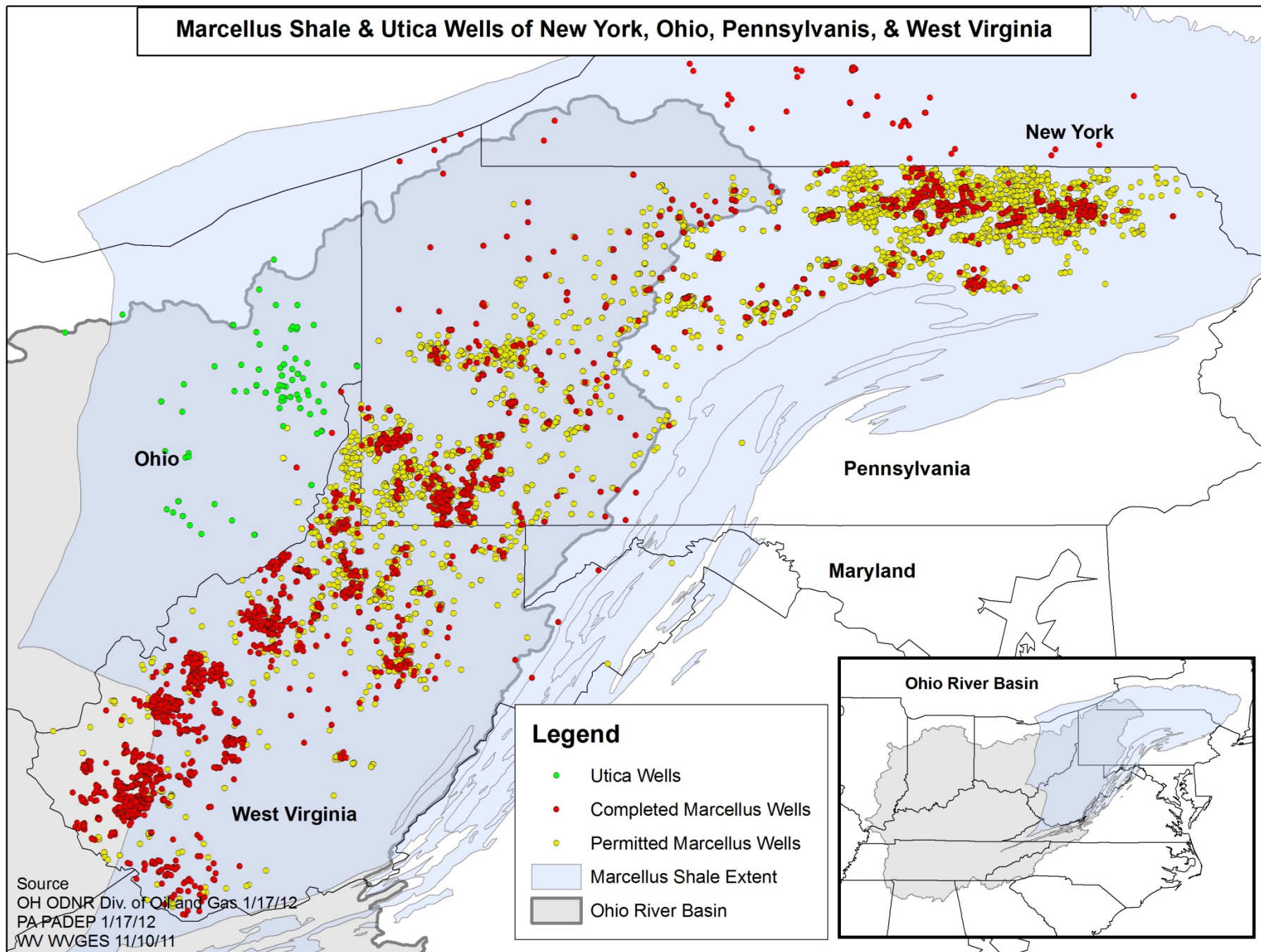


ORSANCO's Potential Role In Shale Gas Development

Feb 2012 Roundtable



Marcellus Shale & Utica Wells of New York, Ohio, Pennsylvania, & West Virginia



Utica Shale Gas Play

Geographic extent of potential source rock.
Marcellus Shale boundary in yellow.

