

An aerial photograph of a rural landscape. A river flows through the upper left portion of the image. The surrounding area is covered in dense green forest. In the lower right, there is an industrial site, likely an oil drilling operation, featuring a tall derrick, various storage tanks, and equipment. The text is overlaid on the image in a large, bold, yellow font.

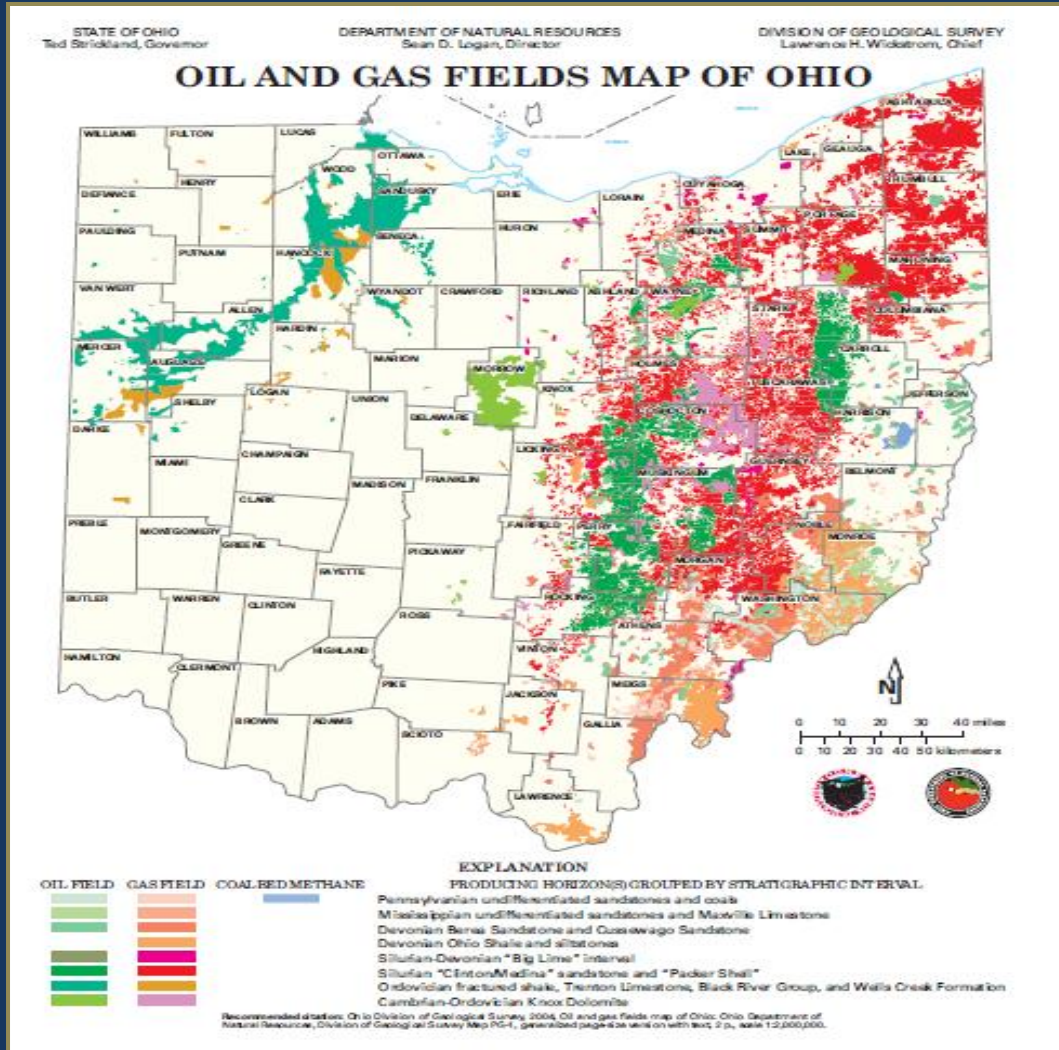
AN OVERVIEW OF UTICA SHALE EXPLORATION AND ASSOCIATED ENVIRONMENTAL CONCERNS

Munson Township
Notre Dame Elementary School
April 4, 2013

Jeffrey C. Dick, PhD
Geological and Environmental Sciences
Youngstown State University

Donald Gillian, 2010

OIL AND GAS FIELDS OF OHIO



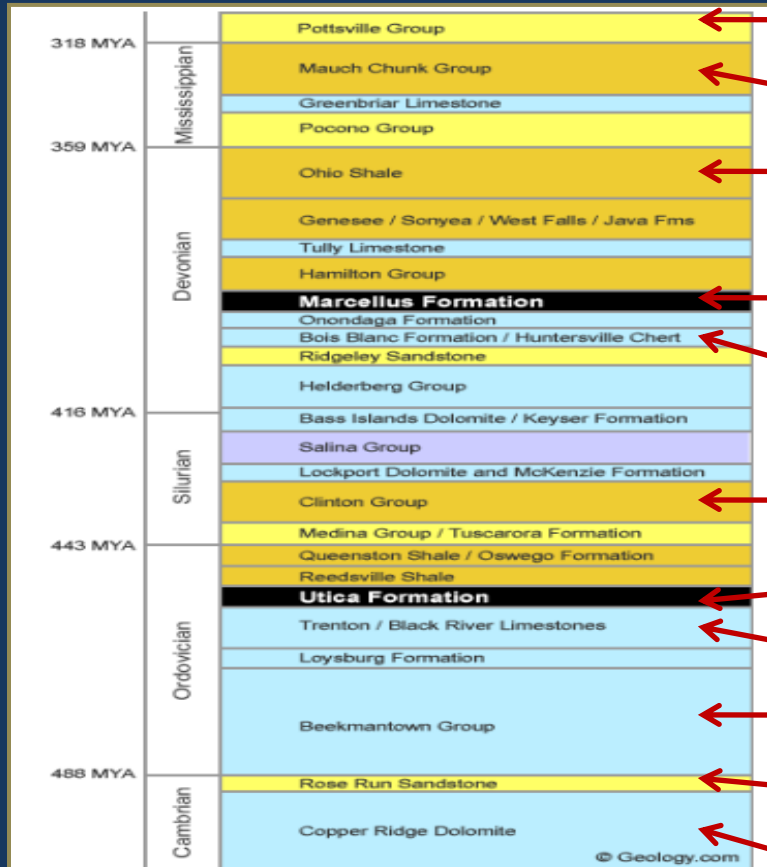
■ ■ OIL

■ ■ GAS

■ Coal Bed Methane

- Total Oil Production: 1.13 BBO
- Total Gas Production: 8.40 TCF
- Total # Wells: > 274,000
- Active # Wells: > 64,000

PRODUCTIVE INTERVALS IN OHIO



Coal Bed Methane
Berea Sandstone
Chagrin-Ohio Shale
Marcellus Shale
Big Lime Intervals
Clinton Sandstone
Utica Shale
Trenton Limestone
Beekmantown Dolomite
Rose Run Sandstone
Trempealeau Dolomite

Figure 5: Generalized stratigraphic sequence of rock units surrounding the Utica Shale and Marcellus Shale. The Utica and Marcellus are so geographically extensive that it is impossible to present a stratigraphic sequence that would be correct in all areas. This diagram presents a generalized sequence of rocks that might be present in the central portion of the Utica Shale Play. Image by Geology.com.

