Barnett Shale Revisited: Plan for Exposure Assessment of Emissions from Unconventional Oil and Gas Development and Production

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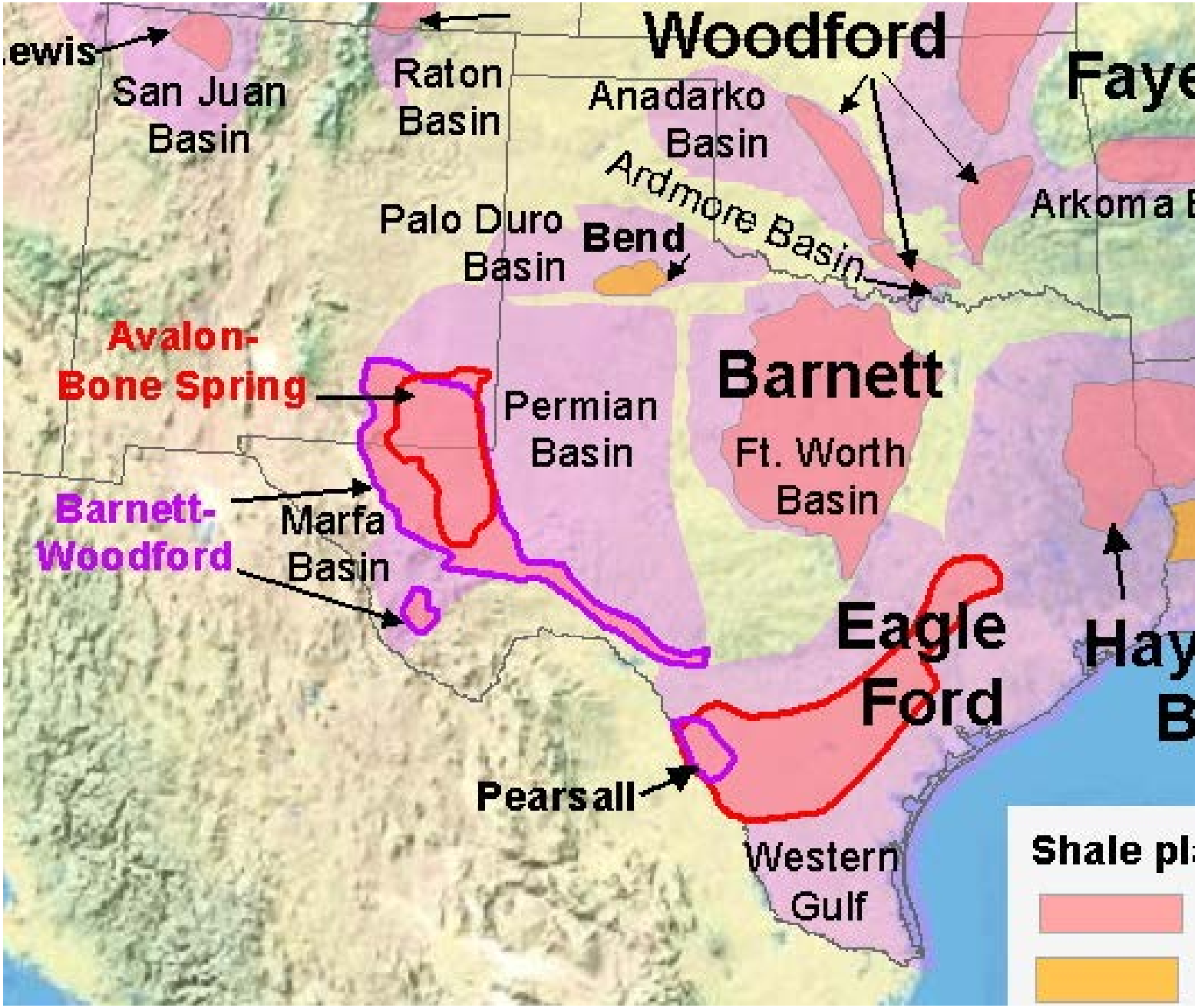
Background Information

