

Hydraulic Fracturing Primer

Colorado Watershed Assembly

October 18, 2010



COGA



Colorado Watershed Assembly

Overview

- Brief hydraulic fracturing primer
- Regulatory overview
- Resources for further information

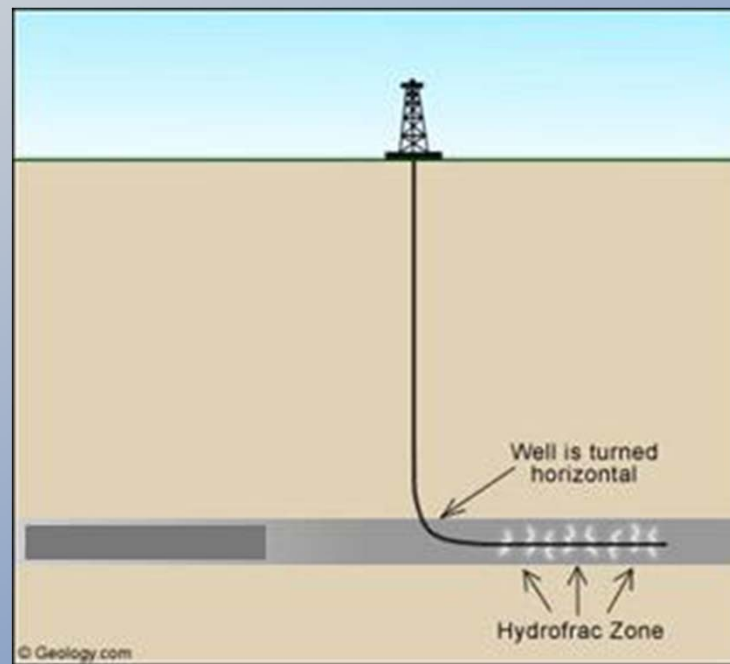


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Hydraulic Fracturing Primer



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Define: Hydraulic Fracturing

- The use of fluids to create a crack by hydraulic pressure
- The continued injection of fluids into the created crack fracture to make it grow larger
- The placement of small granular solids into the crack to ensure the crack remains open after the hydraulic pressure is no longer being applied



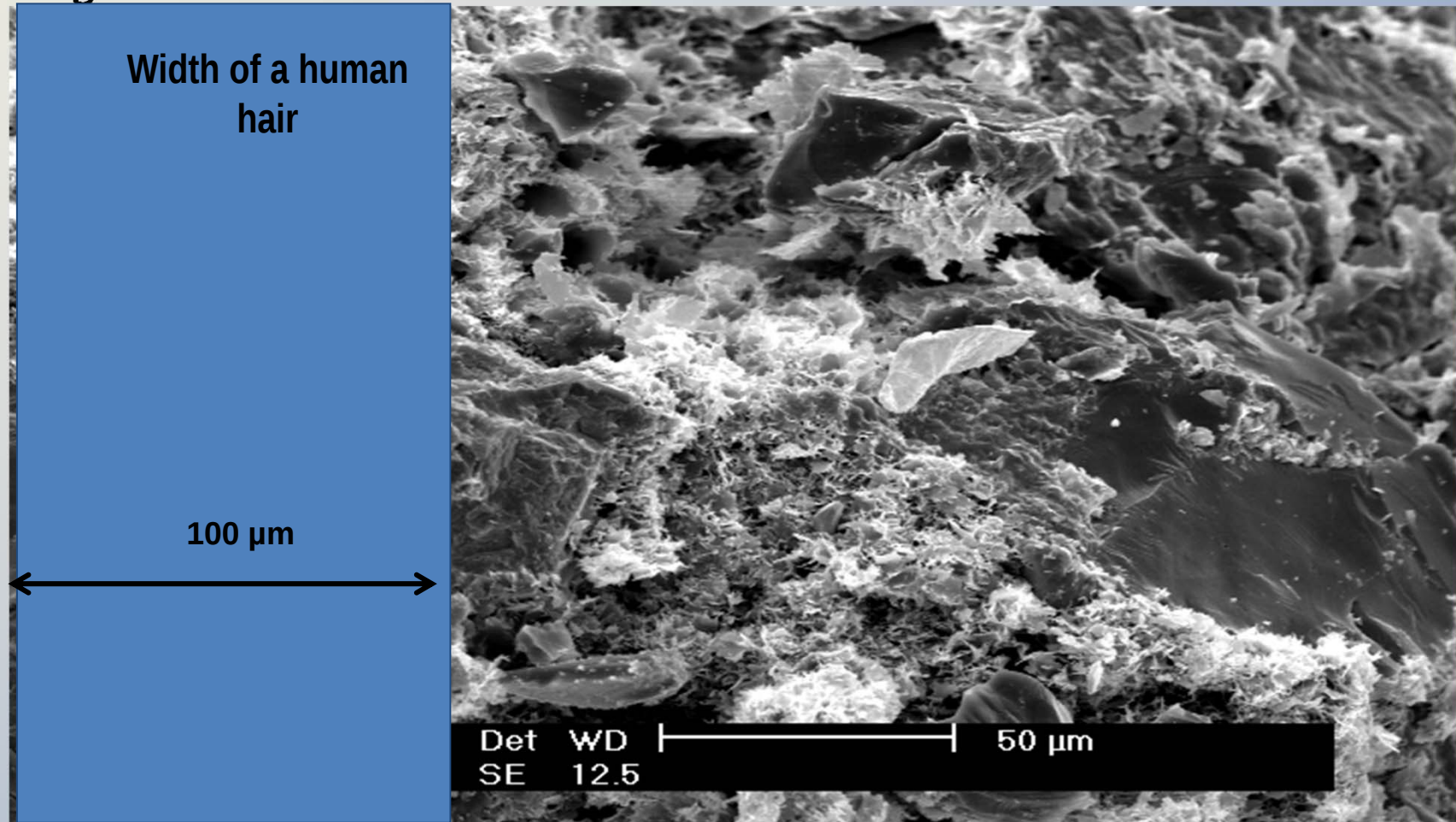
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Why H.F. a Well?

