



Challenges and Benefits of Using Mine Pool Water for Hydraulic Fracturing

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OUTLINE

- Availability of mine water
- Mine water characteristics
- Benefits of using mine water
- Challenges of using mine water
- Evaluation and permitting
- Mine pool management
- Example projects
- Conclusions

PENNSYLVANIA'S CURRENT AMD ISSUES

- 2,400 miles of abandoned mine drainage (AMD) polluted streams
- PADEP has limited funding for treatment of discharges and cleaning streams
- Four main classes of discharges:
 - Active operator, treated discharge
 - Closed mine, treated discharge
 - Orphaned discharge (Pre-1977), no treatment
 - Legacy / Forfeited, discharge treated by DEP

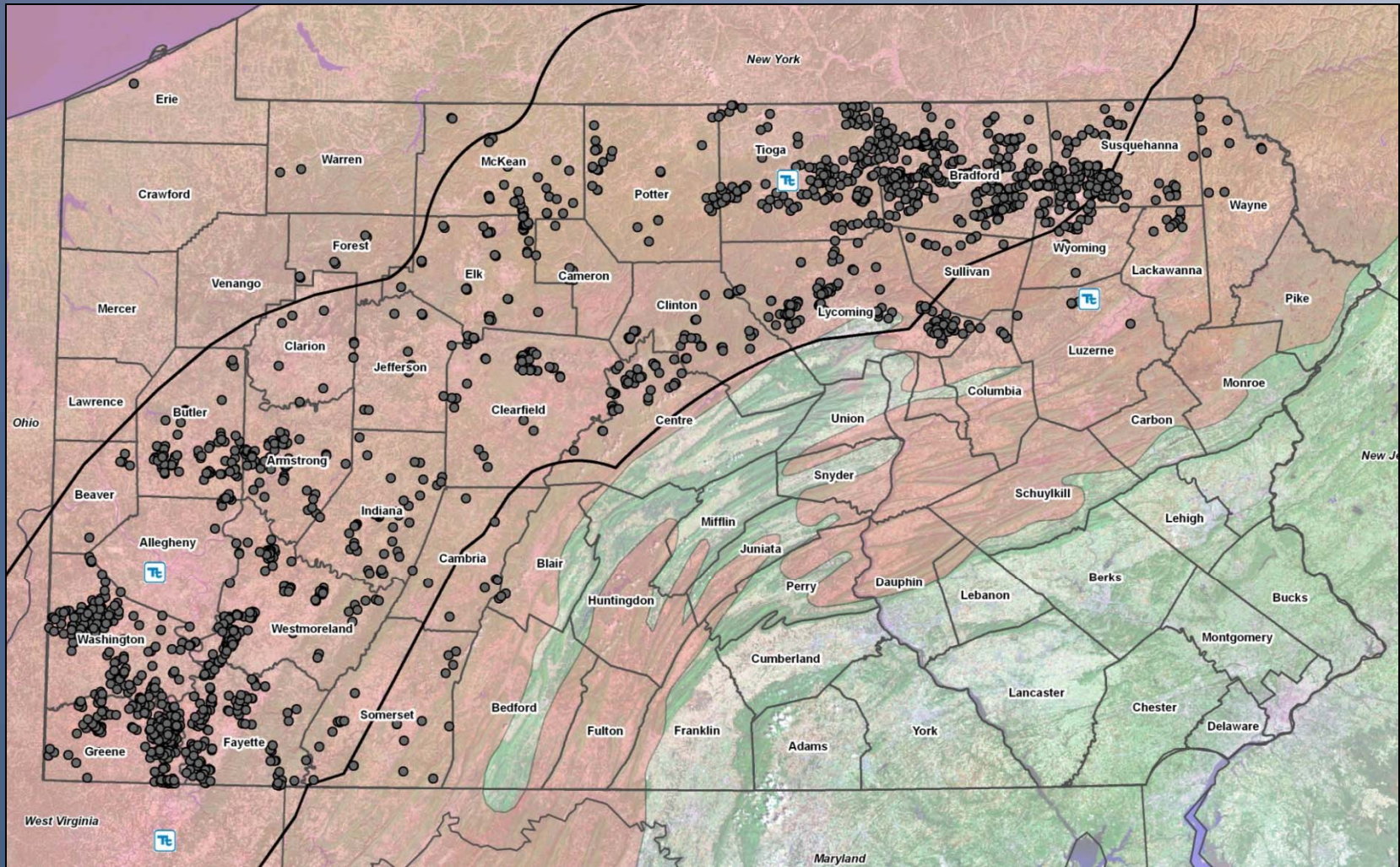


AVAILABILITY OF MINE WATER

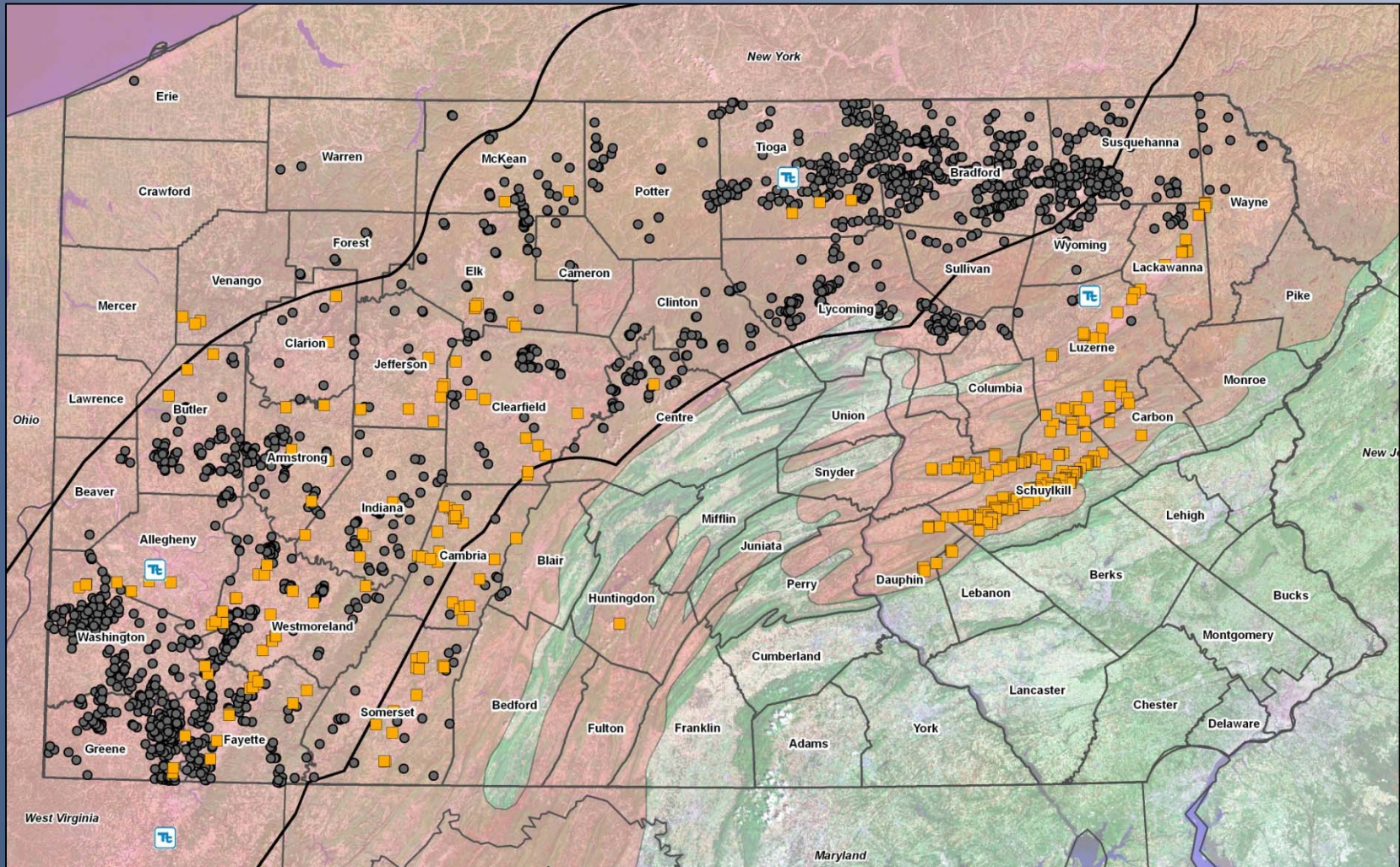
- Hydraulic fracturing requires large volumes of water
 - Water sources are limited
 - Surface water
 - Ground water
 - Water delivery challenges
 - Trucking
 - Piping
- Large quantities of water are available from abandoned mines
- Mine pools are present throughout the Marcellus Shale Play



