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Update on the status and development of issues surrounding enhanced oil recovery (EOR) in the state of Wyoming

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***Update on the
status &
development of
issues surrounding
EOR in Wyoming***



**UW - Enhanced Oil
Recovery Institute**

*Steve Carpenter,
Director UW-EORI
April 11, 2016*

Presentation Overview

1 EORI in Wyoming

2 EOR Issues in Wyoming

3 Questions, Comments, Discussion





IOR



CO₂

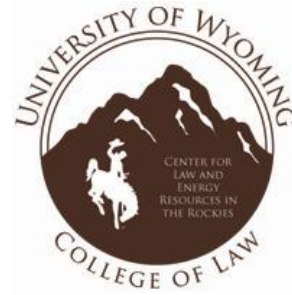
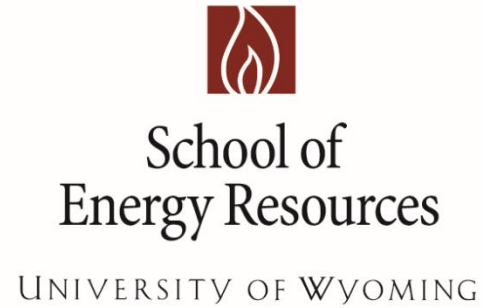
EOR in Wyoming



EOR



EORI Overview



Shell 3D CAVE & new Center for Produced Water



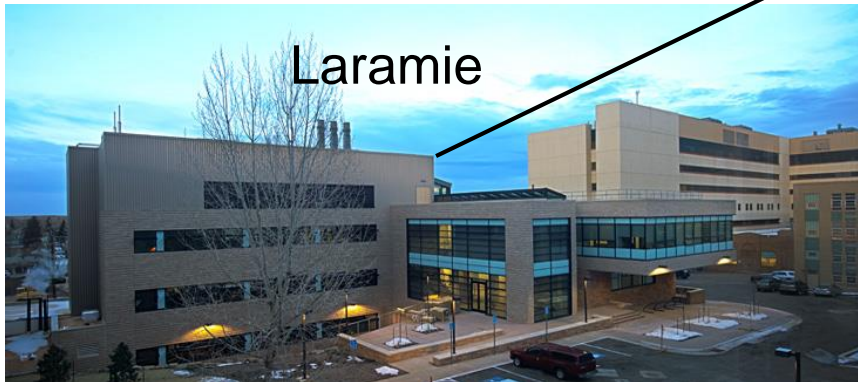
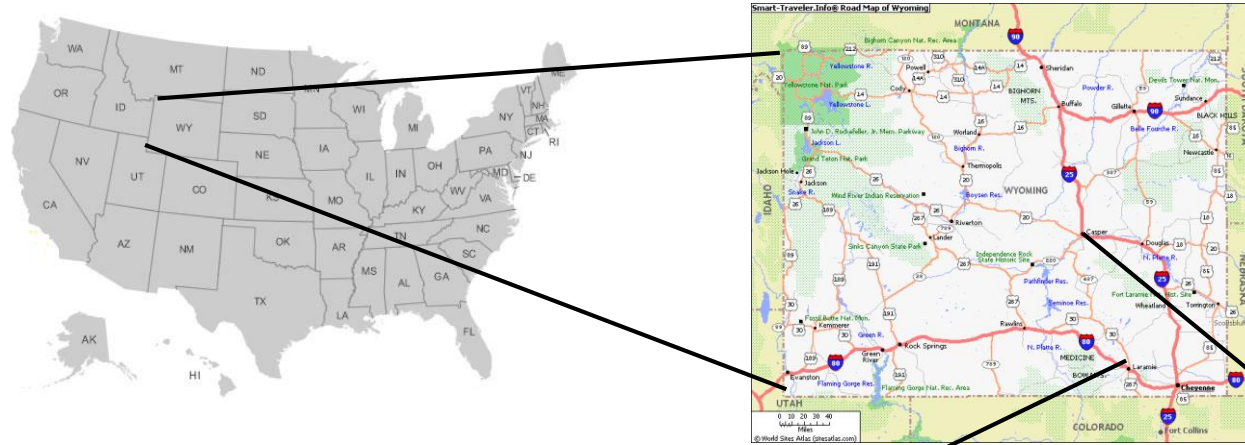
EORI Overview

- Legislatively mandated & funded
- Relocated from Laramie to Casper
- Data platform
- Screening tools to down-select
- Modeling
- Field Demonstrations



