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TRANSPORTING CO2 – ACCELERATING PIPELINE INFRASTRUCTURE DEVELOPMENT

CCS Summit – ACI Conf. – Wash. D.C., Sept. 29-30, 2010

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Quick Reference Sources

- Report of the Interagency Task Force on Carbon Capture and Storage, USEPA, August 2010. Appendix B and M deal with CO2 Transportation.
- Carbon Capture and Storage: Progress and Next Steps, International Energy Agency, 2010.
- U.S. Oil Production Potential From Accelerated Deployment of Carbon Capture and Storage, Advanced Resources International, Inc., March 10, 2010.

Reference Sources - Continued

- Legal Issues Associated with the Development of Carbon Dioxide Sequestration Technology (CRS Report to Congress, March 19, 2010).
- Regulation of CO2 Sequestration Pipelines: Jurisdictional Issues (CRS Report to Congress, April 15, 2008)
- CO2 Pipelines for Carbon Sequestration: Emerging Policy Issues (CRS Report to Congress, January 17, 2008)
- Fourth Annual Wyoming CO2 Conference. http://eori.gg.uwyo.edu/

References Continued

- From EOR to CCS: The Evolving Legal and Regulatory Framework for Carbon Capture and Storage. P.M. Marston and P.A. Moore, 29 Energy Law J. 421(2008), www.marstonlaw.com
- Marston, Philip M., A Regulatory Framework for Migrating from Enhanced Oil Recovery to Carbon Capture and Storage; September, 2010. Available at www.sciencedirect.com
- Wolfe, Lawrence J., CO2 Transportation and Regulation, CCS and EOR in the US. Available at www.hollandhart.com at LJWolfe bio.

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A Simple Proposition

- CCS, on any scale, will require new CO2 pipelines.
- There is no Federal regulatory scheme, nor common state schemes, for the siting and economic regulation of CO2 infrastructure development.
- Only 3600 miles of CO2 pipelines exist, all devoted to EOR.
- The EOR industry wants to develop more CO2 sources and build more pipelines.

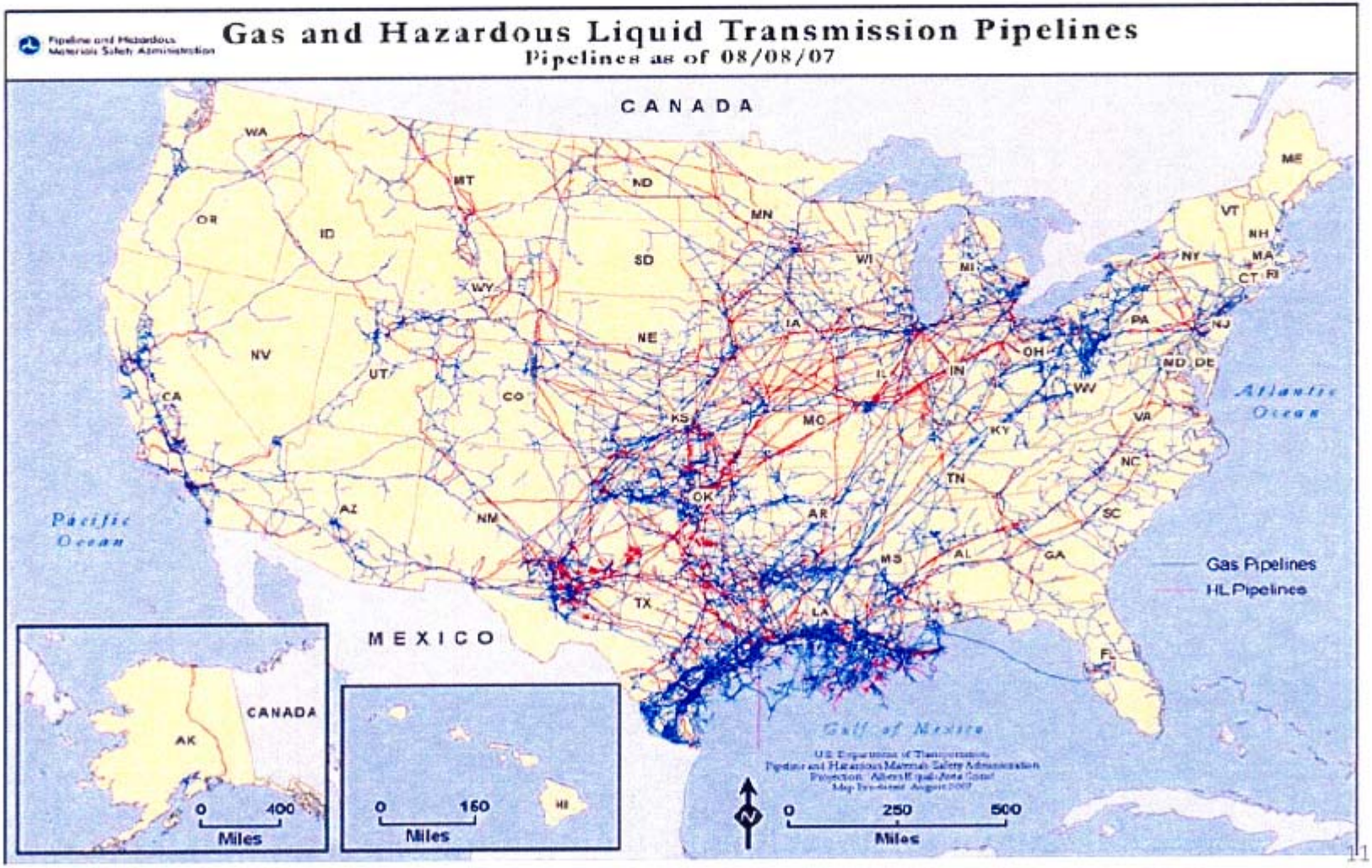
A Simple Proposition continued

- The EOR industry and the CCS industry can work together to meet common goals of GHG reduction and enhanced domestic oil production.
- New sources of CO2 – IGCC power plants, Coal to Liquids Plants, Retrofitted Coal Fired Plants – can supply additional CO2 for EOR.
- However, because these plants will require 24/7 off take of CO2, the financing, construction and operation of the plants and the pipeline system will differ substantially from conventional EOR projects.

