



**pennsylvania**  
DEPARTMENT OF ENVIRONMENTAL PROTECTION

Oil and Gas Management



# **History of Well Plugging and Risks Associated with Orphan & Abandoned Wells and Improperly Plugged Wells**

2018

Information for Potential CFA OAWP Grant  
Applicants

# Regulatory History of Well Plugging

- **1859** – First well drilled, “Drake well”, Titusville, PA
- **1878** – Wells first required to be plugged with wood and sediment
- **1881** – Plugging requirements updated: Fill well with sand or rock sediment and wooden plugs above third producing sand
- **1921** – Plugging requirements updated
  - Fill with sand or rock sediment and each producing strata plugged with wood plug
  - Requires venting of wells through coal layers
  - Allows for casing to be pulled with tubing and packer in place
- **1952** – API standards for cement and well plugging published
- **1956** – Well permitting begins; modern plugging requirements
- **1984** – Modern environmental plugging requirements
- **1989** – First well plugged in DEP plugging program

# Regulatory History of Well Plugging

*42.100.001*  
GENERAL LAWS

PASSED BY THE

LEGISLATURE

OF THE

STATE OF PENNSYLVANIA,

DURING THE

SESSION OF 1881.

BY AUTHORITY.

No. 101.

AN ACT

Regulating the mode of plugging abandoned oil wells, and providing a penalty for the violation thereof.

SECTION 1. *Be it enacted, &c.*, That whenever any well shall have been put down for the purpose of exploring for and producing oil, upon abandoning or ceasing to operate the same, the owner or operator shall, for the purpose of excluding all fresh water from the oil-bearing rock and before drawing the casing, fill up the well with sand or rock sediment to the depth of at least twenty feet above the third sand or oil-bearing rock, and drive a round, seasoned, wooden plug at least two feet in length, equal in diameter to the diameter of the well below the casing, to a point at least five feet below the bottom of the casing, and, immediately after the drawing of the casing, shall drive a round wooden plug into the well at the point just below where the lower end of the casing shall have rested, which plug shall be at least three feet in length, tapering in form and to be of the same diameter at the distance of eighteen inches from the smaller end as the diameter of the well below the point at which it is to be driven; after it has been properly driven shall fill in on top of same with sand or rock sediment to the depth of at least five feet.

Abandoned oil wells to be plugged.

# ▶ Regulatory History of Well Plugging



# Risks

- Environmental/Human Health Issues:
  - Oil/Brine/Gas leaks to the environment/water sources
  - Frac Communications/Drilling Collisions
  - Problems compounded by other mineral resource production
    - Casing deterioration through interaction with acidic mine-influenced water

# ▶ Defining Risk

- What can happen when an orphan or abandoned well is not properly plugged?

Discharges of oil and/or brine to land surface or surface water, or impacts to groundwater



# Defining Risk

- What can happen when an orphan or abandoned well is not properly plugged?

