Reduced Emission (Green) Completion in Low Energy Reservoirs

BP America Production Company

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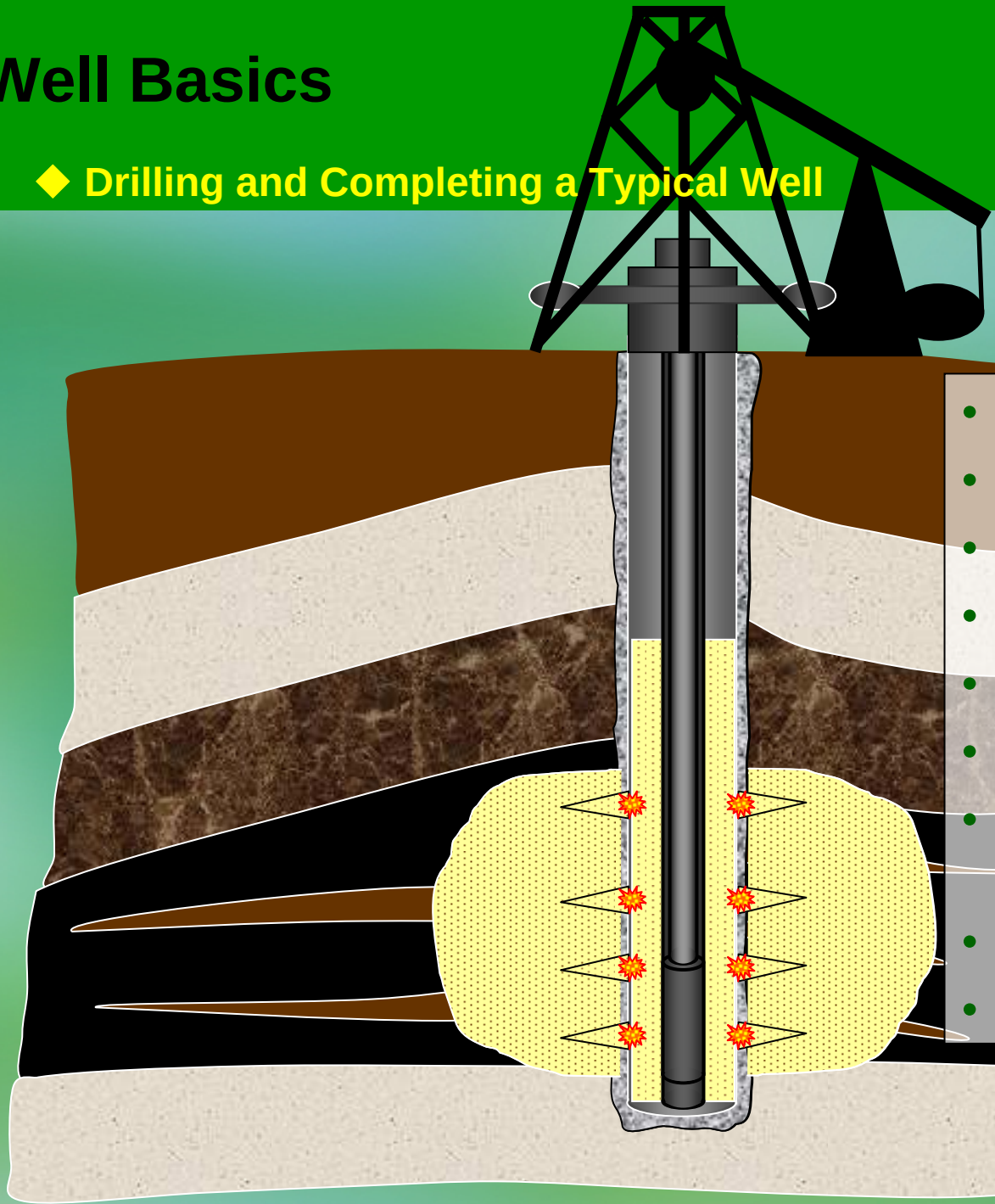
Well Basics

- Drilling and Completing a Typical Well



- Move in, rig up drilling rig
- Drill well
- Run casing
- Cement casing
- Perforate casing
- Frac formation
- Cleanout wellbore and formation
- Install wellhead
- Put well on production

