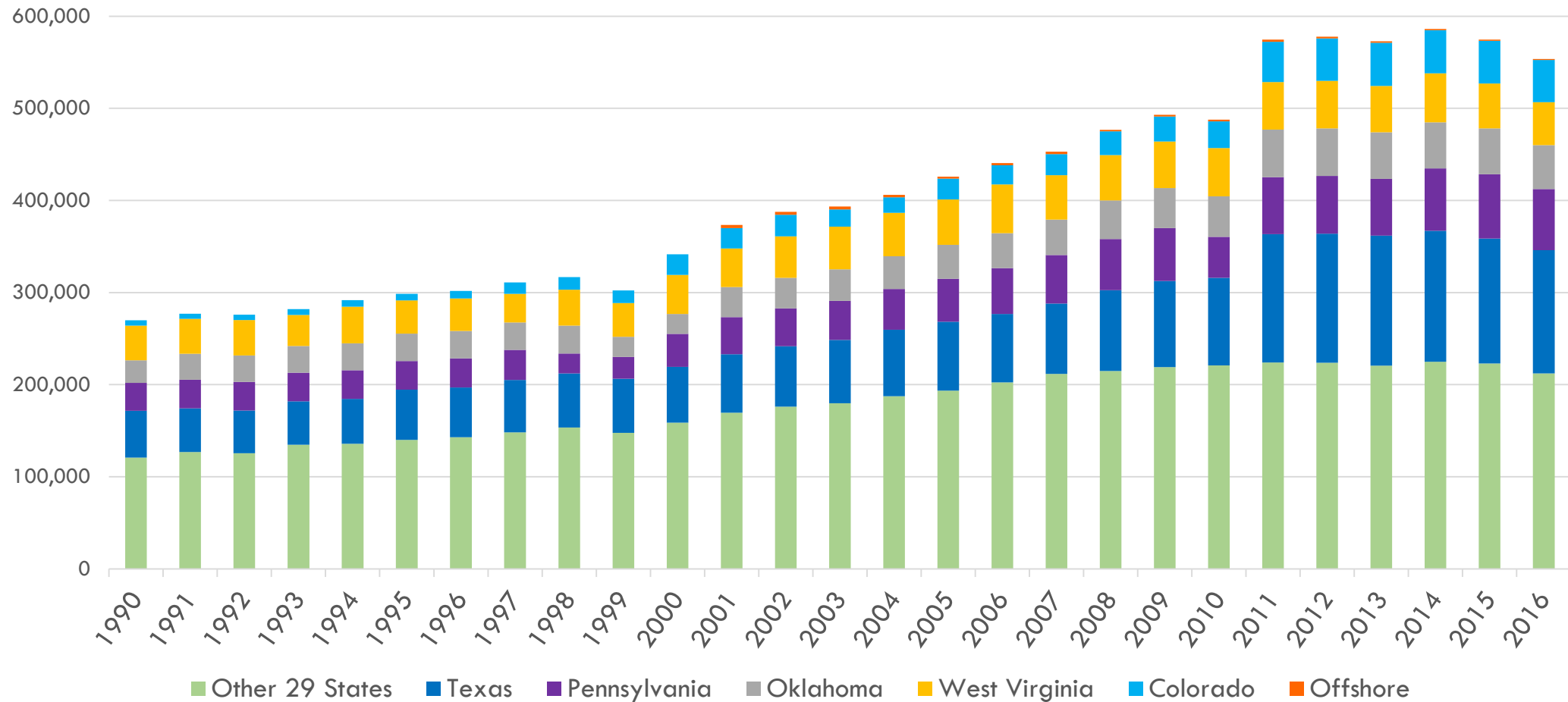


Considerations in Evaluation of Potential Exposures to Emissions from Unconventional Oil and Gas Exploration

Lindsey Jones, MS
Toxicology Division
Texas Commission on Environmental Quality



Number of Producing Gas and Gas Condensate Wells, 1990-2016



Source: US Energy Information Administration, 2017

Production in the Barnett Shale Area, 2000-2017

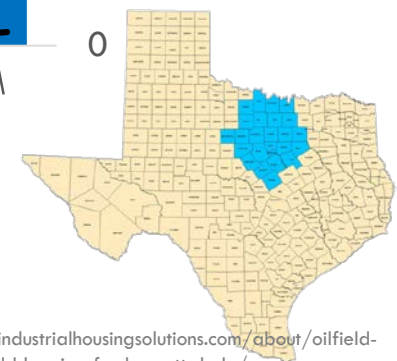
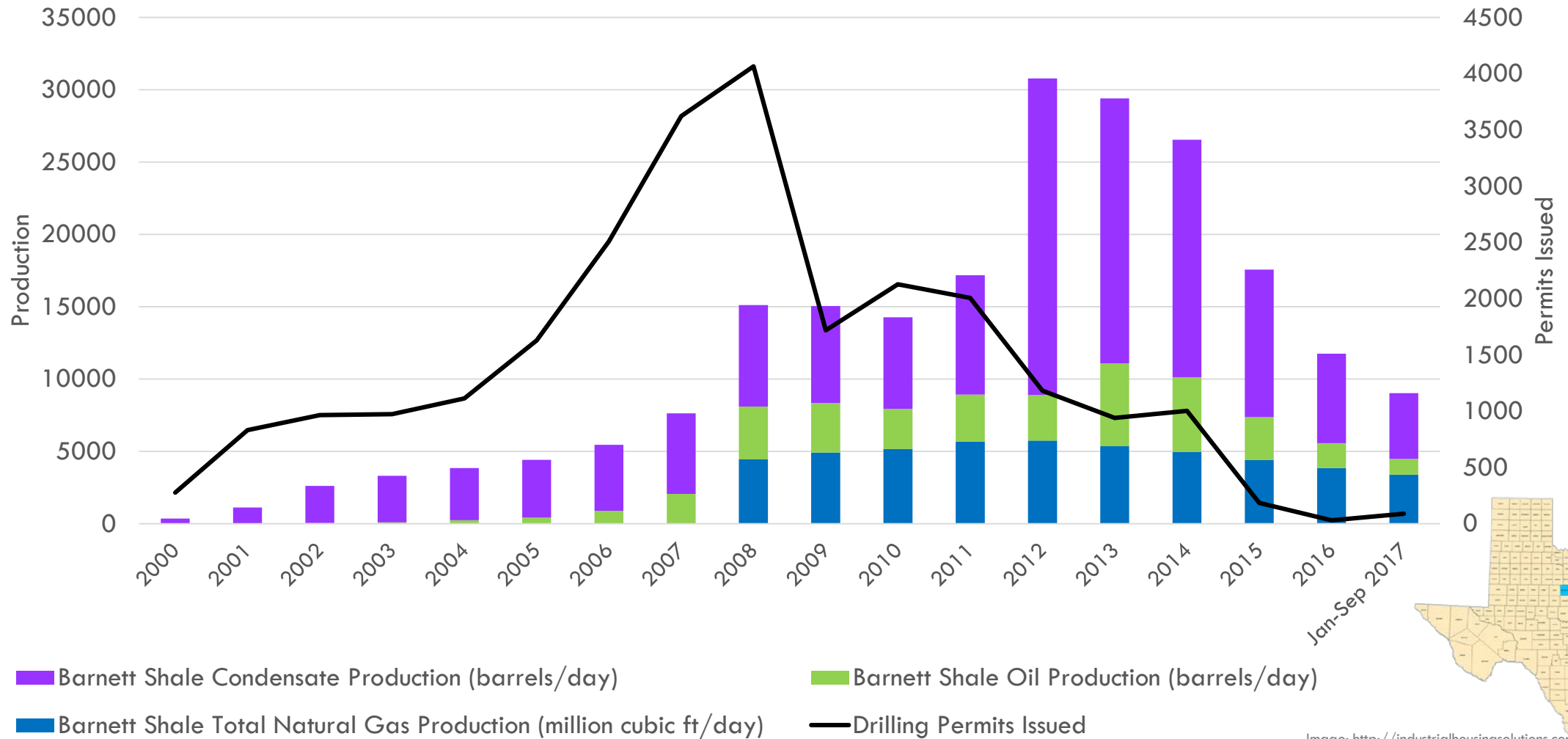


