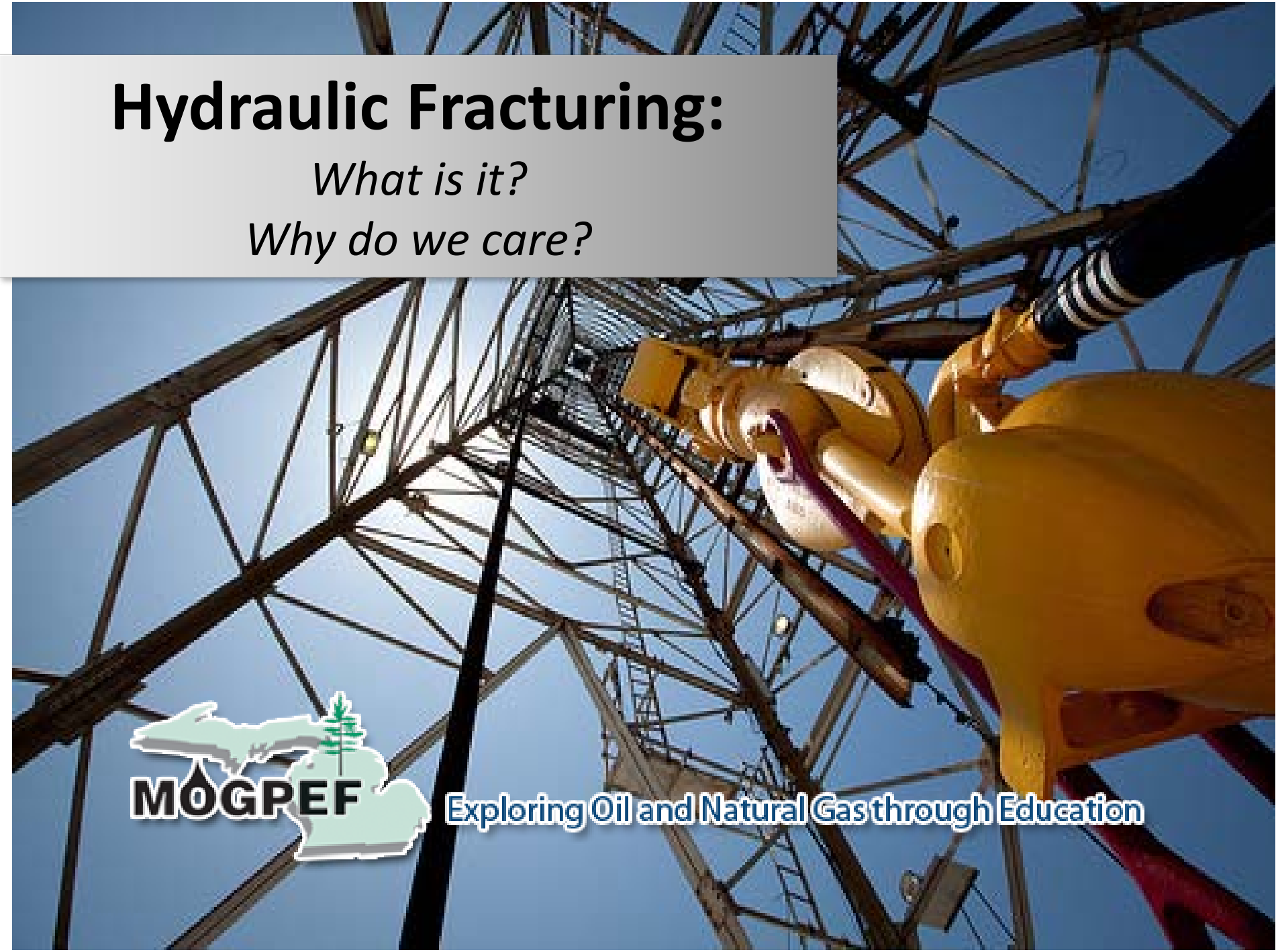
# Hydraulic Fracturing:

*What is it?*

*Why do we care?*



# MICHIGAN OIL & GAS PRODUCERS EDUCATION FOUNDATION

The Michigan Oil and Gas Producers Education Foundation (MOGPEF) was created to provide facts about the Michigan oil and gas industry to the public and to provide financial support for programs that will inform the people of Michigan about the importance of our local oil and natural gas industry and about the environmental safeguards that we employ.

MOGPEF was created in 2003 to assist in supporting educational projects and programs about the oil and natural gas industry. It is a tax-exempt organization under Section 501(c)(6) of the United States Internal Revenue Service code.

Materials and programs developed by MOGPEF area available for use by members of the petroleum, energy, and allied industries and by the general public.

# MILLER ENERGY COMPANY

Miller Energy is an oil & gas exploration and production company that is dedicated to finding and developing our nation's energy needs. Headquartered in Kalamazoo, MI, Miller Energy was founded by John and Gene Miller, both of whom have been pioneers in the oil & natural gas industry. Today, Miller Energy continues its fourth generation of outstanding industry leadership.

Miller Energy's mission is to acquire, develop and maximize returns from an emergent portfolio of long-life domestic oil & natural gas resources. Our proven strategy has allowed for continued success in finding and developing oil & natural gas reserves. The foundation of our success began in the rich Michigan Basin and continues to this day with natural gas production in the Antrim Shale.

WWW.MILLER-ENERGY.COM

# OVERVIEW

- Michigan Activity
- The Fundamentals
- Horizontal Drilling
- Hydraulic Fracturing
- Water
- Regulation
- Economic Impacts

# Michigan Activity

# MICHIGAN'S QUICK FACTS

- Michigan has been producing oil and natural gas since the late 1800's.
- Wells in 64 of the 68 lower peninsula counties have cumulatively produced more than 1.2 billion barrels of oil and 7 trillion cubic feet of natural gas.

1930's – Farm life goes on amidst drilling
(Source: Clark Historical Library)

1983 - Making a connection on the rig floor
(Source: Clark Historical Library)

1938 – West Branch
(Source: Clark Historical Library)

- 17th out of 32 states for oil production.
- 16th out of 33 states for natural gas production.

- Since 1925 more than 56,000 oil or natural gas wells have been drilled in Michigan.
- Michigan has the largest underground storage capacity of any state in the nation.

Source: IPAA, Clark Historical Library at CMU

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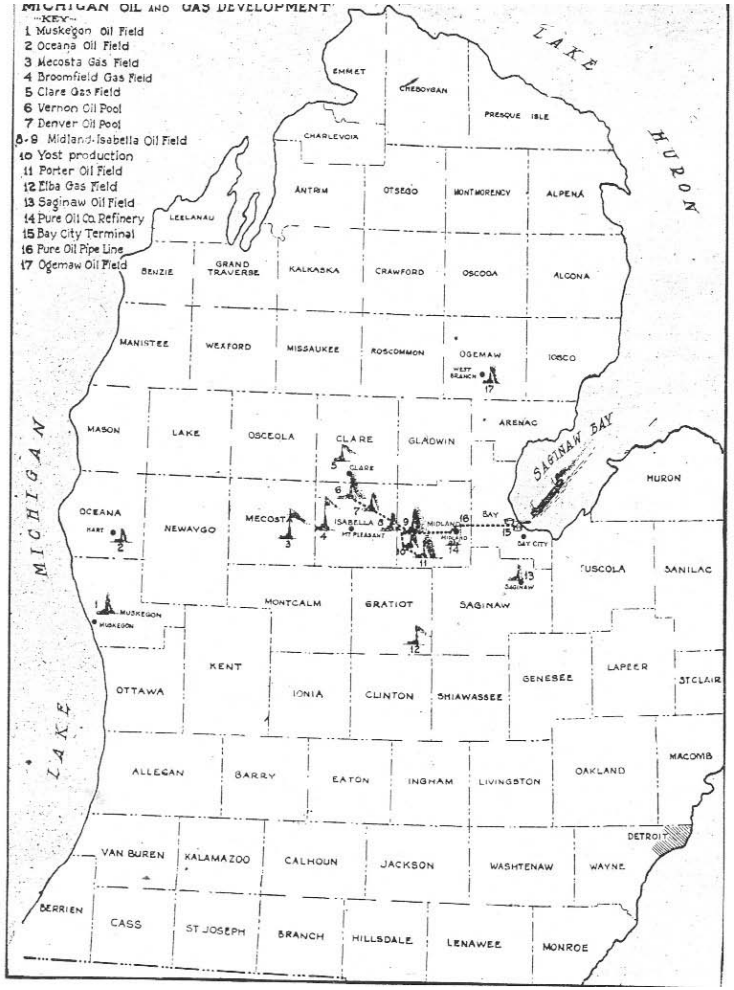
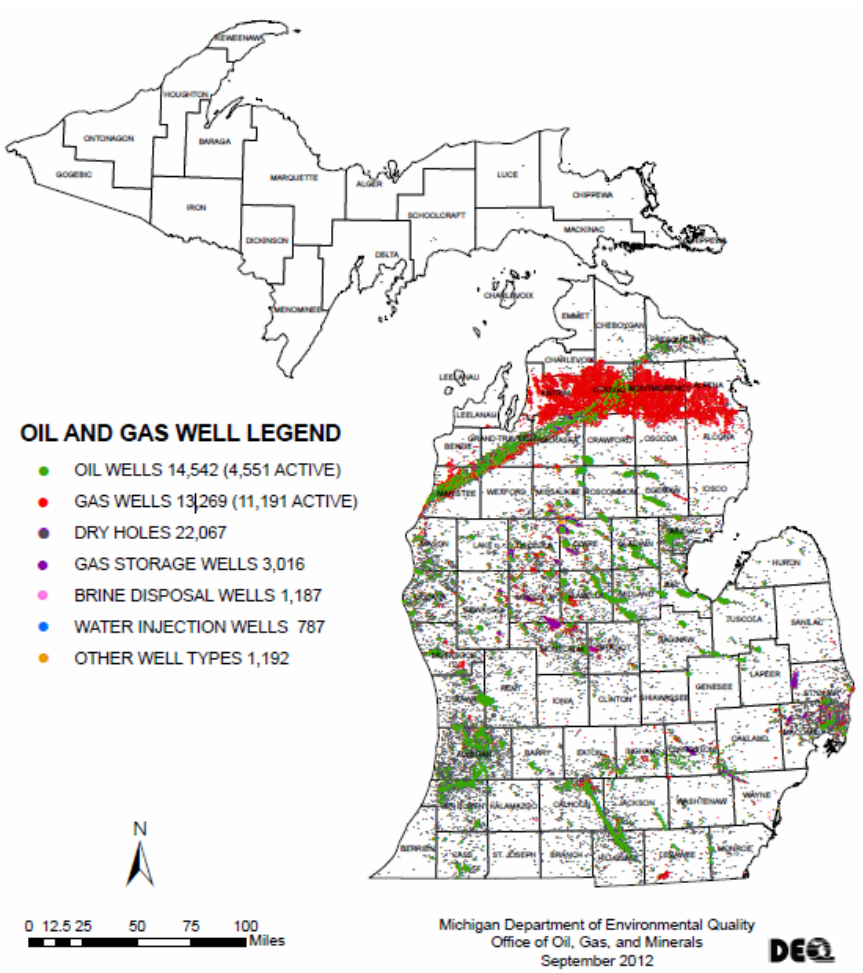
# MICHIGAN'S OIL AND NATURAL GAS WELL MAPS