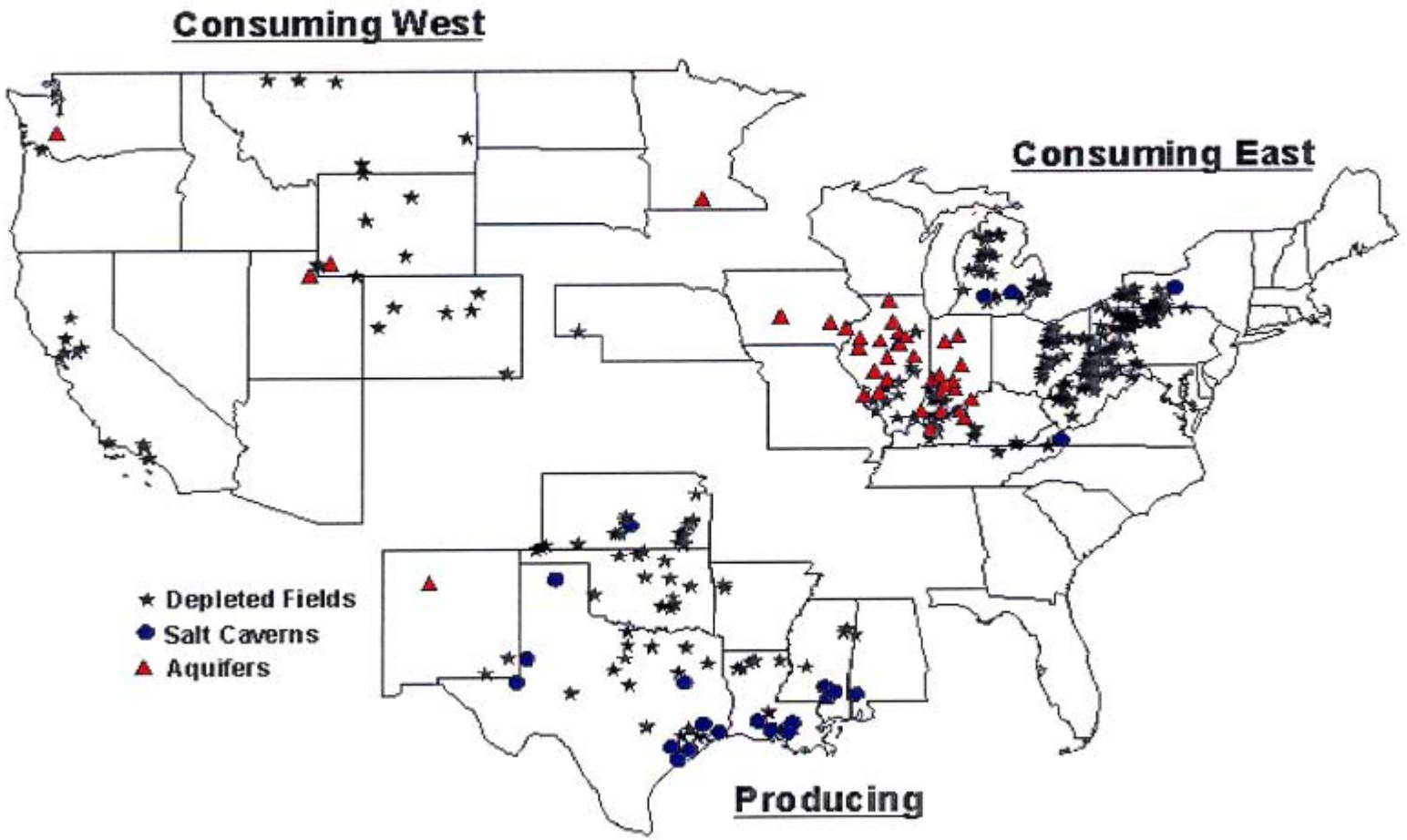
CO2 Infrastructure for EOR

- About 5800 Km (3600 miles) of CO2 pipelines currently. Compare to 800,000 km (500,000 miles) of natural gas and hazardous liquids pipes.
- Annual injection of CO2 is about 50 million metric tons. Most, if not all, of the injected gas remains in storage.
- About 6100 active CO2 injection wells. This injection makes possible the production of about 245,000 BBls of oil. Marston, page 424-426.

480,000 Miles of Natural Gas and HL Pipelines



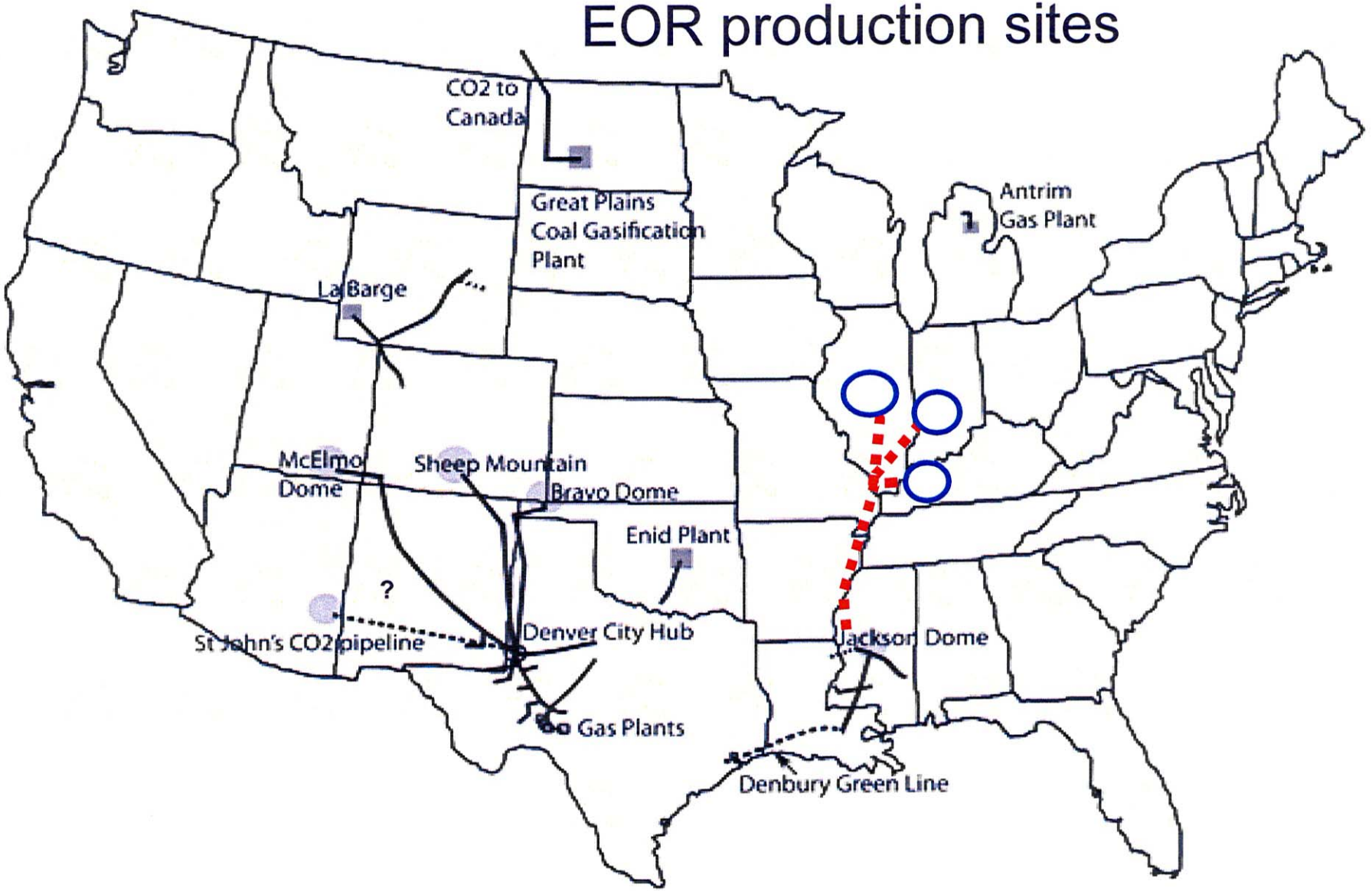
~400 Lower 48 Gas Storage Facilities



Source: Energy Information Administration (EIA), EIA GasTran Geographic Information System Underground Storage Data Base.


CO2 to
Canada
Great Plains
Coal Gasification
Plant
Antrim
Gas Plant
La Barge
McElmo
Dome
Sheep Mountain
Bravo Dome
Enid Plant
St John's CO2 pipeline
Denver City Hub
Jackson Dome
Gas Plants
Denbury Green Line

CO_2 sources, pipelines and EOR production sites



Siting Not Regulated by Federal Agencies

- Siting of new CO2 pipelines is not regulated by any Federal agency. Both FERC and the STB (and predecessor agency ICC) have declined jurisdiction over CO2 pipelines.
- Siting is currently left to the States.
- Rates charged by CO2 pipelines are not regulated by any Federal agency, except the STB will hear complaints about rates.
- No Federal eminent domain for CO2 pipelines

Federal Permits Needed if Cross Federal Lands

- If pipeline crosses Federal land, permits from the Federal agencies will need to be acquired, and NEPA compliance undertaken, either an EA or EIS.
- BLM can regulate CO2 pipeline under the Mineral Leasing Act, as a commodity shipped by a common carrier. EOR pipelines are regulated under MLA; or
- BLM can regulate under FLPMA.

CO2 Pipeline Safety Regulation

- Interstate CO2 pipelines are regulated for safety by the DOT. 49 U.S.C Sec. 601.
- DOT regulates the design, construction, operation and maintenance, and spill response planning. 49 C.F.R. Sec. 190, 195-199).
- DOT applies the same safety requirements as to pipelines carrying crude oil, gasoline and anhydrous ammonia.