Image: <http://industrialhousingsolutions.com/about/oilfield-locations/oilfield-housing-for-barnett-shale/>

Research Question

- Are ambient air concentrations of pollutants at levels that could negatively impact public health or the environment in areas of high oil and natural gas activity?
 - Not included in this question
 - Traffic, noise, light (local jurisdictions)
 - Indoor air quality or personal exposure
 - Water (considered separately)
 - Indirect impacts

Potential Pollutants

- Volatile Organic Compounds (VOCs)
 - Modified TO-15 suite of 84 VOCs (grab, 30-minute, or 24-hour discrete canister samples)
 - Suite of 46 VOCs (1-hour continuous sampling using autoGCs)
- Carbonyls (aldehydes)
 - TO-11 suite of 18 carbonyls (1-hour or 24-hour discrete cartridge samples)

Exposure Considerations

- Constituents and concentrations
- Distance to receptor
 - Emission source is sometimes very close to residences
- Length of exposure



Typical Timelines



**Site selection,
pad site
preparation**

4-6 weeks



Drilling

2-4 weeks



Fracturing

3-5 days



Production

Decades

Investigative Strategy

- Qualitative Sampling and Surveys
 - Pro: Highly mobile, provides data closer to both sources and residents
 - Con: Unspeciated data not useful for health effect evaluations
- Quantitative Sampling
 - Pro: Provides insight into pollutant concentrations and variability over time
 - Con: Not easily movable, expensive
- Special Emission Inventory
 - Pro: Provides insight into likely sources
 - Con: Data collection takes time and relies on calculations

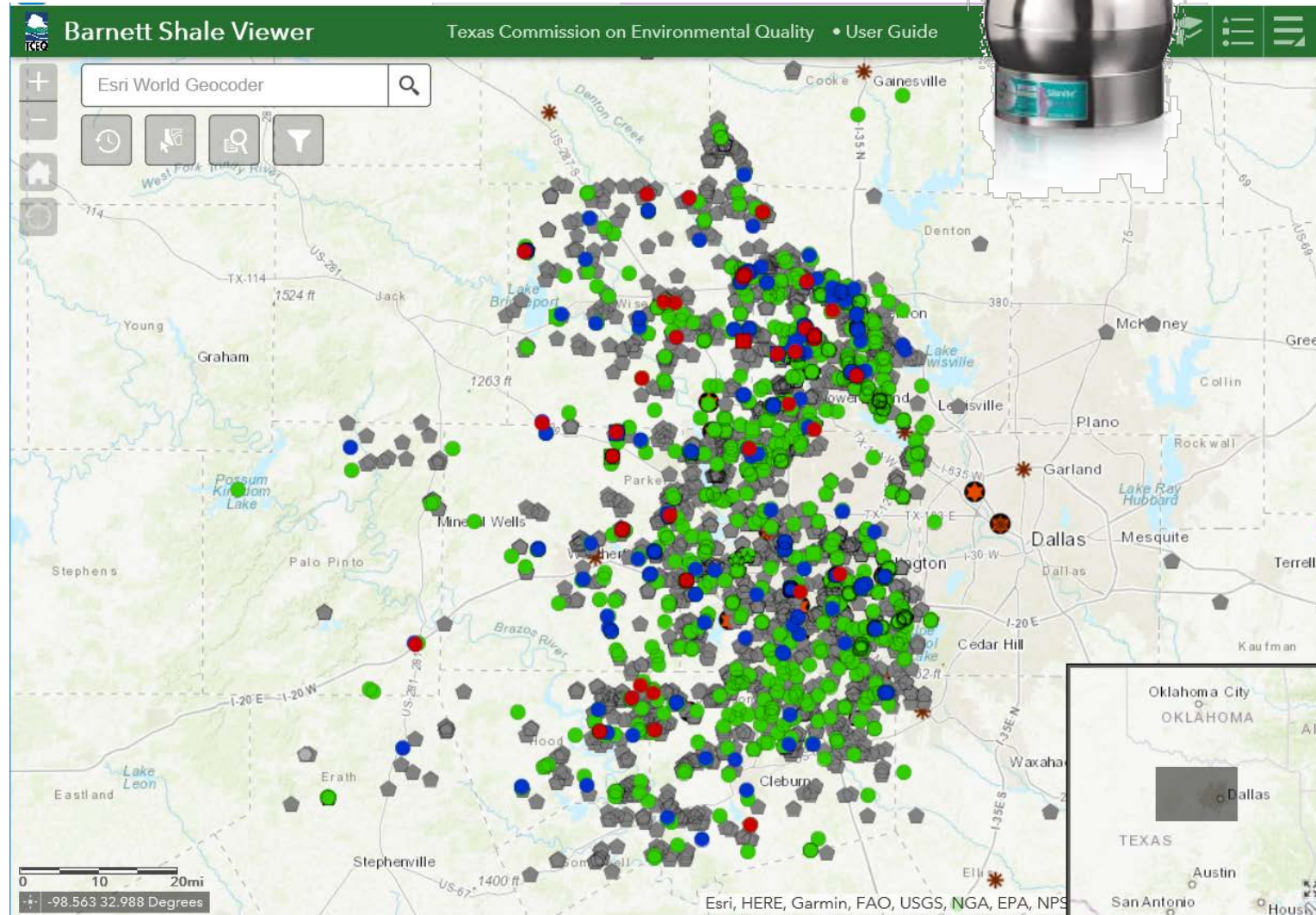
Qualitative Data Collection

- Handheld instruments
 - Over 4000 surveys on the ground
 - Almost all used a survey VOC monitor
 - Over 90 investigations used a handheld H₂S monitor
- Infrared Imaging
 - Over 3000 investigations used a handheld IR camera
 - Thousands of images collected during flyovers in 2005 and 2007



