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Environmental Protection
Agency

Proposed Analysis from the Well File Review

Technical Workshop Series:
Well Construction/Operation and Subsurface Modeling

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EPA Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

EPA Study Goals:

- Assess whether hydraulic fracturing may impact drinking water resources
- Identify driving factors that may affect the severity and frequency of impacts

For more information:
http://www.epa.gov/hfstudy

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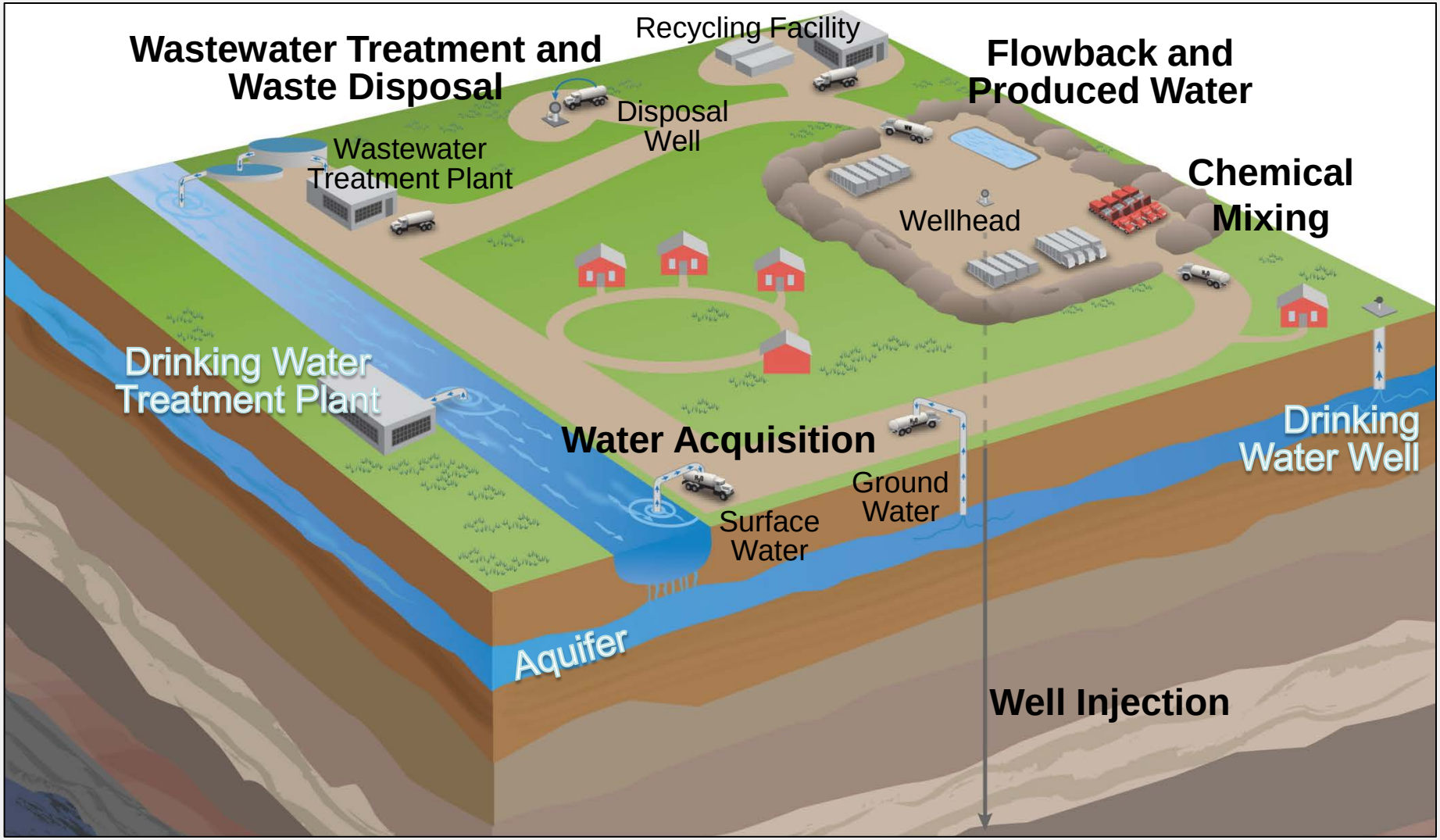
Hydraulic Fracturing Water Cycle



WATER CYCLE STAGES

Water Acquisition → Chemical Mixing → Well Injection → Flowback and Produced Water → Wastewater Treatment and Waste Disposal