CO_2 Construction and Ops

- Interagency Task Force Report describes the issues with CO_2 construction and operation. Appendix B.
- CO_2 Pipelines operate at very high pressures, 2000 lbs psig, in order to maintain liquid phase for injection.
- Pipeline system needs very high quality streams.

State Regulation - Wyoming

- Wyoming – Industrial Siting Act bars State agency from requiring permit. W.S. 35-12-119(c)(iii) – "The construction, operation and maintenance of the following activities are exempt from this chapter: (iii) All pipelines except coal slurry pipelines."
- Wyoming Pipeline Authority – interested in "supersizing" pipelines to make CO2 available for old oil fields in Wyoming.

Montana

- H338 (2009) – Establishes common carrier status to pipelines moving CO2 produced in fuel combustion or gasification.
- S498 (2009) – Regulates CO2 injection wells. Notice, permit, regulation of CO2 injection wells
- Surface owner presumed to own reservoir if deeds do not
- clarify ownership
- Upon certification of completion of well, Board of Environmental Review transfers liability to the state
- Operators pay fees for administration of state's CO2
- program and long term oversight.
- Unitization allowed. (Rewey, NCSL, 6/26/09)

Alternate Regulatory Schemes

- Interagency Task Force – Appendix M, describes various alternatives for nationwide development of a CO2 pipeline system.
  - No Federal Authority – Status Quo
  - Federal Backstop Siting (Model Used for Electric Transmission)
  - Exclusive Federal Siting with Eminent Domain (natural gas pipeline model) or No Eminent Domain (LNG Import Terminal model)

Other Siting Issues

- Siting across Tribal Land.
- Siting across Federal Lands. Avoid the USFS lands, it won't let you across.
- Offshore siting. The BP spill effect?
- Common Carrier Considerations.
- Rate and Tariff Regulation of CO2 Pipelines and Storage.
  - State Based
  - Federal Open Access and Transparency
  - Traditional Public Utility Regulation

Common Carrier issues

- Phil Marston makes important observations about the differences between EOR and CCS. Those differences will require different regulatory approaches.
  - EOR and CCS have different risk profiles
    - EOR designed to drive out oil. CCS will replace existing fluids, primarily water. CCS projects will become large water management projects.
    - CO2 in EOR is valuable, is recaptured and recycled to the end of the project life (many decades). In CCS projects CO2 leakage is prevented only because of regulatory and project requirements.

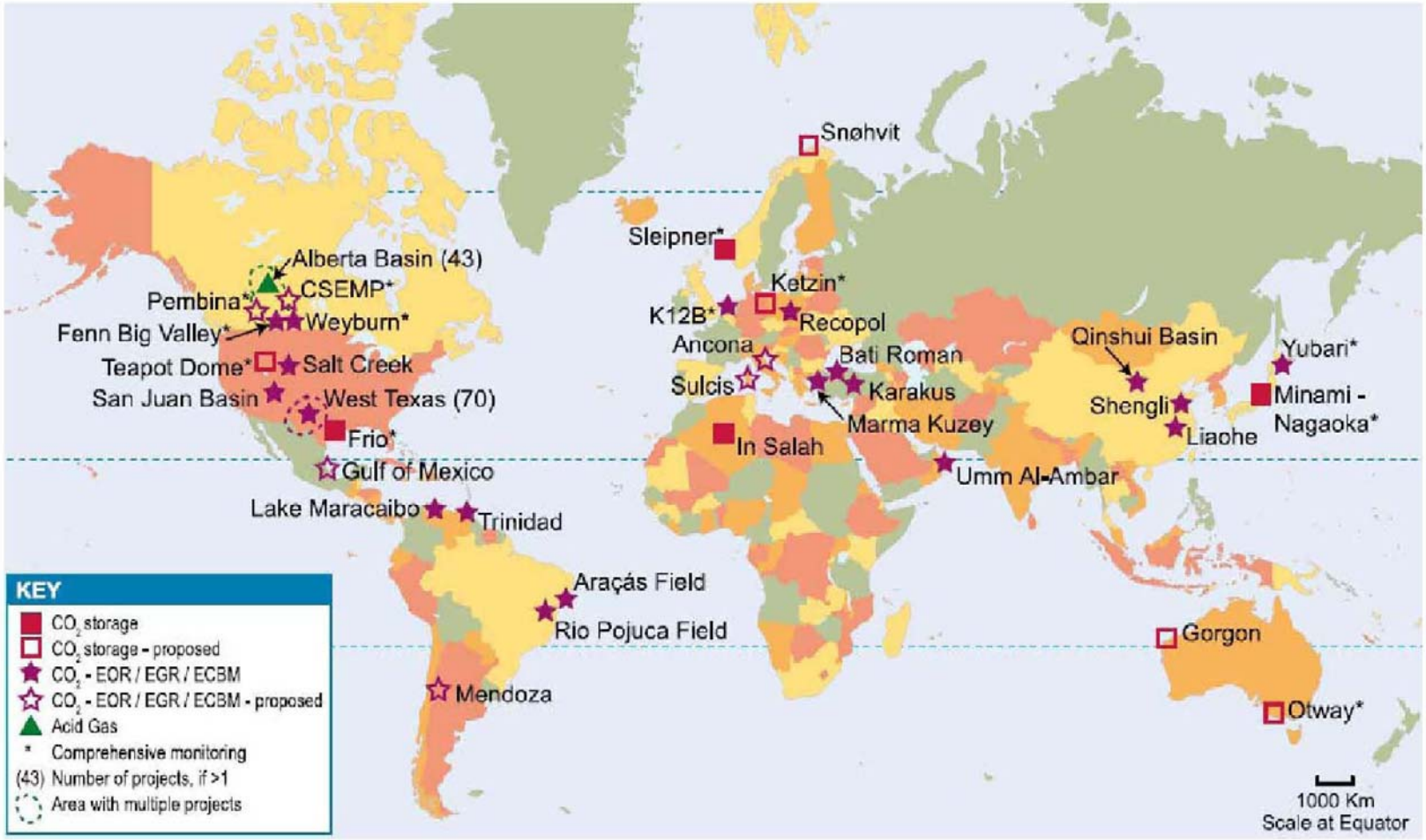
Regulation, continued

- Common carrier concepts, that would require a project to carry CO2 for any shipper, should not apply to CCS CO2 pipelines.
  - CCS CO2 pipelines will be sized, financed and constructed to serve a few projects. Those projects will utilize all the capacity of the pipeline. The projects will demand 100% off take year around, 24/7, because they will be prohibited from venting if the CCS injection is not available.
  - Economic regulation of the CO2 pipelines through common carrier requirements are contrary to purpose and usage for which these pipelines will be built.

There is a shortage of CO2 in the US

- "At the present time, an important limiting factor in new CO2-EOR projects is a shortage of CO2." Interagency Taskforce on CCS, Aug. 2010.
- Many old oil fields in the SE and Rockies that could benefit from CO2 flooding.
- Denbury has long term plans for floods in Wyoming, Montana and North Dakota that exceed 1 Billion cf/day.
- Present supplies in Wyoming are limited. New supplies are dependent on construction of coal gasification plants and power plant CO2 capture.