Quantitative Data Collection

- Field Sampling
 - Over 1700 individual canister samples
 - 52 carbonyl samples
 - Collected distance and source information



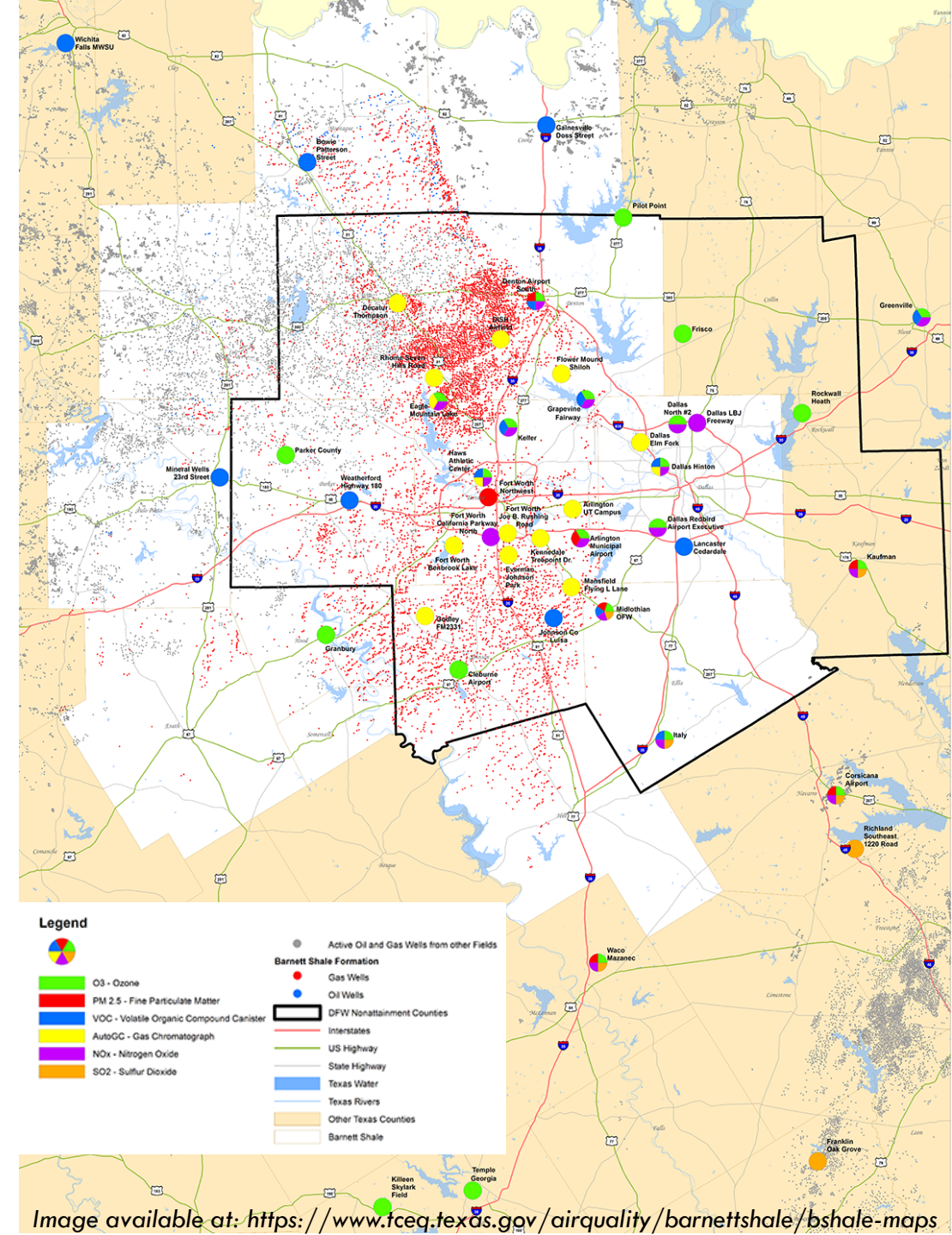
Quantitative Data Collection

- Mobile Monitoring
 - Eight multi-day trips in 2009 and 2010
 - Discrete and real-time sampling for VOCs, NO_x, sulfur compounds, carbonyls



