

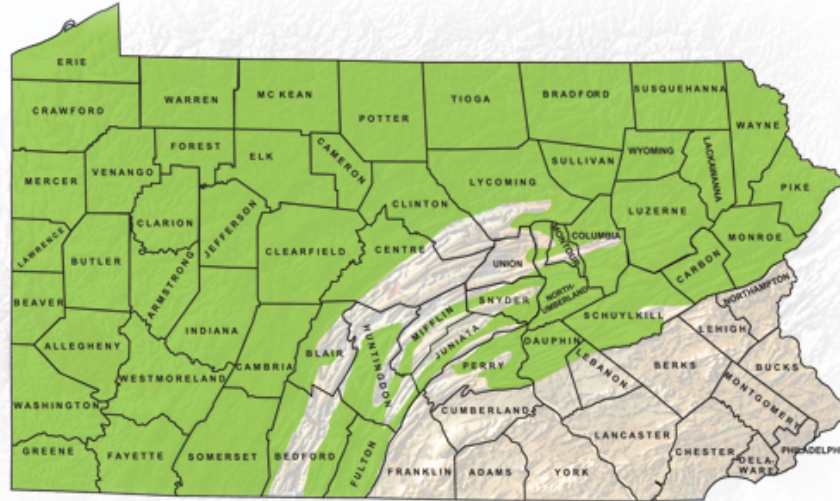
Getting the Waters Tested – The Marcellus Shale Factor Working as a Community



Water Resource



Environment



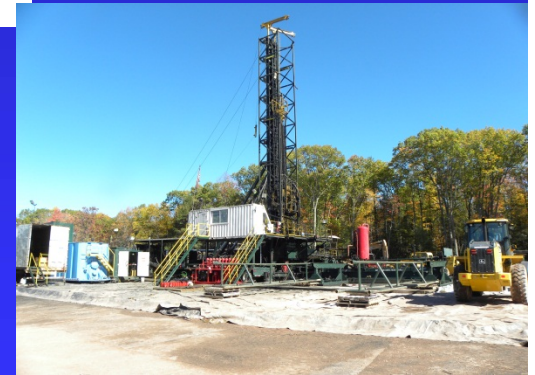
Marcellus Shale Formation



Understanding The Issues
“Water / Private Wells”



Old Issues



New Issues



Presented At

Lackawanna College
Environmental Institute
Marcellus Shale 201- April 14, 2012

Presented by: Mr. Brian Oram, Professional
Geologist (PG),
Soil Scientist, Licensed Well Driller

B.F. Environmental Consultants Inc.

<http://www.bfenvironmental.com>

And

Water Research Center

<http://www.water-research.net>





B.F. Environmental Consultants Inc.



- Professional Consulting Services in the areas of water quality, soils, stormwater, geology, aquifer analysis, and land-development.
- Baseline – Chain-of-Custody
- Expert Testimony
- Water Treatment Process/ Product Development
- <http://www.bfenvironmental.com>

B.F. Environmental Consultants Inc.

Environmental Scientists, Hydrogeologists, & Environmental Education Specialists
Located in Northeastern Pennsylvania

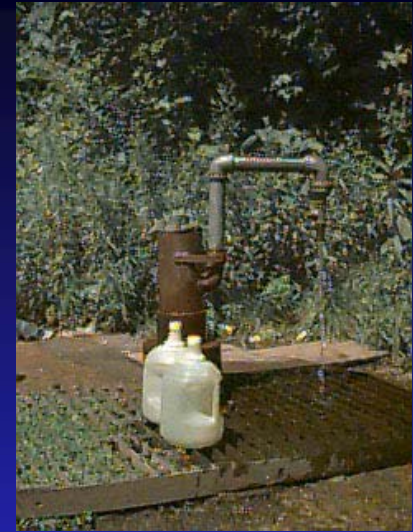
water reuse

hydrogeology

soil testing

Water-Research Center

Education and Outreach Program funded by
B.F. Environmental Consultants Inc.



Outreach Programs

- Environmental and Professional Education and Training for Citizens and Local Municipalities
- Water Quality Help Guides – Information Library
- Community and Business Outreach Programs
- Low Cost – Informational Water Testing Program with National Laboratory
- Citizen Monitoring Programs- Developing Low Cost Water Quality Sensors

Website: <http://www.water-research.net>

Current Work

- Citizens Groundwater / Surfacewater Database –
Certified Data Only!
<http://www.bfenvironmental.com>
- Radon Levels in Private Well – Goal is to Sample
approximately 200 wells in Northeastern PA.
Private Well Owner / Watershed Group Survey
Take the Survey:
<http://www.surveymonkey.com/s/NMG6RQ3>

Announcements

- New Methane Gas Migration and Mitigation Website

<http://www.water-research.net/methanegas.htm>

- New Information Guide for Private Well Owners will be available in April 2012.

<http://www.bfenvironmental.com>

Major Misconceptions

- PA Groundwater is Pure
- Private Wells are Regulated and Protected and Baseline Testing Should be Conducted 6 months Before Drilling.
- Methane Gas is a Marcellus Shale Issue.
- Hydraulic Fracturing Using 10s to 100s of chemicals.

Item 1: Past Water Quality Issues are Not Being Communicated



100 % Pure Water – No Problems

Before Marcellus Shale Development

What was the Quality of Private Well Water?

A USGS survey found that 70% of private wells were contaminated. This contamination could result in acute or chronic health concerns (1996).

Testing Conducted under my supervision at Wilkes University in through out the United States indicates that 30 to over 50 % may be contaminated – Mostly by Total Coliform Bacteria (1989 – 2011).

PSU – Master Well Owner Network suggests that 33 to 50 % of Private Well Owners in PA may have some form of contamination.

DID ANYONE TELL YOU ?????

The Real Facts on Drinking Water



50%

Other
50%

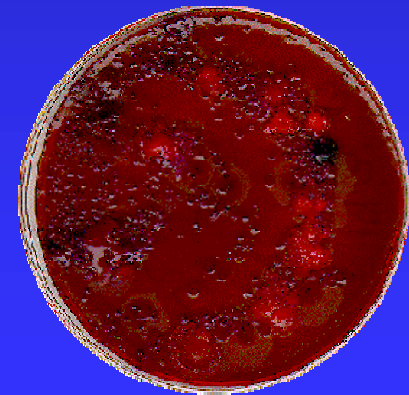
Corrosion



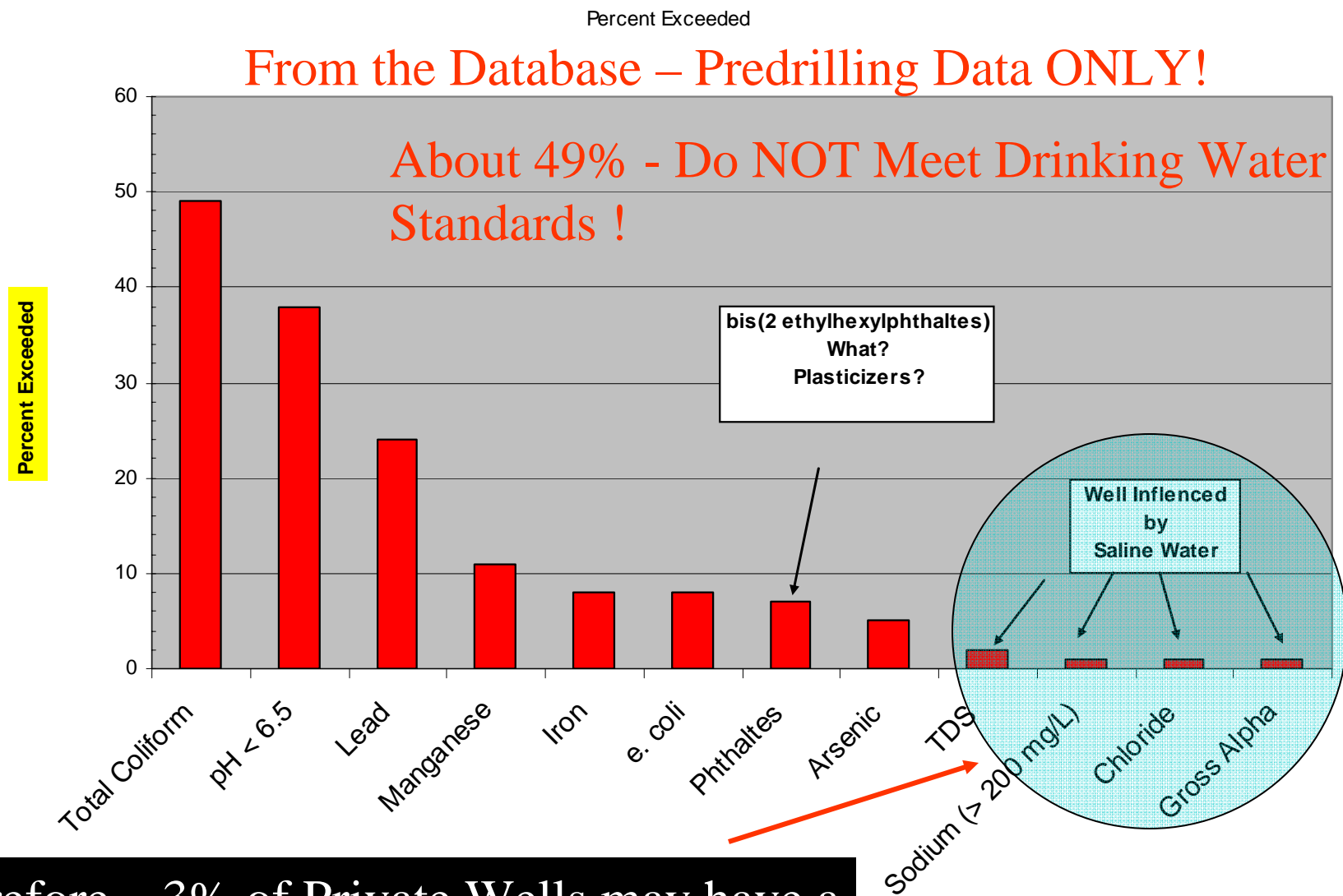
Iron / Manganese



Sediment / Gases



Bacteria



Therefore – 3% of Private Wells may have a Saline water fingerprint.