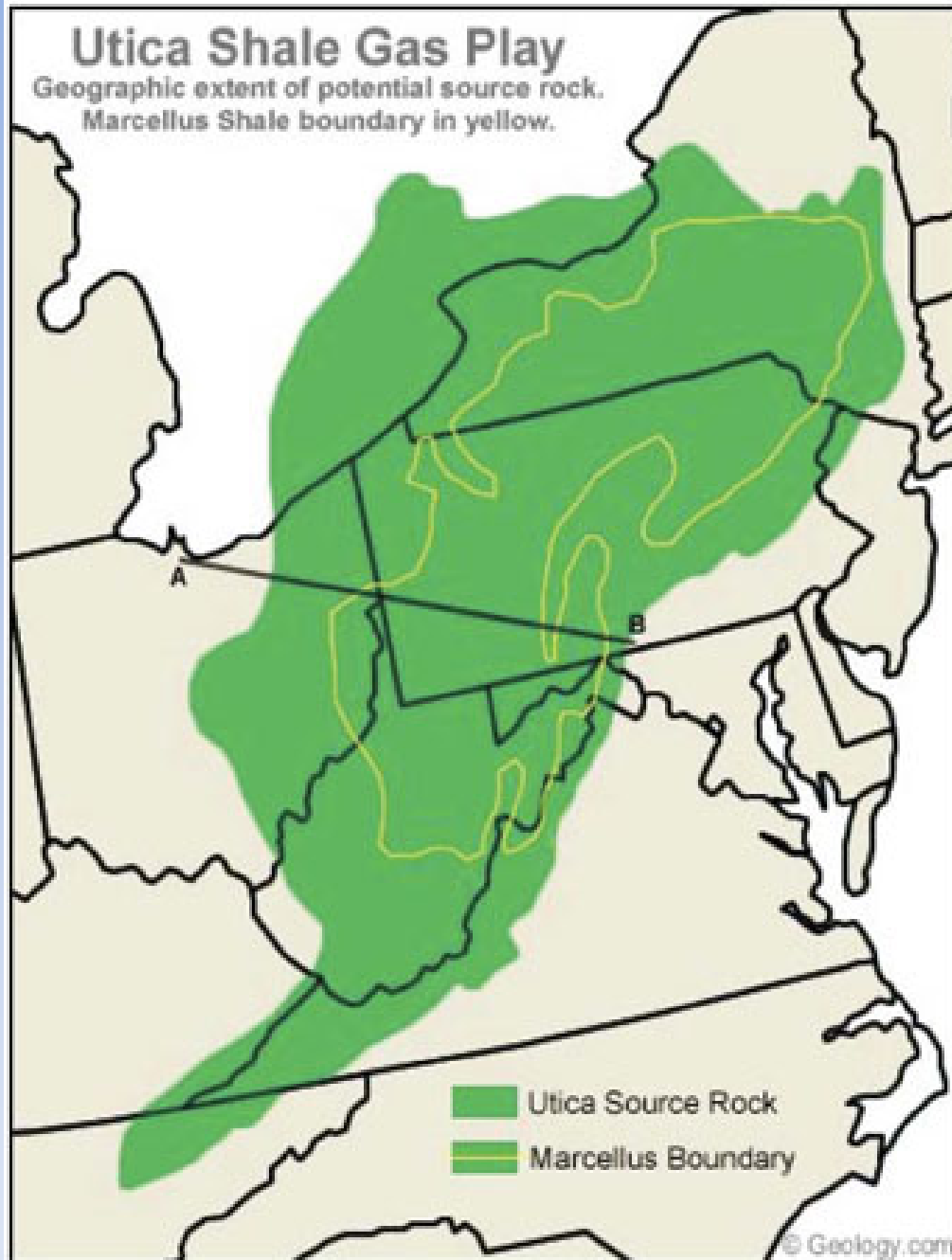


Figure 1. Marcellus and Utica Shale distribution

Marcellus Well Activity

Ohio		
	Marcellus Shale	Utica Shale*
Horizontal Permits issued	11	102
Horizontal Wells Drilled	7	27
<i>*permits issued since December 2009</i>		
<i>Updated 11/17/2012</i>		
Pennsylvania		
Marcellus Well Applications 2005-Present		9,618
Marcellus Wells Drilled 2005-Present		4,436
Marcellus Applications Issued in 2012		68
Non-Marcellus Wells Drilled 2005-Present		19,772
<i>Updated 11/17/2012</i>		
West Virginia		
Marcellus Well Permits since 2008 - 1651.		