Quantitative Data Collection

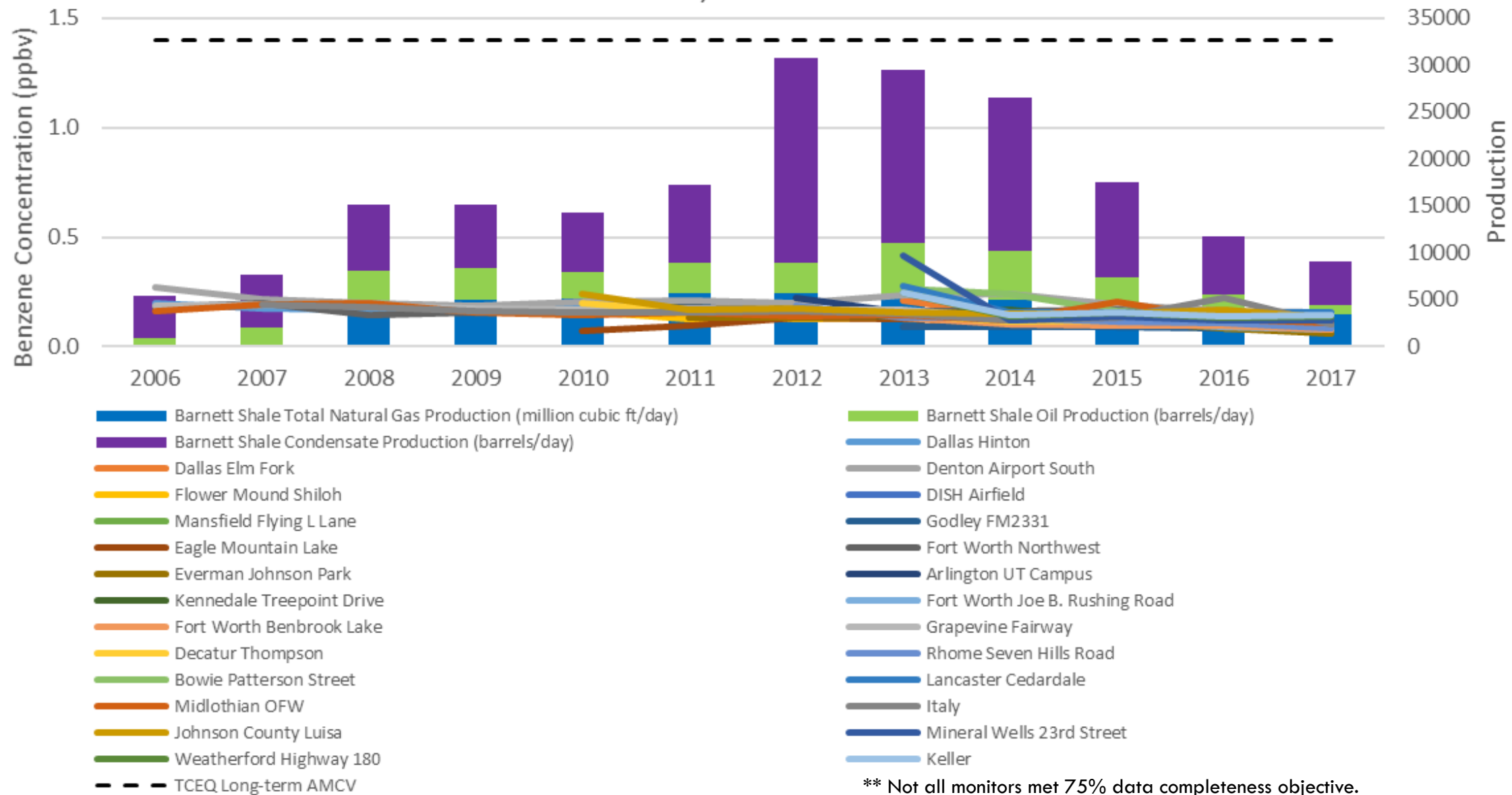
- Fixed-site monitors
 - 2009 – 6 monitoring sites
 - 2 autoGCs
 - 6 canister samplers (2 collocated with autoGCs)
 - 2 carbonyl samplers
 - 2017 – 26 monitoring sites
 - 15 autoGCs
 - 13 canister samplers (2 collocated with autoGCs)
 - 2 carbonyl samplers



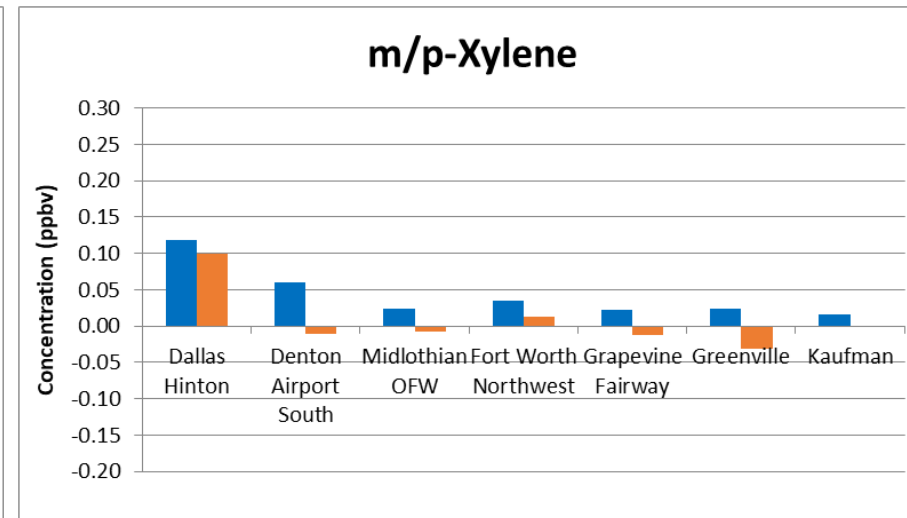
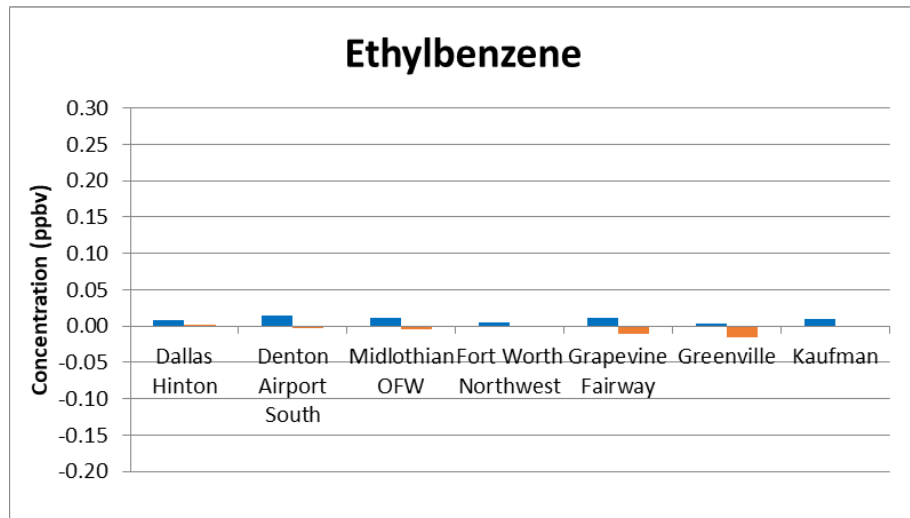
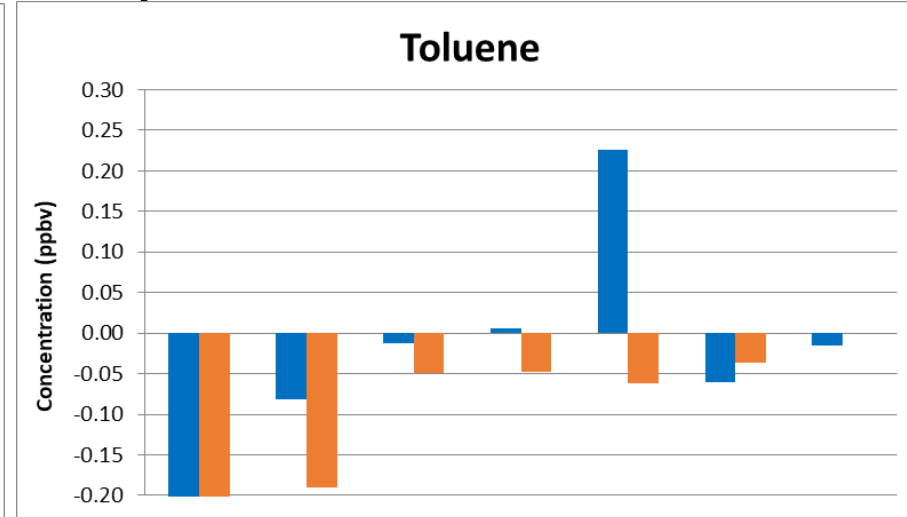
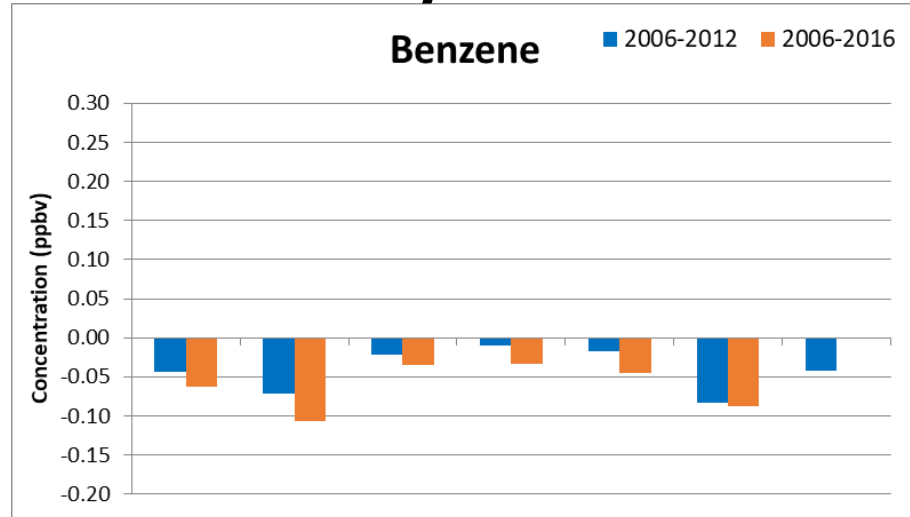
Results to Date

