Assessment of the Potential Impacts of Hydraulic Fracturing for Oil and Gas on Drinking Water Resources

Presentation by the
U.S. Environmental Protection Agency
Office of Research and Development

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HF Study Background

- In FY2010, Congress urged EPA to study the relationship between hydraulic fracturing and drinking water.
- EPA launched this study with the purpose to:
  - Assess whether hydraulic fracturing can impact drinking water resources
  - Identify driving factors that affect the severity and frequency of any impacts
- EPA's HF study was outlined in a 2011 *Study Plan* with additional details provided in a 2012 *Progress Report.*

HF Study Progress

- EPA's HF study has produced:
  - 12 EPA technical reports – Including 9 reports being released today
  - 4 EPA authored journal publications
  - 9 journal publications from colleagues at Lawrence Berkeley National Laboratory
  - Draft Hydraulic Fracturing Drinking Water Assessment report
- All completed products available online:
  - **www.epa.gov/hfstudy**

Final HF Technical Reports Released Today

- Study of water acquisition in the Susquehanna and Upper Colorado river basins.
- Study of sources of selected HF-related chemicals in the Allegheny river and streams in PA.
- Studies of possible impacts to drinking water resources (five retrospective case studies):
  - Northeast, PA (Bradford County)
  - Southwest, PA (Washington County)
  - Killdeer, ND
  - Raton Basin, CO
  - Wise County, TX
- Description of well construction and design characteristics.
- Characterization of spills related to HF operations.

Draft HF Assessment Report

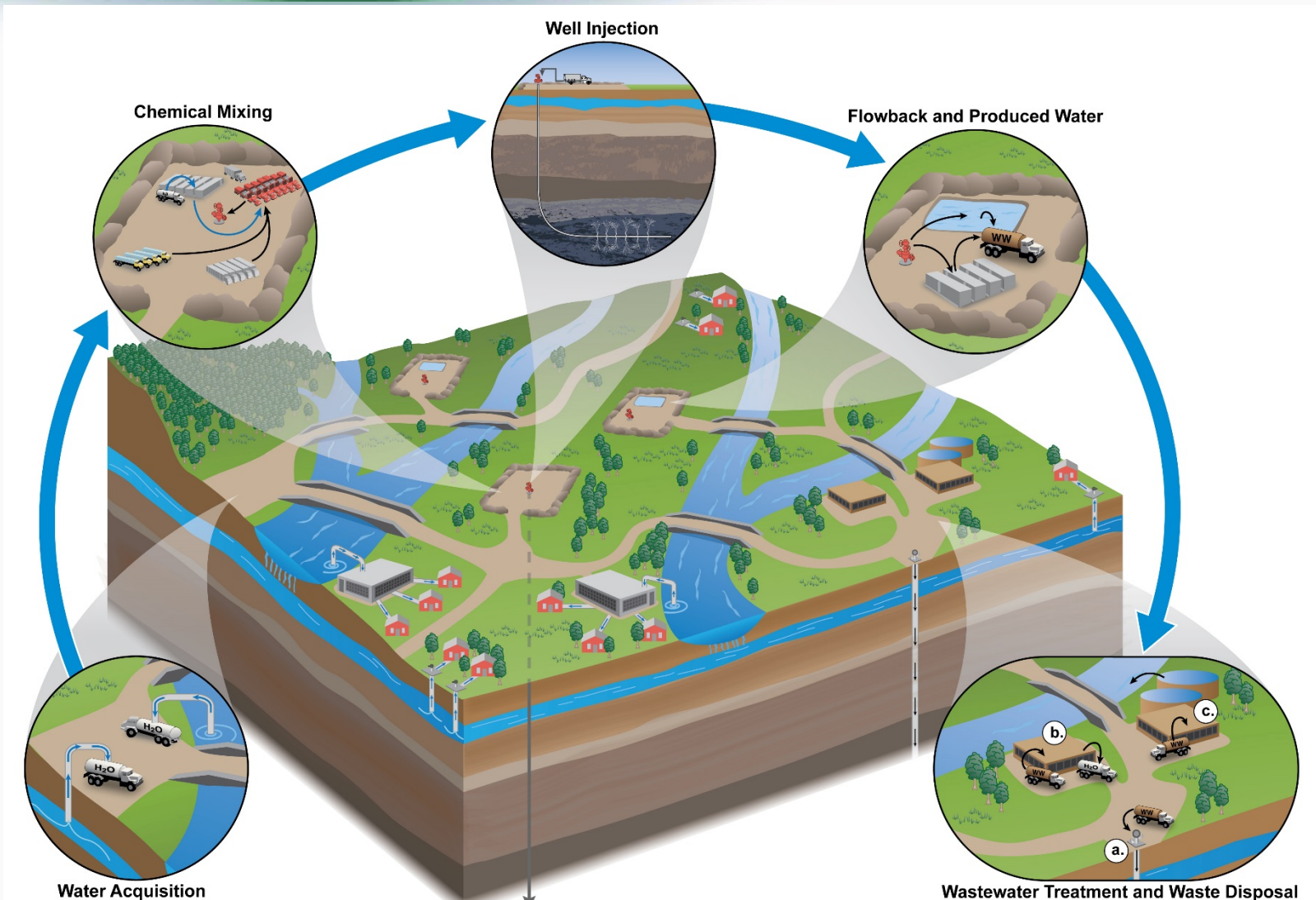
What it is:

- A state-of-the-science integration and synthesis of information
- Based upon EPA research results, a robust literature review, and other information, including input from stakeholders.
- Identifies potential vulnerabilities and addresses questions identified in the *Study Plan* and *Progress Report*

What it is <u>not:</u>

- Not a human health, exposure, or risk assessment
- Not site specific
- Does not identify or evaluate best management practices
- Not designed to inform specific policy decisions
- Does not identify or evaluate policy options

Hydraulic Fracturing Water Cycle: Follow the water



Summary of Impacts on Drinking Water Resources

- Assessment identified potential vulnerabilities to drinking water resources due to hydraulic fracturing activities.
- These vulnerabilities include:
  - Water withdrawals in areas with low water availability
  - Spills of HF fluids and flowback/produced water
  - HF conducted directly into formations containing drinking water resources
  - Well integrity failures
  - Subsurface migration of gases and liquids
  - Inadequately treated wastewater
- Despite vulnerabilities, there is no evidence of widespread, systemic impacts on drinking water resources due to hydraulic fracturing activities.

Water Acquisition: Sources and volume

- Sources of water used for HF include surface water, ground water, and reused wastewaters.
- Cumulative water use is at least 44 BG/year; Median water use for a well is approximately 1.5 MG.
- There is much variability and water use varies between <1 MG to >5 MG per well.
- Factors affecting water use include:
    - length of well (well volume)
    - formation depth and geology
    - fracturing fluid formulation

Water Acquisition: Comparison to other uses

- HF water use is small compared with total water use and consumption at the national and state spatial scales.
- For most counties, HF activities account for <1% of total water use and consumption.
- Potential for impacts on drinking water resources greatest in areas with:
    - High HF water use
    - Low water availability
    - Frequent drought
    - Declining water sources
- Example area experiencing all four factors: southern and western Texas.

Chemical Mixing

Chemical Mixing: HF Fluids

- HF fluids generally consist of:
  - Base fluid
  - Chemical additives
  - Proppants

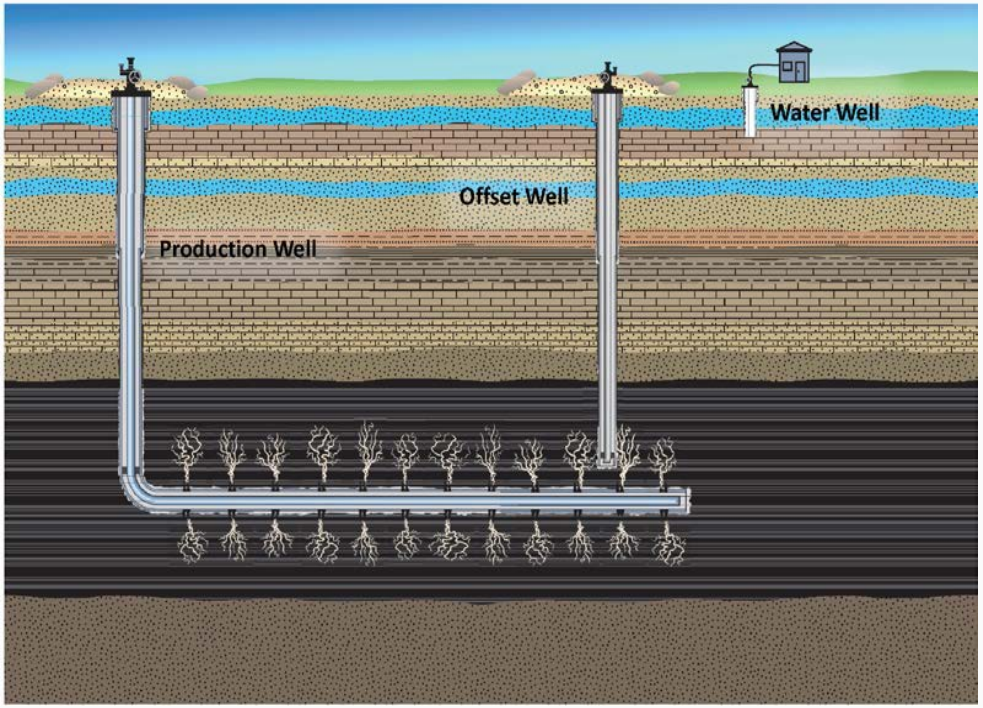
- Base fluids:
  - Largest constituent by volume
  - Most often water
  - Other base fluids include: non-aqueous fluids, acids, energized fluids, foams and emulsions
- Proppants:
  - Most often sands, resin-coated sands, other specialty engineered particles

