



**pennsylvania**  
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Oil and Gas Management



# **Citizens Advisory Council**

## **Abandoned and Orphan Oil and Gas Wells in Pennsylvania**

**Bureau of Oil and Gas Planning and Program Management**

**Division of Subsurface Activities**

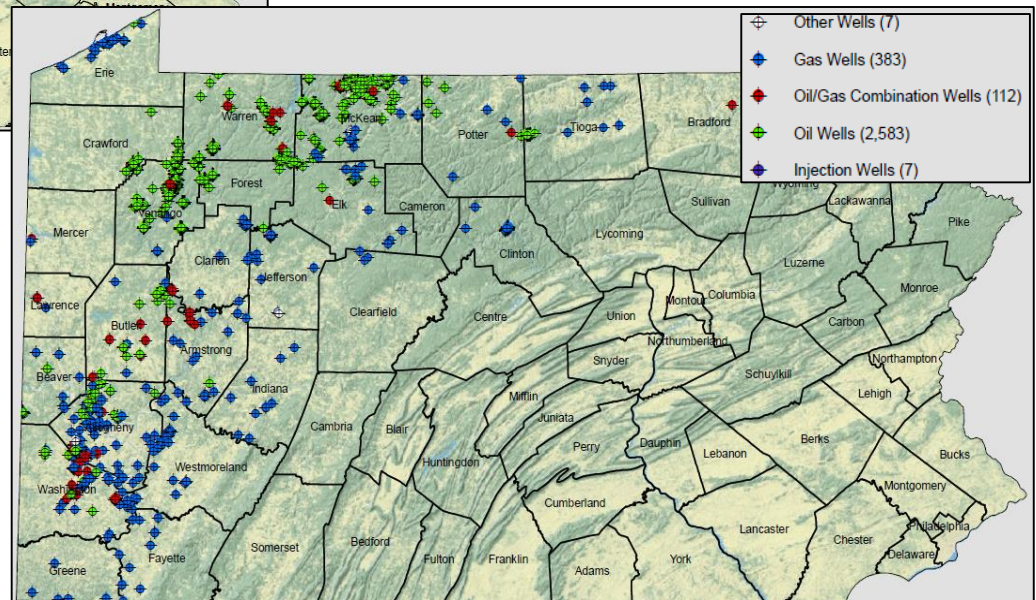
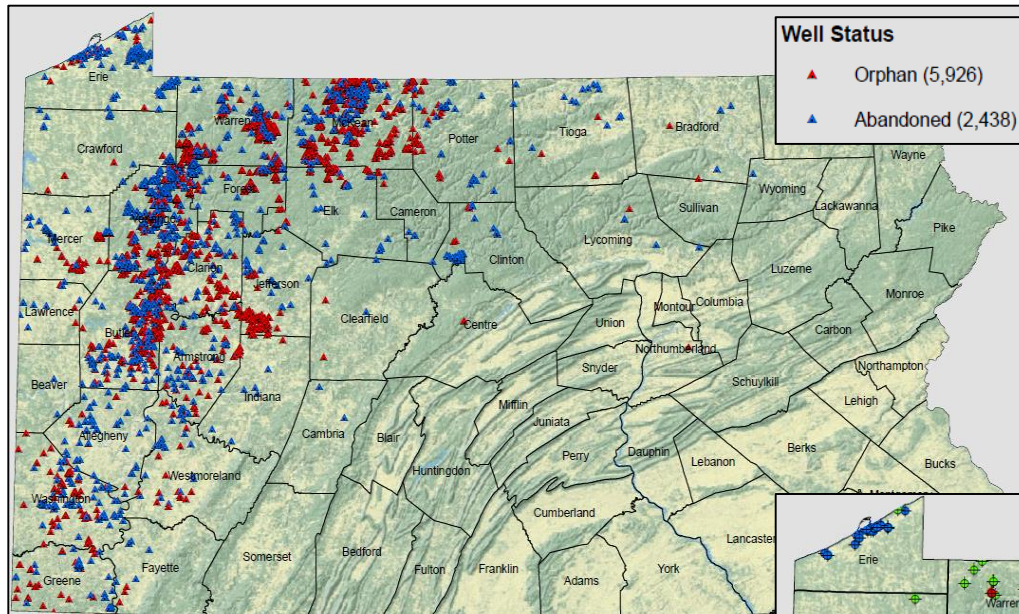
**January 19, 2021**

