
Environmental Issues and Solutions in Exploration, Production, Refining & Distribution of Petroleum

**October 14-16, 2014**
**Houston, Texas**
**Marriott Westchase Hotel**

# *High Density Polyethylene (HDPE) Lined Evaporation Ponds*

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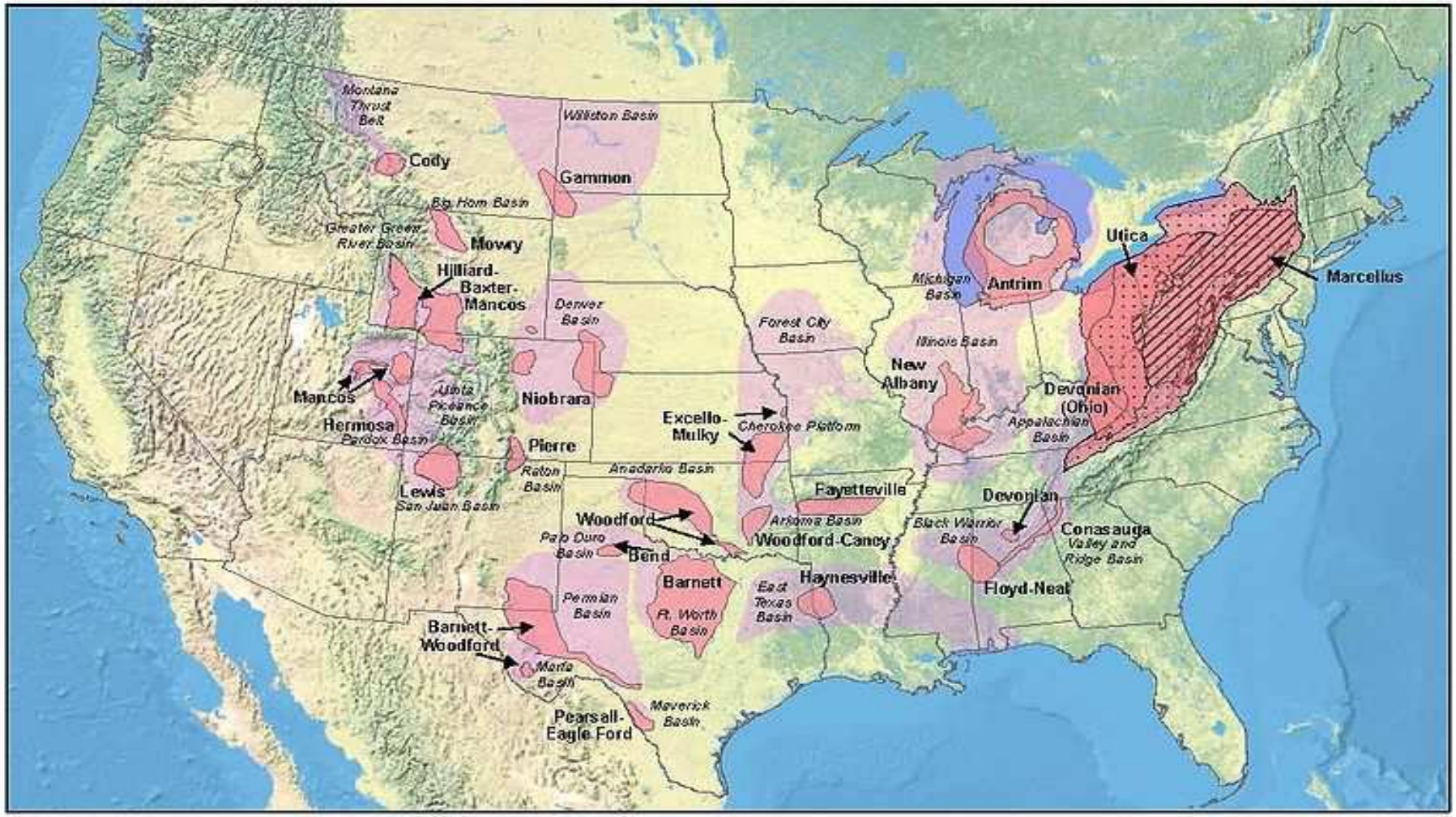
# TOPIC OF PRESENTATION:

Use of High Density Polyethylene (HDPE) as the top layer of brine (production), and flow back water evaporation pond facilities. Case study.

# HDPE Lined Evaporation Ponds

# PURPOSE:

- Dispose of production water and flow back water generated from oil and gas development.
- Several million barrels of production water and flow water is generated each year in the mountain states.
- Other types of evaporation and disposal facilities exist.