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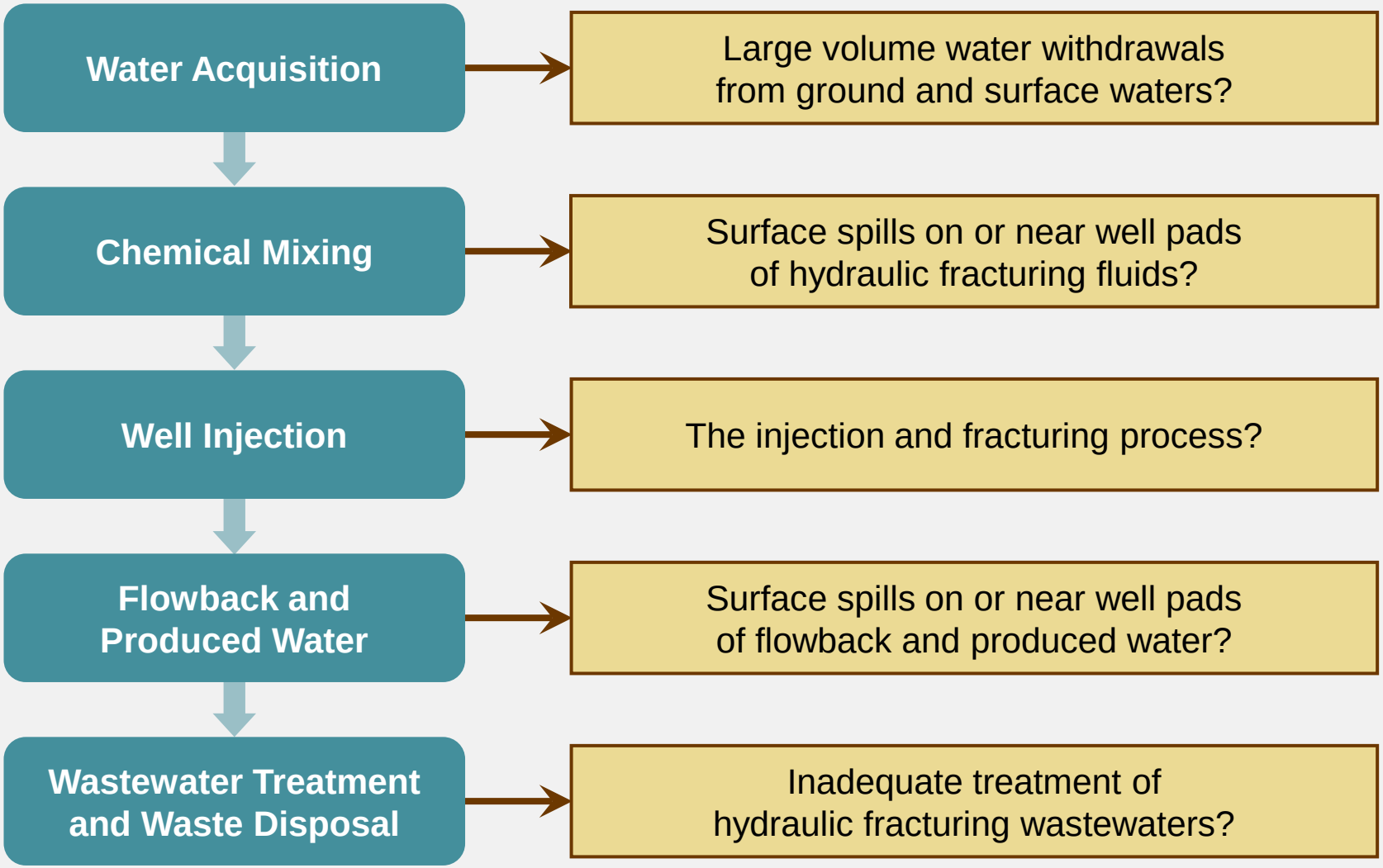
Primary Research Questions

What are the potential impacts on drinking water resources of:



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Well Injection

Secondary Research Questions

- How effective are current well construction practices at containing gases and fluids before, during, and after fracturing?
- Can subsurface migration of fluids or gases to drinking water resources occur, and what local geologic or man-made features might allow this?

Ongoing Research Projects

Literature Review

Service Company Analysis

Well File Review

Subsurface Migration Modeling

Retrospective Case Studies

Well File Review

GOAL

Identify practices or factors that may impact drinking water resources

Identify Hydraulically Fractured Wells

- Provided by nine hydraulic fracturing service companies
- Fractured between Sept. 2009 and Sept. 2010