Electronic Microscope Image of Rock

Magnification: 1000X

Filename: S0178.tif



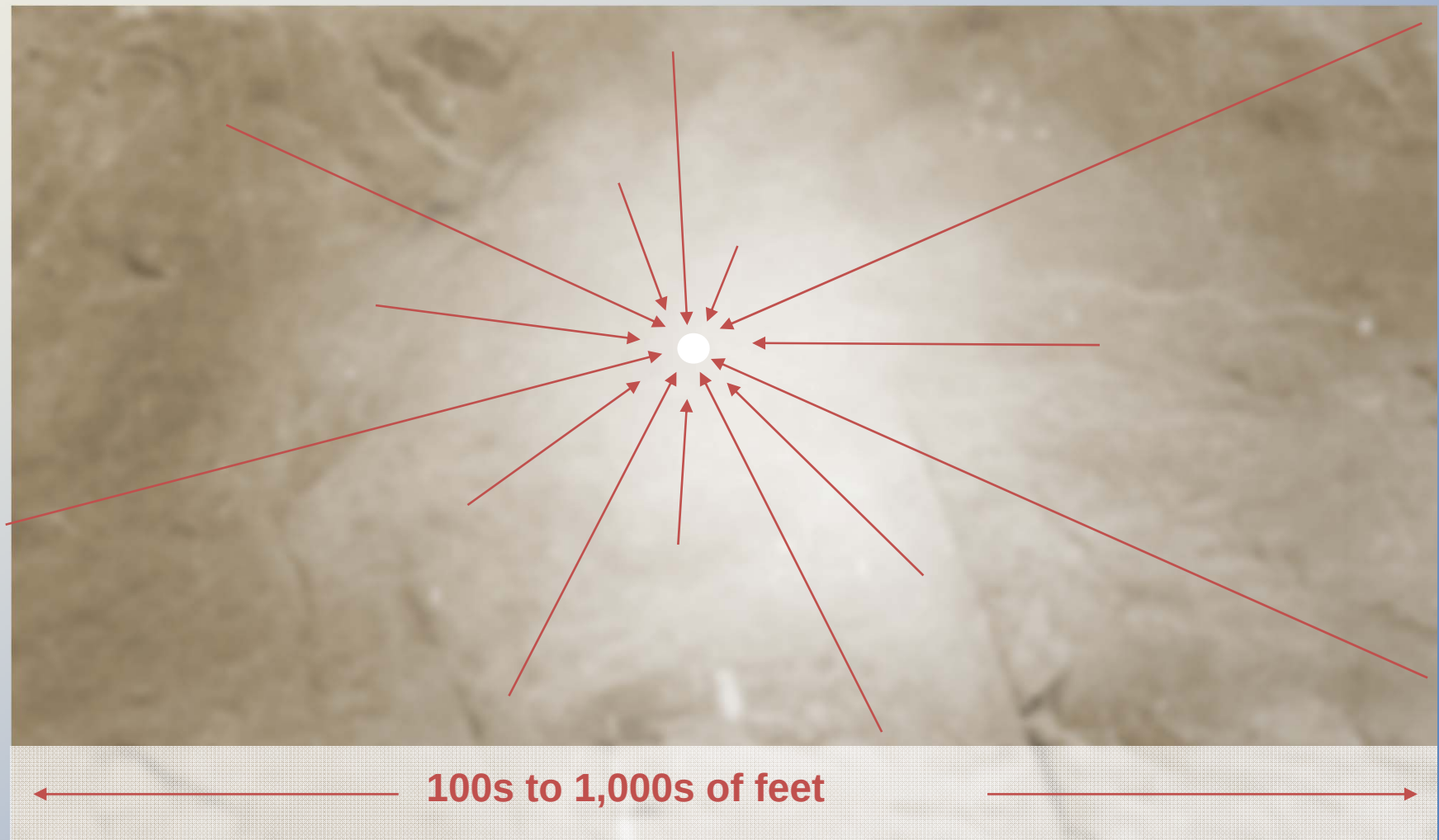
Why H.F. a Well?