1933




2012




Source: MI DEQ

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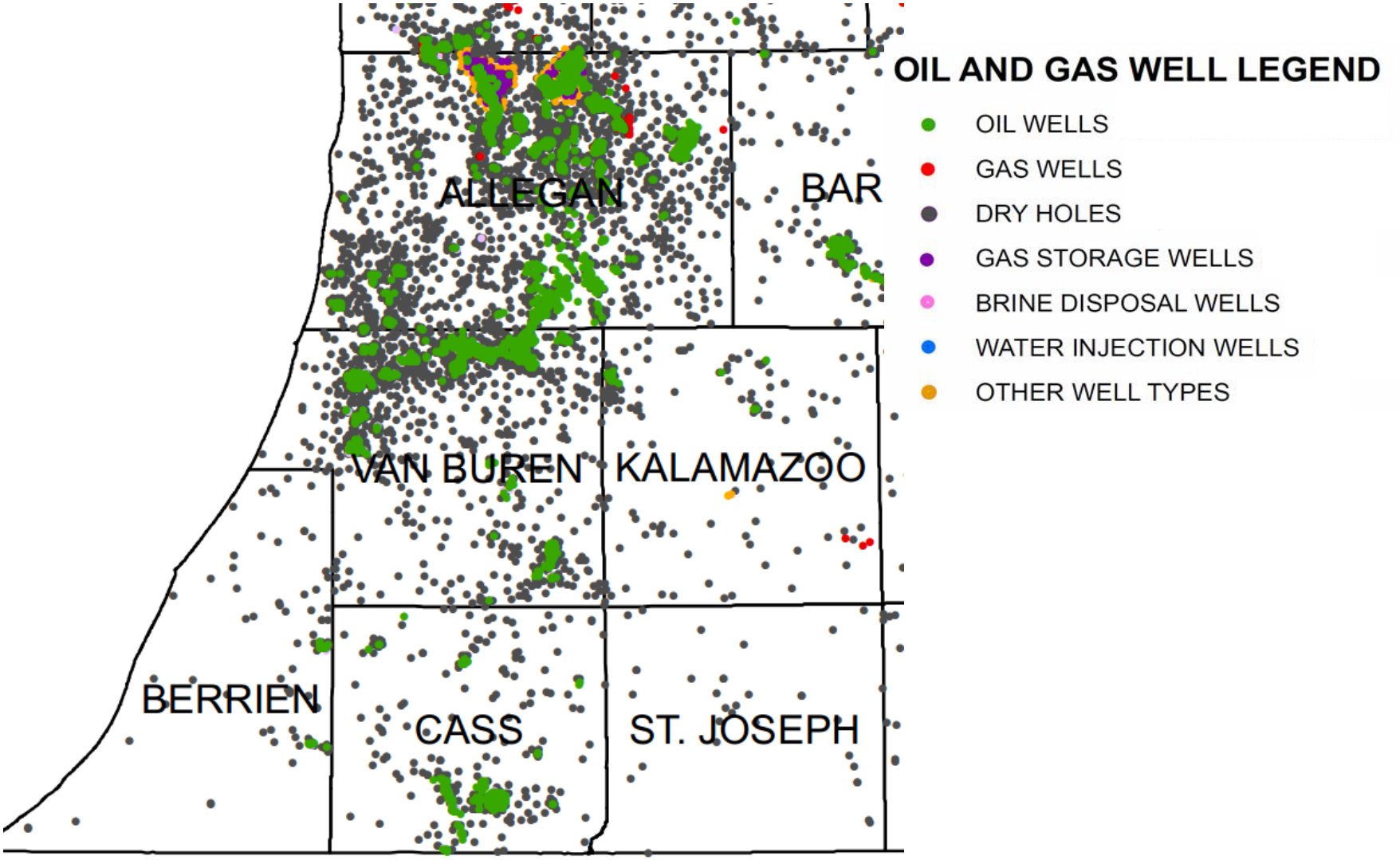
# Drilling activity in SW Michigan




Source: MI DEQ

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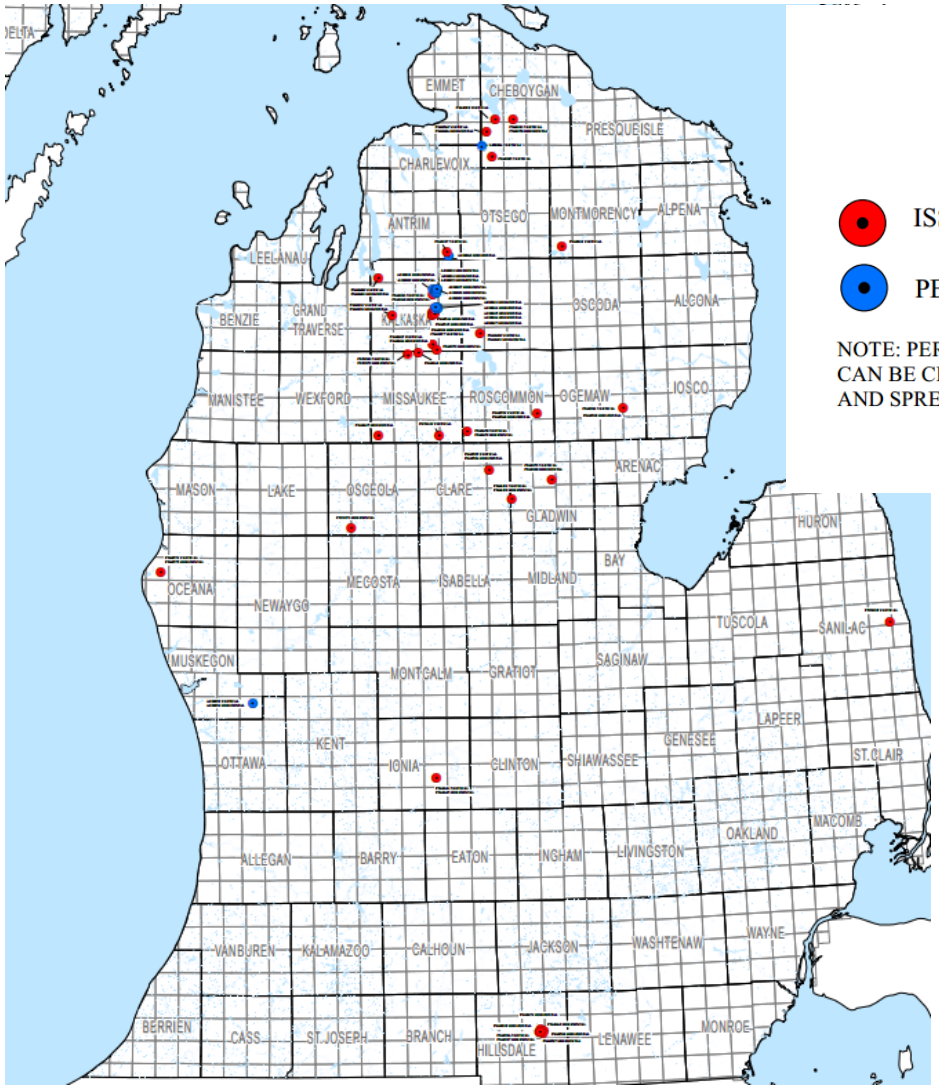
# High volume hydraulic fracturing




## Legend

ISSUED ACTIVE PERMITS (52)

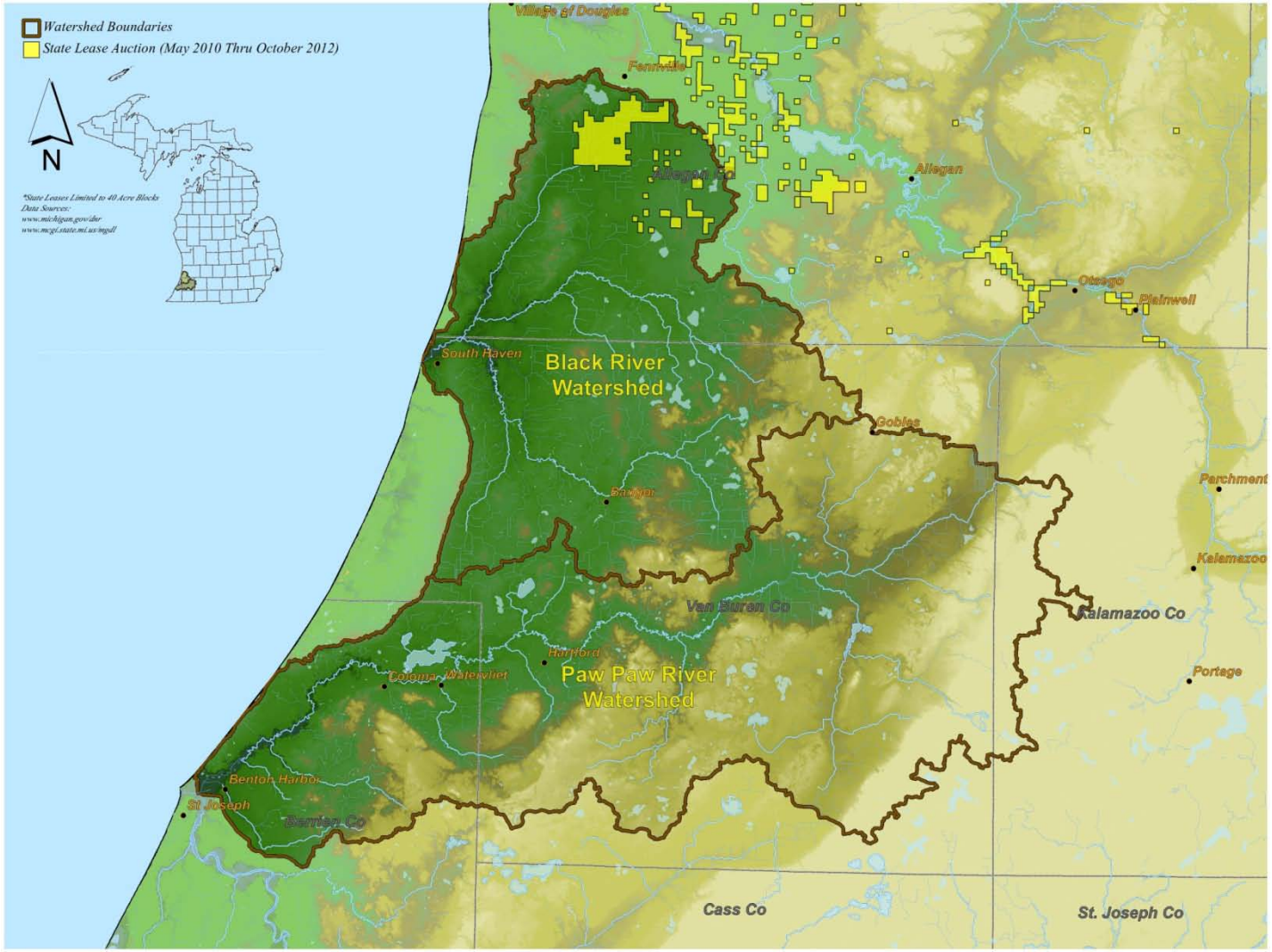
PENDING ACTIVE APPLICATIONS (17)

NOTE: PERMIT NUMBER AND APPLICATION NUMBER CAN BE CROSS REFERENCED BETWEEN THE MAP AND SPREADSHEET.