Chemical Mixing: HF Chemical Additives

- Chemical additives:
  - Perform multiple functions
  - Can be a single chemical or a mixture of multiple chemicals
  - Are injected during different stages of the HF process
  - Generally comprise <2% of injected fluid volumes
  - Thousands of gallons are potentially stored on-site and used in the HF process
- We identified more than 1000 chemicals used as components of HF fluids:
  - Median of 14 unique chemicals used per well
  - No single chemical used at all well sites across country
  - Chemicals used at >65% of well sites include: methanol, hydrotreated light petroleum distillates, hydrochloric acid

Well Injection: Potential subsurface pathways

- Movement of gas or liquids from the wellbore into a drinking water resource
- Movement of gas or fluids from production zone through subsurface rock formations into a drinking water resource



Well Construction and Integrity

- Multiple barriers act together to prevent migration of gases and fluids.
- Inadequate construction, defects and degradation of casings or cement, or absence of redundancies can create pathways leading to contamination of drinking water resources.
- EPA's Well File Review Report:
  - Estimated 66% of wells had one or more uncemented intervals
  - Estimated 3% of wells did not have cement across a portion of the operator defined drinking water zone
- Specific rate of well failures unknown but generally increases over time.

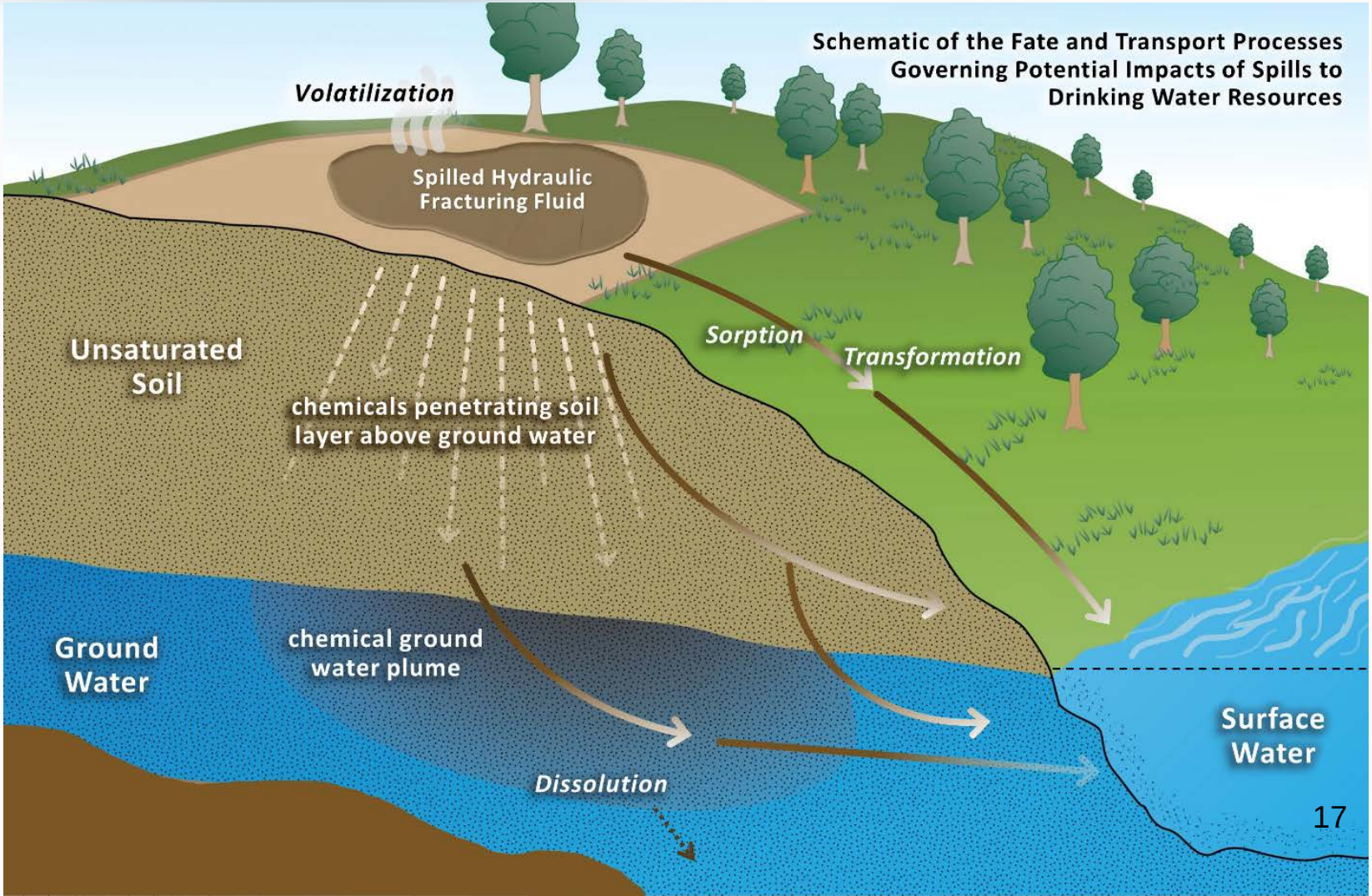
Sub-Surface Movement

- Physical separation between the production zone and drinking water resources can minimize impacts.
- In some cases, the production zone is co-located with drinking water resources:
  - Estimated 0.4% of wells fractured in 2009 and 2010 showed evidence of fracturing directly within a drinking water resource
  - Use of the drinking water resource not well characterized
- Deep HF operations are unlikely to create direct flow paths from fracture production zones to shallow drinking water resources.
- Well-to-well communications provide documented and potential pathways for fluid movement into drinking water resources.

Flowback and Produced Water

- Flowback and produced water come out of the well when pressure is released.
- Amount of fracturing fluid returned to surface is generally 10% to 25% of injected fluid and varies widely.
- Data on produced water composition limited:
  - 134 chemical detected specifically in FB/PW
  - High total disolved solids
  - Metals, organics
  - Naturally occurring radionuclides
- High TDS present analytical challenges for characterizing chemical composition

Chemical Mixing: Spills



Spills of HF Fluids and Produced Waters

- Spills of HF fluids and produced waters have occurred; when spills occur, they can and have reached drinking water resources through multiple pathways.