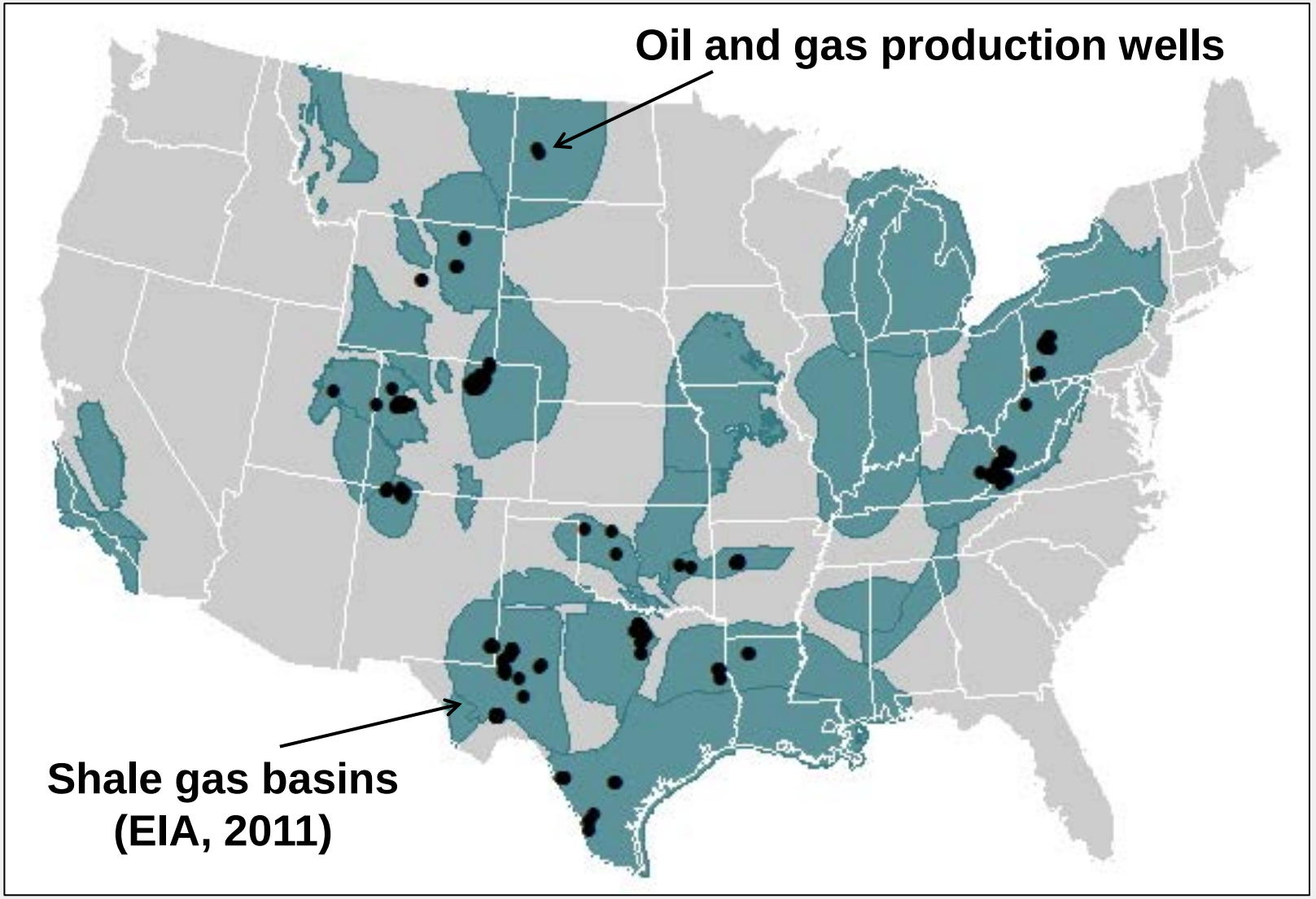
Select Wells for Well File Review

- Select statistically representative sample of wells from nine oil and gas operators of various sizes
- Wells include different geographic areas and completion types

Extract and Analyze Well File Data

- Well construction practices
- Hydraulic fracturing practices, including water acquisition and wastewater disposal

Well Locations



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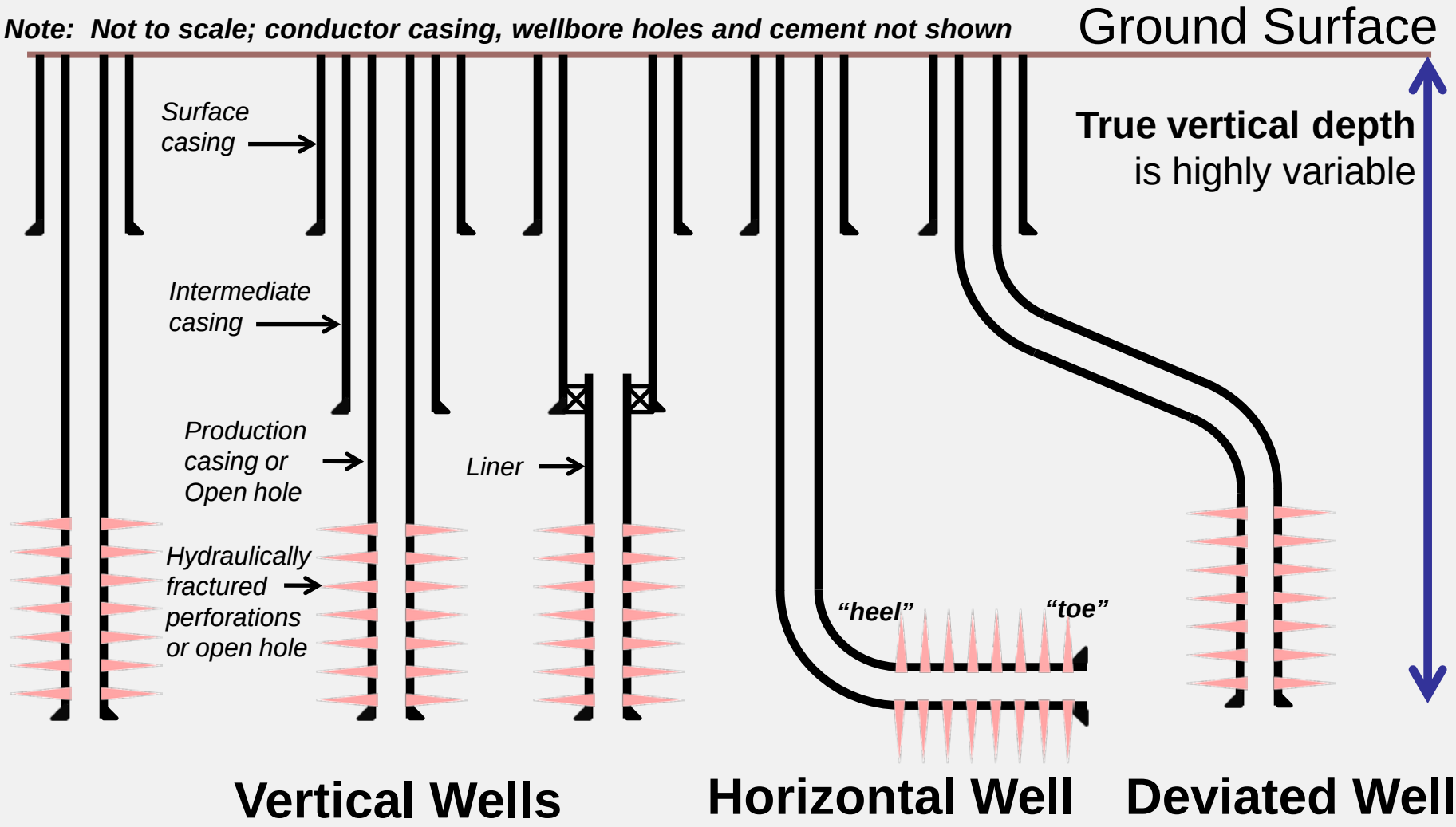
Example Well Completions