bbls & mcf

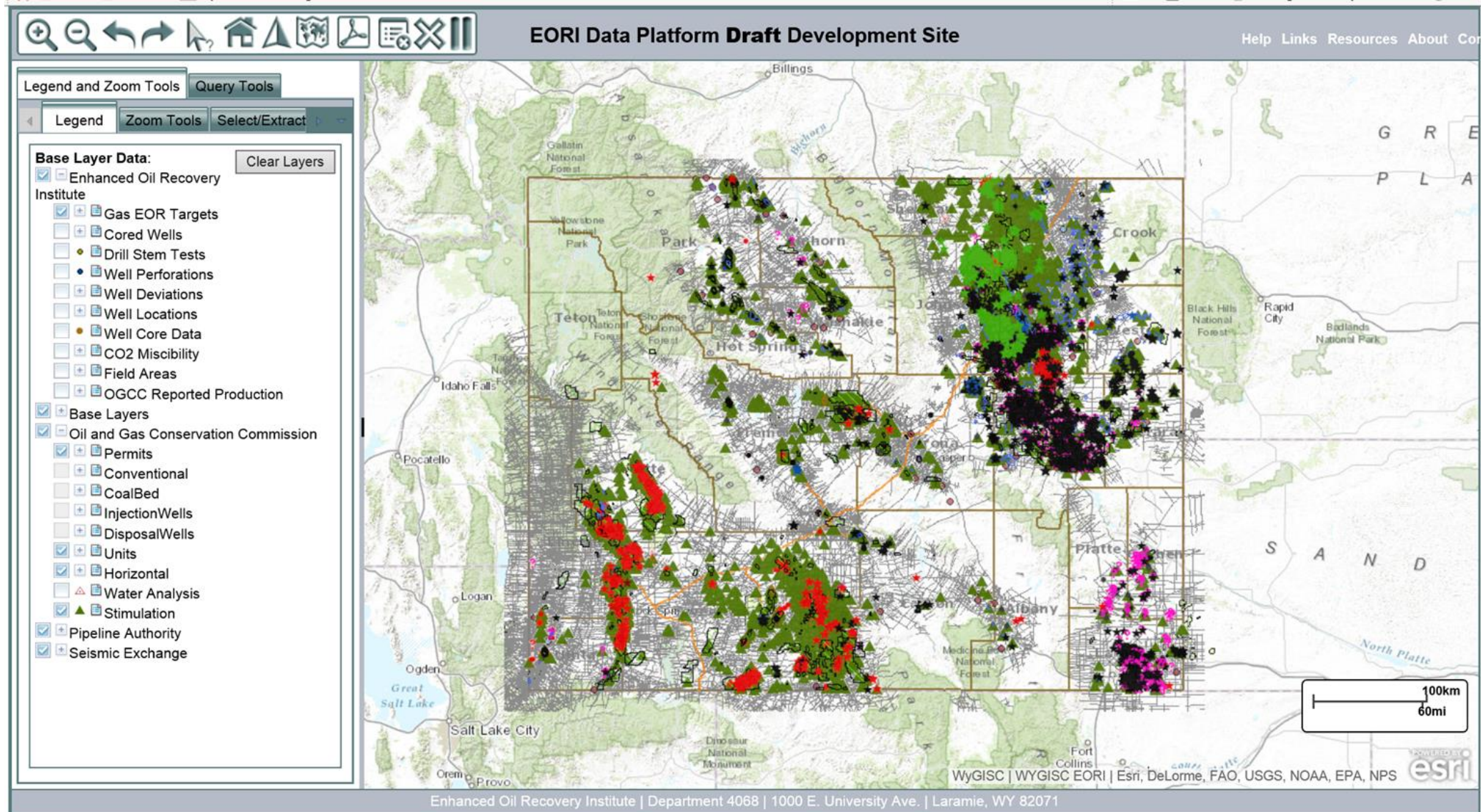
Locations



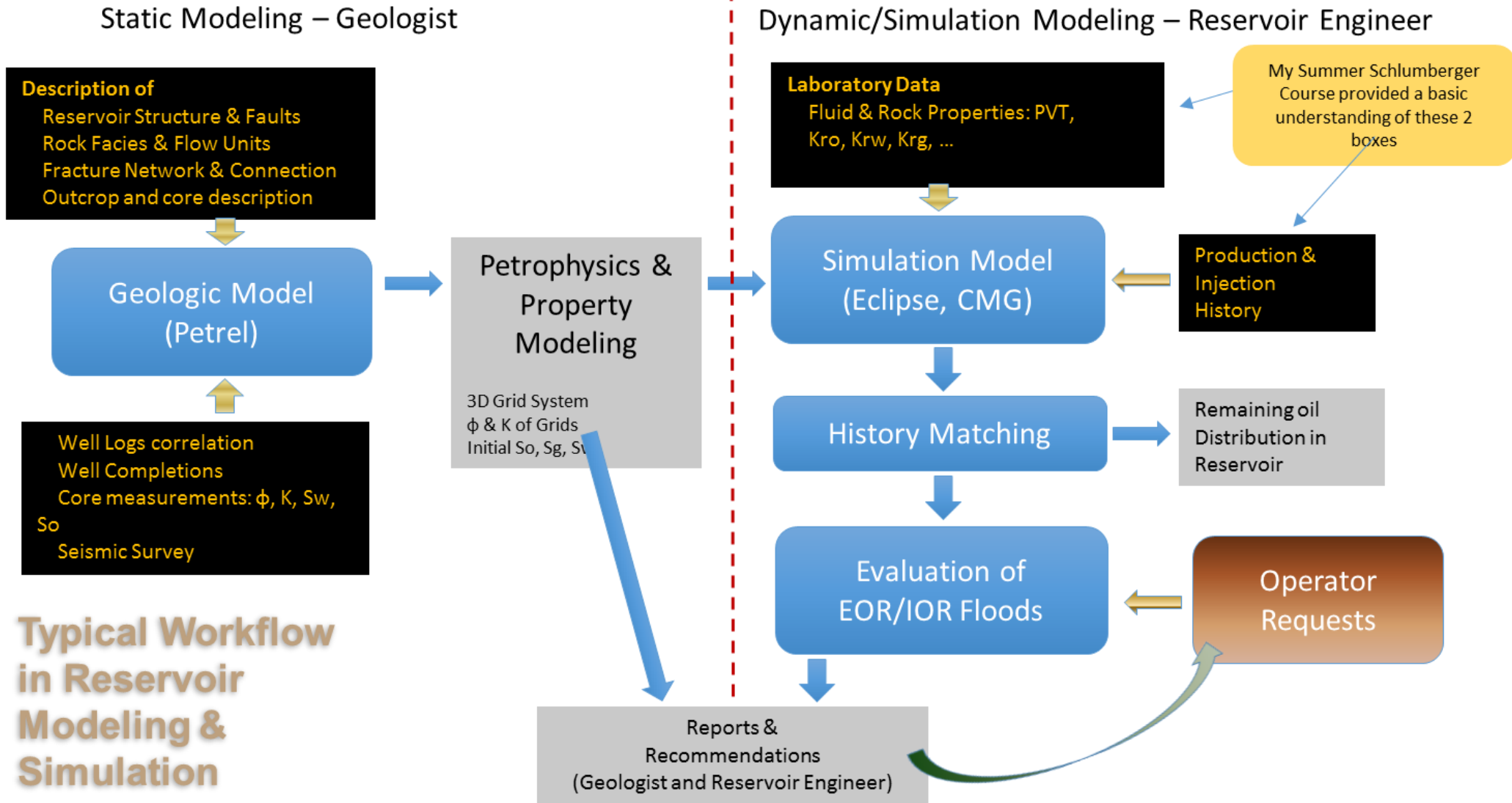
Laramie



Casper

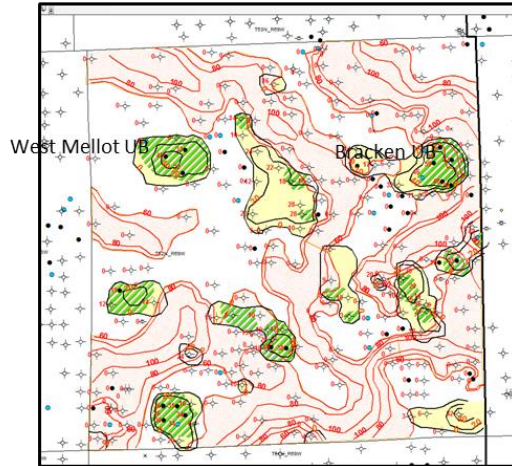


Modeling



Field Demonstrations

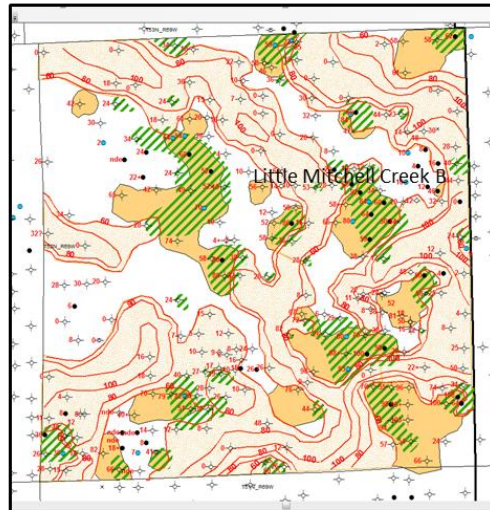
State of play Minnelusa Formation: Upstream and EOR opportunities A review of scope for investment in the Minnelusa of the Powder River Basin