- Increase the **Rate** at which the well is capable of producing oil or gas
- Most unconventional formations **Require** hydraulic fracturing to be economic
- Does not increase total reserves



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Matrix Flow Production

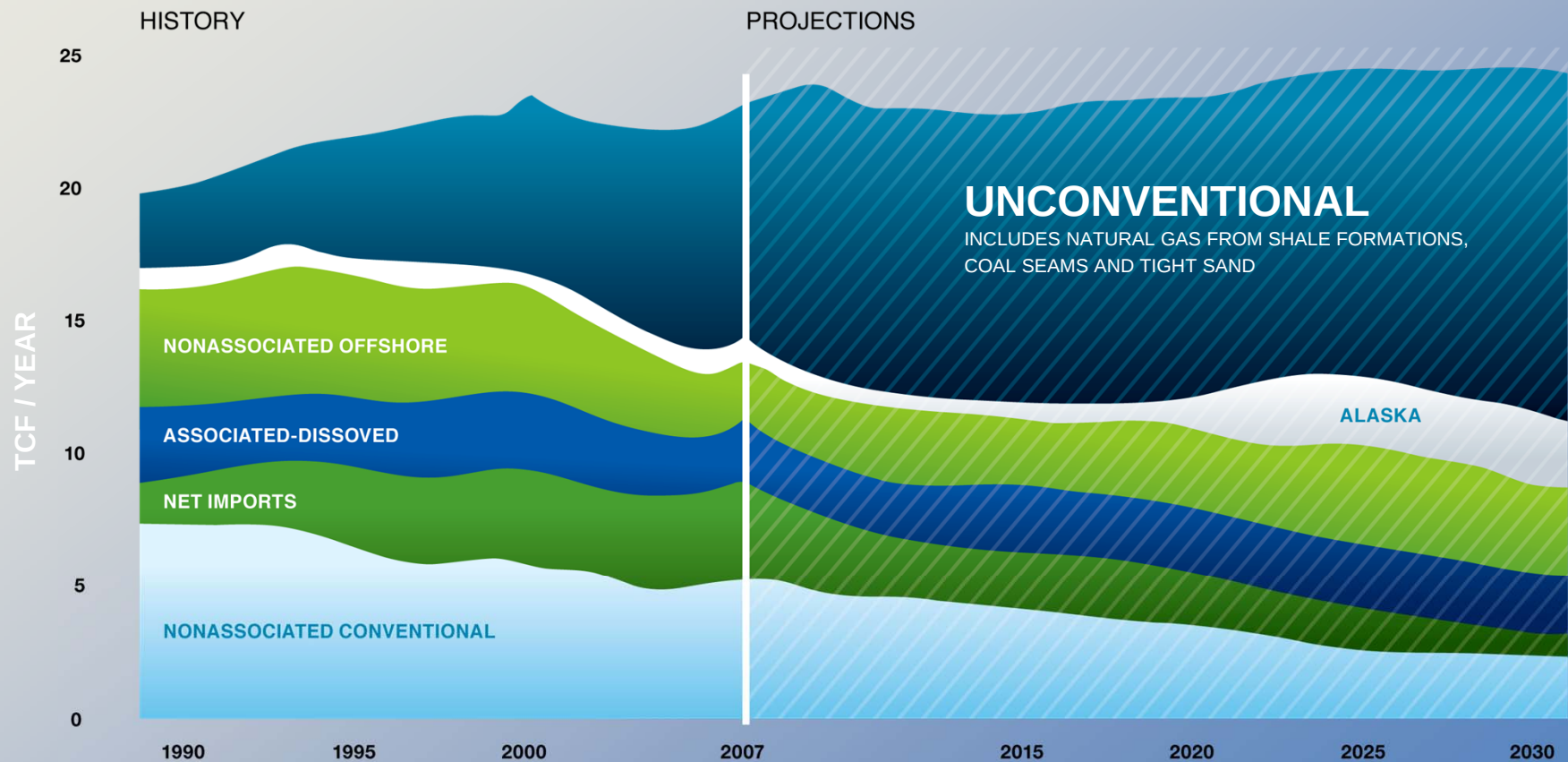


System



What and Why

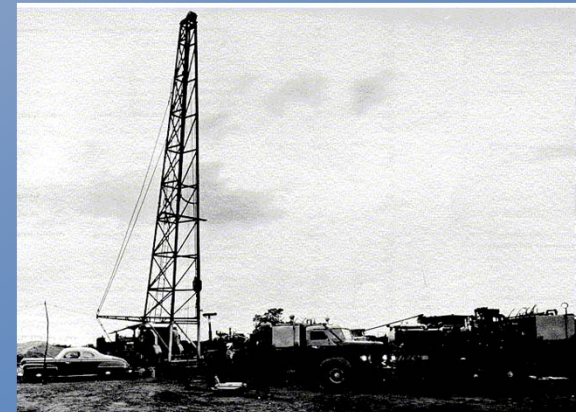
Total Natural Gas Supply by Source



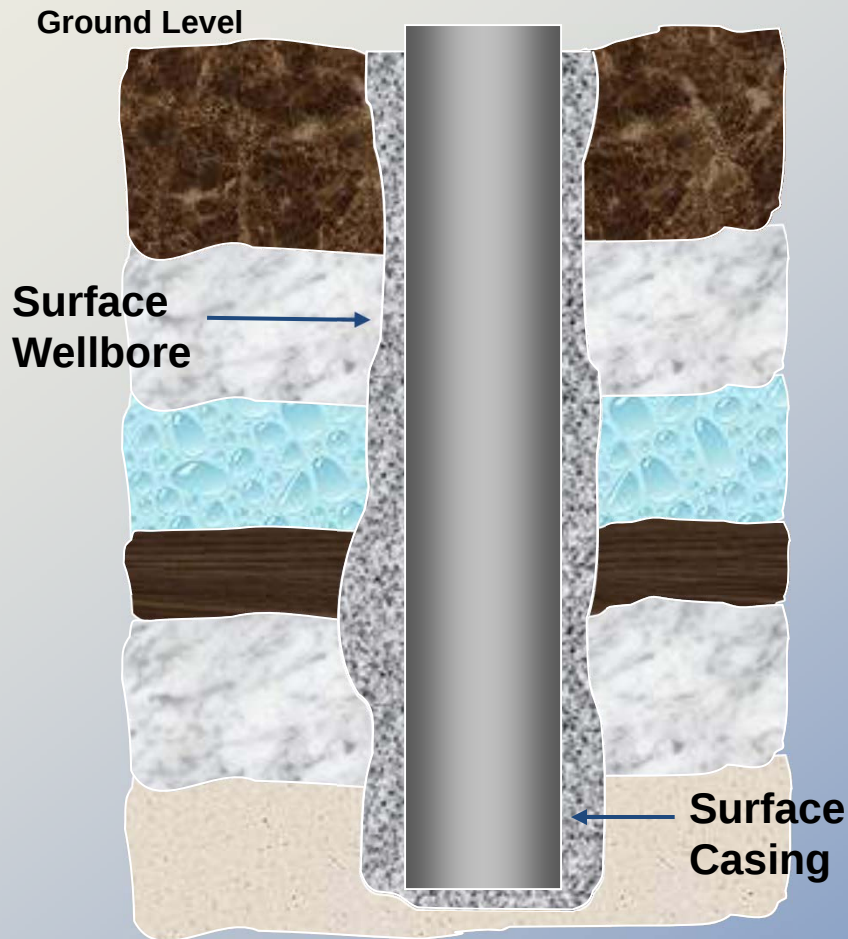
U.S. ENERGY INFORMATION ADMINISTRATION, *ENERGY OUTLOOK 2009*

Development of “HydraFrac” Process

- July of 1947 - Stanolind Oil and Gas
 - 1st Job: Klepper No. 1 gelled kerosene/gasoline mix
 - Hugoton Gas Field, Kansas
- Late 1948 - Patent issued, 23 wells H.F. before commercial application began
- In 1949, The Halliburton Oil Well Cementing Co. was granted an exclusive license to pump the new “Hydrafrac” process
 - 332 wells were treated first 12 months
 - 75% success rate

