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OIL AND NATURAL GAS IN COLORADO

Erik Anglund, Rockies Water Manager



ERIK ANGLUND – ROCKIES WATER TEAM MANAGER

- **FARMER** – Lifelong Longmont area family operations
- **STUDENT** – Mechanical, agricultural, civil & petroleum engineering
- **ENGINEER** – Water supply, quality, conservation, recycling, regulations
- **FATHER** – Family, school, sports, 4H
- **EXPLORER** – Rockies region camping, hunting, hiking, skiing, climbing

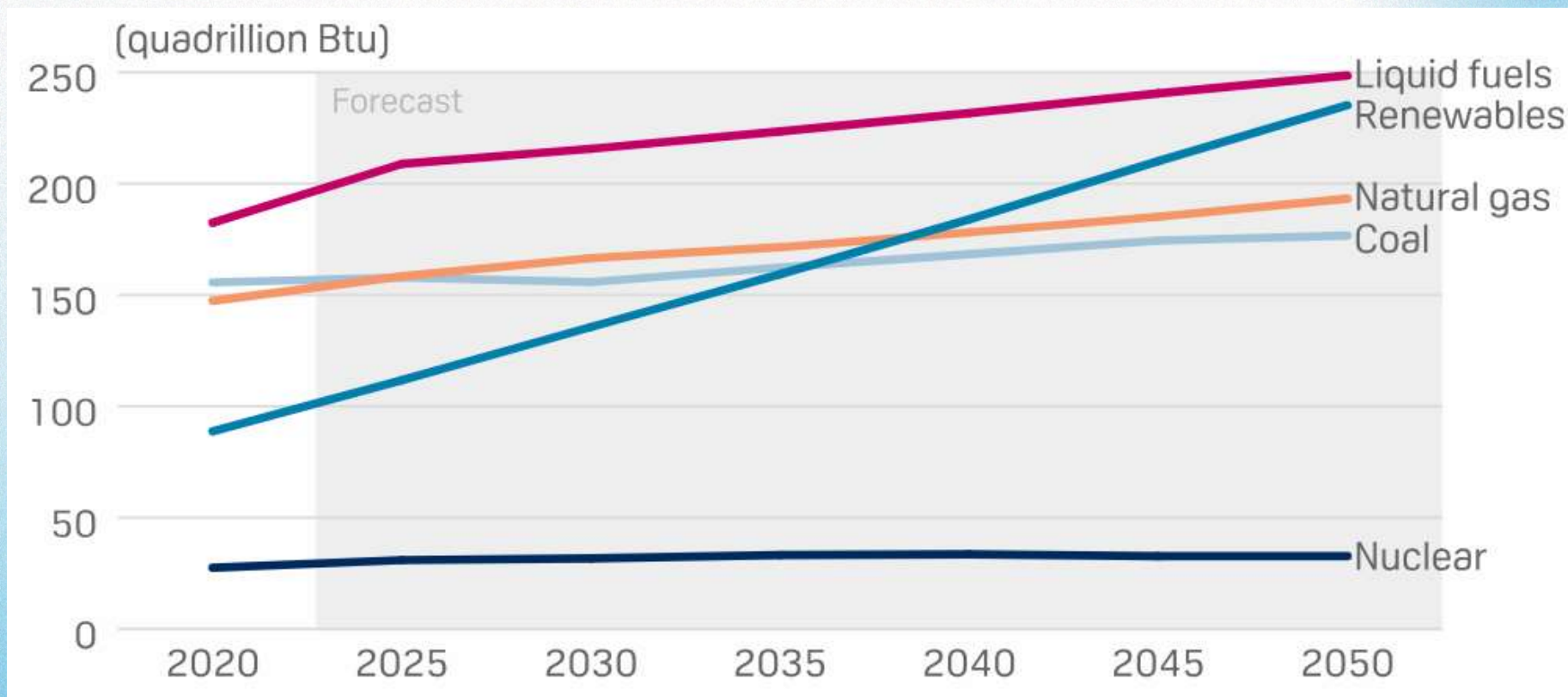


**OIL & NATURAL
GAS ARE
FUNDAMENTAL
FOR MODERN
LIFE**



GLOBAL PRIMARY ENERGY CONSUMPTION SOURCES (2020-2050)

Quadrillion British thermal units



SOURCE: U.S. ENERGY INFORMATION ADMINISTRATION



HOW DO WE PRODUCE OIL & NATURAL GAS?