Marcellus Well Completion Reports since 2008 - 1053		
Non-Marcellus O&G Permits since 2008 - 6455.		
<i>Updated 02/10/12</i>		

Frac Flow Back Waste

- Average Water Use for each frac- 4.8 Million Gallons
- Average Frac Waste 477,000 Gallons
- Average lifetime of Well – 30 years
- Wells may require Re-Fracing.



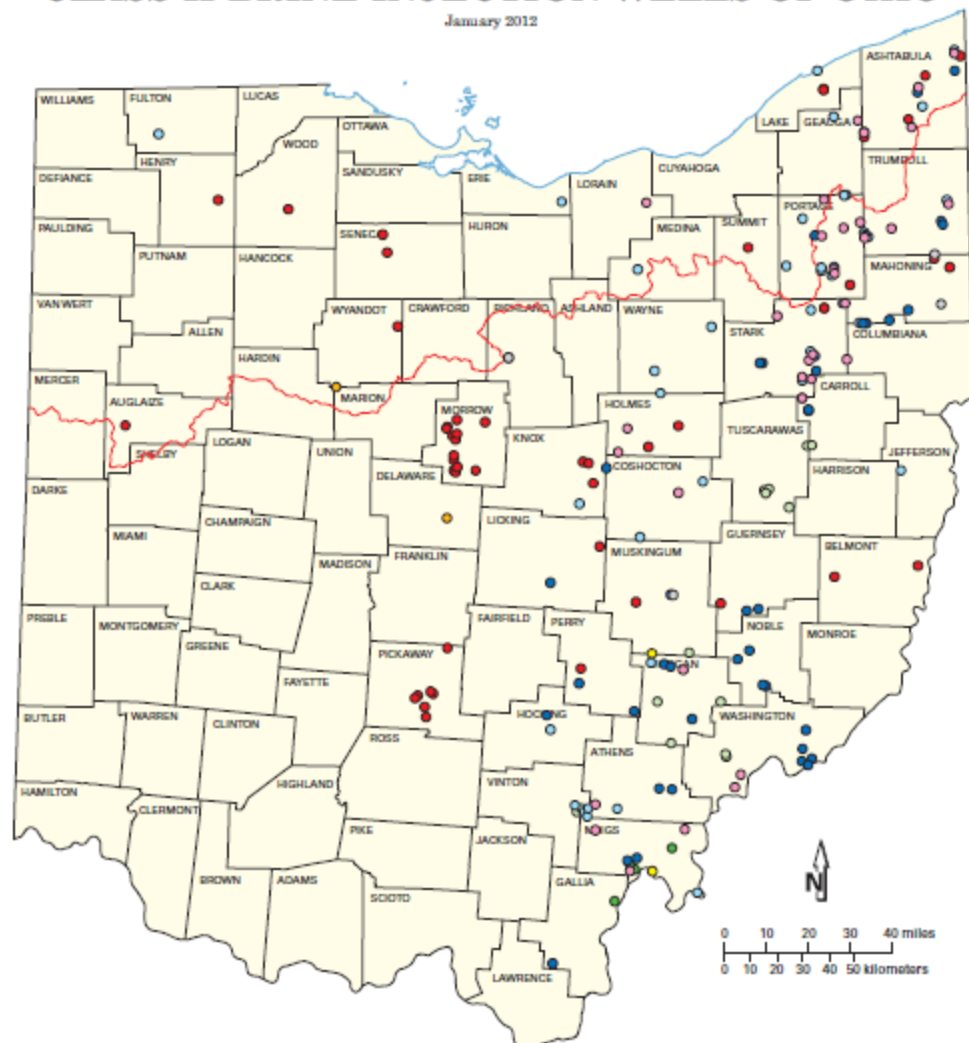
Frac Flow Back Waste

- WV – 81% of Frac Water is reused, 18% sent to Underground Injection Well, 1% other
- PA – 99% reused, Underground Injection Well, industrial Water Treatment Plant
- OH – Sent to Underground Injection Wells or Reused