Communication during fracing

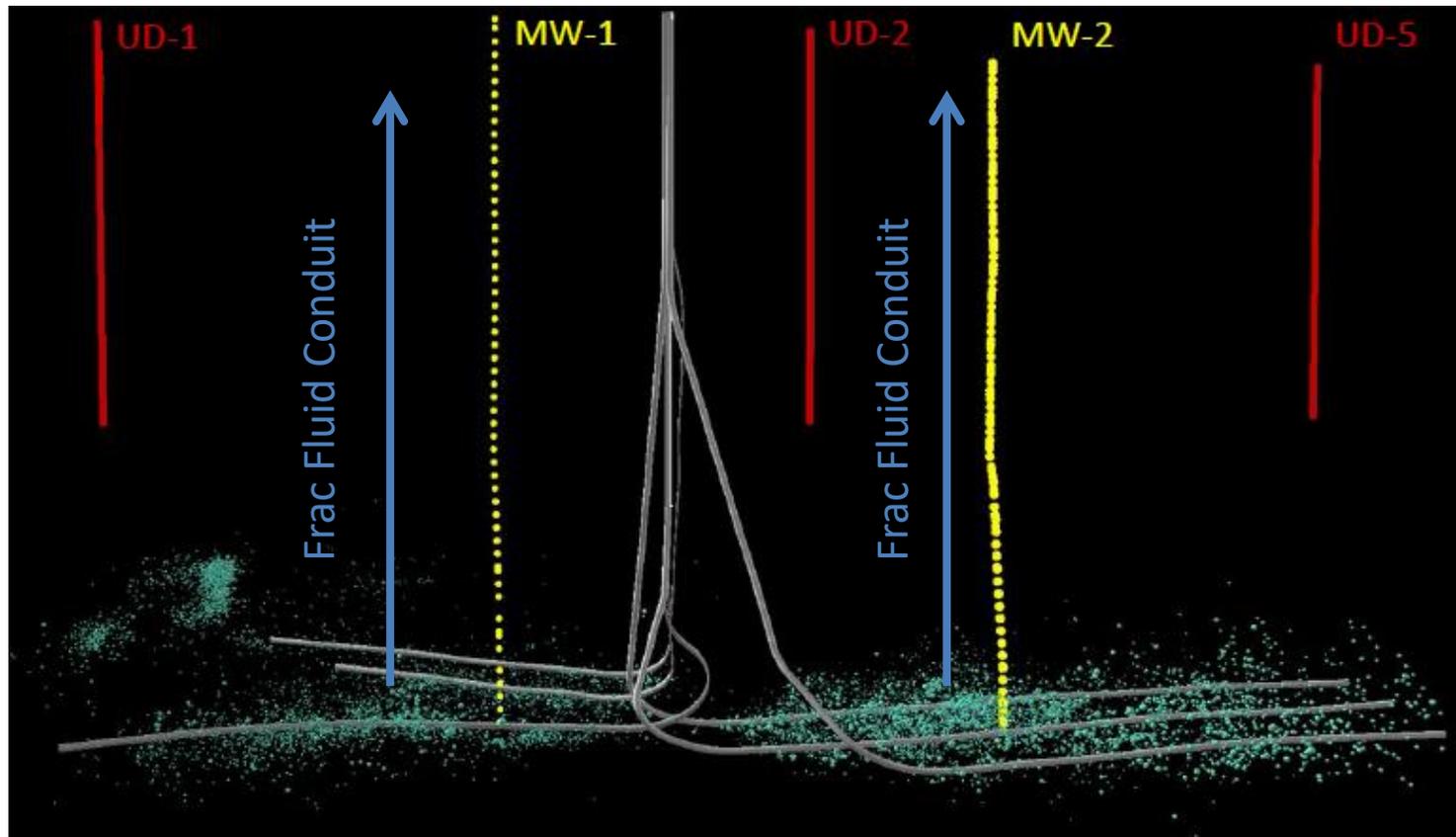
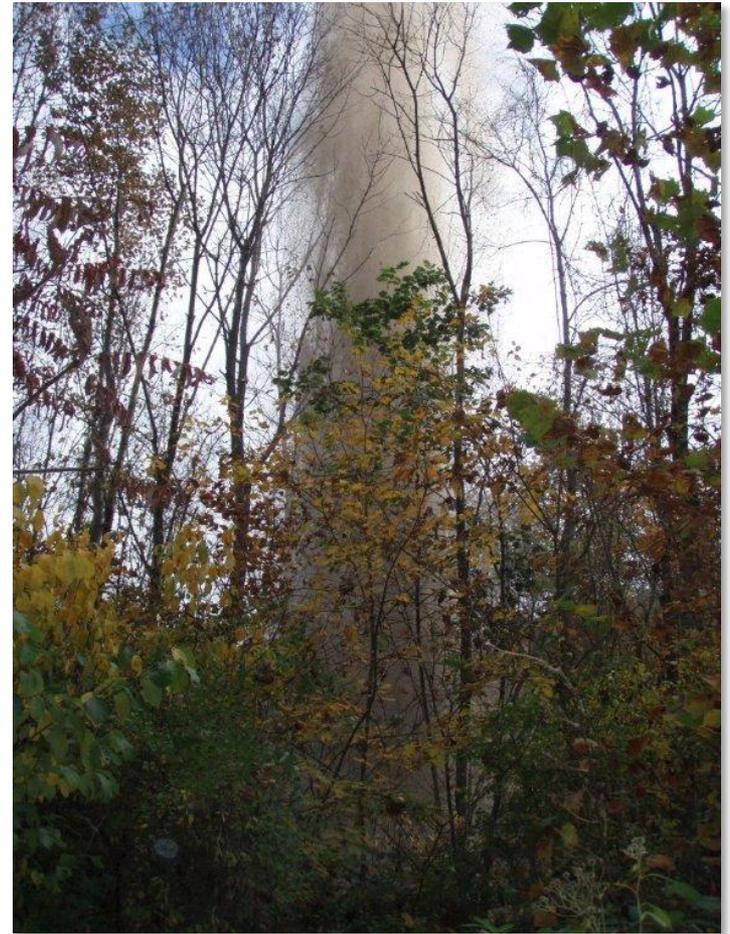


