

Shale oil and gas and surface waters: identifying potential contamination pathways through evaluation of state notice of violation and spill reports

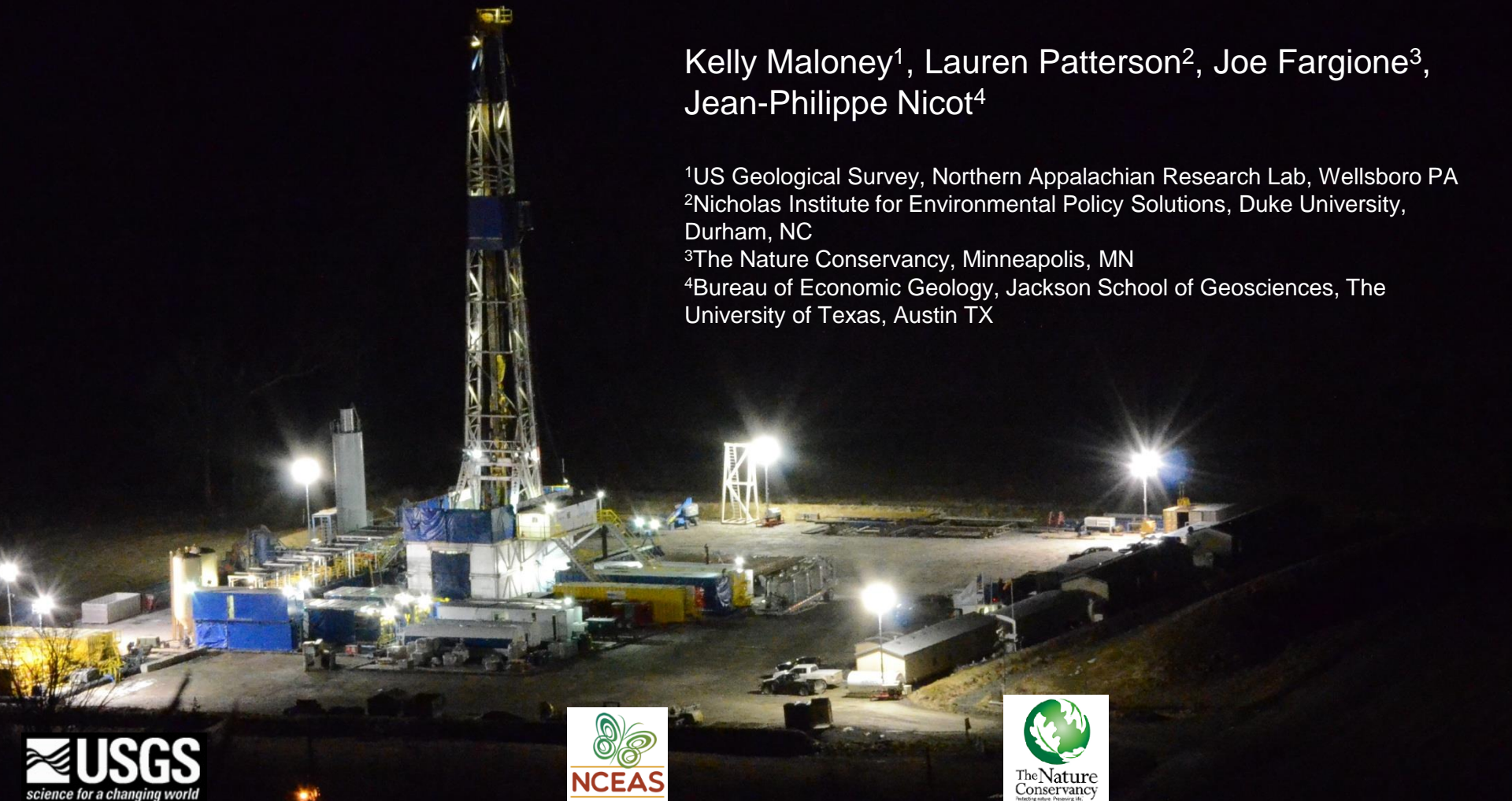
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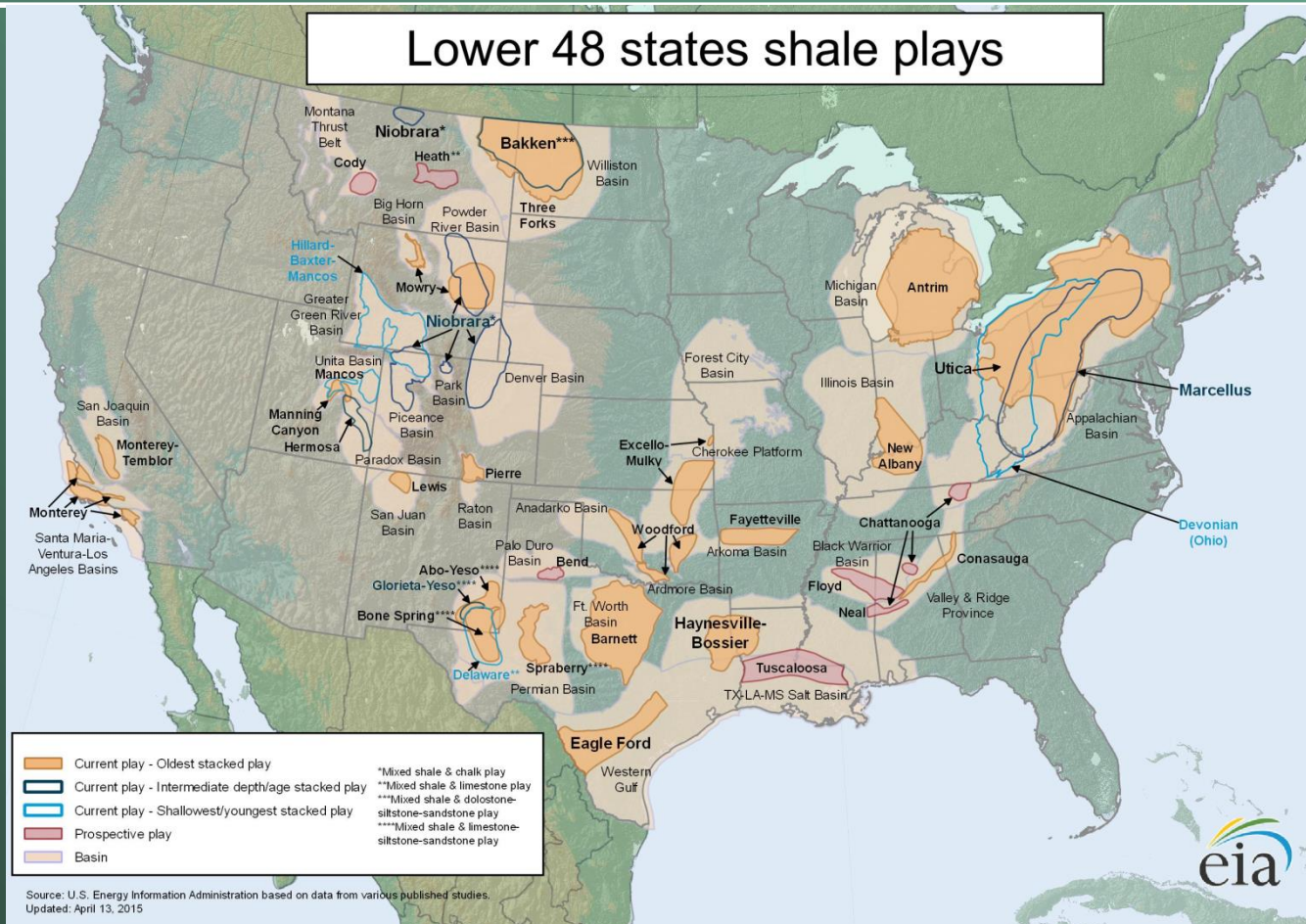
²Nicholas Institute for Environmental Policy Solutions, Duke University,
Durham, NC

³The Nature Conservancy, Minneapolis, MN

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University of Texas, Austin TX