# Presentation Outline

- Plugging Program Status Update
  - Funding
  - Emergency Procurement
  - Estimated Unfunded Liability
- Emerging Environmental/Safety Issues
  - Plugging Effectiveness
  - Short-term Environmental and Safety Risks
  - Emissions
- Summary

# Plugging Program Status Update

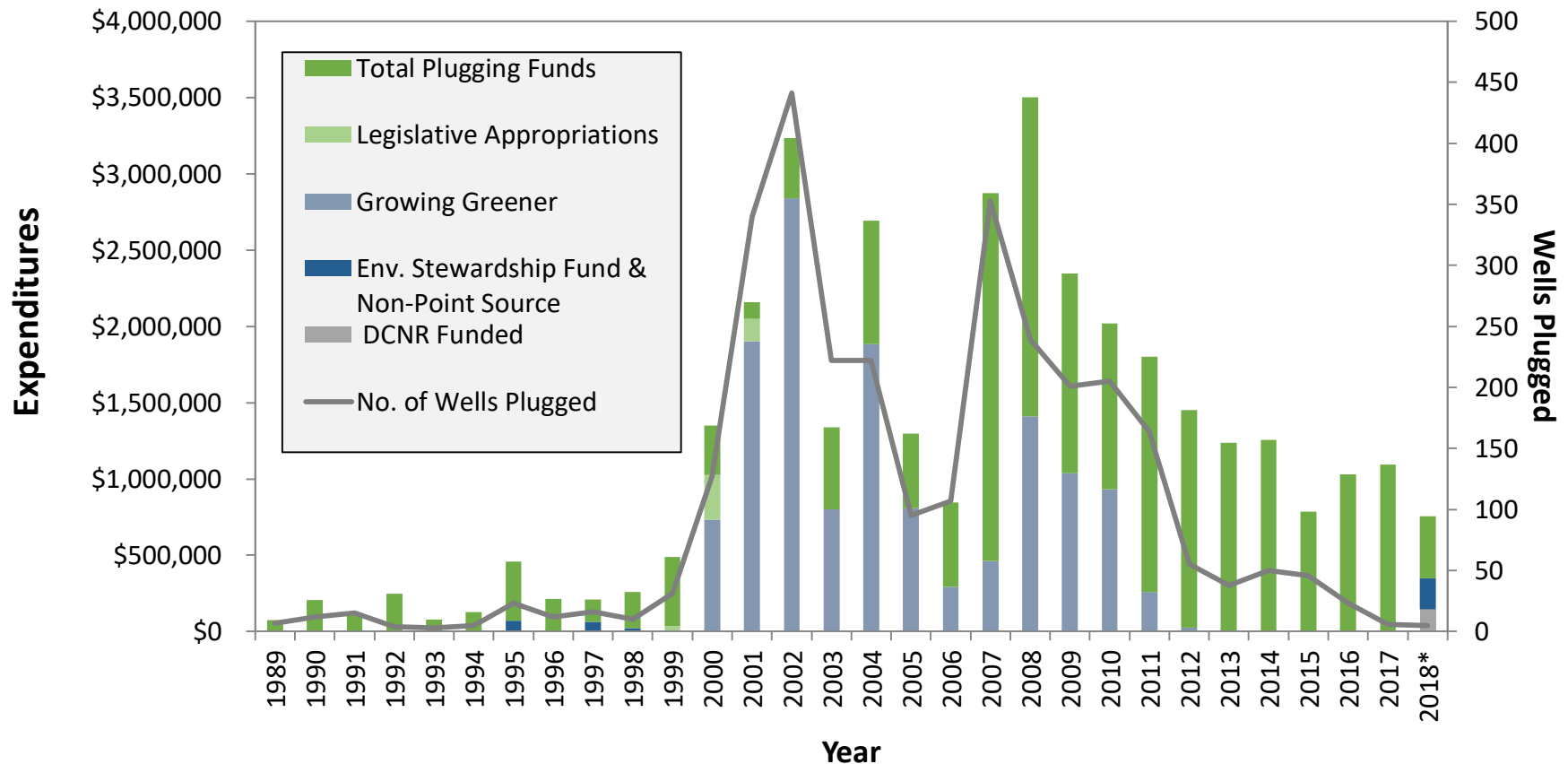
## DEP Abandoned, Orphan, and Plugged Wells