- Over the past decade horizontal drilling and hydraulic fracturing technology developed rapidly
- Barnett Shale Formation was the first field to be developed, as the technology was primarily developed there
- The Barnett Shale Formation and other formations in Texas are among the largest in the world
- Exponential growth near heavily populated, urban areas has lead to increased public concern regarding impacts on human health and welfare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San Juan Basin
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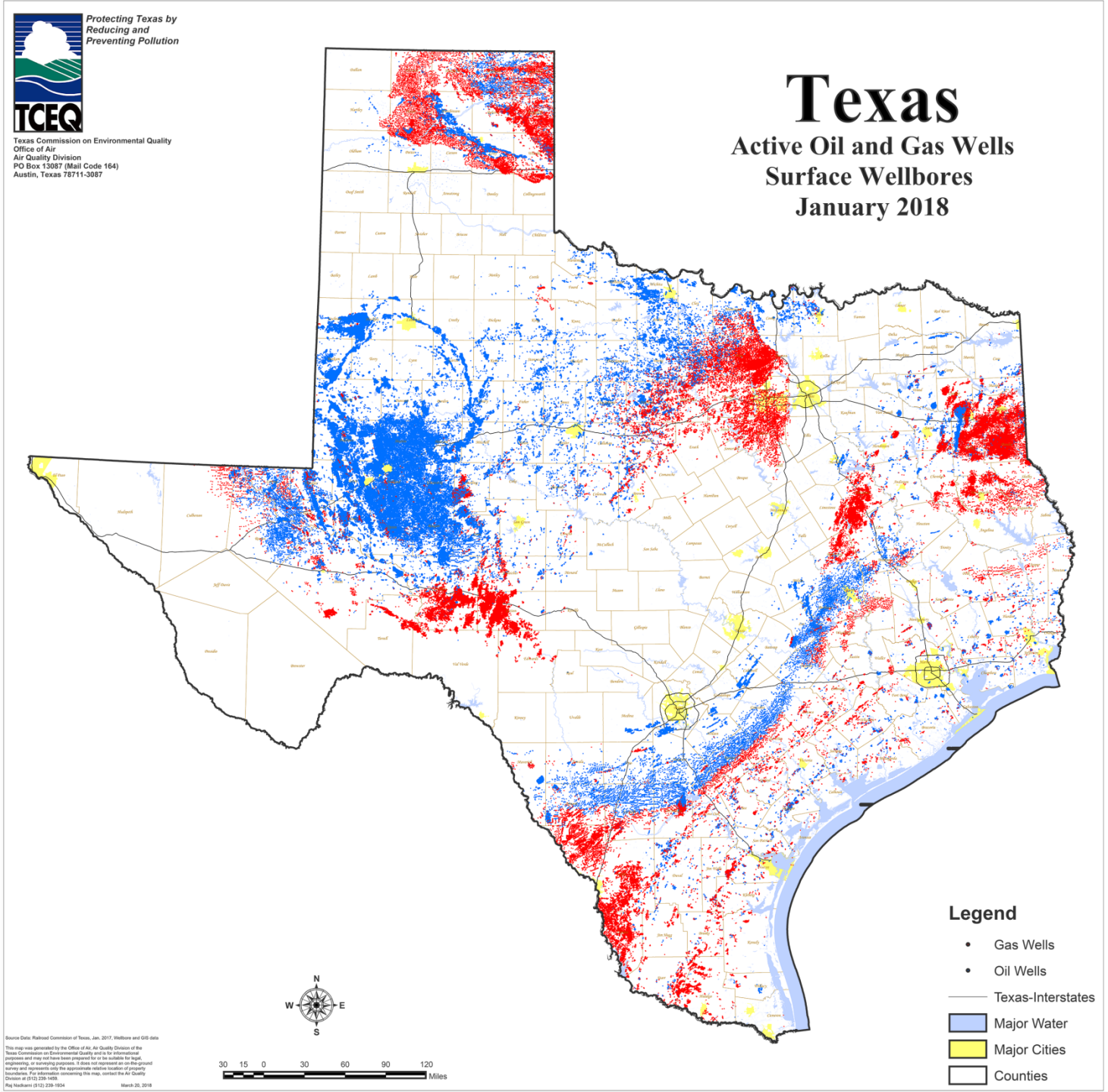
Protecting Texas by Reducing and Preventing Pollution
TCEQ
Texas Commission on Environmental Quality
Office of Air
Air Quality Division
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Texas
Active Oil and Gas Wells
Surface Wellbores
January 2018
Legend
Gas Wells
Oil Wells
Texas-Interstates
Major Water
Major Cities
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Miles
Source Data: Railroad Commision of Texas, Jan. 2017, Wellbore and GIS data
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Raj Nadkarni (512) 239-1934
March 20, 2018