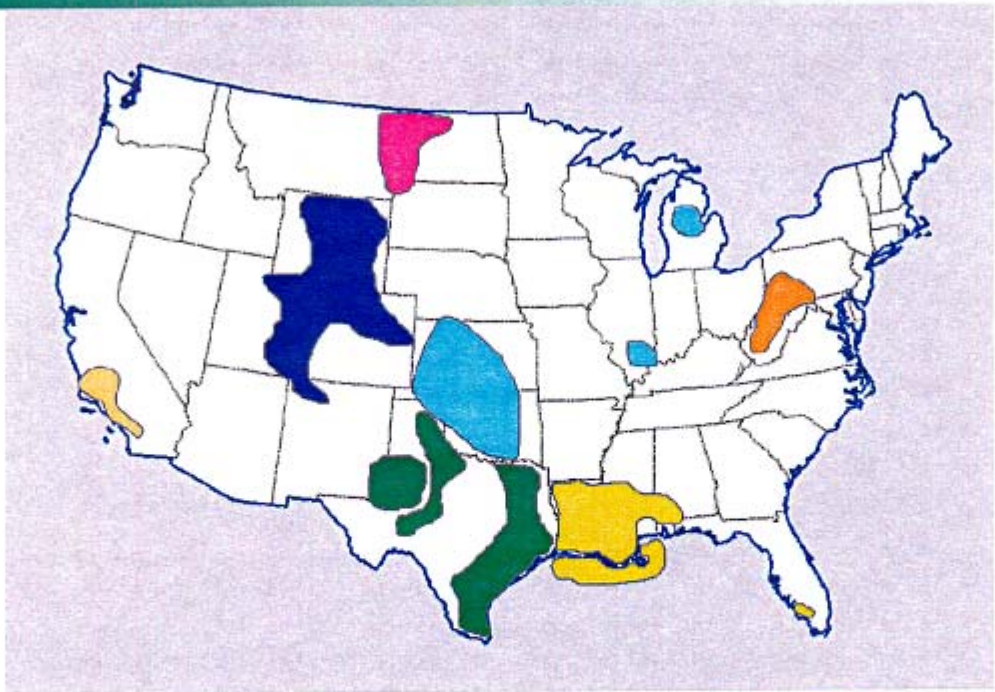
CO_2 Project Locations



Ref: IPCC Special Report on Carbon Dioxide Capture and Storage

EOR and CO_2 demand in lower 48

NRDC
THE EARTH'S BEST DEFENSE

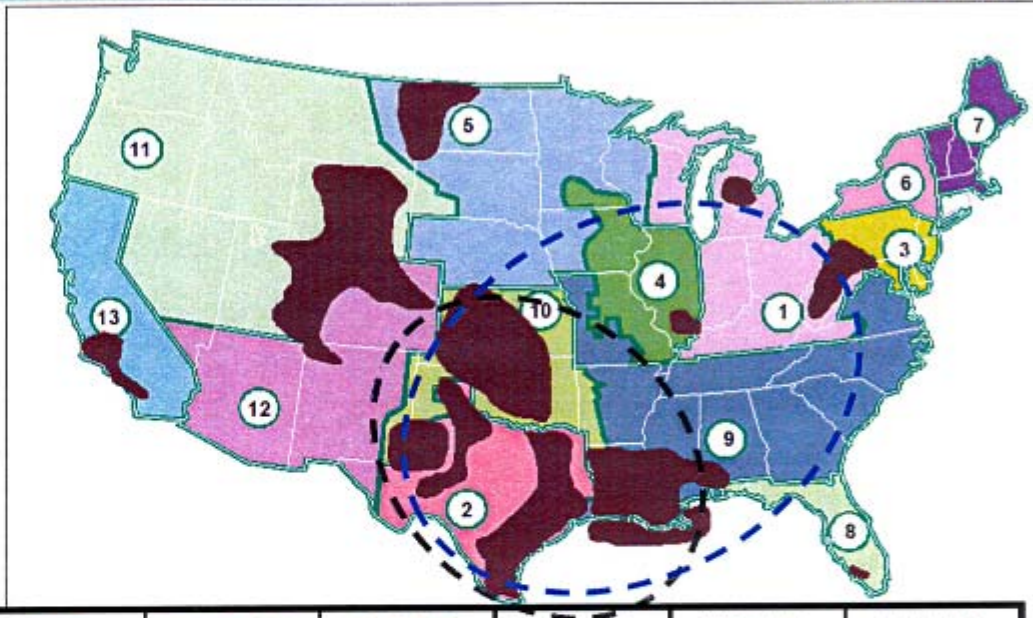


- Economic potential between 38-58 bn bbl, at \$70/bbl and \$45/t CO_2
- CO_2 demand between 10-12 bn tons
- 75% of lower-48 potential in four basins in Gulf, Texas, Mid-Continent

Regional results – Lower 48

NRDC
THE EARTH'S BEST DEFENSE

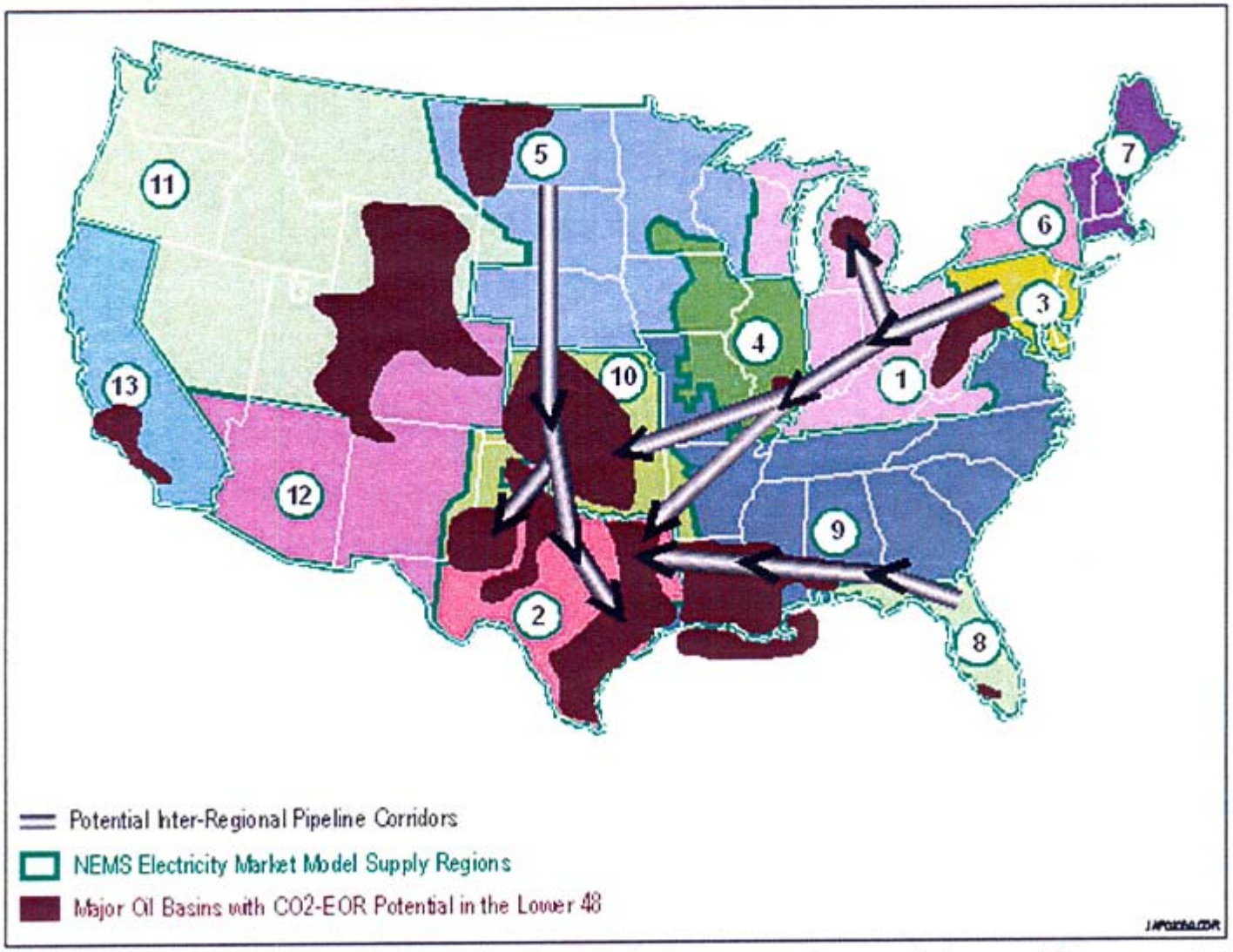
- Regional imbalances in CO_2 supply/demand
- 77% of CO_2 supply within economic distance of 77% of EOR potential
- Inter-regional pipelines