# Plugging Program Status Update

## DEP Plugging Program Funding

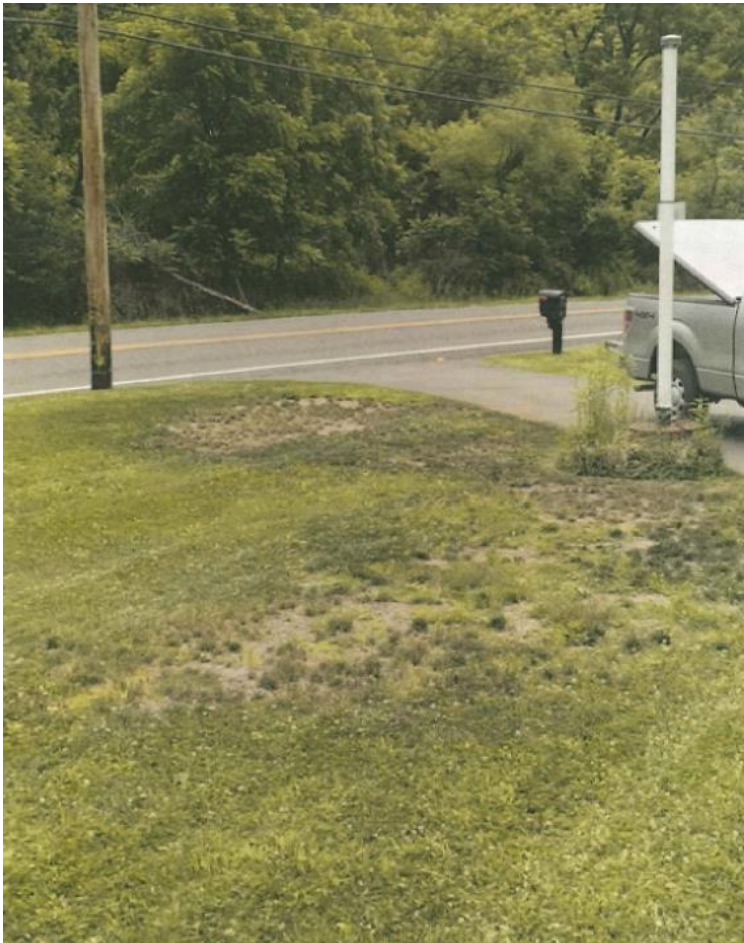
- Since 1985, DEP has received \$150-\$250 surcharges for every drilling permit