# United States Shale Gas Plays

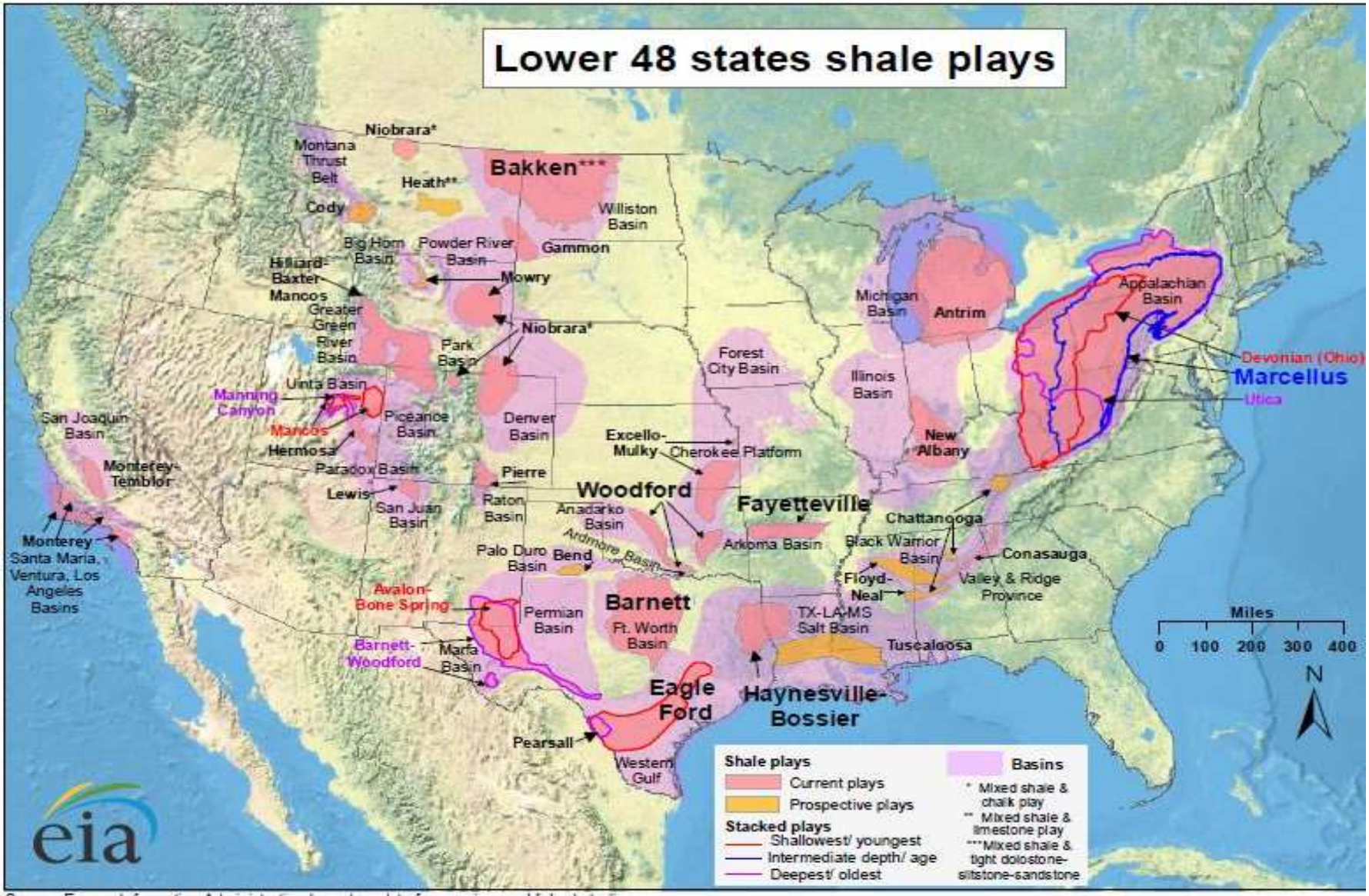
www.eia.doe.gov
Energy Information Administration
Office of Oil and Gas