Power region	CA	NW	MAPP	SPP	ERCOT	SERC	MAIN	ECAR	MAAC
GW by 2030	1.6	0.9	5.8	4.8	2.7	23.9	6.1	19.8	8.7
CO_2 captured over 30 yrs	301	169	1090	902	508	4493	1147	3722	1636
Oil basin	CA	WY, UT, CO	MT, ND, SD	NE, KS, OK	NM, W.TX	E. TX	LA, MS, AL	MI, IL	OH, KY, PA
CO_2 demand	1459	735	125	1758	3078	2182	812	365	41

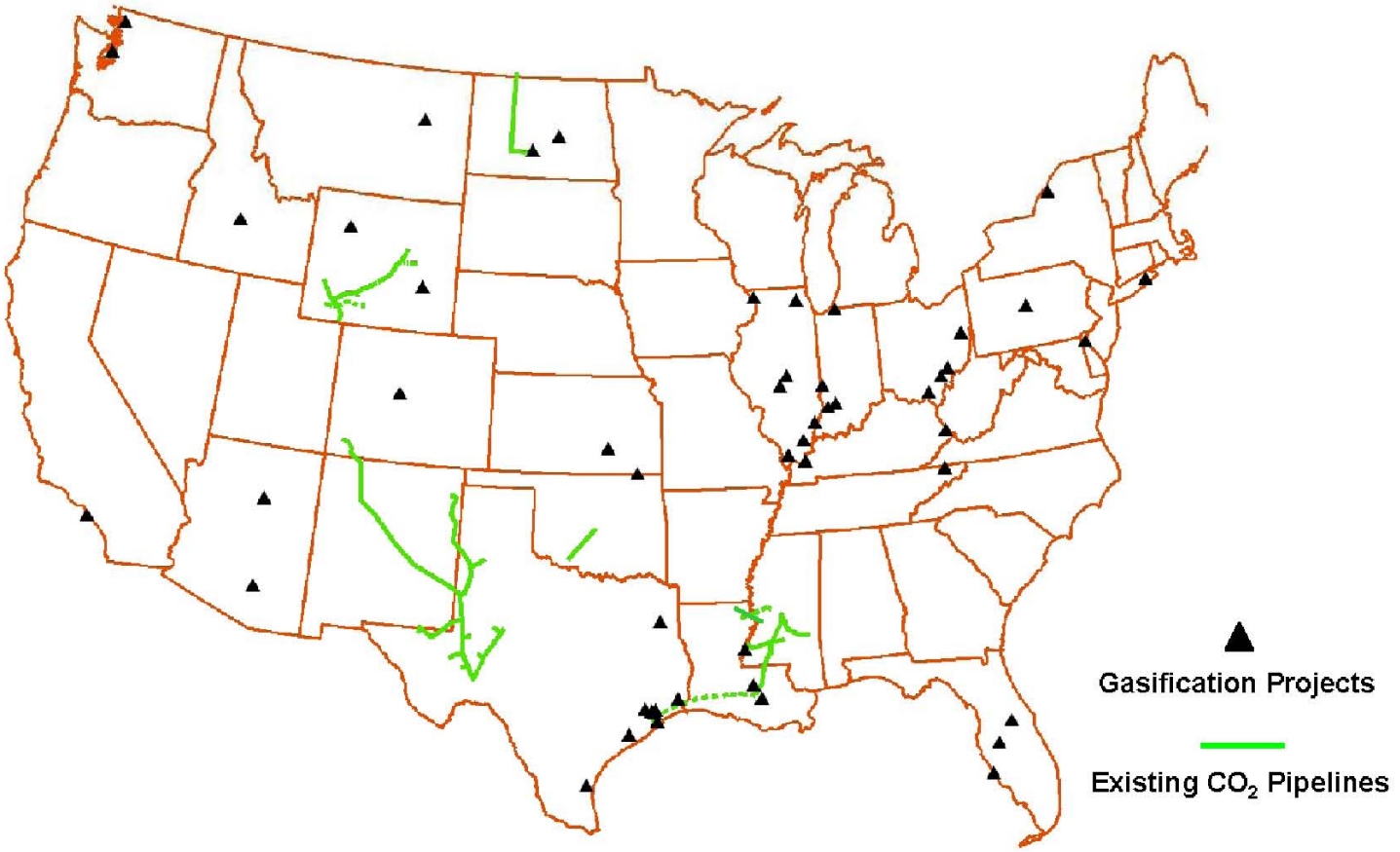
A possible transportation network

NRDC
THE EARTH'S BEST DEFENSE



Source: Advanced Resources International

CO_2 Pipelines vs Proposed Gasification Projects



Medicine Bow - EOR Opportunities in Wyoming

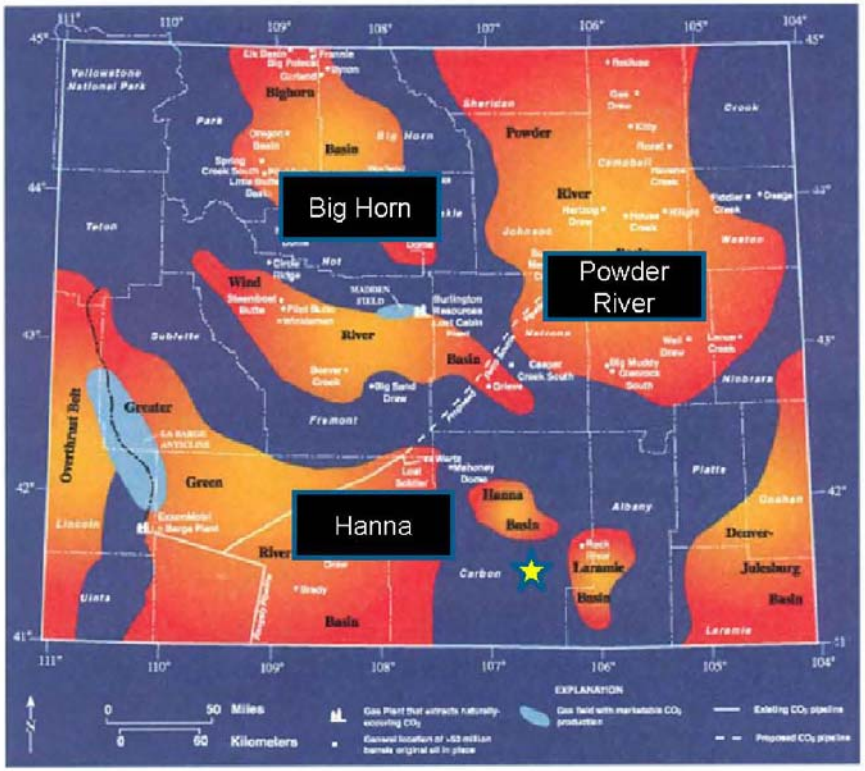


Figure 3. Fields and facilities in Wyoming related to carbon dioxide production, locations of current enhanced oil recovery operations that use carbon dioxide, and major oil fields that had 50 million or more barrels of original oil in place.