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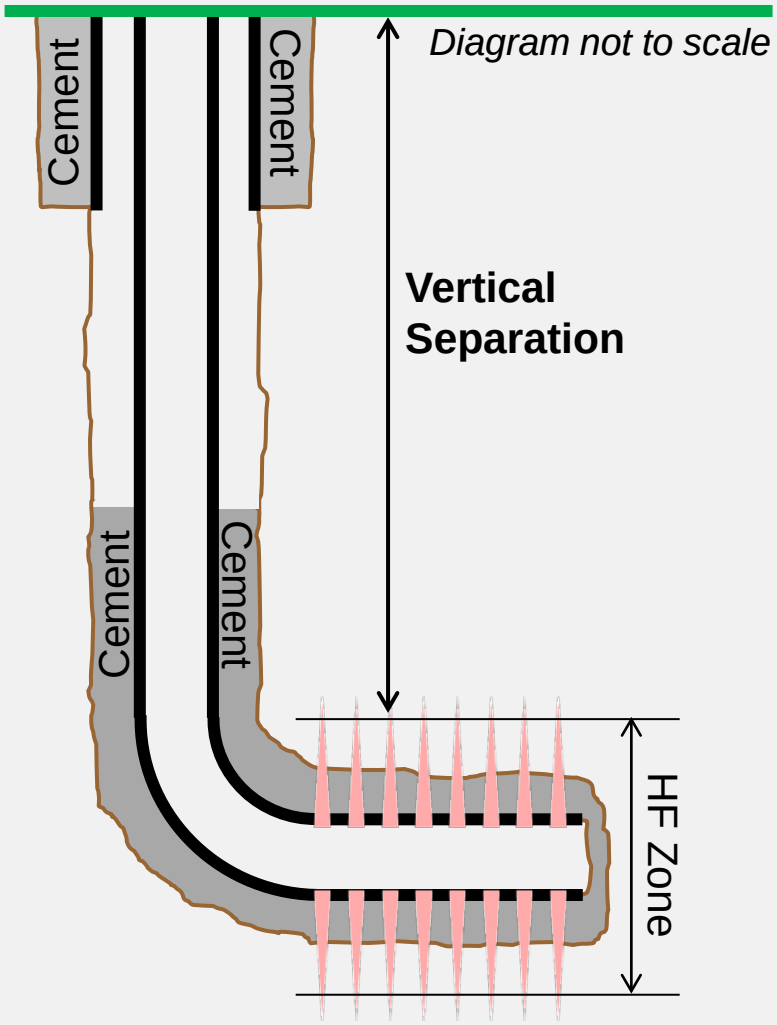
Information Requested

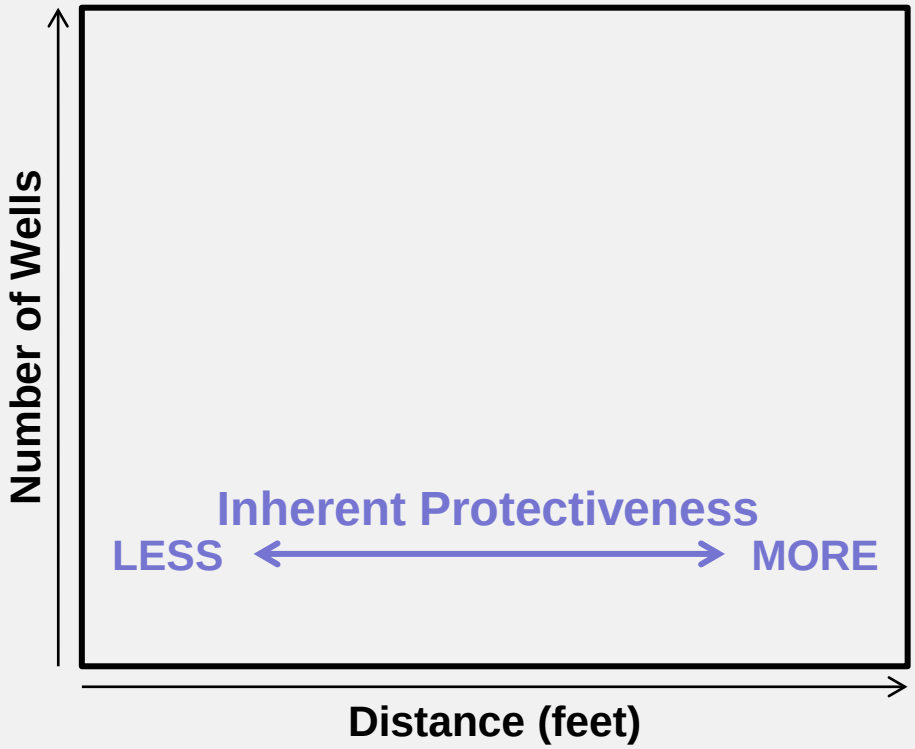
- Geologic maps and cross sections
- Daily drilling and completion records
- Mud logs
- Open hole logs, such as porosity and resistivity logs
- Description of well casings installed
- Cased hole logs, such as cement evaluation logs
- Pressure testing results of installed casing
- Up-to-date wellbore diagram
- Pre- and post-hydraulic fracturing reports, including volumes/additives used
- Source(s) of water used
- Chemical analyses of fluids (used in treatment, water zones, offset locations, flowback)
- Microseismic monitoring results
- Spill/incident reports