DRILLING

5-8 days



HYDRAULIC FRACTURING

5-8 days

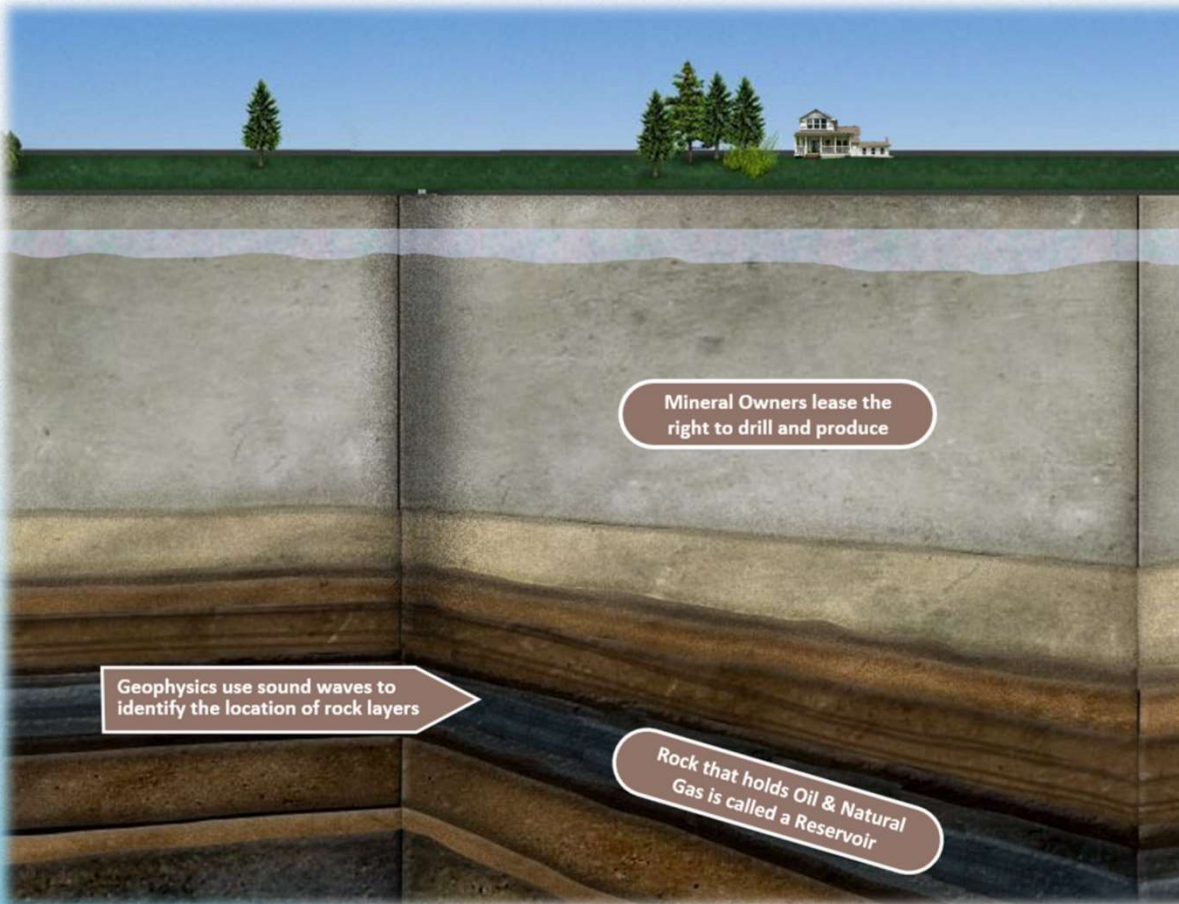


PRODUCING WELL

20+ years

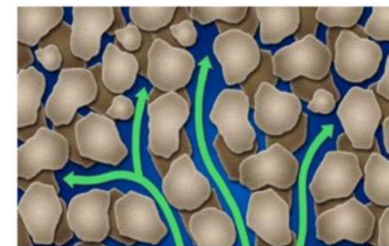


PLANNING HORIZONTAL WELLS



Geologists Study Rock Properties

Porosity: pores are microscopic holes in rock



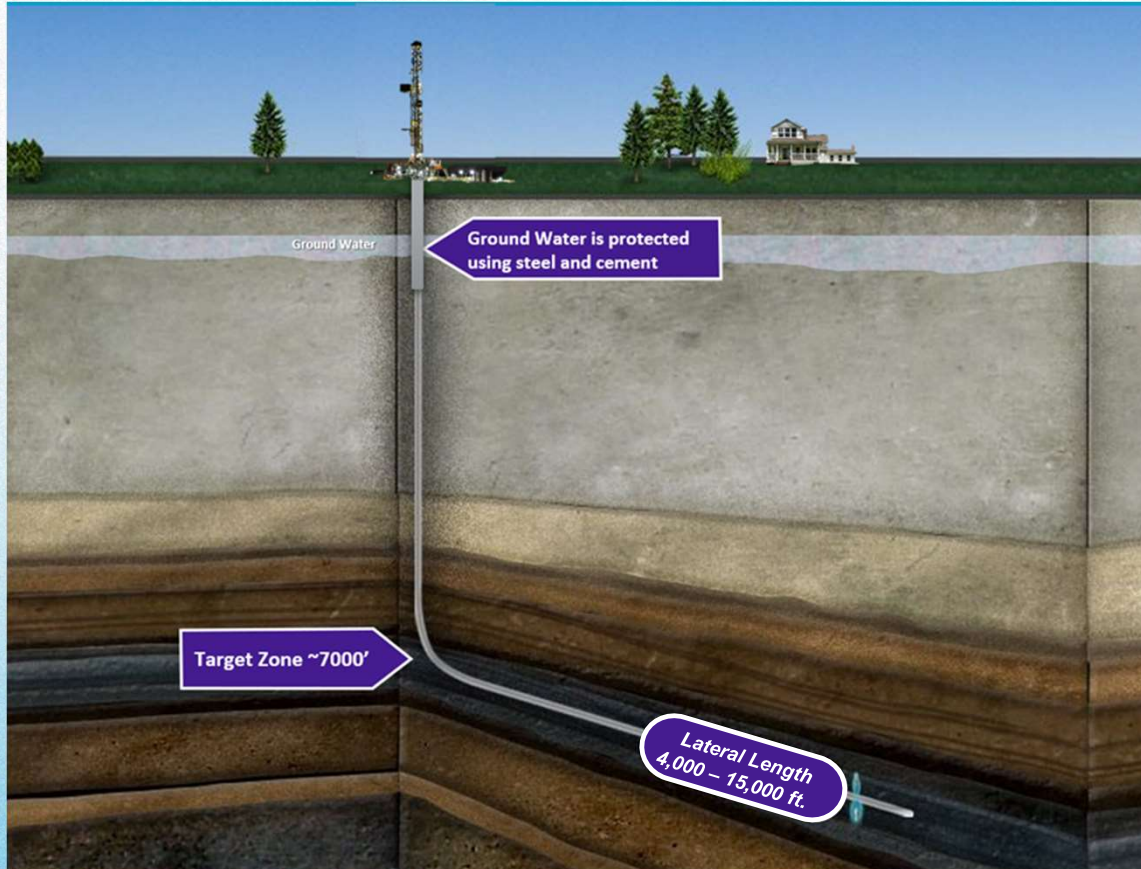
Permeability: passageways between the pores