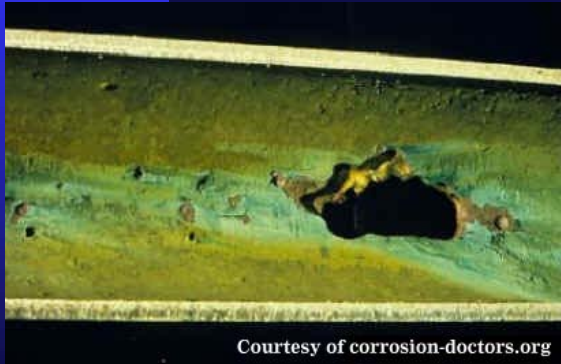
Most Contamination appears to be associated with Total Coliform Bacteria



- Insects, Larvae and Nests / Egg Masses
- Mouse Colonies
- Snakes
- Beehives
- Mud - when casing to close to ground

Therefore – In some cases - the Private Wells are Facilitating Groundwater Contamination.

Corrosion, pH, Iron, Manganese



38 % < pH 6.5

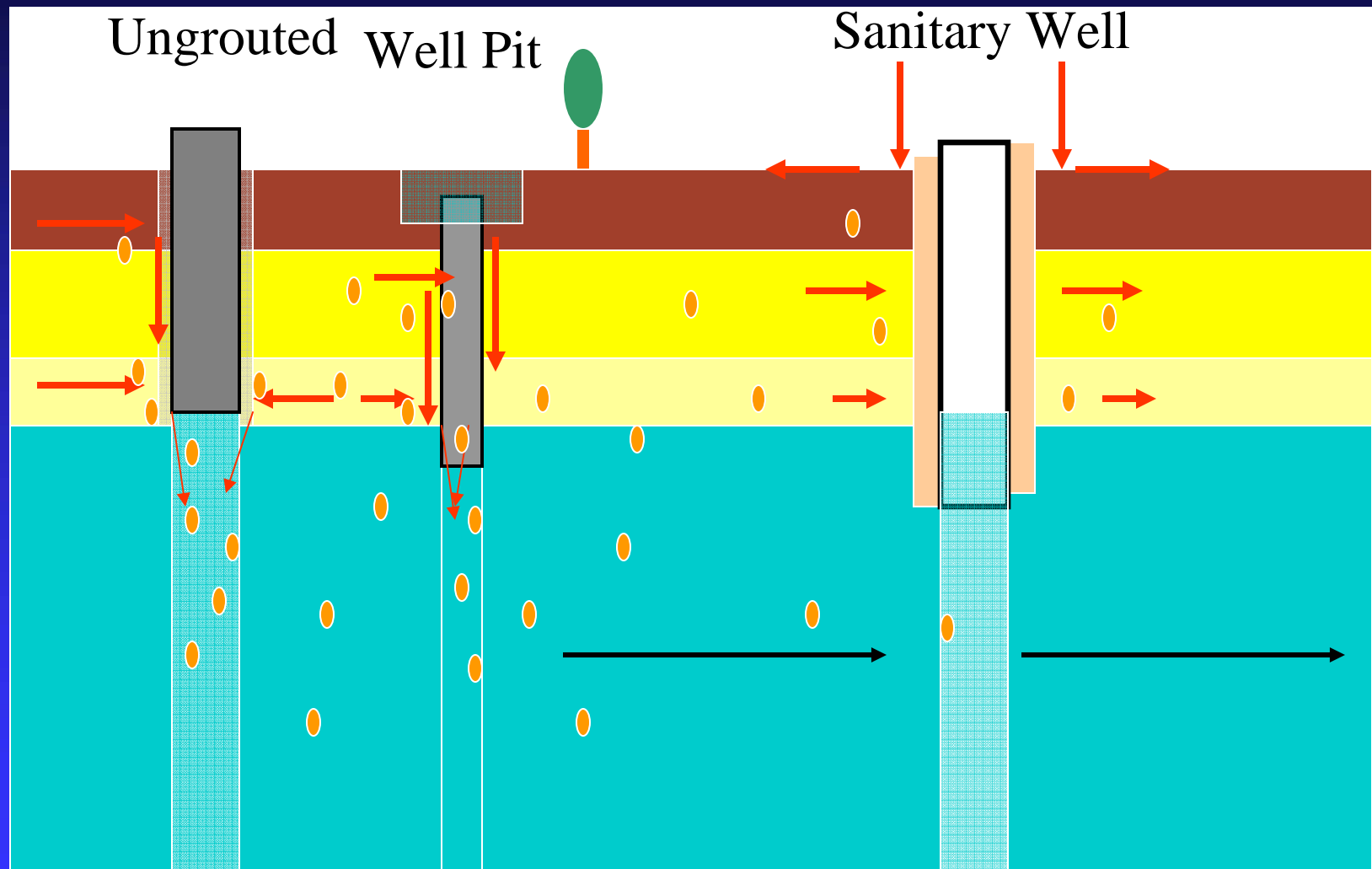
< 3 % > pH 8.5 (saline water)

Leaching Metals- Copper,
Lead, Zinc, and Aluminum

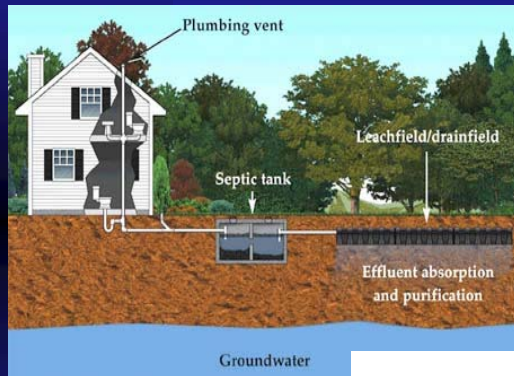
Secondary Drinking Water Standard
Iron – 0.30 mg/L (red or black) **8 %**
Manganese – 0.05 mg/L (black) **11%**

If you are not doing it, add Copper, Lead, Zinc, and Aluminum to
Baseline Testing – Especially if there is evidence of Corrosion.

How Contaminants Can Get In to the Aquifer (Subsurface)



Total Coliform is the cheapest test to evaluate well vulnerability



Not Just a Marcellus
Shale Issue and in some cases
other Private Wells are Part of the Problem



Item 2: Private Wells Not Regulated

- Private Wells Are Not Regulated under Safe Drinking Water Act
 - ◆ EPA – NO
 - ◆ PADEP – NO
 - ◆ County – Very Few Counties in PA
 - ◆ Townships – some have basic ordinance on placement- some have comprehensive requirements- but most have nothing.
 - ◆ Provisions in Oil and Gas Law – Presumed Liable.
 - ◆ Private Wells protected to a standard set for drinking water quality or to the quality that was established during a baseline test.
 - ◆ Quantity is also protected, but this is based on use not yield.
 - ◆ The standard is no adverse impact
 - ◆ Requires chain of custody, third-party contractors, and independent laboratories.

Do Not Conduct Baseline Testing Until 6 Months of Drilling

- When to Conduct Baseline Testing
 - ◆ Citizens were told to wait until 6 months prior to drilling.
 - ◆ NOT a Good Answer
 - ◆ When to Conduct Baseline Testing ?
 - ◆ NOW !

Current Situation – HB1950

- Natural Gas Drillers – assumed liable for an “impact” if it occurs within 2500 feet and 1 year after stimulation or alteration.
- Increased set-backs- public water supply (1000 feet)
- Spring or water body – From 100 to 300 feet.

Item 3 -Methane Migration (Natural, Induced, Facilitated)

Smell is Odorless, Colorless, and Looks Like This:



Add Ignition Source
And Oxygen



Methane in Water

- Methane has been a hidden issue in NEPA- at least to the “Public” – but it was first reported in the late 1700s and published in 1937 by PA Geologic Society.
- The gas is colorless, tasteless, and odorless and there are no known health effects.
- Potential concerns relate to flammability/ explosiveness of gas.
- Background – appears to range from non-detect to over 20+ mg/L (highly variable) in Northeast Pennsylvania.

