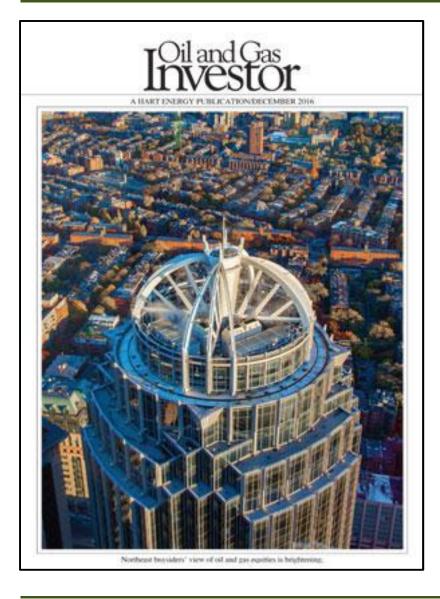
A Challenged Natural Gas Super-giant

Presented to AAPL MLBC 2/09/2017

Gregory Wrightstone Wrightstone Energy Consulting gwrightstone@gwrightstone.com Wrightstoneenergy.com



Allegheny County - December O & G Investor



ALLEGHENY COUNTY:

Massive resource potential development in Allegheny County, Pennsylvania, has to jump many hurdles-and it may not have the running room to succeed.

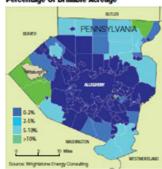
ARTICLE BY GREGORY WRIGHTSTONE and

qualify it as a super-giant gas field. But various factors, including high population density, have conspired to place most of these reserves off-limits to full development. Allegheny and two adjoining counties, Washington and Greene, are situated within the "core of the core" of the recently named Appalachian Mega-Giant Gas Field. Each county has recoverable natural gas reserves likely ranking them at or near the highest county natural gas reserve base in the nation.

As the second-most populous county in the state and home to Pittsburgh, Allegheny County presents unique challenges to full development of the resources. By a quirk of nature, these three counties lie atop some of the best shale reservoir rock in the world in the Marcellus, Utica and the lesser-known Upper Devonian Burket/Geneseo Shale.

Estimates of total technically recoverable reserves exceed 150 trillion cubic feet equivalent (Tcfe) for Allegheny County alone (equivalent converts 1 bbl of liquid to 6 Mcf of gas). This is

Percentage Of Drillable Acreage

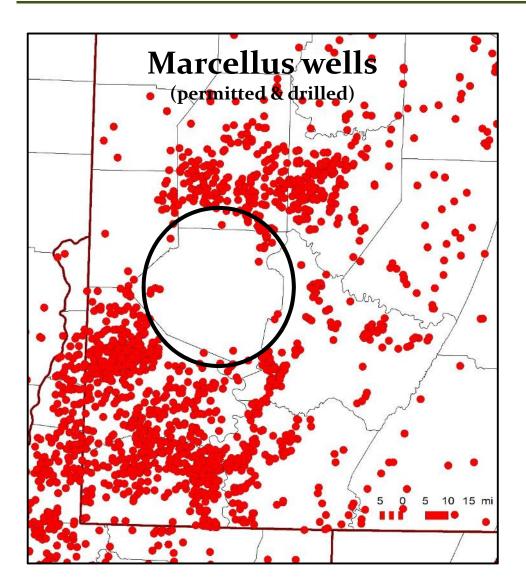


llegheny County, Pennsylvania, sits atop nearly five times the minimum required for clasvast reserves of natural gas, enough to sification as a super-giant gas field (30 Tcf) and enough natural gas to provide all of America's needs for more than five years. At today's currently depressed market prices, the total value of this resource exceeds \$400 billion, and the value of potential royalty payments to landowners in the county is more than \$60 billion.

Of the three counties, Allegheny County provides the greatest challenges to development of the resources due mainly to the urban/ suburban nature of the majority of the county. Residences, office buildings, political issues, regulatory restrictions, topography and splintered subsurface rights all contribute to prevent full development of the resources. To date, only the peripheral, semi-rural margins of the county have seen any shale gas development at all. These obstacles are likely to preclude development across large portions of the county, and only 4% of the entire county's acreage appears to have viable drilling locations available.

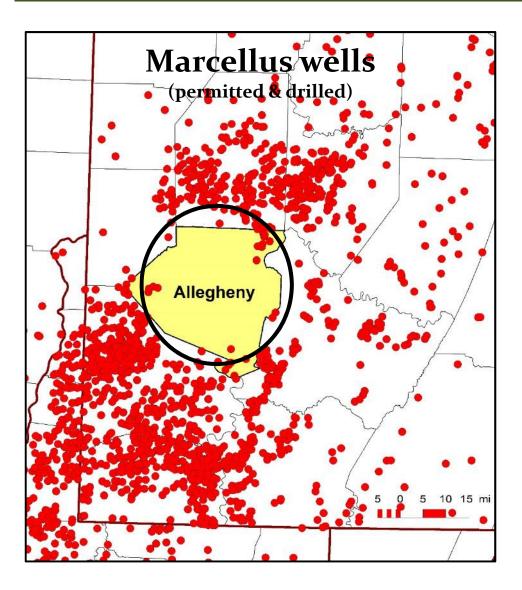
The size of the prize
The Marcellus Shale is the most prolific natural gas resource in the world, and Allegheny County is situated in the heart of some of the best productive areas of the "Southwest Core Area" of the resource. The productive portion of this black, organic-rich shale is about 80 feet in thickness and found at drilling depths ranging from 5,500 feet along its western boundary with Beaver County deepening to more than 7,000 feet in the southeast. The hydrocarbons that would be produced in the county vary corresponding generally to depth, with liquids-rich wet gas in the shallowest areas in the west that would feed the yet-to-be-built Shell ethane cracker plant, and trending to dry gas in the southeast.

Based on production results from existing wells completed by top-tier companies surrounding and within Allegheny County, it is estimated that the Marcellus has 58 Tcfe of technically recoverable reserves. Significant liquids and ethane contribute to the large converted equivalent numbers in the wet gas areas.