Shale Gas Plays
Basins

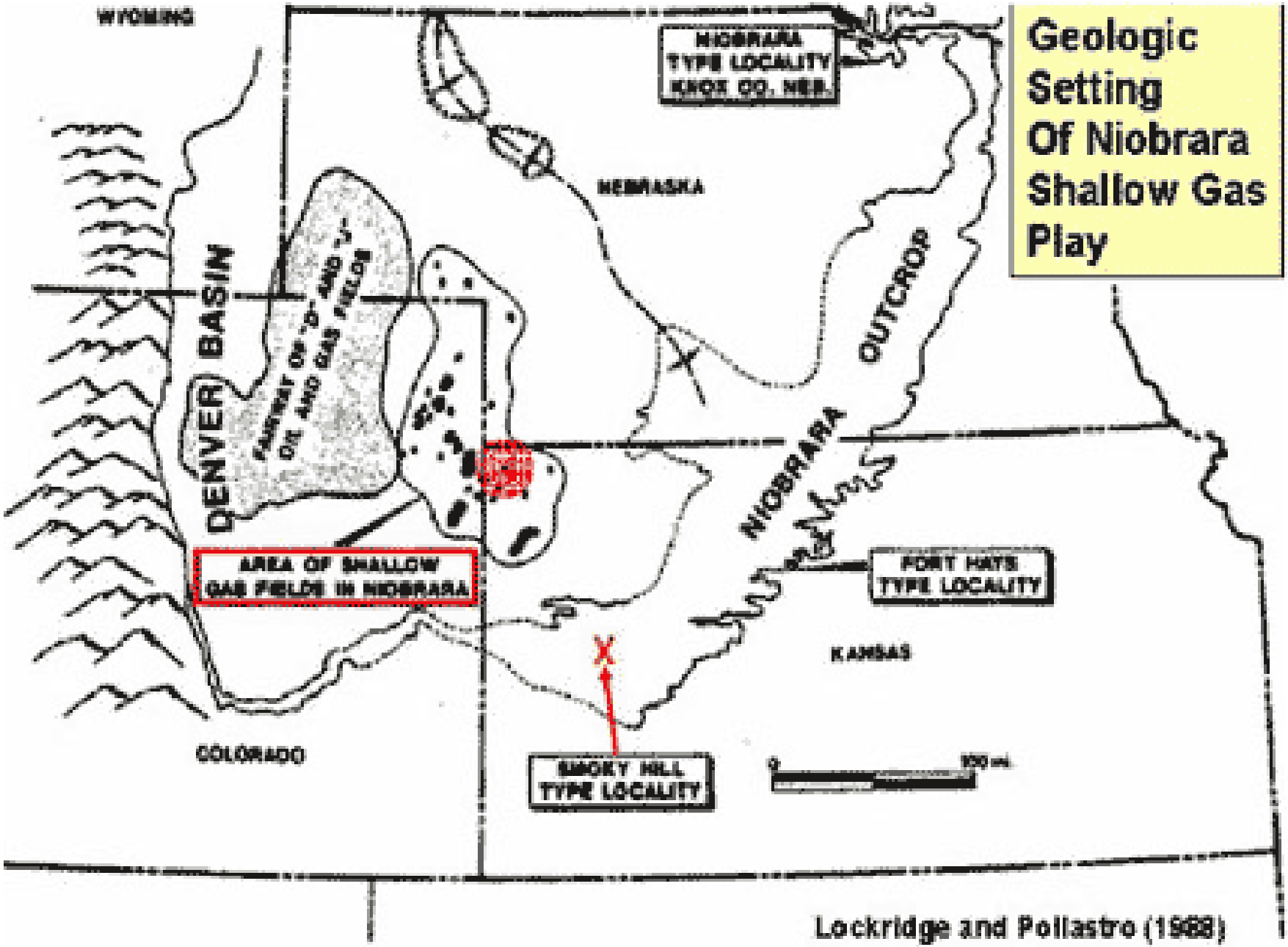
**Stacked Appalachian Plays**
Marcellus
Utica
Devonian (OH shale)