CLASS II BRINE INJECTION WELLS OF OHIO

January 2012



EXPLANATION

- | | |
|---|---------------------------------------|
| — Lake Erie-Ohio River drainage divide | ● Silurian "Clinton/Medina" sandstone |
| ● Mississippi sandstone | ● Ordovician shale and limestone |
| ● Devonian Berea Sandstone | ● Cambrian/Ordovician Interval |
| ● Devonian shale | ● Multiple Injection zones |
| ● Silurian/Devonian "Big Lime" Interval | ○ Permitted locations |



Recommended citation: Ohio Department of Natural Resources, 2012, Class II brine injection wells of Ohio: Ohio Department of Natural Resources, Division of Geological Survey and Division of Oil and Gas Resource Management, page-size map, scale 1:2,000,000.



Marcellus Shale State Requirements

- PA
 - Moratorium on sending well waste water to WWTP
 - Currently no approved shale waste discharges from WWTPs.
- WV
 - Stringent permitting requirements at domestic or industrial WWTPs if accepting frac waste water.
- OH
 - Moratorium for sending well waste water to WWTP
- NY
 - No Marcellus Drilling until Draft EIS is finalized.

Surface Water Quality Monitoring

- West Virginia
 - Cooperative agreement with USGS to test GW quality by testing nearby wells and streams from 2011-2012
 - West Virginia Water Research Institute (WVWRI) has an established monitoring network on the Monongahela River (19 Parameters including Br- & TDS)
- Ohio
 - No monitoring directly related to Drilling