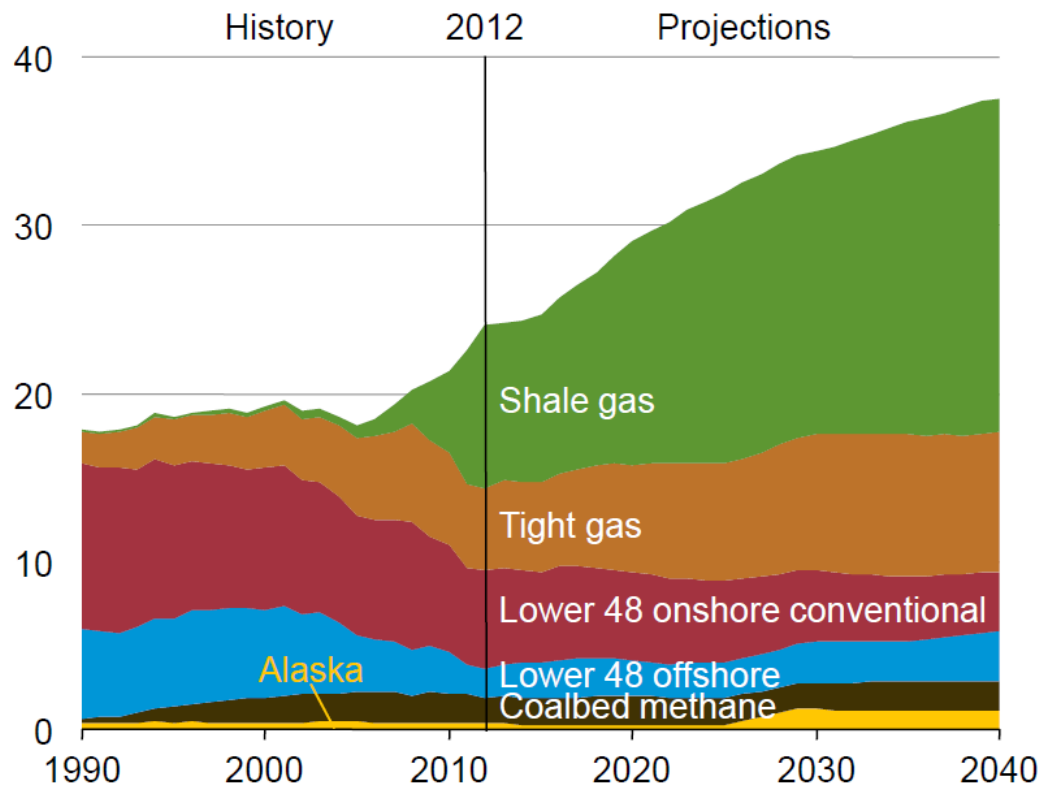
Issue: Shale Plays are Common



http://www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/maps/maps.htm

Issue: Natural Gas from Shale Forecasted to Increase Over Next 30 Years

Figure MT-44. U.S. natural gas production by source in the Reference case, 1990-2040 (trillion cubic feet)



EIA Annual Energy Outlook 2014

Extraction of Shale Gas and Oil



Site
Identification

Site
Prep./Infrast.

Drilling

Hydraulic
Fracturing

Gas
Production

Long-term

Issue: Potential to Affect Headwater Streams



Infrastructure



Lori Davies



Sediments



Spills/Leaks



Water Withdrawal

Issue: Spills/Leaks – Not Much Known

- PA - Violations related to spills and erosion most common (Rahm et al. 2015).
- CO – Spills mostly occur during production phase of development and equipment failure and human error are leading causes (CODNR – OGCC 2014).



Spills/Leaks

- Data are needed on pathways, materials, volumes and rates.
 - State notice of violation and spills databases.
 - Focus on Colorado and Pennsylvania.
 - Colorado:
 - long history of HF with vertical and directional wells.
 - Denver, Greater Green River and Piceance Basins.
 - Spills database.
 - Pennsylvania:
 - largely horizontal.
 - NOV database.
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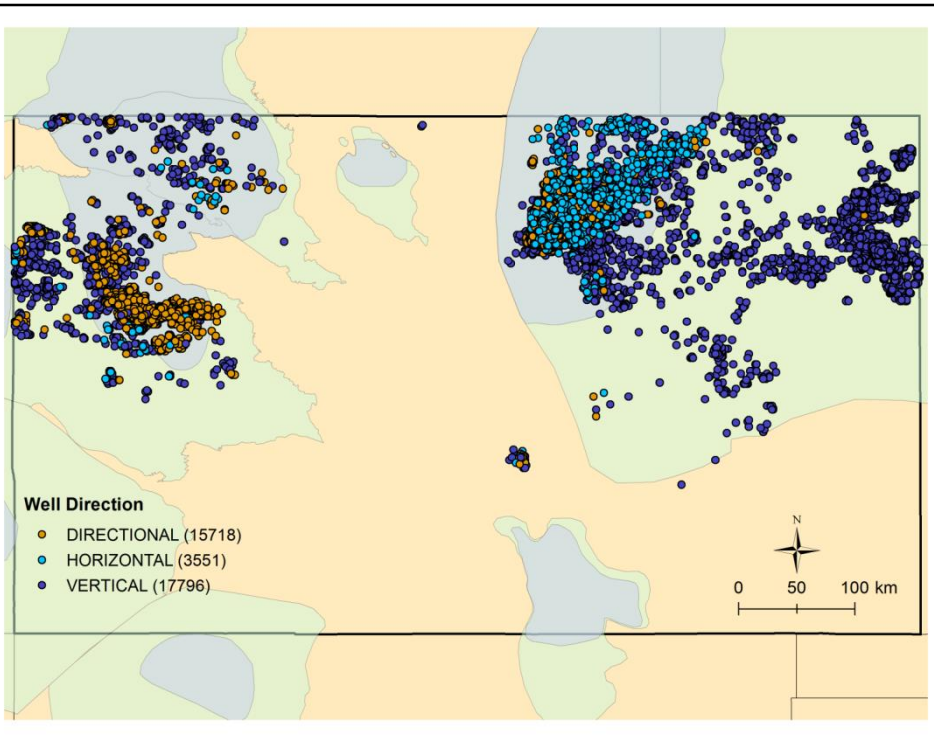
Spills/Leaks - Methods

- Download NOV and spill data from each state for 1995-2014 (April 2014 for CO).
 - QA/QC'd each record for duplicates, pathways, materials and volumes.
 - Downloaded well data from the IHS database.
 - API number, well direction and spud date.
 - Formation, Play and HF information.
 - Used the IHS data to identify well direction and if unconventional (combination of direction and play).
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UOG Well Locations

Colorado

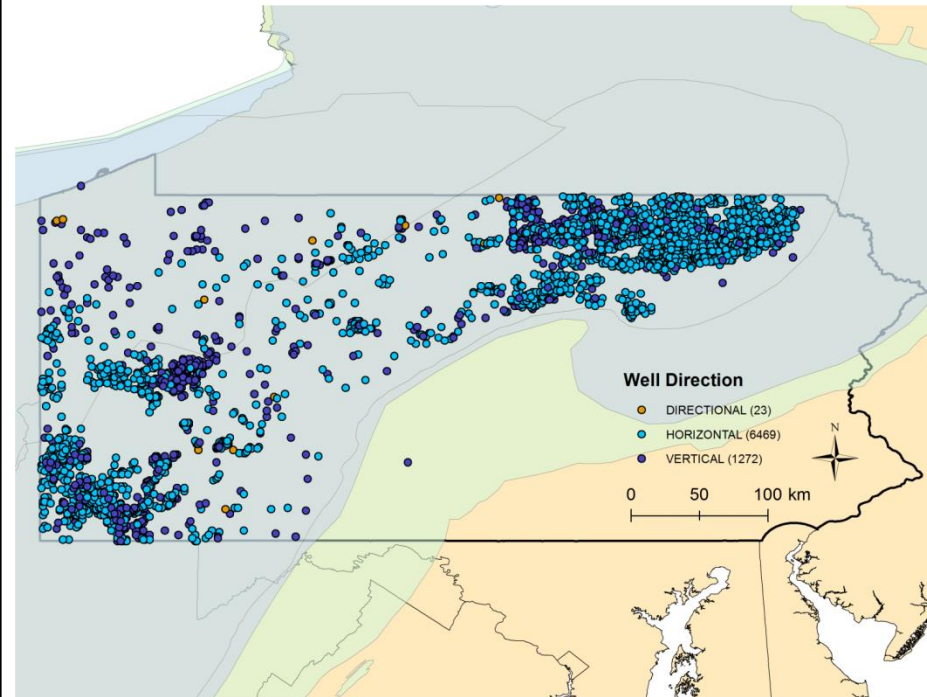
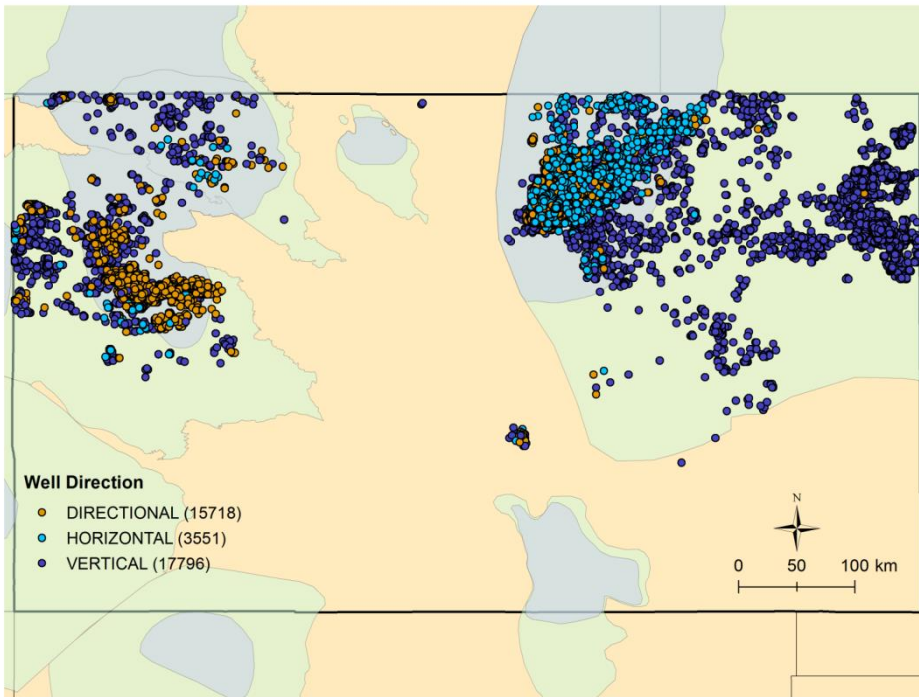
Pennsylvania