NORTH AMERICA SHALE PLAYS



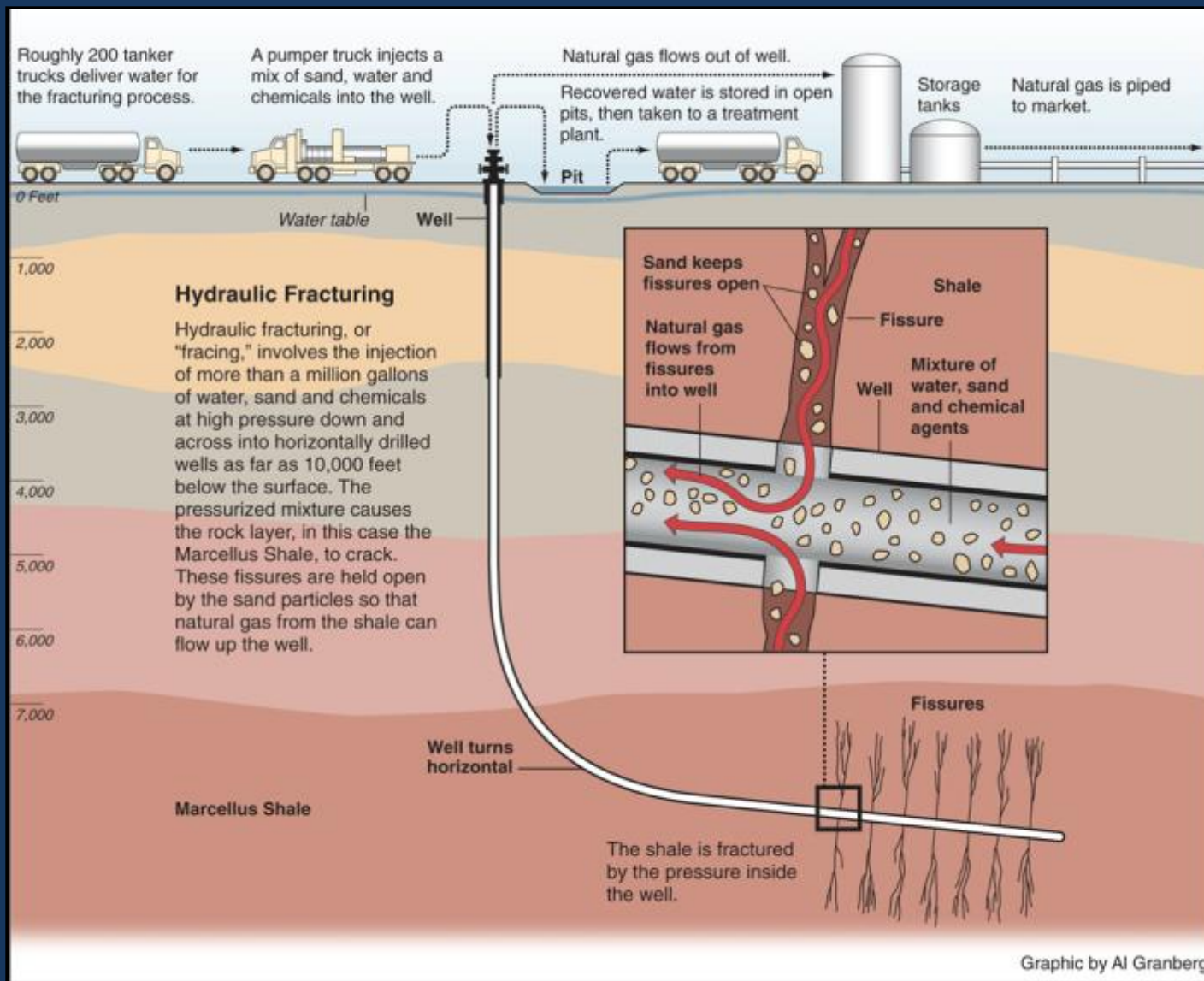
HYDRAULIC FRACTURING or FRACKING

- INDUSTRY DEFINITION: A completion process wherein water, sand, and chemical compounds are pumped under high pressure to fracture a producing formation in order to stimulate production.
- COMMON DEFINITION: Just about anything to do with shale production or unconventional drilling

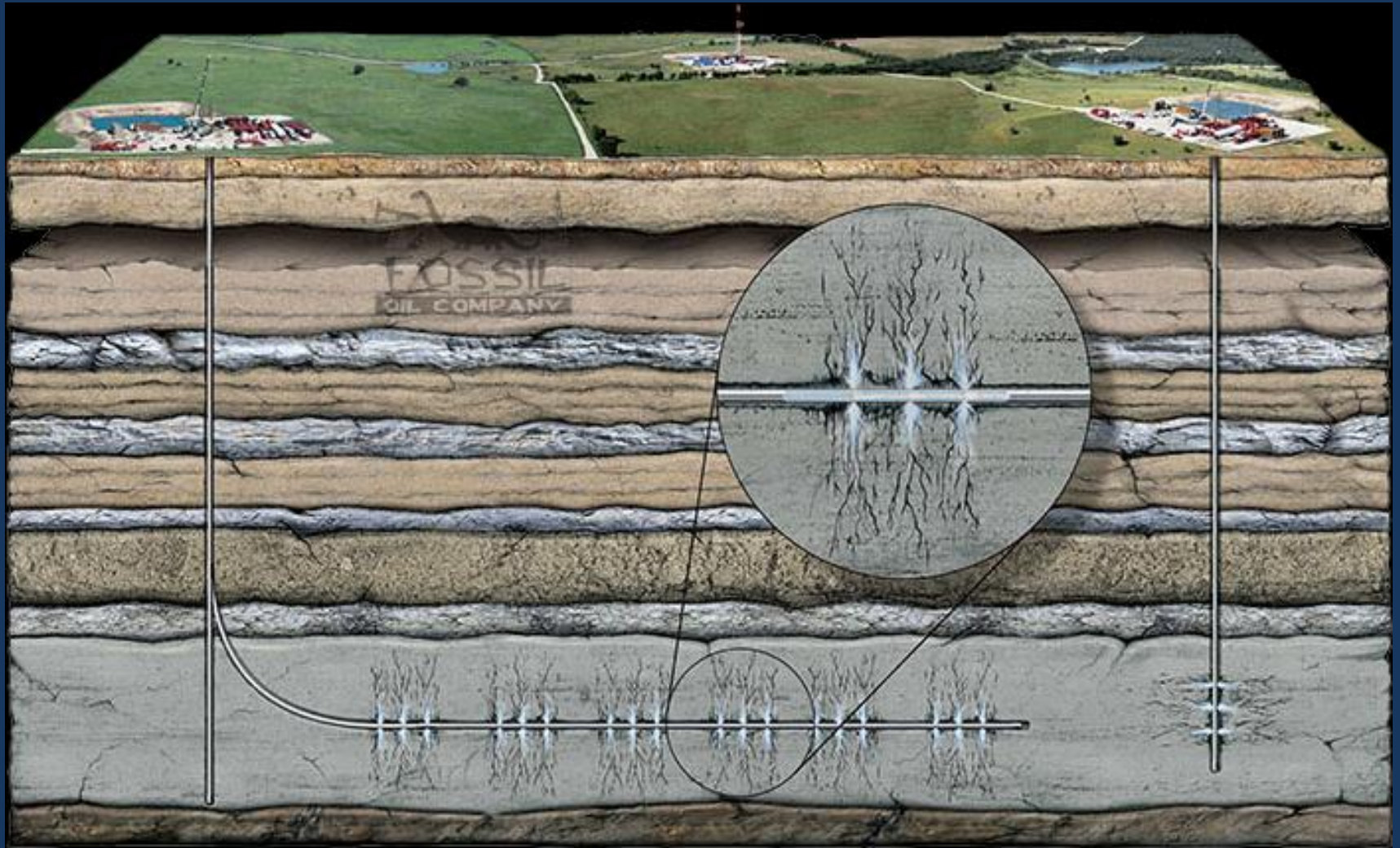
UTICA DRILLING SITE CARROLL COUNTY, OHIO