Proposed Graph for Analysis

Generic Well Diagram



Vertical Separation between HF Zone and Ground Surface (Bar Graph)



If multiple zones are fractured, distance between ground surface and uppermost zone is graphed

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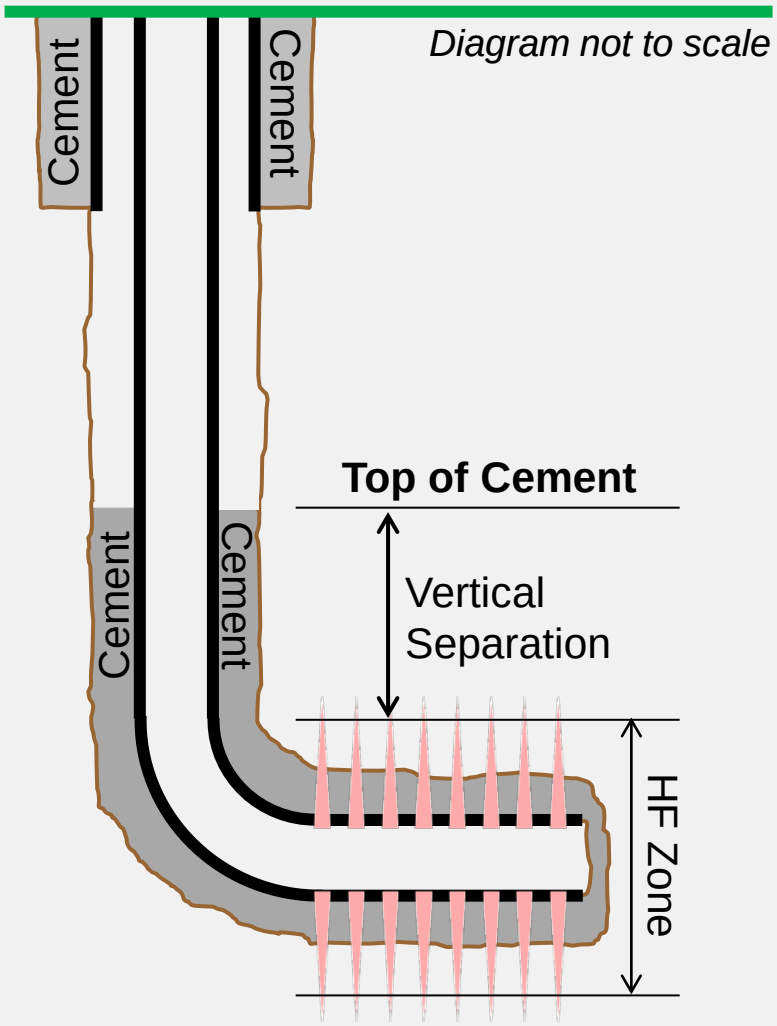
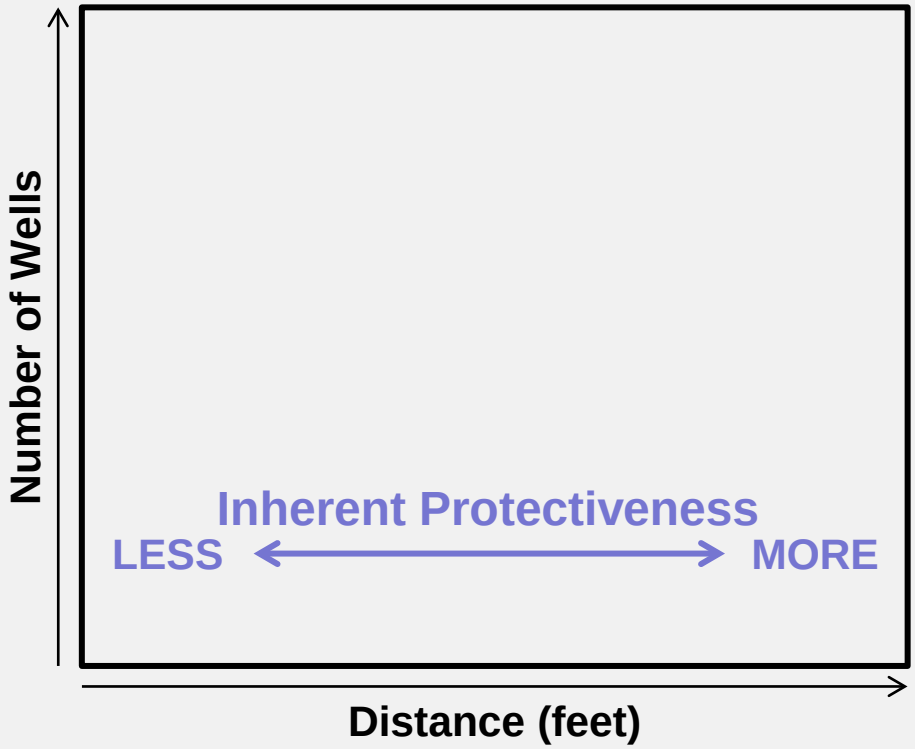
Proposed Graph for Analysis

Generic Well Diagram



Vertical Separation between HF Zone and Top of Cement (Bar Graph)



If multiple zones are fractured, distance between top of cement and uppermost zone is graphed