West Mellot UB Bracken UB

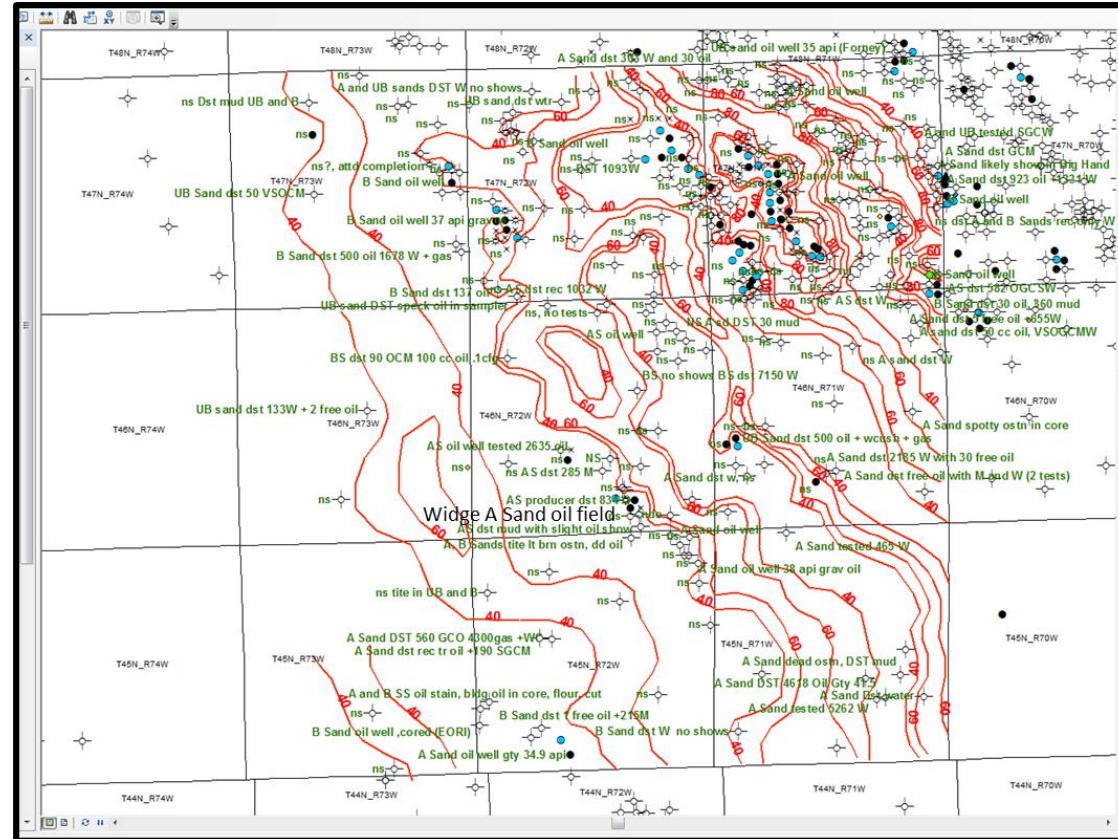
Minnelusa Upper B Sand Isopach and shows

Map showing the distribution of the Upper B sand in T52N R 69W with West Mellot and Bracken UB oil fields. Note other shows and leads in the Township. Hatched green lines enclose Upper B Sand shows and production. Red shaded areas are Opeche greater than 60 feet. Yellow shading is extent of Upper B Sand.



Minnelusa B Sand Isopach and shows

Map showing the distribution of the B sand in T52N R 69W with Little Mitchell Creek oil field. Note other shows and leads in the Township (slanting green hash marks). Red values are B sand thickness. Shaded red area shows Opeche thickness greater than 60 feet. Orange shading is thickness of B Sand greater than 40 feet.



Overview of a frontier Minnelusa area of high gravity oil (35 degree+) oil near Widge Field (46N 72W) in 9 townships in the SW, deeper part of the Minnelusa fairway. The map reveals abundant oil shows in several zones of the Minnelusa, indicating significant exploration potential. Encouragement provided by this and other maps such as EOR "state of play" Maps will encourage investment in this play in this and other regions targeted for work.

Wyoming EOR Projects

Enhanced and Improved Oil Recovery Projects in Wyoming

Enhanced Oil Recovery Commission



Enhanced Oil Recovery Institute

EOR_IOR_Projects

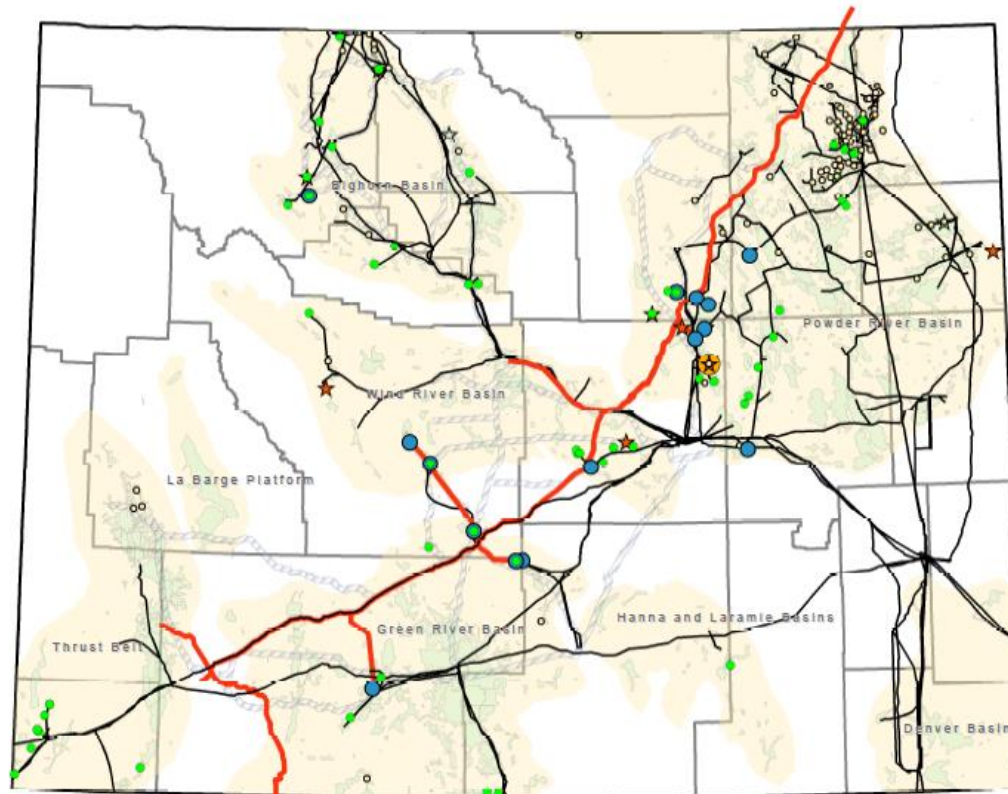
- Chemical
- Gas injection
- ☆ Mining
- ★ Thermal
- Carbon dioxide
- Microbial
- ▨ WPA Pipeline Corridors
- Carbon Dioxide
- Crude Oil

References:

Oil & Gas Conservation Commission - WOGCC
 Department of Energy NIPER-583
 Society of Petroleum Engineering - SPE
 State Geological Survey - WSGS
 Pipeline Authority - WPA
 Geological Association - WGA
 Bureau of Land Management - BLM
 Wyoming Geographic Science Center - WyGIS
 Enhanced Oil Recovery Institute - EORI



School of Energy Resources



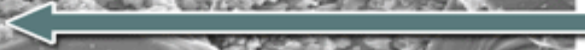
This map was prepared by the Enhanced Oil Recovery Institute (EORI) at the University of Wyoming. Information represented in this publication is considered to be reliable. Neither EORI nor the author makes any warranty or assumes any liability or responsibility for the accuracy of information presented within this work product of EORI.