- Using a total of more than 100,000 gallons of fluid.

Source: MI DEQ

# Why we are here




Source:

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The
Fundamentals
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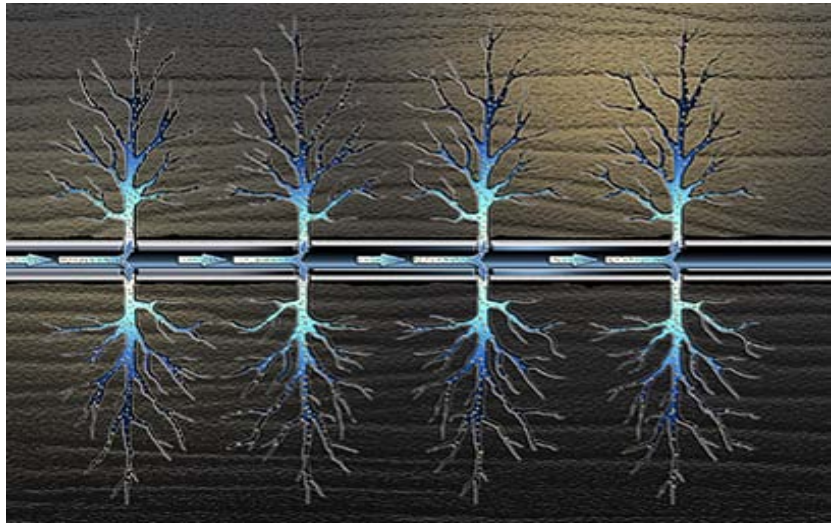
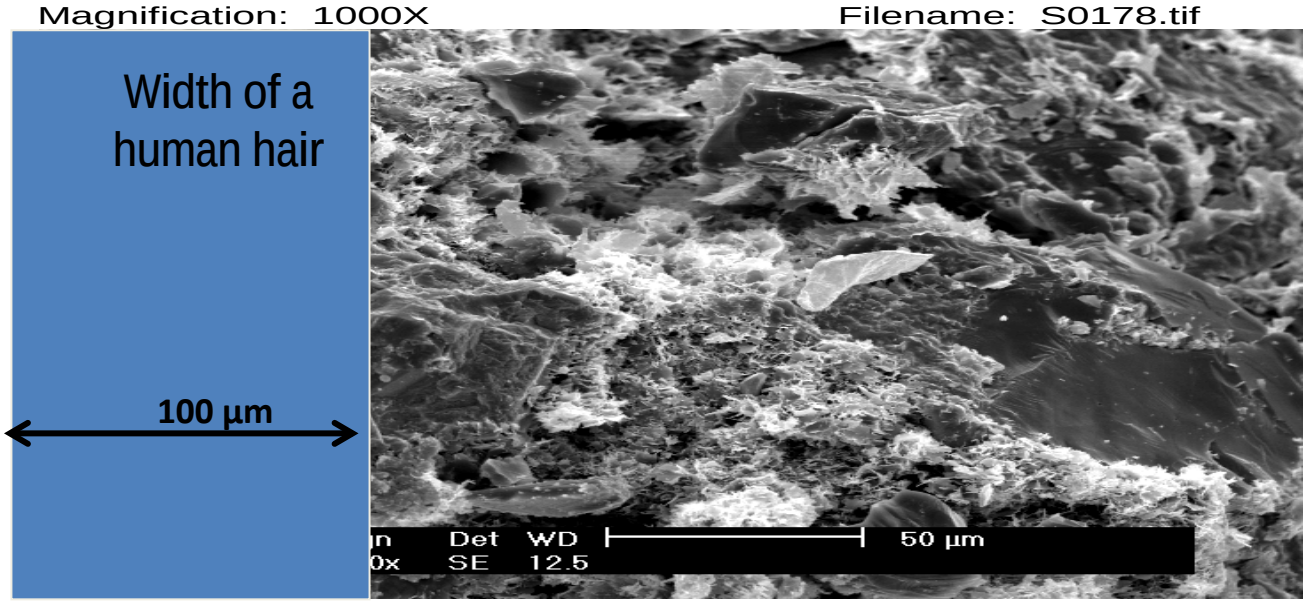
# Definition

- The use of water, sand, and chemicals pressurized and pumped into the well to form microscopic fractures
- The placement of small granular solids into the crack to ensure the crack remains open after the hydraulic pressure is no longer applied



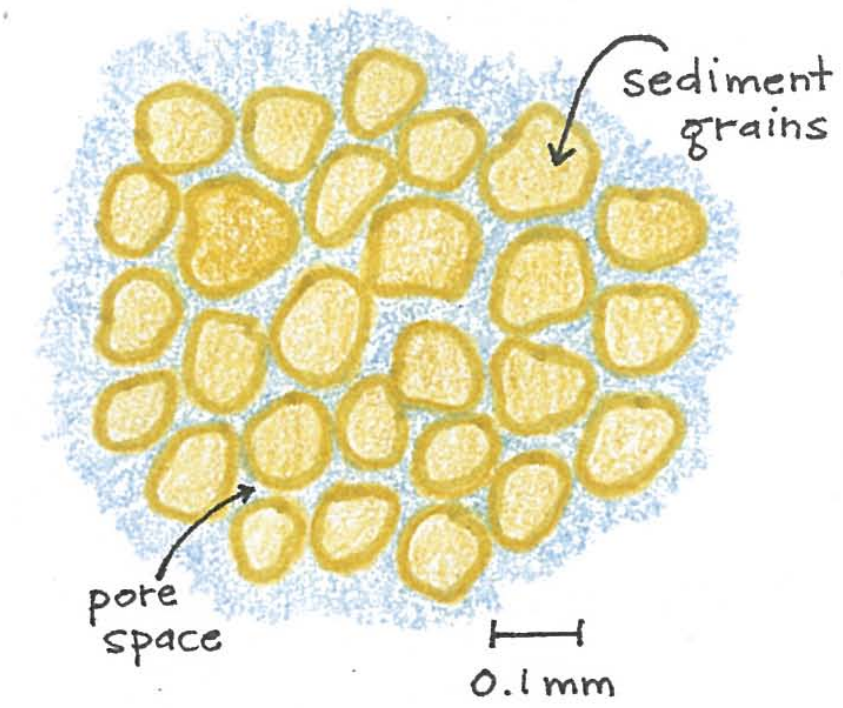
# Why hydraulically fracture a well?

- Increase the **rate** at which the well is capable of producing oil or natural gas
- Over 95% of wells drilled today **require** hydraulic fracturing in order to be economic
- Does not increase total **reserves**

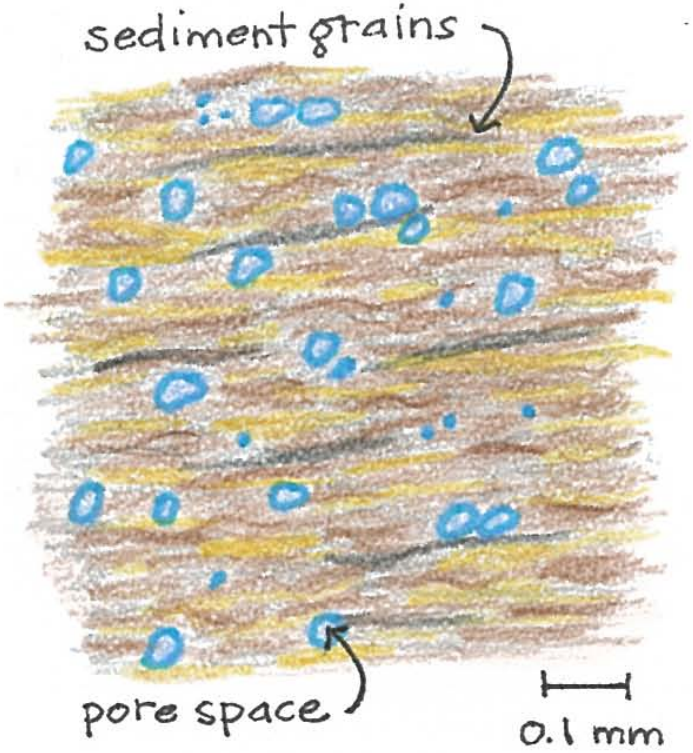



Source:

# Porosity and Permeability



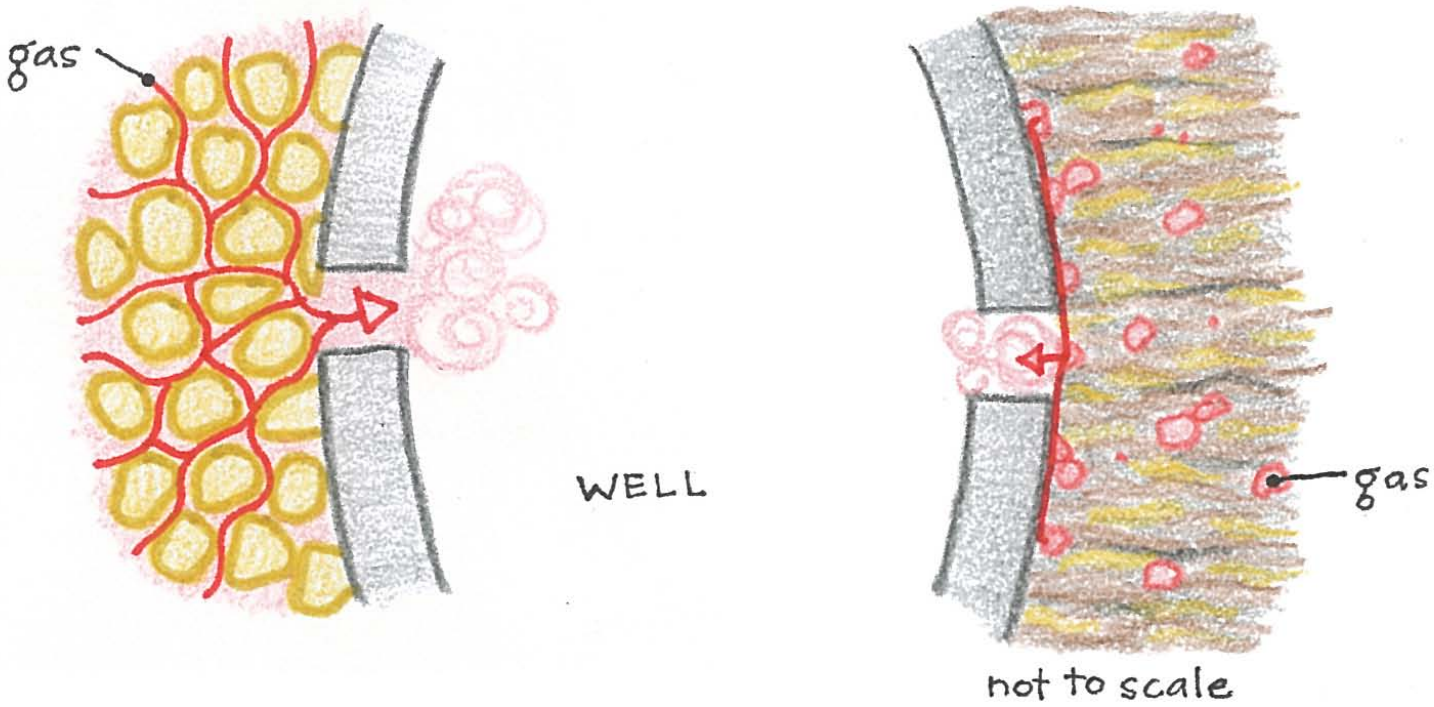

Microscopic view of sandstone




Microscopic view of shale

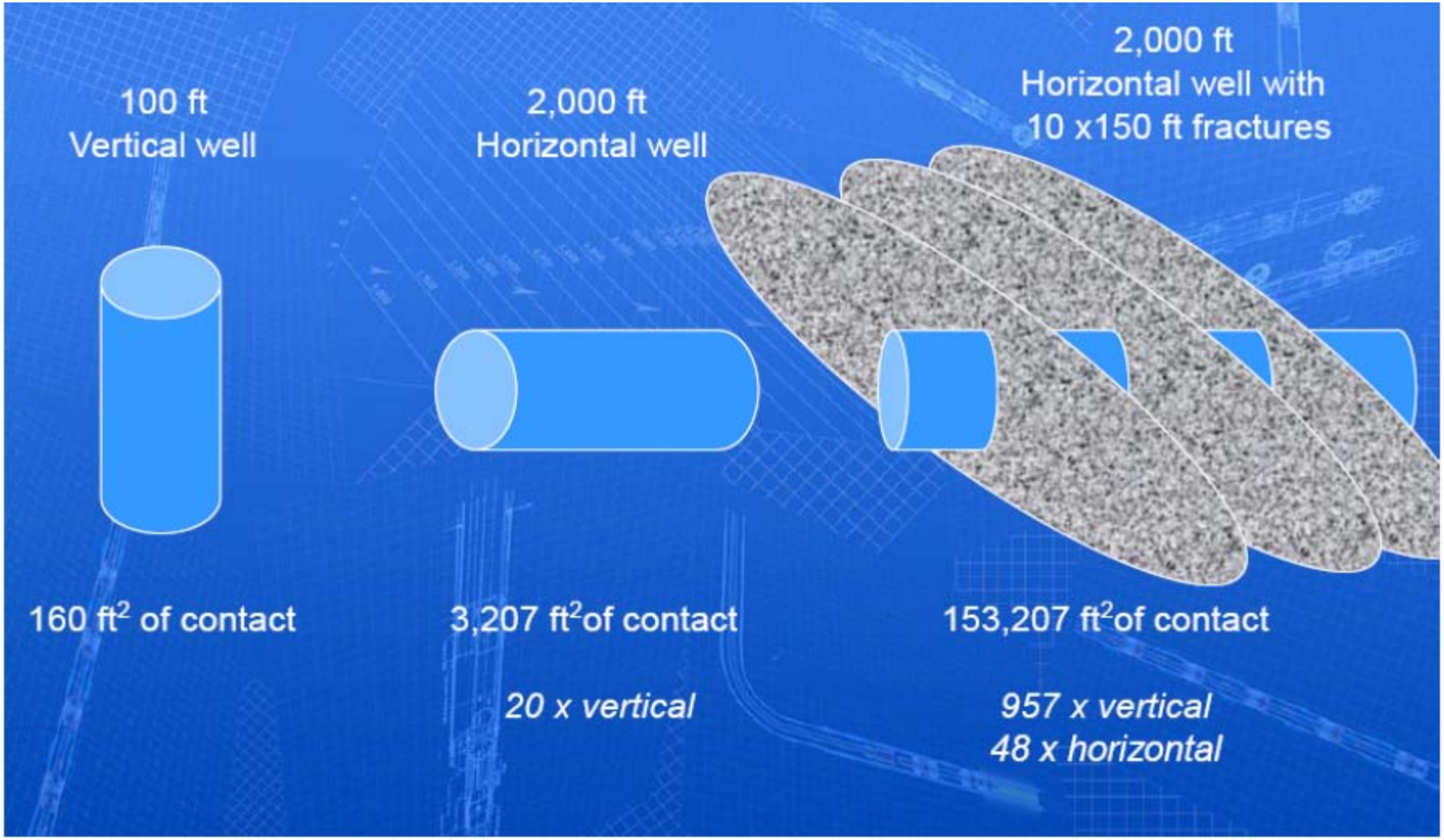
Source: Natural Resource Defense Council

# The role of permeability

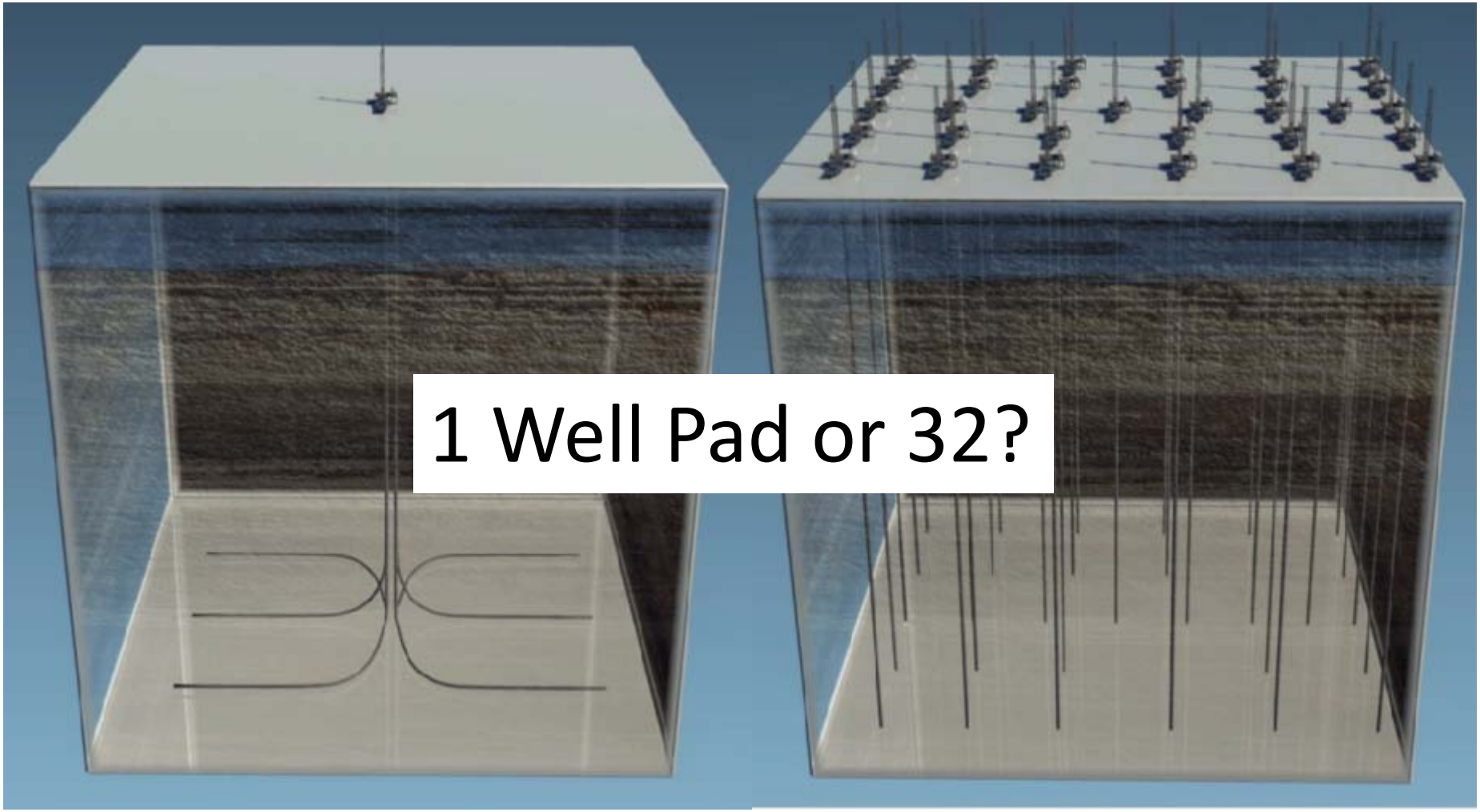



Source: Natural Resource Defense Council

# Fractured Contact



# Surface Footprint



# “HydraFrac” Process

- July of 1947 – Stanolind Oil & Gas
  - 1st Job: Klepper No. 1
  - Hugoton Gas Field, Kansas
- Lake 1948 – Patent issued, 23 wells hydraulically fracture before commercial application began.
- In 1949, The Halliburton Oil Well Cementing Co. was granted an exclusive license to pump the new “HydraFrac” process.
  - 332 wells were treated in the first 12 months
  - 75% success rate