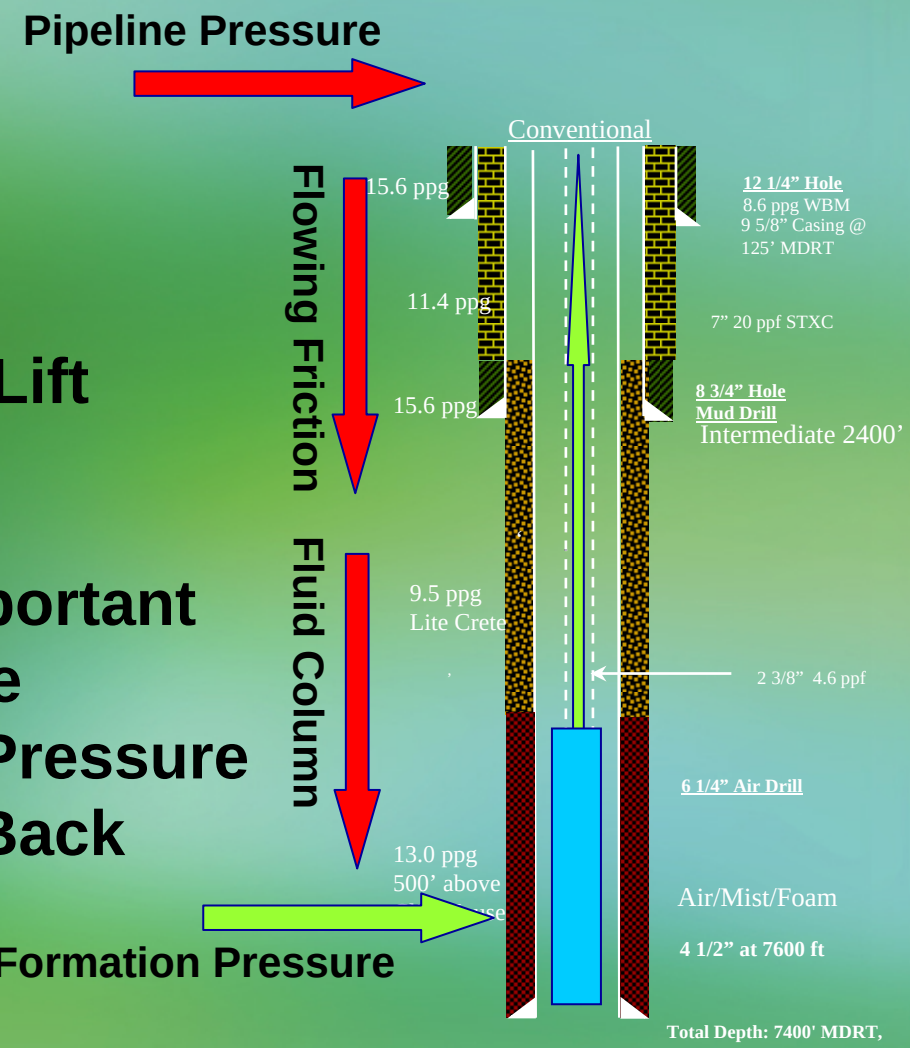
Well Clean Out

Well Flow:

- Depends on Delta P
- Flow Rate is a f of Delta P
- Rate Determines Velocity
- Velocity Determines Fluid Lift