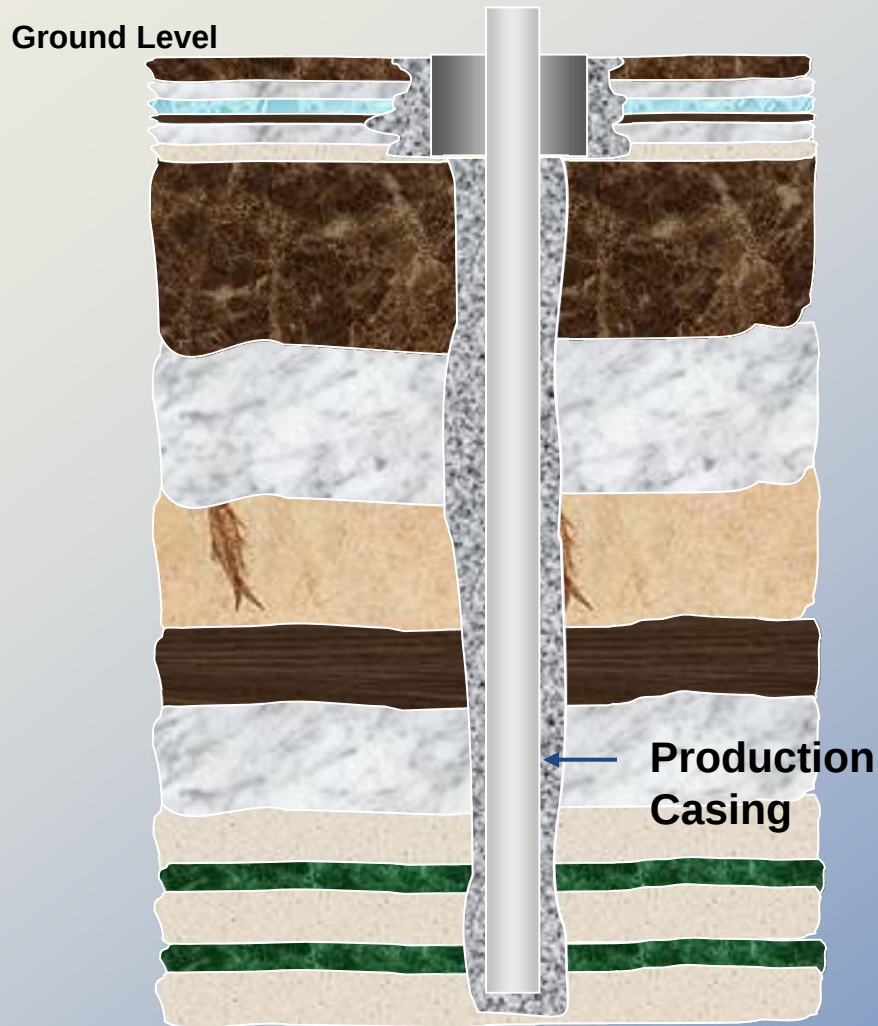


Typical Well – Surface Casing



- Purpose
 - Protect ground water
 - Provide stable wellbore during drilling operation
 - Provide well control during drilling
- Depth Requirements
 - Set by State and BLM regulations
 - 1,000 to 4,000 ft
- Cement Helps
 - Protect casing from corrosion
 - Provide zonal isolation
 - Support casing in wellbore