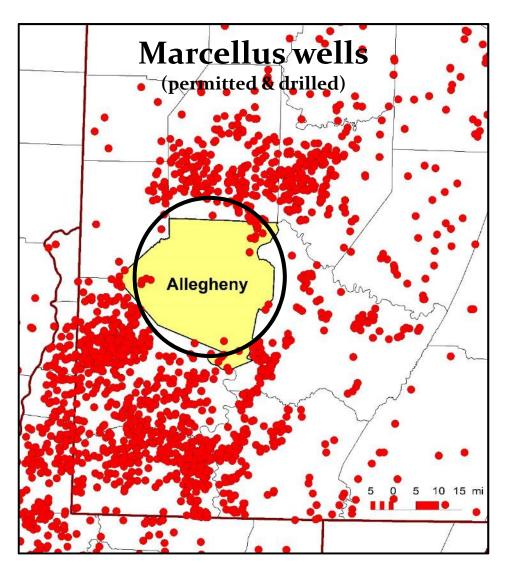
Why is that big hole in the middle of all the wells?





Allegheny County-Home to the 2nd largest population in Pennsylvania





Allegheny County review

- Resources/Size
 - Burket/Geneseo
 - Marcellus
 - Utica
- Challenges to Development
 - Regulatory Offsets
 - Homes/Businesses
 - Streams
 - Topography
- Where can we drill?



Allegheny County, Pennsylvania

Home to THE largest natural gas reserves in the world

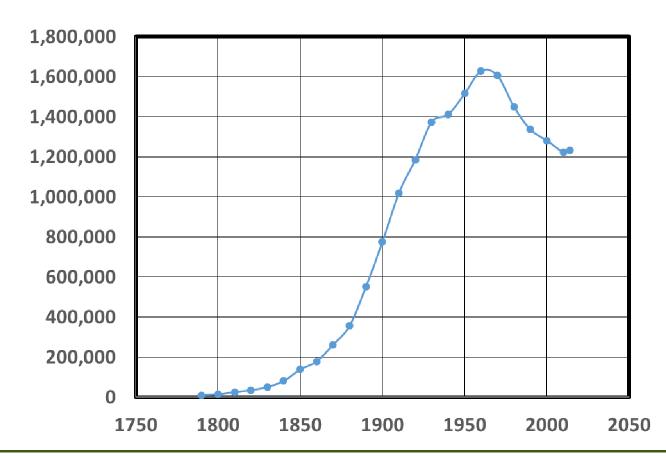
Home to 2nd largest population in the state

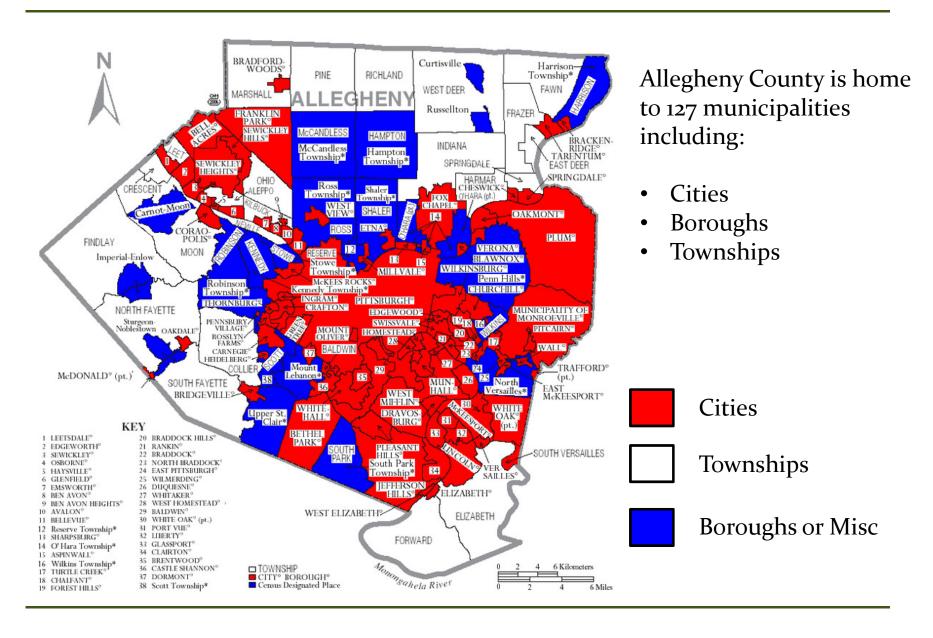
Can the two coexist and what is the future of gas development in the county?



Some background on the county

- 2nd most populous county in Pennsylvania (behind Philadelphia)
- Population of 1,231,225 (2014)





Reservoirs... & the size of the prize

Allegheny County - The Size of the Prize

World's Largest Non Associated Gas Fields (Tcf)				
No.	Field Name		Country	Recoverable Reserve Tcf
1	South Pars/North Dome	ψ	Iran & Qatar	1235
2	Urengoy		Russia	222
3	Yamburg		Russia	138
4	Hassi R'Mel	•	Algeria	123
5	Shtokman		Russia	110
6	South Iolotan-Osman	011800 چې	Turkmenistan	98
7	Zapolyarnoye		Russia	95
8	Hugoton		USA (TX-OK-KS)	81
9	Groningen		Netherlands	73
10	Bonavenko		Russia	70
11	Medvezhye		Russia	68
12	North Pars	ψ	Iran	48
13	Dauletabad-Donmez	\$	Turkmenistan	47
14	Karachaganak		Kazakhstan	46
15	Kish	Ψ	Iran	45

Table Sources: Global Natural Gas Reserves - A Heuristic Viewpoint Raphael Sandrea, 2006

Size refers to ultimate recoverable reserves expressed in trillion cubic feet

Giant:

>3 TCF

Super-Giant:

>30 TCF

Mega-Giant:

>300 TCF

Appalachian Mega-Giant likely has >2,000 TCF (recoverable reserves) making it easily the largest natural gas field in the world.