Methane Gas

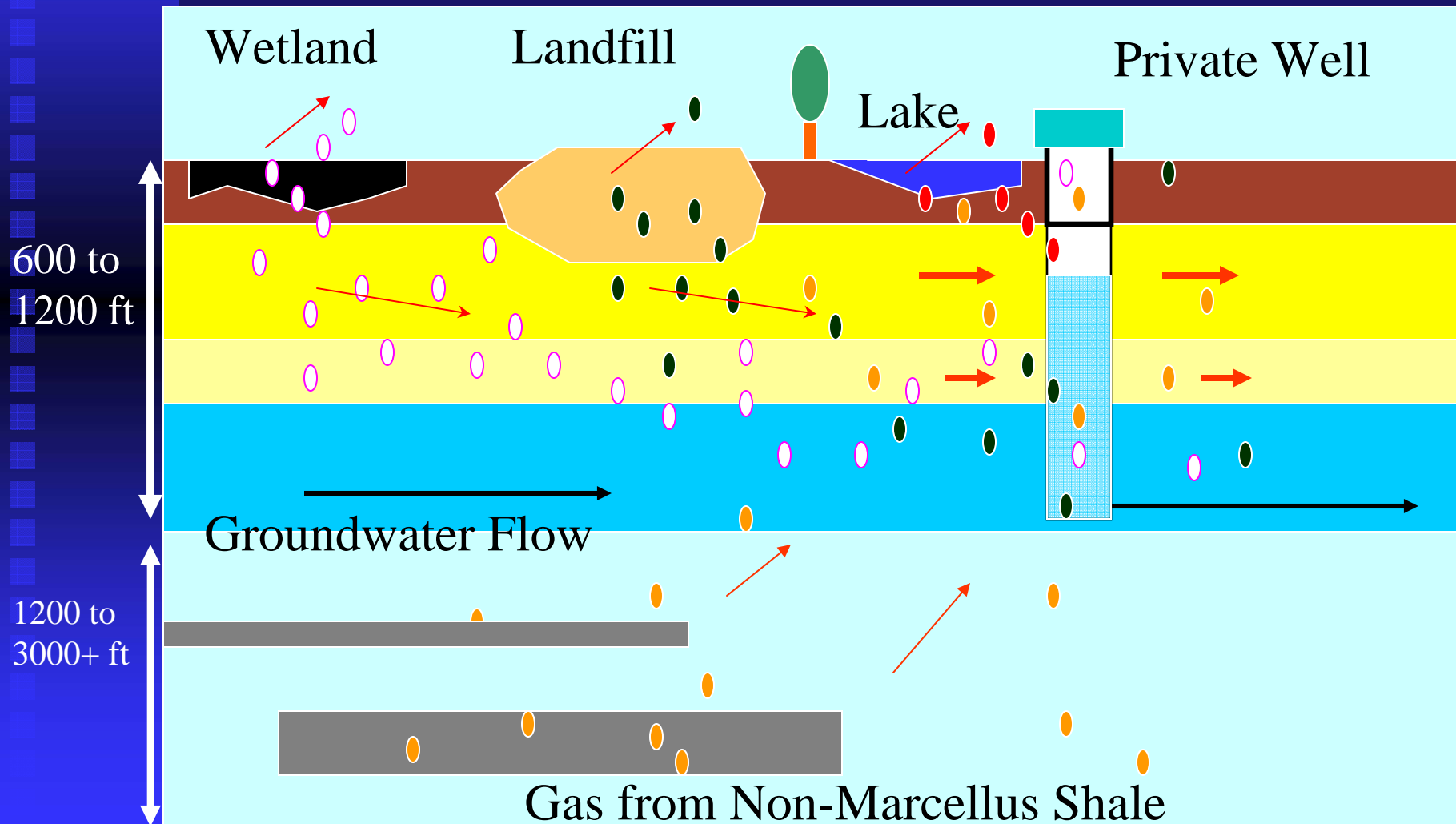


Video from Salt Springs State Park – Fall 2010, by Brian Oram

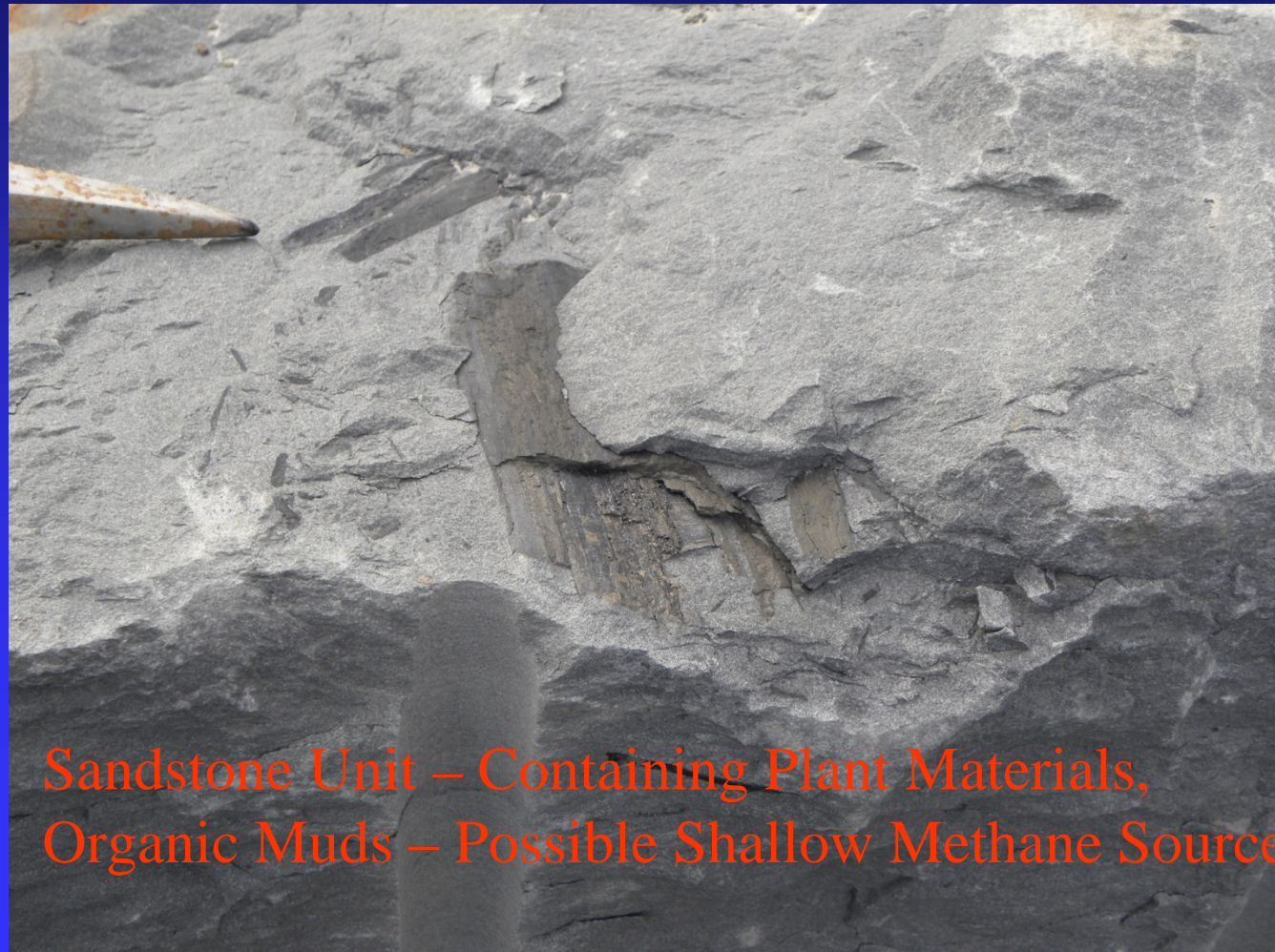
<http://www.friendsofsaltspringspark.org>

“At the base of the gorge is a bubbling salt spring, traces of an 1850s woolen mill, and mid-19th century farmhouses and barns.”

Methane Gas Migration- Not Related to Marcellus Shale

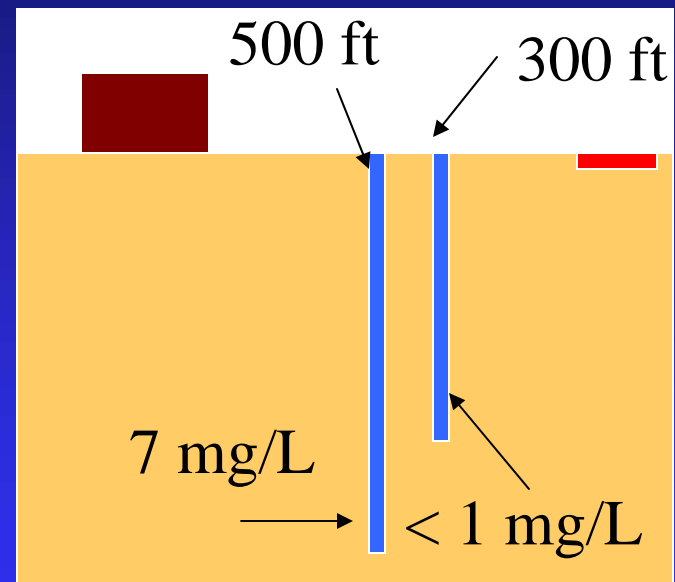
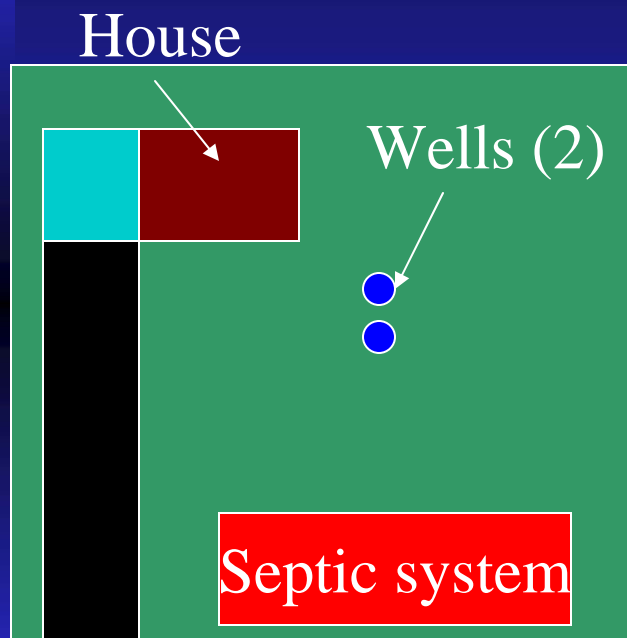


Rock Sample from Quarry – West of Dimock

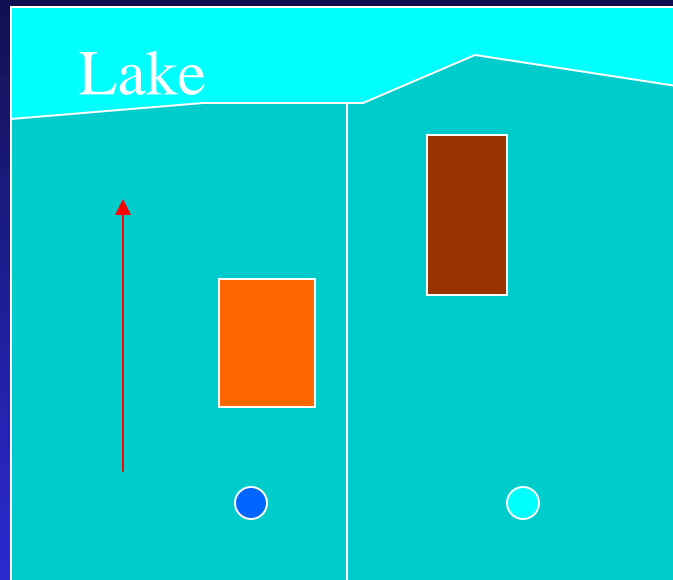


Sandstone Unit – Containing Plant Materials,
Organic Muds – Possible Shallow Methane Source

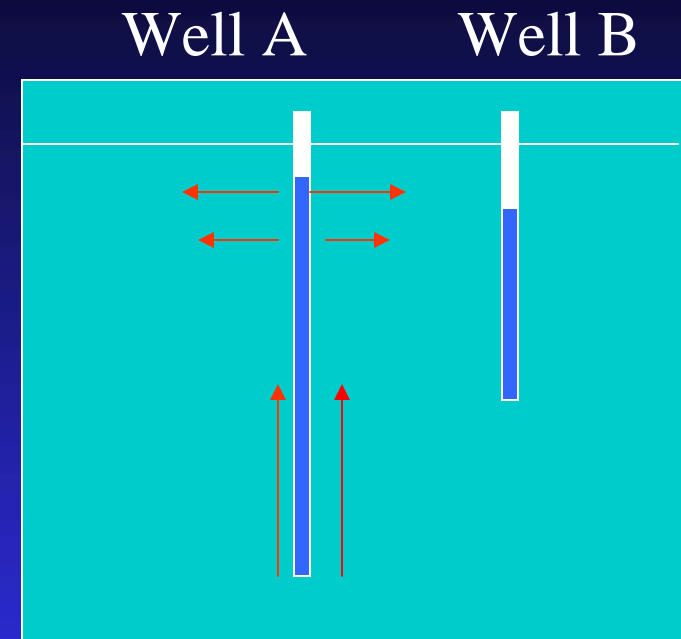
Methane Variability- Actual Examples- Depth Well Depths