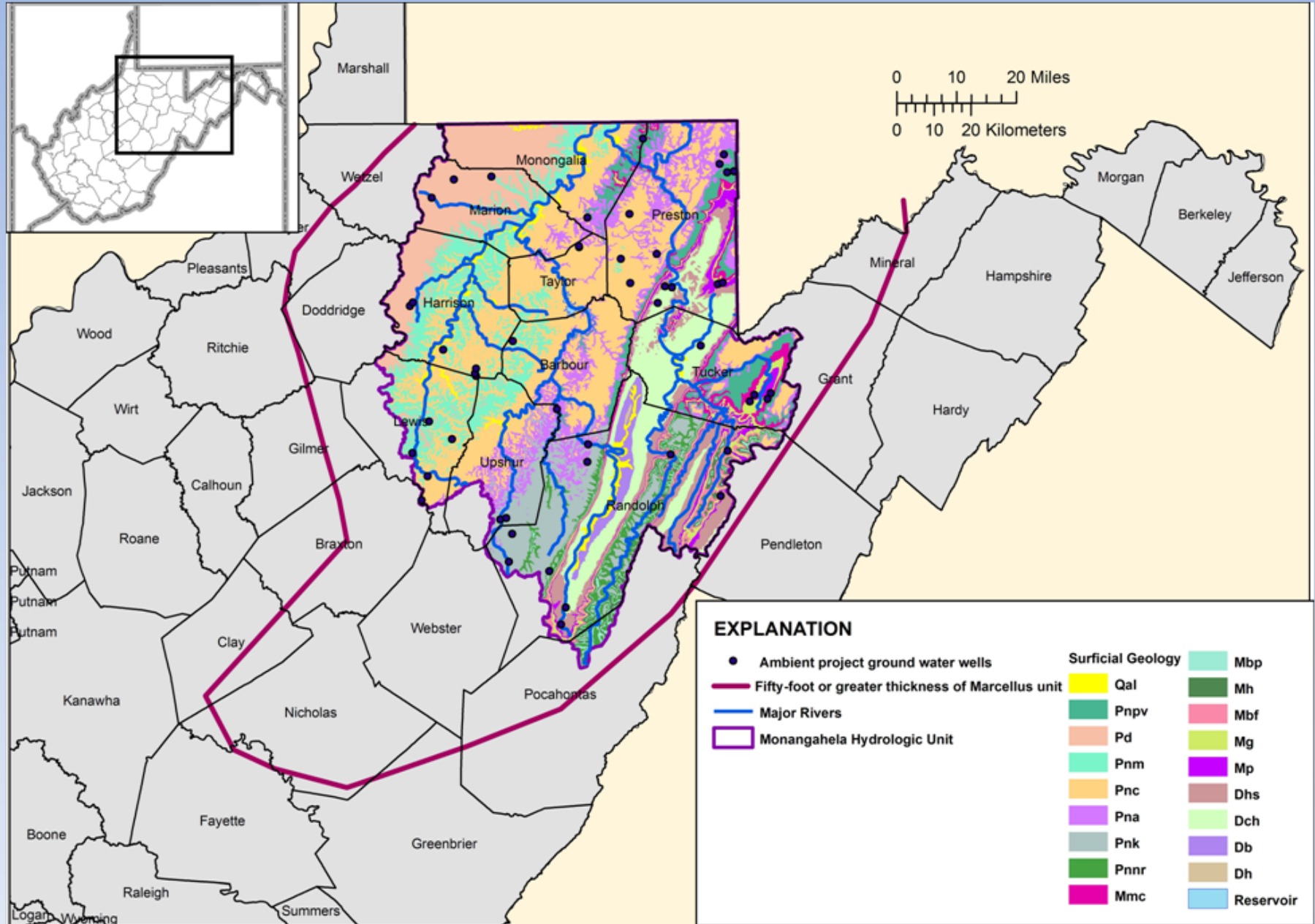


Surface Water Quality Monitoring

- Pennsylvania
 - RAIN (River Alert Information Network) – a surface water protection network monitoring Cond, pH, & Temp at 13 Locations (adding a 14th in WV)
 - Freshwater Biology Team has a monitoring network for Fish Creek, WV; Cross Creek & Tenmile Creek, PA
 - Modifications to existing monitoring network to address Marcellus.
- Susquehanna
 - Network of 51 in-stream monitors
 - 50% of well applications get a baseline biological assessment at a fee of \$5700



Study Area of USGS & WVDEP Ground Water Study of Marcellus Shale Gas Play in North Central WV