UOG Well Locations

Colorado

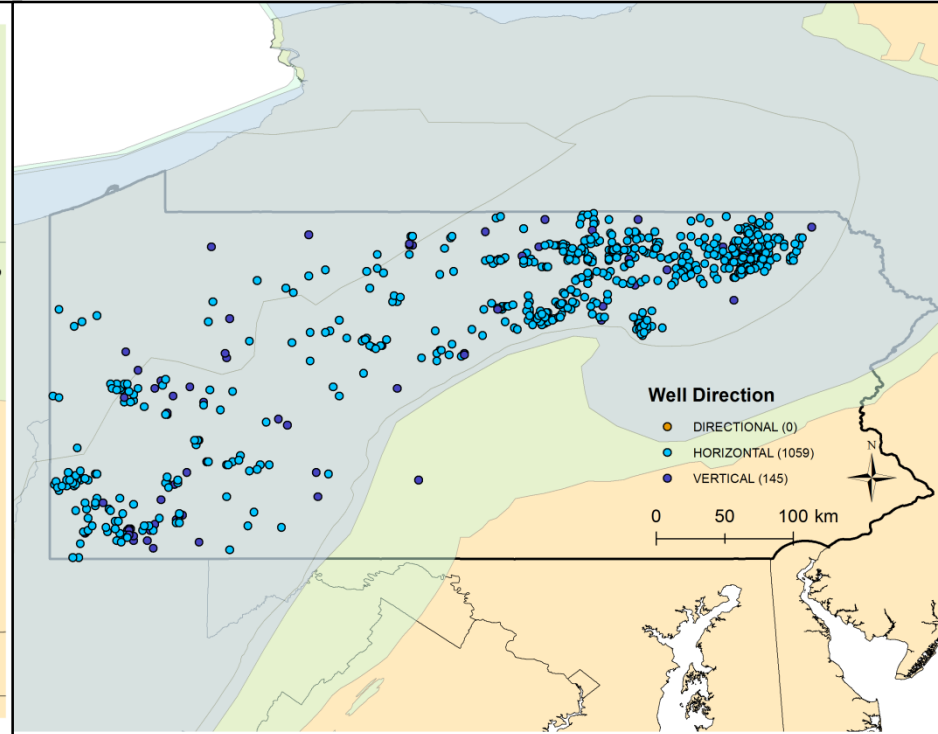
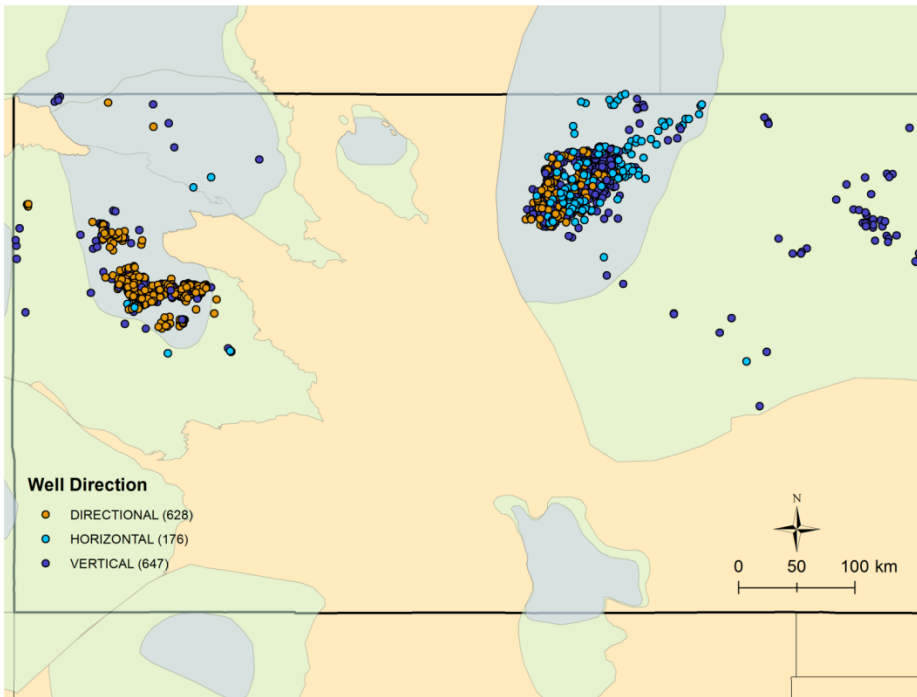
Pennsylvania