Map and Data Prepared by:
 Nick Jones PG- Senior Geologist & Technical Lead
 &
 Vandy Jones- Research Geologist
 2014





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EOR Issues in Wyoming



EOR



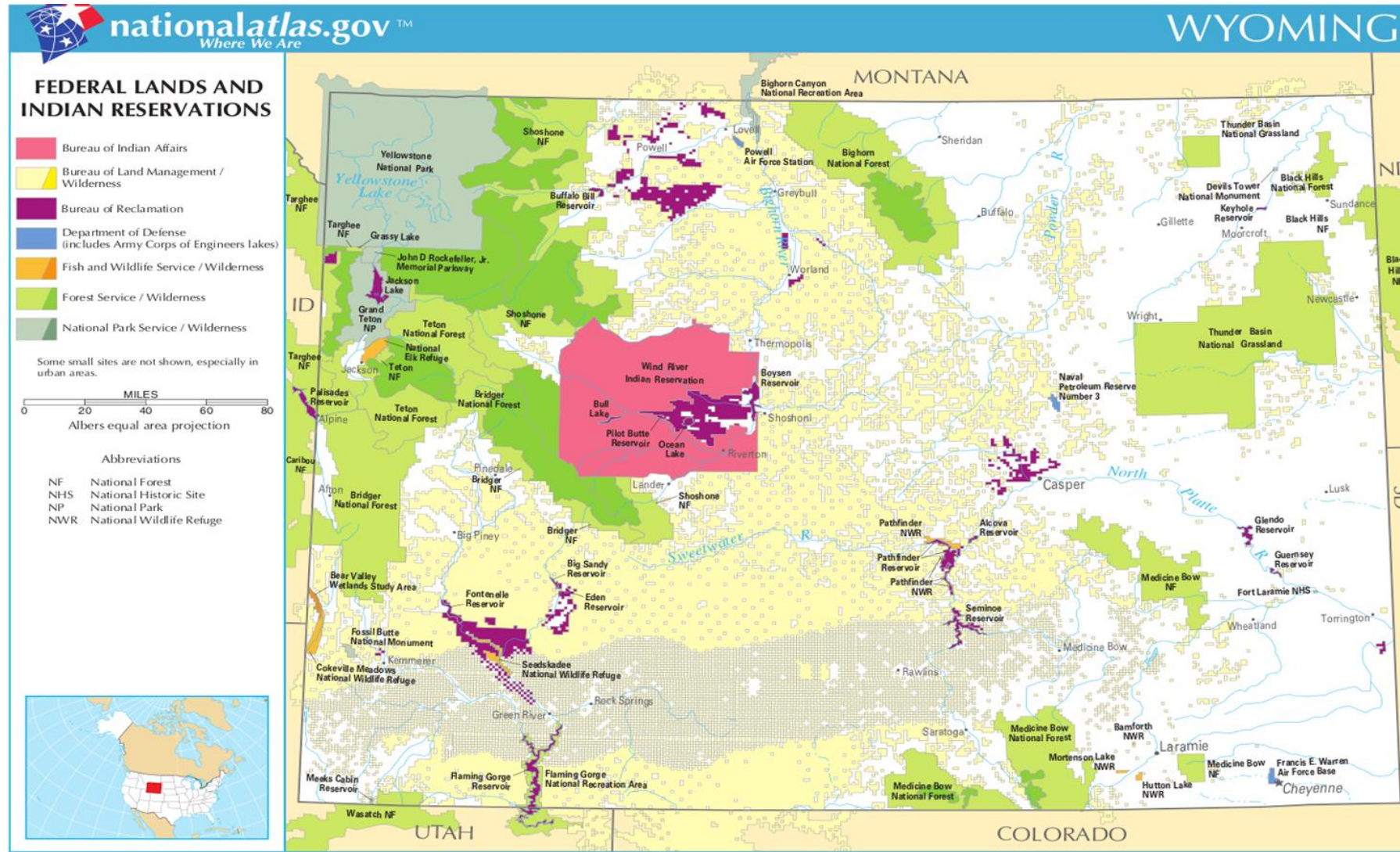
EOR Experience/Issues in Wyoming

- Hydraulic Fracturing
- Permitting on BLM & State Land
- Sage Grouse
- New Flaring Rules
- New Research

Hydraulic Fracturing

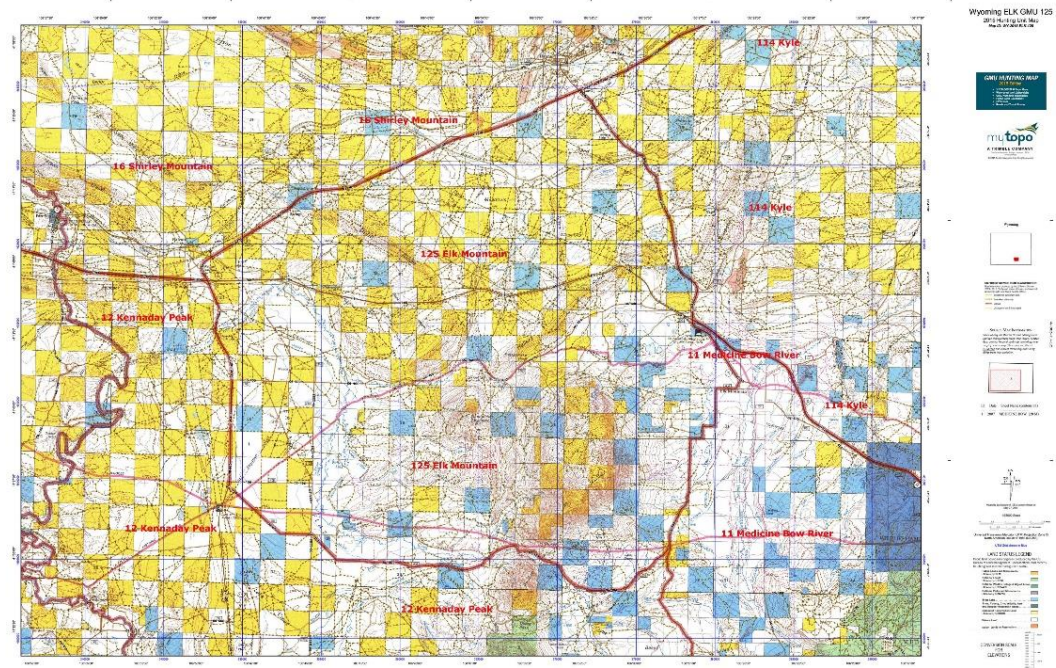
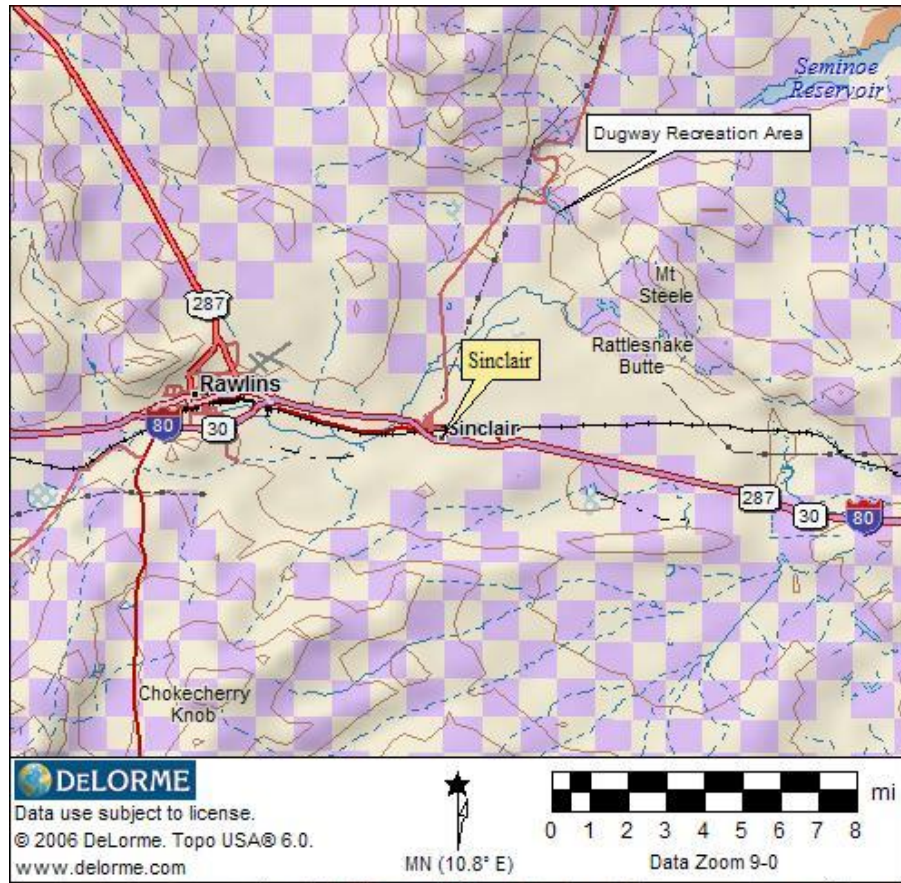
- 2010 - First U.S. state to implement comprehensive rule
- Chemical disclosure on a well by well basis
- Permit required prior to commencement of drilling