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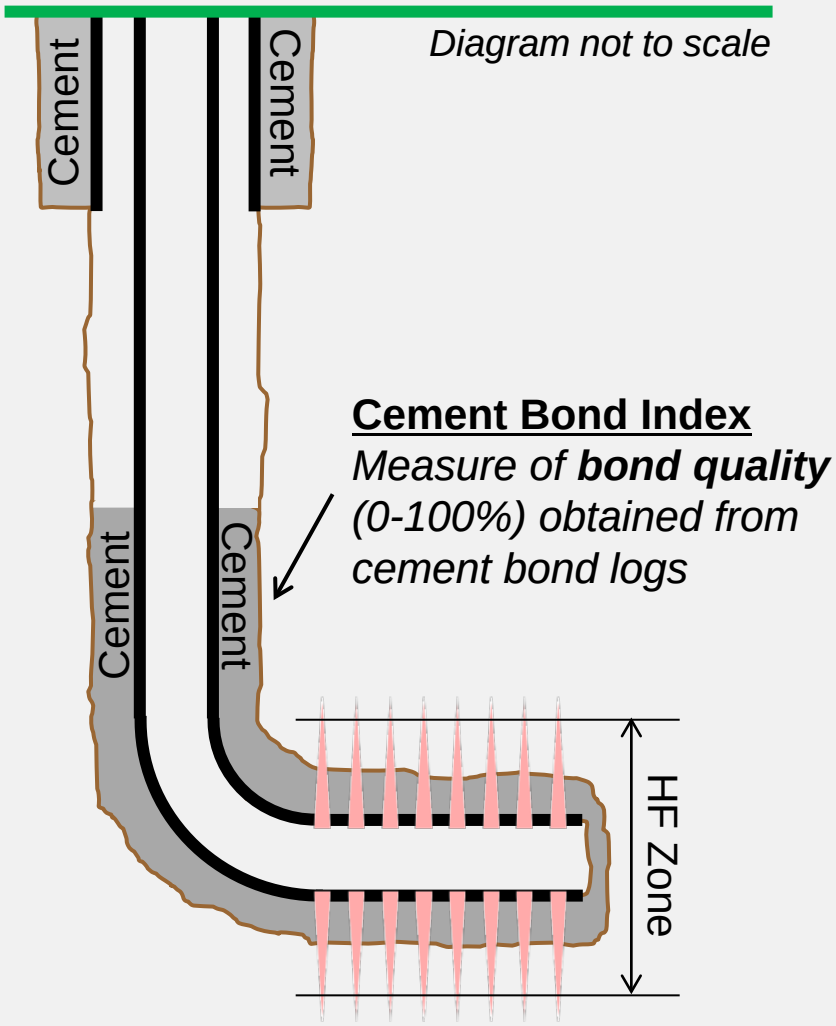
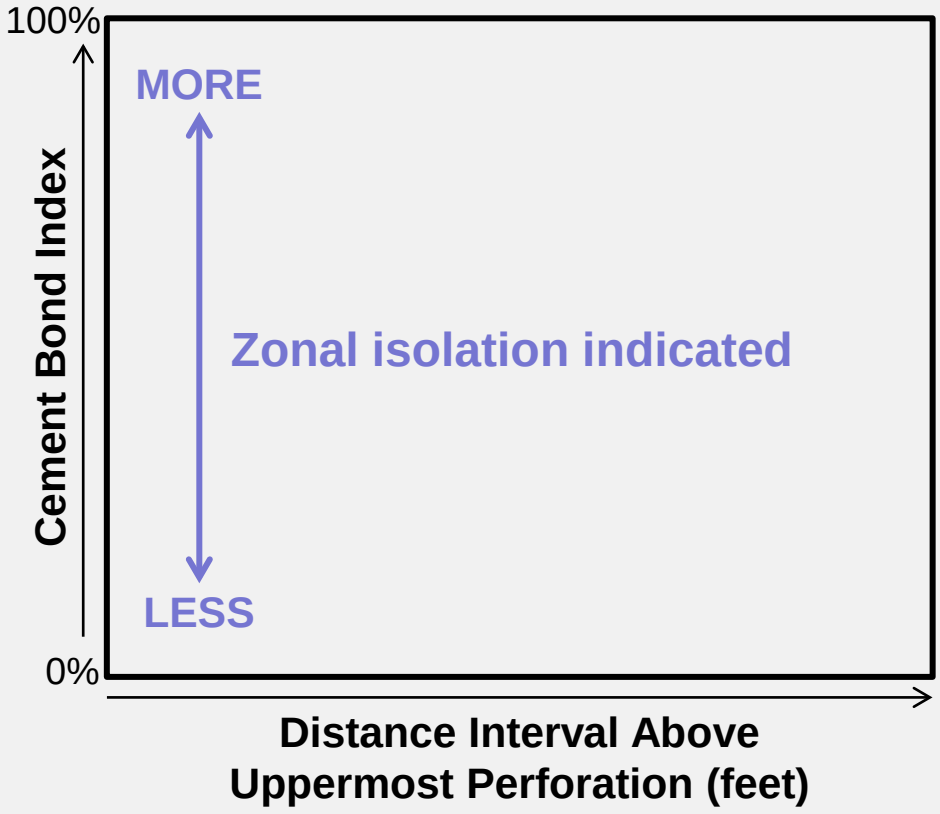
Proposed Graph for Analysis

Generic Well Diagram



Distribution of Cement Bond Indices (Box and Whiskers Plot)



