HYDRAULIC FRACTURING AND WATER RESOURCES IN OHIO: HOW TO PROTECT THE GROUNDWATER THROUGH PROPER WELL CONSTRUCTION AND CEMENTING PRACTICES

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Historically, most oil and gas wells in Ohio have needed to be stimulated to make them economically viable.

Stimulation first started in the 1880s in the Trenton Limestone in the Lima-Findlay oilfield area.
INITIAL WELL STIMULATION TECHNIQUES IN OHIO

- Initially, oil and gas well stimulation methods used in Ohio involved explosives – mainly nitroglycerin.
- Typical oil and gas wells were “shot” with one quart of nitro for every foot of reservoir rock.
- This was the primary completion technique employed in Ohio until the advent of hydraulic fracturing.
HYDRAULIC FRACTURING IN OHIO

- Hydraulic fracturing was first used in Ohio in 1951 and met with considerable success – particularly in the tight, Clinton sandstone.
- Hydraulic fracturing dramatically reduced the number of dry holes drilled in Ohio.
- Tens of thousands of oil and gas wells have been successfully hydraulic fractured in Ohio since 1951.
MYTHS ABOUT HYDRAULIC FRACTURING

- There is a lot of misinformation out there regarding hydraulic fracturing!
- Ohio DMRM has conducted over 1000 groundwater investigations since 1983 and has no cases where hydraulic fracturing causing groundwater contamination.
REAL HYDRAULIC FRACTURING DATA – MARCELLUS SHALE FRAC HEIGHT DATA (FROM AMERICAN OIL AND GAS REPORTER & HALLIBURTON)
POTENTIAL AVENUES FOR GROUNDWATER CONTAMINATION RELATED TO OIL AND GAS OPERATIONS

- Surface contamination – spills, equipment failure, pit leakage
- Bad cement jobs
- Poor or improper well construction
- Casing integrity issues
- Improperly plugged and abandon wells
REGULATORY REFORM HAS HELPED!

Incidents Caused by Regulated Activities by Year and Key Regulatory Reforms

Legend
- Green: Plugging & Abandonment
- Yellow: Off-Site Waste Management/Disposal
- Light Blue: Production/Workover
- Purple: Waste Storage Treatment
- Red: Well Stimulation
- Drilling & Completion
- Blue: Site Preparation
- Other: Urban drilling rules
- Other: Orphan well emergency program
- Other: Annular disposal rules
- Other: Annular disposal mechanical integrity test
- Other: Reserve pit construction standards
- Other: Closure of all produced water earthen pits
- Other: Authority to order water supply replacement
- Other: Produced water tracking
- Other: Established deep injection of produced water as preferred disposal method
- Other: Class II UIC Primacy
SURFACE CONTAMINATION ISSUES

- Typically, a historical problem that has been eliminated by regulatory reforms
- Still can happen with poor practices
- More likely on conventional vertical wells
BAD CEMENT JOBS

- Classic example of a bad cement job and a real bad stimulation decision
- Top of cement at 3648 feet on backside of production casing
- No remedial cementing prior to stimulation
- Perforated production casing from 3720 to 3740 feet
- Only 72 feet of cement above top perforation and most of that was less than 80% bond
BAD CEMENT JOB - CONTINUED

- No remedial cementing
- Well was hydraulically fractured
- Frac job circulated back to surface on backside of production casing halfway through the job
- Immediately shut down frac operation
- No contamination
Although the frac job did not cause contamination, the bad cement job allowed for natural gas migration up the backside of the production casing.