MARCELLUS SHALE MAP – WELLS ONLY



WELLS AND MINE DISCHARGES



MINE WATER CHARACTERISTICS



- Typical flow ranges from 300 gpm to 3,000 gpm (1/2 MGD to 1.5 MGD)
- Acidic or neutral
- Iron 1 ppm to 100 ppm
- Aluminum, manganese
- Sulfates 50 ppm to 1,000 ppm

BENEFITS OF USING MINE WATER

- Goodwill / Environmental benefit - reduce metal loadings and pollutants to watersheds
- Reduce 'clean' water withdraw
- General close proximity and abundant supply of mine water
- For active mines – existing infrastructure and clear ownership
- Less road damage

CHALLENGES OF USING MINE WATER

- Water Quality
 - Treatment may be required
 - Quality varies
- Abandoned discharges – unclear ownership of water and liability
- Impact of withdraw from mine pool
 - Destabilization of mine
 - Flow may be required for a stream
- Interbasin transfers



EVALUATION AND PERMITTING

- PADEP white paper: *Utilization of Mine Influence Water in Well Development for Natural Gas Extraction*
 - Environmental impact from mine water and benefit to watershed
 - Current mine water flow and volume at the site
 - Proposed volume to be used
 - Characterization of the mine water
 - Proposed site development, including storage facilities
 - Spill Prevention Plan
 - Evaluation of mine pool
 - History of mining
 - Mine pool recharge rate
 - Potential of impacts due to subsidence
 - Potential of impacts to water supplies
- Water Management Plan, E&S Plan, NPDES?

MINE POOL MANAGEMENT

- Lower or maintain pool levels to eliminate unmanaged discharge
- Complex issues
 - History of mining, multiple discharges
- Treatment
- Quality varies with change in pool elevation
- Operating & maintenance
- Not an exact science – need for experience

EXPLORATION AND PRODUCTION FIRMS

- Need water – 5mil gallon/frac
- Need goodwill – environmental benefit
- Want low water cost/less road damage
- Environmental compliance managed by PADEP



EXAMPLE PROJECT – DELAWARE RIVER BASIN

- **Project Driver:** DRBC surface water use limitations
 - DRBC – Severe limits on GW/SW withdrawals
 - Supports use of treated mine water imported from Susquehanna River
 - PADEP & Lackawanna River Groups support mine water use

- **Tetra Tech:**
 - Developed concept to use mine pool water
 - Installed weirs & monitored flows and quality
 - Developed conceptual treatment/transport plan/cost estimate