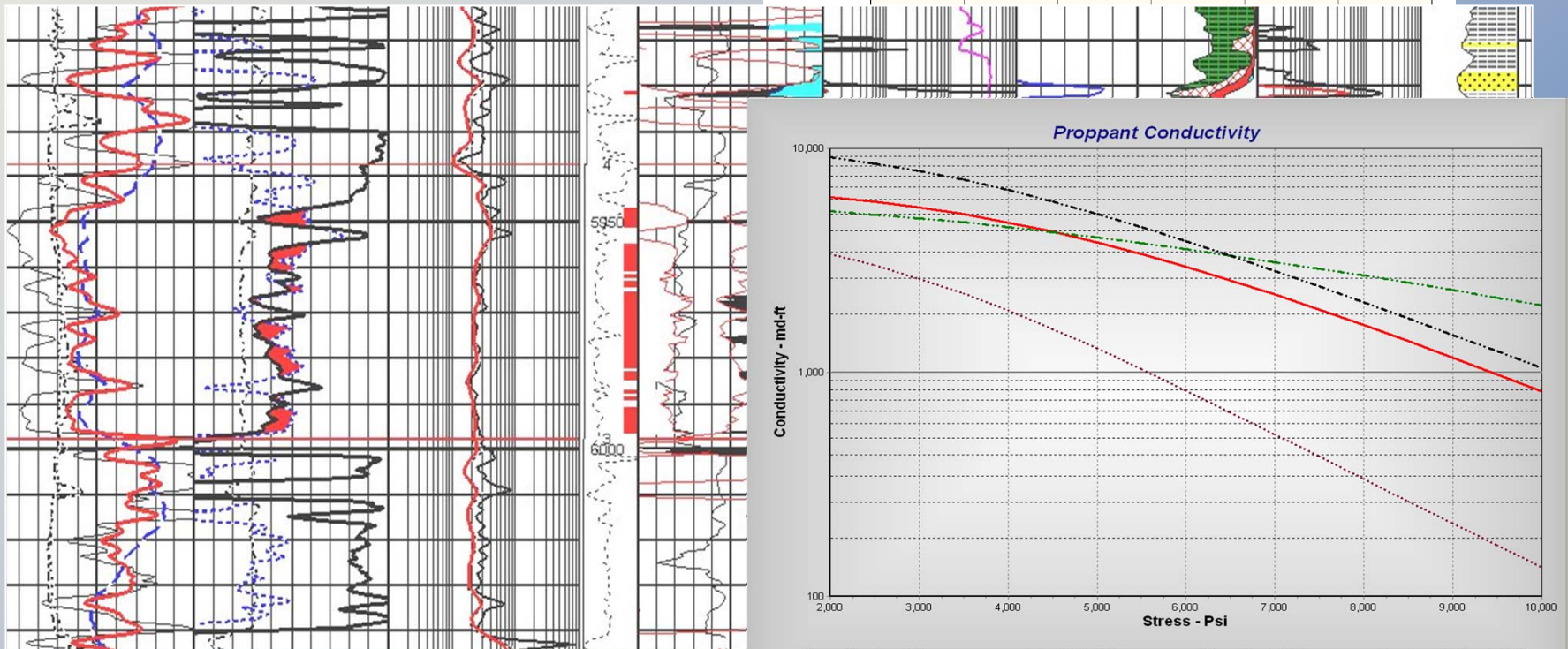
Typical Well – Production Casing



- Purpose
 - Provide zonal isolation
 - Provide well control
 - Well path to productive intervals
- Cement Requirements
 - Set by State regulations
 - Set by BLM regulations
 - Operator requirements
- Cement Helps
 - Protect casing from corrosion
 - Support casing in wellbore

Fracture Design

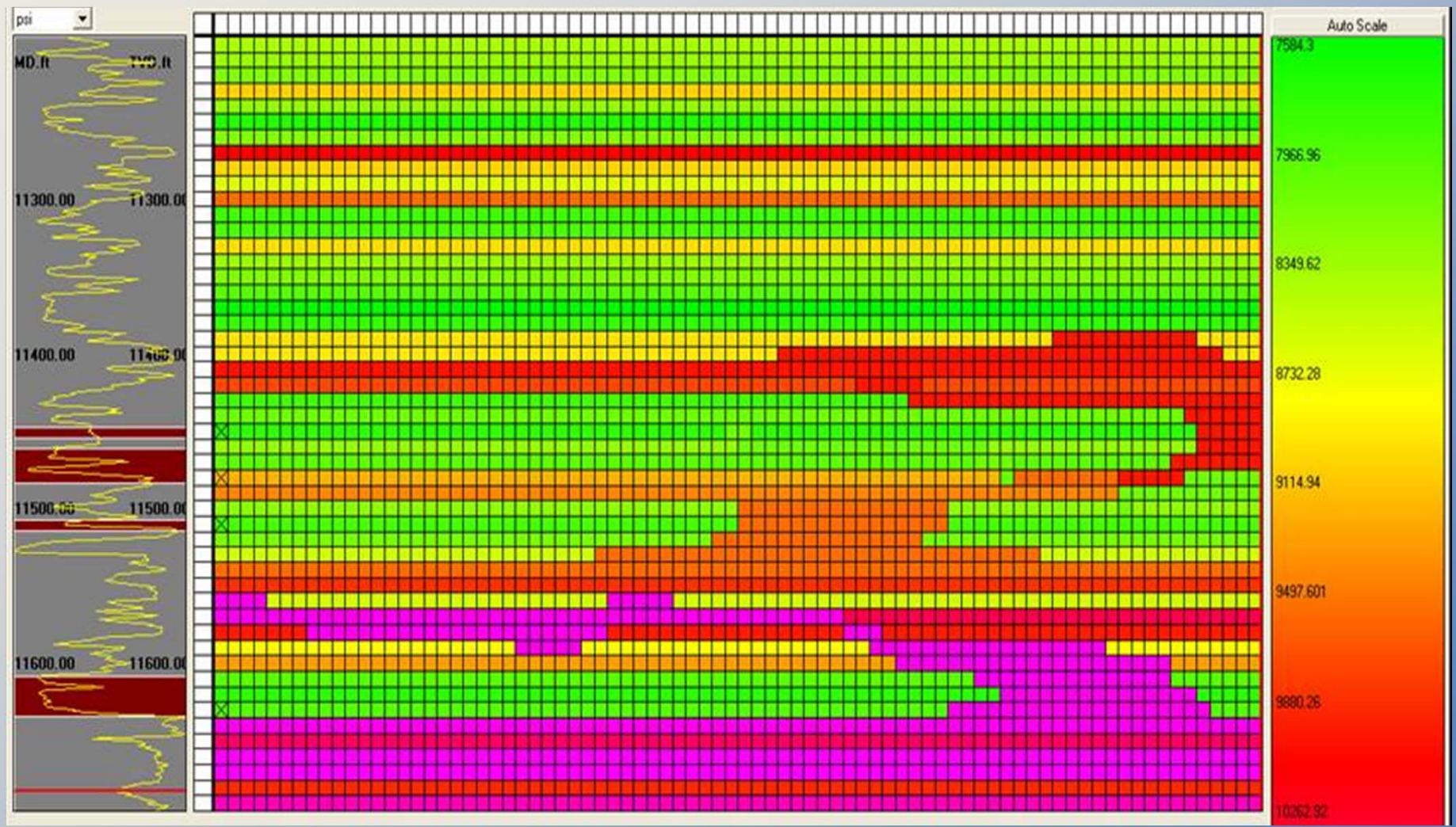
- Data Required
 - Petrophysics/Formation properties