Impact Where There is NO Drilling – Baseline Testing



Groundwater Flow Towards
The Lake



Direction of Groundwater
Flow - UP

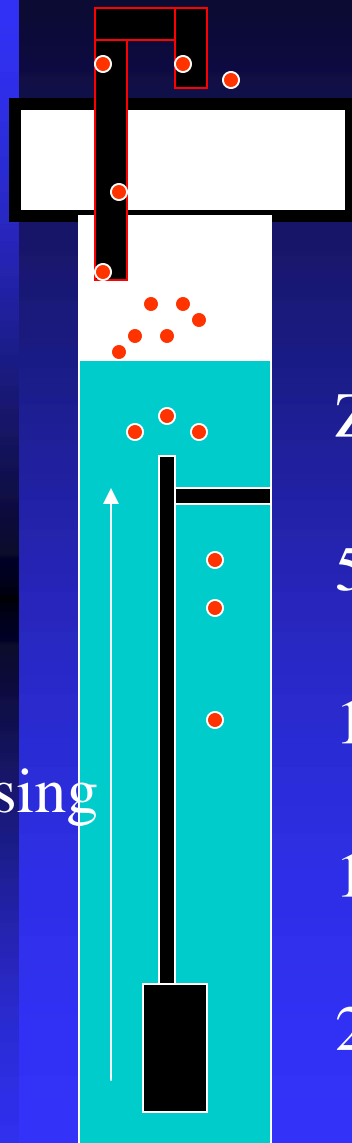
Well A- 300 feet

Methane – 10 to 15 mg/L – the real problem, Barium 4 mg/L, Radon 577 pCi/L, Chloride 250 + mg/L, Bromide 1.5 mg/L, Strontium 5.57 mg/L, Iron – 3.2 mg/L

Well B – 200 feet

Methane – 6 mg/L, Chloride 30 mg/L, Barium 1.13 mg/L, Strontium 2.15 mg/L, Radon < 60 pCi/L, Iron – 1.39 mg/L

Well A may be Impacting Well B



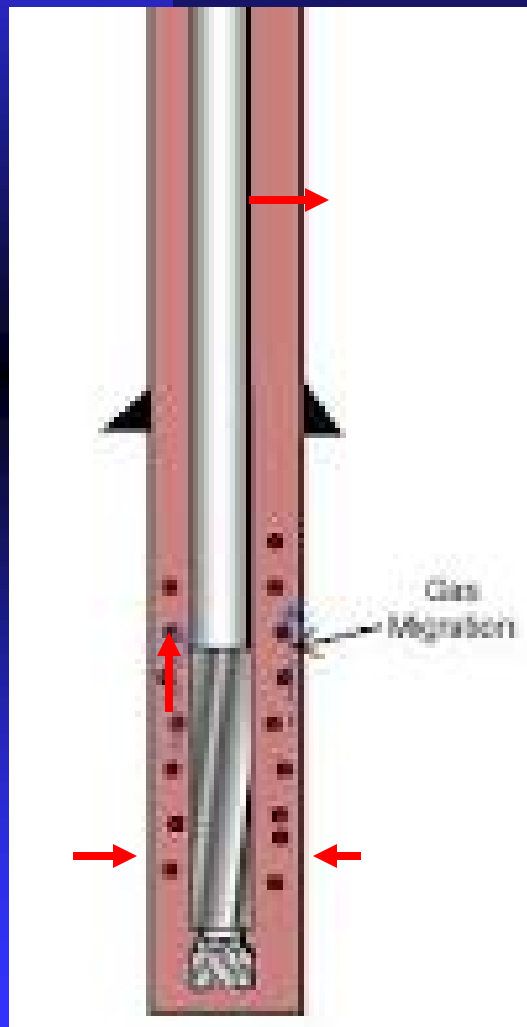
Methane Solubility

Zero Head	28 mg/L
50 feet Head	69 mg/L
100 feet Head	110 mg/L
150 feet Head	151 mg/L
200 feet Head	192 mg/L

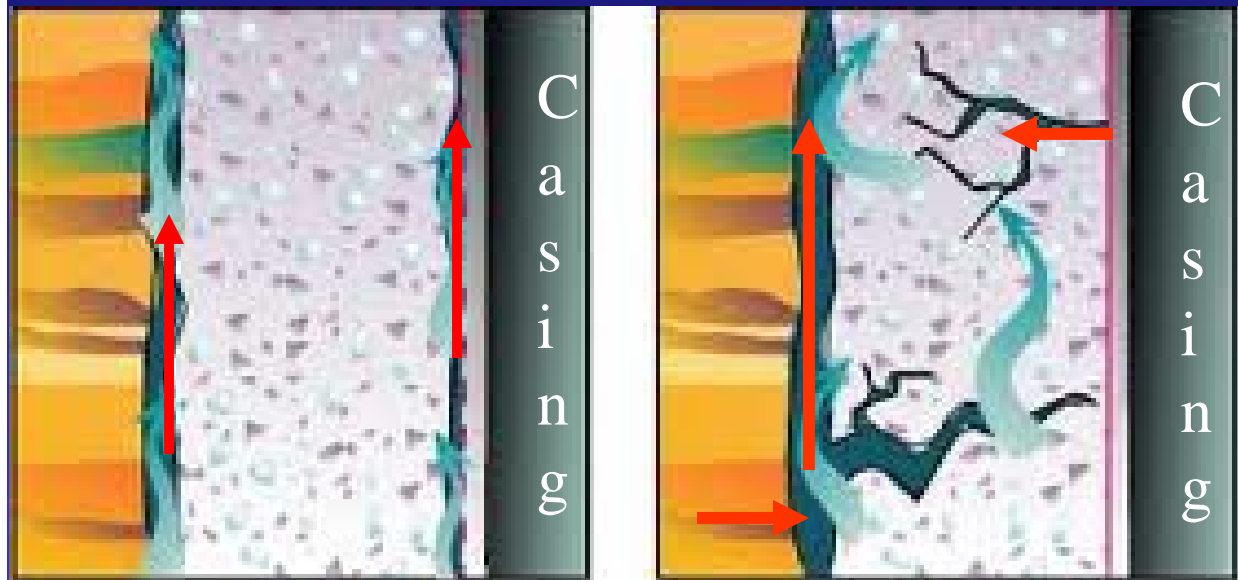
Therefore, Water Well methane levels can exceed 28 mg/L if water is not in equilibrium with the atmosphere.

Freshwater – Solubility as a function of pressure.