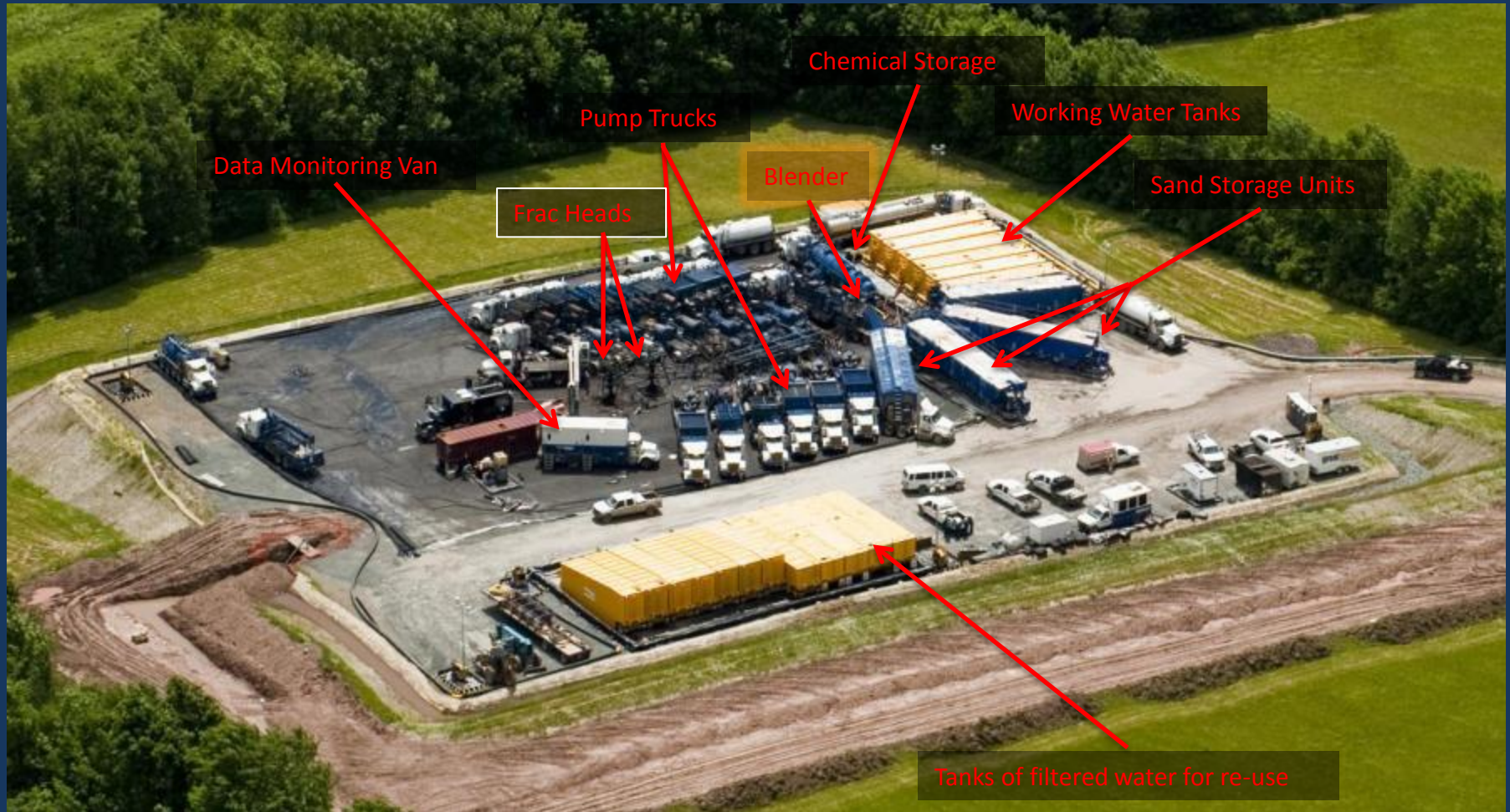
UNCONVENTIONAL DRILLING



CONVENTIONAL VS UNCONVENTIONAL DRILLING



TYPICAL FRAC JOB

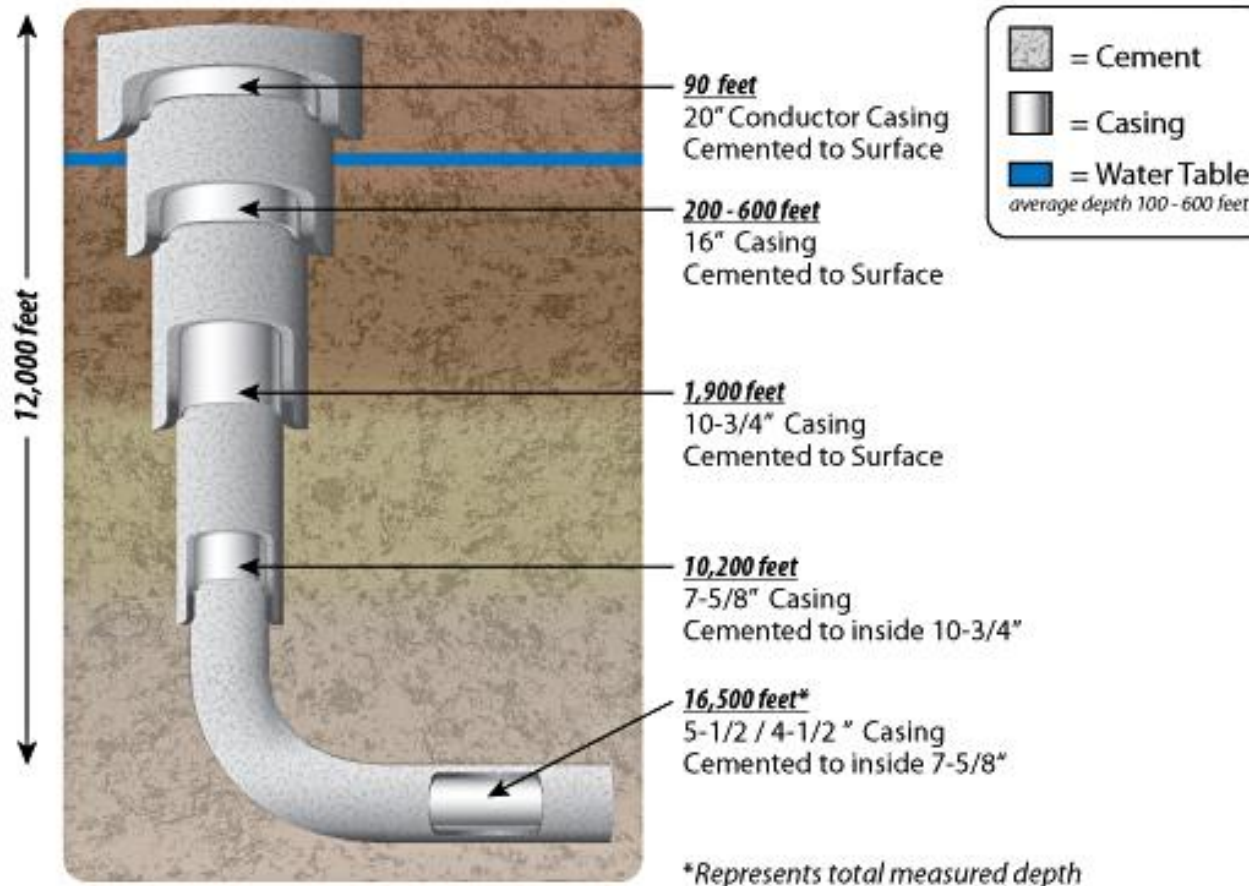


DRILLING IS WATER USE INTENSIVE



TYPICAL CASING STRING

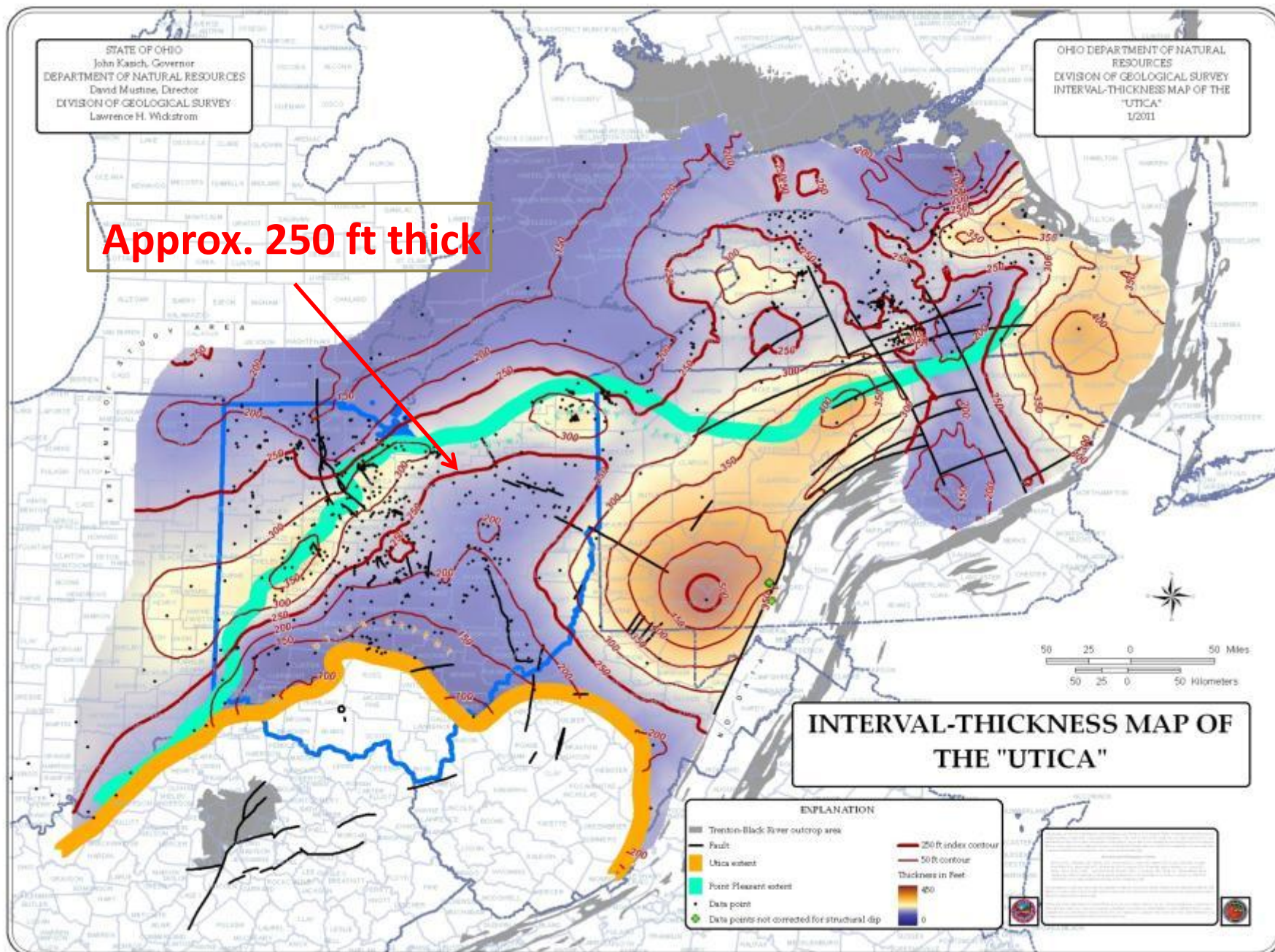