- β , sg, size, CD

Predict-K
3.0

Frac Simulator Input – Total Stress

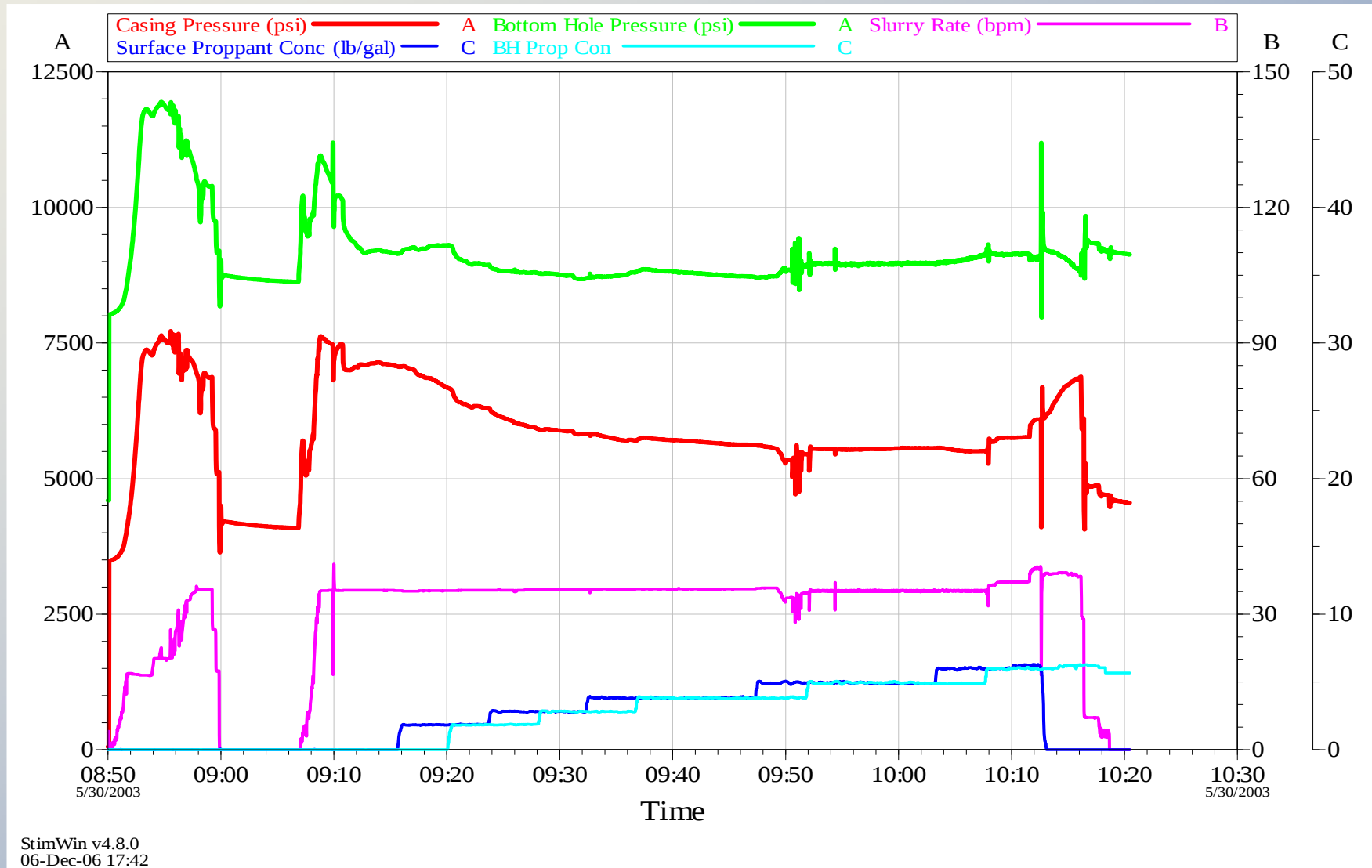


Pump Schedule

- A pump schedule is required for the simulator to determine the predicted fracture geometry
 - Fluid and proppant volumes
 - Treatment rate
 - Additive rates