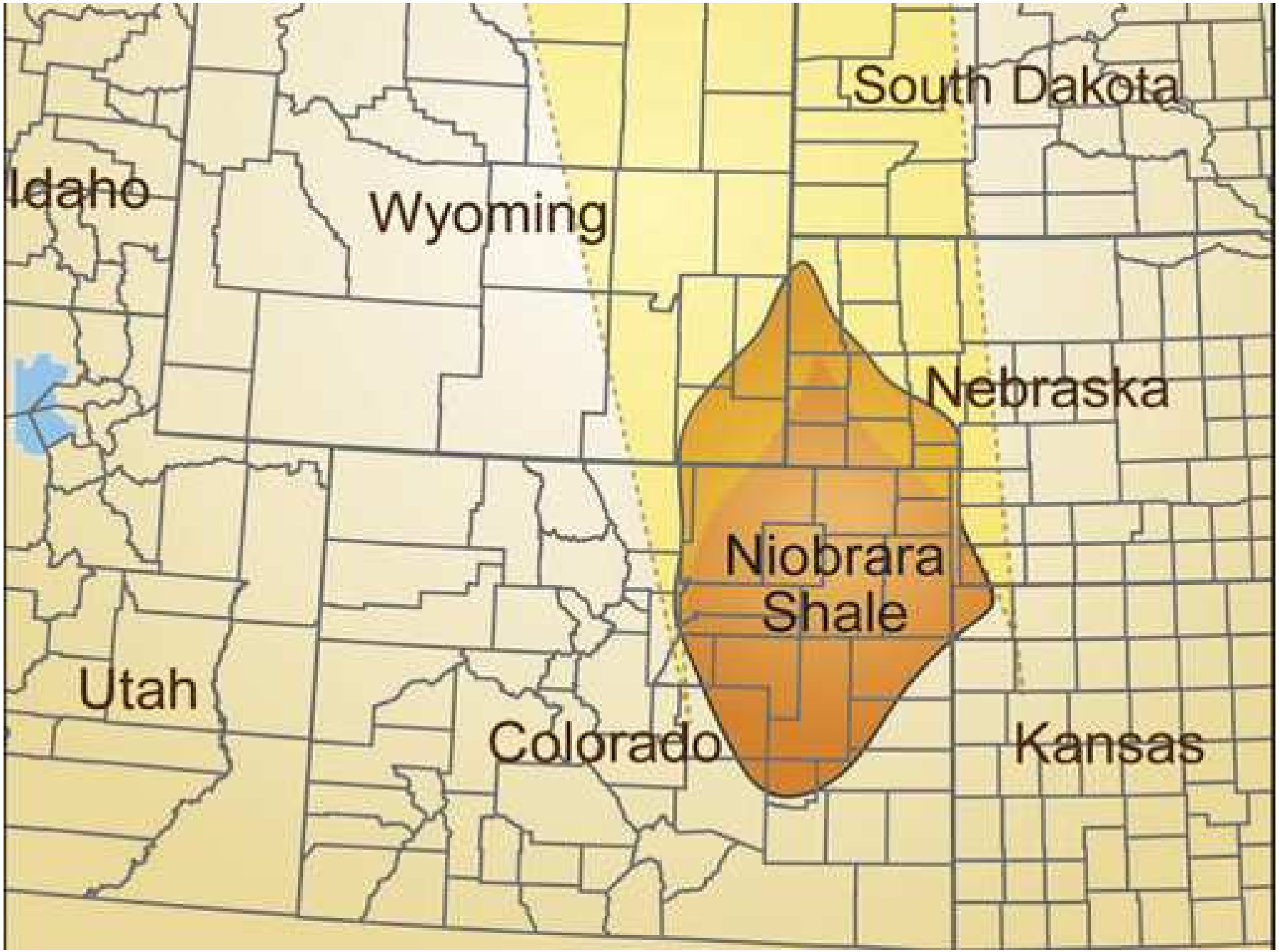
November 2008
Miles
0 150 300 600

N

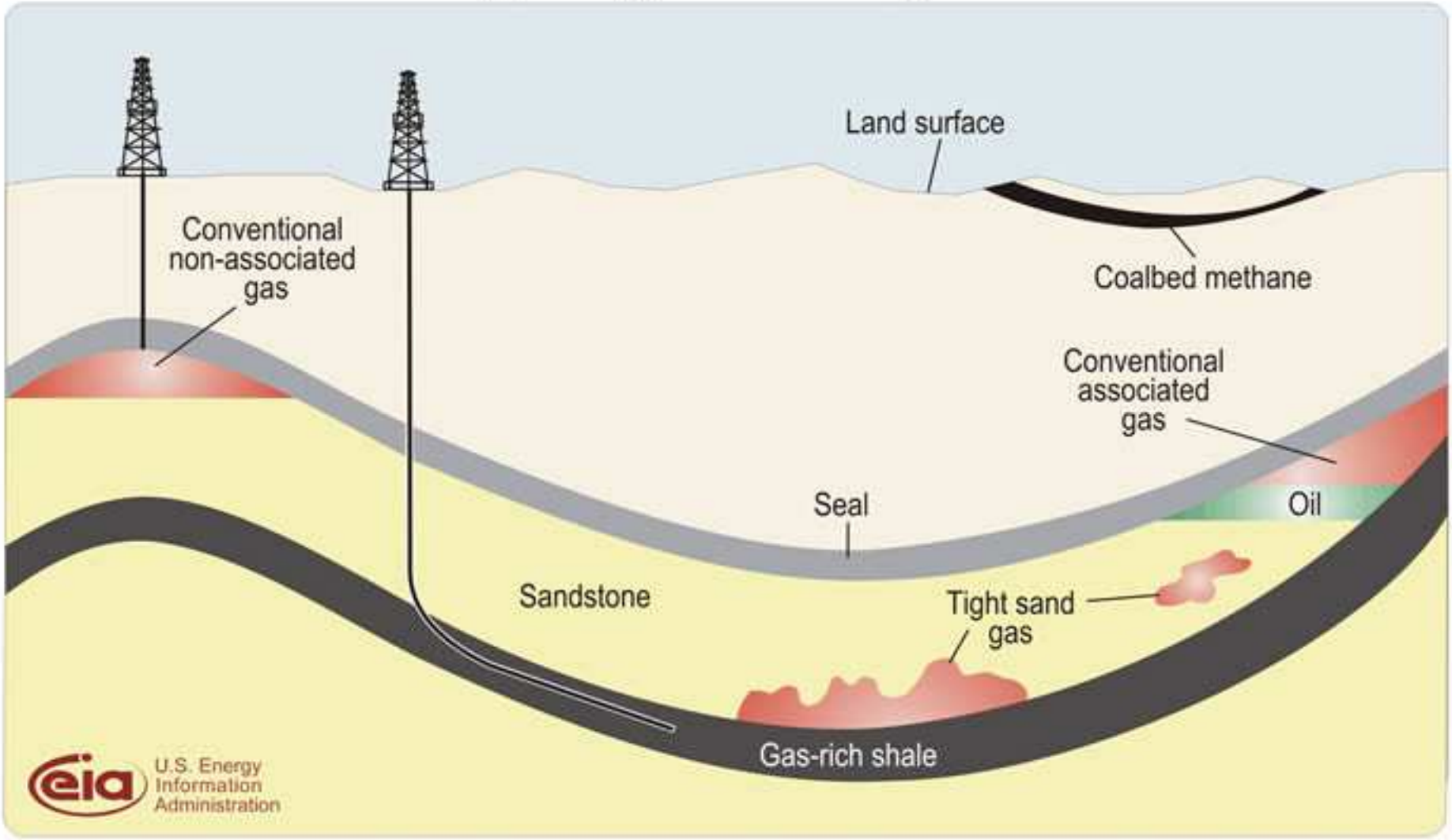



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011


Geologic Setting Of Niobrara Shallow Gas Play
WYOMING
NIOBRARA TYPE LOCALITY KNOX CO. NEB.
NEBRASKA
DENVER BASIN
FARMER OIL AND GAS FIELDS
NIOBRARA OUTCROP
AREA OF SHALLOW GAS FIELDS IN NIOBRARA
FORT HAYS TYPE LOCALITY
KANSAS
COLORADO
SMOKY HILL TYPE LOCALITY
Lockridge and Pollastro (1988)