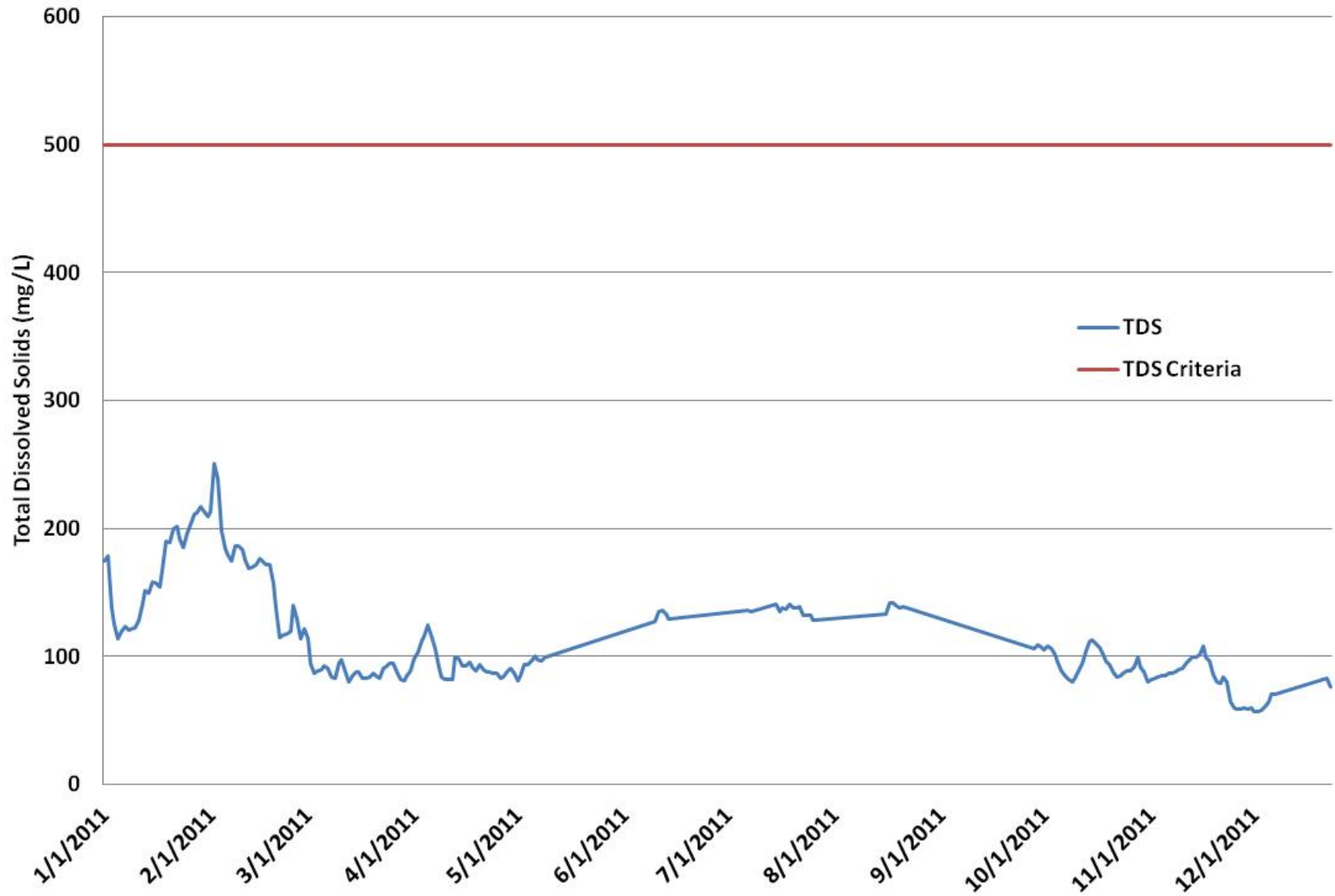


Parameters to be tested in cooperative agreement with USGS on wells and streams

Constituent		Method	
Field Measurements and Unstable Constituents			
pH		Field meter	
Alkalinity, carbonate		Titration, increment	
Barometric Pressure		Barometer	
Specific Conductance		Field meter	
Major Constituents (dissolved, 0.45 micron filtration)			
Calcium		ICP-AES	
Magnesium		ICP-AES	
Strontium		ICP-AES	
Potassium		ICP-AES	
Sodium		ICP-AES	
Silica		ICP-AES	
Iron		ICP-AES	
Manganese		ICP-AES	
Boron		ICP-AES	
Trace Elements (dissolved, 0.45 micron filtration)			
Aluminum		ICP-MS	
Antimony		ICP-MS	
Arsenic		cICP-MS	
Barium		ICP-MS	
Beryllium		ICP-MS	
Cadmium		ICP-MS	
Chromium		cICP-MS	
Cobalt		cICP-MS	
Dissolved Gases			
Argon		GC-TCD	
Carbon Dioxide		GC-TCD	
Methane		GC-TCD	
Radio-Chemicals			
Gross-Alpha/Beta Count		Th-230 Curve, ESL/ Cs-137 Curve, ESL	
Radium-224/226		AS, ESL	
Isotope Ratios for Water and Major Ions			
¹³ C/ ¹² C Dissolved Inorganic Carbon		MS, IST	
³⁴ S/ ³² S and ¹⁸ O/ ¹⁶ O of Sulfate		MS, RSIL	