Source: Colorado Oil and Gas Association

# Good news!

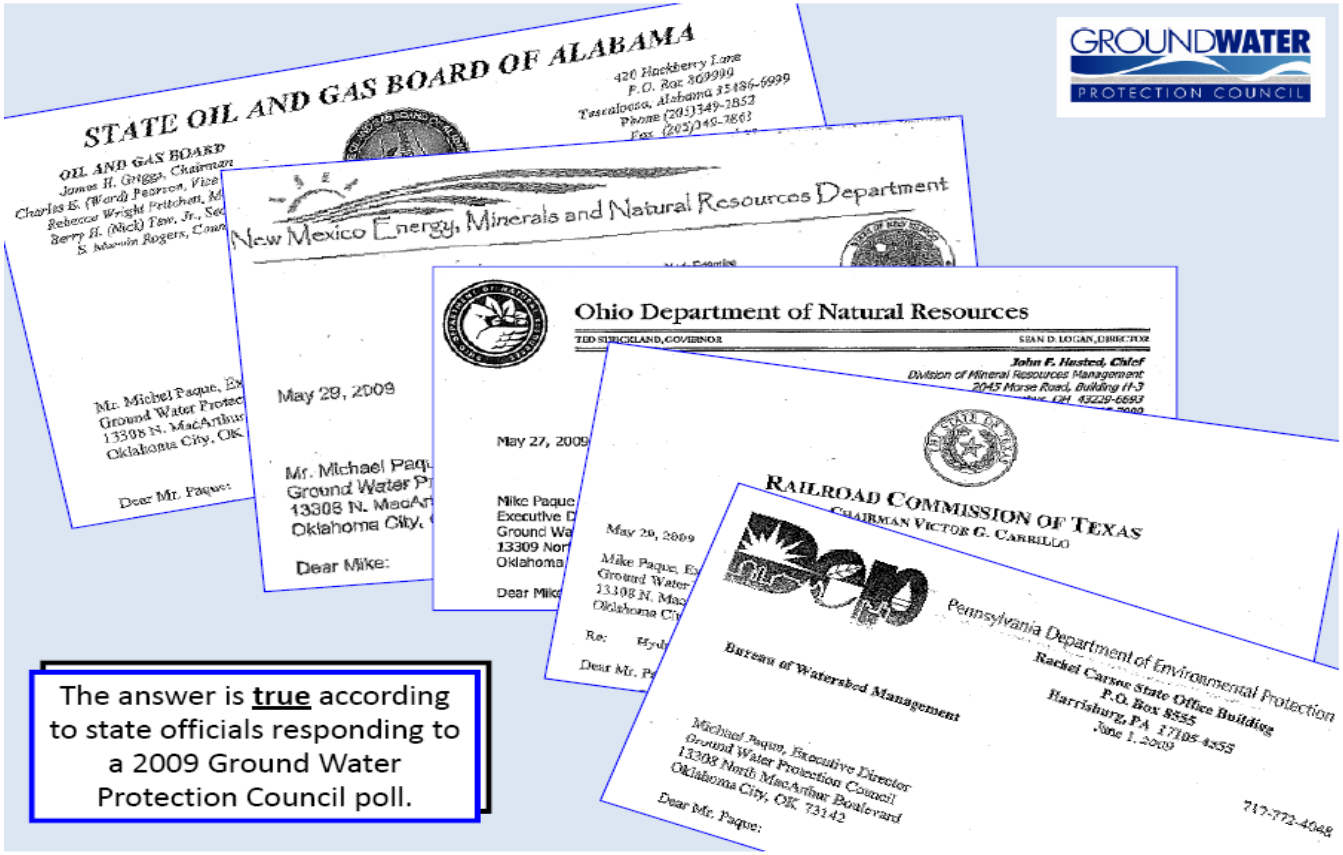
- History has proven the process of hydraulic fracturing is safe.
  - In the U.S., there have been over 1,000,000 hydraulic fracturing stimulations within the USA without compromising fresh groundwater, and
  - Over 12,000 of those have taken place in the state of Michigan.

True or False?

Source:

# True!

- The Michigan DEQ was a contributor to this report!




Source: Ground Water Protection Council

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Horizontal
Drilling
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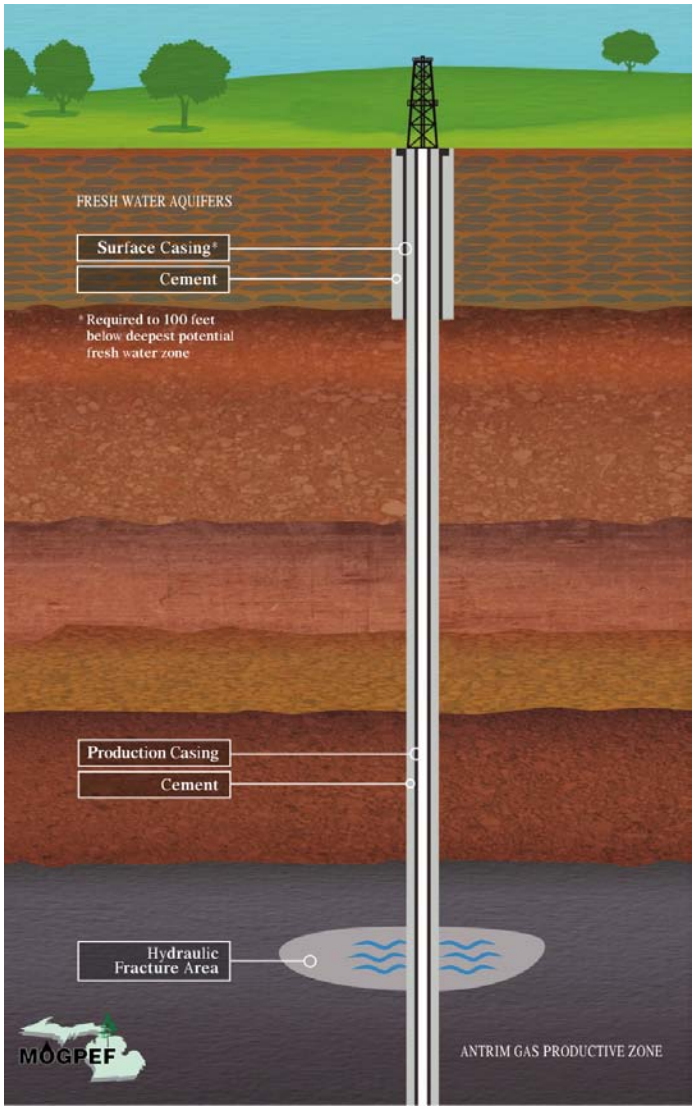
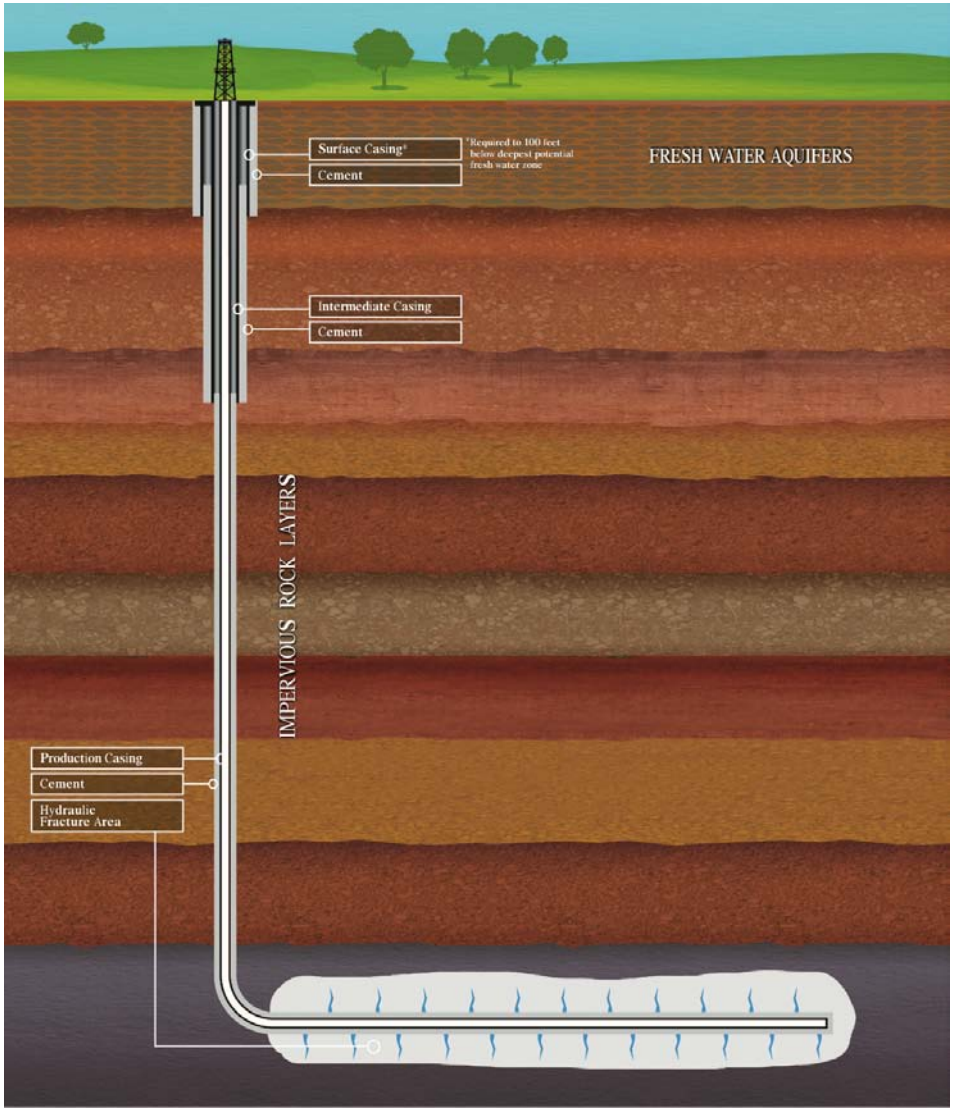
# Drilling Types