Problem Formulation and Risk Management

- Many unknowns were present during the rapid development in the Barnett Shale Area
- The agency employed many techniques to characterize risk:
  - IR Camera and helicopter flyovers
  - Emissions inventories
  - Mobile monitoring trips
  - Field investigations
  - Fixed-site monitors

Helicopter Mounted IR Camera: Source Detection/Identification

- Flyovers were conducted in 2007 and 2010
- The 2010 flyover resulted in images of over 5,000 individual storage tanks and identified 88 sources of significant hydrocarbon emissions.
- Flyovers conducted 3-4 times per year

Helicopter Mounted IR Camera: Source Detection/Identification

WMV

Eagle Ford flyover.wmv

TCEQ

Problem Formulation and Risk Management

- In addition to efforts by the agency, the TCEQ also worked in collaboration with the public to address concerns:
  - Reduced response time to complaints to 12 hours
  - Gave citizens canisters to collect samples when they observed odors or health effects
  - Worked with citizens to select monitoring sites
  - Hosted open house and public meetings

TCEQ

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Characterizing Exposure

- Process of Collecting Data
  - Hand held equipment often used to scan possible sources of emissions
    1. Toxic Vapor Analyzers (TVA) surveys measured total volatile organic compounds (VOCs) up to 450 ppm
    2. Infrared (IR) gas imaging camera surveys at oil and natural gas sources
    3. Collection of air samples (grab samples or 30 min canister)
- Analysis
  - Collection of air samples (grab samples or 30 min canister)
  - Sample analyzed by gas chromatography followed by mass spectrometry (GCMS)
- Can be considered worst-case scenario
- Field investigators also recorded additional details which are integral to understanding exposure scenario

Characterizing Exposure

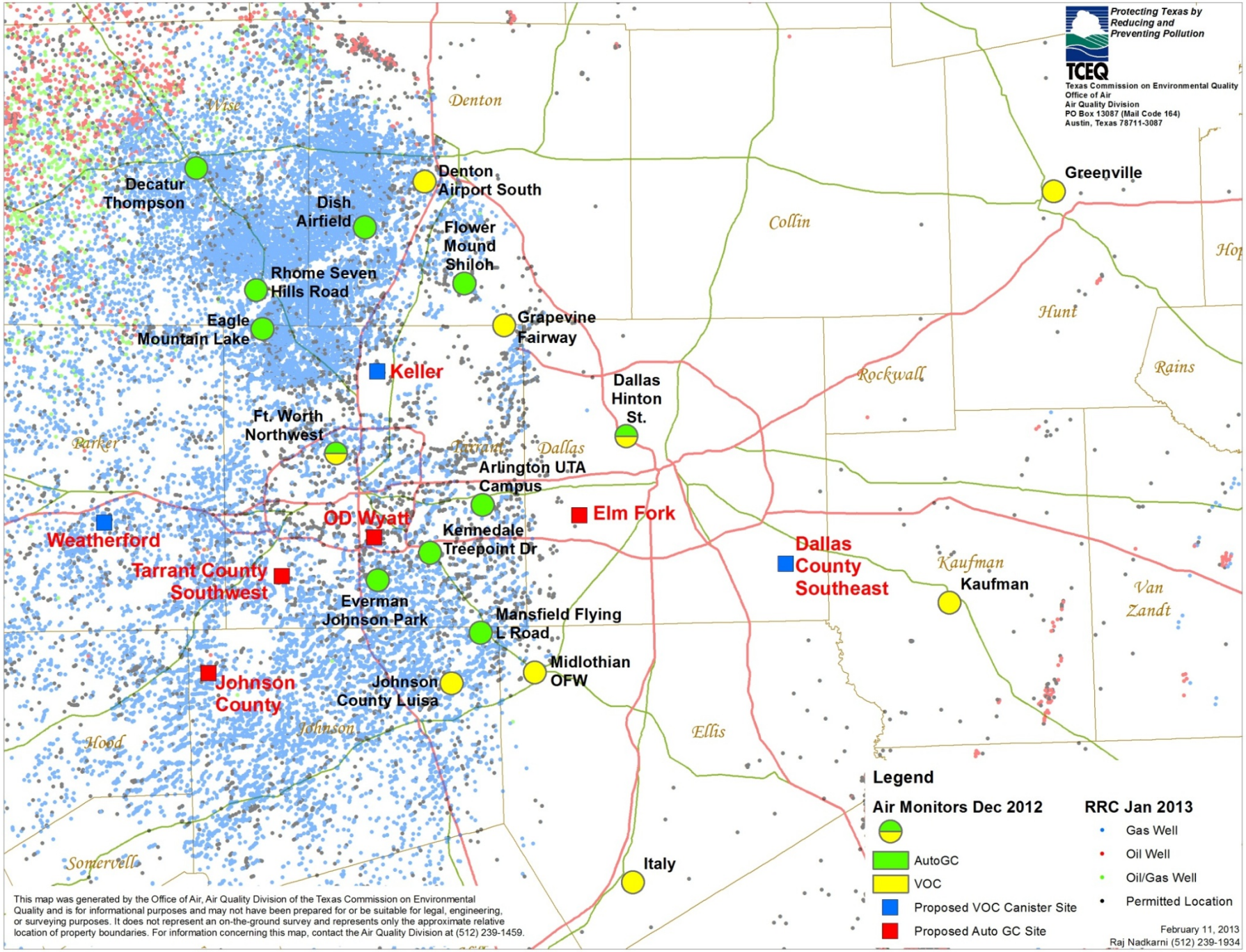
- Approximately 6300 samples were collected in the Barnett Shale area
  - Includes field blanks, duplicates, controls, etc.
  - ~1600 samples were 30 min, grab, or stationary canister
  - Samples were collected by field investigators in the region, by staff from the central office, and by citizens
  - Additional parameters were collected to better characterize each sample
- Additional samples have also been collected in Eagle Ford Shale area