- Surface-production casing annulus was shut-in, but gas pressure was occasionally blown down.
- Pressure build-up allowed overpressurization of the annulus.
- Allowed natural gas to migrate from annular space through natural fracture system into aquifers.
- Took approximately 32 days to migrate into the aquifers.
ANNULUS OVERPRESURIZATION
BAD CEMENT JOB - REMEDIATION

- Remedial cementing conducted after initial contamination
- Deep natural gas source was eliminated with remedial cementing
- 26 water wells replaced due to natural gas invasion
POOR OR IMPROPER WELL CONSTRUCTION

- Well construction issues can lead to groundwater contamination
- Inadequate surface casing or too deep of surface casing installation can lead to potential contamination from deeper brackish or brine formations
- Eliminated with required casing programs or intermediate casing strings
CASING INTEGRITY ISSUES

- Casing integrity is a critical issue with well construction.
- Ohio is drafting rules that will allow only used casing that has been drifted and tested prior to installation.
- Ohio oil and gas inspectors still have the ability to reject any casing brought on site prior to installation.
IMPROPERLY PLUGGED OR UNPLUGGED ABANDONED OIL AND GAS WELLS

- In the Appalachian Basin, there are 1000s of old, improperly or “unplugged” oil and gas wells that pose a hazard for groundwater contamination.
- Most of these wells were drilled between the 1860s to early 1900s.
- Identifying historical legacy contamination versus current contamination issues can be a problem and difficult to resolve.
POTENTIAL SHALE PLAYS IN OHIO

- Ohio has three potential shale plays
- Utica Shale – Point Pleasant Formation will be the dominant play – being compared to the Eagle Ford play of south Texas
- Marcellus will be pretty much limited to the eastern part of the state
- Maybe some minor activity in the Ohio Shale
EXTENT OF THE MARCELLUS SHALE IN THE APPALACHIAN BASIN (FROM OHIO DIVISION OF GEOLOGICAL SURVEY)
LOCATION OF THE UTICA SHALE EXTENT IN THE APPALACHIAN BASIN
AREAS OF POTENTIAL MARCELLUS AND UTICA PRODUCTION IN OHIO (FROM OHIO DIVISION OF GEOLOGICAL SURVEY)
GENERALIZED GEOLOGY OF A UTICA SHALE WELL IN OHIO (FROM OHIO DIVISION OF GEOLOGICAL SURVEY)
CONCERNS WITH SHALE PLAYS AND POTENTIAL FOR GROUNDWATER CONTAMINATION IN OHIO

- The Division has identified several concerns dealing with the drilling and hydraulic fracturing of Marcellus and Utica wells.
- Shallow fugitive natural gas zones that may lead to bad cement jobs or annulus overpressurization.
- Potential for frac communication from new horizontal Utica wells into existing or plugged conventional Rose Run or Beekmantown oil and gas where the Utica Shale is exposed and uncemented.
TYPICAL LOCATION FOR UTICA HORIZONTAL WELL IN OHIO

- Horizontal Utica well unit location encompasses approximately 140 to 240 acres
- 5000 to 8000 foot laterals
- Typical existing vertical Rose Run or Beekmantown well drilled on a 40 acre spacing
We are still in exploration mode for the Utica Shale in Ohio.

Area of exploration is moving westward into central Ohio where there is existing production from deeper formations.

Need to review well construction and cementing of surrounding conventional oil and gas wells penetrating into or through the Utica Shale.
TYPICAL DEEP PRODUCING WELL IN OHIO
TYPICAL ROSE RUN WELL

- The Rose Run Sandstone occurs approximately 900 to 1000 feet below the Utica Shale
- Cementing of the production casing on these wells normally does not provide cement coverage across the Utica Shale
- Will need to research horizontal frac extension distances from the multiple-stage Utica Shale frac jobs to ensure no communication with existing deep vertical wells
The Division has experienced good cooperation and communication with the oil and gas industry with the development of the shale plays.

Shale players have been very proactive in Ohio.
WATER SAMPLING

- The shale players are conducting pre-drilling water sampling programs in Ohio
- Sampling all water sources within 2500 to 3000 feet of the proposed drilling operation
NEW RULES FOR WELL CONSTRUCTION

- The Division is working with the oil and gas industry in developing more stringent well construction standards for Ohio.
- These rules are in draft stage and should be up for public review and comment later this fall.
- Will strengthen construction standards and cementing practices.
CONCLUSIONS

- There has never been a groundwater contamination case in Ohio caused by hydraulic fracturing.
- Continued changes in regulations over the years have dramatically reduced groundwater contamination caused by oil and gas activities.
- New rules are being developed for more stringent well construction and cementing practices.
QUESTIONS?