# ▶ Plugging Program Status Update

## Recent Emergency Procurement Trends

- Antaki Well: \$14,000 for stray gas mitigation system



# ▶ Plugging Program Status Update

## Recent Emergency Procurement Trends

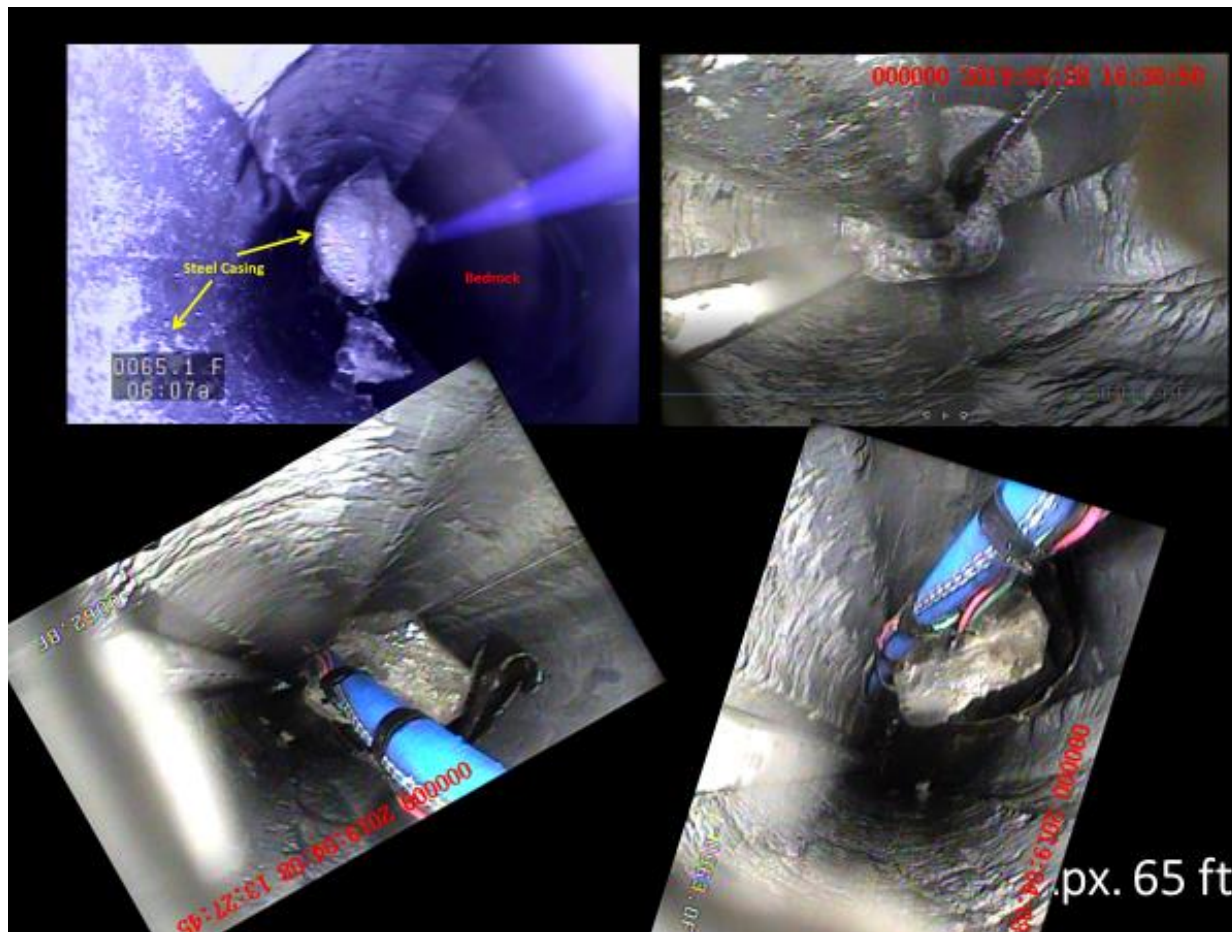
- Antaki Well: \$14,000 for stray gas mitigation system