EOR Potential in WY

Reserves in Place = 8 bn bbls
Recoverable w/ CO2 = 5%-15%
Recoverable w/CO2 = .4-1.2 bn bbls
CO2 @ 6mcf/bbl = 2.4-7.2 TCF

Medicine Bow Site

CO2 EOR Regions

Source:
www.eori.uwyo.edu
www.fe.doe.gov/programs/oilgas/eor/

Site located near EOR and CCS opportunities

DKRW Advanced Fuels

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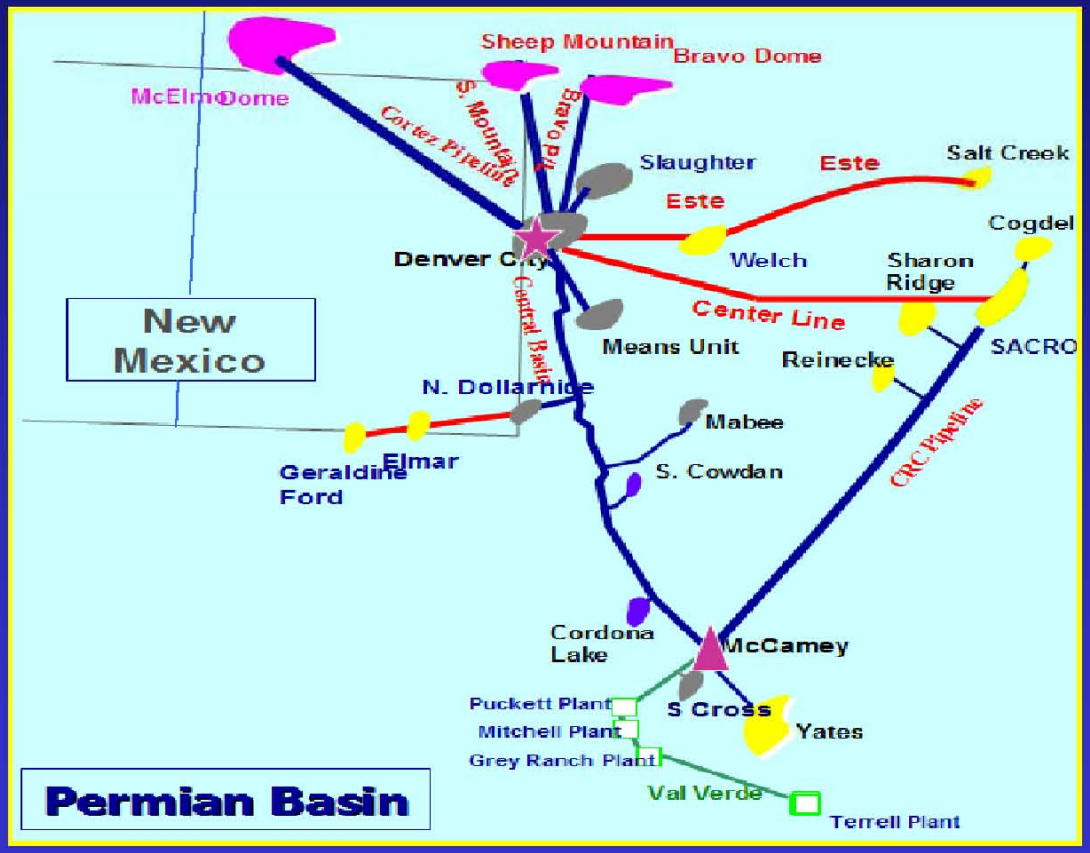
REGION OF INFLUENCE

CO_2 Pipeline To Canada

THIS CO_2 EOR IS BIG BUSINESS*

Case History: Permian Basin Fields & Infrastructure

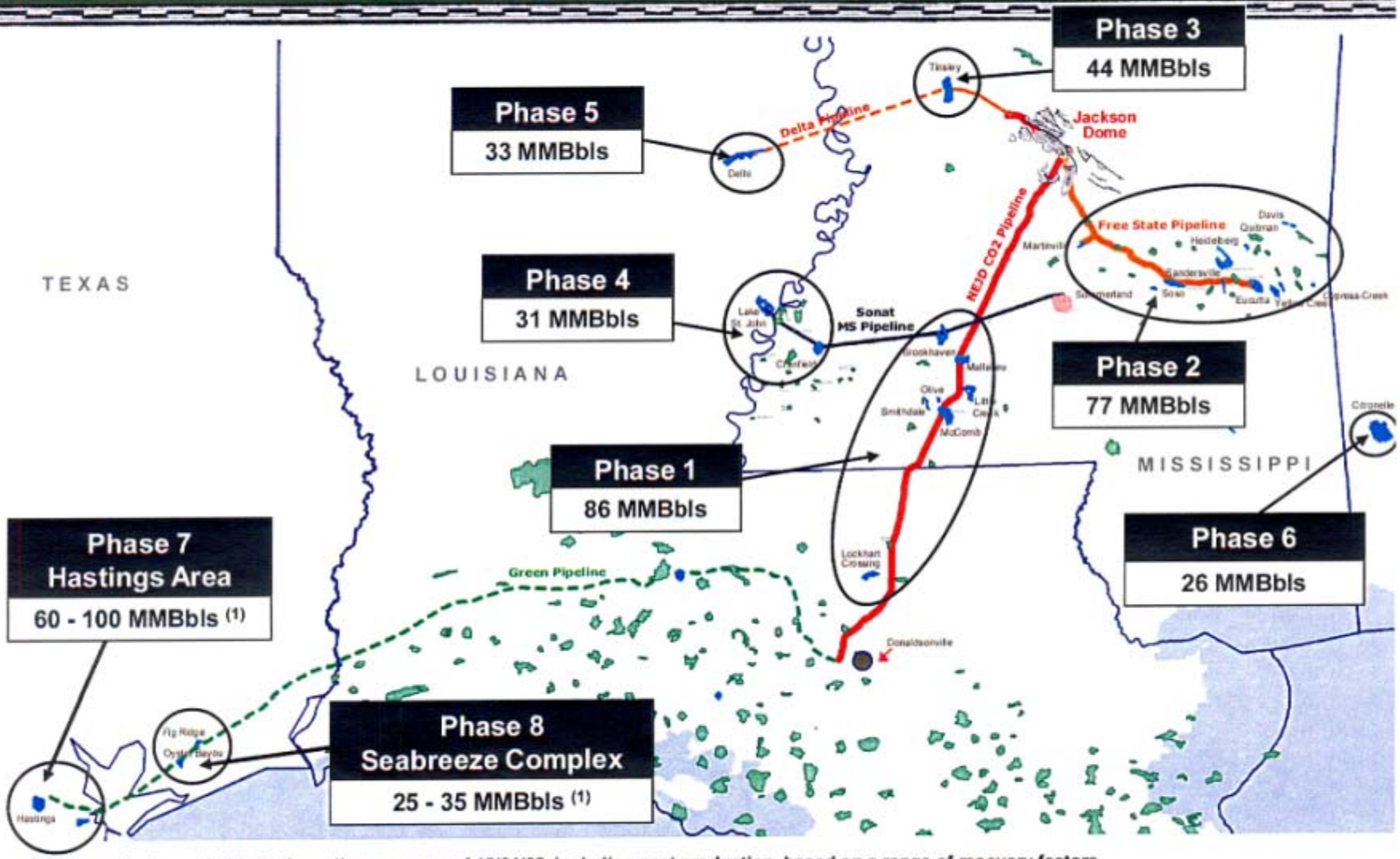


*** Est. yearly PB figures:**

- the 180,000 bopd is directly valued at $3.3 billion ($50/bbl)
- The 1.7 bcfpd commodity CO_2 transaction value is ~$400 million