Characterizing Exposure

- Additional data to characterize samples
  - Location sample was collected
  - Who collected the sample (region/monitoring team/citizen)
  - Reason sample was collected (complaint/investigation/follow-up)
  - Possible emissions sources
  - Distance sample was taken from source
  - Meteorological conditions
  - Site-specific observations (health effects/odors)
- These additional detail allow for a much more comprehensive understanding of emissions and the potential for human exposures

Characterizing Exposure

- In addition to short-term samples collected by canisters, fixed site monitors (canister and auto GC) were sited in the area
- These monitors provide information regarding long-term exposure
- They are also useful to provide information about background levels of chemicals in the area before and after oil and gas production and development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Weatherford
Kennedale Treepoint Dr
Tarrant County Southwest
Everman Johnson Park
Mansfield Flying L Road
Dallas County Southeast
Kaufman
Midlothian OFW
Johnson County
Johnson County Luisa
Italy
Legend
Air Monitors Dec 2012
AutoGC
VOC
Proposed VOC Canister Site
Proposed Auto GC Site
RRC Jan 2013
Gas Well
Oil Well
Oil/Gas Well
Permitted Location
February 11, 2013
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What We Have Found

- Short-term samples for carbonyls, NO_x, and sulfur compounds have not detected chemicals at short-term levels of concern.
- Less than 5% of VOC canister samples had a short-term, health- or odor-based AMCV exceedance.
  - VOCs detected above an odor-based AMCV*:
    - Isobutane, Isopentane, Isoprene, 2-Methylpentane, m & p-Xylene, n-Pentane, n-Propylbenzene, p-Diethylbenzene, Styrene, Cyclohexane, Methylcyclohexane
  - VOCs detected above a short-term, health-based AMCV*:
    - Benzene, Carbon Disulfide, 1,2-Dibromoethane, Isobutane, Isoprene, Methylcyclopentane, 2-Methylpentane, n-Butane, n-Heptane, n-Octane
- Citizen complaints – odor and irritation

What We Have Found

- 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.

Future Directions

- Evaluation of trends within the data used to characterize individual samples
- Do these data have relationships with measured chemical concentrations?
- Are there trends with certain sources?
- Do observations vary when complaints were made? When citizens collect samples?
- How do the observations of short-term data relate to long-term trends?

Questions?