- Nearly all of the issues documented arose from human or mechanical failures.
- These items were quickly remedied and could have been avoided through increased diligence on the part of the operator.
- Corrective actions amounted to little more than replacing worn gaskets, closing open hatches, and repairing stuck valves.

Annual Average Benzene Concentrations and Production in the Barnett Shale Area, 2006-2017



Changes in Annual Average BTEX Concentrations at Stationary Canister Sites, 2006-2016

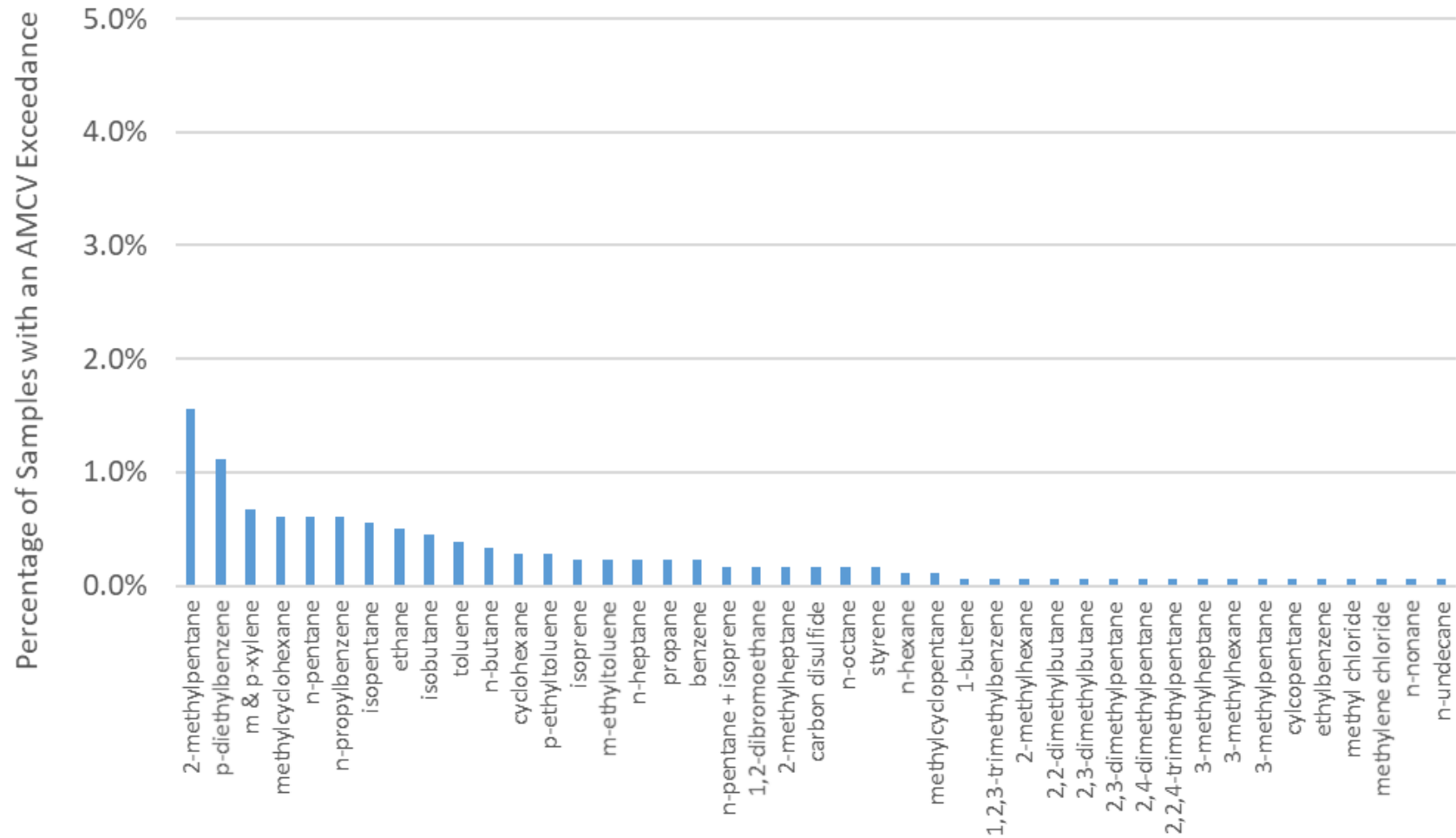


Single Canisters

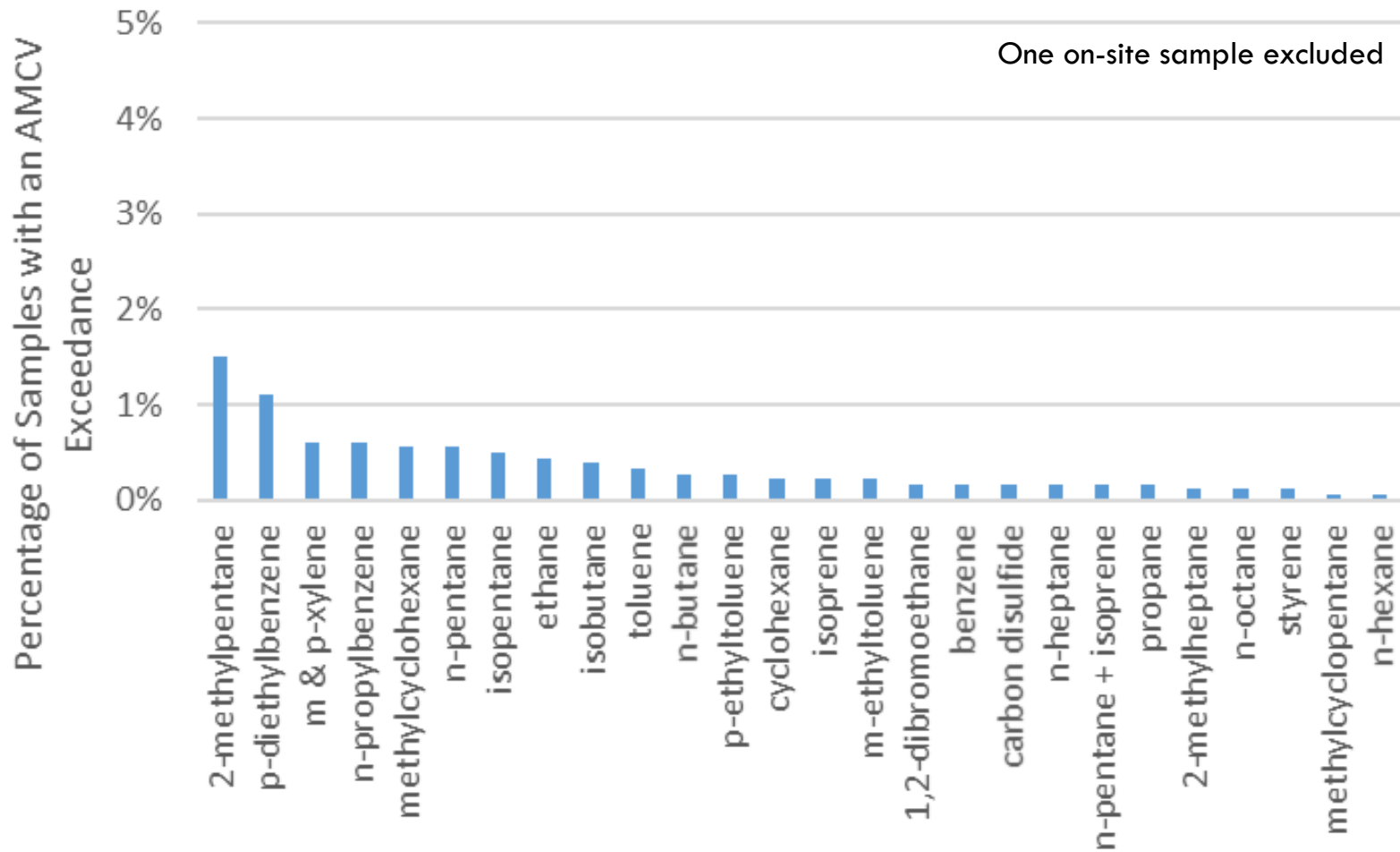
- Over 1700 samples collected since 2009
- <4% of collected canisters had exceedances of short-term health or odor comparison values
- Repeat investigations showed concentrations below short-term comparison values



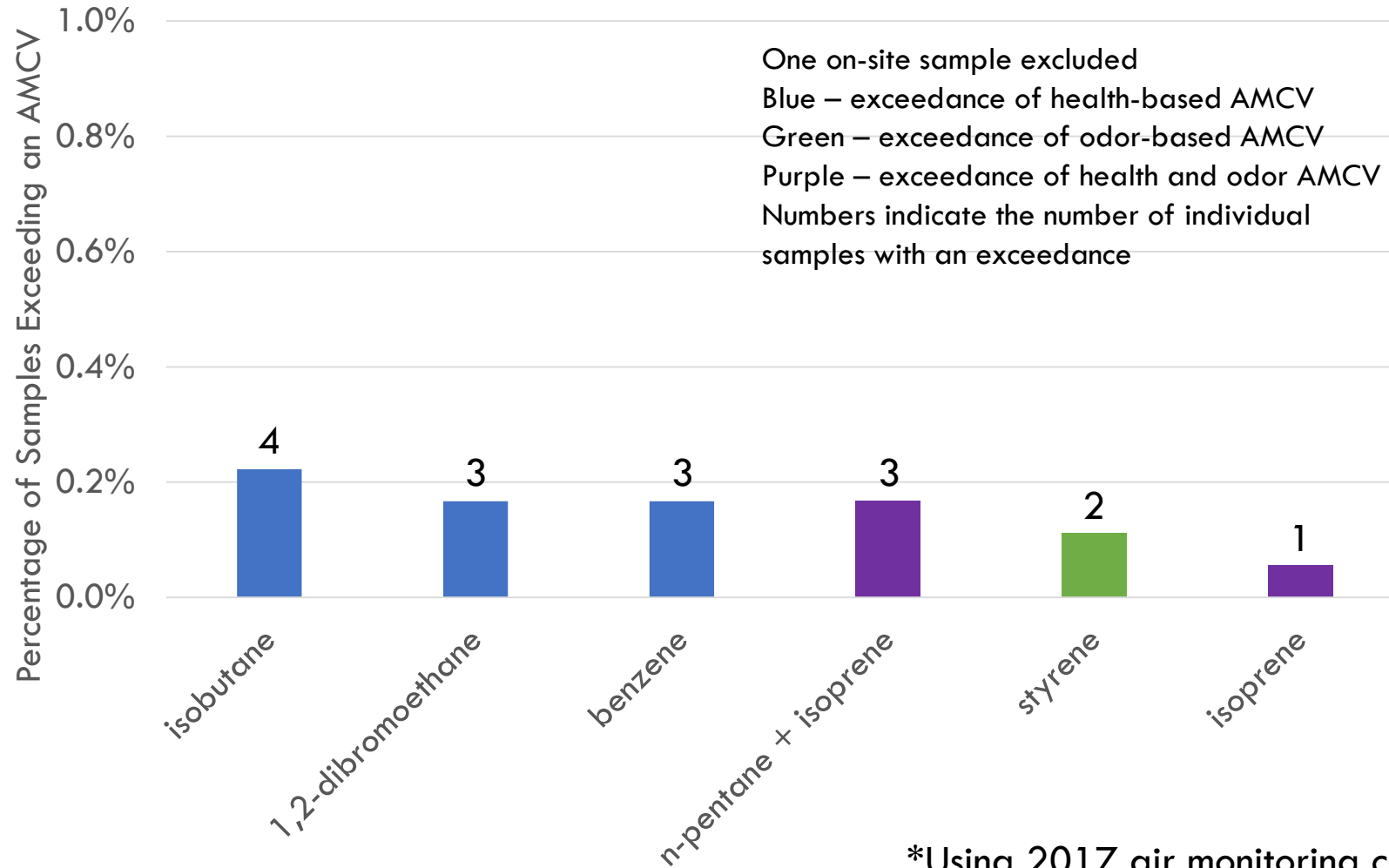
Investigation Canisters with an Exceedance of a Health or Odor Value, 2009-2017