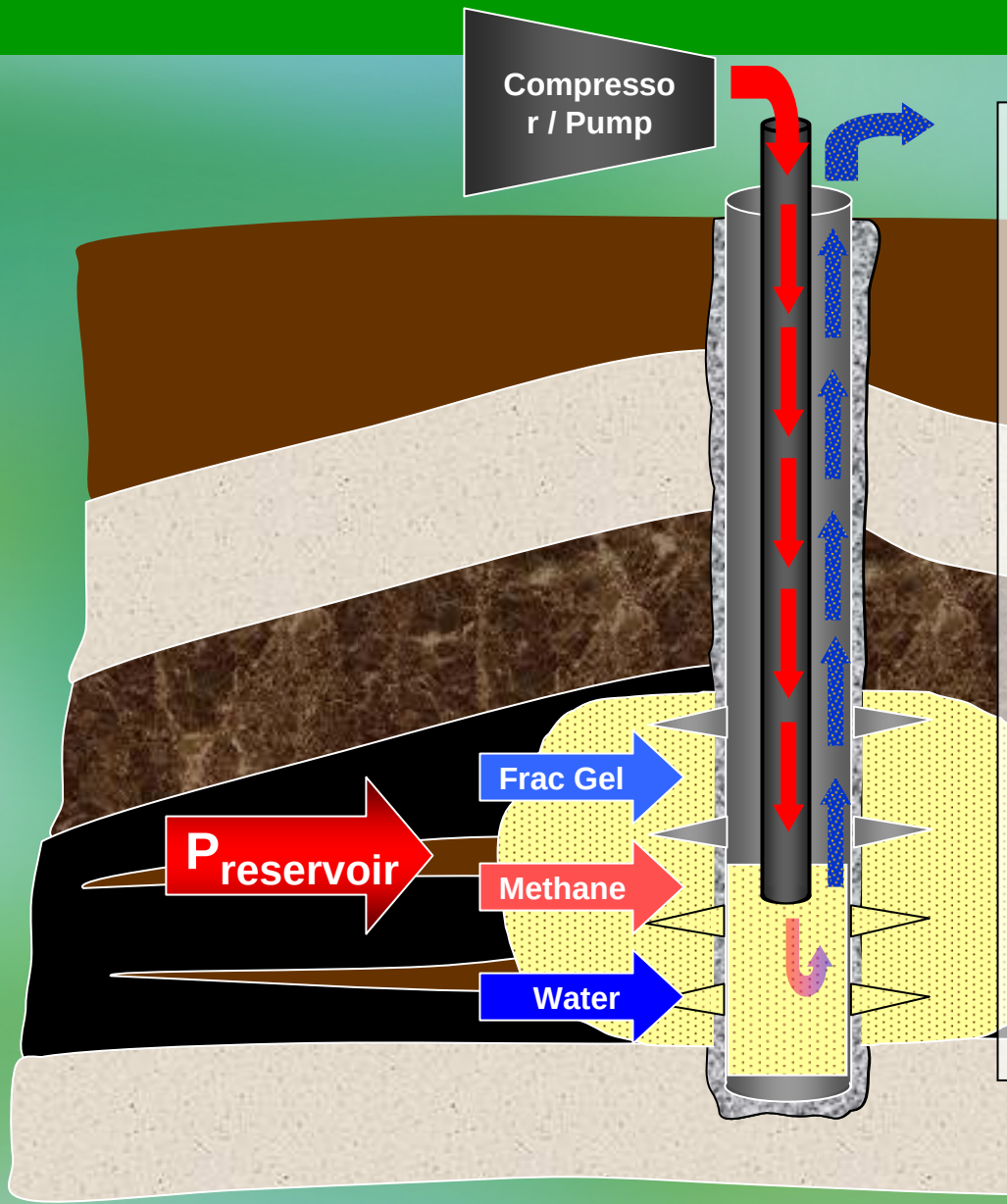
Formations:

- Recovery of Frac Fluids Important
- Formation Pressure Must be Greater Than Sum of Back Pressure
- "Green Completion" Adds Back Pressure