Image modified/courtesy of Richard Hammack, NETL (2014)

# ▶ Defining Risk

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# Risks

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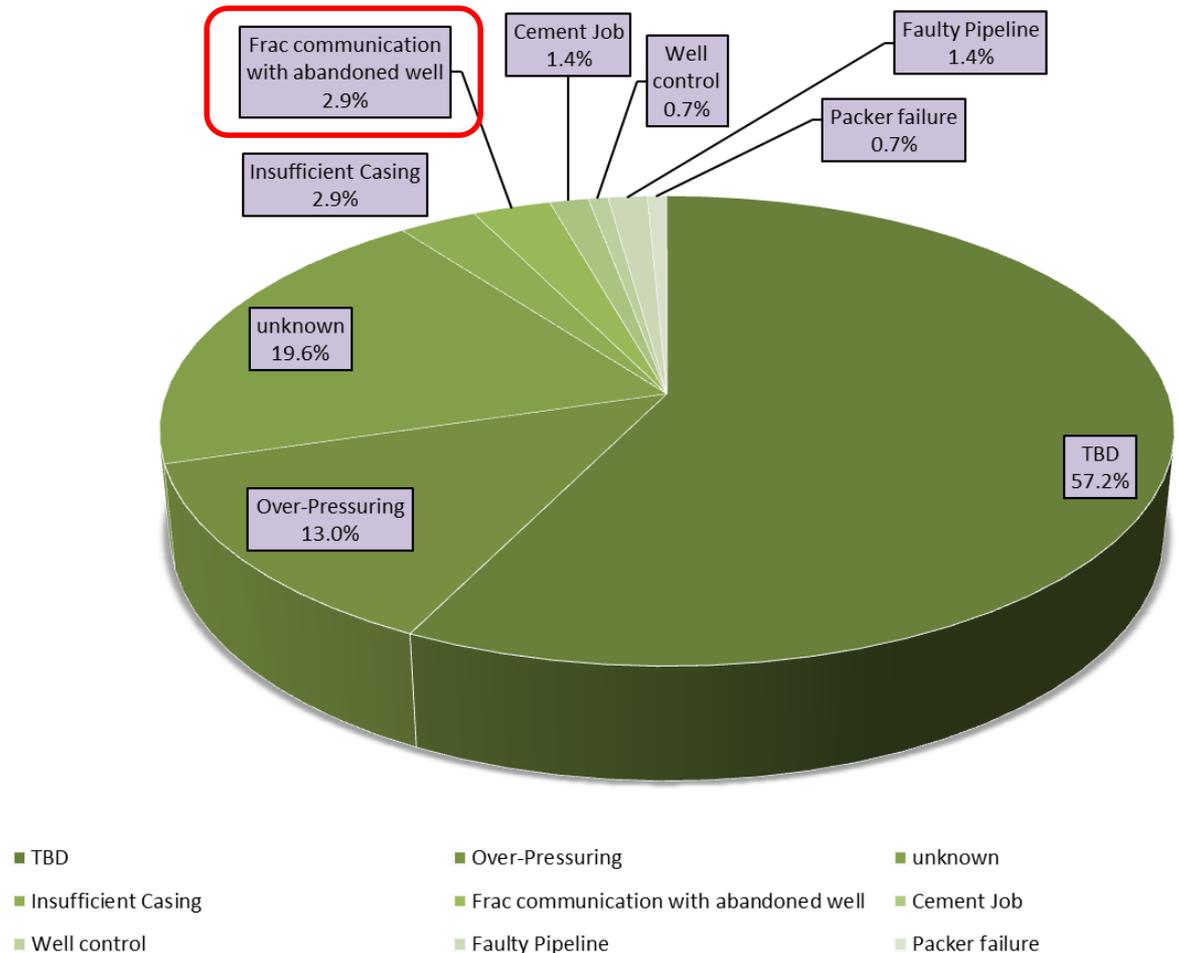
# Defining Risk

- What can happen when an orphan or abandoned well is not properly plugged?