Casing Design for Typical DeSoto Parish, Louisiana, Haynesville Shale Well



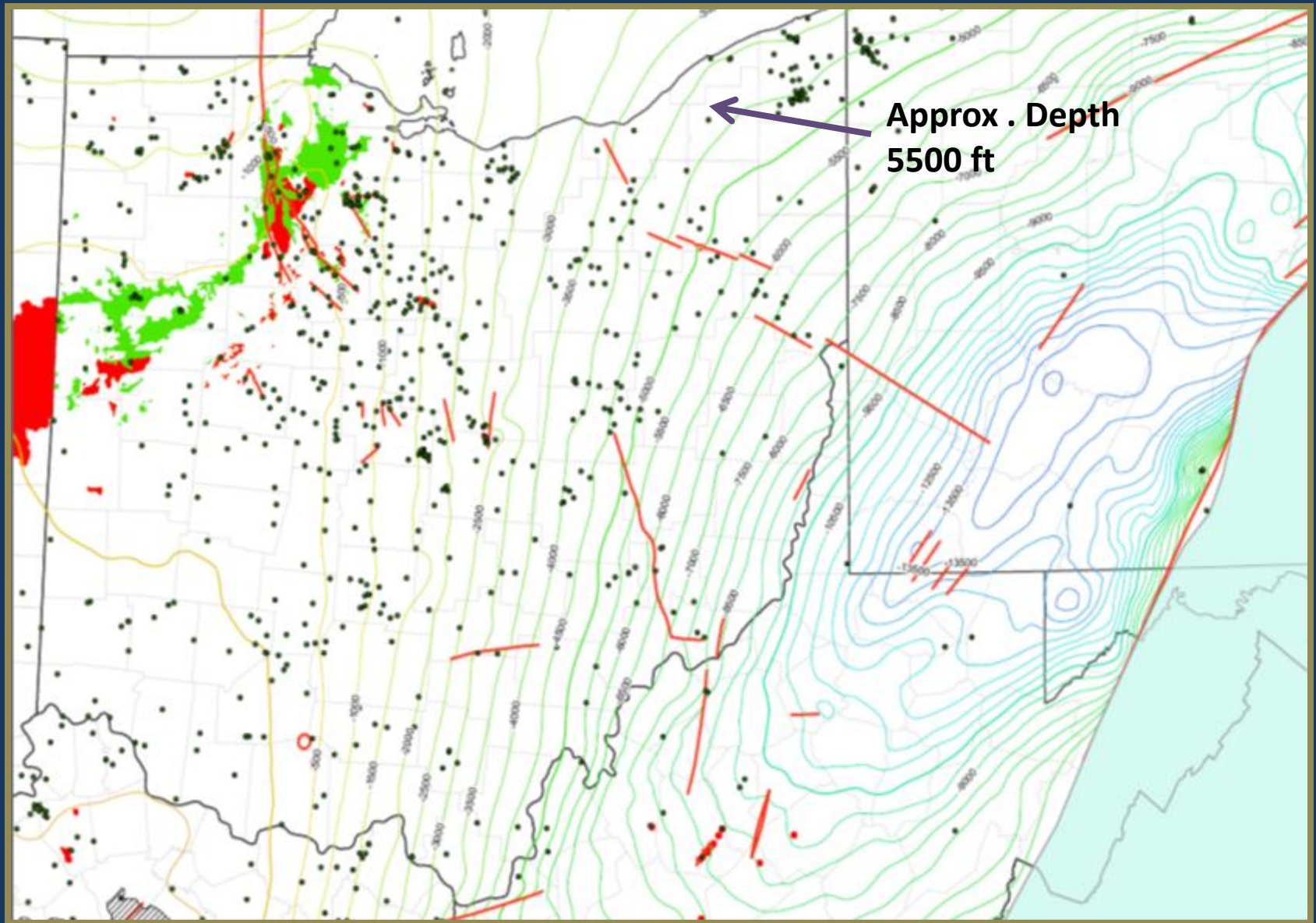
STATE OF OHIO
John Kasich, Governor
DEPARTMENT OF NATURAL RESOURCES
David Mustine, Director
DIVISION OF GEOLOGICAL SURVEY
Lawrence H. Widstrom