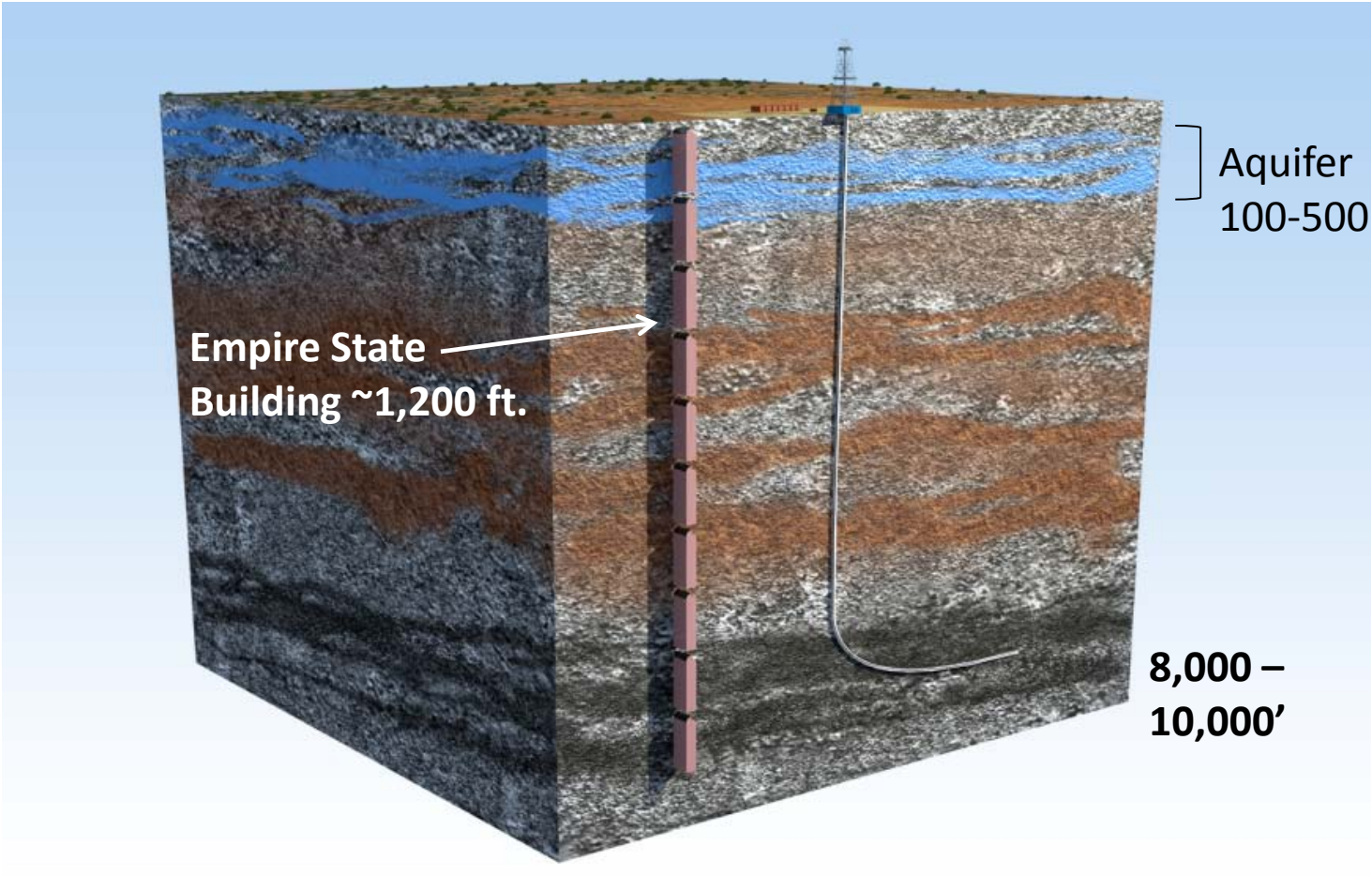



Source: MOGPEF

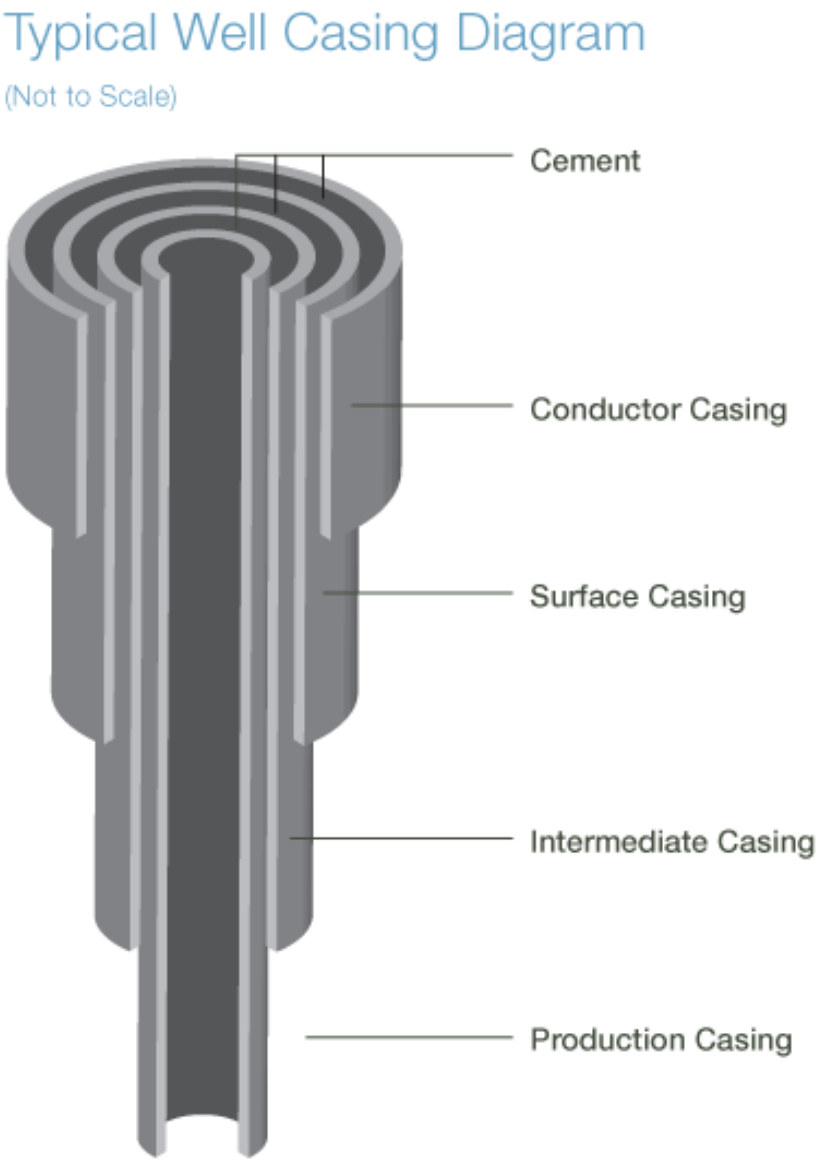
# Drilling Distance

- Typical depth of a Michigan deep horizontal well.



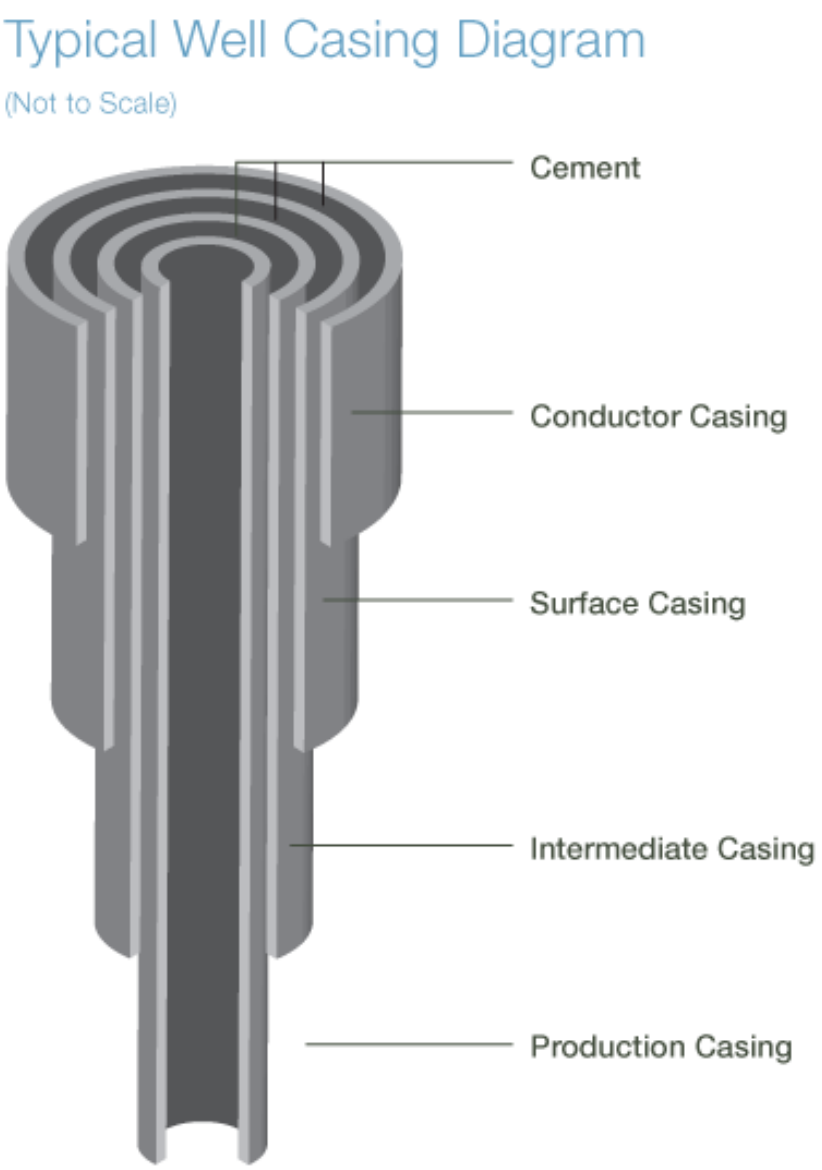
# Casing

- Multiple layers surrounding the aquifer
  - Conductor Casing
  - Cement
  - Surface Casing
  - Cement
  - Intermediate Casing
  - Cement
  - Production Casing
  - Cement



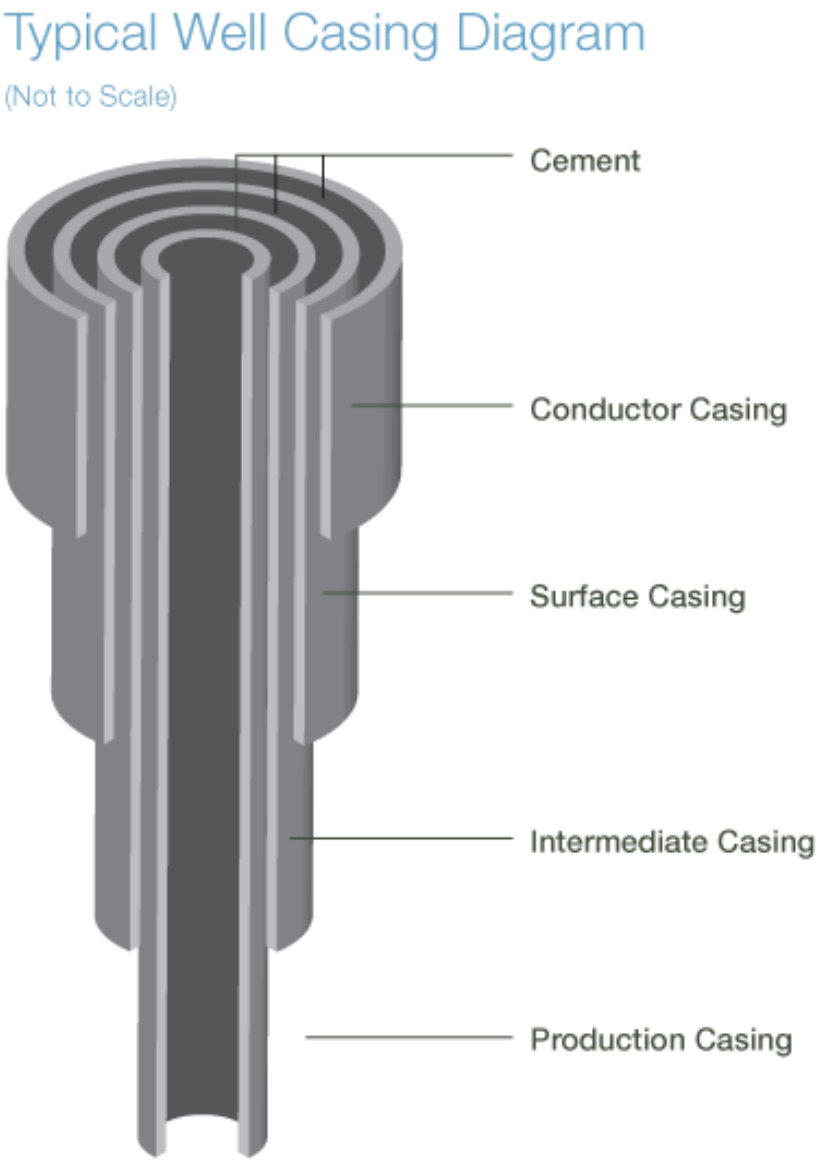
# Surface Casing

- Purpose
  - Protect ground water
  - Provide stable wellbore during drilling operation
  - Provide well control during drilling
- Depth Requirements
  - Set by State regulations
  - Extends below the aquifer
- Cement Helps
  - Protect casing from corrosion
  - Provide zonal isolation
  - Support casing in wellbore