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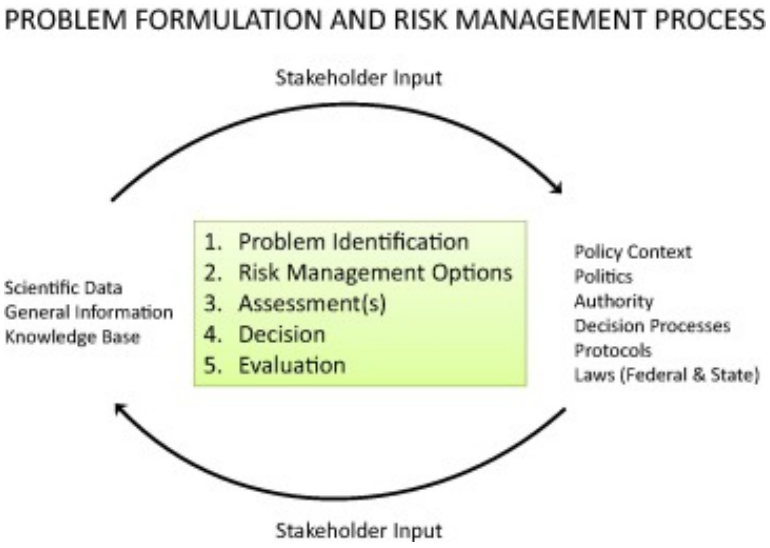
Website:

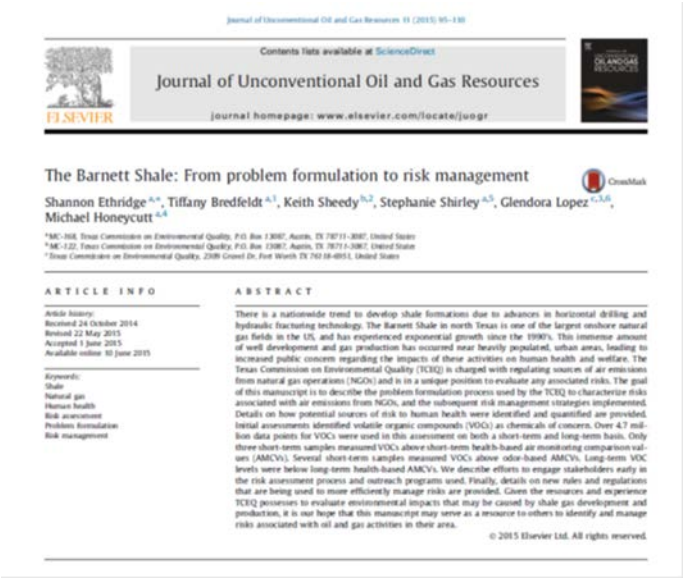
https://www.tceq.texas.gov/airquality/barnettshale

Problem Formulation and Risk Management Pub:

https://www.sciencedirect.com/science/article/pii/S2213397615000270

Problem Formulation and Risk Management





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The Barnett Shale: From problem formulation to risk management

Shannon Ethridge, Tiffany Bredfeldt, Keith Sheedy, Stephanie Shirley, Glendora Lopez, Michael Honeycutt

ARTICLE INFO

ABSTRACT

There is a nationwide trend to develop shale formations due to advances in horizontal drilling and hydraulic fracturing technology. The Barnett Shale in north Texas is one of the largest onshore natural gas fields in the US, and has experienced exponential growth since the 1990's. This immense amount of well development and gas production has occurred near heavily populated, urban areas, leading to increased public concern regarding the impacts of these activities on human health and welfare. The Texas Commission on Environmental Quality (TCEQ) is charged with regulating sources of air emissions from natural gas operations (NGOs) and is in a unique position to evaluate any associated risks. The goal of this manuscript is to describe the problem formulation process used by the TCEQ to characterize risks associated with air emissions from NGOs, and the subsequent risk management strategies implemented. Details on how potential sources of risk to human health were identified and quantified are provided. Initial assessments identified volatile organic compounds (VOCs) as chemicals of concern. Over 4.7 million data points for VOCs were used in this assessment on both a short-term and long-term basis. Only three short-term samples measured VOCs above short-term health-based air monitoring comparison values (AMCVs). Several short-term samples measured VOCs above odor-based AMCVs. Long-term VOC levels were below long-term health-based AMCVs. We describe efforts to engage stakeholders early in the risk assessment process and outreach programs used. Finally, details on new rules and regulations that are being used to more efficiently manage risks are provided. Given the resources and experience TCEQ possesses to evaluate environmental impacts that may be caused by shale gas development and production, it is our hope that this manuscript may serve as a resource to others to identify and manage risks associated with oil and gas activities in their area.

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