UOG Spill Locations

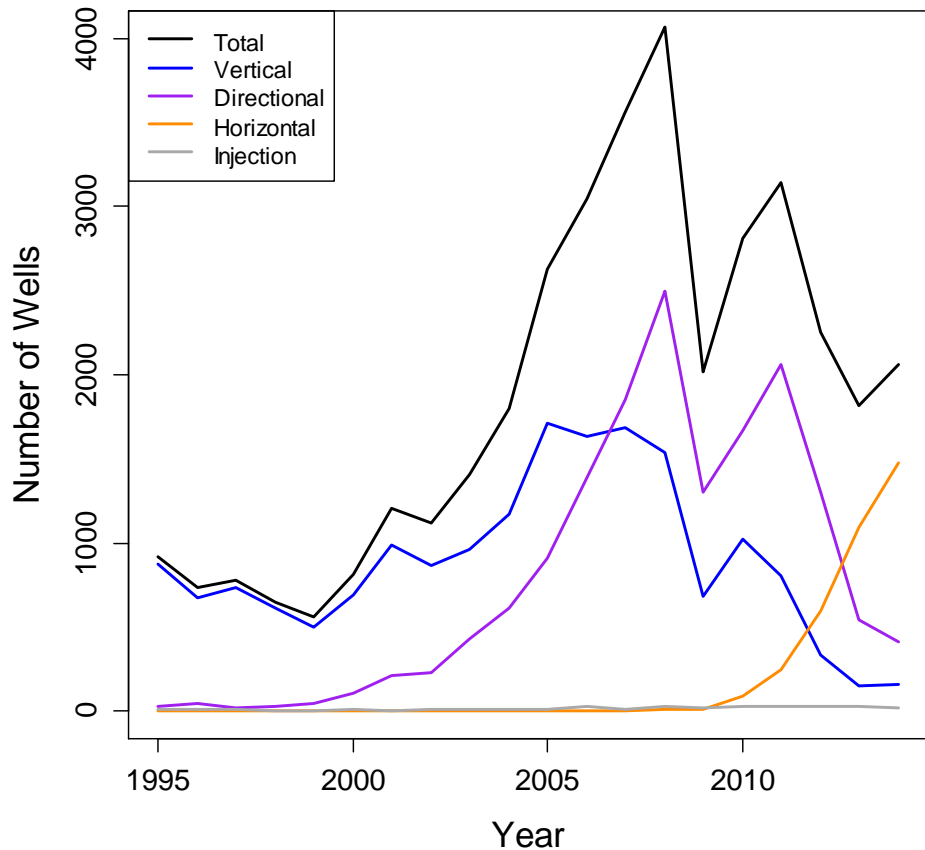
Colorado

Pennsylvania

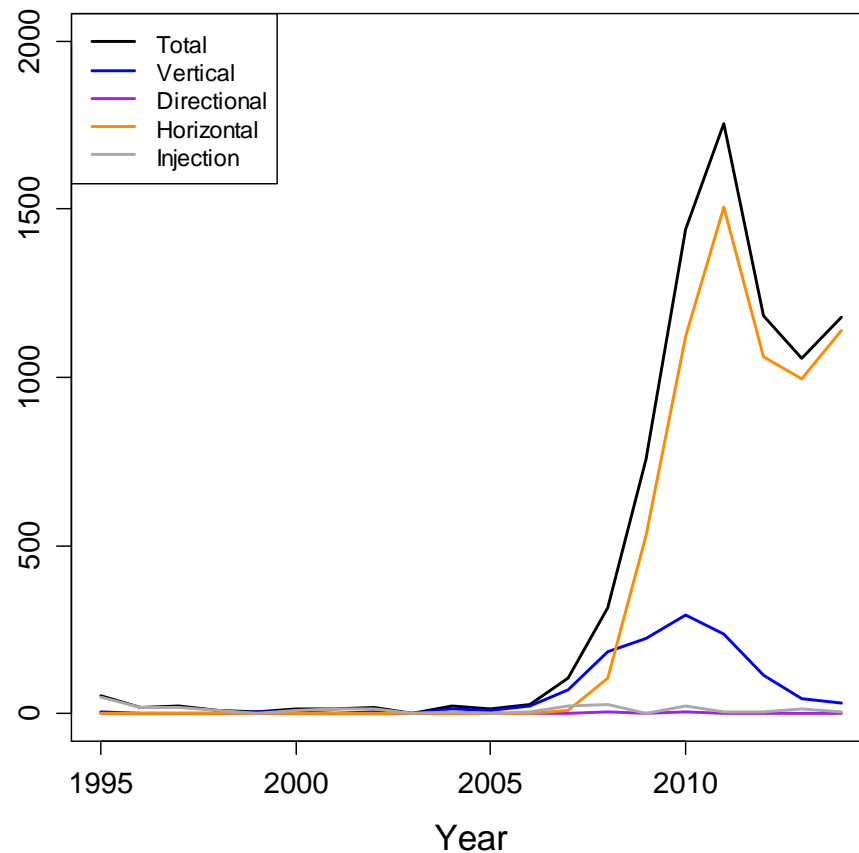


UOG Wells by Year

Colorado

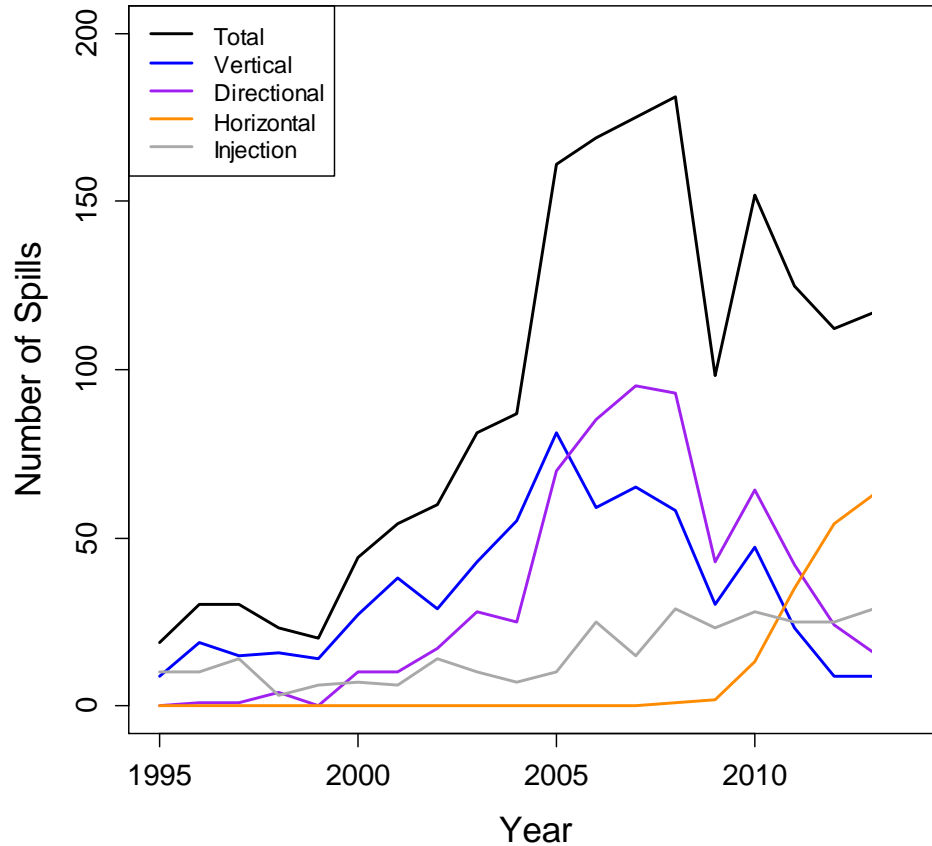


Pennsylvania

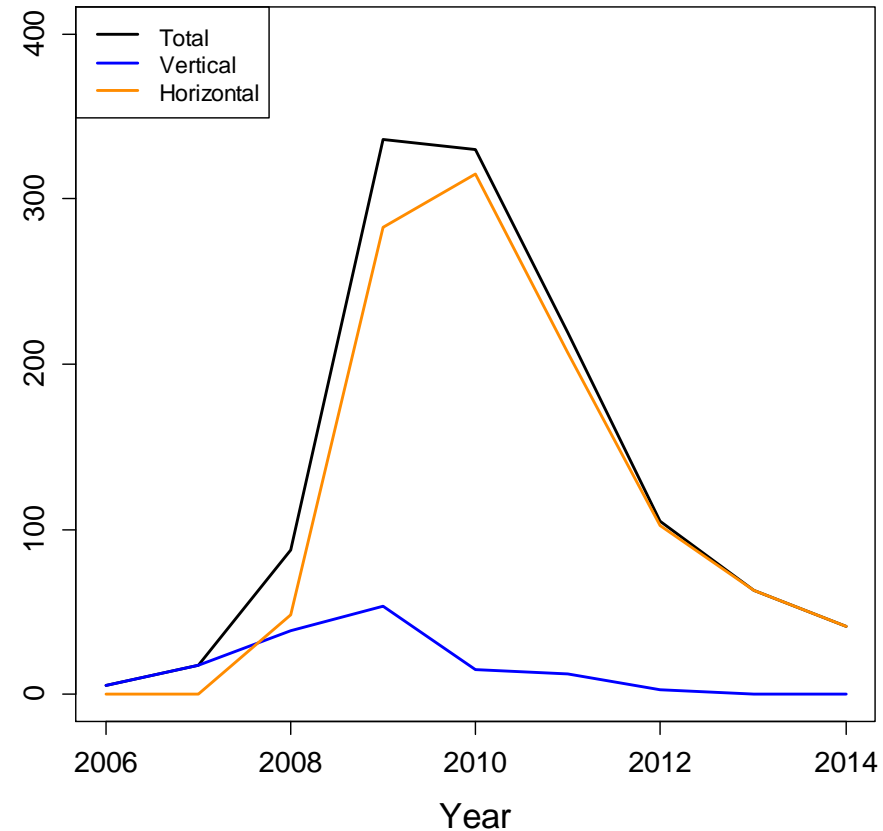


UOG Spills by Year

Colorado

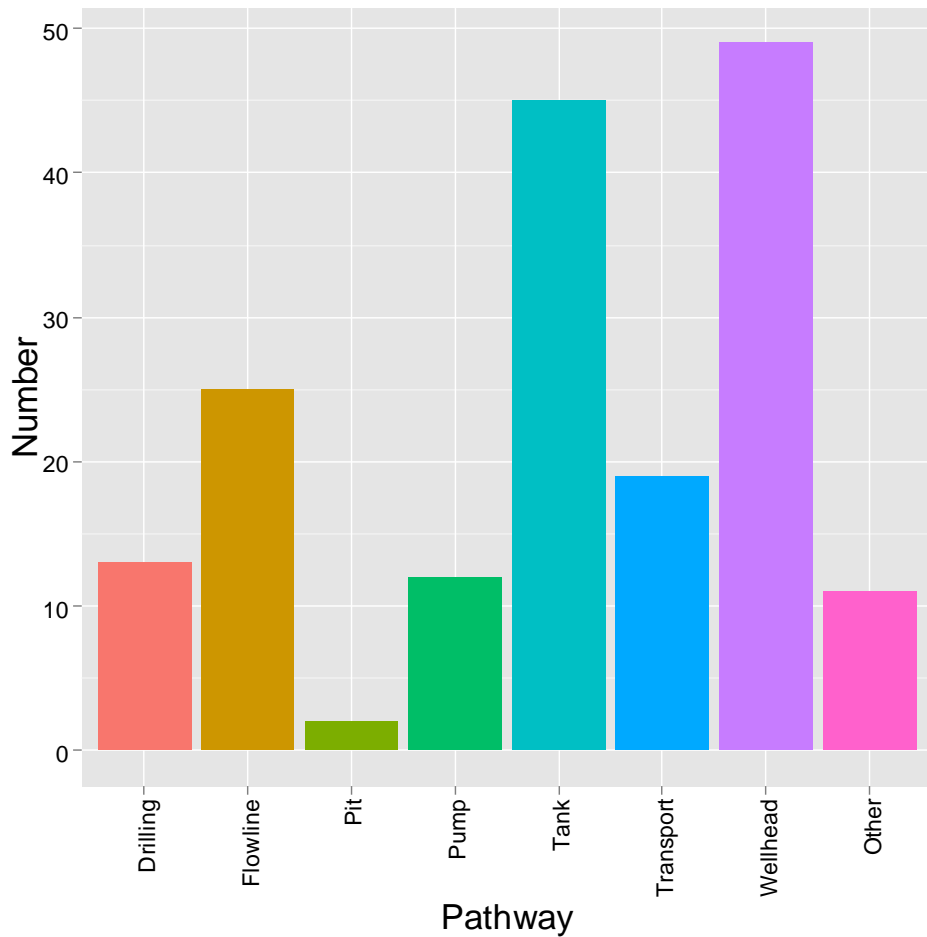


Pennsylvania

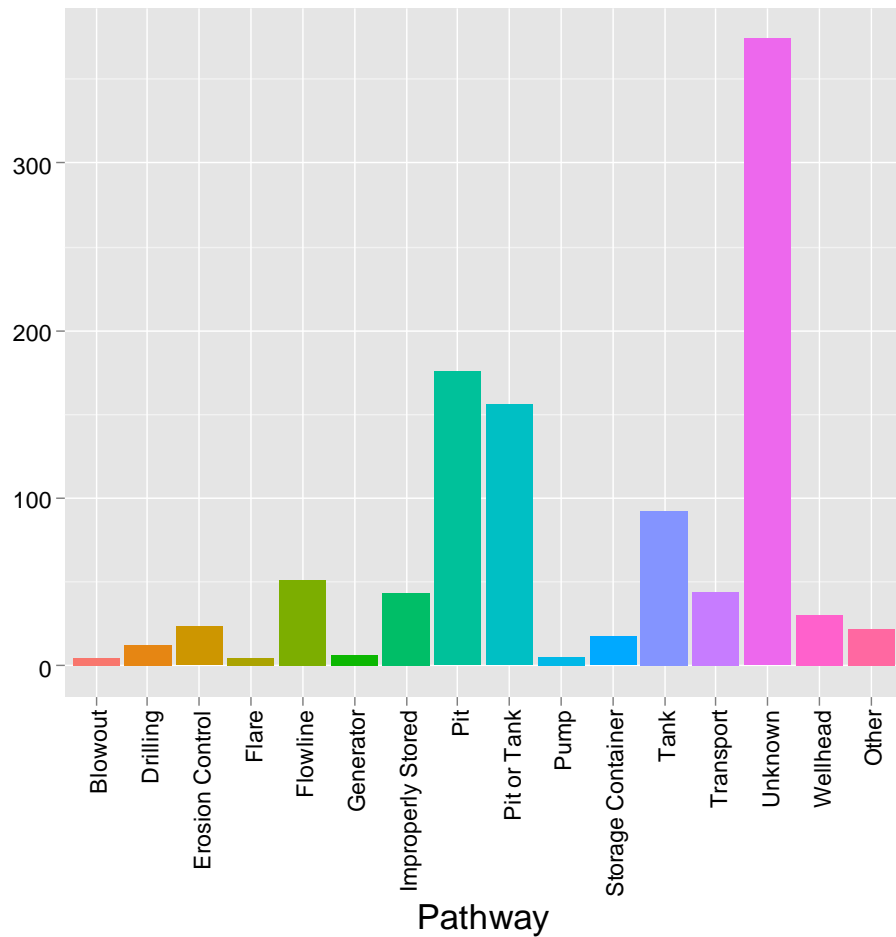


Major Pathways – Horizontal Wells

Colorado

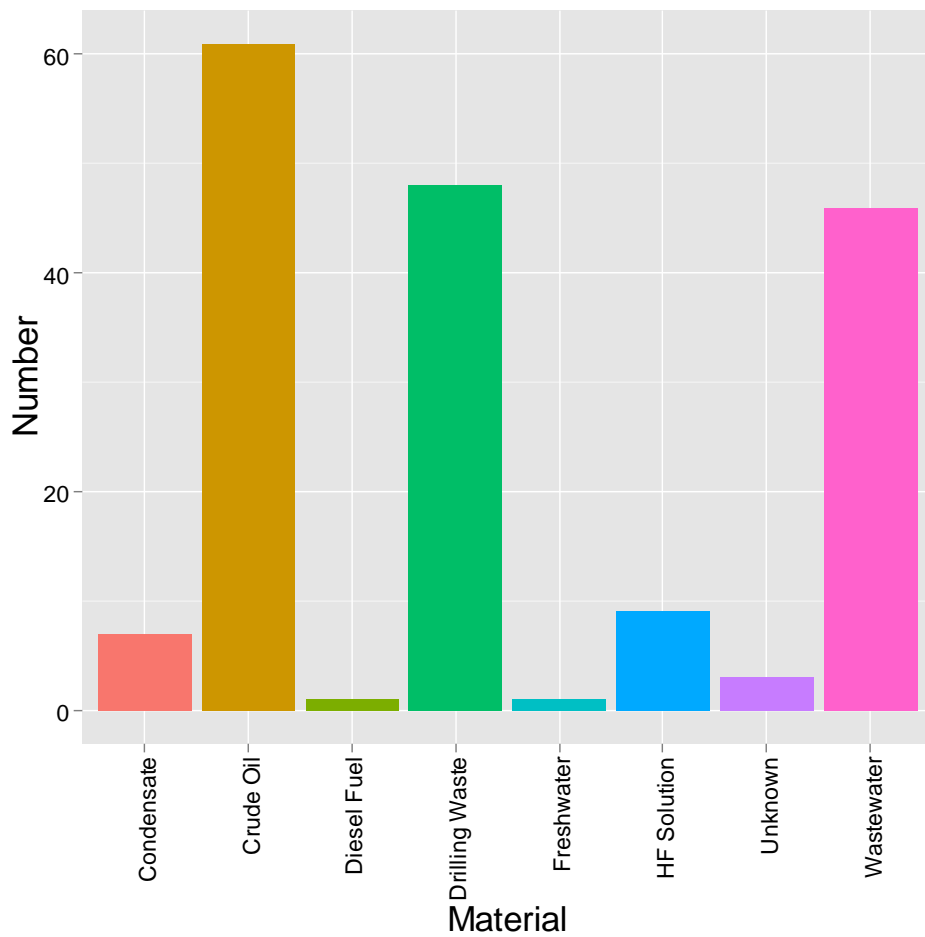