TDS Data from RAIN on the Ohio River at Mile Point 4

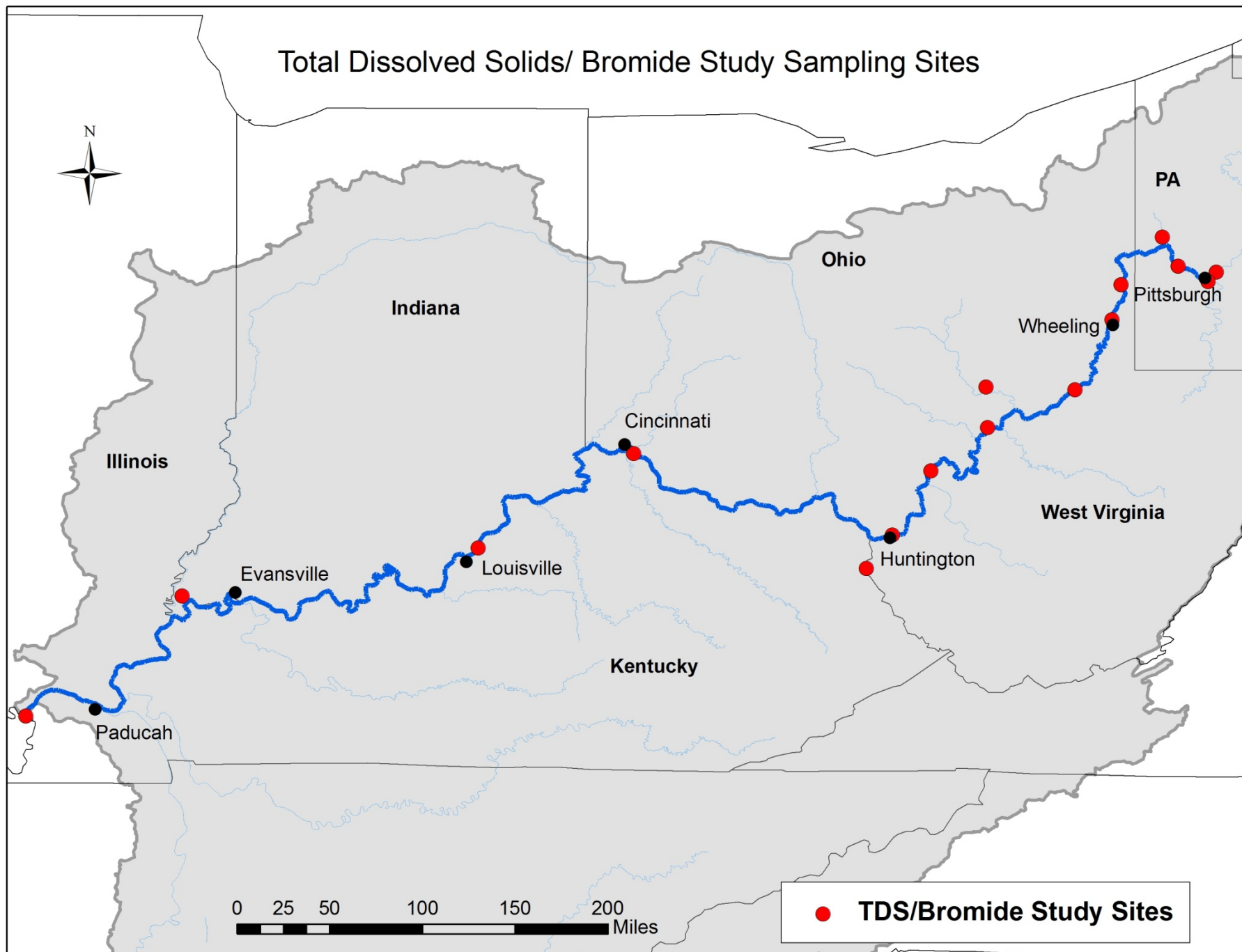
Source: RAIN, Site O4, 1/1/11-12/31/11, translated from Cond. to TDS using 0.625 factor



Total Dissolved Solids/Bromide Study

- To Characterize ambient background levels of TDS & Bromide
- Develop site-specific translators to convert conductivity to TDS.
- Provide data to support possible development of an Ohio River bromide stream criterion.
- Weekly Samples from 17 Sites (4 tribs) for 1 year (Dec '11 – Dec '12)

Total Dissolved Solids/ Bromide Study Sampling Sites



QUESTIONS?