Investigation Canisters with an Exceedance of a Health or Odor Value, 2009-2017



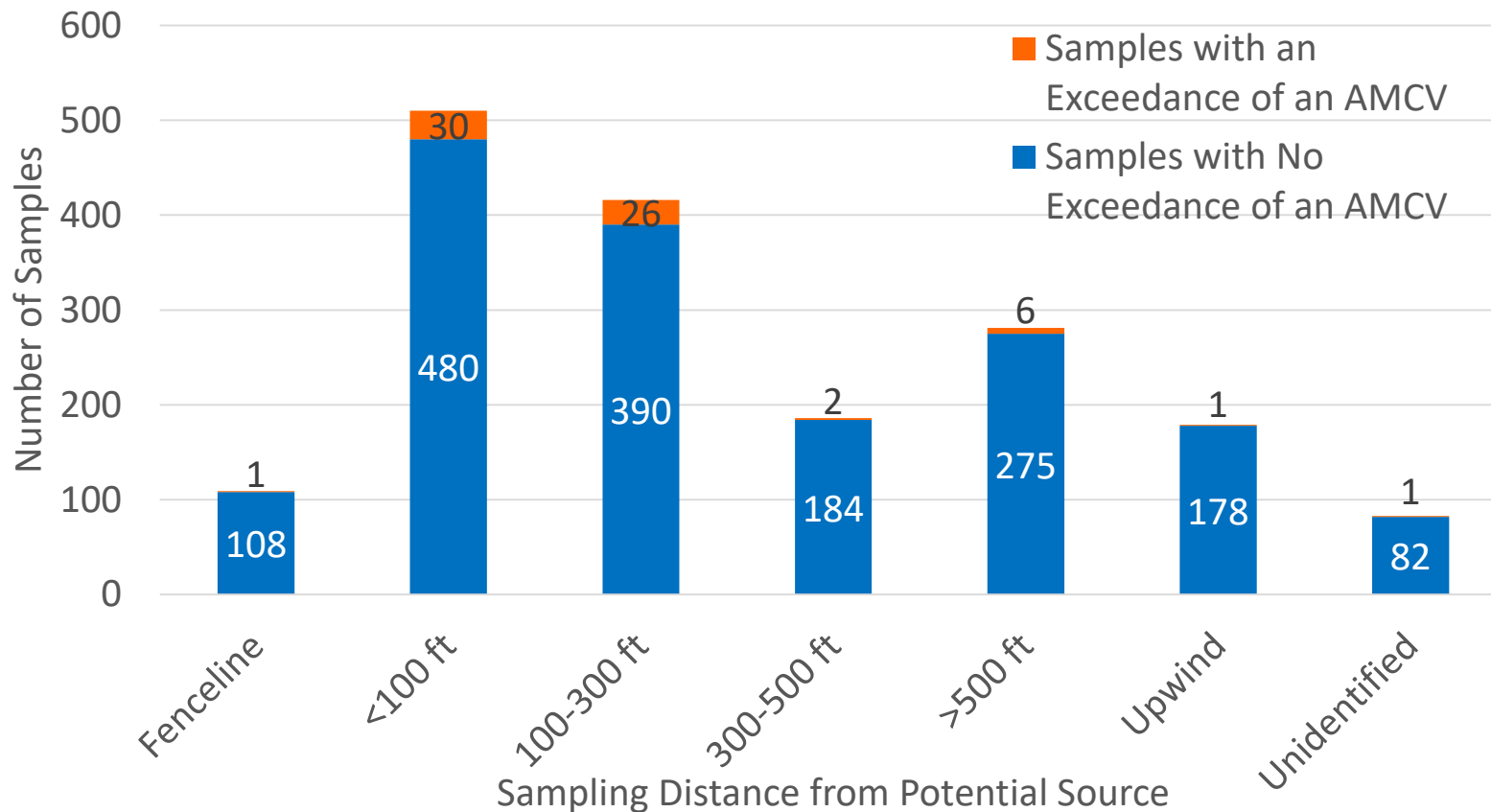
Investigation Canisters with an Exceedance of a Health or Odor Value, 2009-2017