Source: Plants and animals, like Plankton

With heat, pressure, and time organic matter becomes oil and natural gas

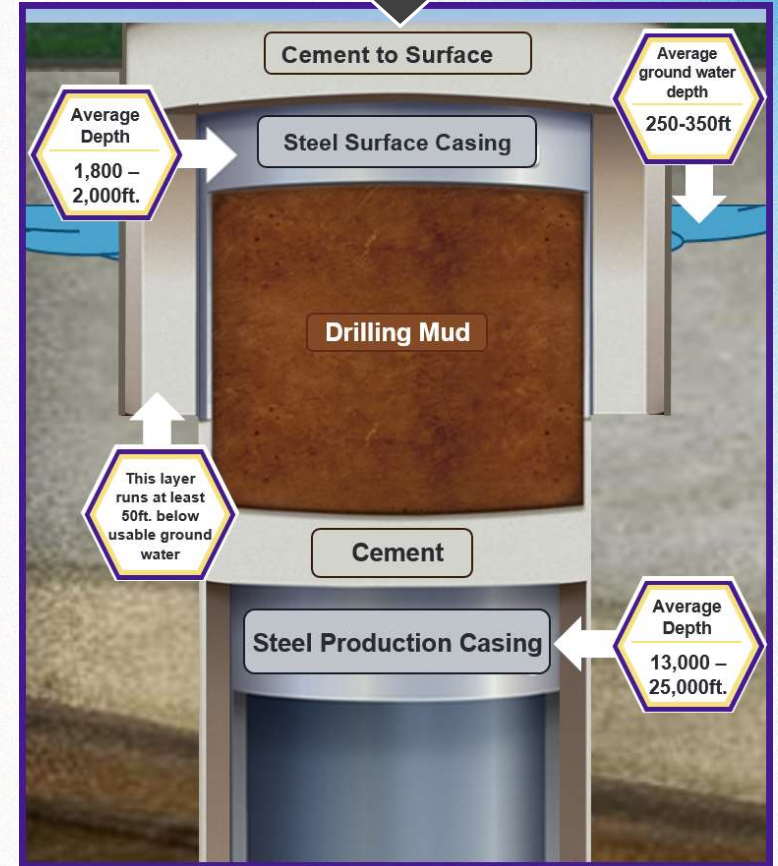


DRILLING HORIZONTAL WELLS

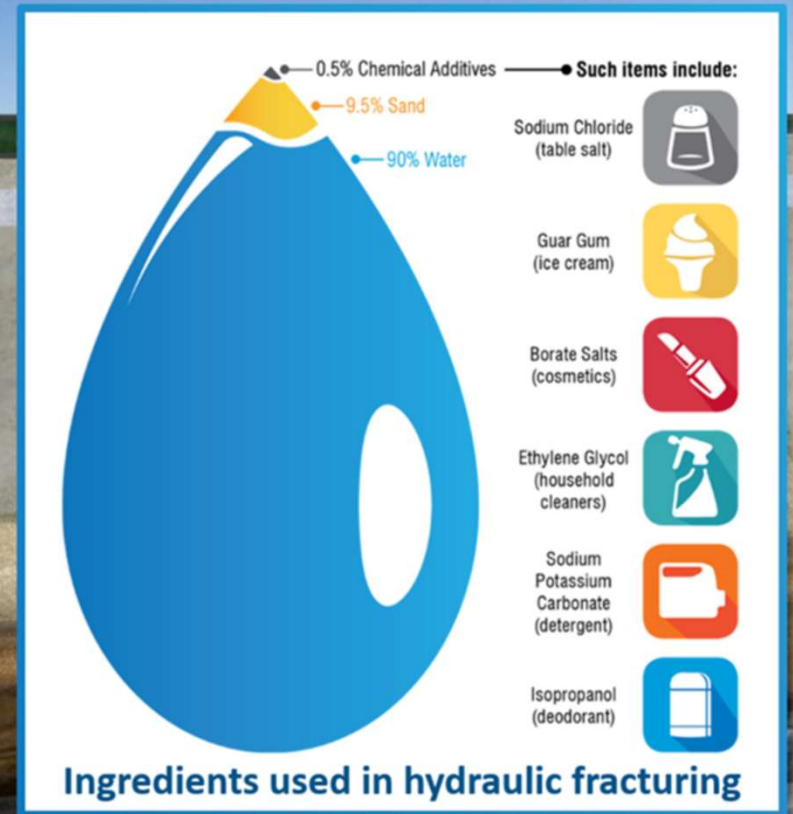
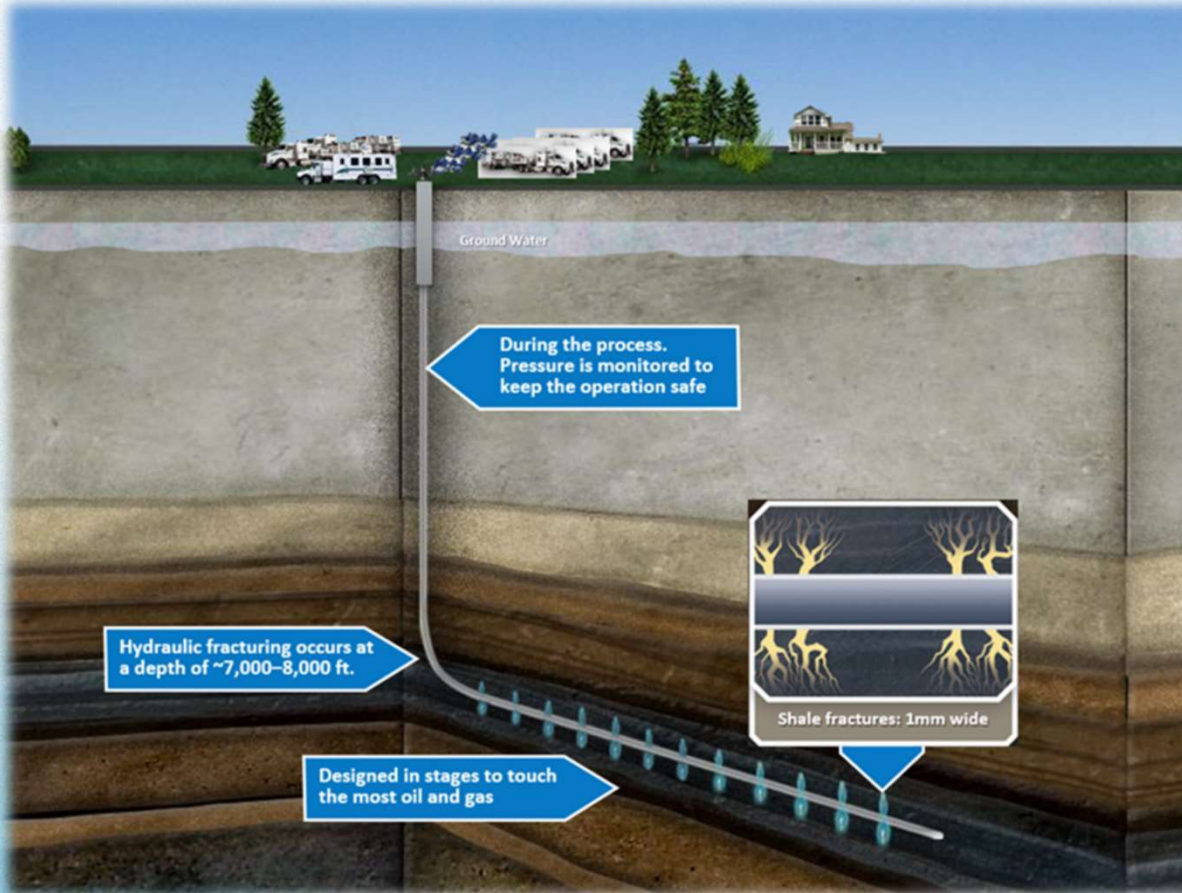