Permitting on BLM & State Land



Permitting on BLM & State Land

But on a unit, section, or project scale...



...the permitting obligations can triple – local, State, and Federal, which can take years to complete

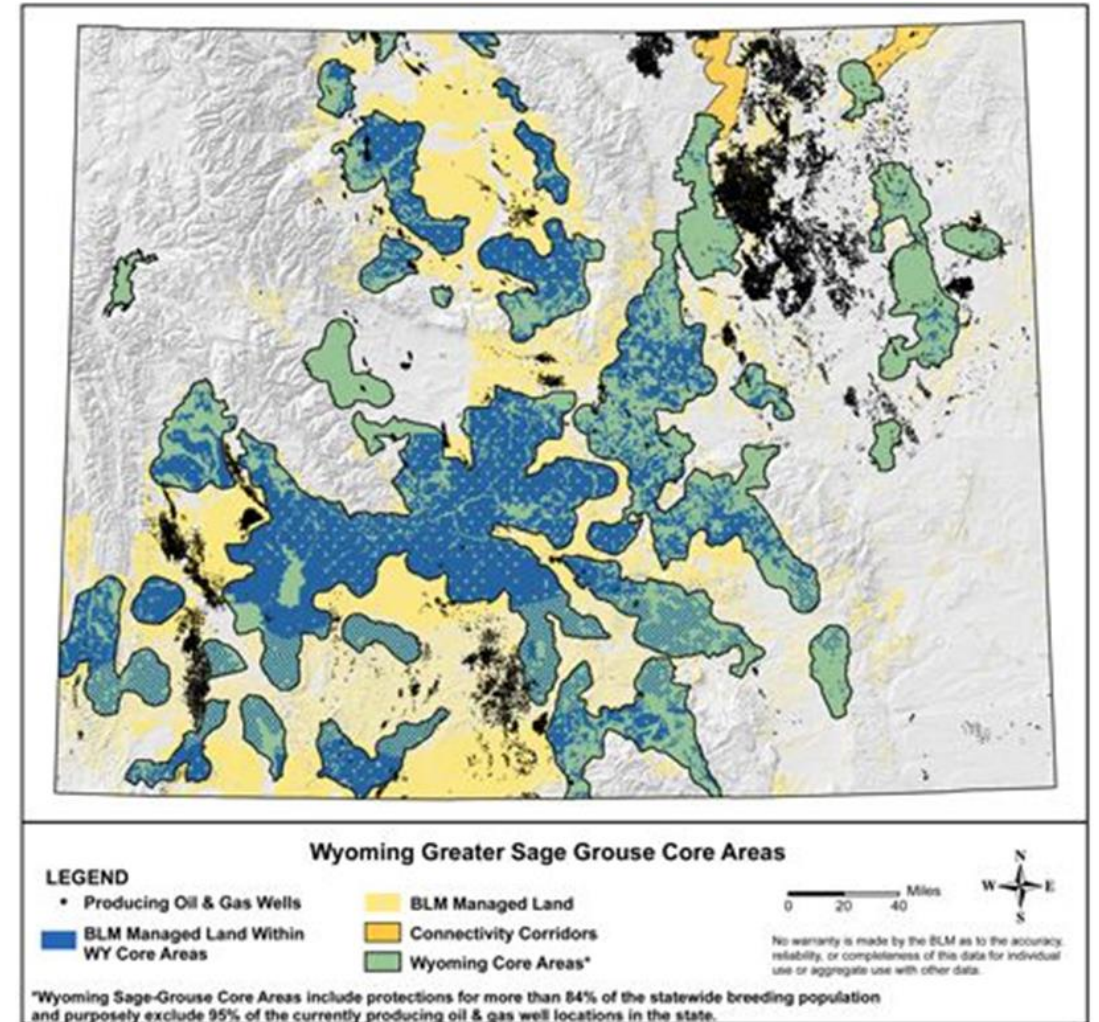
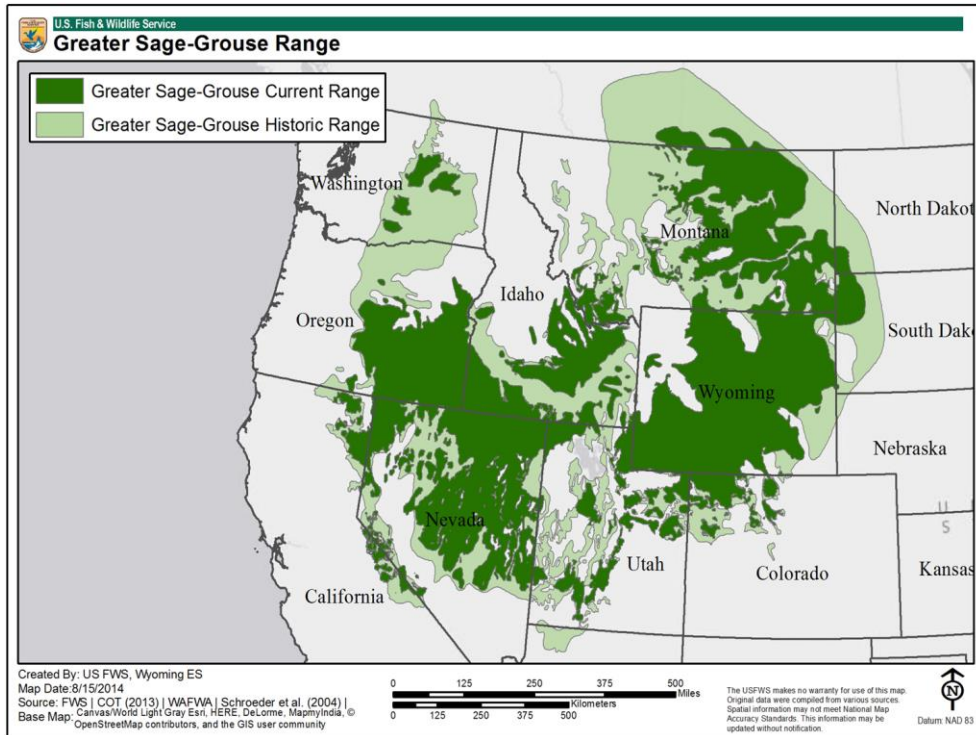
Greater Sage Grouse (GSG)

- 2005 F&W ruled GSG not threatened & not warranted listing Endangered Species Act
- 2007 lawsuit F&W suggest GSG is endangered
- 2008 creation of Wyoming Sage Grouse Conservation