- Total number and frequency of spills due to HF activities unknown.
- Based upon spill data reviewed:
  - Hundreds of spills of hydraulic fracturing fluids and produced waters have occurred
  - Spill volumes varied greatly: 2 gallons to 1.3 Million gallons
  - Most common causes of spills were equipment failure and human error
  - Of those spills reviewed, 8% of documented spills reached a surface or ground water resource; 64% reached soils

Hydraulic Fracturing Wastewater

- HF produces large volumes of wastewater.
- Most HF wastewater is disposed of using underground injection control (UIC) wells.
- UIC disposal varies geographically:
  - 95% UIC in Barnett Shale area (TX)
  - 10% UIC in Marcellus Shale area (PA)
- Wastewater reuse varies geographically:
  - 5% wastewater use in Barnett Shale area
  - 70% wastewater reuse in Marcellus Shale area
- Other disposal options for HF wastewater:
  - Centralized wastewater treatment facilities (CWT)
  - Evaporation pits, land irrigation and road spreading

HF Chemical Characterization

- 1,173 chemicals reportedly used in HF fluids or detected in FB/PW.
- 148 have human oral toxicity reference values.
- Absence of toxicity reference values limits ability to conduct future site specific exposure/risk assessments.
- CBI limits complete characterization of chemical use in HF operations:
    - From EPA's analysis of the FracFocus 1.0 database
    - One or more ingredients were claimed as confidential in more than 70% of disclosures
    - Operators designated 11% of all ingredient records as confidential business information

Conclusions

- Assessment identified potential vulnerabilities to drinking water resources due to hydraulic fracturing activities.
- The number of documented impacts to drinking water resources is small relative to the number of fractured wells.
- Despite vulnerabilities, there is no evidence of widespread, systemic impacts on drinking water resources due to hydraulic fracturing activities.

Use of Assessment

- EPA's assessment represents a synthesis of the science and contributes to overall understanding of potential impacts.
- The assessment helps to advance the science and understanding of hydraulic fracturing by identifying potential vulnerabilities.
- The assessment can inform future decisions by industry and by federal, tribal, state, and local entities concerning how best to protect drinking water resources now and in the future.

What's Next

- Science Advisory Board (SAB) review of draft assessment:
  - Public, open process
  - Opportunity to comment on charge questions
  - Opportunity to address SAB panel concerning EPA's draft assessment
  - Opportunity to provide comments on the draft assessment
- Agency will use comments from public and SAB to revise draft assessment and release as final.