Formation:		Corcoran		Date Pumped:						Sec. TS RW			
Stage	Fluid Schedule	Volume (gals)	Cumulative Volume (gals)	Proppant Type	Prop Conc (ppg)	Proppant Total (lbs)	Rate (bpm)	Stage Time h:min:sec	Total Time h:min:sec	FR-56 (gpt)	LP-65 (gpt)	GP 1000 (gpt)	Liqui Chlor (gpt)
1	Water Frac	7,000	7,000			0	60	0:02:47	0:25:40	1.00	0.44	1.00	1.00
2	Water Frac	5,000	12,000	30/50 Sand	0.50	2,500	60	0:02:02	0:22:53	1.00	0.44	1.00	1.00
3	Water Frac	6,500	18,500	30/50 Sand	0.75	4,875	60	0:02:40	0:20:51	1.00	0.44	1.00	1.00
4	Water Frac	12,500	31,000	30/50 Sand	1.00	12,500	60	0:05:11	0:18:11	1.00	0.44	1.00	1.00
5	Water Frac	13,100	44,100	30/50 Sand	1.50	19,650	60	0:05:33	0:13:00	1.00	0.44	1.00	1.00
6	Water Frac	6,300	50,400	30/50 Sand	2.00	12,600	60	0:02:44	0:07:27	1.00	0.44	1.00	1.00
7	Water Frac	4,800	55,200	30/50 Sand	2.25	10,800	60	0:02:06	0:04:44	1.00	0.44	1.00	1.00
8	Water Frac	2,300	57,500	30/50 Sand	2.50	5,750	60	0:01:01	0:02:38	1.00	0.44	1.00	1.00
9	Water	4,068	61,568			0	60	0:01:37	0:01:37	1.00	0.44		1.00
Totals		61,568				68,675							

The Frac – Treatment Graph



Frac Fluids

- Depending on the fluid system being pumped various additives are used:
 - Polymers
 - Crosslinkers
 - pH Control
 - Gel Breakers
 - Surfactants
 - Clay Control
 - Bacteria Control
 - Fluid Loss Additives
- Additives are transported in concentrated form
- Typically injected at less than 3 gallons per 1,000 gal of water (0.3%)
- All additive injection rates are controlled.
- The purpose of any additive is to help improve the overall process



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What Happens to the Fluids?

- Much of it is recovered during flowback - amount depends on:
 - Formation characteristics
 - Type of fluid being pumped
- Fluid that does not flow out of well is trapped in the hydrocarbon bearing formation
- There is a reason that gas and oil are still in the hydrocarbon bearing formation after millions of years



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Treatment Control Center



COLORADO REGULATIONS



Colorado Oil and Gas Conservation Commission

- Groundwater complaints
 - Hundreds of complaints
 - No verified instances of hydraulic fracturing harming groundwater in Colorado
- Water sampling
 - Since 2000, baseline and periodic water sampling for over 2,000 water wells in the San Juan Basin
 - Independently verified; no significant increase in chemical concentrations



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- Rule 205 – Disclosure of Chemicals
- Rule 317 – General Drilling Rules
- Rule 317B – Drinking Water Protection
- Rule 318A – Greater Wattenberg Area
- Rule 341 – Bradenhead Monitoring
- Rule 608 – CBM Baseline Sampling
- Rules 903, 904, and 905 - Updated Pit Rules
- Rule 906 - Spill Notification



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- Rule 205 – Disclosure of Chemicals
 - Inventory chemicals at drilling sites for use downhole
 - Available to agency officials promptly upon request
 - Available to health officials with confidentiality requirements
- Rule 317 - General Drilling Rules
 - Run a cement bond log on all production casing to confirm that aquifers are protected



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- Rule 317B – Drinking Water Protection
 - Near surface waters and tributaries that are sources of public drinking water
 - Mandatory setbacks
 - Enhanced environmental precautions
- Rule 318A - Greater Wattenberg Area
 - DJ Basin
 - Sample water wells before drilling



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- Rule 341 – Bradenhead Monitoring
 - Objective: confine stimulation fluids to the objective formations
 - During stimulation, bradenhead annulus pressure continuously monitored
 - If pressure increases above 200 psig, verbal notification and reporting requirements
 - All well stimulation record kept for at least 5 years



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- Rule 608 – CBM Baseline Sampling
 - Coalbed methane operators
 - Pressure test wells
 - Sample nearby water wells before, during, and after operations
- Rules 903, 904, and 905 - Updated Pit Rules
 - Enhanced requirements for pit permitting, lining, monitoring and containment



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- Rule 906 - Spill Notification
 - Promptly report any spills that threaten waters
 - Commission, Environmental Release/Incident Report Hotline, and landowner



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Resources at coga.org

- Hydraulic Fracturing Fact Sheet
- COGA's The Truth About *Gasland*
- Other Fact Sheets
 - Natural Gas Facts
 - Socioeconomic Benefits
 - Environmental Benefits
 - Natural Gas Supply
- Candidate Education Packet

www.coga.org



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Questions?

*Thank you for your interest in
Colorado's natural gas industry!*



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