OHIO DEPARTMENT OF NATURAL
RESOURCES
DIVISION OF GEOLOGICAL SURVEY
INTERVAL-THICKNESS MAP OF THE
"UTICA"
1/2011

Approx. 250 ft thick



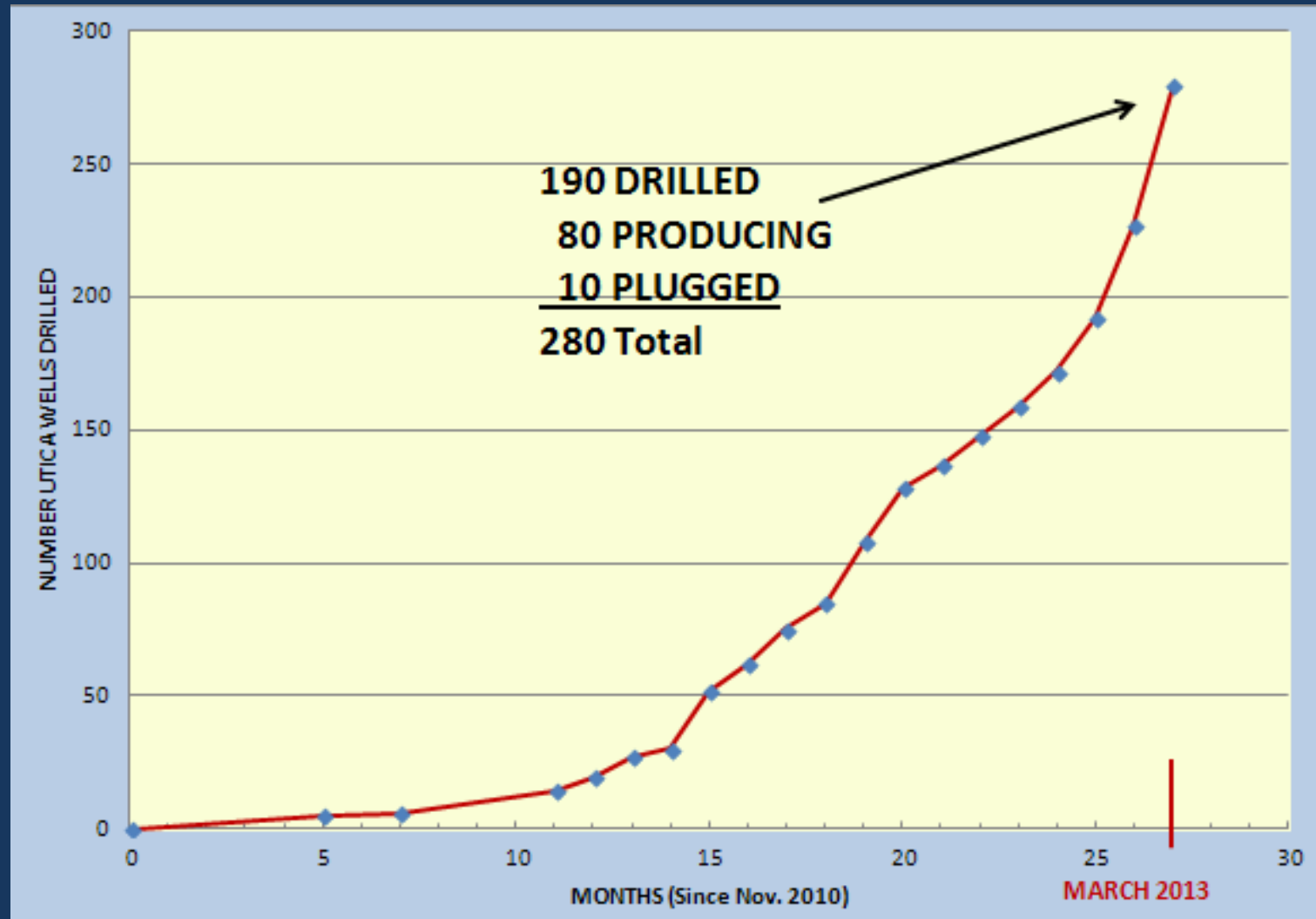
UTICA – PT. PLEASANT ELEVATION



23 OPERATORS
20 COUNTIES
588 PERMITS
32 WELLS DRILLING
280 WELLS DRILLED
80 WELLS PRODUCING

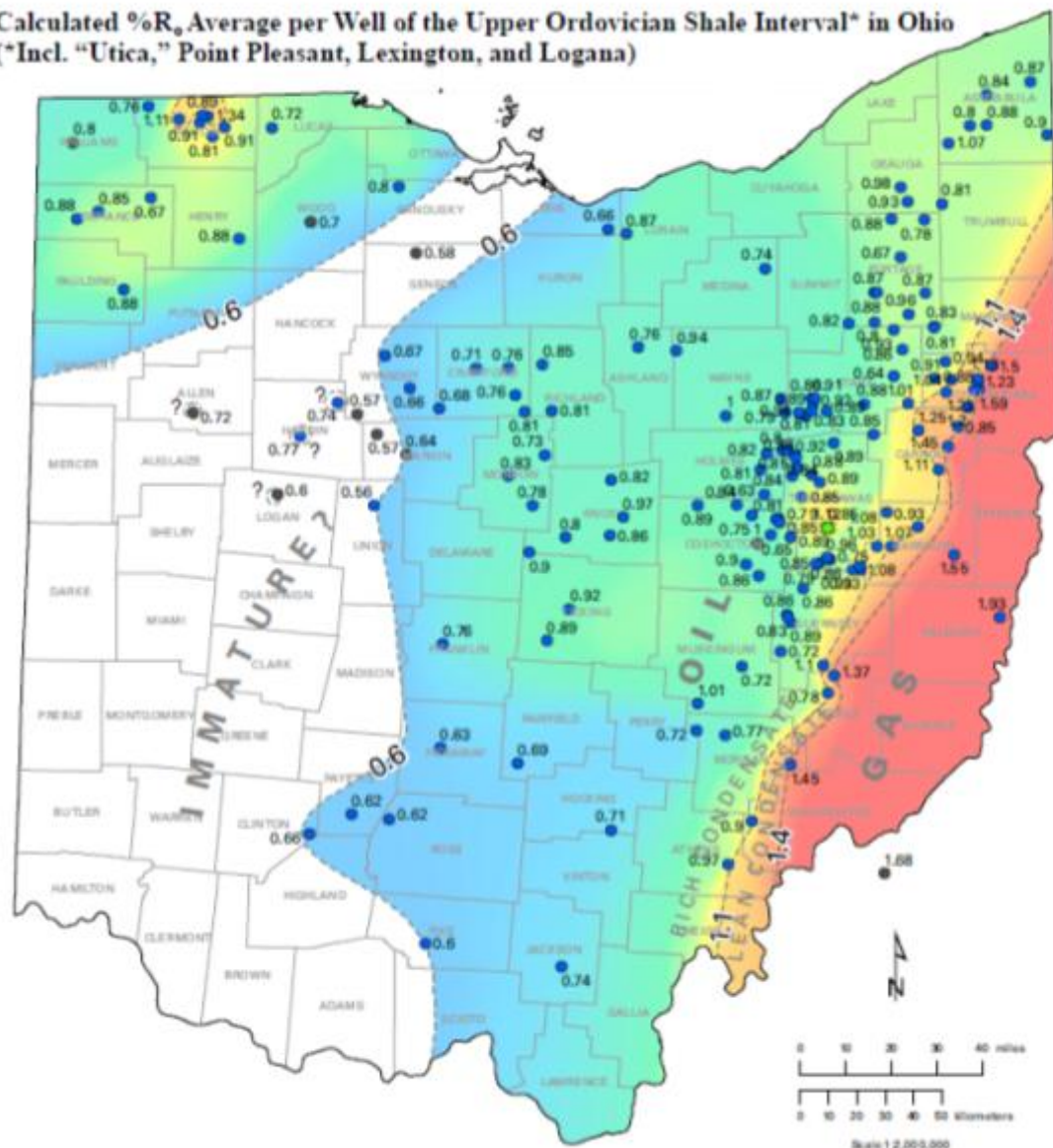


UTICA-POINT. PLEASANT SHALE DRILLING IN OHIO



THERMAL MATURITY PRODUCTION PROJECTION

Calculated % R_o Average per Well of the Upper Ordovician Shale Interval* in Ohio
(*Incl. "Utica," Point Pleasant, Lexington, and Logana)



EXPLANATION

% R_o data source

- Core
- Cuttings
- Sidewall core/cuttings

--- % R_o contour

% R_o average



DISCLAIMER

This map was prepared by the Ohio Department of Natural Resources, Division of Geological Survey. Contour lines are interpretive and may not reflect actual geologic conditions. These lines may be modified at a later date and should not be considered absolute or final. Dashed lines indicate a higher degree of uncertainty and reflect interpreted trends. Analyses of TOC, $\delta^{13}C$, and other geochemical characteristics may not indicate recoverable hydrocarbons and should not be used for property valuation purposes. Neither the State of Ohio nor any of its agencies, nor any person acting on its behalf:

- (1) Make any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of information contained on this map, or that the use of any information disclosed on this map may not infringe privately-owned rights; and
- (2) Assume any liabilities with respect to the use of, or for damages resulting from the use of, information disclosed on this map.