AAPG Memoir 97 (2012) – The Appalachian Basin Gas Play: Its History of Development, Geologic Controls on Production, and Future Potential as a World-class Reservoir Zagorski, Wrightstone & Bowman

Allegheny County - The Size of the Prize



Marcellus & Burket (Upper Devonian) Gas-in-Place nearly equals the sum of the remaining 14 largest gas fields in the world (does

not include the Utica Shale GIP)

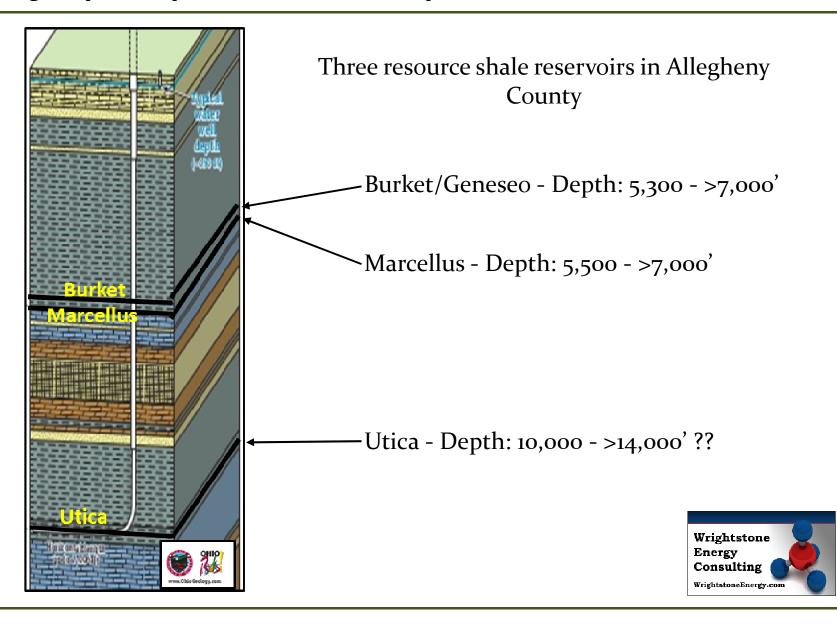
		No.	Shtokman 130 Medvezh'ye		Yamburg 289
NORTH	V	Groningen 100	EUROPE	Urengoy 353	Zapolyarnoye 95
oton 5	NORT	tassi R'Mel	Karachaganak 48		Galynysh 490 Dauletabad-Donmez
Marcellus 3,698	ATLANT OCT 1	-	AFRICAN	Sou	of Pars/North Dome
	SOUTH	TROPIC OF	North Pars 59	INDIA OCEA	
TH		SOUTH			Aus
F1C AN	We -	5		Service Lay Geographic	ver Credits: Content may not refl 's current map policy. Sources: I

				In-Place
			Size	Reserves
Rank	Field Name	Country	(Km)	(TCF)
	Marcellus/Burket			
1	(Upper Dev)	United States	148,000	3,698
2	South Pars/North	Iran & Qatar	35,000	1,800
3	Urengoy	Russia	6,300	353
4	Yamburg	Russia	3,900	289
5	Hassi R' Mel	Algeria	3,500	110
6	Shtokman	Russia	3,100	130
7	Galynysh	Turkmenistan	2,800	490
8	Zapolyarnoye	Russia	2,700	95
9	Hugoton	United States	2,300	115
10	Gronigen	Netherlands	2,100	100
11	Bovanenko	Russia	2,000	171
12	Mevezhye	Russia	1,900	83
13	North Pars	Iran	1,400	59
14	Dauletabad-Donmez	Turkmenistan	1,300	67
15	Karachaganak	Kazakhstan	1,300	48
	Total GIP - All			7.600
	Fields			7,608
	Total GIP -			2.000
	Marcellus & Upper			3,698
	Total GIP -			
	Conventional			3,910
	Systems Only			

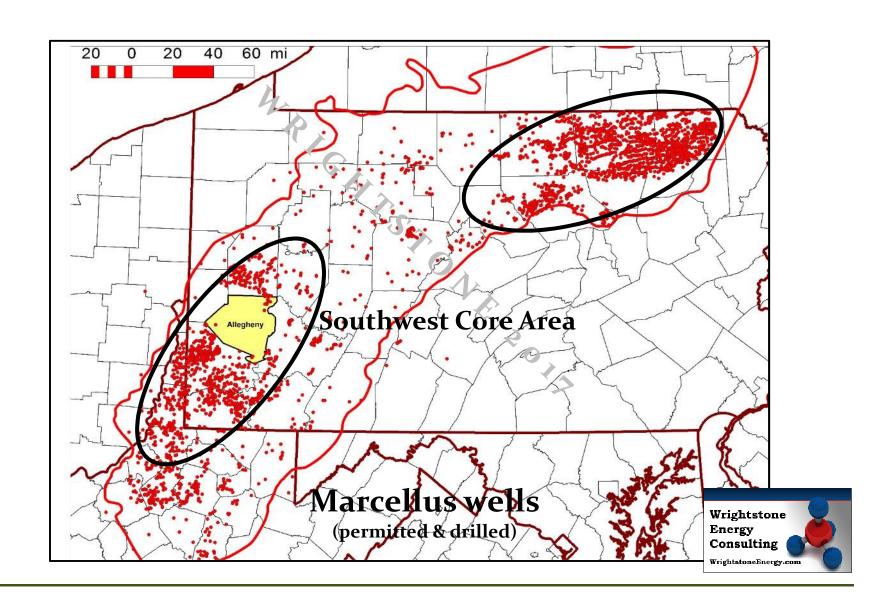
Modified from Zagorski et al 2016, unpublished AAPG volume "Giant Fields of the Decade 2000 to 2010"