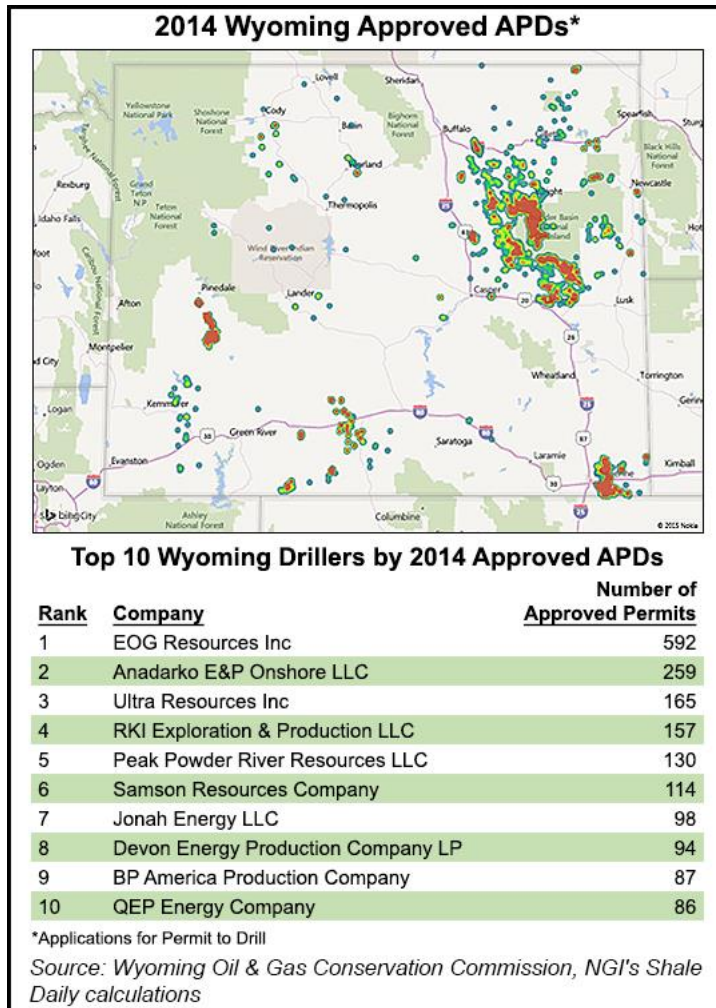


Greater Sage Grouse (GSG)

GSG Core Areas limit if and when “development” can occur



Wyoming Flaring Rule



- Flaring of $>100\text{mcf/day/well}$ requires a permit
- Permit requires some form of remediation, usually re-injection (disposal, storage, or EOR) or capture and sale



outdoorcouncil.org

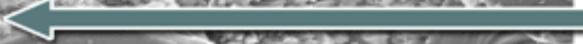
EORI New Research

- All ROZ aspects
- Drilling & Completions
- Shale & ultra-tight sand model – geological and reservoir engineering
- Pressure maintenance & flooding – based on drive mechanism
- Optimum production & drawdown– based on drive mechanism
- Effect of shutting in vs. future performance– based on drive mechanism
- Optimum horizontal drilling patterns & spacing
- Understanding of development of stacked unconventional plays
- Produced Water Research





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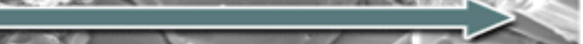