Proper Well Construction Protects Groundwater

An Example of a Typical Well Design



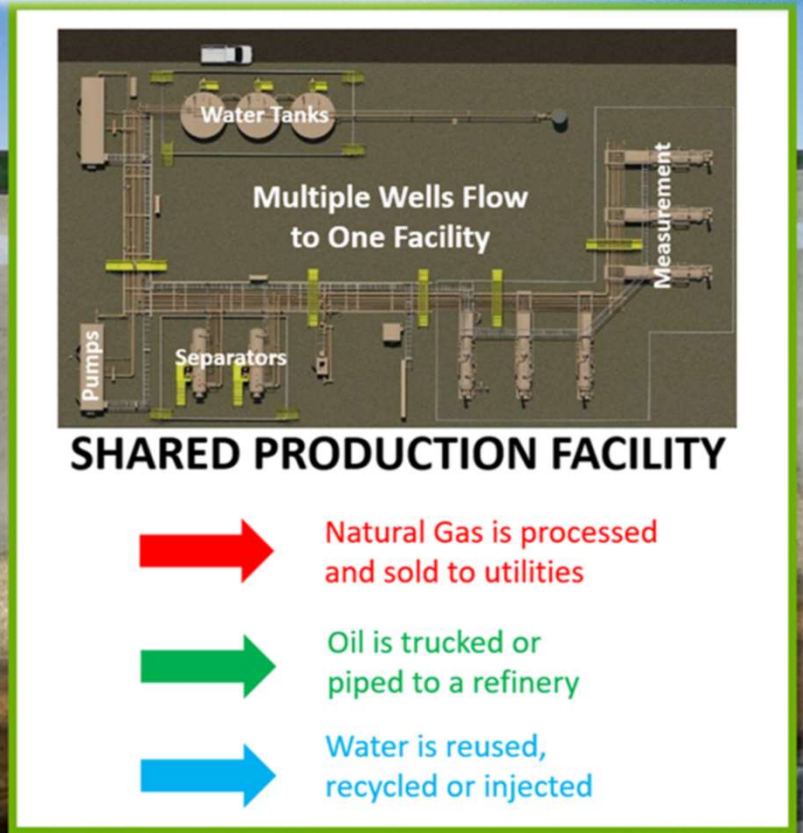
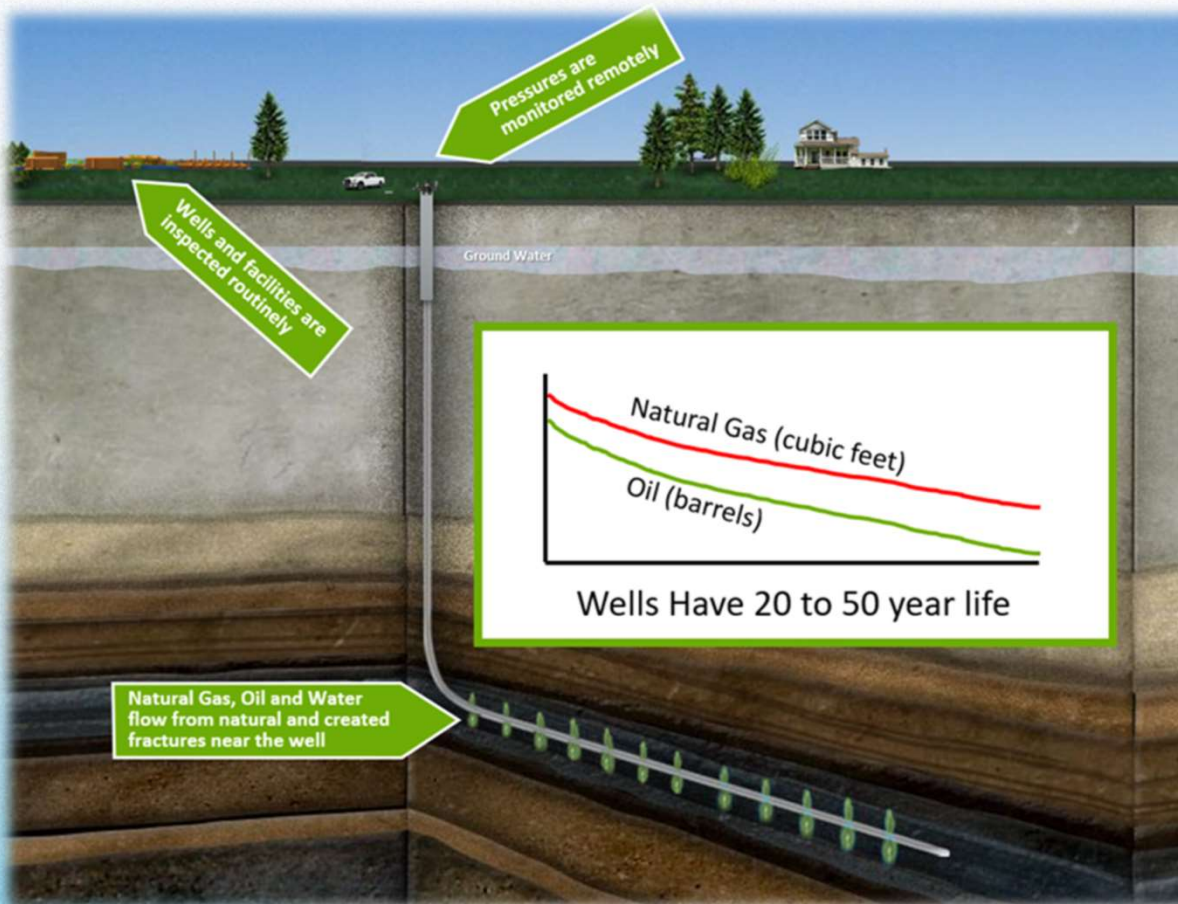
HYDRAULIC FRACTURING WELLS



SOURCE: FRACFOCUS, [WHAT IS FRACTURING FLUID MADE OF?](#)



PRODUCING WELLS



WATER-ENERGY NEXUS

The water-energy nexus

It takes water to produce energy



Nuclear power plant:
75,000–450,000 liters/MWh



Natural gas:
570–1,100 liters/MWh



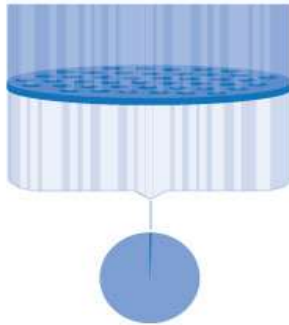
Wind and solar photovoltaic:
2–100 liters/MWh

Unconventional production:
Use 100–10,000 times more water than conventional production.