NPR (2014)

Distribution of Causes in Confirmed Stray Gas Cases: 1987 to 2015 (n = 138)



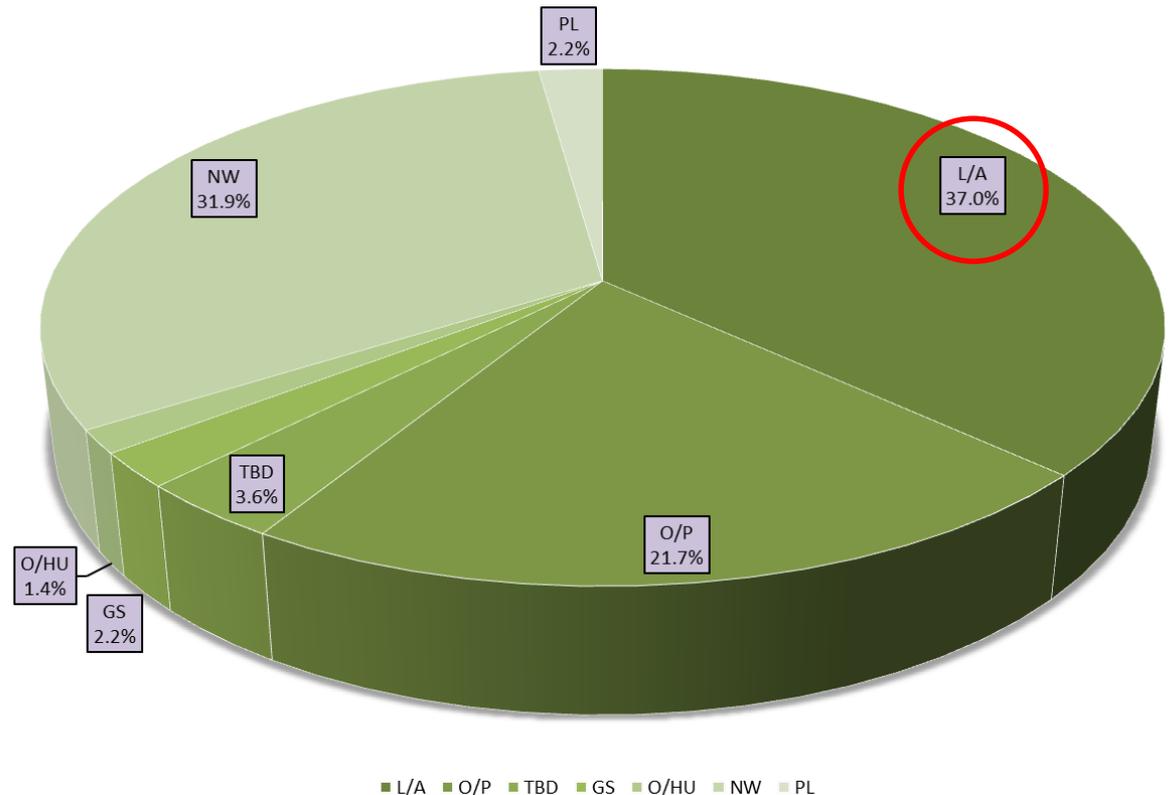
# Defining Risk

- What can happen when an orphan or abandoned well is not properly plugged?