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Summary & Discussion

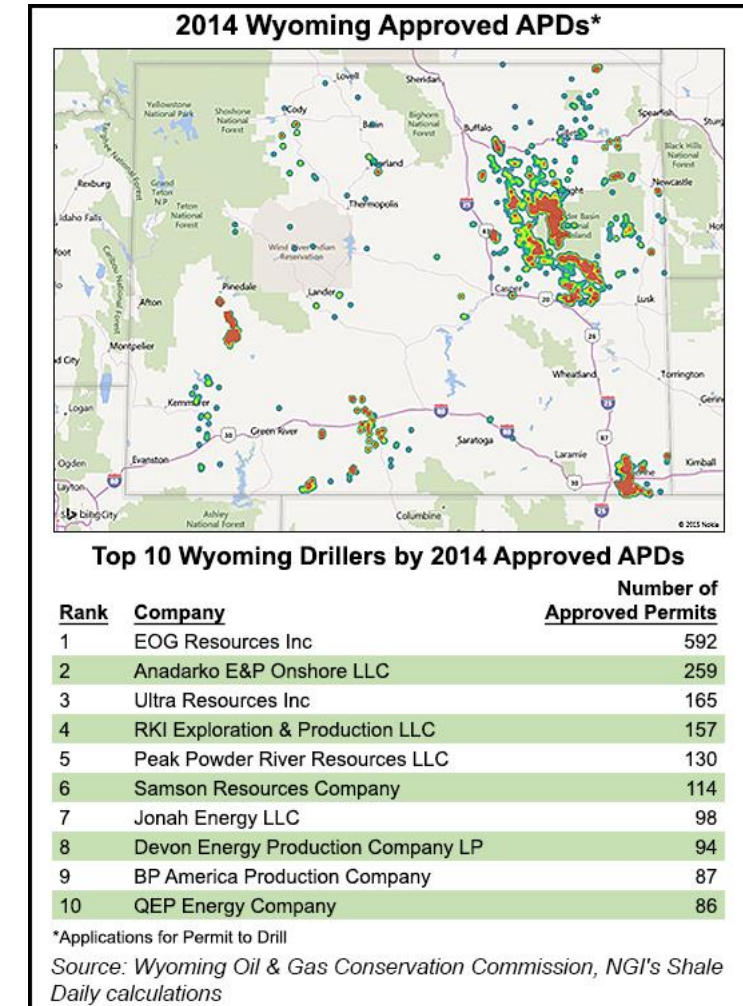


EOR



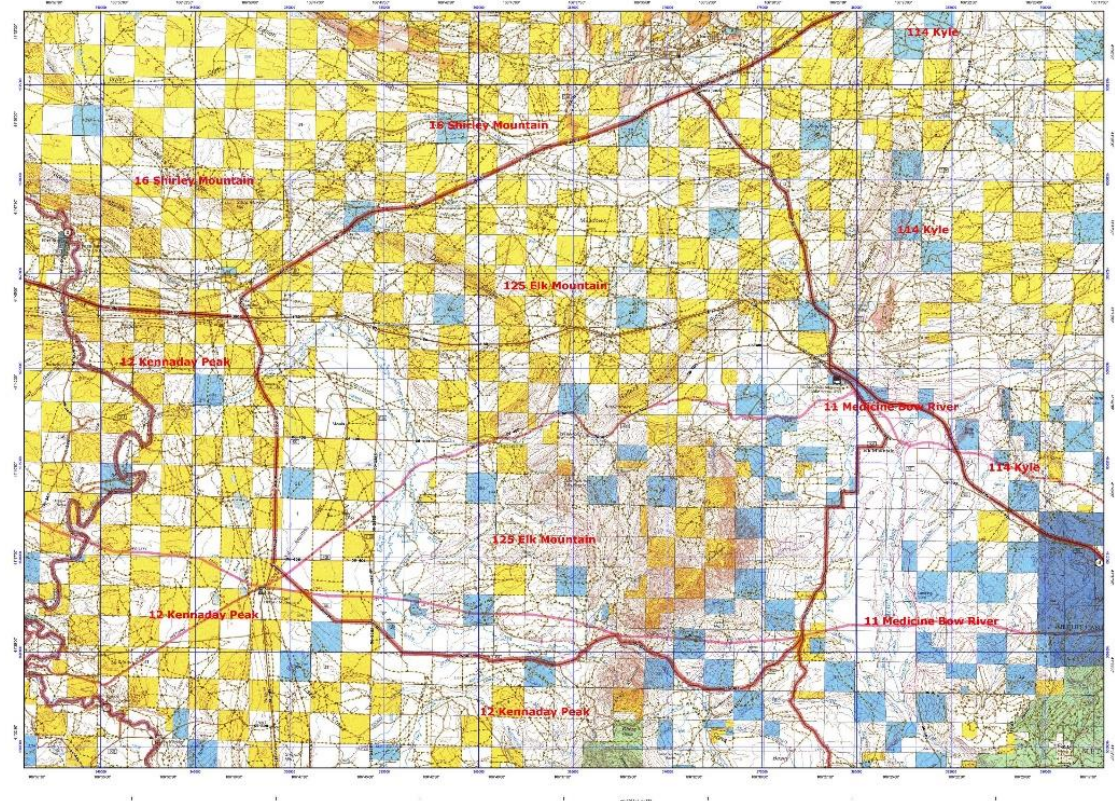
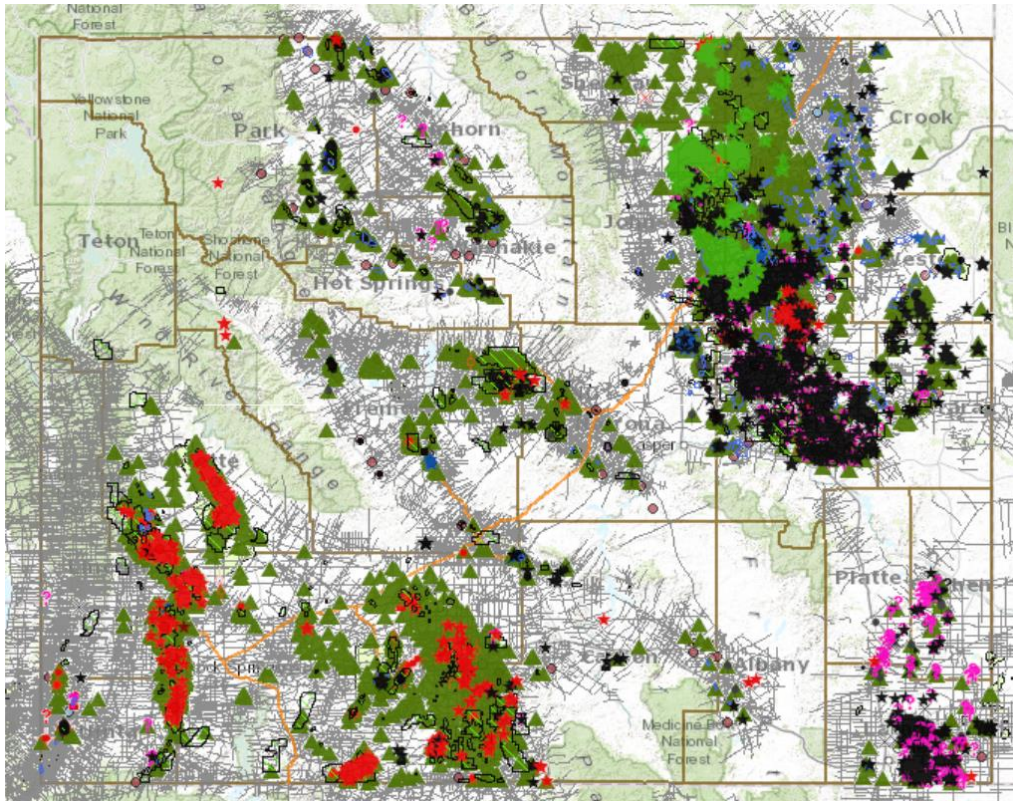
Summary

- Fracturing
- BLM & State Land
- GSG
- New Flaring Rules
- New Research



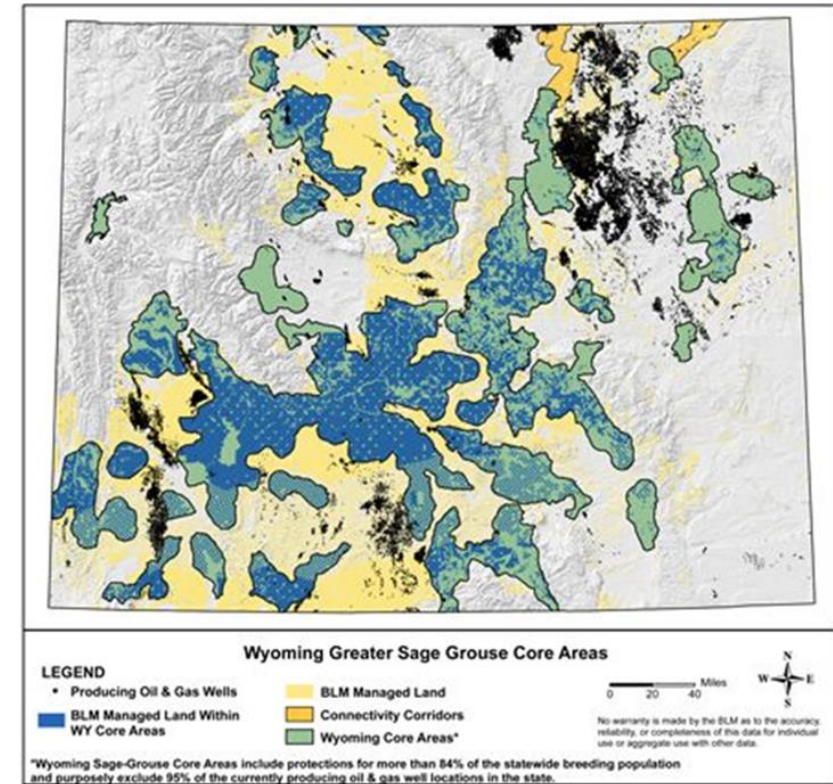
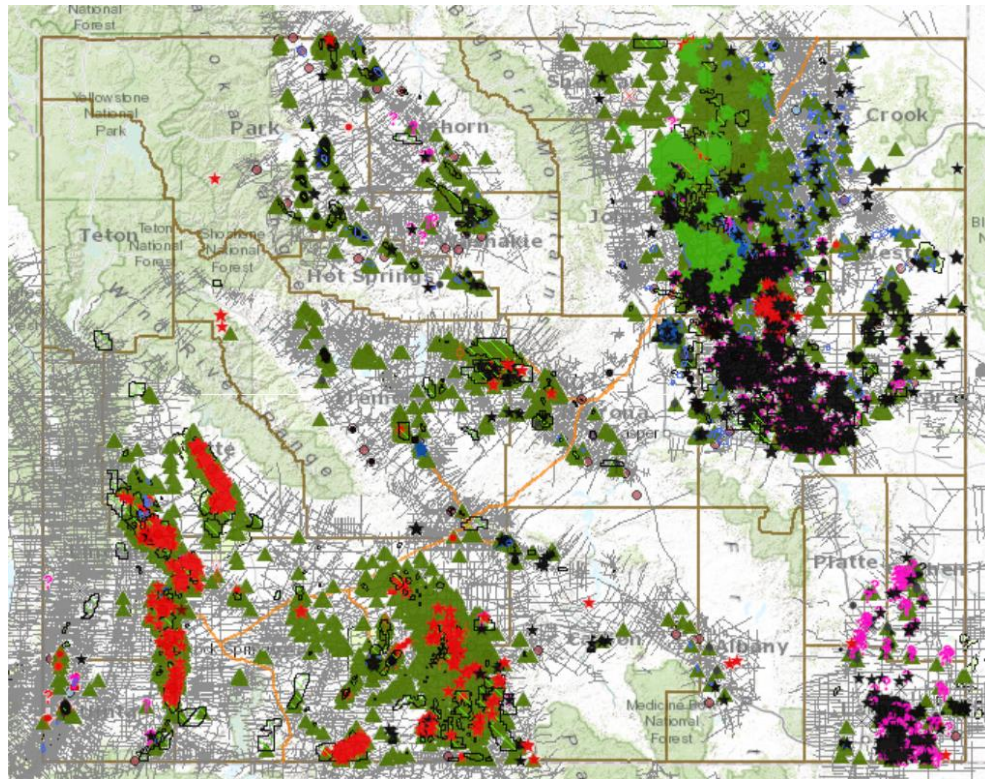
Summary