Problems with Gas Migration and Cement



Does not Bound

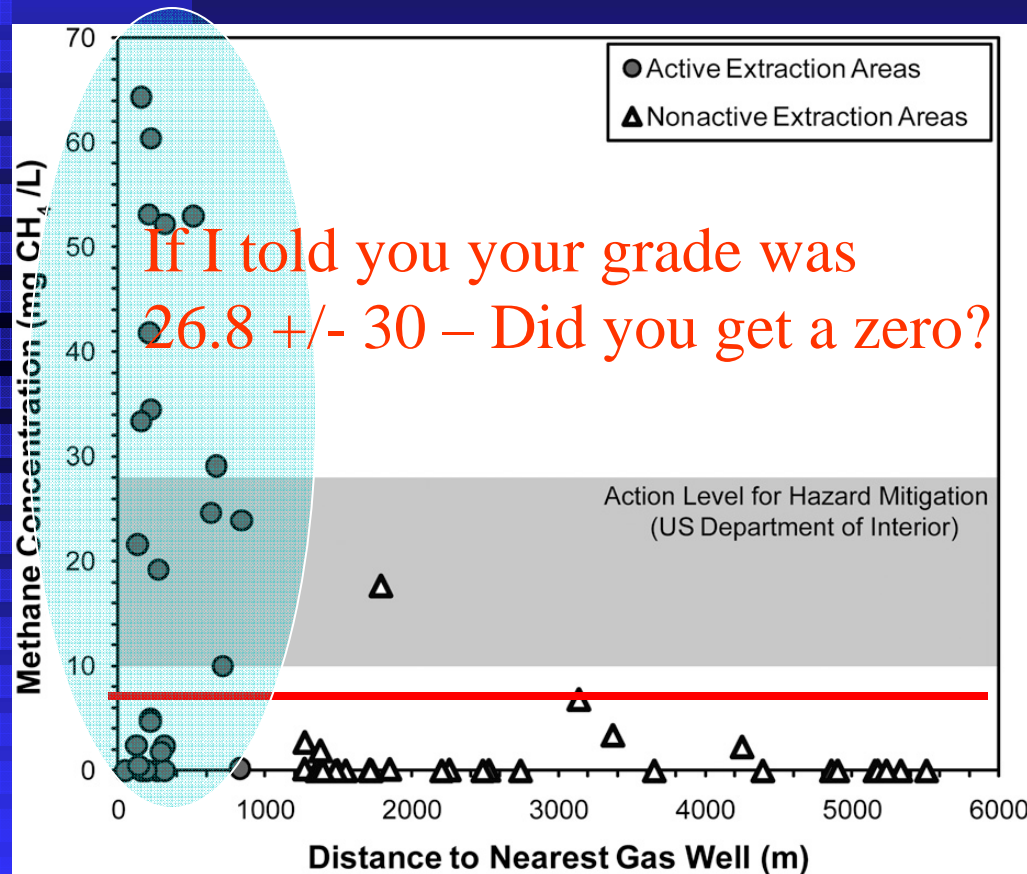


Migration



Methane Gas Migration – At Wellhead – Prior to Regulation Change

Duke Study- “Gas Well Drilling and Hydraulic Fracturing” by Osborn

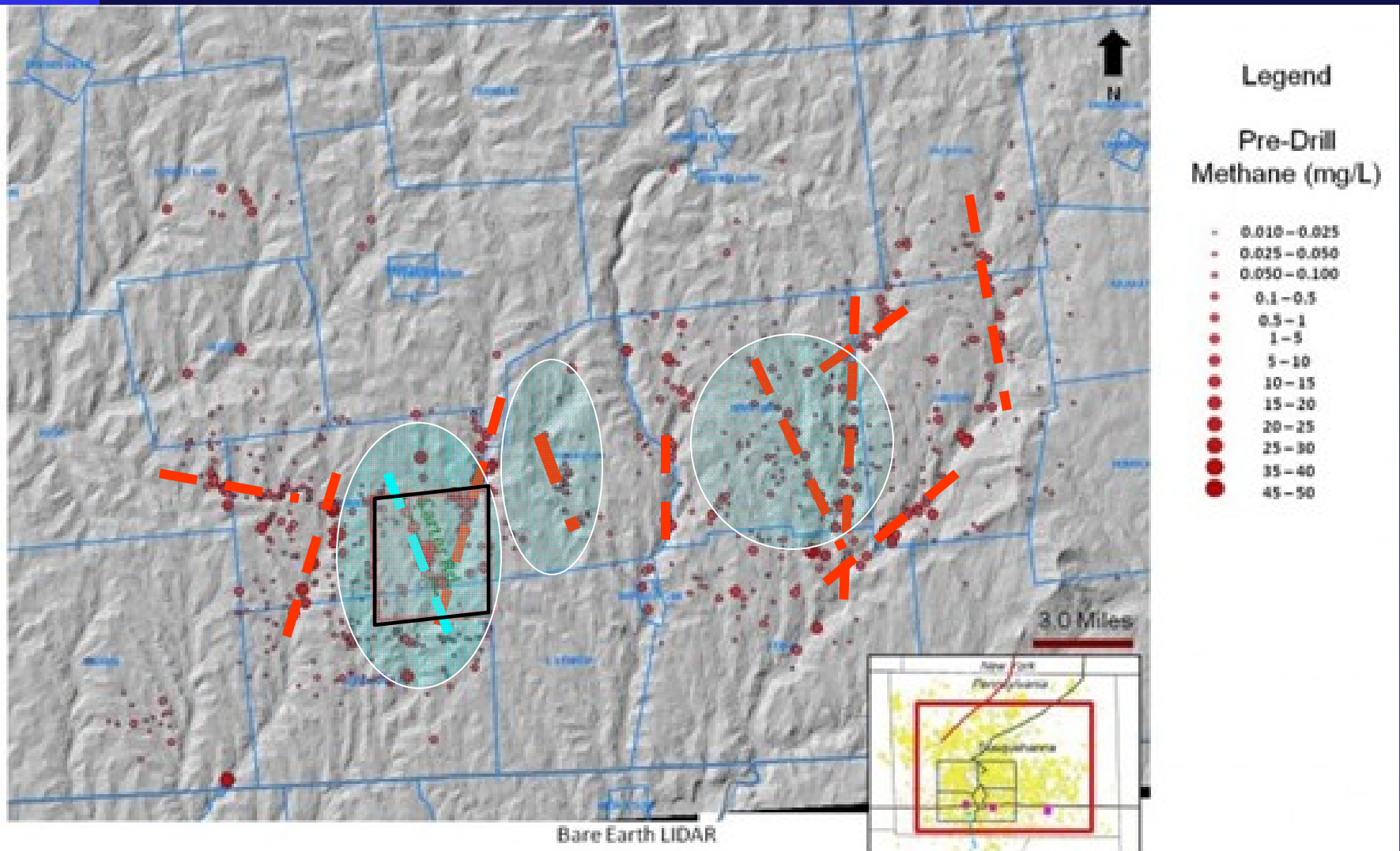


Note:

1. Action Level is 7 mg/L
2. Study done in an area with “suspected” gas migration Problems- Not Considered.
3. Data suggest a simple 2-D relationship.
4. Many samples well above Saturation- Influenced by Pump Depth.
5. Contains No Pre-Drill Data- for the shaded area.

Title is spin.

Cabot – Quick Look

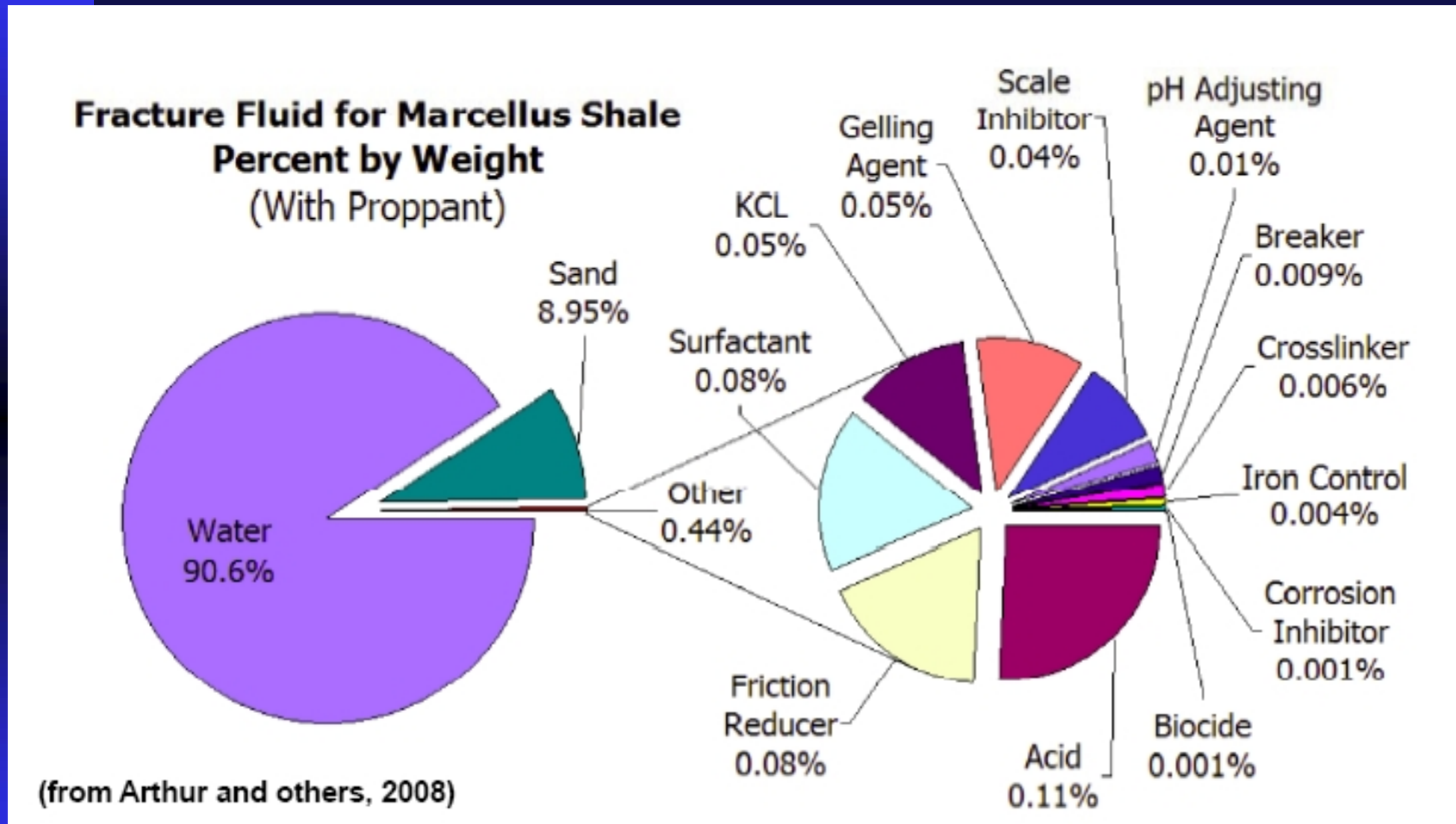


It looks like background methane levels may follow a linear/ curvilinear trend.

Protective Casing and Cement— Do it Right !



Item 4: Hydrofracturing Process Uses 10s to 100s of Chemicals

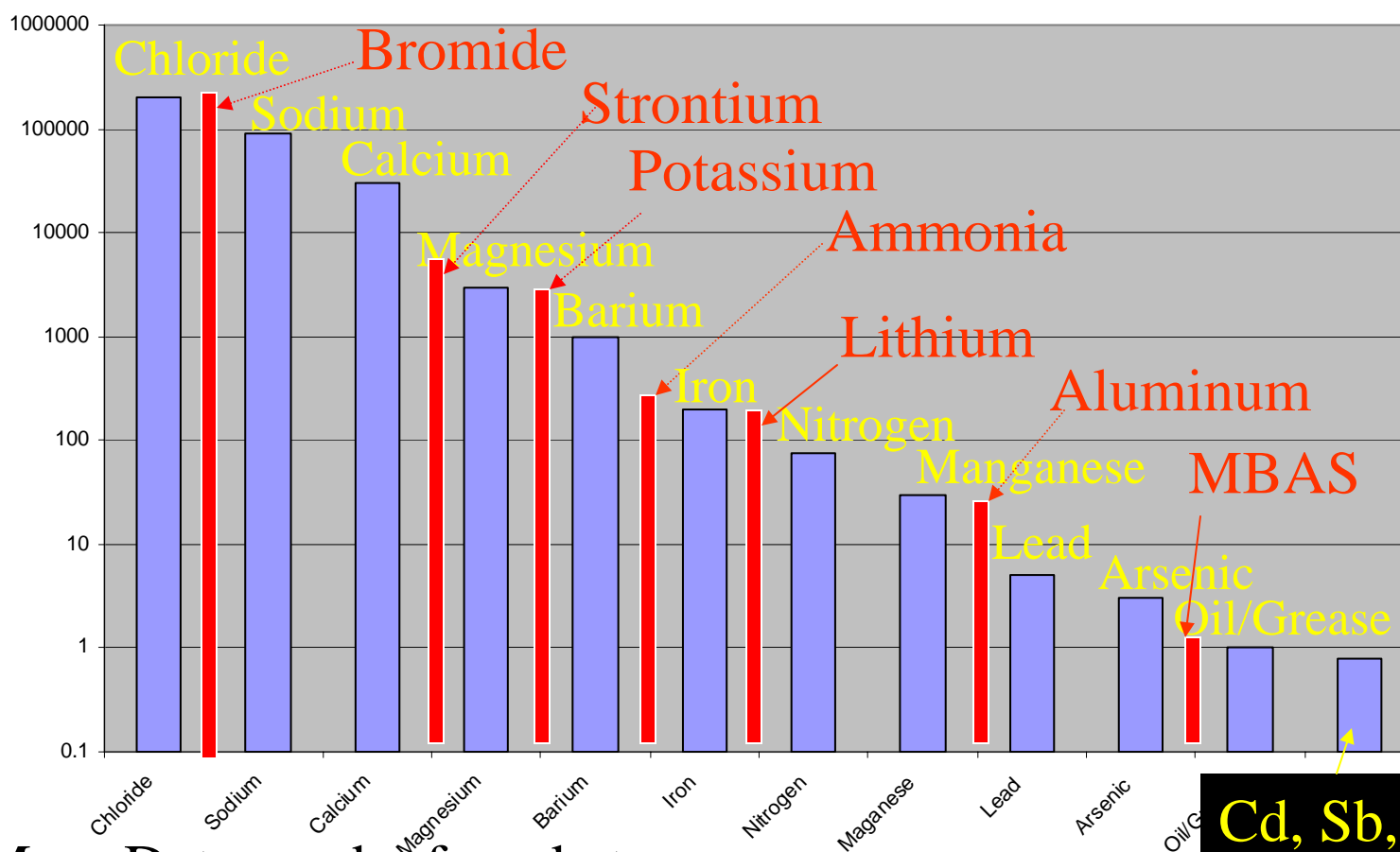


Arthur et. al., 2008 – All Consulting – “Natural Gas Wells of the Marcellus Shale”, Presented at Groundwater Protection Council 2008 Annual Forum.