It takes energy to produce drinkable water

Desalination: The process that removes salt and minerals from sea water, is a heat energy and electricity intensive process.



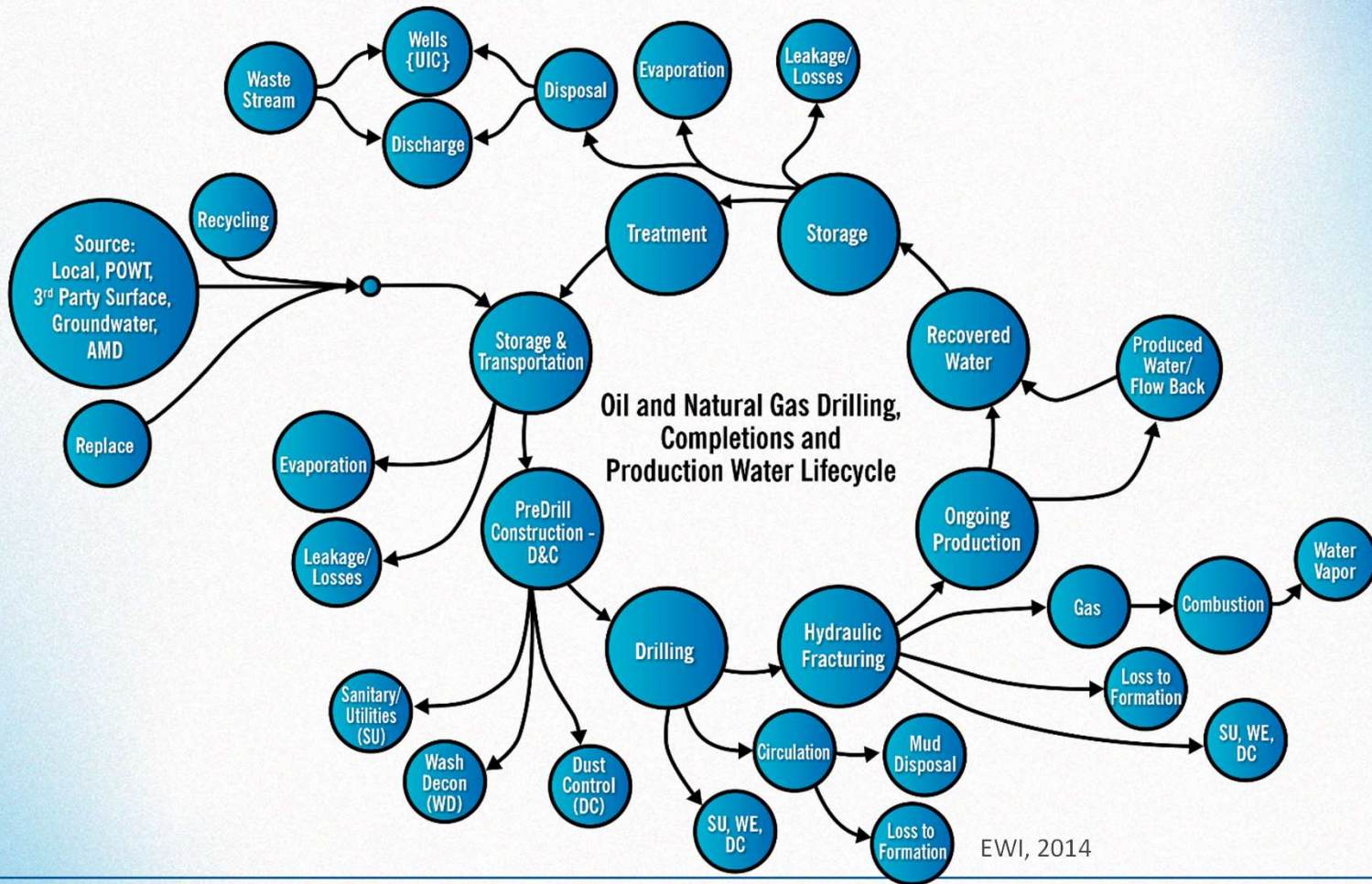
Desalination produces **24 billion cubic meters** of drinkable water yearly or 0.6% of global water supply.