Pennsylvania

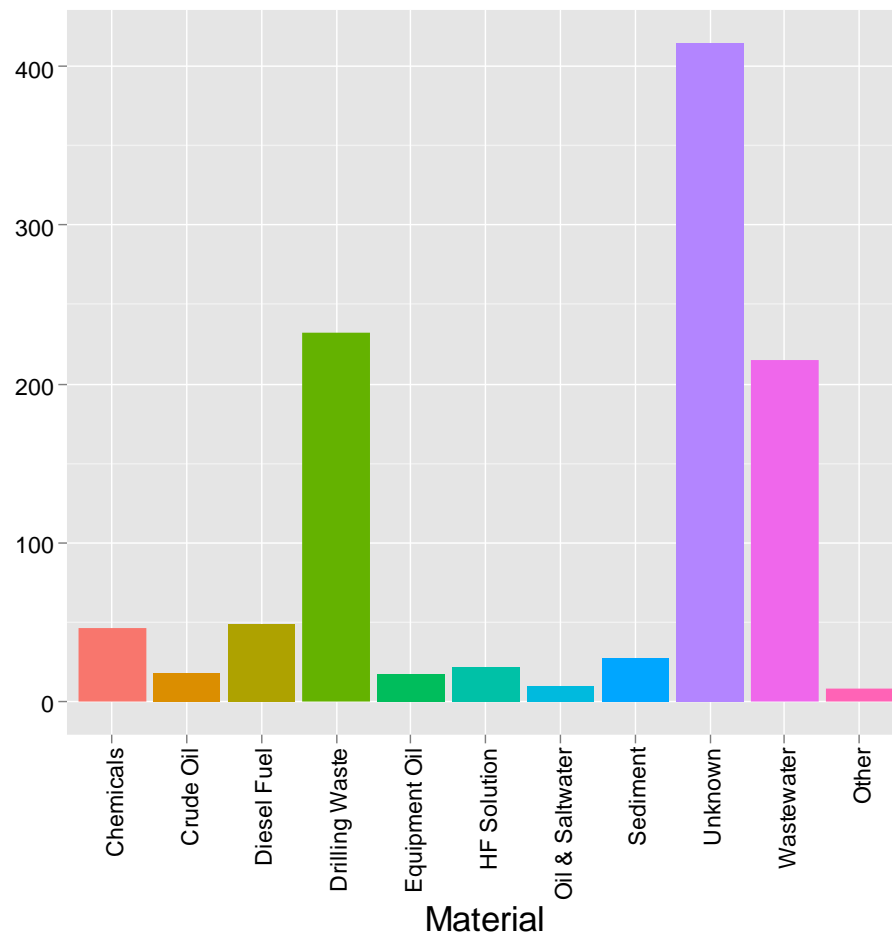


Materials Spilled – Horizontal Wells

Colorado

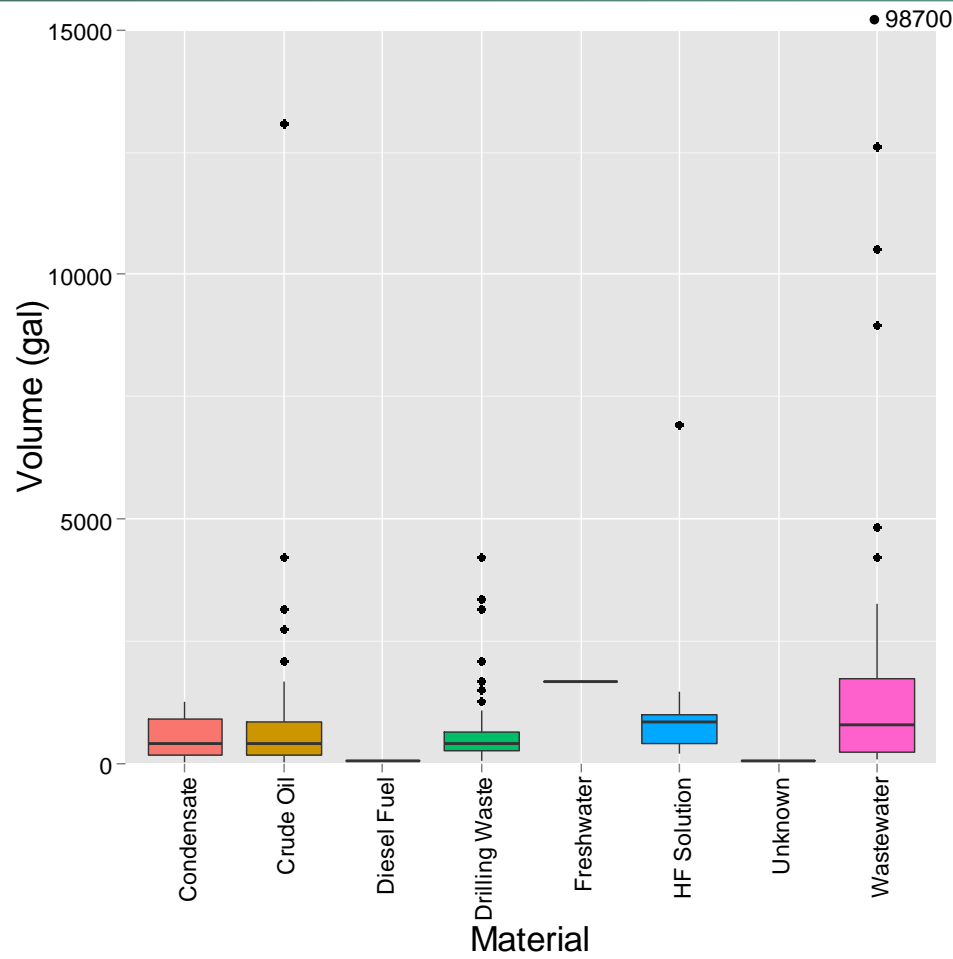


Pennsylvania

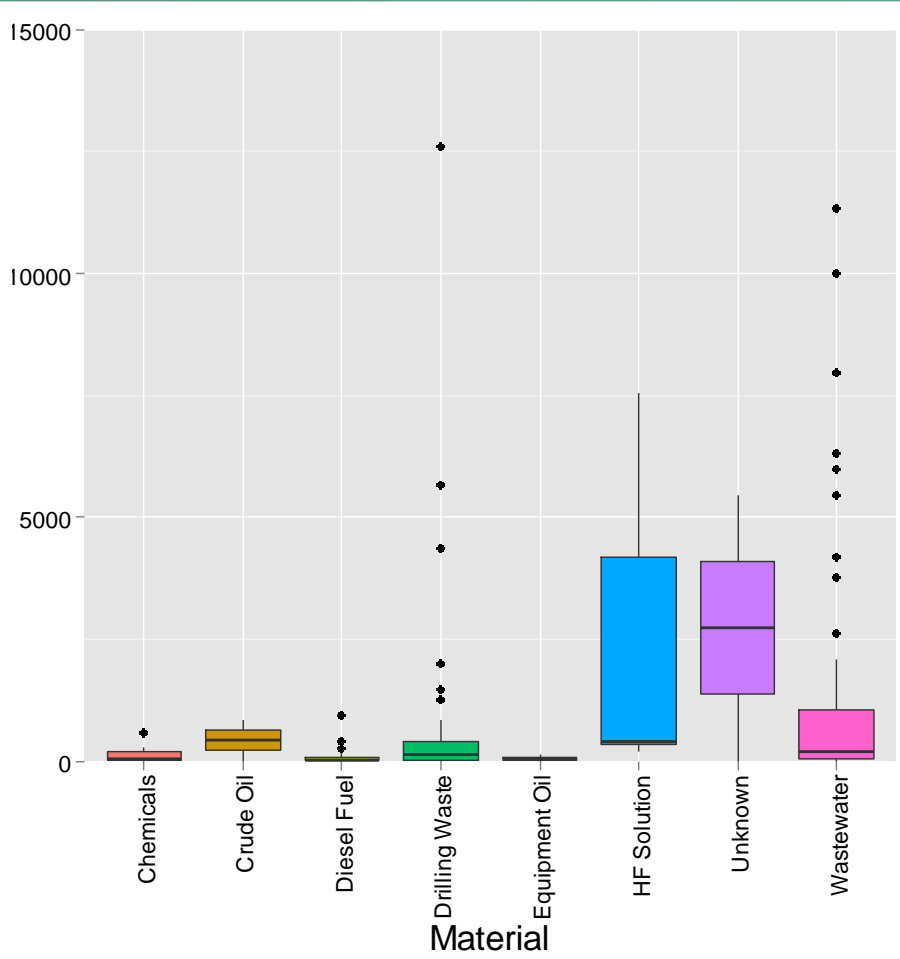


Volumes Spilled – Horizontal Wells

Colorado



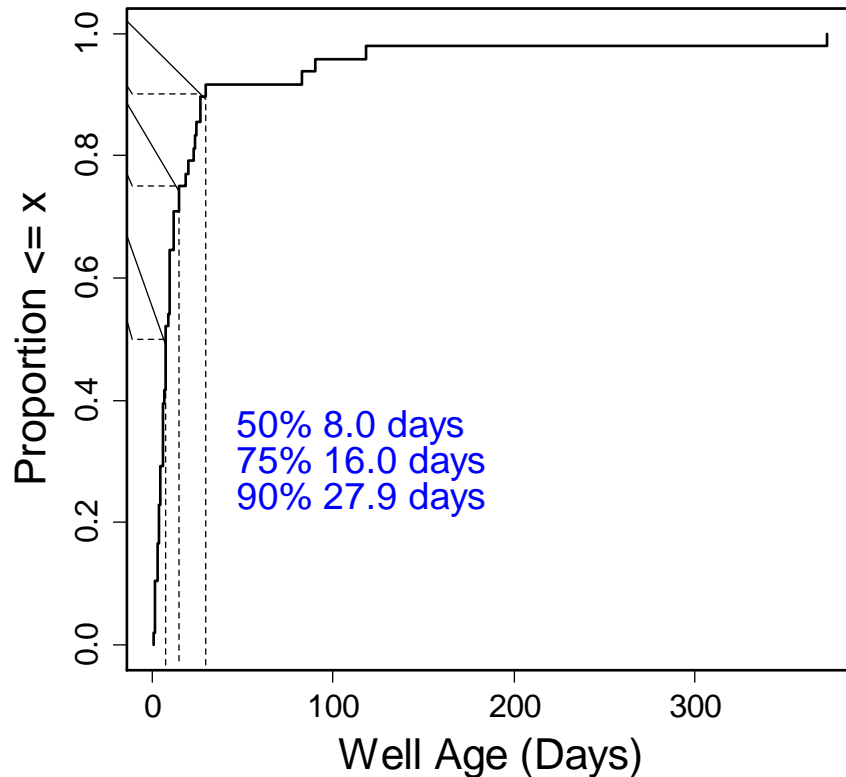
Pennsylvania



Well Age & Spills – Horizontal Wells

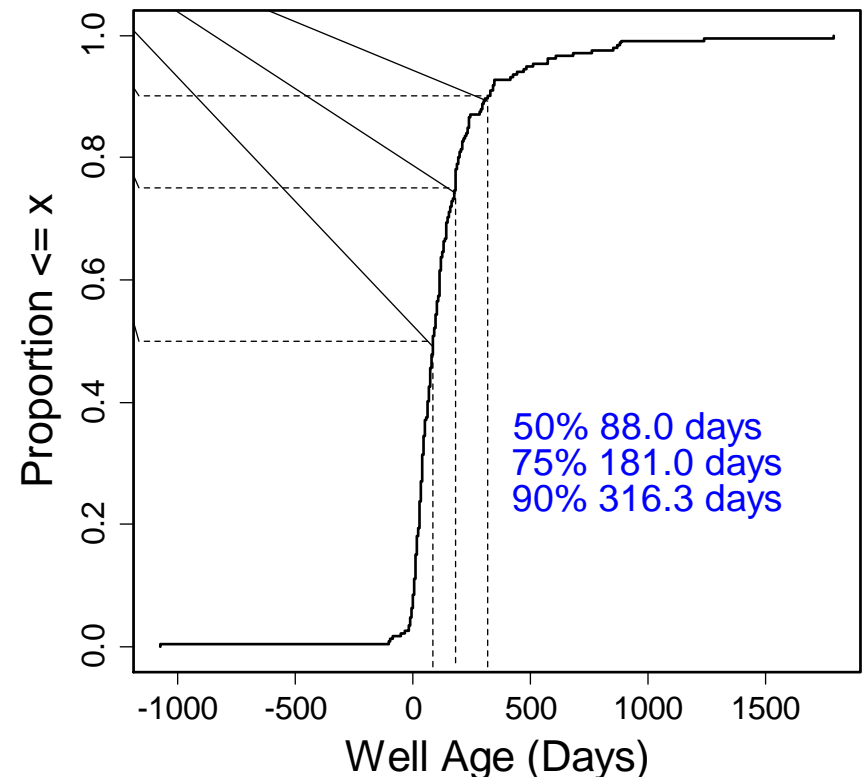
Colorado

Drilling Waste



Pennsylvania