Ohio Department of Natural Resources
Division of Geological Survey
3/2013

www.ohiogeology.com



Scale 1:2,000,000

OHIO GEOLOGICAL SURVEY OIL & GAS INTERACTIVE WEB MAP

Developed in cooperation with the Division of Mineral Resources Management

Locate Address

Zoom to County

Table of Content/Legend

Zoom In

Zoom Out

Reset, Zoom to Full Extent

Zoom To Last Extent

Pan

Hotlink-View Well Card

Identify Feature

Query Database

Measure Distance

Set Map Units

Buffer Selected Feature(s)

Select Feature(s) by Rectangle

Clear Selection

Tool Help

Print Layout

Zoom In

Wells current as of 3/21/2013. Map created 4/4/2013



OHIO GEOLOGICAL SURVEY OIL & GAS INTERACTIVE WEB MAP

Developed in cooperation with the Division of Mineral Resources Management



Locate Address:

Zoom to County

- Table of Content/Legend
- Zoom In
- Zoom Out
- Reset, Zoom to Full Extent
- Zoom To Last Extent
- Pan
- Hotlink-View Well Card
- Identify Feature
- Query Database
- Measure Distance
- Set Map Units
- Buffer Selected Feature(s)
- Select Feature(s) by Rectangle
- Clear Selection
- Tool Help
- Print Layout



Pan



Wells current as of 11/15/2012, Map created 12/10/2012

LAYERS

- All Layers
- Oil and Gas Layers
 - ☒ Wells
 - ☐ Directional Drill Wellbore
 - ☐ Core Holdings
 - ☐ Oil and Gas Fields
- Basemap Layers
 - Map Background(choose 1)
 - ☐ USGS Topo Map (DRG)
 - ☐ Color Aerial Photos (2005)

Refresh Map

☒ Auto Refresh

Help:

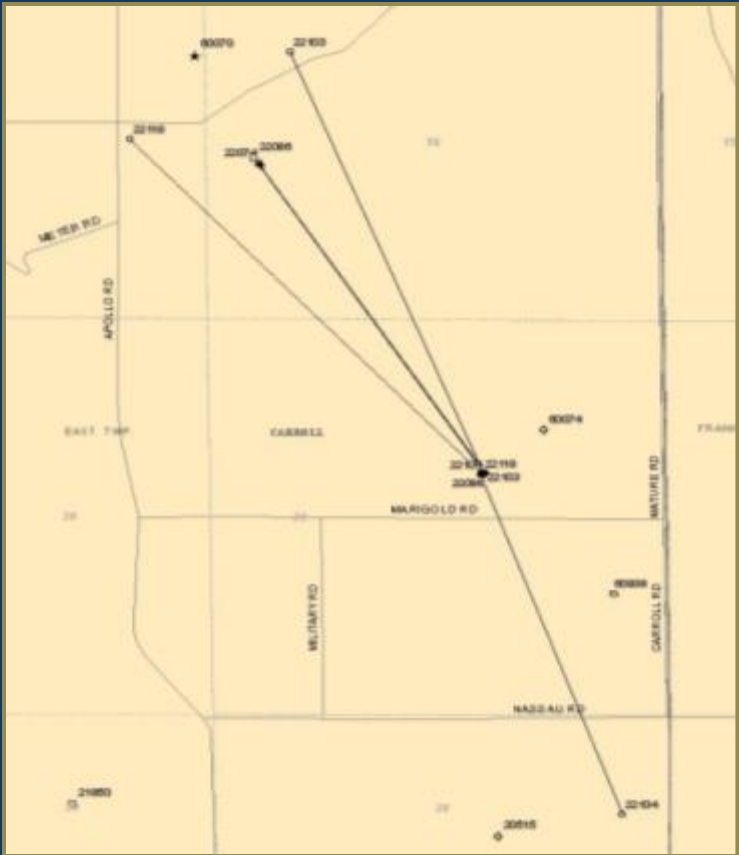
Note: Layers are scale dependent. This means you must be zoomed in to certain scales to view some layers.

- A closed group, click to open.
- An open group, click to close.
- A map layer.
- A hidden group/layer, click to make visible.
- A visible group/layer, click to hide.
- A visible layer, but not at this scale.
- A partially visible group, click to make visible.
- An inactive layer, click to make active.
- The active layer.
- Layer's detailed legend (hidden), click to open.
- Layer's detailed legend (open), click to hide it.
- A layer with Metadata, click to view it.
- A layer with no Metadata.

Formation Code

CONTACT US

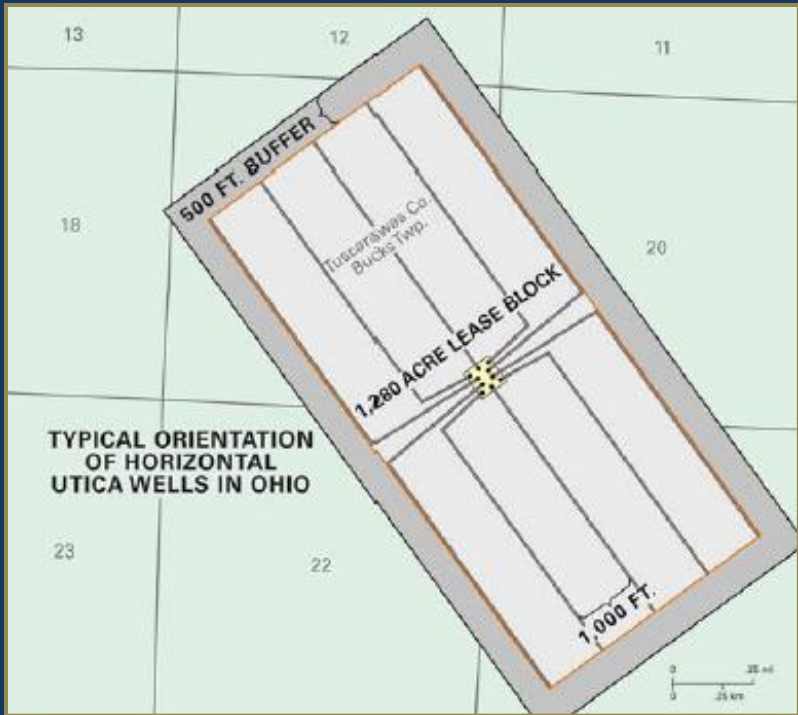
Bucey 1H, 3H, 5H & 6H
Carroll County, OH



ODNR Geological Survey, 2012

Permit	County	Status	Well Name & Number	Comments
11/14/2011	Jefferson	Drilling	Asuncion 15-11-3 6H	
11/14/2011	Jefferson	Permitted	Asuncion 15-11-3 8H	
9/20/2011	Jefferson	Drilled	Asuncion 15-11-3-1H	Waiting to frac well.
8/11/2011	Jefferson	Drilled	Asuncion 15-11-3H	Waiting to frac well.
11/21/2011	Columbiana	Permitted	Ayview Acres 27-16-5 1H	
11/18/2011	Columbiana	Drilled	Ayview Acres 27-16-5 3H	Waiting to frac well.
11/21/2011	Columbiana	Drilling	Ayview Acres 27-16-5 5H	Drilling lateral.
1/20/2012	Carroll	Permitted	Bucey 21-14-4 1H	
12/6/2011	Carroll	Drilled	Bucey 21-14-4 5H	
12/6/2011	Carroll	Drilled	Bucey 21-14-4 6H	Waiting to frac well.
3/9/2011	Carroll	Producing	Bucey 3H	Finished Fracing well

IDEAL SPACING (DRILLING UNIT)
IS ONE PAD PER TWO SQUARE MILES



USEFUL DEFINITIONS

- PRODUCTION FLUIDS
 - OIL, NATURAL GAS, NATURAL GAS LIQUIDS
 - BRINE: NATURALLY OCCURRING HIGH TDS (>100,000 mg/L) PRODUCED WATER
 - FLOWBACK: HYDRAULIC FRACTURING FLUID THAT FLOWS FROM THE WELL DURING INITIAL PRODUCTION TESTING

MIDSTREAM ACTIVITY

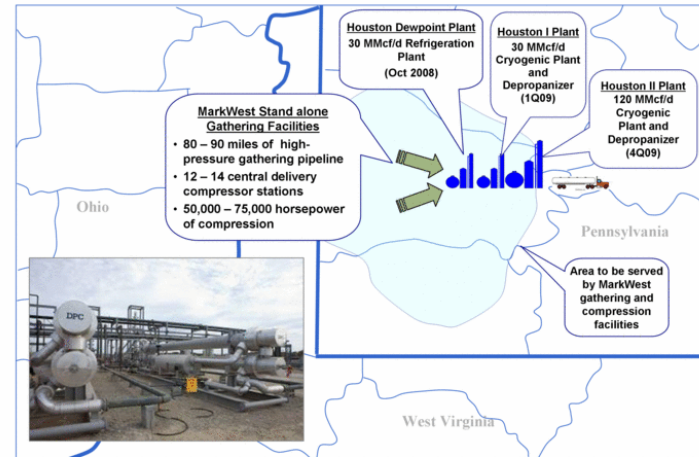
- GATHERING SYSTEM PIPELINES
- COMPRESSION STATIONS
- PROCESSING PLANTS
- CRYOGENIC NGL SEPARATION PLANTS
- RAIL AND TRUCK FACILITIES