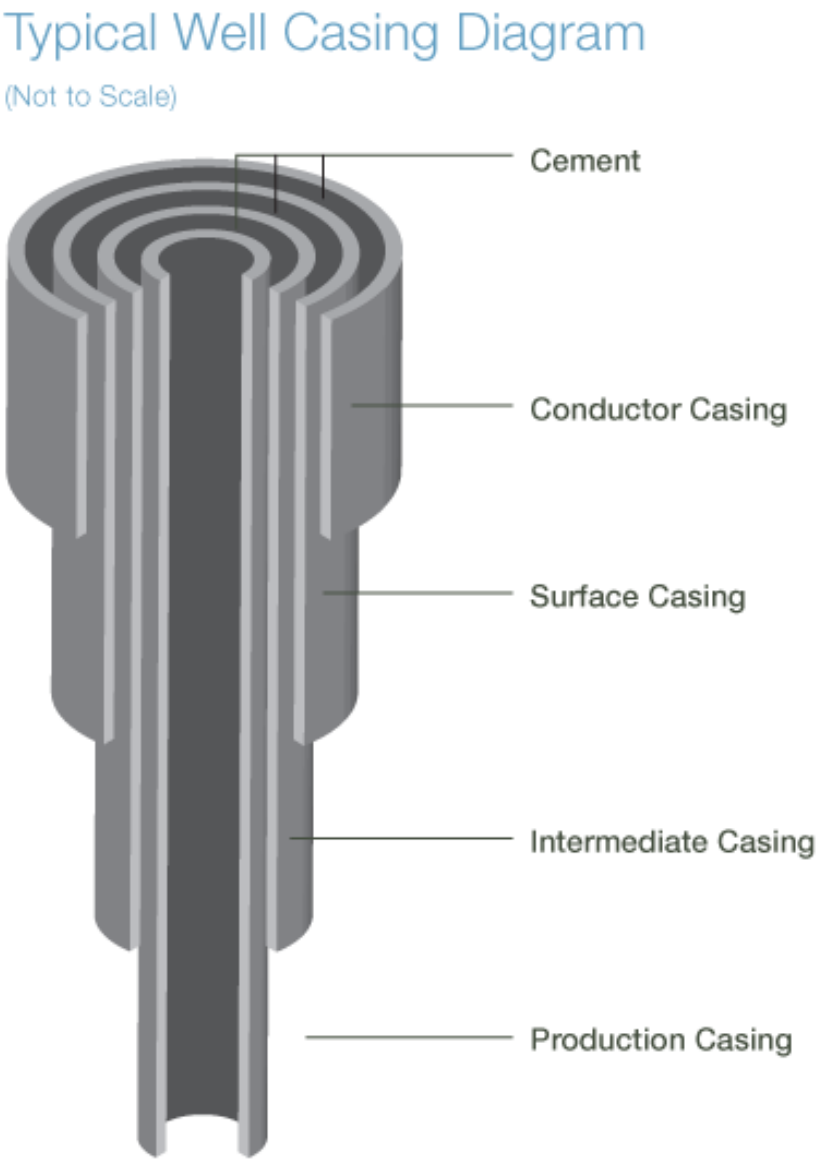
# Intermediate Casing

- Purpose
  - Typically the longest section of casing
  - Provide stable wellbore during drilling operation
  - Provide well control during drilling
- Depth Requirements
  - Set by State regulations
  - Required for drilling to deeper formations
- Cement Helps
  - Protect casing from corrosion
  - Provide zonal isolation
  - Support casing in wellbore



# Production Casing

- Purpose
  - Installed last and is the deepest section of casing
  - Provides a conduit for production
- Depth Requirements
  - Set by State regulations
- Cement Helps
  - Protect casing from corrosion
  - Provide zonal isolation
  - Support casing in wellbore



# A different view…

Source: MOGPEF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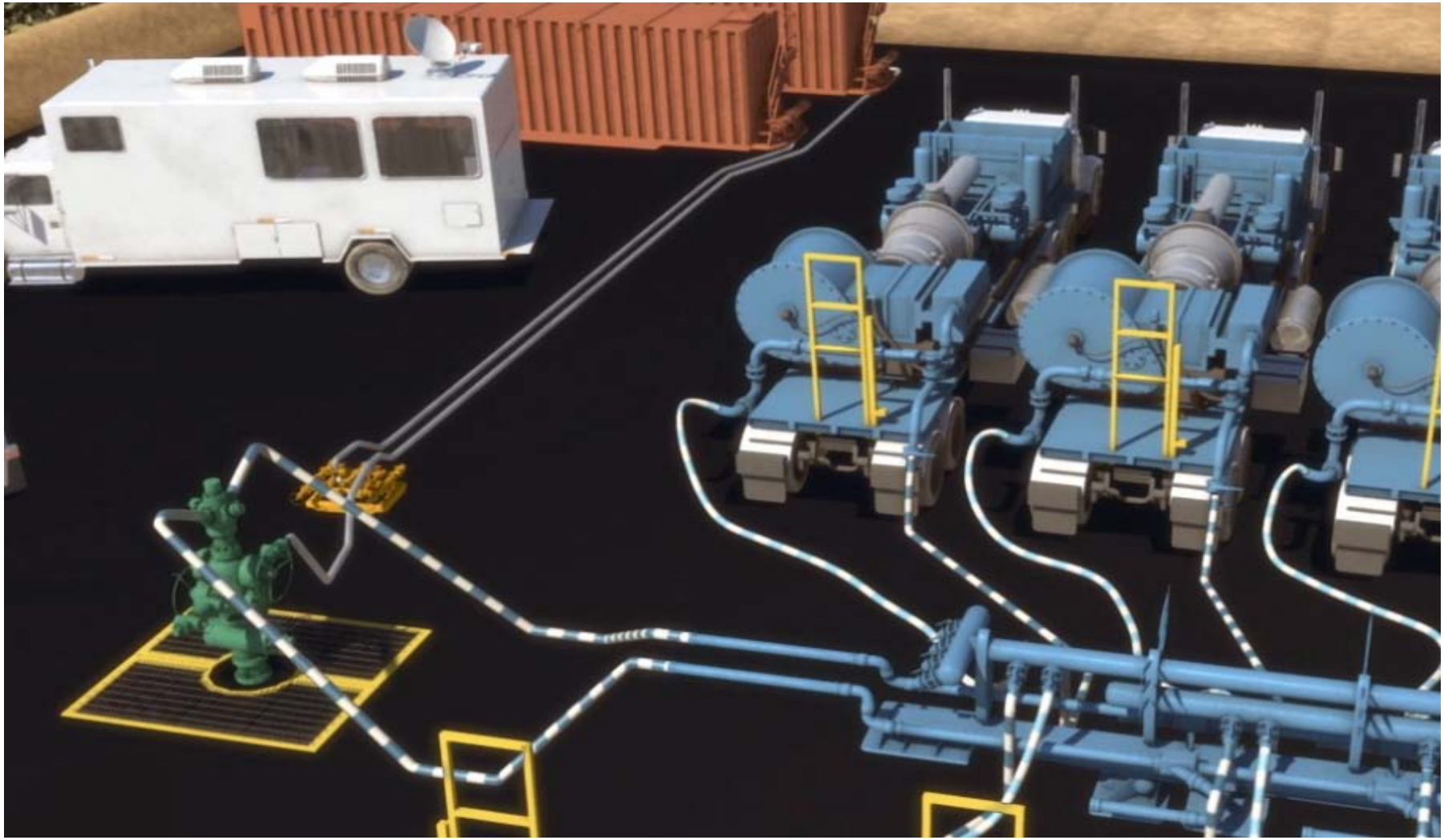
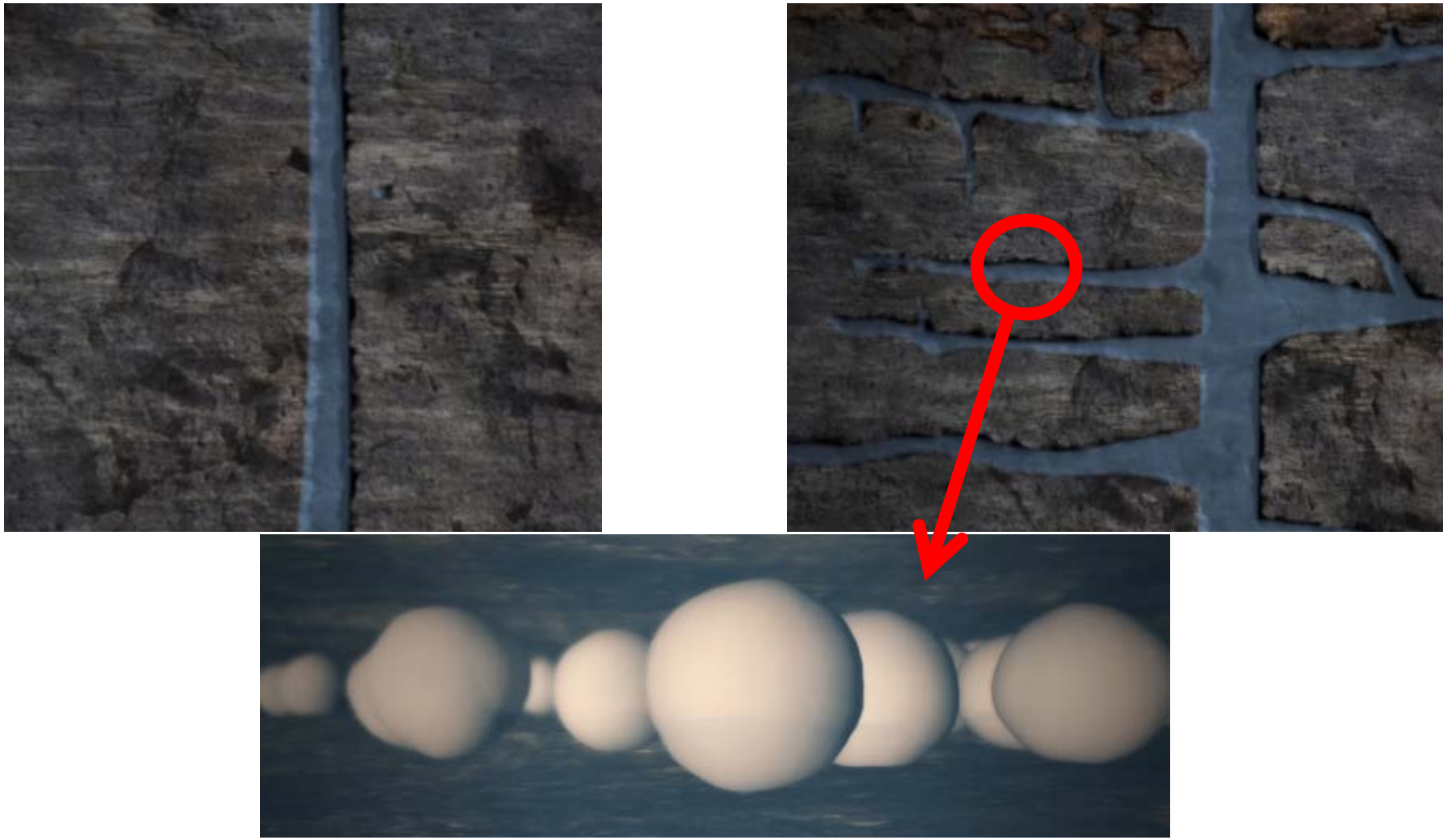
# Perforating Gun