Compare where development is desired (APD, permits)...to BLM land



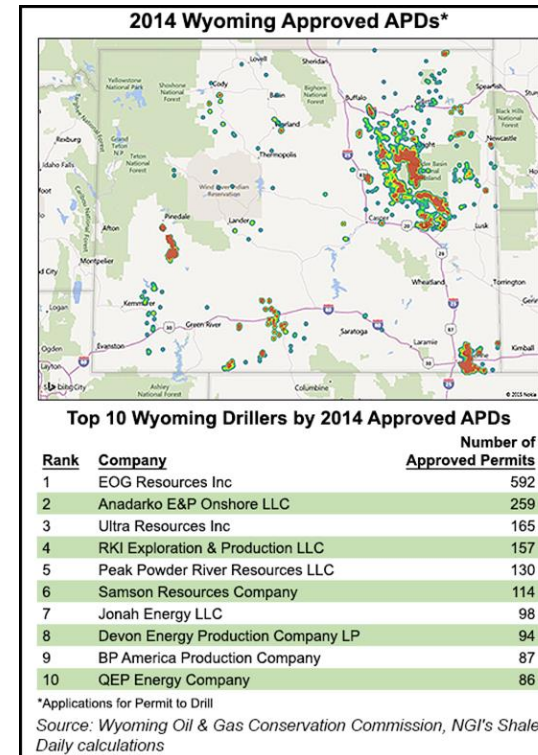
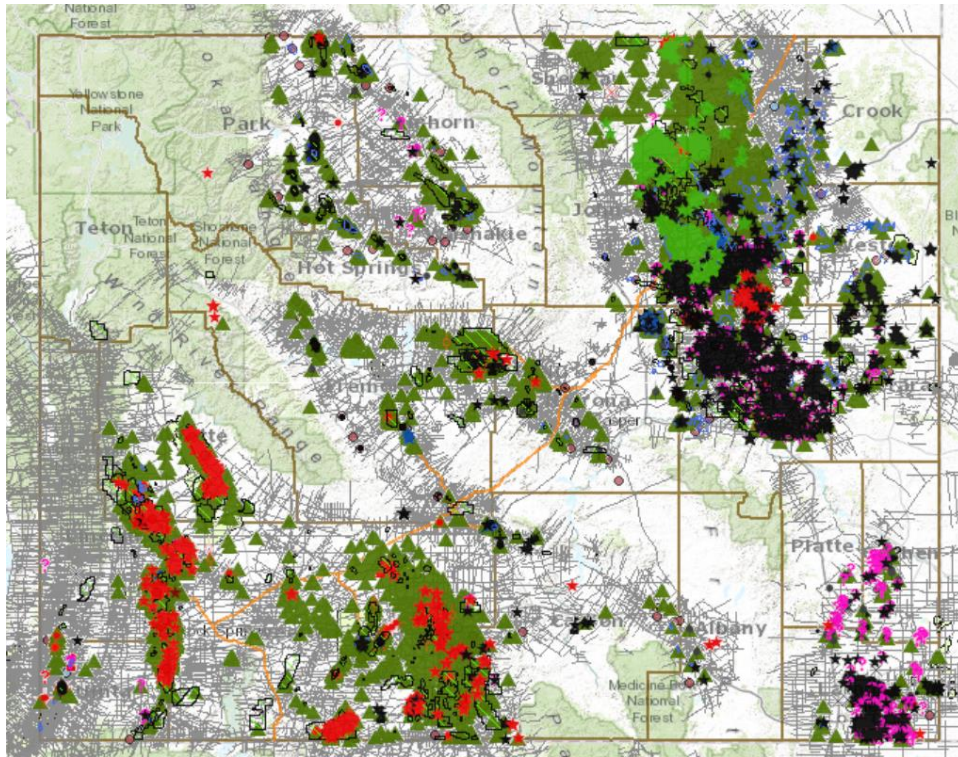
Summary

Compare where development is desired (APD, permits)...to GSG Core Areas



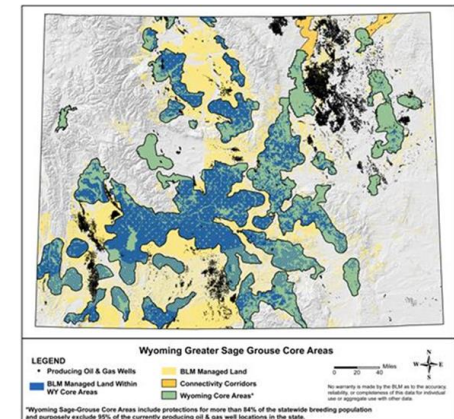
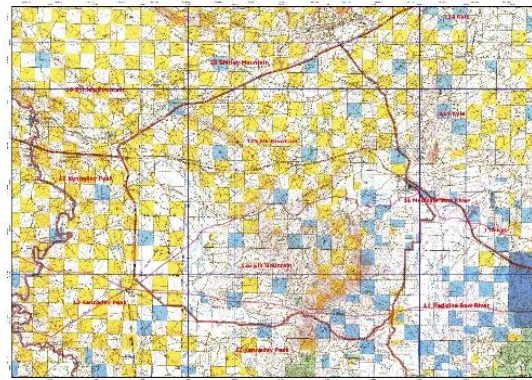
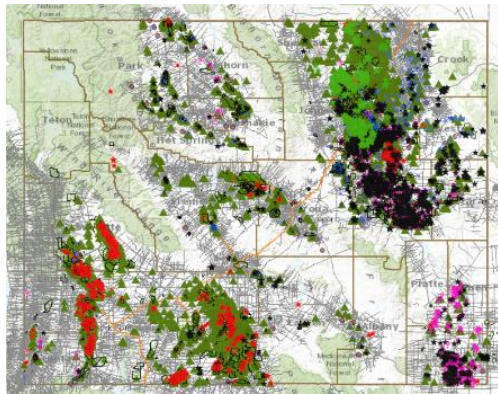
Summary

Compare where development is desired (APD, permits)...to infrastructure for flaring



Summary

Compare where development is desired (APD, permits)...to all the collective restrictions...



...development is severely hampered...the **science is the science**, but without the public will and regulatory framework to allow the full value chain to reach commercial scale **EOR will not reach its full potential**

Summary

New Research includes Western Governor's Association
EOR Initiative and research with operators:



The 10th Annual Wyoming EOR CO₂ Conference

July 12, 13, 14, 2016 at the Casper Events Center



WYOMING EOR_{CO₂} CONFERENCE

Thank You for Your Attention

Enhanced Oil Recovery Institute

www.uwyo.edu/eori/

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