# Plugging Program Status Update

## Recent Emergency Procurement Trends

- Antaki Well: Approximately \$350,000 for plugging



# ▶ Plugging Program Status Update

## Recent Emergency Procurement Trends

- John Barron Well: \$179,000 for flaring and plugging





# Plugging Program Status Update

## Recent Emergency Procurement Trends

- John Barron Well: \$179,000 for flaring and plugging



# ▶ Plugging Program Status Update

## Recent Emergency Procurement Trends

- John Barron Well: \$179,000 for flaring and plugging



# Plugging Program Status Update

## Recent Emergency Procurement Trends

- Monahan Well: \$160,000 for plugging



# ▶ Plugging Program Status Update

## Recent Emergency Procurement Trends

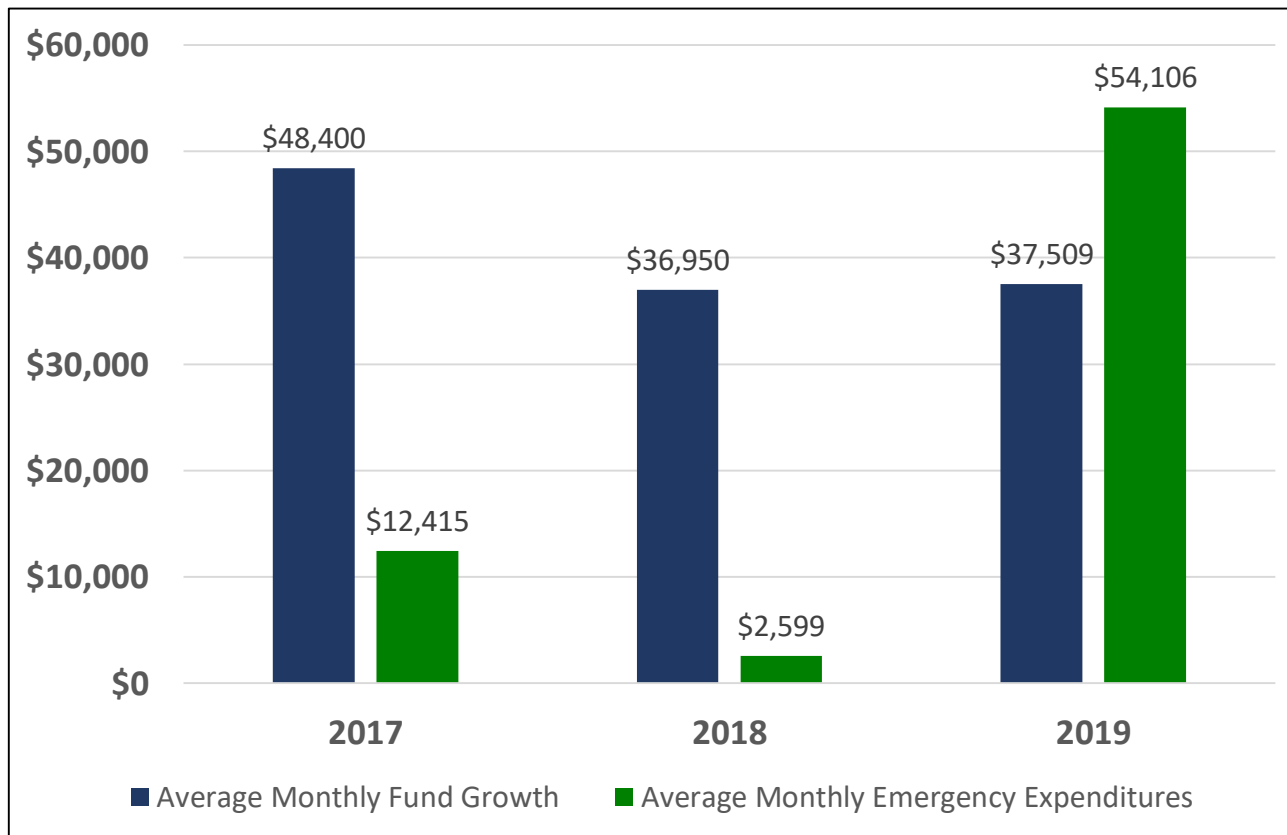
- Monahan Well: \$160,000 for plugging



# Plugging Program Status Update

## Recent Emergency Procurement Trends

- DEP's emergency procurement trends also suggest expenditures have the potential to exceed fund growth



# Plugging Program Status Update

## Mass Abandonment

- In 2018 two operators with major holdings abandoned approximately 2,750 wells
- Tens of thousands of conventional oil and gas wells will eventually need to be plugged but they may not have a viable owner that can afford to plug them
- Bonding levels do not equate to actual plugging costs
  - \$2,500 single conventional well bond
  - \$25,000 blanket bond (unlimited number of conventional wells)
  - Thousands of wells are under a single blanket bond or have no bonds at all (Pre-Act wells)

# Plugging Program Status Update

## Crunching the Numbers

- There are more than 8,000 wells in DEP's Abandoned and Orphan Well database – DEP has the statutory authority to plug these wells
- Over the last four years, DEP has added 345 wells to its Abandoned and Orphan Well database
- Mass abandonment is likely to continue increasing DEP's plugging liability
- Since 1989, DEP has plugged a little over 3,000 wells
- Comparing peer reviewed research (Dilmore et al., 2015; Kang et al., 2016) to public databases, there could be as many as 200,000 additional legacy wells, many of which will require plugging as they are discovered

# Plugging Program Status Update

## Cost Modeling/Liability Forecasting

- A conservative estimate of \$33,000 per well has been derived from reviewing contract costs
- Liability forecasting changes significantly based on per-well cost assumptions
  - At \$33,000 per well, DEP's plugging liability ranges somewhere between \$280 million (8,500 wells) and \$6.6 billion (200,000 wells)



# Emerging Environmental/Safety Issues

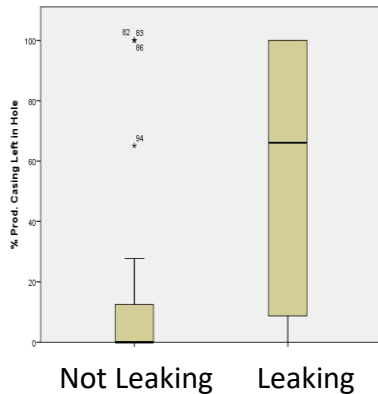
## Plugging Effectiveness: Field Investigation and Statistical Analysis