# Fluids are pumped



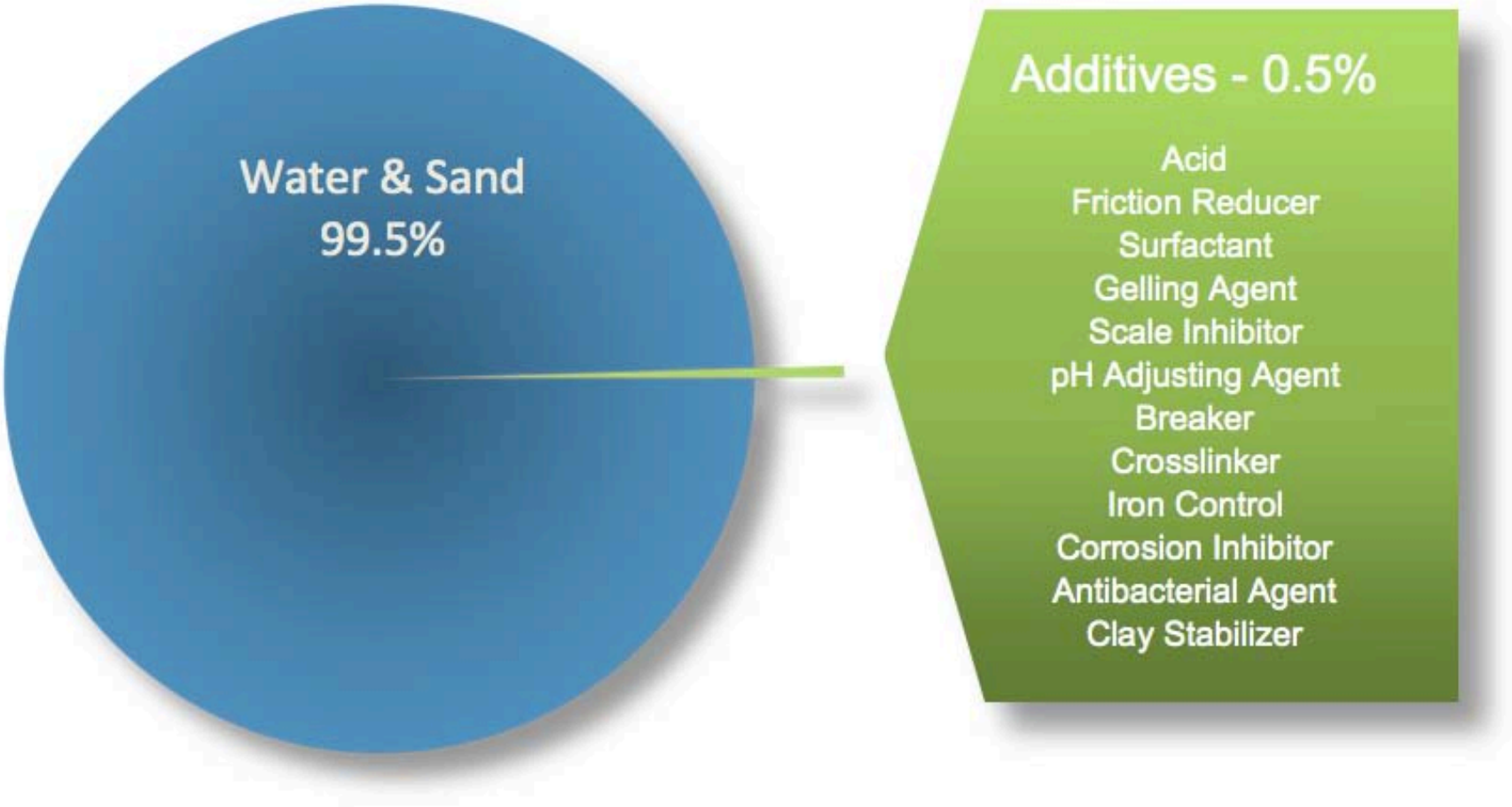
Source: CHK

# Fractures and Proppant



Source: CHK

# Hydraulic fracturing fluids



# Hydraulic fracturing fluids

| Additive | Main Compound | Common Use |
|---|---|---|
| Diluted Acid | Hydrochloricor, Muriatic Acid | Swimming Pools |
| Biocide | Glutaraldehyde | Dental Disinfectant |
| Breaker | Ammonium Persulfate | Bleaching Hair |
| Crosslinker | Borate Salts | Laundry Detergents |
| Iron Control | Citric Acid | Food Additive |
| Gelling Agent | Guar Gum | Biscuits |
| Scale Inhibitor | Ethylene Glycol | Antifreeze |
| Surfactant | Isopropanol | Glass Cleaner |
| Friction Reducer | Polyacrylamide | Water and Soil Treatment |

# Hydraulic fracturing fluids

- Depending on the fluid system being pumped various additives are used:
  - Polymers, Crosslinkers, pH Control, Gel Breakers, Surfactants, Clay Control, Bacteria Control, & Fluid Loss Additives
- Additives are transported in concentrated form
- Typically injected at less than 3 gallons per 1,000 gal of water (0.3%)
- The purpose of any additive is to help improve the overall process

# What does it look like?

# Water Management

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# Water Use

- Typical Michigan vertical well uses approximately 50,000 gallons.
  - This is similar in size to a restaurant aquarium.

- Typical Michigan horizontal well uses approximately 5 million gallons.
  - This is similar in size to 8 acres of corn in a growing season.

Source: MOGPEF

# How much is 5 million gallons?

- Equivalent to:
  - A 1,000 megawatt coal-fired power plant in 12 hours
  - A golf course in 25 days
- Compared to other energy forms – natural gas has the lowest water usage per MMBTU of energy produced.
- The chemical reaction of burning natural gas releases water molecules into the atmosphere:
  - 11 million gallons of water is added to the atmosphere from burning 1 billion cubic feet of natural gas.

Source: Energy In Depth

# Regulation

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# Michigan's track record

- Successful history
  - Nearly 60 years of experience
  - Over 12,000 wells in Michigan
- Safe
  - Water resources are protected
  - No incidences of harm
- Regulated
  - Compliant to both state & regulatory agencies

Source: MOGPEF

# Exempt from Federal laws?

- **Claim**: Oil and natural gas wells are exempt from federal laws.

- **Truth**: In every step of the way, oil and natural gas production is regulated at the federal, state, and local levels – **often at multiple levels simultaneously**.

A 2012 study by the Government Accountability Office (GAO) makes clear that oil and natural gas developers are required to comply with no fewer than 8 federal regulations.

Source: Government Accountability Office, Energy In Depth

# INDUSTRY AND REGULATORY OVERSIGHT

- Michigan DEQ Supervisor of Wells Instruction 1-2011
- US EPA
- Model Regulatory Framework
- Groundwater Protection Council
- Interstate Oil and Gas Compact Commission




# Economic Impact

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# Abundant, clean and affordable

- Oil and natural gas production has risen dramatically over the past 10 years.
  - Since 2005 we've reduced imports from 50% to 45% - this couldn't have taken place without hydraulic fracturing.
- Natural gas is playing a major and growing role in our clean energy future – burns cleaner meaning less pollution.
  - It also provides a good bridge fuel for renewables such as wind, solar or biofuels.
- It's abundance means lower energy costs for you and your family, along with businesses.

# What we use it for

- Petroleum/Oil
  - Transportation
  - Propane, Butane
  - Nearly all plastics
  - Medicine
  - Clothing
  - Makeup
  - Solvents
  - Ink
  - Eye Glasses
  - 1000's more
- Natural gas
  - Transportation
  - Residential
    - 80% of MI homes are heated with natural gas
  - Electricity Generation
  - Manufacturing
  - Fertilizer

# What roles does this play in MI?

- More than $150 million in income to 8,000 private Michigan landowners annually.

- Pay approximately $78 million annually in state and local taxes.
- $8.3 billion annual Michigan labor impact.
- Over $16.8 billion overall to Michigan's economy.

Source: MOGA, API (PwC Study, 2011)

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# MICHIGAN JOBS FROM MICHIGAN COMPANIES

- Michigan's oil and natural gas industry supports 10,000 jobs directly.
- In all, over 150,000 Michigan jobs are provided for or supported by our industry.


Source: MOGA, ANGA, API

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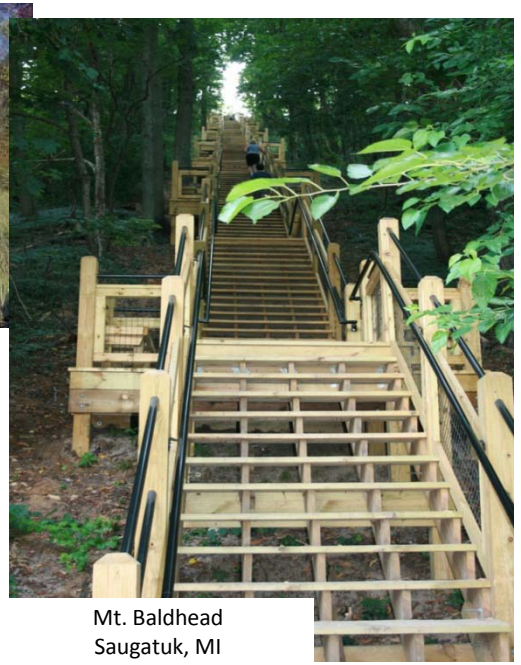
# MICHIGAN NATURAL RESOURCES TRUST FUND

- Established in 1976 in a partnership between the energy industry and conservation.
- More than $1.25 billion in funding for more than 1,600 approved projects.

Riverfront Boardwalk
Allegan, MI

Lake Michigan Nature Preserve
Casco Township, Allegan County

Harbor Natural Area
Saugatuk, MI



Mt. Baldhead
Saugatuk, MI

Source: Michigan DNR

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# CONTACT INFORMATION

*Thank you for your interest in MOGPEF. Please feel free to contact us at:*


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