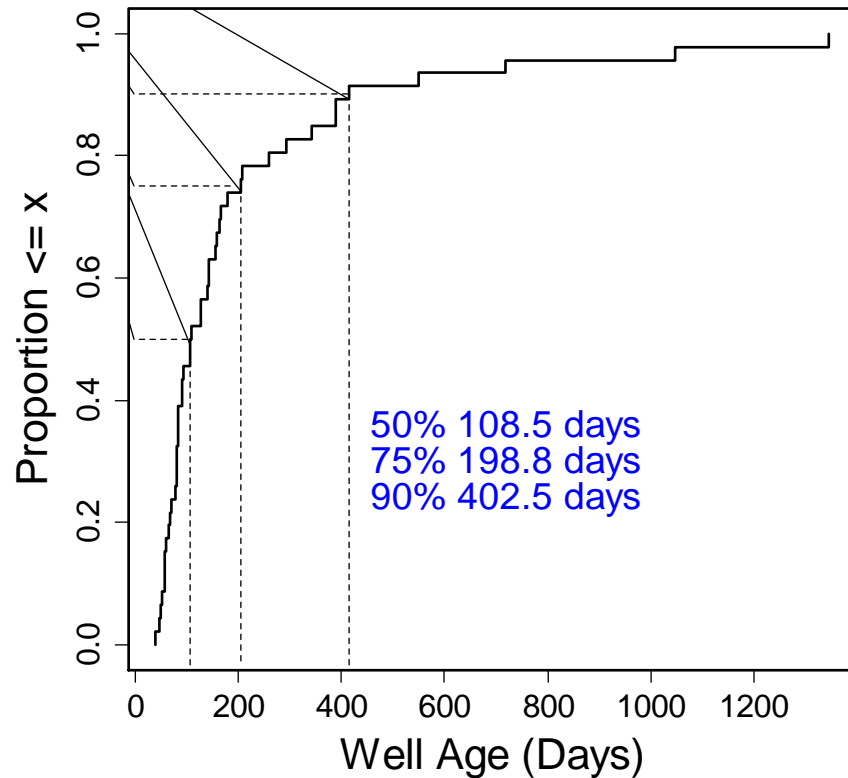
Drilling Waste



Well Age & Spills – Horizontal Wells

Colorado

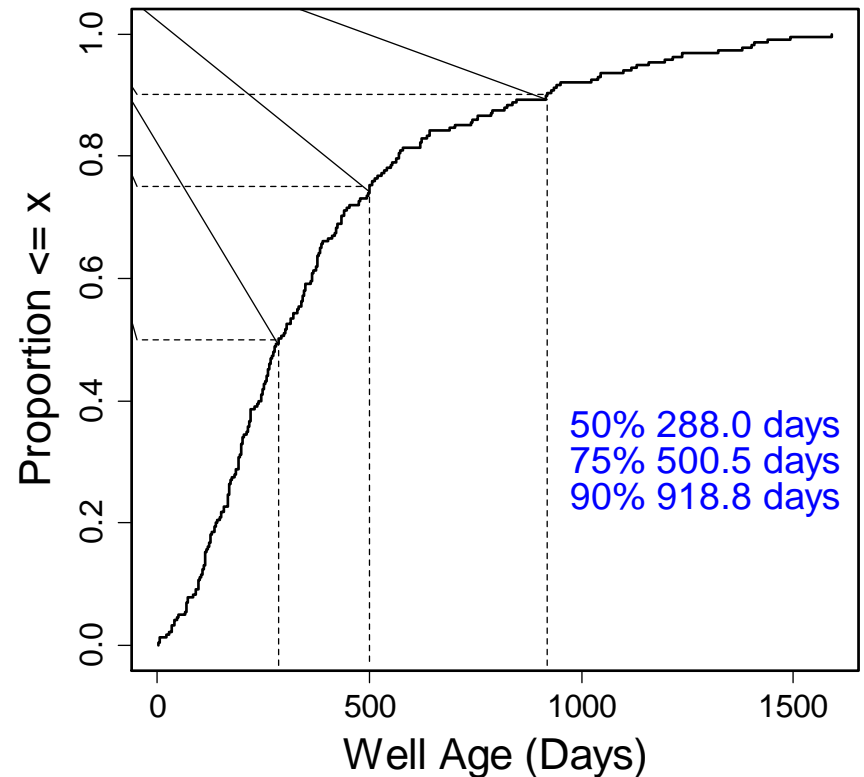
Wastewater



n:46 m:0

Pennsylvania

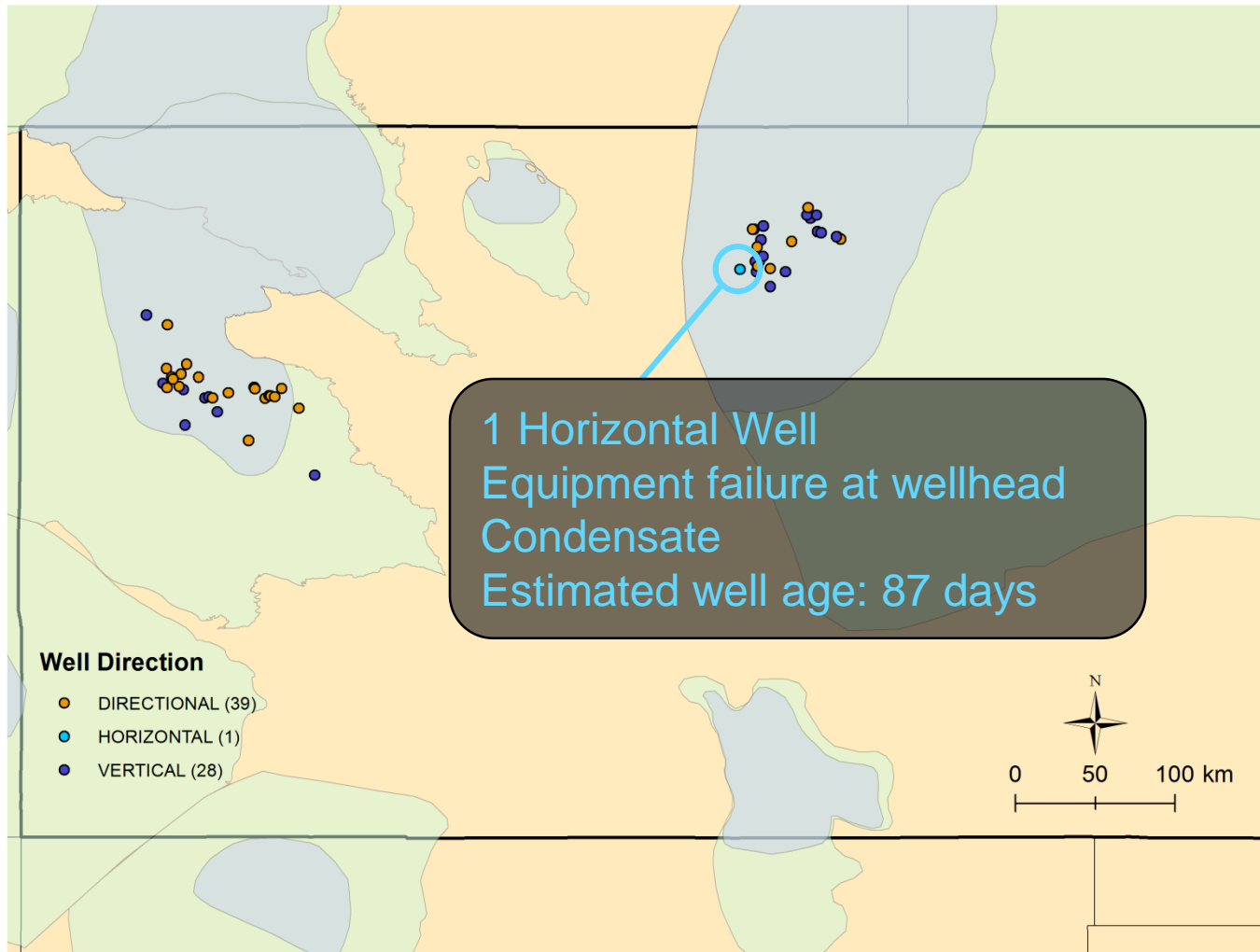
Wastewater



n:215 m:0

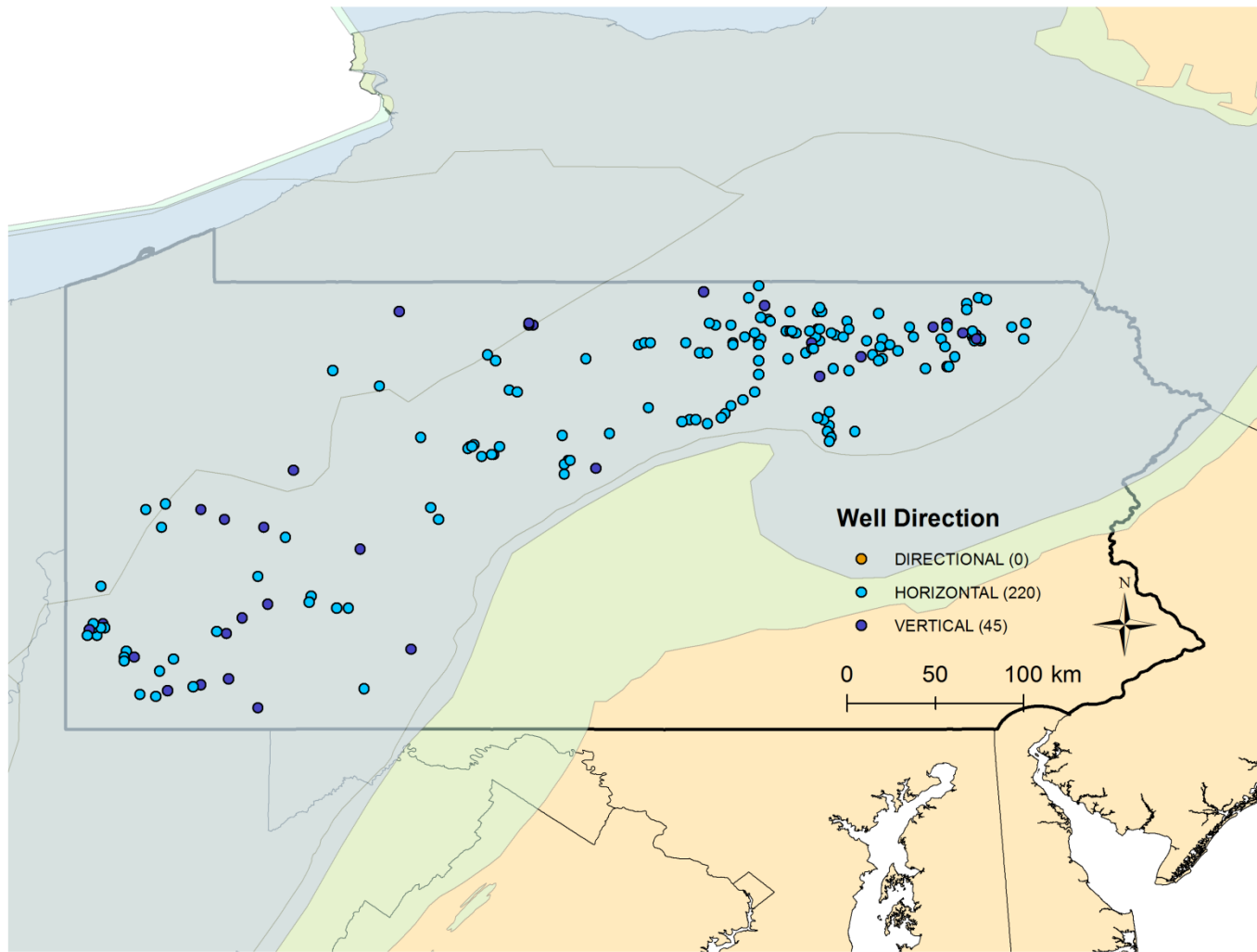
Colorado – Horizontal Wells

Surface Waterways



Pennsylvania – Horizontal Wells

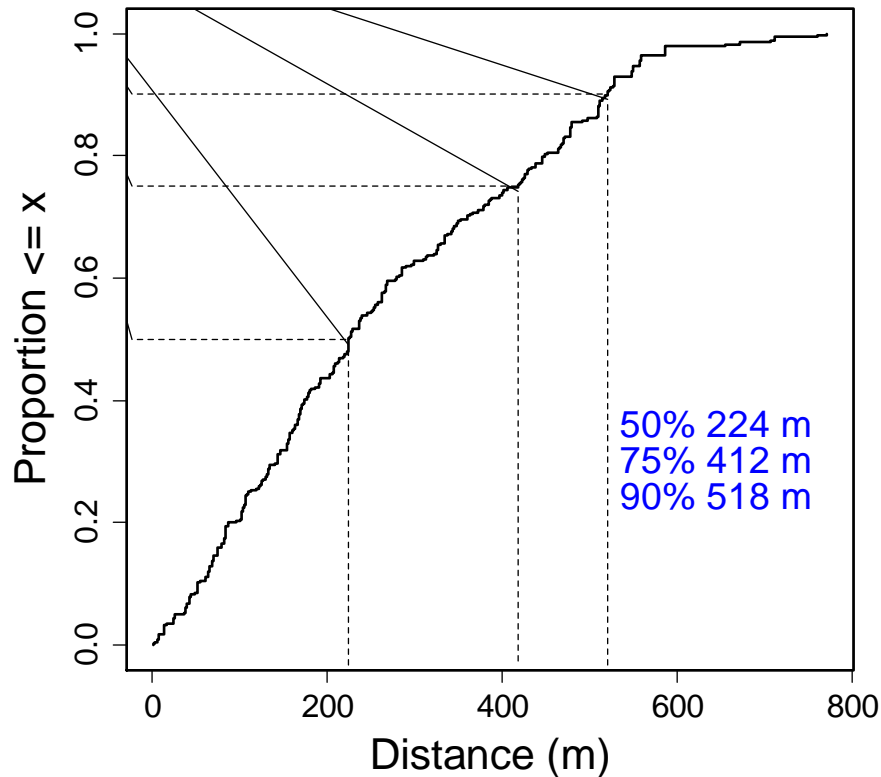
Surface Waterways



Distance to Stream– Horizontal Wells