South Dakota
Idaho
Wyoming
Nebraska
Niobrara
Shale
Utah
Colorado
Kansas

# Schematic geology of natural gas resources



# Produced Water, Flow Back Water and Leachate

In the shale, if the natural fracture is not fully developed, then the shale is further opened using hydro-fracture to assist with the release of the gas and oil from the shale.

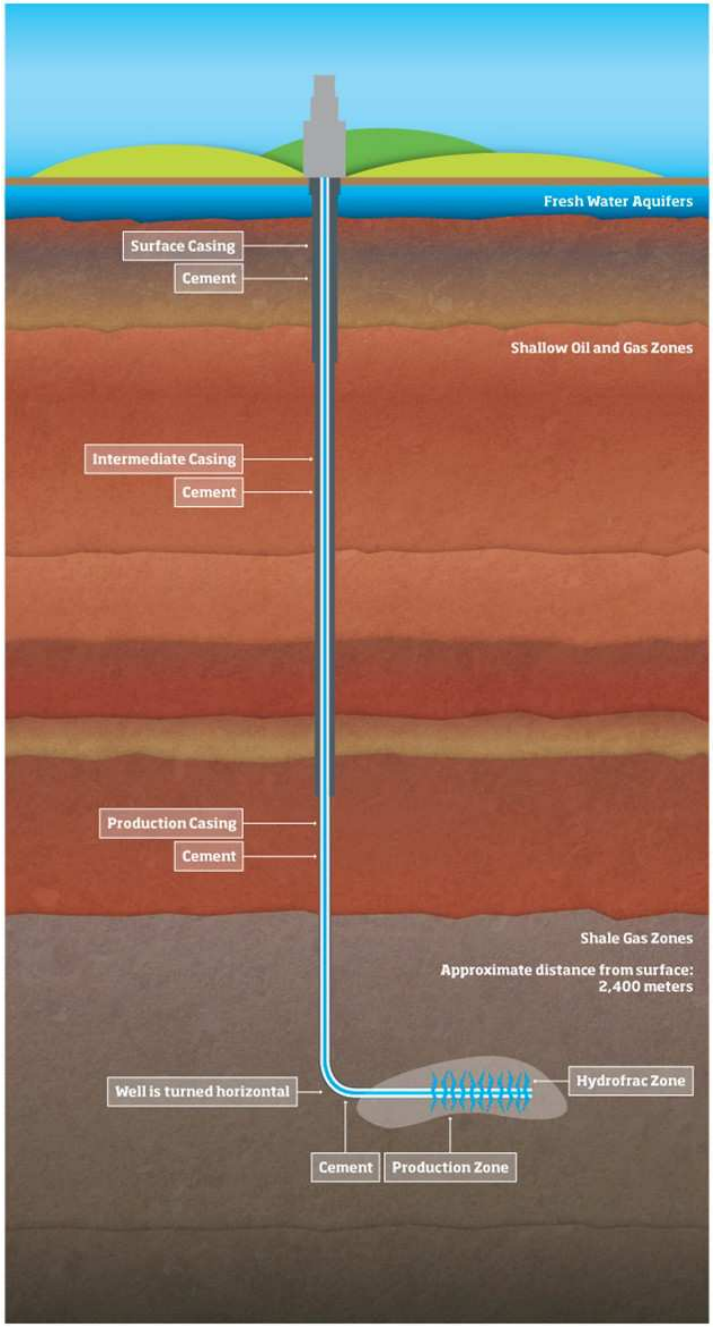
The cleats are opened up with a frac-water mixture injected into the formation at various locations within the seam.

A typical shale gas/oil extraction well diagram with horizontal fracturing.

Good websites to visit for videos of fracking or horizontal drilling:

http://www.northernoil.com/drilling.php

http://youtu.be/6u4Srzx6Ncw

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# SELECTION OF TECHNOLOGY:

Technologies for managing production and flow back water:

- Disposal injection into acceptable zone
- "Frac" injection of the water into the production formation to enhance yield
- Treatment for surface discharge or reuse
- Evaporation