- Conduct well site investigations utilizing high sensitivity gas monitoring equipment to determine if plugs are leaking
- Analyze field data and compare to other leaking plugged wells and non-leaking plugged wells to determine variables that may be influencing rate of plug failure

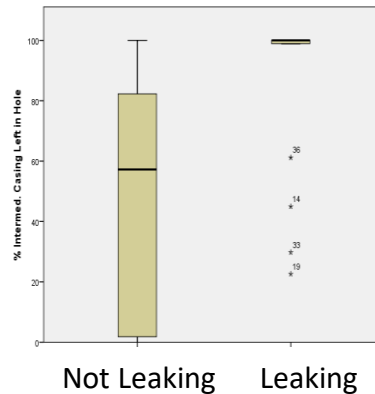


# Emerging Environmental/Safety Issues

% Production Casing Left



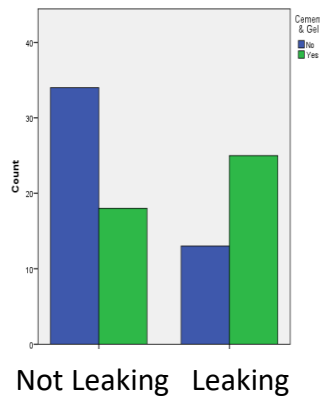
% Intermediate Casing Left



## Box Plots Suggest:

- Leaking wells have substantially more production or intermediate casing left in the ground than non-leaking wells – differences are statistically significant ( $p < 0.05$ )

Cement & Gel



## Bar Charts Suggest:

- Leaking wells have a greater ratio of cement & gel plugs

# Emerging Environmental/Safety Issues

## Shallow Charged Zones Possibly Attributable to Legacy Activities



# Emerging Environmental/Safety Issues

Risks associated with Abandoned, Orphan, and improperly plugged wells can be compounded by mine-influenced water in areas of coal mining



# Emerging Environmental/Safety Issues

## Encroachment

- High population density areas/regions of active development may introduce intersections between legacy wells and occupied enclosed spaces
- During Phase I/Phase II site assessments, a thorough review of legacy development is critical for mitigating client liability
  - PA Geologic Survey Farmline Maps
  - PASDA
  - DEP Oil and Gas Mapping Tool
  - Local Government Resources
- The Good Samaritan Law affords liability relief for third parties who volunteer to decommission legacy wells for which there is no responsible party