Due to be released 12/2016

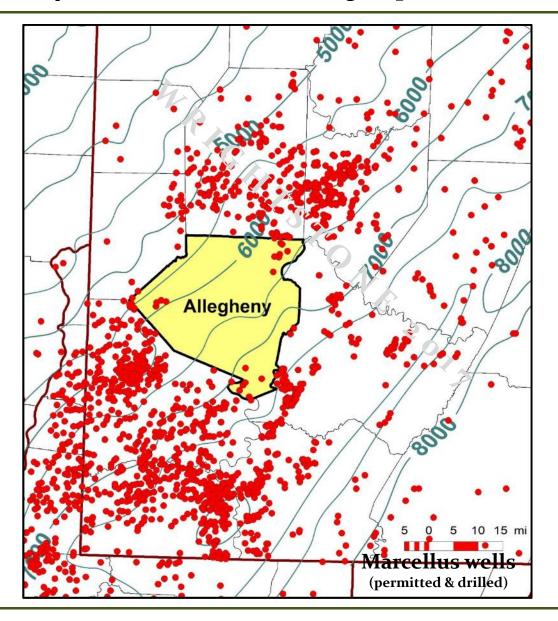
Allegheny County - Resources Shale Plays



Allegheny County - Marcellus Shale

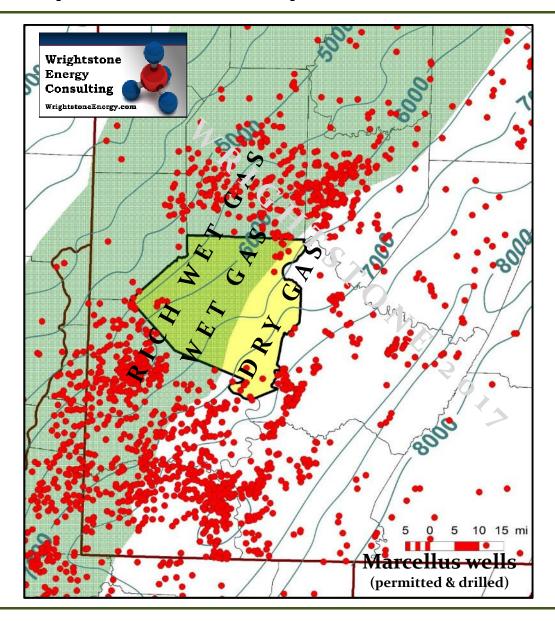


Allegheny County - Marcellus Shale Drilling Depth

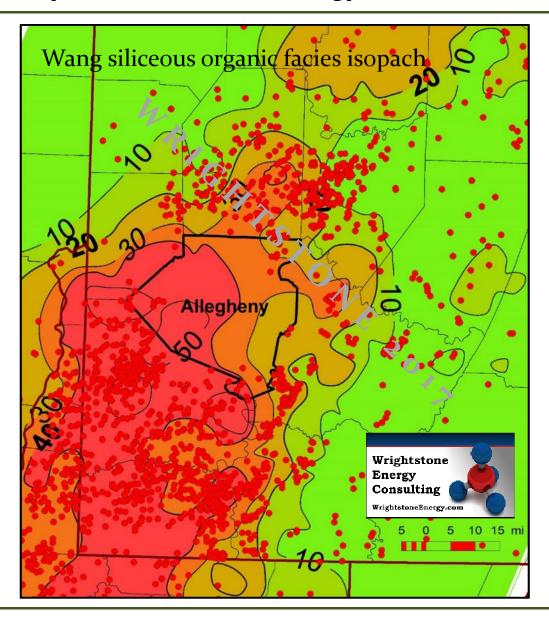




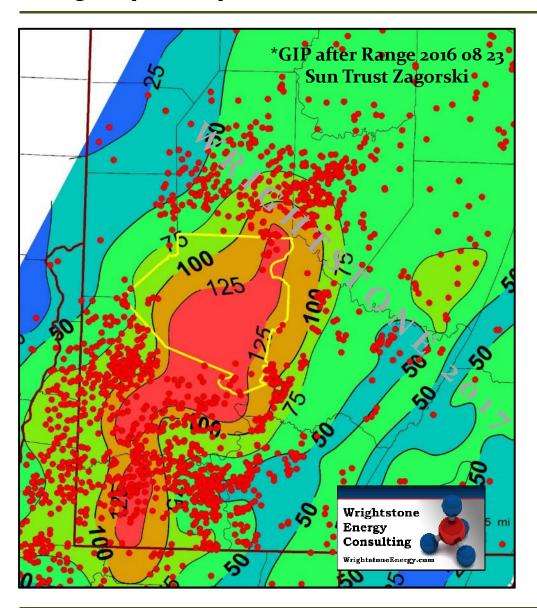
Allegheny County - Marcellus Shale Hydrocarbon Zonation



Allegheny County - Marcellus Shale Geology



Allegheny County - Marcellus Shale Gas-in-Place



Gas-in -place*
BCFe/square mile

- Ranges from 90 to >150 BCFe
- Average of 130 BCFe

Allegheny County - Marcellus Shale Recoverable Reserves

Recoverable reserves assigned using BCFe/1,000' of lateral basis

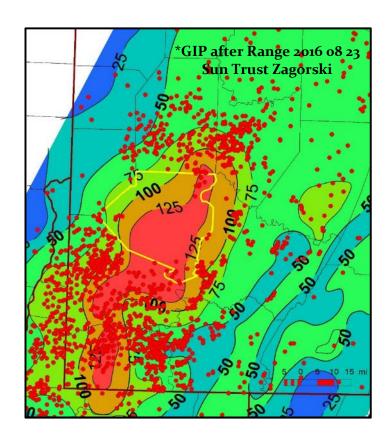
Sources:

- Proprietary EURs
- Corporate Reporting

Company	Avg EUR/1,000'
Range	2.62 (max >3.6)
Consol	1.95
EQT	2.1
Rice	2.16

Calculations:

- 750' spacing = 17.22 acres/1,000'
- Average EUR/1,000' = 2.1 BCF
- Average EUR/acre = 122 MMCF