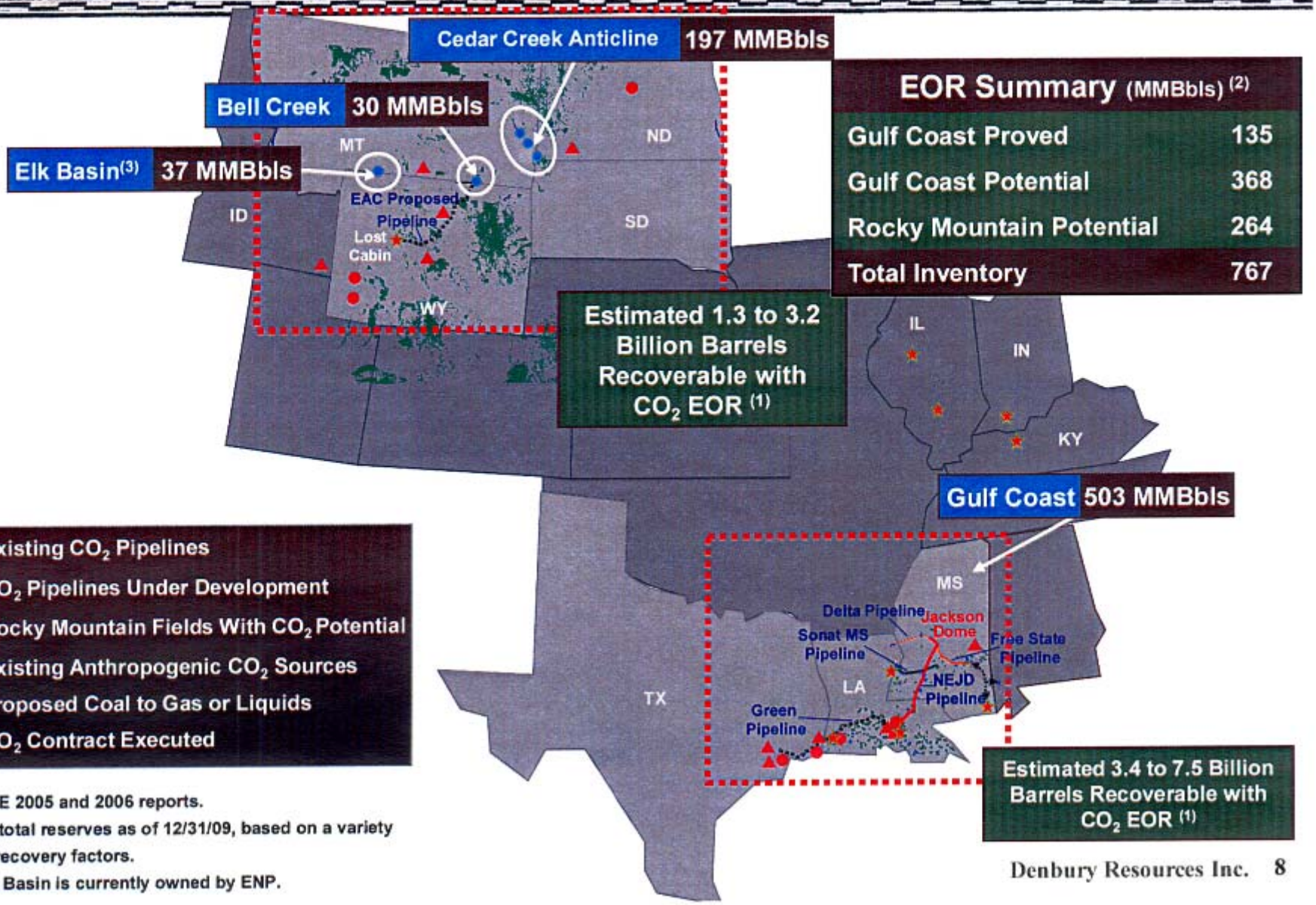
And just the 2500 miles of CO_2 Pipelines themselves are conservatively worth over $2 billion

2009 - CO_2 Projects



(1) Proved plus probable tertiary oil reserves as of 12/31/08, including past production, based on a range of recovery factors. Hastings Field was purchased 2/2/09.

Transferring Gulf Coast CO_2 Success to Rockies



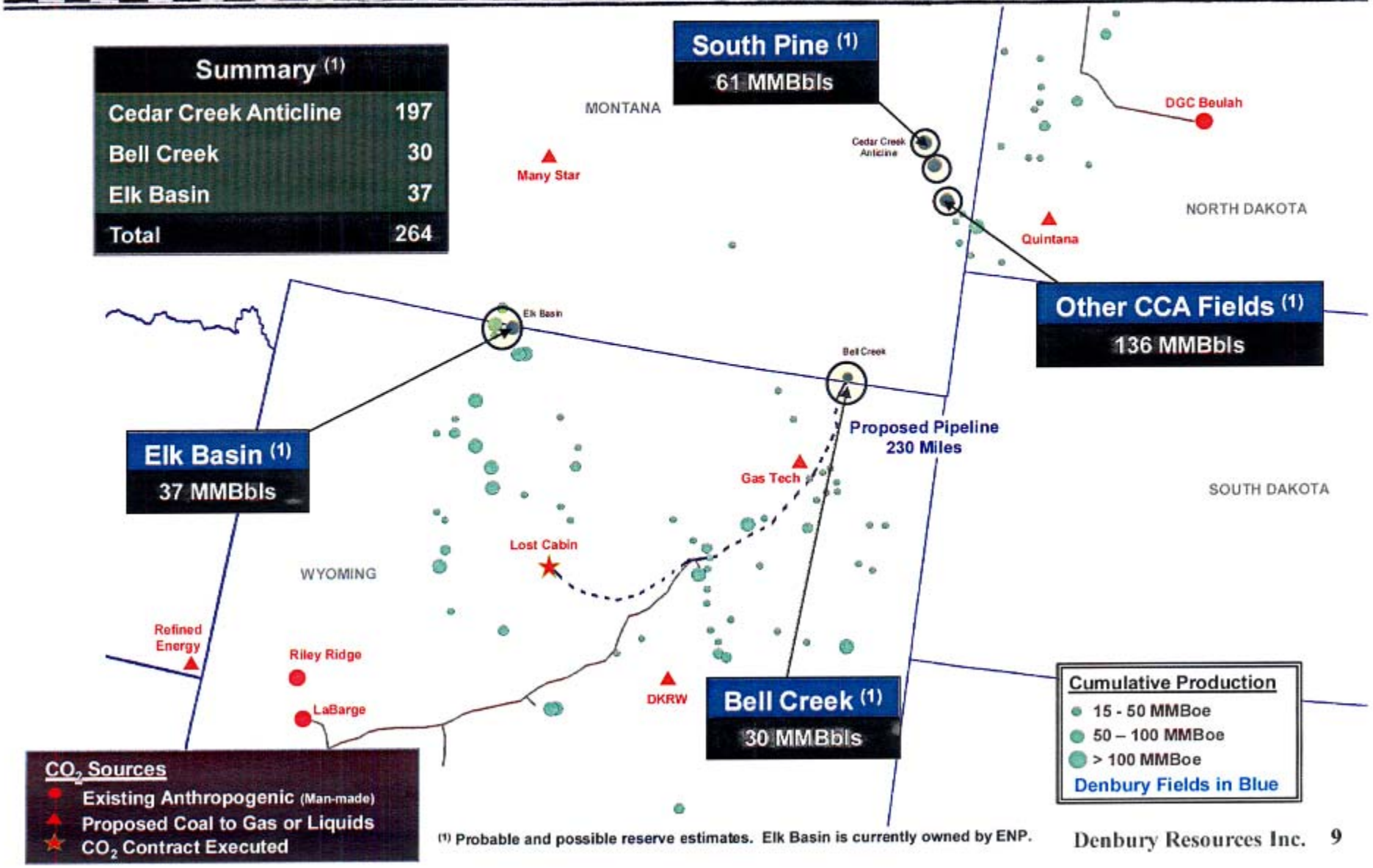
EOR Summary (MMBbls) (2)	
Gulf Coast Proved	135
Gulf Coast Potential	368
Rocky Mountain Potential	264
Total Inventory	767

(1) DOE 2005 and 2006 reports.

(2) 3P total reserves as of 12/31/09, based on a variety of recovery factors.