# HDPE Lined Evaporation Ponds Not Extinct Yet?

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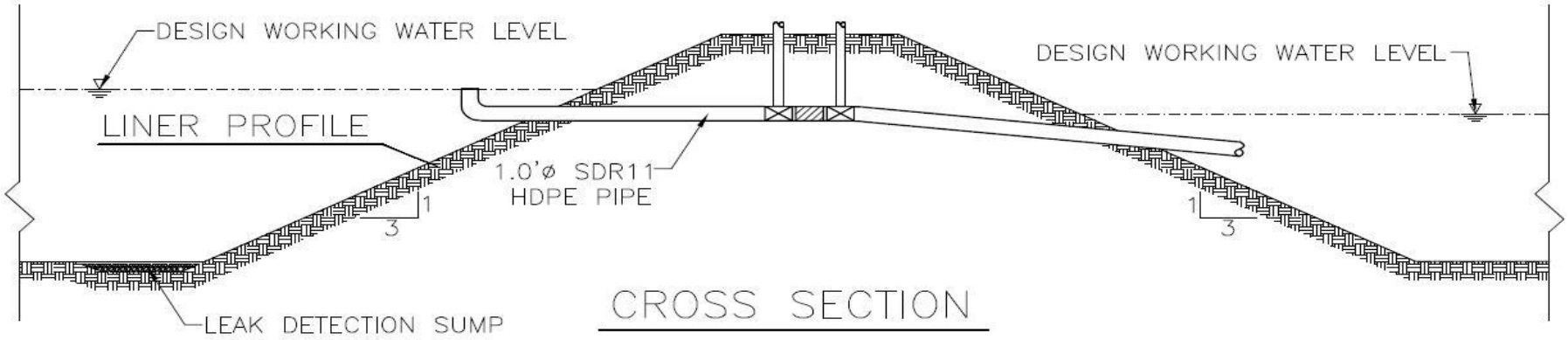
# DESIGN…WHY HDPE?:

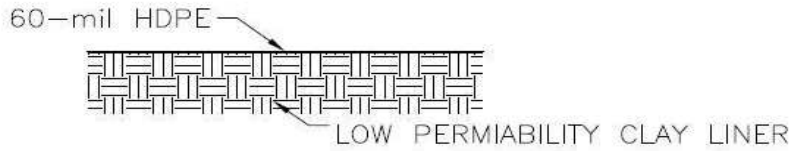
Textured 60-mil HDPE for top liner of ponds not buried.

- Ultraviolet (UV) degradation resistance.
- Durability (20 plus years, *Ivy 2002*).
- Chemical resistance.
- Black color enhances evaporation of water.
- HDPE was chosen over clay liner and other geomembranes due to being the most compatible with site conditions and regulations (i.e. exposed to sunlight, desiccation, and hydrocarbons).
- Textured surface used to aid with traction if operations personnel fall into ponds, and to increase slope friction and stability.

# DESIGN (continued):




CROSS SECTION




LINER PROFILE

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High Density Polyethylene (HDPE) designed as the primary or top layer of the lined ponds in order to protect the groundwater and to enhance the evaporation of the production water within the ponds.

# CONSTRUCTION

Ponds designed and constructed with one or two geomembranes over compacted clay or geosynthetic clay liner and a geonet leak layer in between to monitor the primary liner for leaks.

# CONSTRUCTION

Geomembrane panels are welded together throughout the installation performed by trained and certified technicians.

# CONSTRUCTION

Geomembrane panels are tested for strength throughout the installation performed by trained and certified technicians.

# Projects located in semi-arid regions:

- Eastern Utah (Danish Flats) near Cisco
- North of Baggs, WY (Southern Cross)
- Cheyenne, WY (Silo Field)


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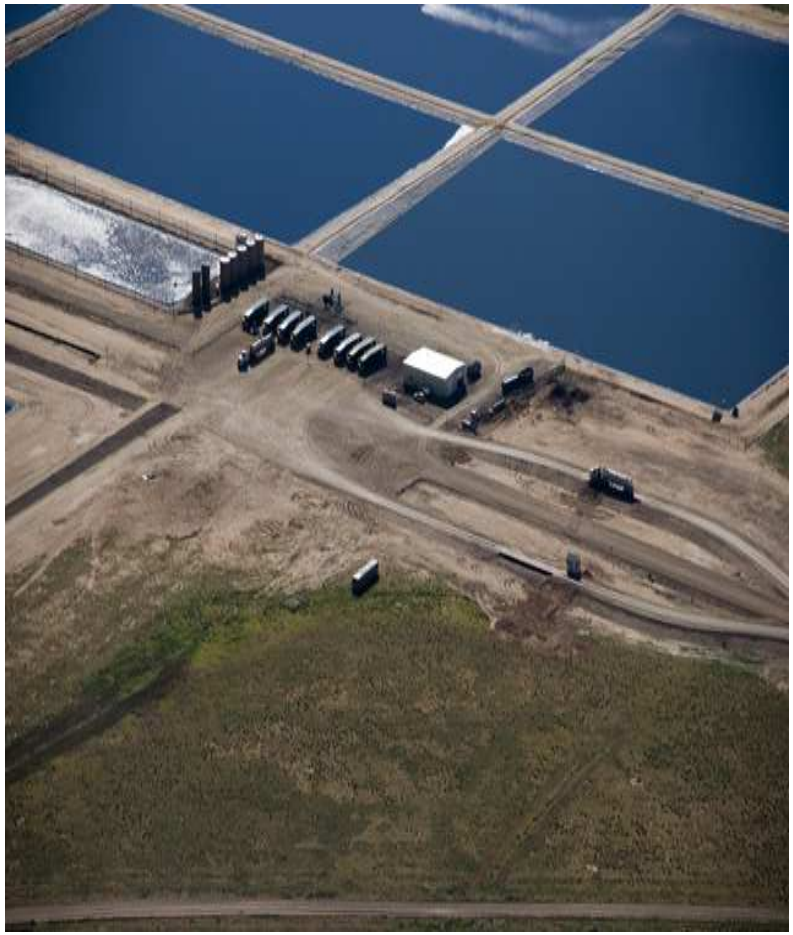
# PROCESS:

Production water delivered to the sites via tanker trucks for disposal by evaporation.