Total Marcellus recoverable reserves for Allegheny County: 58.2 TCFe

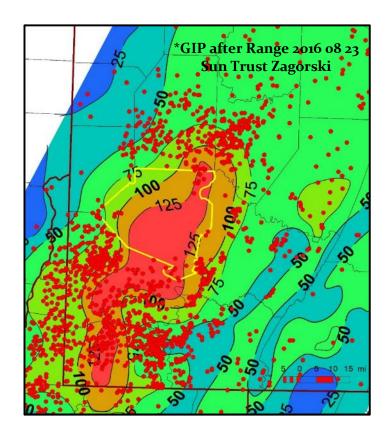
Allegheny County - Marcellus Shale Recoverable Percentage

Fun with numbers:

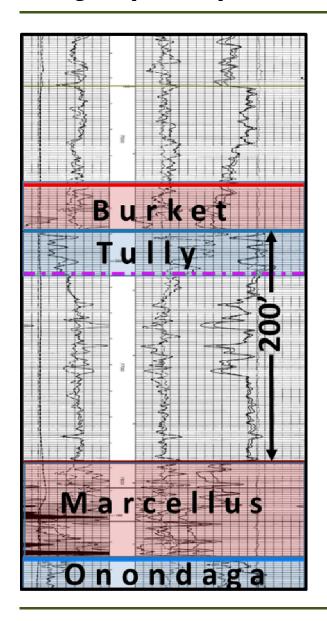
Range Southwest Core:

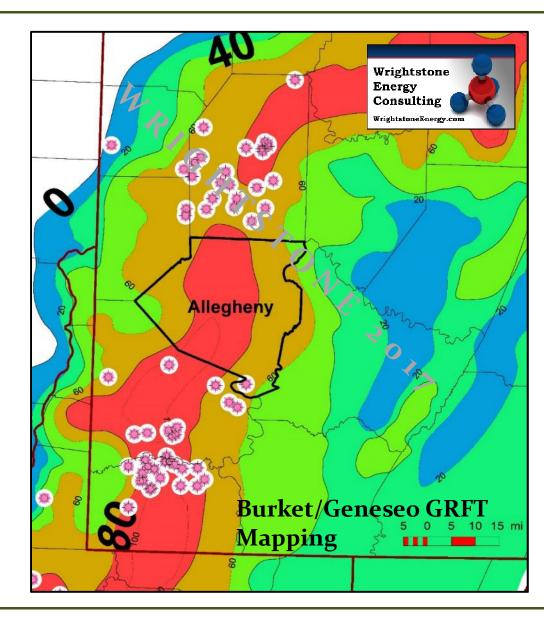
- GIP:
 - ~130 BCF/section = 203 MMCF/acre
- EUR:
 - 2.6 BCF/1,000' = 152 MMCF/acre
 - (Range spacing is 1,000')

This implies a 56% recovery factor



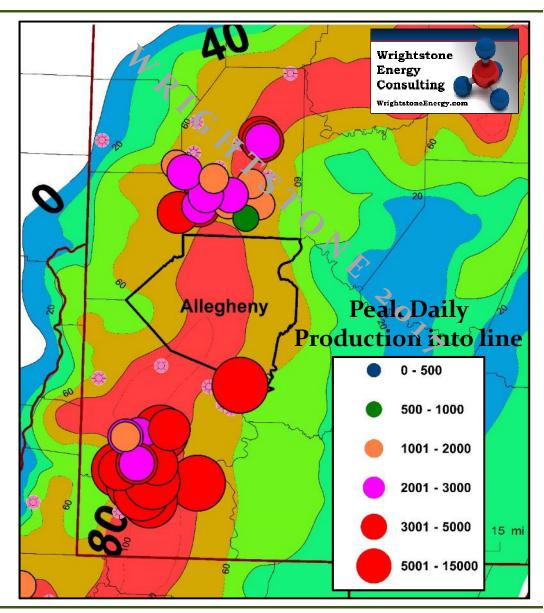
Allegheny County – Burket/Geneseo Shale



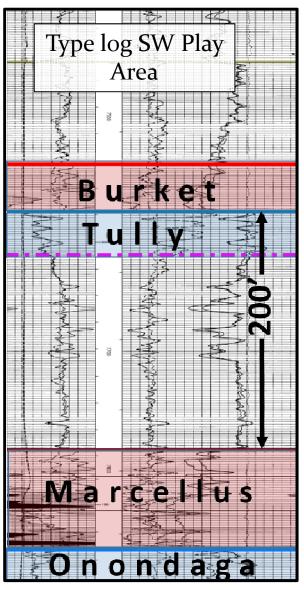


Allegheny County – Burket/Geneseo Shale

High daily production rates from wells on-trend with Allegheny County.

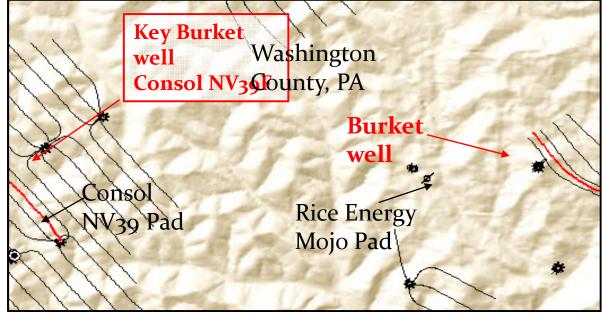


Burket / Marcellus Fracture Interaction/Enhancement ??



Data indicate:

- Most Burket wells in SW Core area drilled as stacked lateral between deeper Marcellus wells
- Staggered pattern between Marcellus wells at half spacing
- Likely done as zipper fracs with Marcellus wells from same pad



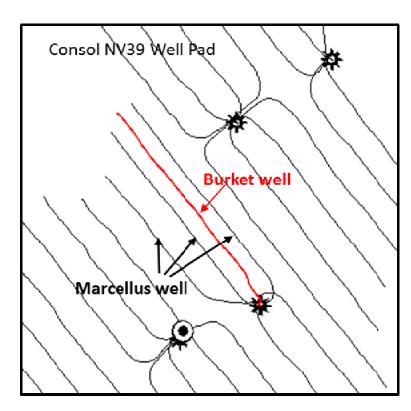
Burket / Marcellus Fracture Interaction/Enhancement ??