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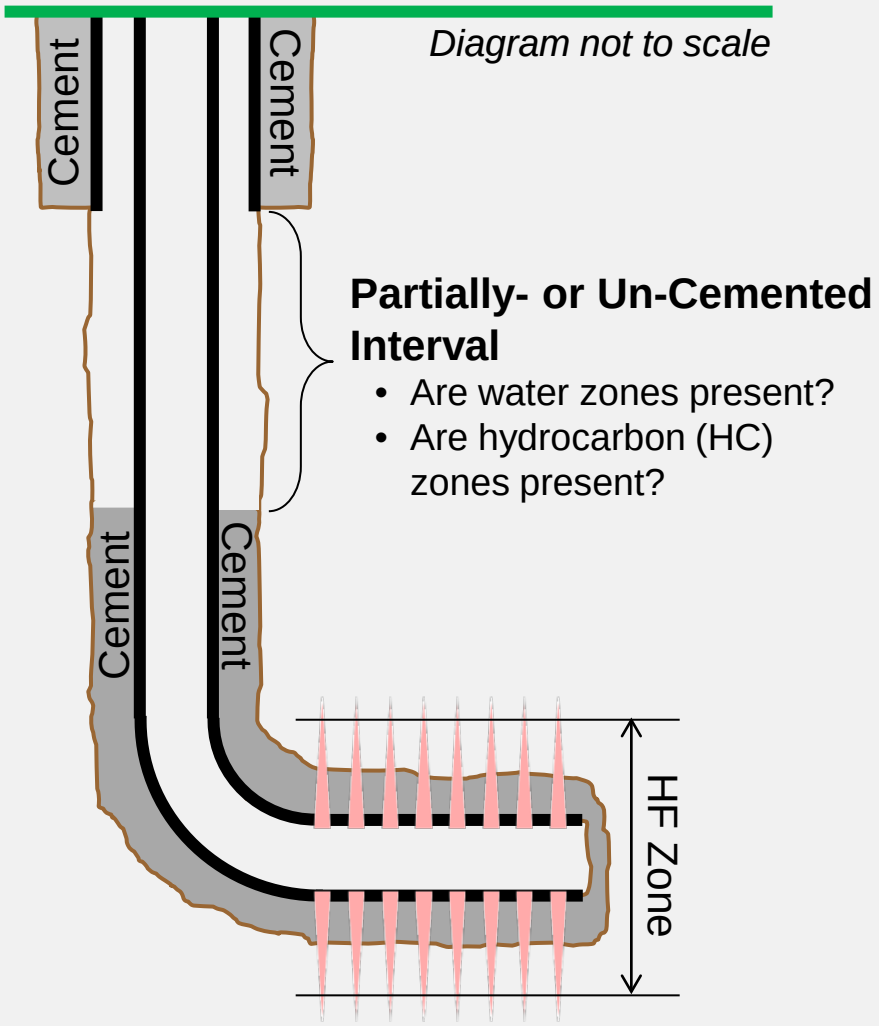
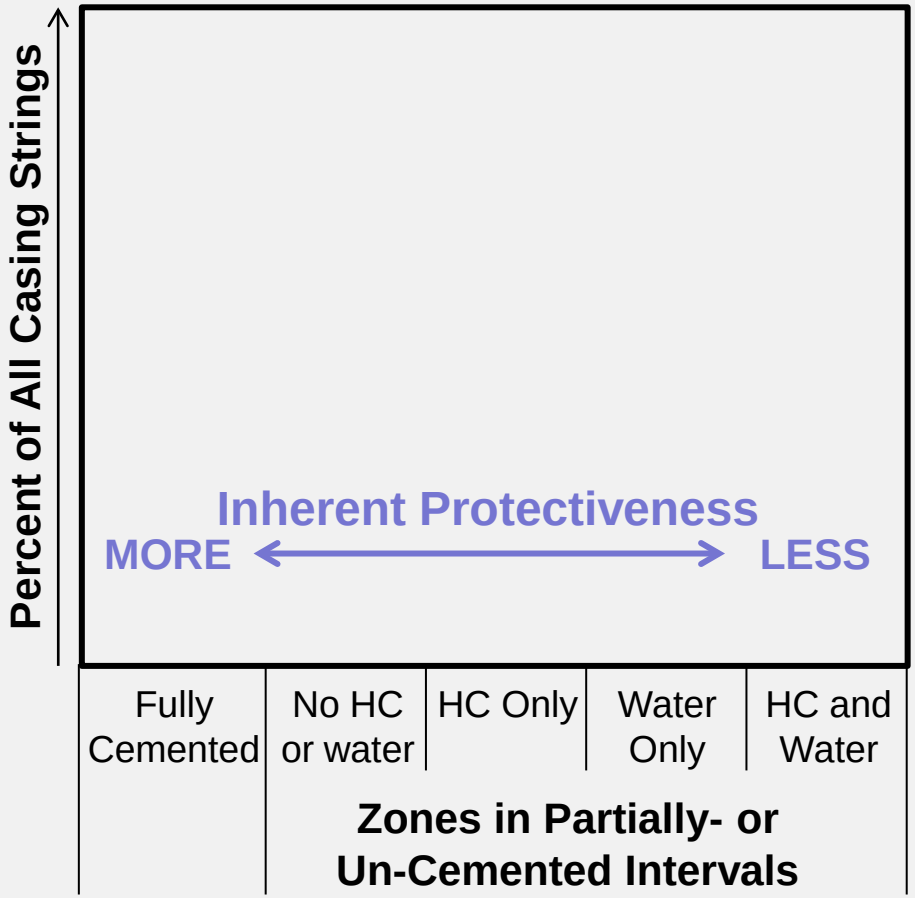


Zones and Degree of Cement (Bar Graph)



