WATER RESOURCES ISSUES RELATED TO SHALE GAS DEVELOPMENT

Protection of drinking water
Fracking chemicals
Adequate wastewater treatment
Impact of water withdrawals
Surface water impacts
Regulations and enforcement
Potential Concerns / Problems

- Surface water impacts from well site, roads & pipeline construction (sediment, nutrients)

- Groundwater impacts from brines, stimulation fluids, production fluids

- Surface or groundwater impacts from spills or containment failures (drilling mud, recovered stimulation fluids & production fluids)

- Methane gas migration
Seismic Testing
Earth Disturbance

- Roads, drilling pads
Earth Disturbance
Surface Rigs

Deep & Horizontal
24” conductor casing (brown) is installed up to 50 feet deep and cemented (grey) to the surface.

20” casing is installed through the 24” casing and continuing up to 500 feet deep. This casing is cemented to the surface to isolate and protect near-surface groundwater.

13 3/8” casing is installed through the 20” casing and continuing up to 1000 feet deep. This casing is also cemented to the surface to protect the groundwater aquifer from the gas well.

5 1/2” casing continues down and is turned laterally into the Marcellus formation at a depth of 5000 to 9000+ feet below the surface.

Horizontal, “lateral” portion of well extends from 3,000 to over 10,000 feet within Marcellus formation.

Fresh groundwater zone up to 1000 feet deep

Vertical portion of well

Kick off point for the bend from vertical to horizontal drilling.
Freshwater Use for Drilling

- Typically 3 to 5 million gallons per well
- Access to water = landowner control
- Allocation of water = state control
  - Basin commissions, DEP, Clean Streams Law
- Water withdrawals
  - Purchase water from communities
  - Large rivers and impoundments
  - Small streams and groundwater
  - Incentives – wastewater
- Biggest concerns
  - Withdrawals in western PA
  - Illegal withdrawals – enforcement
  - “loss of water”
Hydraulic Fracturing

- 3 to 6 million gallons of water per well
- Average flowback around 10%
- EPA study of fracking is on-going
Pre and Post Hydraulic Fracturing

Every 300-500 feet of casing is perforated to inject fluids into the shale for hydraulic fracturing.

Approximately 0.5 to 1 million gallons of fluids are injected into each stage.
Types of Waste Fluids

Drilling Fluids

Brine

Flow-Back / Frac Return

Production Fluids
Typical Wastewater Concentrations

Characteristics
• High TDS
• High salt (sodium, chloride)
• High metals (barium, etc.)
• Organic carbons

Photo courtesy – Paul Hart, Hart Resource Technologies, Inc
Wastewater Options

• Conventional treatment – treatment and discharge
  • Treatment facilities or POTW’s

• Deep injection wells – limited in PA

• Reuse / recycling
  • Directly dilute and reuse
  • Basic treatment then dilute

• Membrane filtration
  • Requires some pre-treatment
  • Reuse or discharge to stream

• Distillation
  • Produces clean water but $$$
  • Reuse or discharge to stream
Changing Wastewater Treatment

Data sources:
Paul Hart, Hart Resource Technologies, + PA DEP
Restored Well Site

Picture courtesy Fortuna Energy
Groundwater Issues

- High density of groundwater wells in Pennsylvania
- Many never tested
- Poor well construction

Water Wells drilled 1966-1994
METHANE IN WATER

• Can occur naturally in groundwater or migrate from gas wells

• Detected in ~20% of water wells

• Gas well casing and cementing critical to prevent methane migration

• No drinking water standard - saturation concentration in groundwater = 28 mg/L at atmospheric pressure

• Symptoms = effervescent or cloudy water, spurting faucets, bubbling sound in well
Awareness of pre-drilling water quality problems was generally very low.

Dissolved methane ~ 20% of supplies.
Fraced = 0.9892x - 0.5615 (R² = 0.85)

Control = 0.9543x + 13.945 (R² = 0.92)

No statistical correlation between TDS difference and distance to gas well or time since fracing.
Water Supply Complaints

• Perceived changes reported by 12% of Phase 1 and 17% of Phase 2 well owners

• 82% of perceived changes and 100% of those who filed DEP complaints were within 3,000 feet of nearest Marcellus well

• Most complaints either could not be evaluated or could not be confirmed – some problems could be intermittent?
Protecting Surface Water During Drilling

- Clean Streams Law
  - Broad authority to regulators to protect water quality

- River Basin Commissions

- Oil and Gas Act
  - Setbacks (typically 100 feet)

- Erosion and Sedimentation Plans

- Stream encroachment permits

- Site restoration plans
SURFACE WATER MONITORING
No presumed responsibility, many volunteer networks
Additional Actions to Protect Water

- Leasing stipulations
  - Greater setbacks to water
  - Use of tanks vs. pits for wastewater
  - Pre + post-drilling testing of ALL water
  - Water flow measurements (before seismic)
  - Proper retirement of seismic holes
  - Access to water (and payment)
  - No surface lease?

- Voluntary water testing and documentation

- Reporting obvious problems (sediment, tastes, odors, loss of water, etc.) and report problems to DEP and gas drilling company