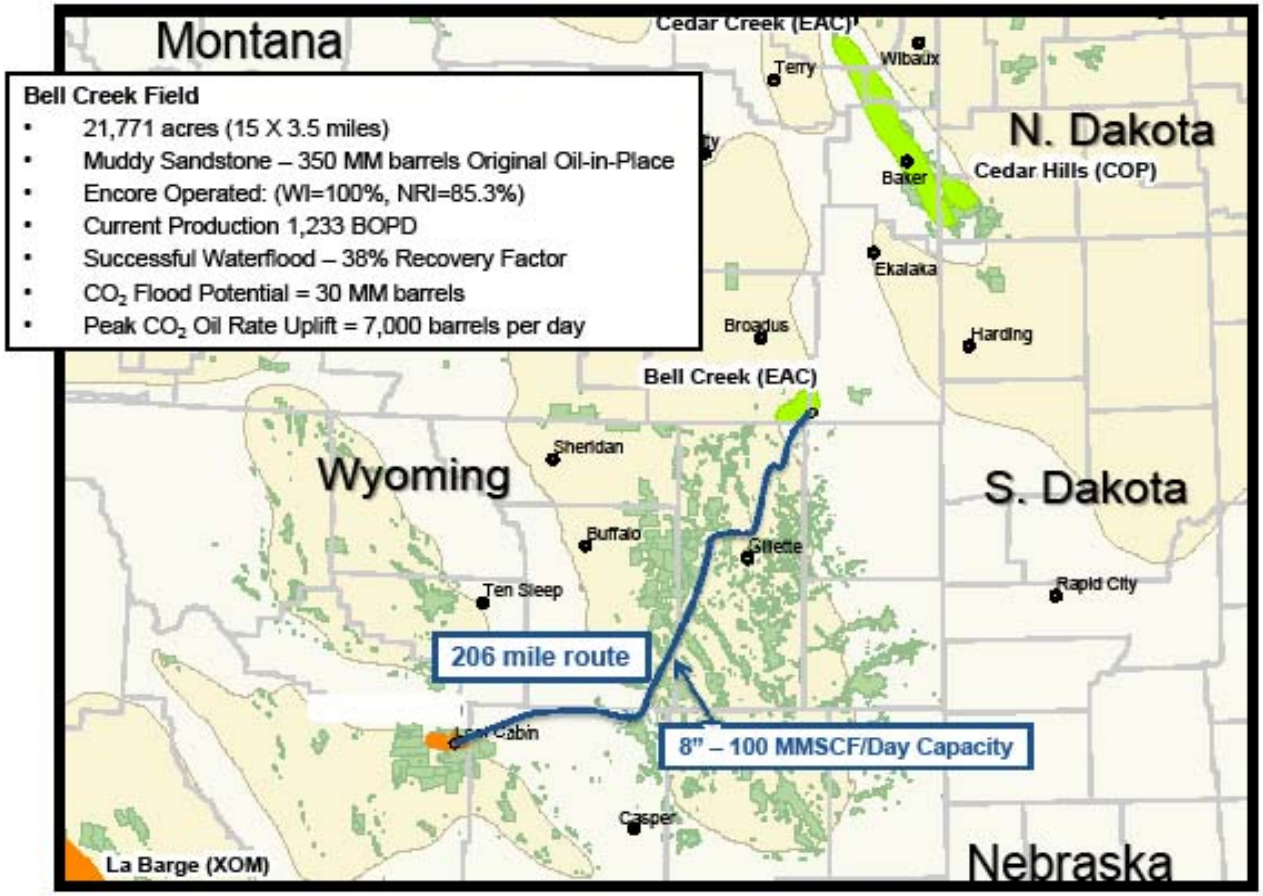
(3) Elk Basin is currently owned by ENP.

Rockies CO_2 Projects



(1) Probable and possible reserve estimates. Elk Basin is currently owned by ENP.

Bell Creek CO_2 Project – Overview Map



Bell Creek Field

- 21,771 acres (15 X 3.5 miles)
- Muddy Sandstone – 350 MM barrels Original Oil-in-Place
- Encore Operated: (WI=100%, NRI=85.3%)
- Current Production 1,233 BOPD
- Successful Waterflood – 38% Recovery Factor
- CO_2 Flood Potential = 30 MM barrels
- Peak CO_2 Oil Rate Uplift = 7,000 barrels per day

Bell Creek is a good stepping stone to Cedar Creek

- Encore will control the infrastructure in the Northern Powder River Basin into the Williston Basin.
- Bell Creek is an ideal project from an Original Oil-In-Place and reservoir characteristics standpoint.
- Encore will leverage our CO_2 knowledge and infrastructure into acquisition opportunities and expanding into our existing fields.
- The Cedar Creek Anticline is a 200 MM barrel CO_2 target.

Anadarko's Wyoming EOR Assets

- **Fields**
  - Monell
  - Salt Creek
- **Pipelines**
  - 33 mile, 8"
  - 125 mile, 16"
- **CO_2 Supply**
  - XOM Shute Creek

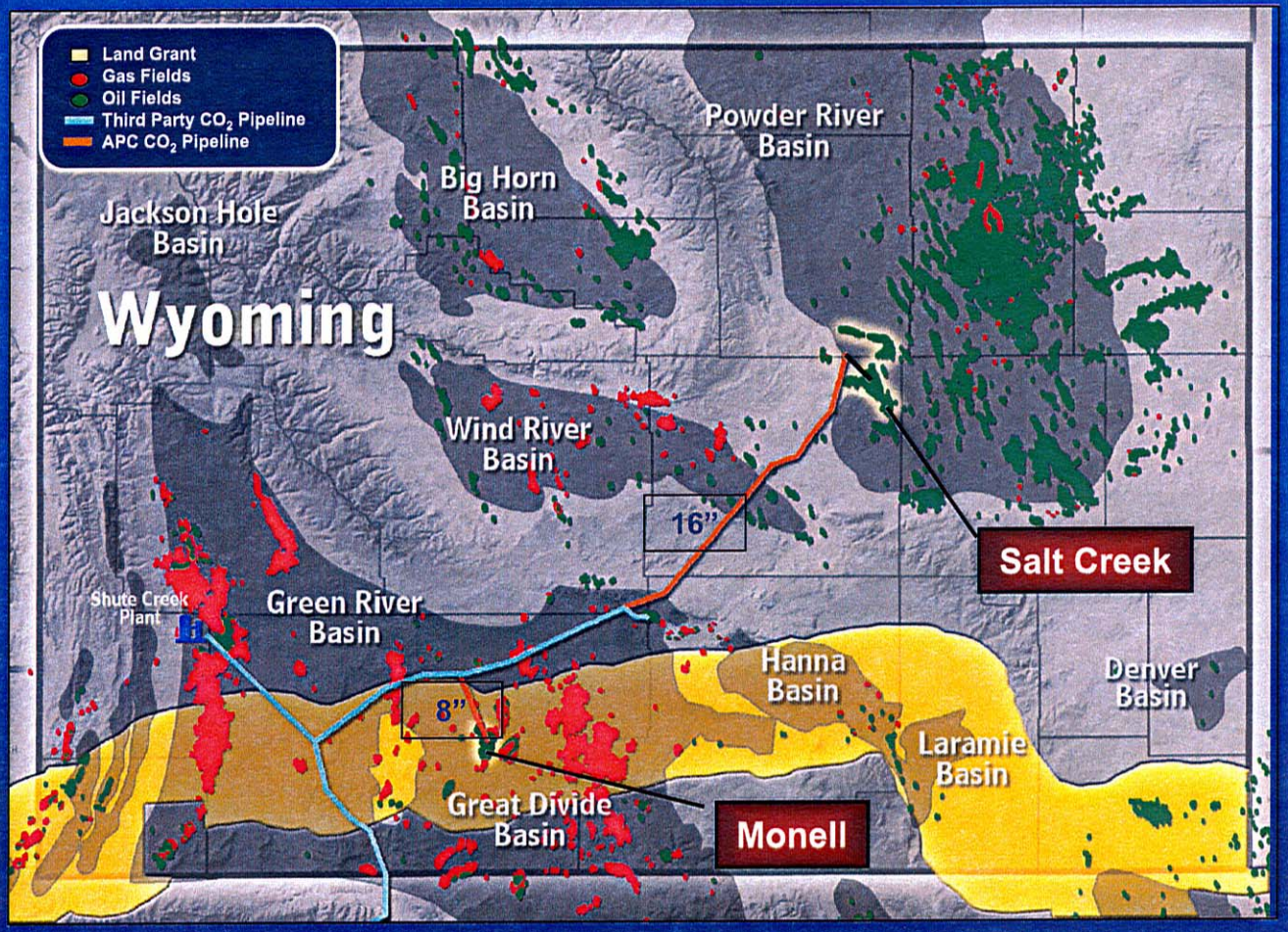


Photo by Jason Aslinger

Questions?
Thanks!

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