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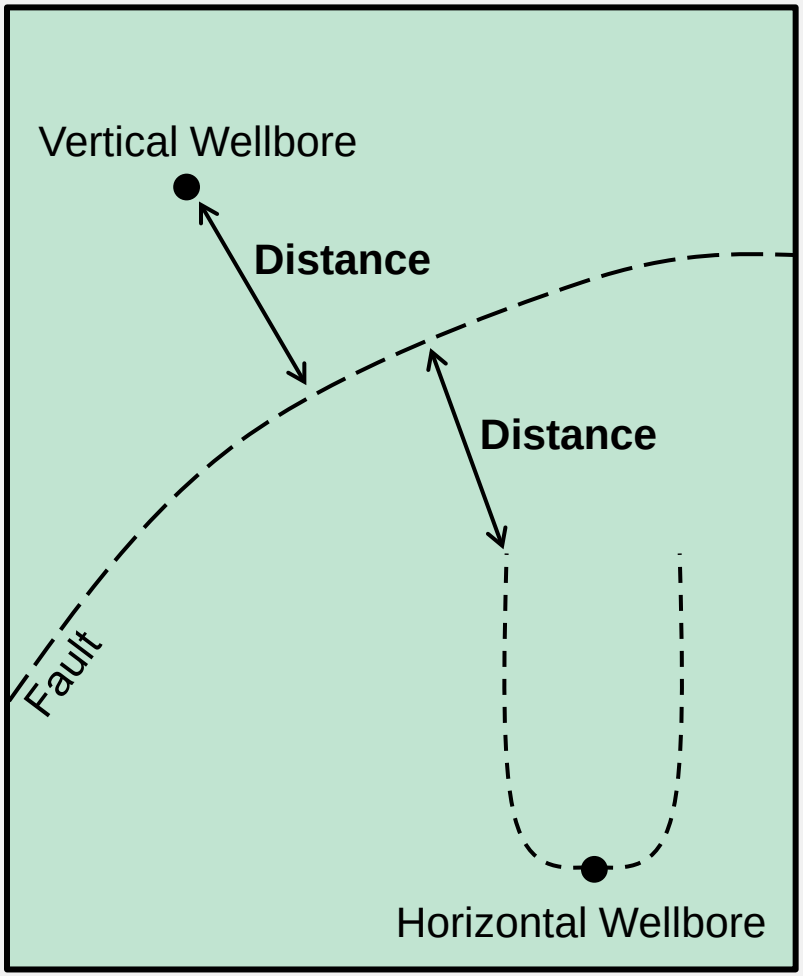
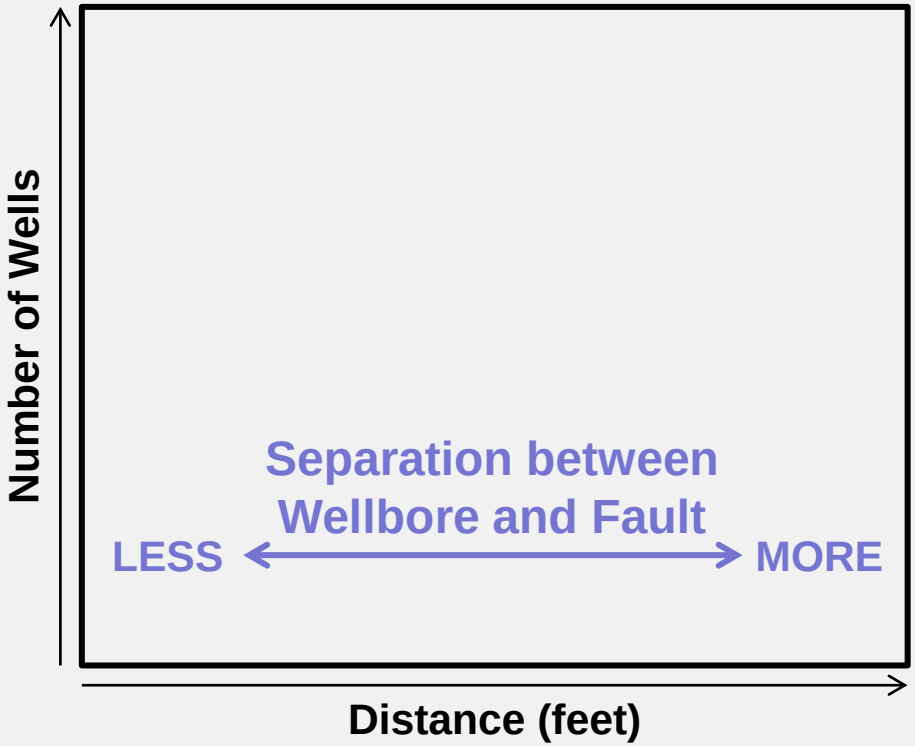
Proposed Graph for Analysis

Top View



Distance to Nearby Faults (Bar Graph)



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Other Potential Factors of Interest

- **Surface casing setting depth** vs. drinking water resource depth
- **Trend in water usage** – fresh vs. recycled
- **Flowback volumes and disposition**
- **Patterns of additives used** as a function of geologic lithology treated
- **Pre-stimulation casing test pressure** vs. maximum treatment pressure
- **Spills and the remedial actions** taken during and after hydraulic fracturing
- **Degree of monitoring** and other data available in file to assure the operator that conducting hydraulic fracturing is protective of drinking water resources
  - *Examples:*
    - Formation water sampling to confirm presence/absence of underground source(s) of drinking water
    - Frequency of cement evaluation (i.e. cement bond logs)
    - Annular monitoring during hydraulic fracturing
    - Offset well monitoring during/after hydraulic fracturing

Session Outline

- Finding the drinking water resource (Williams)
- Well construction and integrity (Syed)
- Cement to isolate and hydraulic fracture (Tipton)
- Cement challenges (Badalamenti)
- Leaky wells (Ingraffea)
- Systems to verify barriers (op de Weegh)
- Field level isolation (Carey)
- Different well experiences (Hemenway)