Consol NV39F

Outperforming Consol type curve*

Predicted: 5.8 BCFe

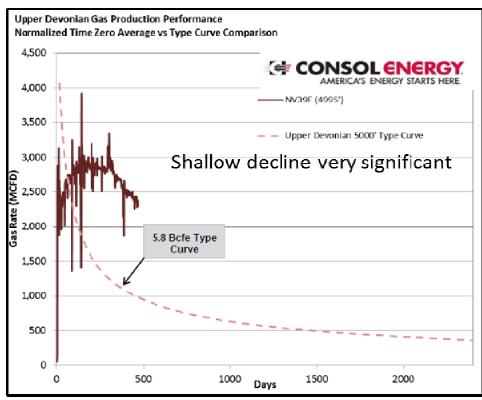
Actual: 9.0 BCFe



*Consol 3Q 2014 Company Presentation

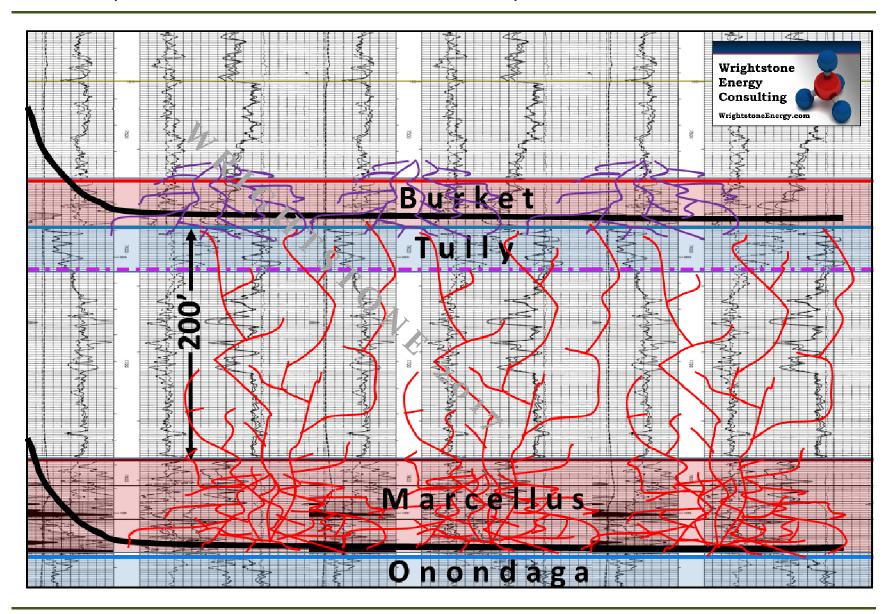
Consol reports "great impact" on underlying Marcellus

 2 Marcellus offsets tested 10.0 & 9.0 MMCF/d



Consol 3Q 2014 Company Presentation

Burket / Marcellus Fracture Interaction/Enhancement ??



Allegheny County – Burket/Geneseo Shale

Recoverable reserves assigned using BCFe/1,000' of lateral basis

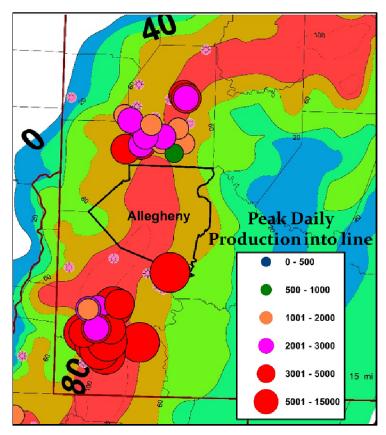
Sources:

- Proprietary EURs
- Corporate Reporting

Company	Avg EUR/1,000	
Consol	1.5	

Calculations:

- 750' spacing = 17.22 acres/1,000'
- Average EUR/1,000' = 1.5 BCF
- Average EUR/acre = 87 MMCF

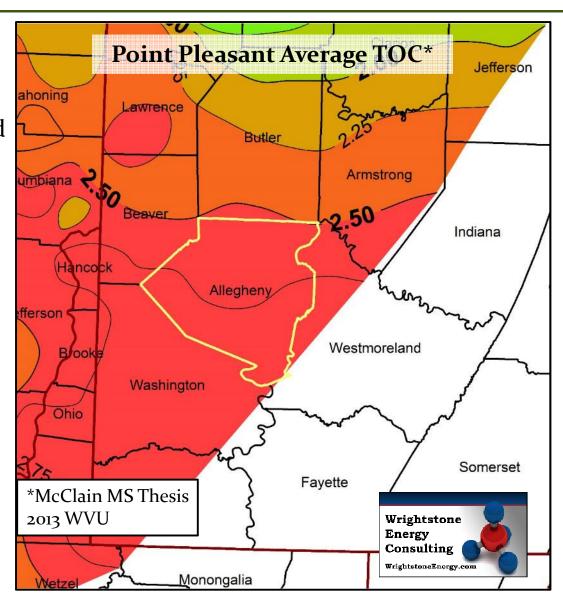


Total Burket/Geneseo recoverable reserves for Allegheny County: 42 TCFe

Allegheny County - Utica Shale

TOC is key production metric

Allegheny County is situated in the heart of the best reservoir based on TOC



Allegheny County - Utica Shale

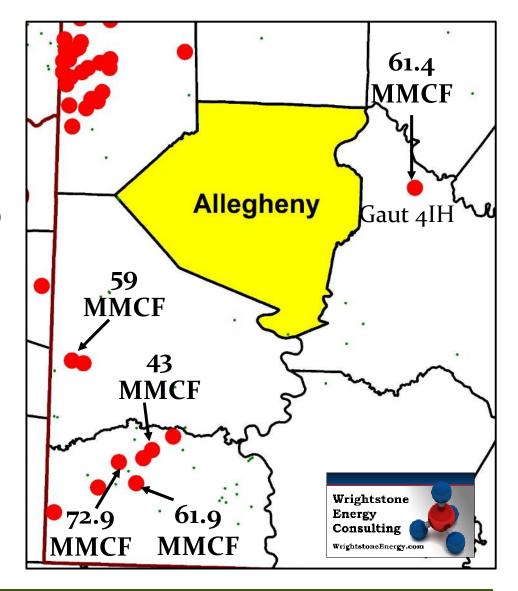
- No wells drilled yet in Allegheny County
- Outstanding flow rates surrounding Allegheny County