CRYOGENIC NATURAL GAS LIQUIDS PROCESSING PLANT

MARKWEST PLANT NEAR HOUSTON, PA



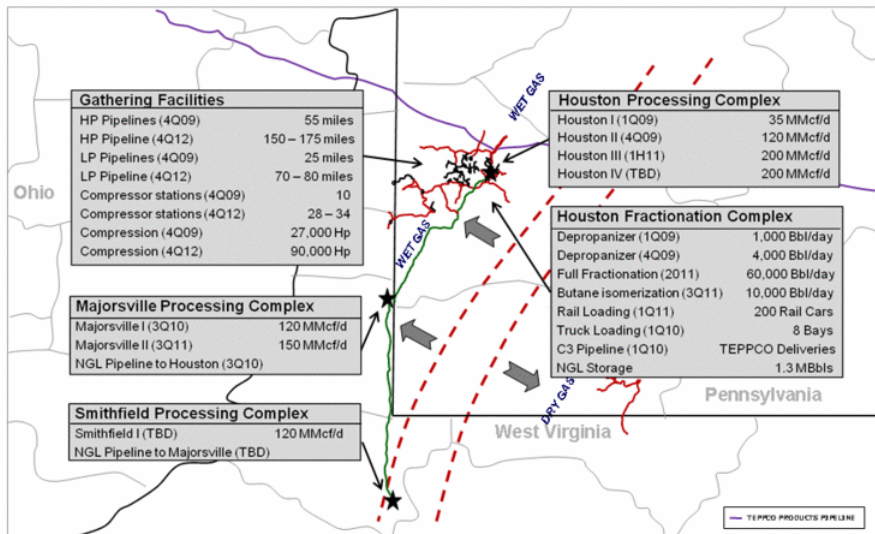
Current Facilities and Projects under Construction



MARKWEST
Energy Partners, L.P.

Liberty Marcellus Project Schedule

THE ENERGY & MINERALS GROUP



MARKWEST UTICA

MarkWest Utica Overview

- **Joint venture with The Energy & Minerals Group (EMG)**

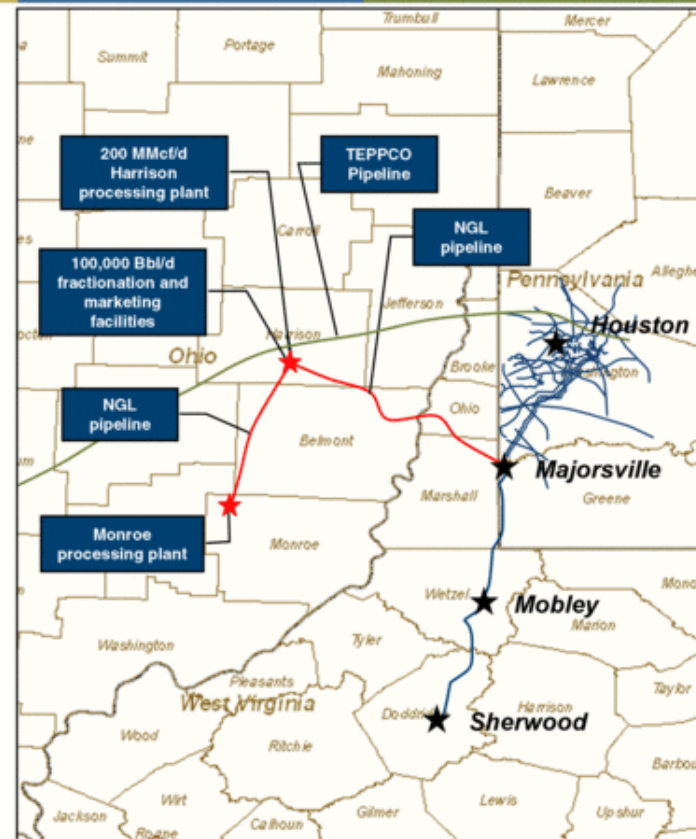
- Long-term partnership to develop significant natural gas processing and NGL fractionation, transportation, and marketing infrastructure to serve producers' drilling programs in the Utica shale in eastern Ohio
- Partners one of the best midstream companies with a strong financial partner that share a common view towards the value of the Utica
- Allows MarkWest to meet the significant gathering and processing needs of its producer customers while significantly reducing MWE's up-front capital

- **Competitive advantages**

- Extensive gathering, processing, transportation, fractionation, storage, and marketing infrastructure throughout the Appalachian region
- Extensive NGL marketing experience in the Northeast

- **Announced midstream development**

- 200 MMcf/d cryogenic processing complex in Harrison County, Ohio by mid-2013
- Monroe County, OH processing complex in 2013
- 100,000 Bbl/d fractionation, storage, and marketing complex in Harrison County in 2013



PRODUCTION FLUID ISSUES (BRINE AND FLOWBACK)

- DISPOSAL AND RECYCLING ARE CRITICAL TO UTICA SUCCESS IN OHIO
- PA AND WV MARCELLUS PRODUCTION
 - LIMITED DISPOSAL CAPACITY
 - US EPA CONTROL & GEOLOGICAL ISSUES
- BRINE PRODUCTION FOR THE LIFE OF A WELL
 - REMAINS CONSTANT (4 – 6 Bbls/day, 84 – 252 gpd: Marcellus)
 - GEOMETRIC PROGRESSION WITH INCREASING NUMBER OF WELLS
- INITIAL MARCELLUS FLOW BACK: 10 – 20 %
 - RECYCLING AND RE-USE MEASURES ARE EFFECTIVE AS LONG AS WELLS ARE BEING DRILLED AT A STEADY RATE