Frac Water Chemical Disclosures

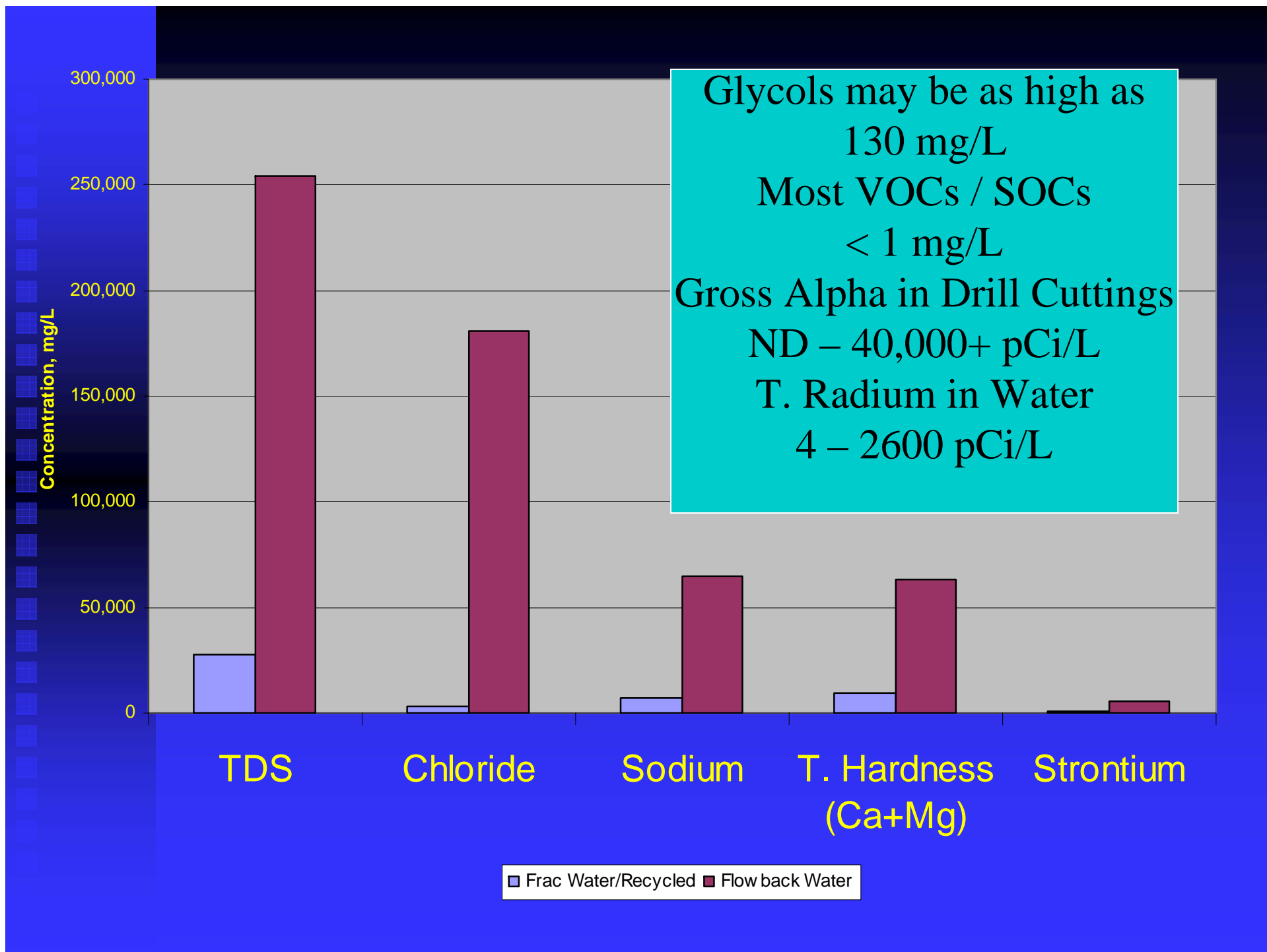
- FracFocus''- <http://fracfocus.org/>. - the hydraulic fracturing chemical registry website.
- This website is a joint project of the Ground Water Protection Council Interstate Oil and Gas Compact

Approximate Flowback Water - Wastewater Chemistry Concentration - mg/L (Source: PSU and Marcellus Shale Coalition)



More Data can be found at
<http://www.bfenvironmental.com>

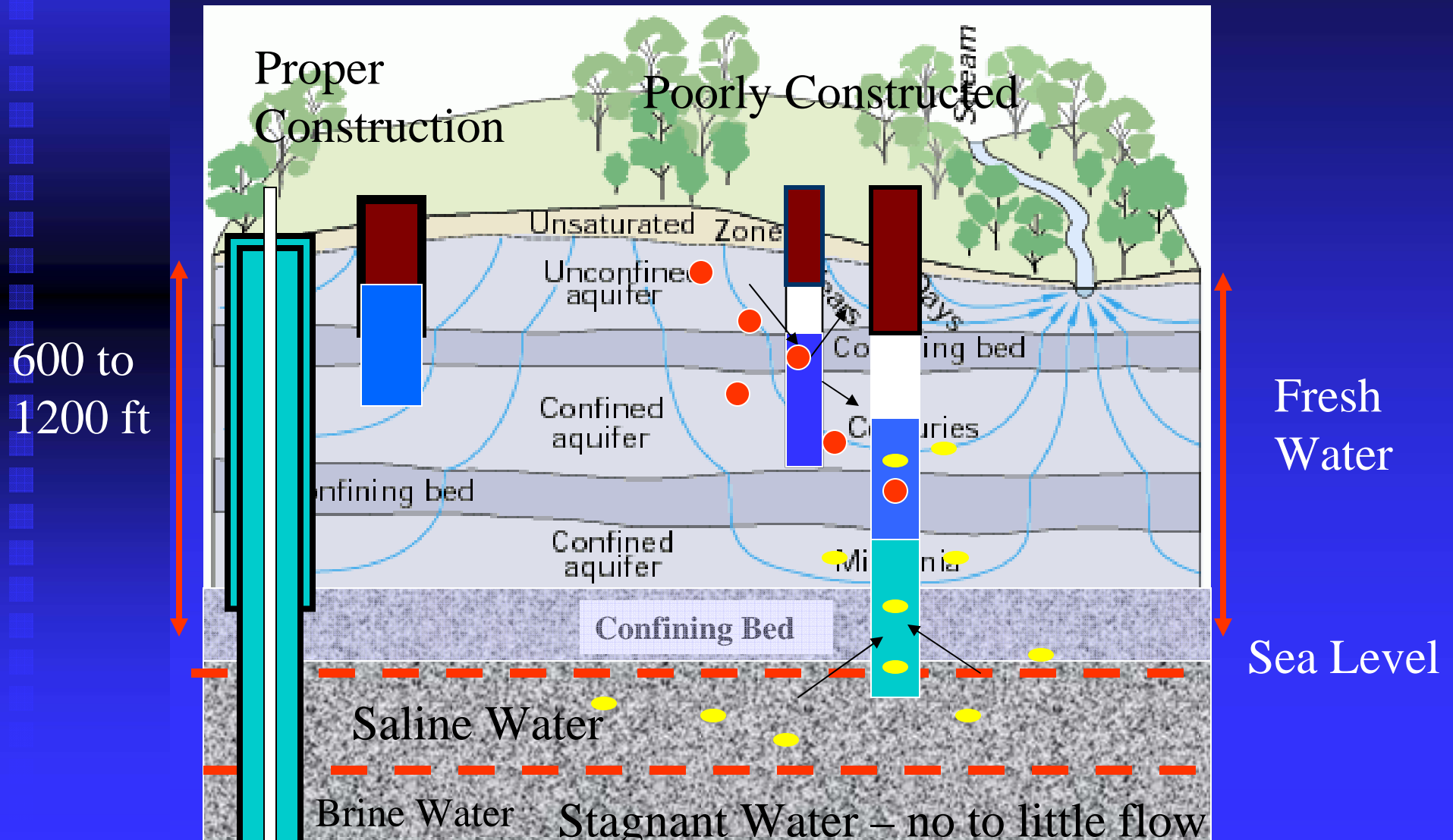
**Cd, Sb, Be, Cr
Ni, Ag, Tl and
other trace
metals**



Item 5- How Water Gets “Dirty”