- Danish Flats facility went operational with 4 ponds in May 2008, and currently at 14 ponds operational as of Sep 2012.
- Southern Cross facility went operational with 2 ponds in July 2008 with an additional 3 ponds constructed in 2011 and 2012.
- Silo Field near Cheyenne, WY went operational in June 2012 with 3 ponds and state-of-the-art oil/water separation equipment.



# PROCESS (continued):

- Each constructed evaporation pond is approximately 5.2 acres at the top of the berm (DF, Utah=70 acres of ponds, Southern Cross, WY=20 acres of ponds, and Silo Field, WY will be 15 acres of ponds).
- The evaporation ponds are designed to hold at capacity:
  - 330,000 barrels (42 gallon/barrel) of water at 12 feet depth
  - 580,000 barrels at 22 feet deep
- Production water (brine water) or flow back water is delivered by truck and moved from an off-loading area to the ponds by gravity, or via force main after removal of the hydrocarbons through pretreatment.
- Hydrocarbons are removed through various pretreatment processes, including gun barrel tanks, sludge pits and state-of-the-art equipment.
- Emissions from pretreatment are routed to a control device.

Truck receiving area/off-loading via hose and pipeline to initial phase separation in acceptance pits or gun-barrel tanks (Danish Flats, Southern Cross, and Silo Field).

At Danish Flats, off-gases from acceptance pits and gun barrel tanks are routed to a control device, which includes a thermal oxidizer and scrubber.

From acceptance pits/gun-barrel tanks the water moves by gravity to the HDPE lined settlement/sludge pond for last stage of hydrocarbon removal and collection at Southern Cross, Danish Flats, and Silo Field. However, these sludge ponds require bird-netting to cover the water, which will likely have floating hydrocarbon.

These sludge ponds also are emission sources for volatile organic compounds (VOCs) and may be concerns with air pollution permitting if the sheen is not removed promptly.

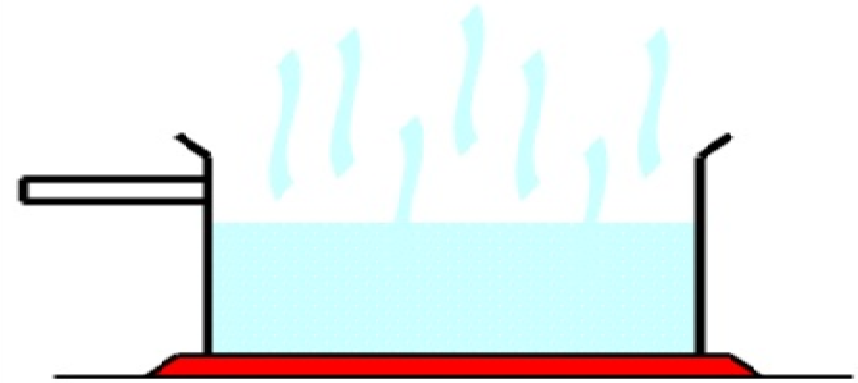
The water is fed by gravity or force main pipe to the evaporation ponds from the settlement/sludge pond or directly from the oil/water separation equipment.

# EVAPORATION:

- Ponds designed to store and evaporate production and flow back water.
- Top layer of the pond liner is textured surface 60-mil HDPE.
- Climate at these sites are ideal in the semi-arid mountain west for evaporation during May through October.
- HDPE liner aided evaporation due to black color of surface.

# EVAPORATION (continued):

- Design evaporation rate estimated to be approximately 50 inches of water annually at Danish Flats, and 40 inches at Southern Cross.



- Actual annual evaporation encountered during 2008 was nearly 70 inches (an increase of nearly 30% due to shallower water in ponds); in 2009 and 2010 was nearly 60 inches (increase ~15%); and for 2012 was measured at 42 inches for May through August at Danish Flats (incomplete data); and in 2010 was approx. 55 inches at Southern Cross (increase ~30%).
- Design evaporation at Silo Field is approximately 45-46 inches per year.

# EVAPORATION (continued):

- Evaporation is enhanced using the surface of the HDPE geomembrane.

# EVAPORATION (continued):

- During ideal conditions for evaporation (May through October) of water which has been found to be up to 1-inch (approx) per day on the hottest days in July in August.

- During low evaporative months of November through April, the facilities store the water in the ponds.