Basics of Low Energy Reservoir Post-frac Cleanouts

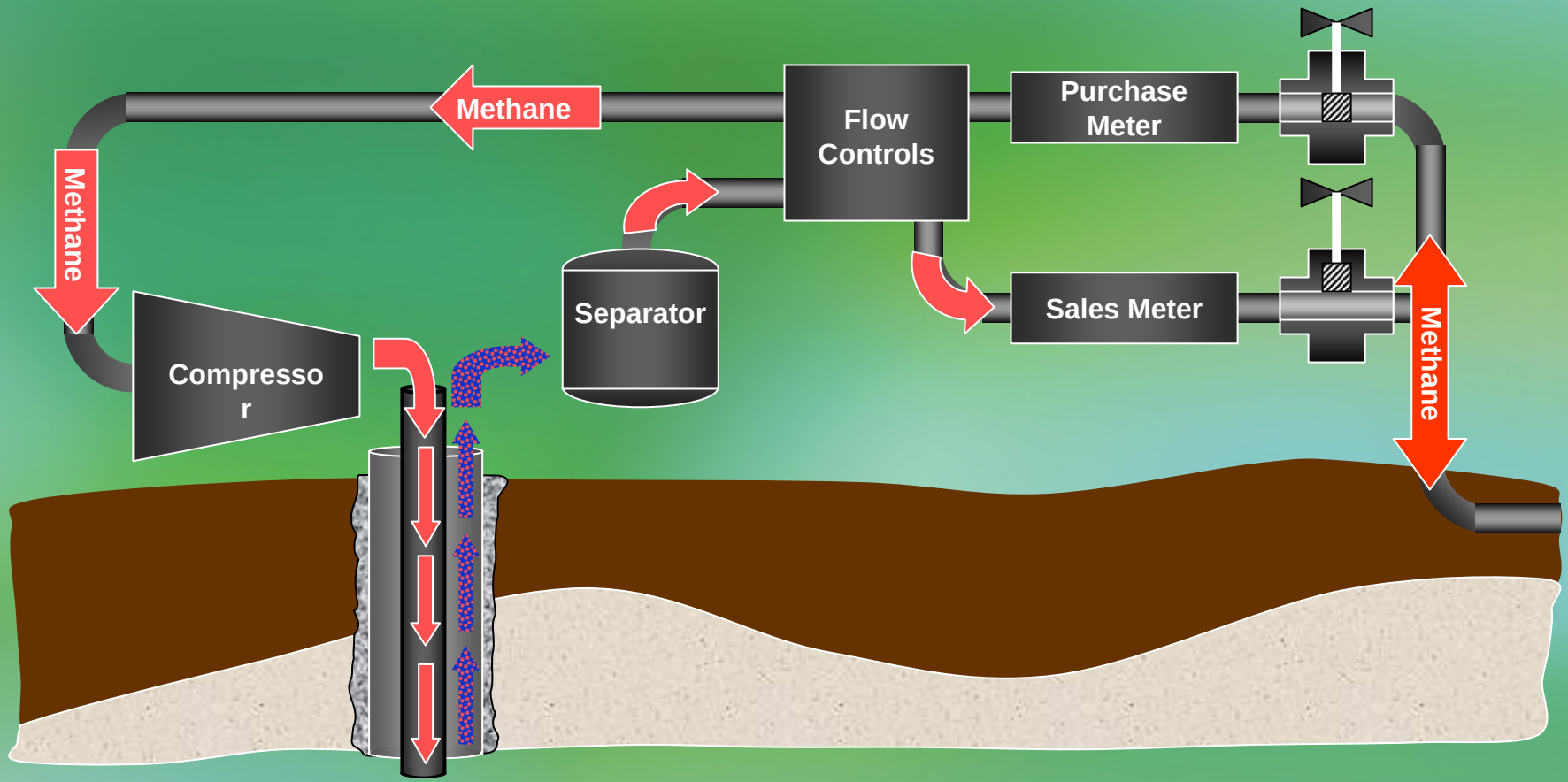
◆ Underbalanced Cleanouts



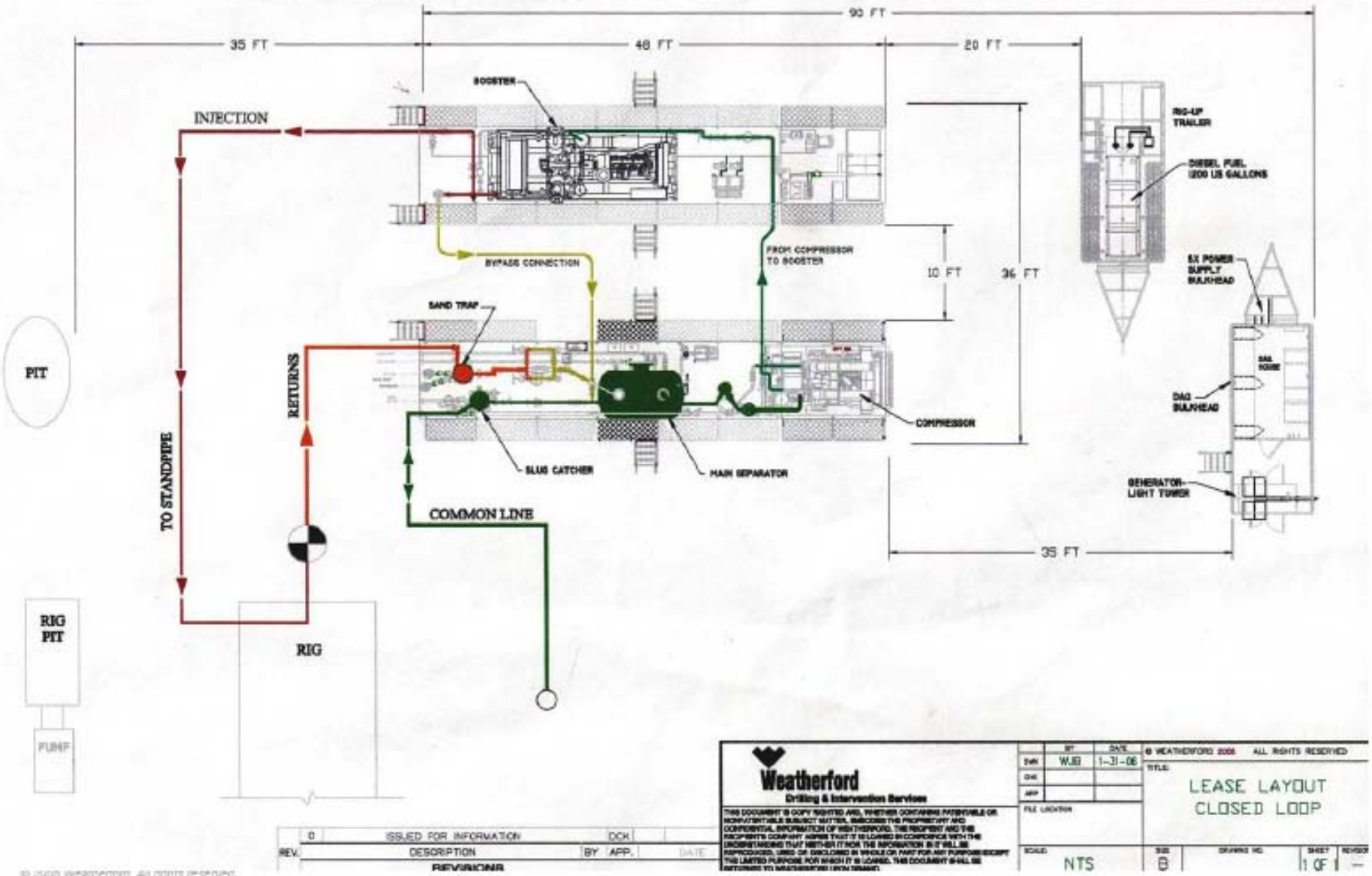
- Compressor / pump is used to pump high-pressure fluid down the wellbore to wash the frac sand out.
- Tubing is run into the wellbore to provide separate paths for the fluid entering the wellbore and the fluid / sand leaving the wellbore.
- Fluid used can be a gas (air, nitrogen, natural gas) or a liquid (water).
- Using a gas results in an “underbalanced” situation (pressure in the wellbore is less than reservoir pressure).
- Consequently, fluid (frac gel, water and natural gas) will flow from the reservoir into the wellbore and then out of the well.

Basics of Post-frac “Green” Cleanouts

- Must have:
  - Pipeline for sales gas and initial fuel/injection gas
- Eventually, the well begins making gas and the excess can be sold back to the pipeline.



“Green” Completion Layout



“Green” Completion Unit

Basics of Post-frac “Green” Cleanouts

◆ “Green” Cleanouts – Pros and Cons

Pros

- Reduce GHG emissions
- Sell gas instead of venting / flaring
- No visible flares
- Safer (no mixing of air and methane)

Cons

- Must have an operational pipeline
- Requires a great deal of specialized equipment
- Expensive
- Cleanouts not as effective (back-pressure from the pipeline)
- Cost of “green” completion unit - approximately 30% more than a conventional air cleanout unit
- Value of gas sold - roughly equal to the additional cost