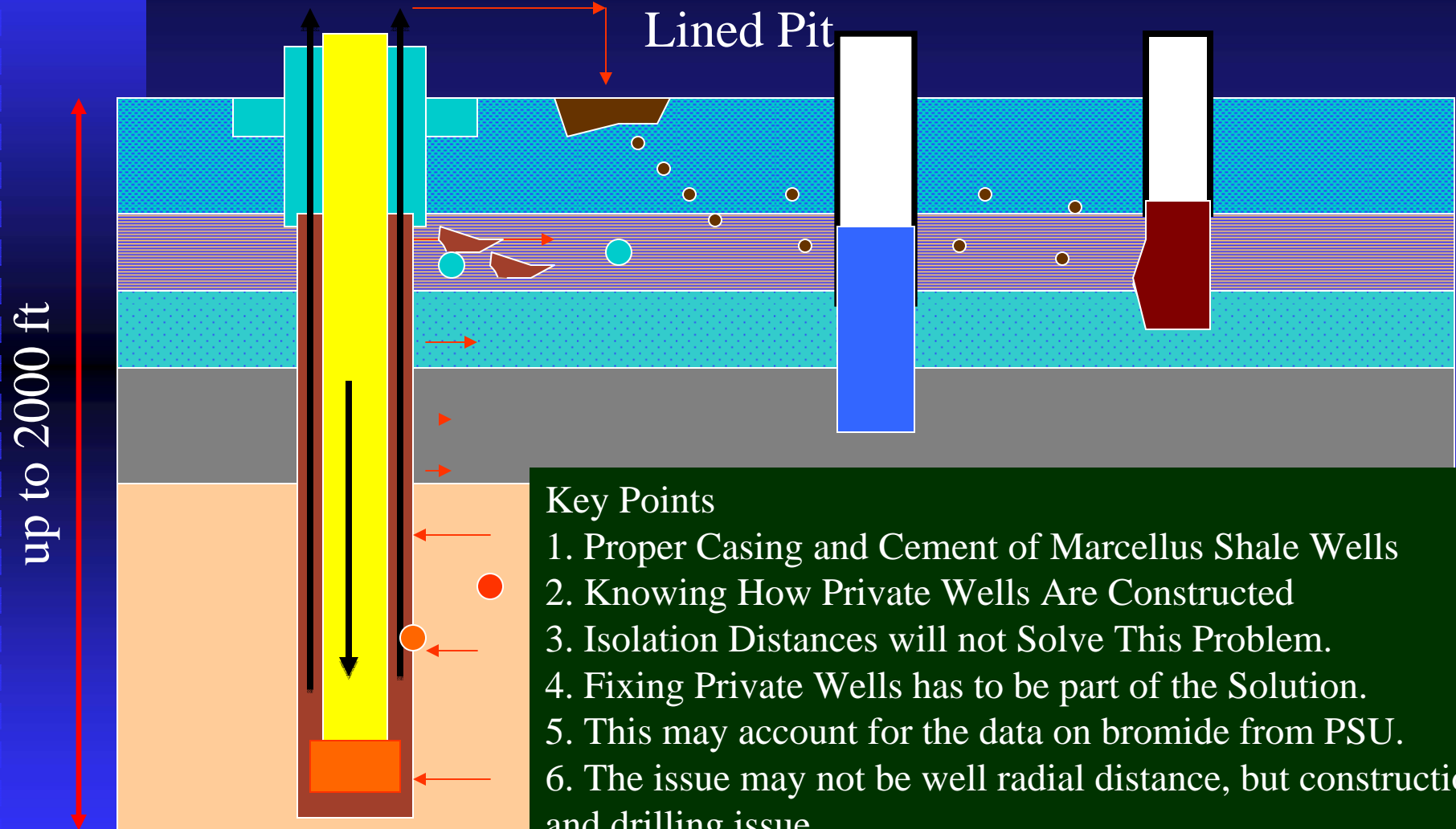
- Influence by
 - ◆ Well Construction
 - ◆ Loss of Circulation
 - ◆ Nuisance “Bacteria”

Properly Constructed Wells and Poorly Constructed Wells



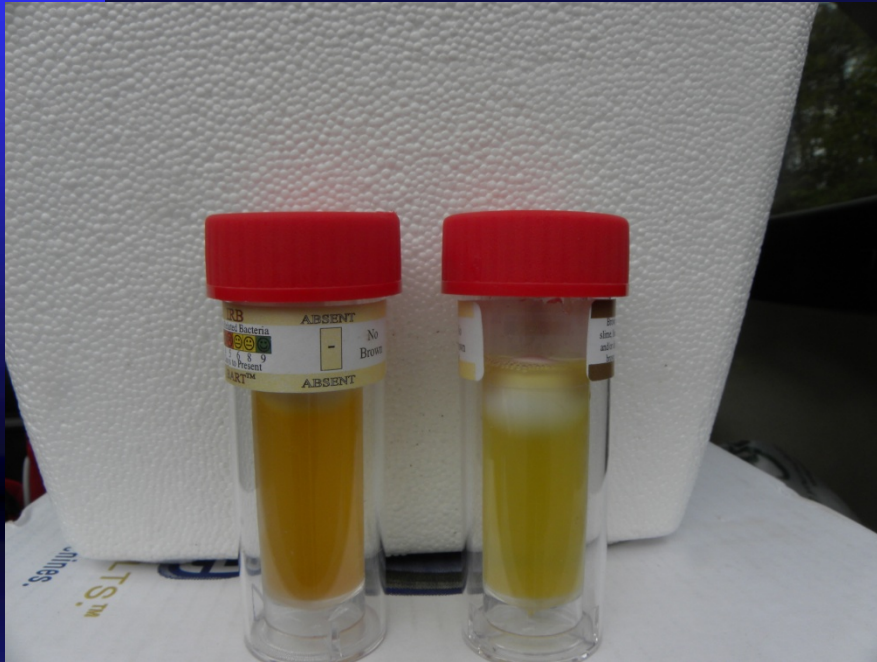
PSU Study -Migration and Disturbance During Drilling-losing circulation

Proper Construction Poor Construction
Lined Pit



Key Points

1. Proper Casing and Cement of Marcellus Shale Wells
2. Knowing How Private Wells Are Constructed
3. Isolation Distances will not Solve This Problem.
4. Fixing Private Wells has to be part of the Solution.
5. This may account for the data on bromide from PSU.
6. The issue may not be well radial distance, but construction and drilling issue.
7. Recommend closed loop drilling with water within freshwater aquifer (no muds) or water-based muds.



Does this Look Familiar?

Part of the Reason for the Discolored Water May be Iron Bacteria
Iron Related Bacteria is a common problem in NEPA –About 50%
of Wells with an Iron Problem or Coliform Problem have IRB.

I am not saying there is no methane gas in the water.

Water has a
Purple Hue !



Oram, 2011
Susquehanna County, PA

Example of Nuisance Bacteria

Iron Related Bacteria Count - > 140,000 colonies per ml

Aluminum – 0.511 mg/L, Iron 1.87 mg/L, Manganese – 5.4 mg/L,

Lead 0.029 mg/L, **Methane - < 0.001 mg/L**

Baseline Testing

■ Baseline Testing

- ◆ Proper Well Purging, Field Monitoring, and Sampling
- ◆ Documenting Existing Conditions and Well or Water Source Information
- ◆ Chain-of-Custody Protocols
- ◆ Using a Certified Lab / Using Certified Methods
- ◆ Picking Water Quality Parameters

Summary

- Baseline Testing is a Function of:
 - ◆ Local Geology and Land-Use
 - ◆ Well Construction and Location, Existing Water Quality Issues
 - ◆ Other Private Wells
 - ◆ Who is the Client?
 - ◆ Clients Budget.

Suggested Baseline- For Citizens from PADEP (11/2010)

- Alkalinity, Chloride, Conductivity, Hardness, Oil and Grease, pH, Sulfate, Total Dissolved Solids, Total Suspended Solids, Total Solids
- Barium, Calcium, Iron, Magnesium, Manganese, Potassium, Sodium, Strontium
- Ethane/Methane
- Total Coliform / E. coli

Baseline Testing – Oram's Recommendations for Citizens

- Where are you located?
- What is your surrounding land-use?
- Do you have any water quality problems- such as discolored water, odors, or staining?
- Do you have a water treatment system?
- Do you have any health concerns or special needs?
- What is the source of your water?
 - ◆ Well, Spring, Cistern, etc

It is not a One Size Fits ALL Approach

Same Baseline Parameters?



Quarry



Mixed
Hazards



Saline Seep

Suggested Baseline- For Citizens

- Testing Package # 1 Recommendations

Total Coliform with e. coli confirmation, chloride, sodium, bromide, barium, pH, total dissolved solids, MBAS, iron, manganese, and methane/ethane/propane.

- Testing Package # 2 Recommendations

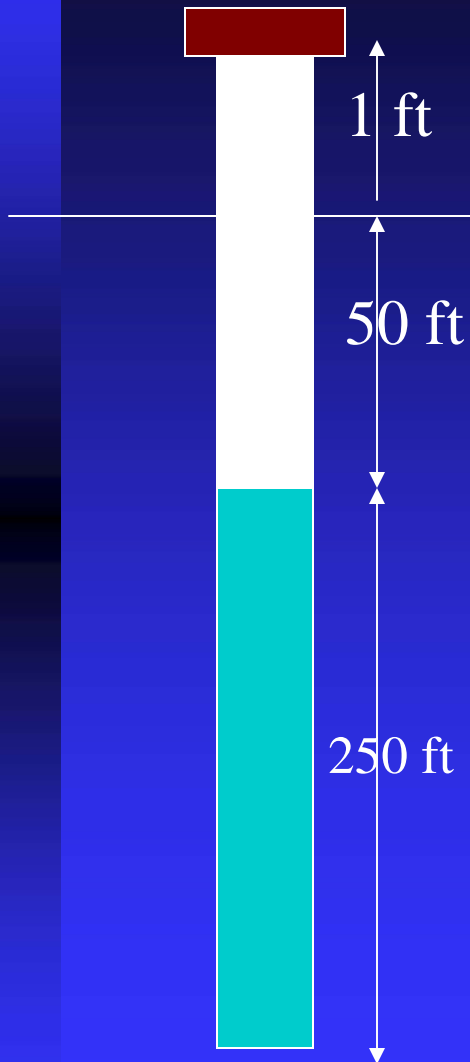
Package # 1- plus T. Hardness, Magnesium, Selenium, Strontium, Conductivity, Calcium, Zinc, Alkalinity, Arsenic, Nitrate, Total Suspended Solids, Sulfate, Oil & Grease, Aluminum, and 21-VOCs/MTBE.

- Testing Package # 3 Recommendations

Package #1 and # 2 - plus Potassium, Sulfide, Ammonia, Acidity, Nickel, Gross, Alpha/Beta, Lead, and Uranium.

It may be advisable to add Glycols, and other organics and inorganics Depending on surrounding land-use, use of geothermal wells, and past history.