Ohio's Class II Injection Wells

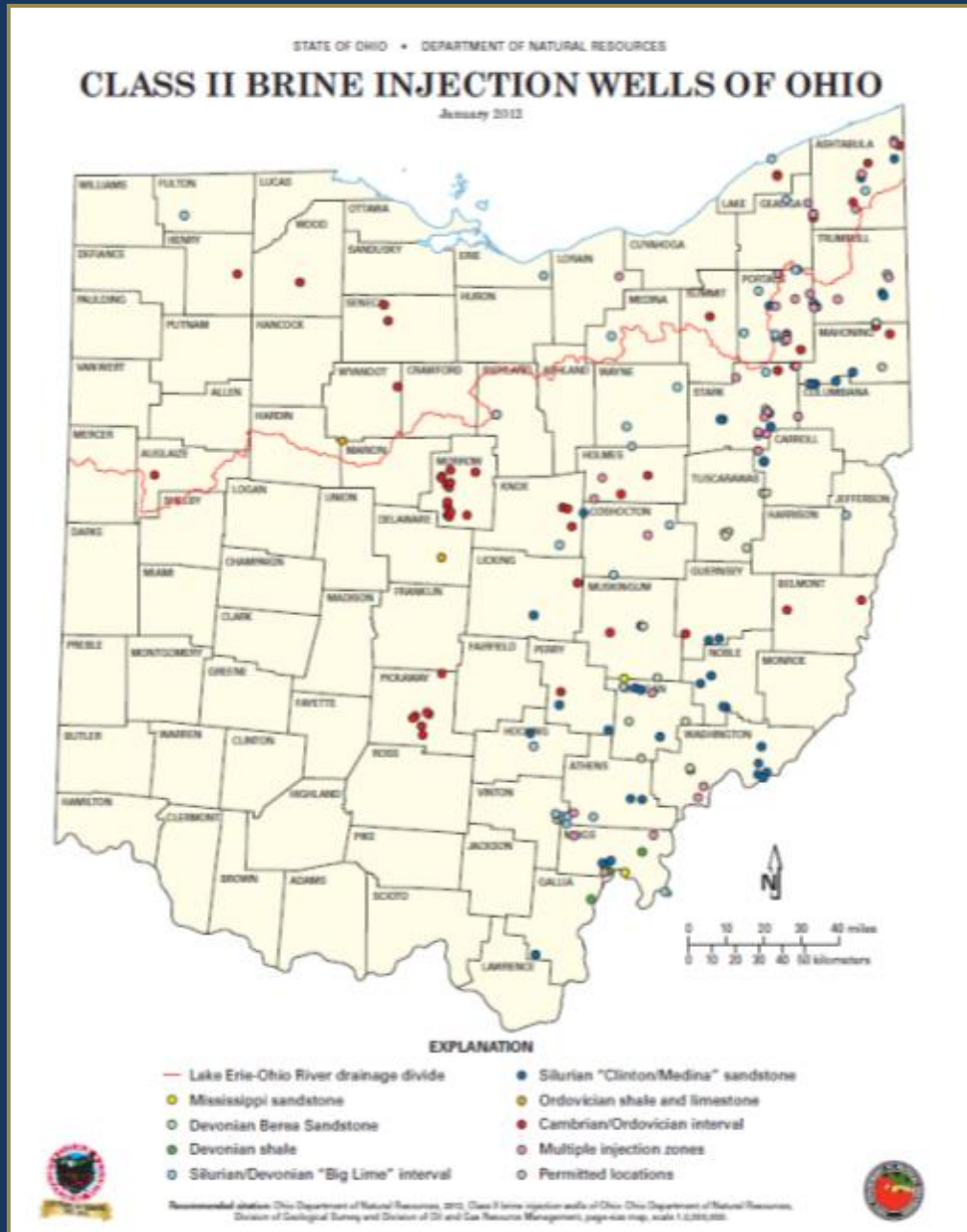
Brine and frac flow-back water disposal

Put the fluids back from where they came and isolated from surface and ground water

> 65,000 oil & gas wells
Operating in Ohio

Primacy est. 1983

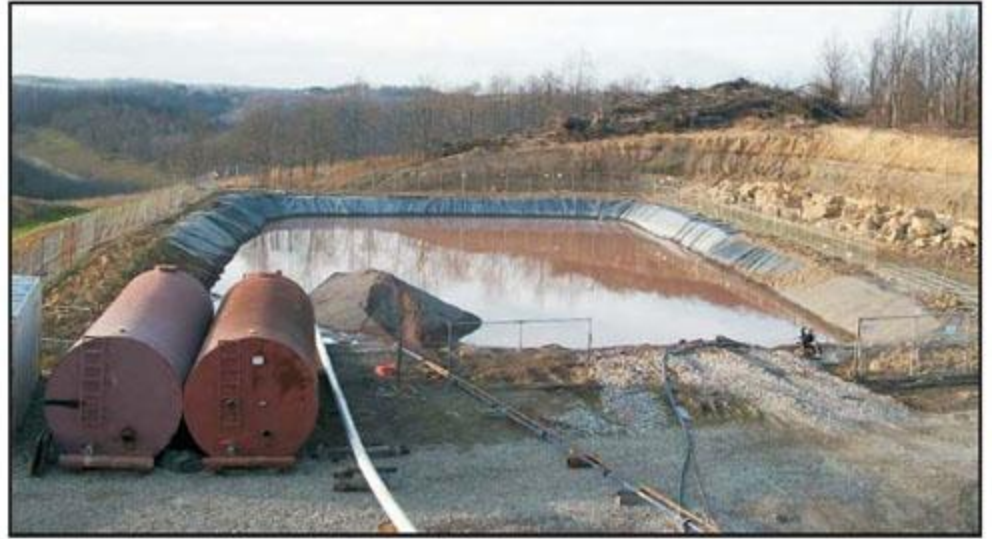
196 Permitted



POTENTIAL SOURCES OF WATER CONTAMINATION

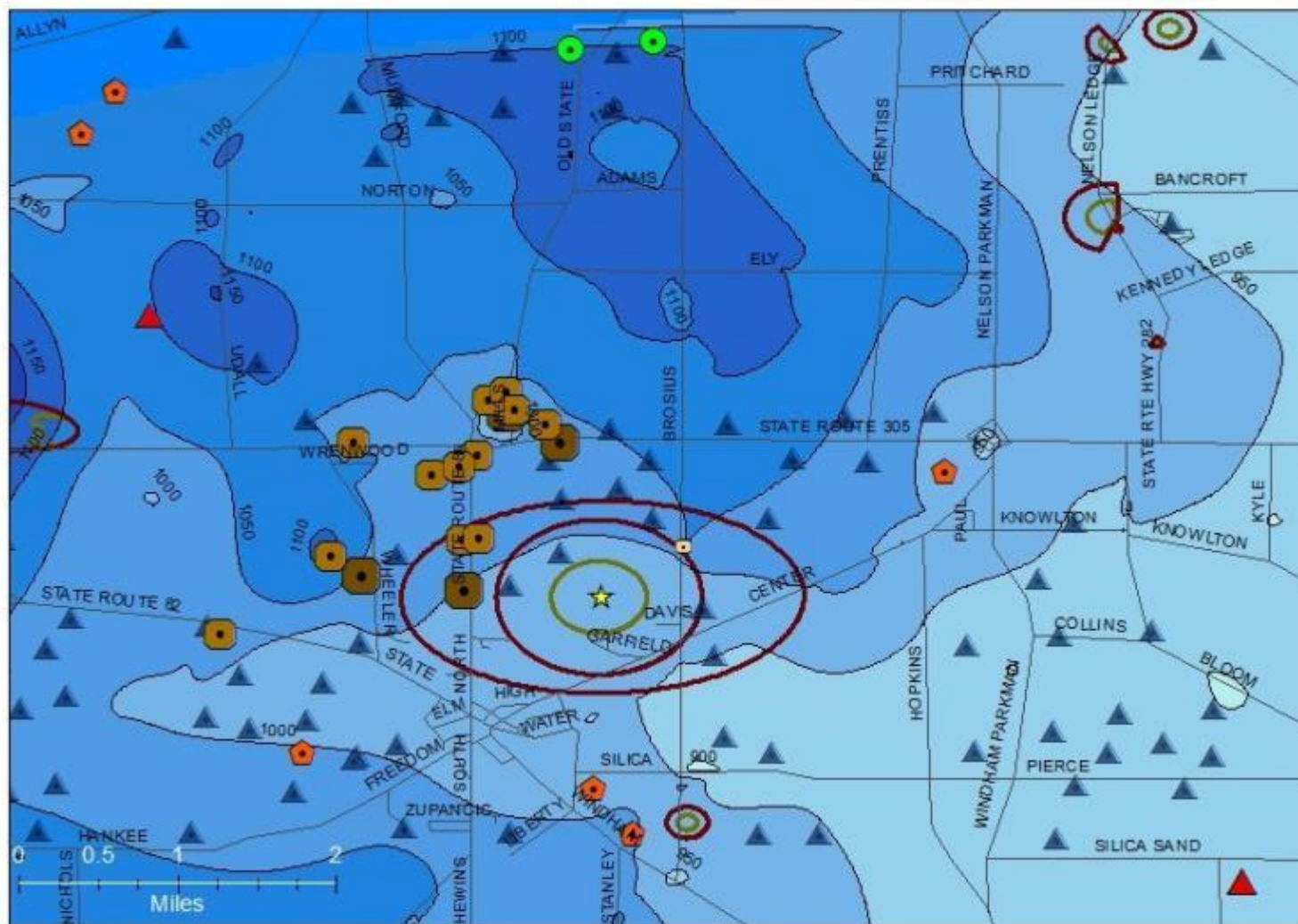
- Production fluid spills/negligent handling
- Production fluid transport
- Drilling fluid spills/mud pit reclamation
- Failed tubing well-head flanges
- Pipeline rupture or corrosion
- Insufficient production fluid storage
- Production fluid disposal – Class 2 Injection
- Bad casing cement job (well casing seal)
- Casing failure – traditional wells

SPILLAGE POTENTIAL



BASELINE TESTING

- IMPORTANT TO TEST GROUND WATER AND SURFACE WATER QUALITY PRIOR TO DRILLING AND INJECTION ACTIVITIES
- TESTING IS PARTICULARLY IMPORTANT FOR MUNICIPALITIES WITH PUBLIC DRINKING WATER SOURCES
- OHIO EPA, ODNR and COUNTY HEALTH DEPARTMENTS RECOMMEND A “3-TIER” SET OF TESTING PARAMETERS



THANK YOU

Jeffrey C. Dick, Ph.D.
Professor and Chair
Geological and Environmental Sciences
Director, Natural Gas and Water Resources Institute
Youngstown State University
Youngstown, Ohio 44555
jcdick@ysu.edu
330.941.1756