- Approximately **37%** of confirmed stray gas migration incidents have been attributed to legacy/abandoned wells

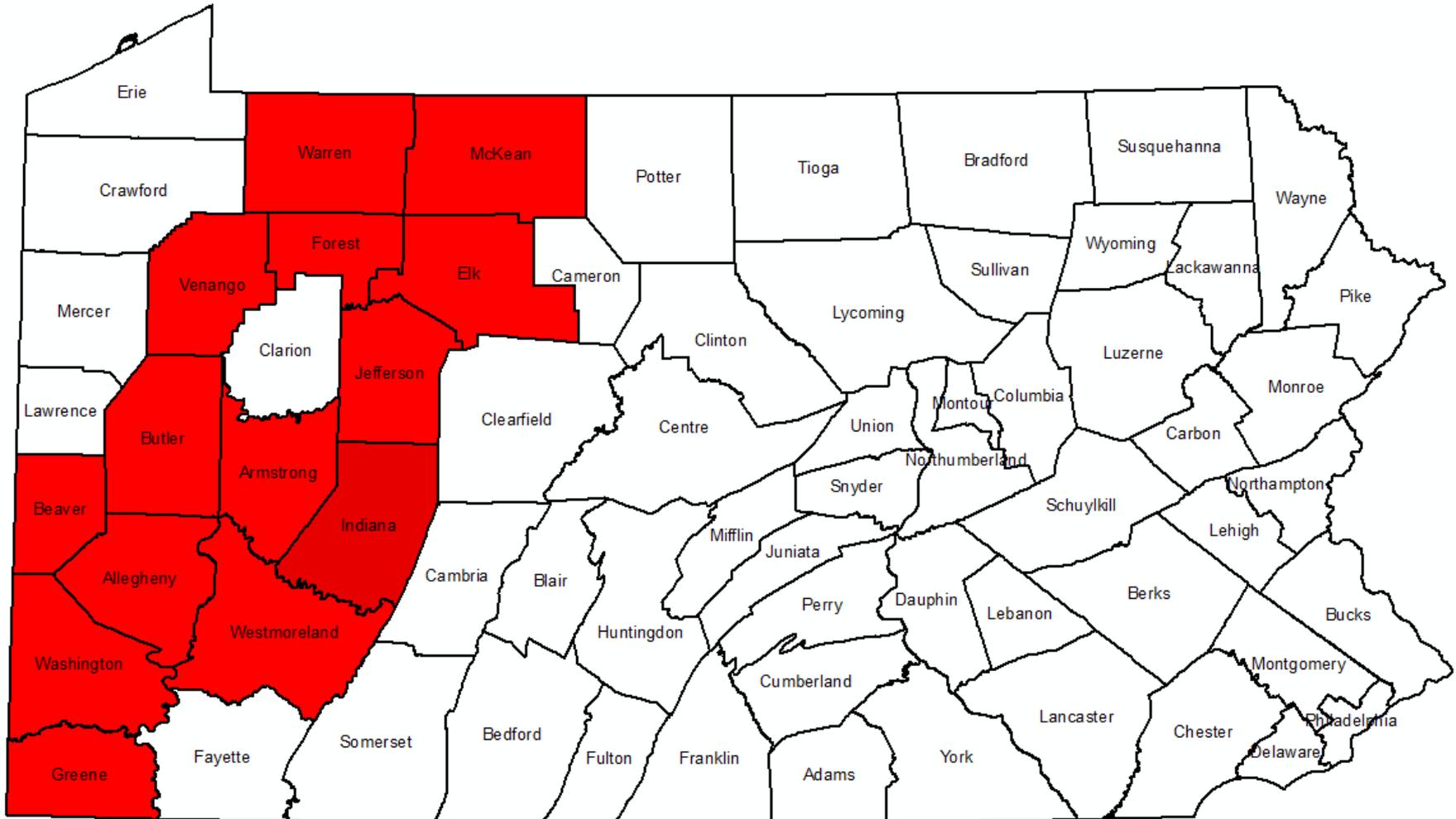
- Total # of water supplies affected by L/A cases 2001-2015: **55**

Distribution of Sources in Confirmed Stray Gas Cases: 1987 to 2015 (n = 138)



# Defining Risk

## Counties in Which Confirmed Stray Gas Incidents Were Associated with Legacy and Abandoned Wells: 1987- 2015



# Defining Risk

- Example cases: Clinton County
  - In November 1998 the Department responded to a complaint of stray gas in three water supply wells. Through the course of the investigation it was discovered that because one of the affected water wells was located in the basement of a church, combustible gas migrated from the well and into the structure, causing a significant risk of explosion. It was also discovered that during a recent road resurfacing project, an abandoned gas well was paved over. The Department proceeded to remove the recent pavement and plug the abandoned well. Two of the three impacted water wells returned to normal and a marked improvement in conditions was noted at the third water well.