Company	Avg EUR/1,000'
Consol	2.8
EQT	2.6 – 6.0 (Scotts Run)
Rice	2.33

Calculations:

- 1,000' spacing = 22.97 acres/1,000'
- Average EUR/1,000' = 2.5 BCF
- Average EUR/acre = 108.9 MMCF

Total Utica recoverable reserves for Allegheny County: 51.9 TCF



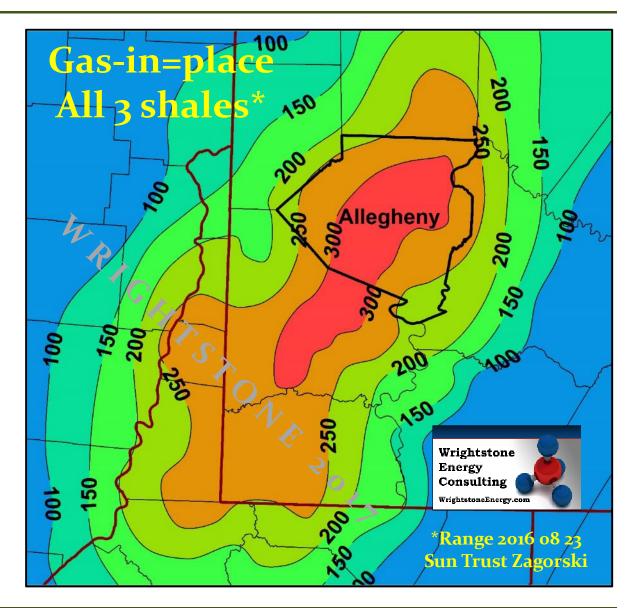
Allegheny County – Burket/Geneseo Shale

Total technically recoverable reserves (TCFe)

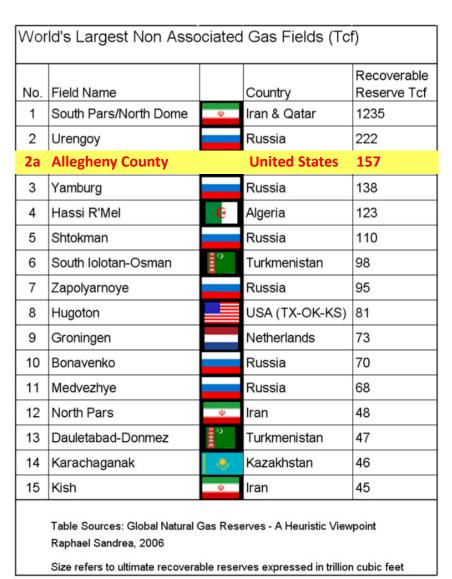
Burket/Geneseo 41.5 Marcellus 58.1 Utica 51.9

> Total Allegheny County

> > 151.6 TCFe



Allegheny County - The Size of the Prize



Allegheny County alone

Would rank above all but 2 of the world's largest conventional gas fields for recoverable reserves

AAPG Memoir 97 (2012) – The Appalachian Basin Gas Play: Its History of Development, Geologic Controls on Production, and Future Potential as a World-class Reservoir

Zagorski, Wrightstone & Bowman



Drilling Access Issues

- Regulatory restrictions
 - Set backs from habitable buildings or businesses
 - Set backs from streams
- Topography
- Legal
 - Force pooling
 - Marcellus/Burket
 - No force pooling in Pennsylvania for Marcellus/Burket
 - Multiple small tracts required to be under lease
 - Areas with old drilling leading splintered ownership
 - Utica
 - Force pooling is available in Pennsylvania for Utica
 - Pipeline availability
 - Splintered O&G rights
 - Community & environmental activism opposition

Set backs.... The waters have been muddied

Act 13 passed in 2012

- Established Impact Fee
- 500' set backs from homes/businesses
- 300' set backs from streams

Anti-drilling environmental activists sued to overturn the law

State Supreme Court in December 2013 ruled portions of the Act 13 restricting local zoning was unconstitutional including:

- Cannot preempt local zoning rules
- Must allow municipalities to restrict drilling in certain zoning

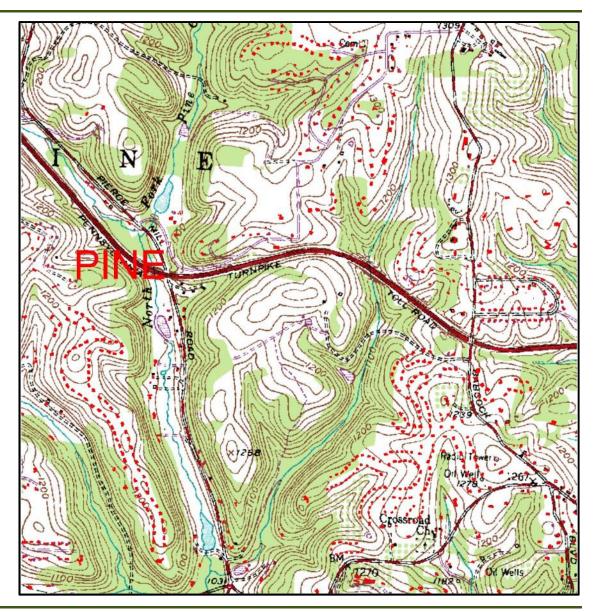
Anti-drilling activists want:

- Set backs of 2,000' or greater (de facto drilling ban)
- Drilling limited to areas zoned for industrial use