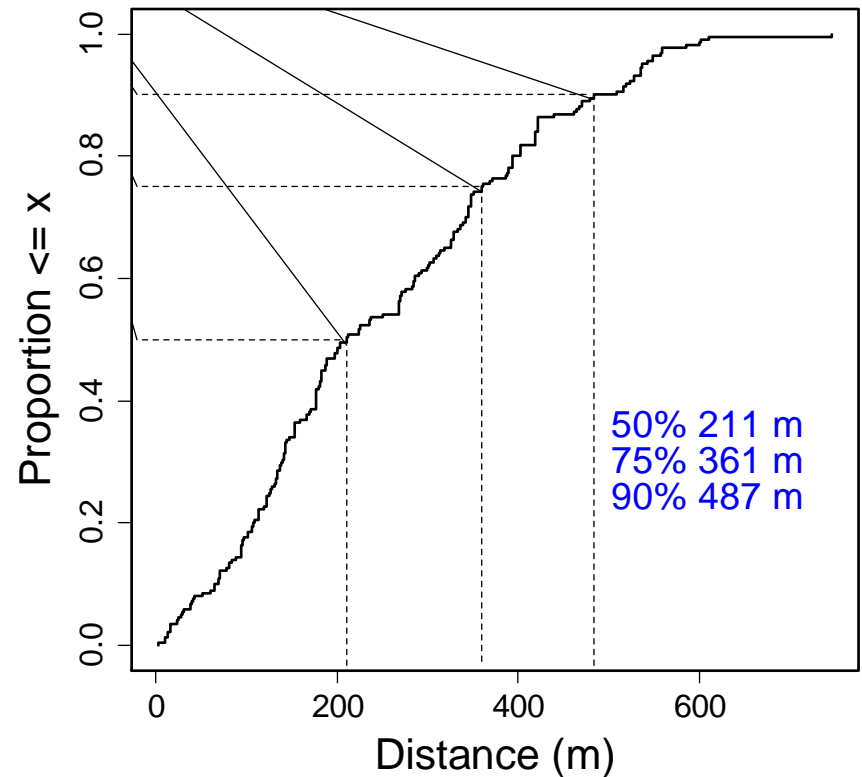
Pennsylvania

Non-Waterway Incident



n:339 m:0

Waterway Incident



n:220 m:0

Summary

- Results are preliminary but highlight potential to identify pathways and materials spilled.
- Data from CO and PA varied in level of detail.
- Horizontal wells and associated spills increased in both states.
- Tanks, pits, flowlines and transport were major pathways.
- Drilling fluids and wastewater most often material spilled (crude oil also in CO).
- Temporal variation in material spilled.

Future Plans

- Investigate more detailed pathway and material spilled (if possible).
 - Analyze spill data from ND and NM in similar fashion.
 - Estimate rates of spills for each material by state.
 - Evaluate spills at injection and disposal wells?
 - Incorporate findings into biological vulnerability analysis.
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