# Defining Risk

- Example cases: Allegheny County
  - The natural gas migration problem in Versailles has been ongoing for many years. During the boom period from 1919 through 1921, over 175 wells were drilled in the Borough of Versailles, which was part of the McKeesport Gas Field. Some wells produced little or no gas and were abandoned without casing or plugging. Other wells produced for a few years and were also abandoned without plugging. During World War II, the call for scrap steel resulted in the removal of steel casings and wellheads. Wells were covered over or otherwise abandoned. Over the years many venting systems have been installed by property owners, the borough, and DEP. In 2007 and 2008, DEP let an emergency contract to rehabilitate a well on the Saraka property to relieve the natural gas pressure in the area. The DOE's National Energy Technology Laboratory (NETL) conducted an extensive study of the area. Versailles Boro has subsequently received a number of state and federal grants to investigate and mitigate the risks.

# Defining Risk

- Example cases: Allegheny County
  - Stray gas was noted in residence. The source of gas is an abandoned gas well, probably located under the parking lot of the Ross Park Mall. Gas service was terminated at the house in the adjacent subdivision. Mall management staff were contacted to help locate any abandoned wells. The stray gas problem at the subdivision was mitigated by installing a venting system until the abandoned wells under the parking lot can be located.

# ▶ Defining Risk

- Example cases: Washington County
  - Stray gas was encountered in soils adjacent to a business. The origin/mechanism of migration is an abandoned gas well. Gas was leaking from the well in the parking lot and has been found adjacent to the building's slab foundation. DEP issued a contract to plug the well and initially vented the well until plugging work could commence. Plugging was recently completed.

# ▶ Defining Risks

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

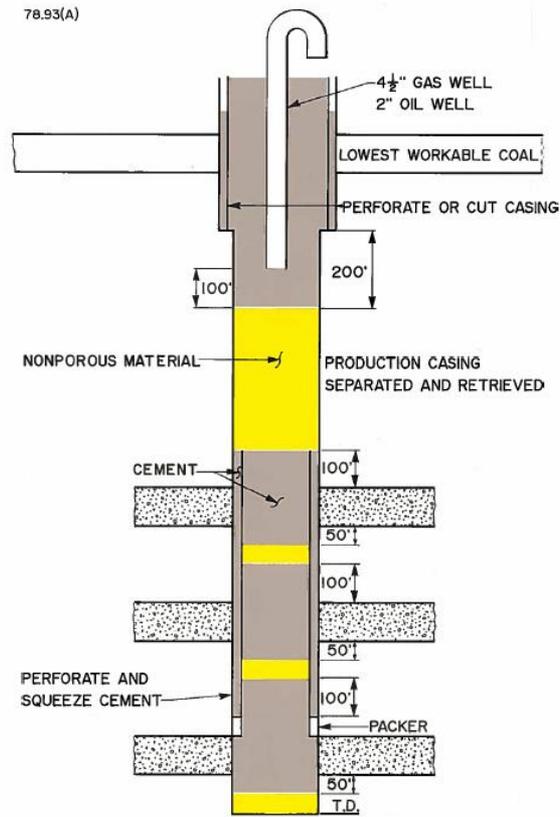


# Defining Risks

- Failed and Improperly Plugged Wells
  - Gas migration is the result and has the potential to be a serious public safety issue
  - Improperly plugged wells are a significant financial liability for Pennsylvania
  - The number of plugged wells will grow in time, but plugging does not always represent the last chapter in a well's life

# Reducing Risks

- Risks associated with abandoned and orphan wells can be reduced through proper plugging
- Interim procedures such as well venting are also effective mitigation strategies
- In cases where wells cannot be located in the field, treatment at the source through the installation of mitigation systems also provides protection of public safety



# Conclusion

- Regulatory requirements for well plugging have evolved over time
- Wells plugged prior to modern plugging requirements may still pose a risk to human health and environment
- Abandoned / orphan /improperly plugged wells can and have caused impacts to the environment and human health
- The longer an abandoned wells sits, the more likely it is going to cause a problem; and it is highly probable it will cost more money to plug it