Estimating Specific Capacity



Specific Capacity =
Gpm/ft of drawdown

gpm = 5 gpm

Static Water Level – 50 feet

Dynamic Level – 200 feet

$Sc = (5 \text{ gpm} / (150 \text{ ft})) =$

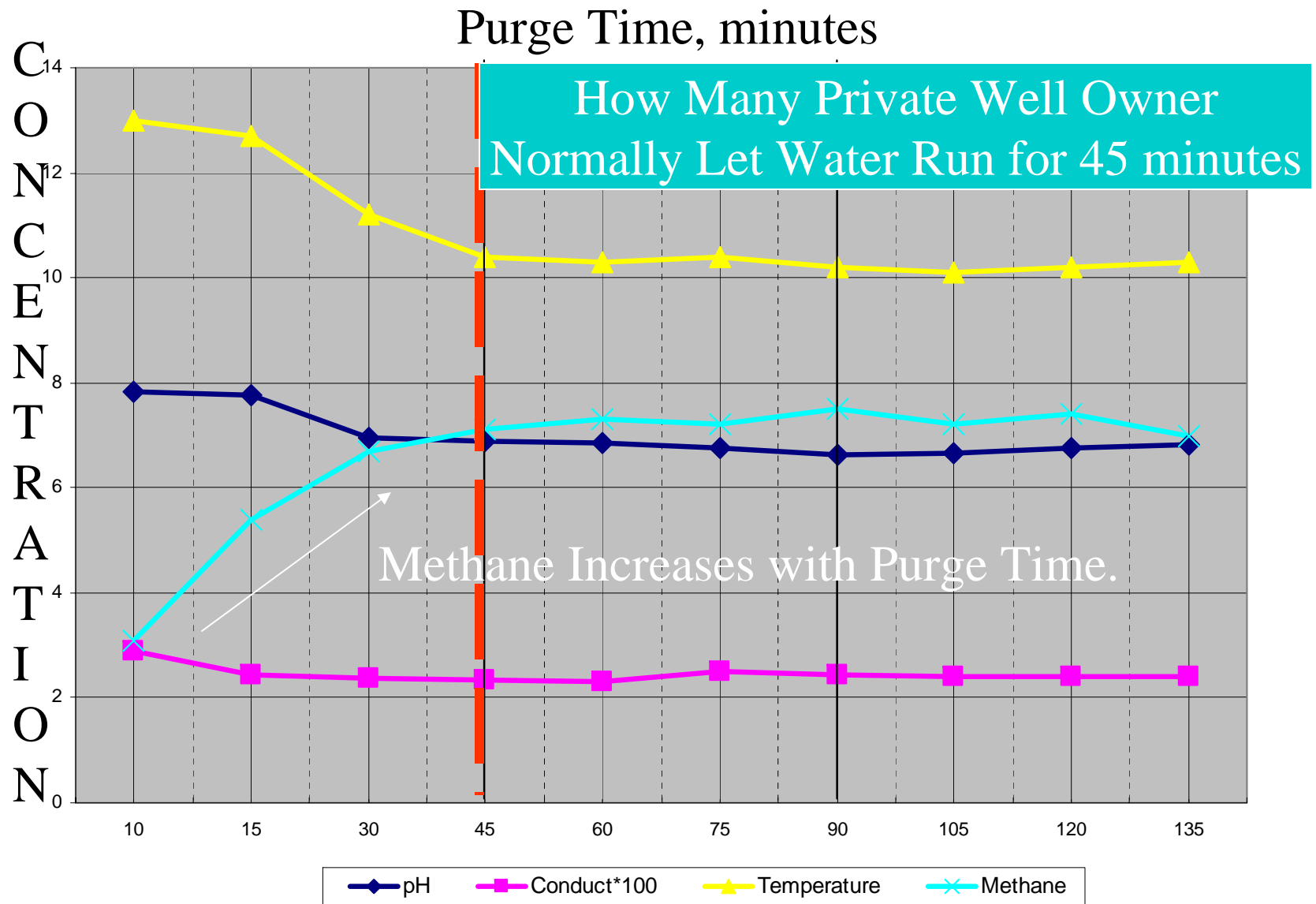
$Sc = 0.03 \text{ gpm/ft drawdown}$

Less head pressure

More methane will
be released.



Methane



1 WBV = 45 minutes

PSU Study (2011)

- No Significant Difference Pre and Post Drilling
- Methane – No Significant Difference No Correlation to Distance
- Increased Level of Bromide – Later found most of the data wrong..
- Findings Used to Support a 2500 ft radius.
- Recommended adding bromide to baseline analysis.
- Movement Probably – loss of circulation or movement along stress release fractures (near surface)
- Later discovered most of Br- data wrong !

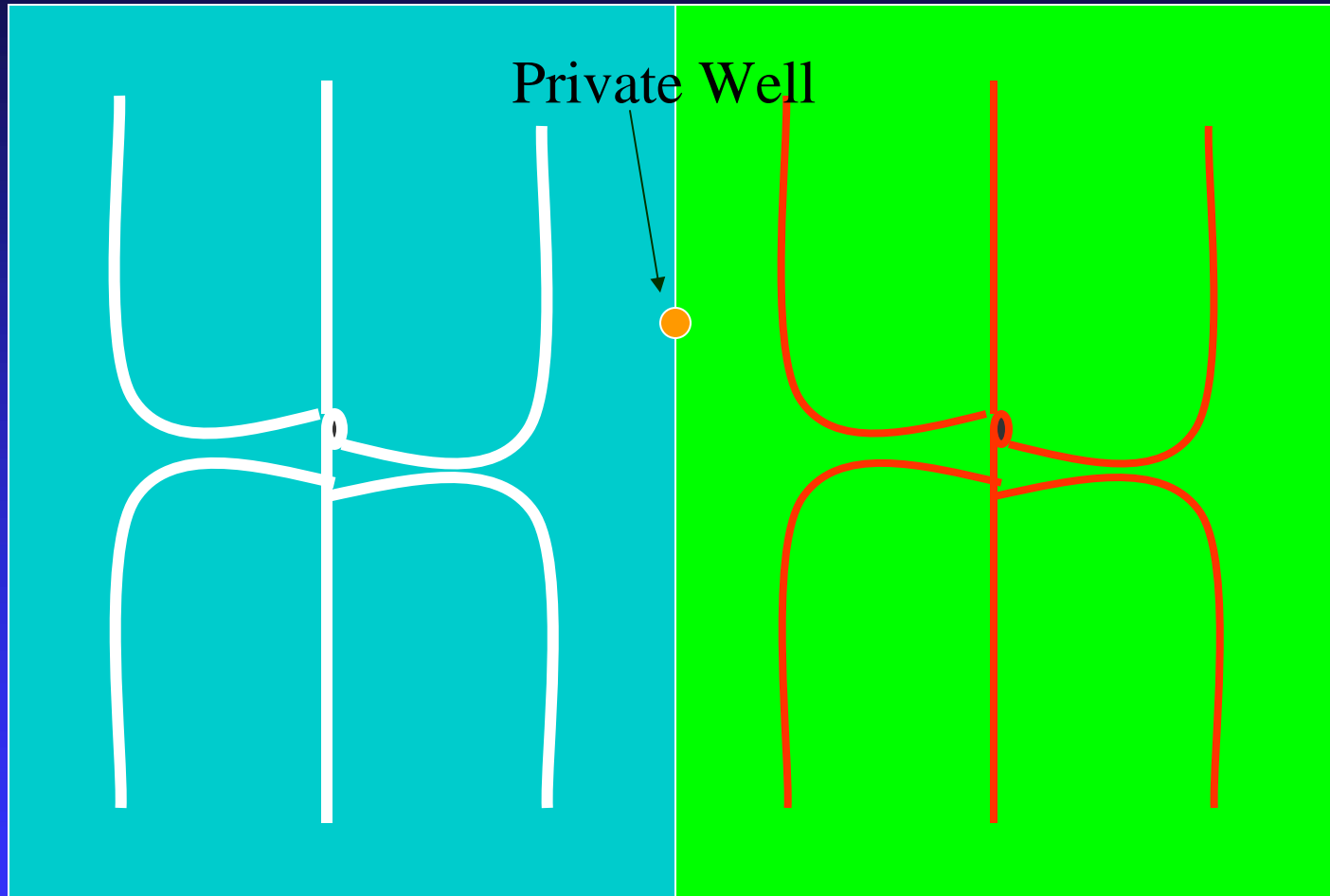
I am glad they agree with me about adding bromide. Bromide change is very interesting. They do not mention that bromide levels could impact the use of ozonation systems.

Related to Marcellus Shale

- Yes – Baseline Testing at a Further Area
- Yes – Assumed Responsibility over a Larger Time Frame- Maybe 2 years with a reduce radius with time.
- Yes – Liners and Self- Contained Drilling Pads
- Yes- Closed Loop Drilling and Water Reuse
- Yes – Cement Bound Logs and More Disclosure
- Yes – Higher Permit Fees so Inspectors Working for the Citizens are On Site
- Yes – Private Well Construction Standards

Problem – This does nothing to fix the Problems we have and have nothing to do with Marcellus shale.

My Primary Concern with Respect to Radius
and Assumed Liab is “Who is Responsible”



Company A

Company B

New Community Resource Helping To Take Action



Download a Free Copy (pdf) or Link to
a copy email – bfenviro@ptd.net

Also:

1. We are Working on a Regional Citizen Water Quality Database.
2. We provide informational water testing- not Certified Test- Screening Testing Post Drilling

**WATER QUALITY
DATABASE
CONSENT &
INFORMATION**

Add Your Data to the Citizen Database
FREE Evaluation of Your Baseline Data
bfenviro@ptd.net

Recent Site Tour- Towanda, PA



I took both photos – First Time on the Drilling Platform

Certificate of Completion

Training Event

Getting the Waters Tested – The Marcellus Shale Factor
Working as a Community – Private Well Owner

4/17/2012

2 – hour PDH or 0.2 CEUS

Presented by

Mr. Brian Oram, PG

B.F. Environmental Consultants Inc

15 Hillcrest Drive

Dallas, PA 18612

More Online Training @

<http://www.bfenvironmental.com>





Presented by:

Mr. Brian Oram, Professional Geologist (PG),
Soil Scientist, Licensed Well Driller, IGSHPA

Accredited Geothermal Installer

B.F. Environmental Consultants Inc.

<http://www.bfenvironmental.com>

And

Water Research Center- Free Information
on Water Quality

<http://www.water-research.net>