Sources: IEA World Energy Outlook 2012, IRENA Desalination technology brief (2012)

- Energy and water considerations
- State priority
 - Groundwater Protection Council (GWPC)
 - Interstate Oil and Gas Council (IOGCC)
 - Texas, Colorado, Utah, Wyoming
- Federal priority
 - Funding
 - Regulations that impede the use of water
- Industry priority
 - Energy Water Initiative (22 companies)
 - Water treatment technologies
 - Water infrastructure



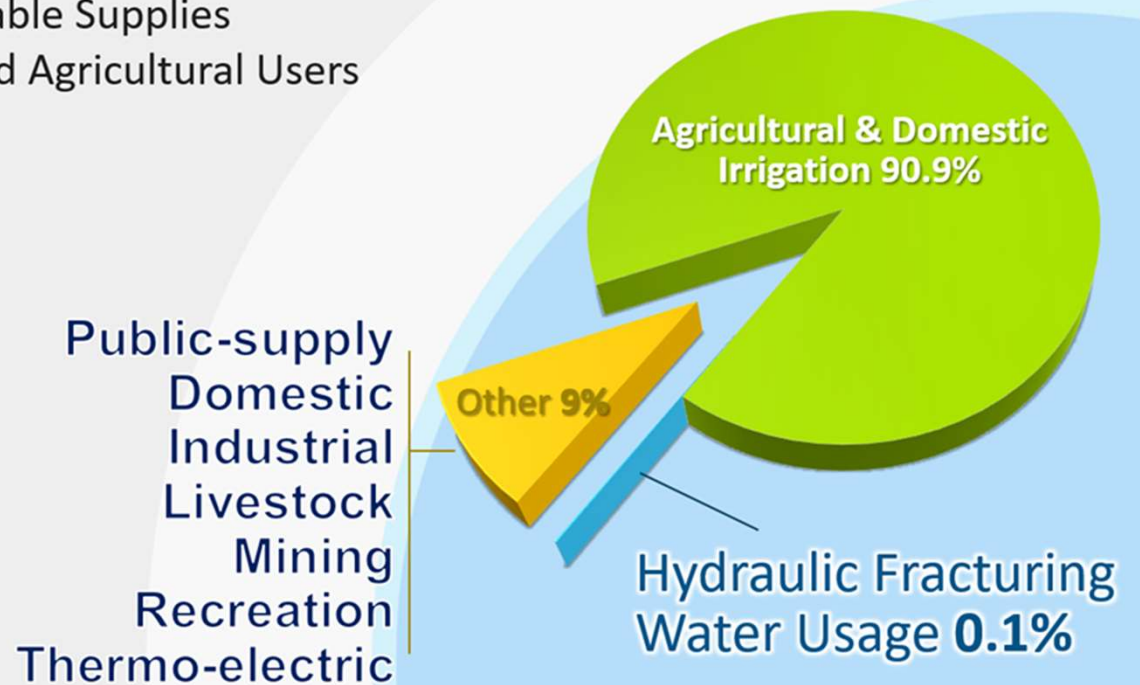
LIFE CYCLE OF WATER IN UPSTREAM OPERATIONS



RESPONSIBLY MANAGING WATER

Our Approach to Water Sourcing in Colorado

- **Non-Potable** Supplies (Effluent)
- **Commercial and Industrial** Water
- **Recycling and Re-using** Fully Consumable Supplies
- **Avoid Competition** with Municipal and Agricultural Users