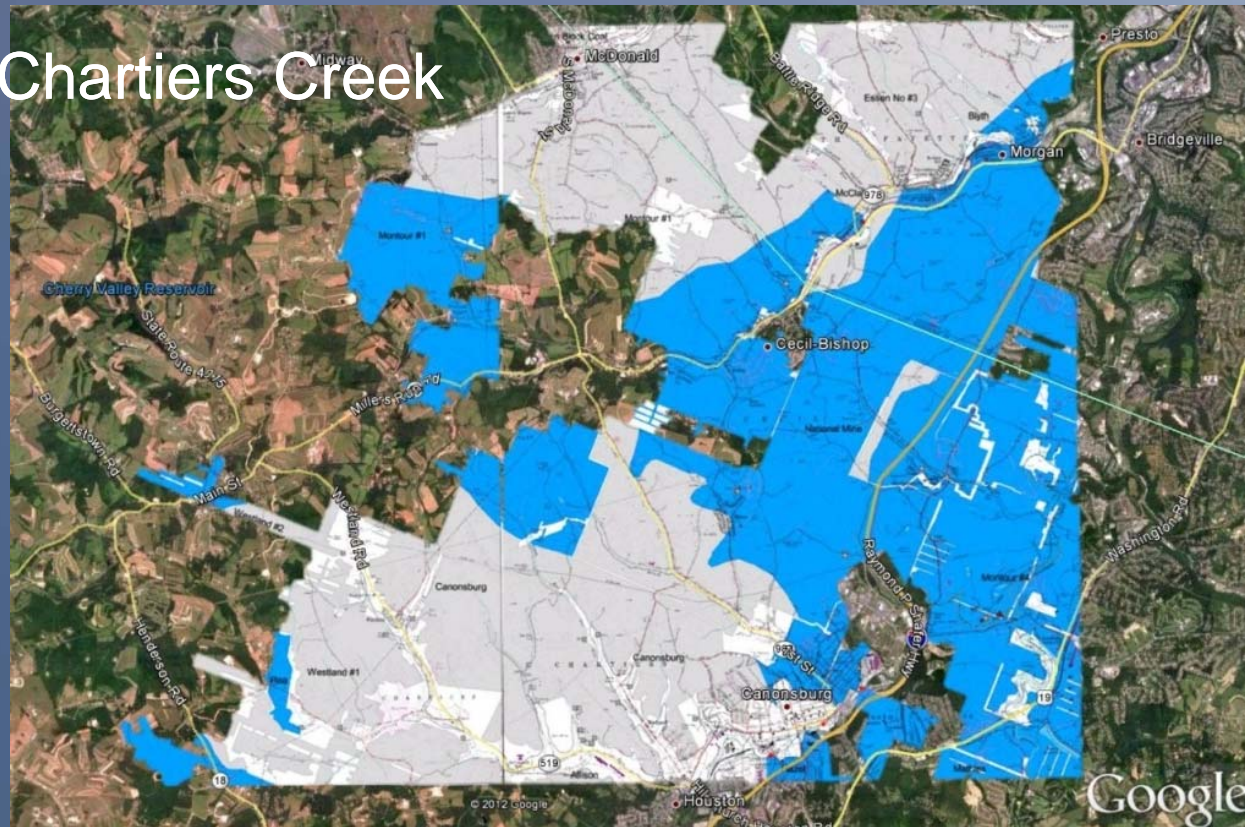


EXAMPLE PROJECT – GLADDEN MINE

- Gladden Mine Pool
- South Fayette Township, PA
- Project participants:
 - South Fayette Conservation District
 - PA DEP
 - Range Resources
 - Tetra Tech

EXAMPLE PROJECT – GLADDEN MINE

- Mine history
 - Three mine pools
- Discharge to Chartiers Creek



EXAMPLE PROJECT – GLADDEN MINE



- 2005 report by Chartiers Nature Conservancy
 - “Without treatment of Gladden Mine discharge, Millers Run or Chartiers Creek could not be restored”
- Discharge characteristics:
 - Flow ~700 gpm
 - pH 6.0
 - Iron 100 ppm
 - Sulfate 760 ppm

EXAMPLE PROJECT – GLADDEN MINE

- **DEP goal:**

- Clean the stream
 - Acid neutralization
 - Iron removal
 - Sustainable treatment

- **Range Resources goals:**

- Water supply for well development of adequate quantity/quality
- Reasonable cost
- Goodwill

EXAMPLE PROJECT – GLADDEN MINE

- Concept
 - Hydrated lime (or similar material) treatment system
 - Lower mine pool
 - Add second treatment stage for use well use
 - Pump treated water to impoundments at wells
 - Discharge excess water to stream
 - 3rd party operator
 - Cost share
 - Capital
 - Operating and Maintenance
 - Trust Fund
- At end of drilling, plant and trust fund donated to DEP

CONCLUSIONS

- Issues
 - Liability
 - Cost sharing
 - Environmental compliance
 - Drilling schedule
 - Cost of gas
 - Incentives
 - EPA acceptance

CONCLUSIONS

- Self control vs. regulated
- Don't miss other opportunities
 - CSO
 - Alkaline Ash

THANK YOU!

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