# Emerging Environmental/Safety Issues

## Encroachment



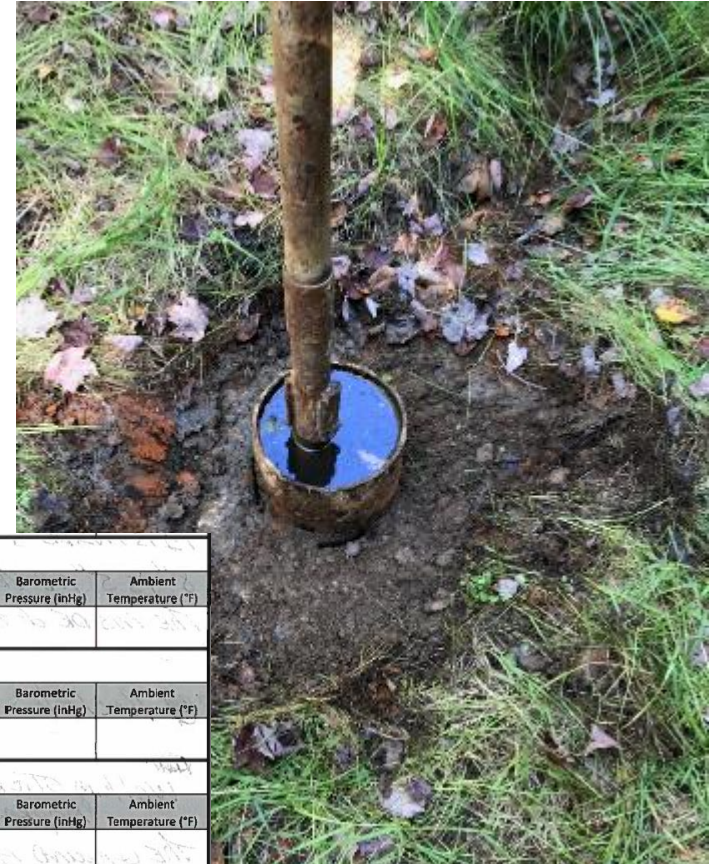
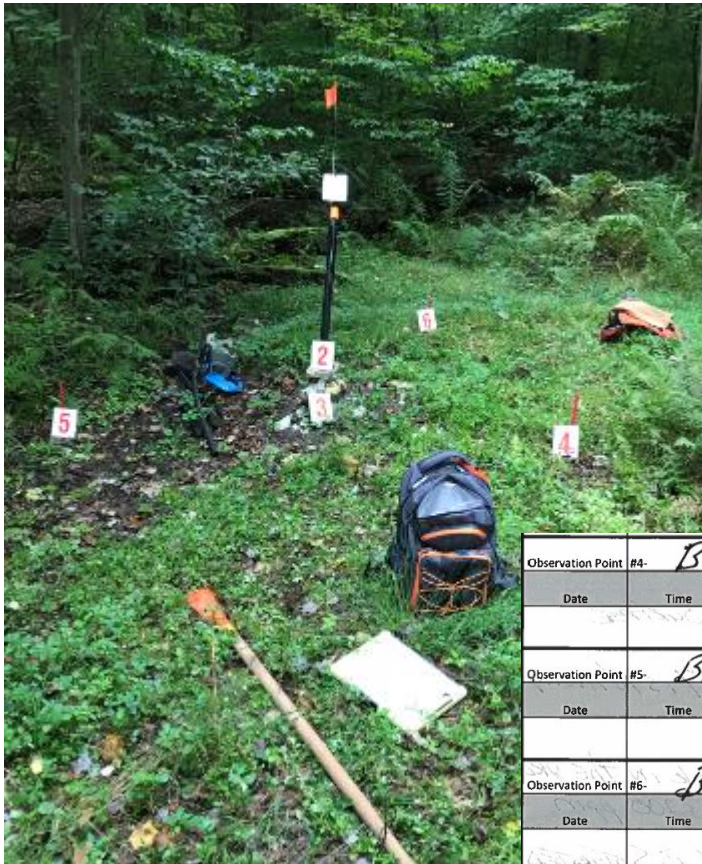
# Emerging Environmental/Safety Issues

## **Improperly Decommissioned Gathering Systems**

- Stubbed off segments of gathering lines have the potential to introduce stray gas into the subsurface if not properly decommissioned during well plugging
- Recent DEP field work has identified elevated soil gas concentrations in association with such systems

# Emerging Environmental/Safety Issues

## Improperly Decommissioned Gathering Systems



Observation Point	Date	Time	Gas Concentration	Concentration Unit (ppm or %)	Volume ft <sup>3</sup> /day	Barometric Pressure (inHg)	Ambient Temperature (°F)
#4- BAR HOLE #4			6620	ppm			
#5- BAR HOLE #5			7860	ppm			
#6- BAR HOLE #6			500	ppm			
#7- BAR HOLE #7 10' AWAY			360	ppm			

ABBREVIATIONS  
OH - Open Hole

VPI - Venting Pipeline



# Emerging Environmental/Safety Issues

## Emissions

- McGill University
  - Kang et al. (2016) found a high occurrence of leaking abandoned and plugged wells
  - Isotopic signatures support deep, oil-associated origin
  - In some cases, gas was found to be flowing through the soil beyond the footprint of the outermost well casing
  - DEP is currently working to understand if Kang et al.'s (2016) emission regression model can be used as a risk-management tool

# Summary

- Pennsylvania has a significant history of legacy oil and gas development and the potential for hundreds of thousands of wells with no associated responsible party
- Unfunded plugging liability is currently estimated at \$280 million, but could be much higher – it is forecasted to grow
- An analysis of failed plugs suggests that further improvements may be necessary to ensure long-term plug integrity
- Legacy wells are contributing to environmental and public safety risks



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# Thank You! Questions?

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**Rewriting Pennsylvania's Legacy ([dep.pa.gov/legacy\\_wells](http://dep.pa.gov/legacy_wells))**