Ideal conditions for evaporation occurs when:

- The air temperature is above 80 degrees Fahrenheit and sunny,
- The wind blows, and
- The level of water in a pond is not greater than 3 feet deep.


# MAINTENANCE:

- After several years of operation (possibly 8 to 10 years), the “salt” from the production or brine water builds up as precipitate in the pond bottoms.

- Upon excessive build-up of sediments or upon closure, then all the water is evaporated and the sediments dried and either removed or the facility buried (closure).

# CONCLUSIONS:

- Evaporation facilities are serving a need of the region and the oil/gas industry.
- Evaporation of production/flow back water is one of the low cost methods for disposal.
- HDPE as the top layer is the right choice due to proven durability and resistance to UV and chemical degradation.
- HDPE improves the evaporative ability of the ponds with the black color of the liner.

# HDPE Lined Evaporation Ponds

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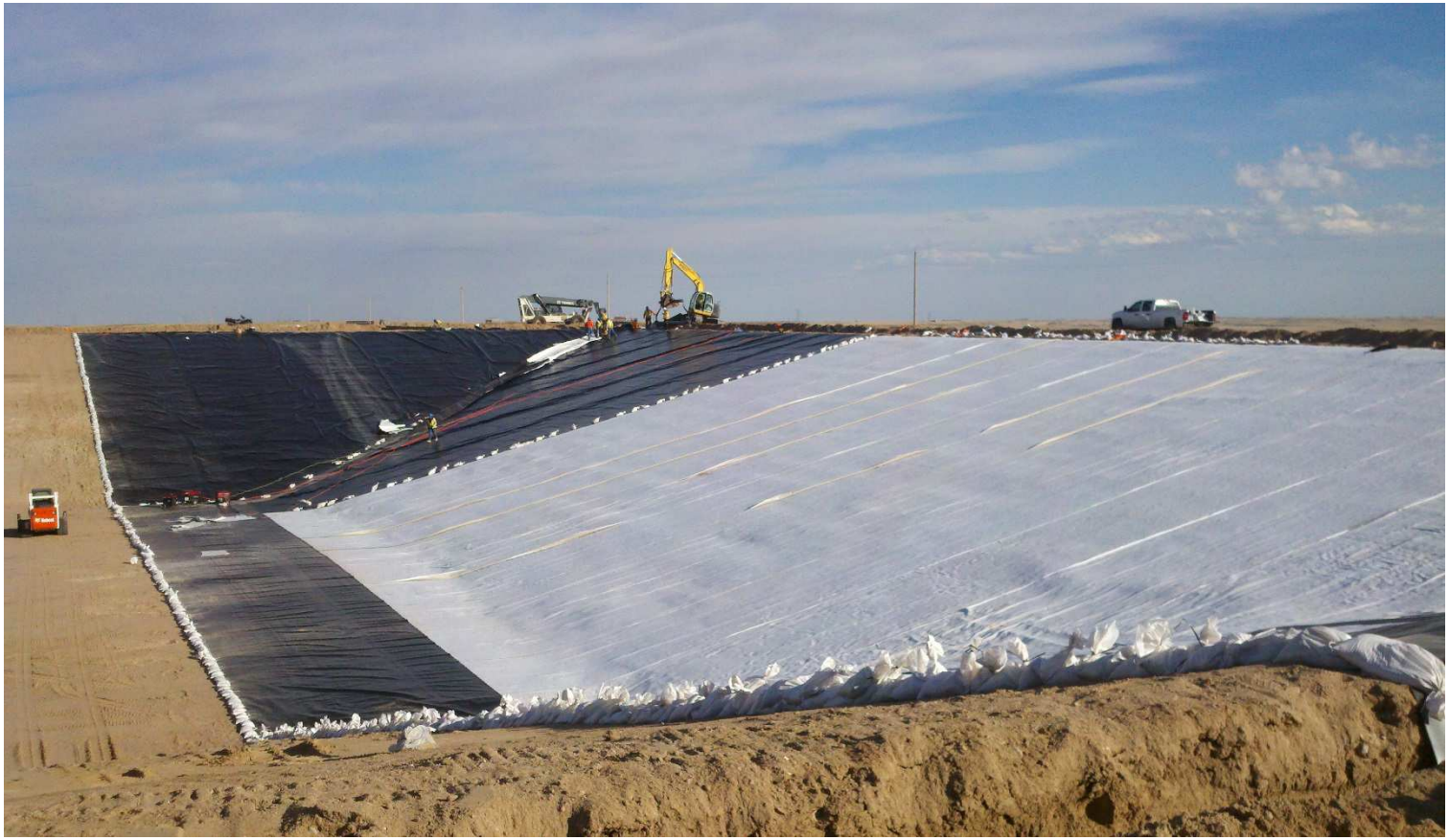
Southern Cross with five ponds operational (2014), including enhanced evaporation sprayers:

# HDPE Lined Evaporation Ponds

Silo Field under construction 2011, includes GCL, and double geomembrane with leak layer in between:



# HDPE Lined Evaporation Ponds

Silo Field under construction 2012

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SUPER BOWL CHAMPIONS
NFL
Reebok


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# Questions are welcome.

Thank you for your interest.

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