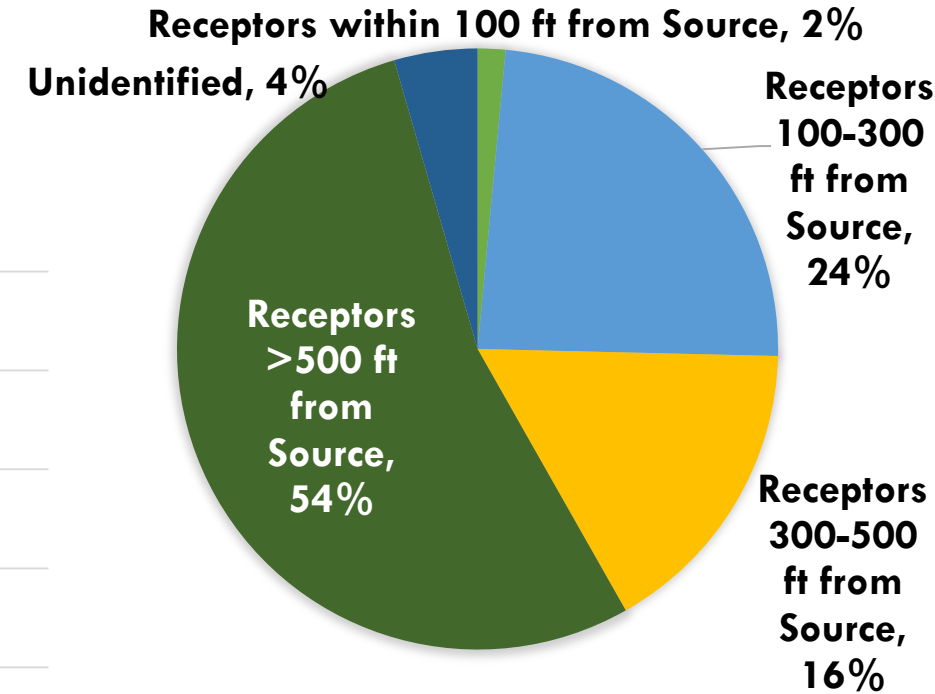
*Using 2017 air monitoring comparison values (AMCVs)

Sampling Distances

Location of Discrete Cansiter Samples in Relation to Potential Sources in the Barnett Shale, 2009-2017



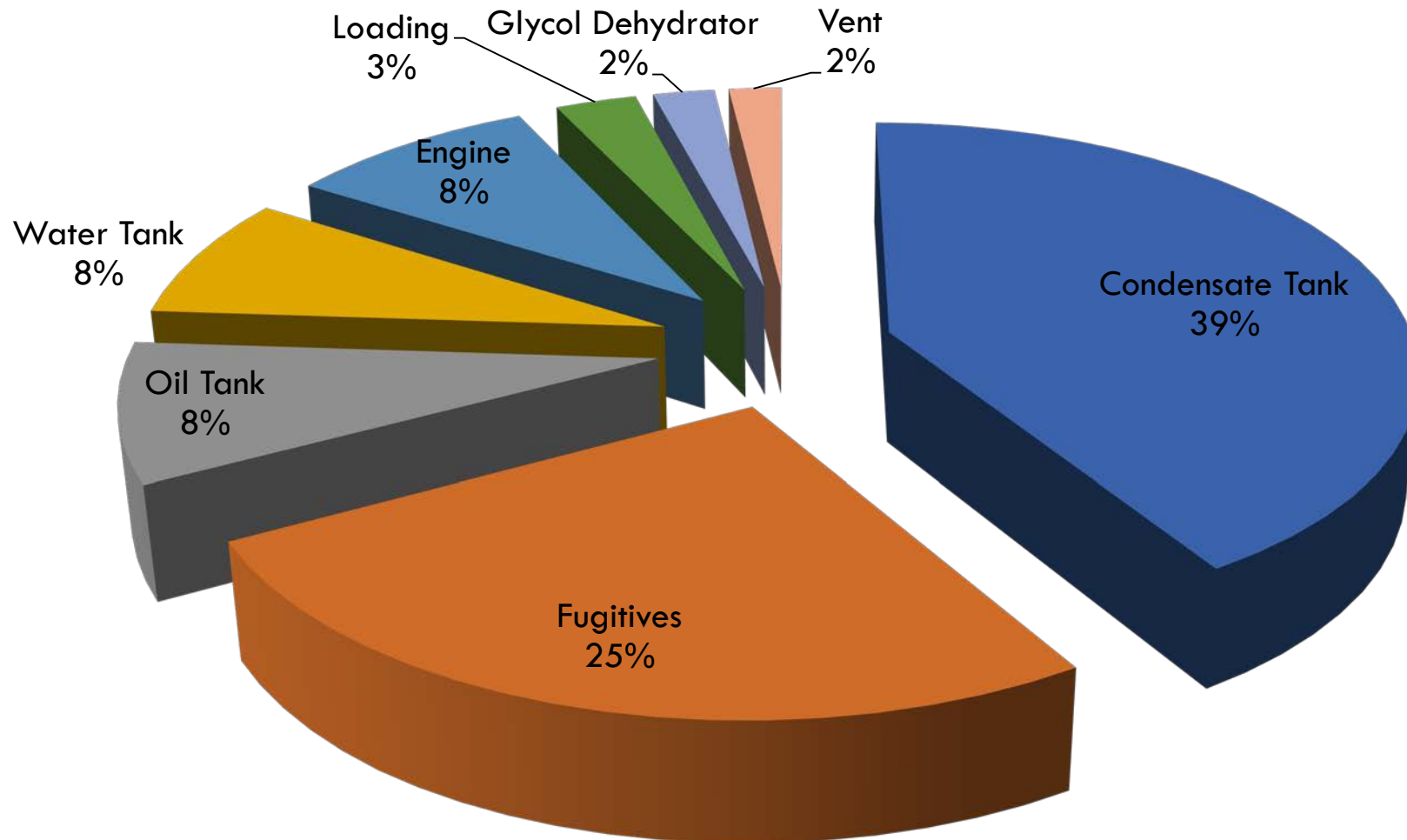
Location of Canister Samples with a Short-Term AMCV Exceedance



Carbonyl Concentrations

- None of the 52 sample concentrations was above a level of health concern
- Relatively consistent concentration independent of sampling location
- Formaldehyde, acetaldehyde, and acetone were the most abundant carbonyls detected
- Formaldehyde concentrations were typical for populated areas

Barnett Shale Special Emissions Inventory-VOCs , 2009



Conclusions

- Monitored ambient VOC, carbonyl, and H₂S concentrations remain below a level of health concern
- Using a multi-pronged approach to evaluating potential for exposure leads to a more complete picture of potential risk and helps to focus investigative efforts

Moving Forward

- Ensure transparency of our efforts through abundant and timely communication with all interested parties
- Evaluate data from the existing ambient air quality monitoring network and samples collected during investigations
- Maintain a frequent, routine investigative presence while also providing timely complaint response
- Adjust as necessary



Extras

Lower 48 states shale plays



- Current play - oldest stacked play
- Current play - intermediate depth/age stacked play
- Current play - shallowest/youngest stacked play
- Prospective play
- Basin

* Mixed shale & chalk play
 ** Mixed shale & limestone play
 *** Mixed shale & dolostone-siltstone-sandstone play
 **** Mixed shale & limestone-siltstone-sandstone play

Source: U.S. Energy Information Administration based on data from various published studies.
 Updated: June 2016



Wells and Ambient Air Quality Monitors