Source: International Gas Union



WATER OPERATIONS

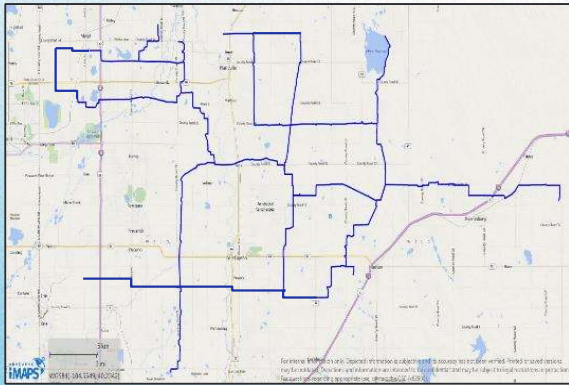


Water Sourcing

Water Transportation

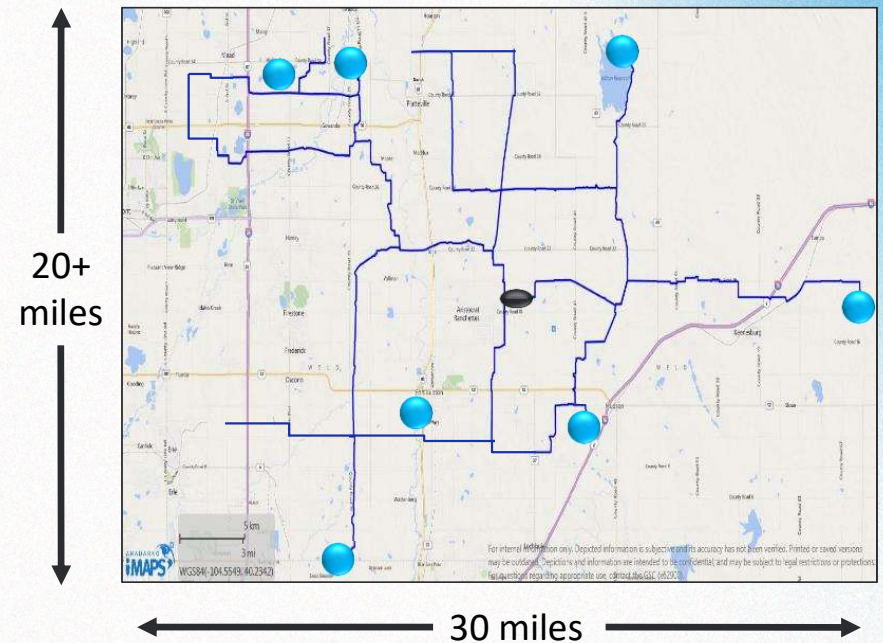


Water Treatment



WATER ON DEMAND SYSTEM

- Over 180 miles of permanent pipeline
- Serving 4 frac crews simultaneously
- Up to 10 different water sources
- Eliminating 1,500+ truck trips per day
- Delivered 450,000,000 barrels to-date
- Reduced well pad water storage tanks
 - (from 100+ to ~ 20)



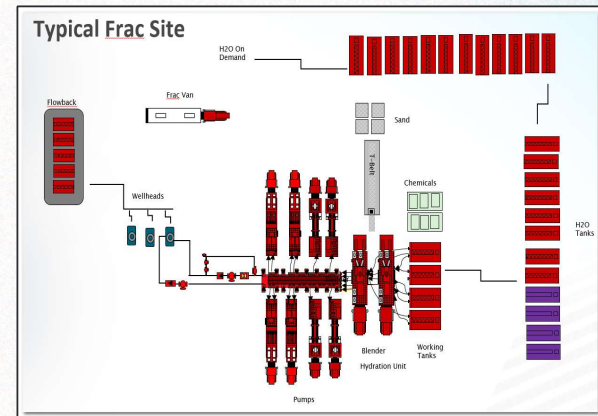
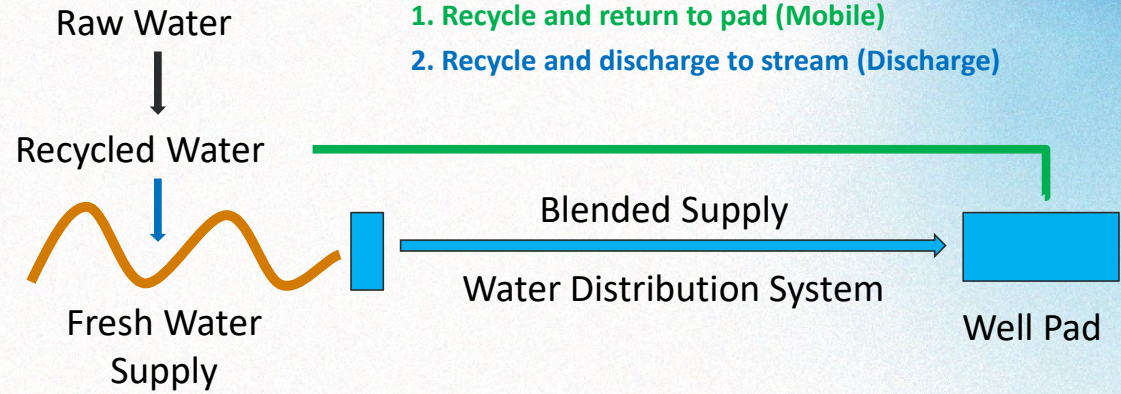
— Water Pipelines

● Water Storage Facilities

● Water Sources



WATER RECYCLING



ADDITIONAL WATER SERVICES

Drilling



Cooling



Fire Suppression



3rd Party Operators



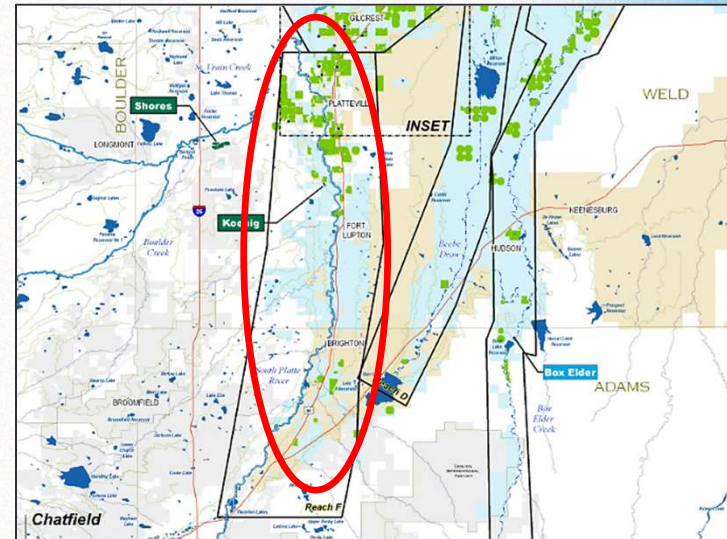
Road/Pad Construction



Additional Regional Needs



REGIONAL BENEFITS THROUGH PARTNERSHIPS



- Short-term Oxy diversion
- Long-term irrigation company diversion
- Designed to irrigation company specifications
- Through Oxy collaboration and funding

- Enhancement of critical river section
- Increase in agricultural irrigator supply
- Beneficial use of commercial water
- Through Oxy collaboration and funding