Thanks to Robert Johnson of ADKL for summary

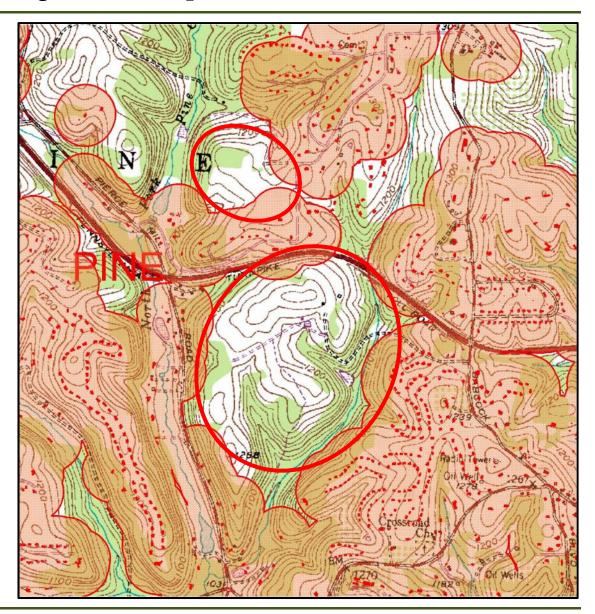
500' Set backs from all habitable dwellings and business buildings

Shape file from county showing all homes and offices



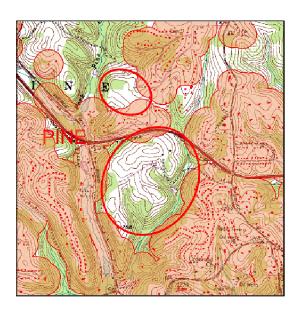
500' buffer around all buildings

ID possible sites for drilling pads using shape file buffer map



GIS layer 2 years out of date

Lots of construction in that time





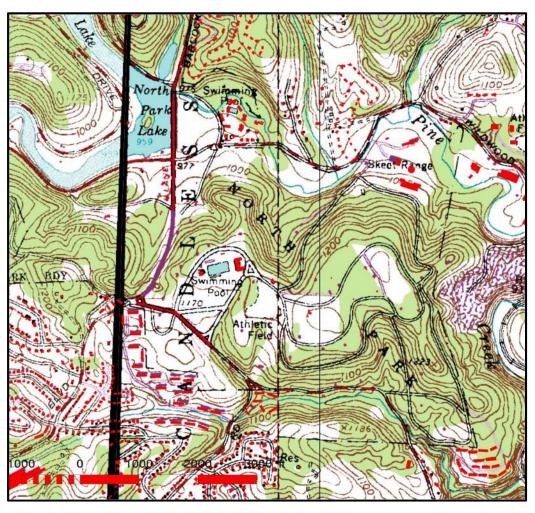
County layer had issues w/ non-homes showing up... like cell phone towers



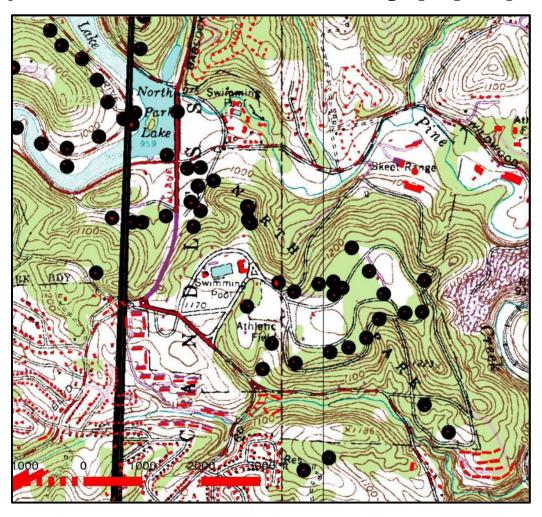
County layer had issues w/ non-homes showing up... park pavilions

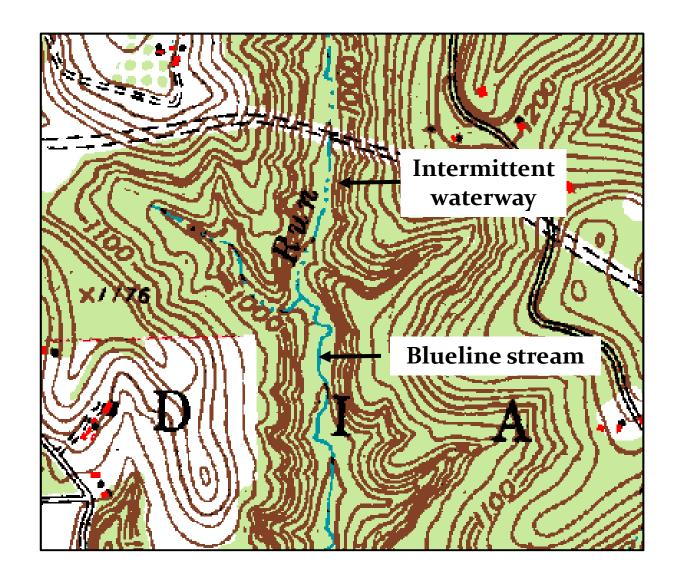


County layer had issues w/ non-homes showing up... park pavillions

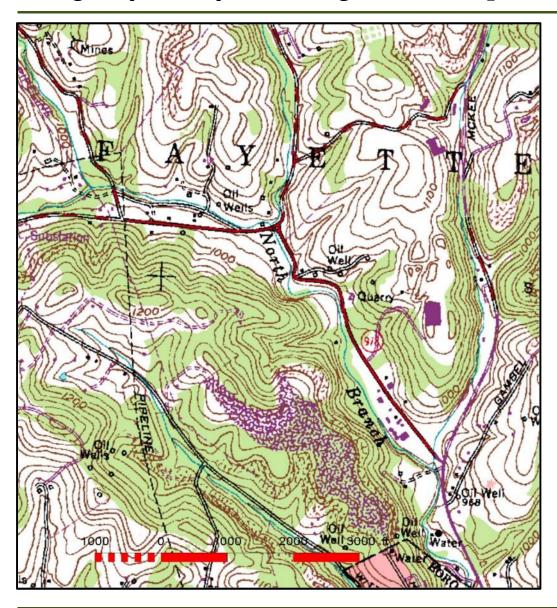


County layer had issues w/ non-homes showing up... park pavilions



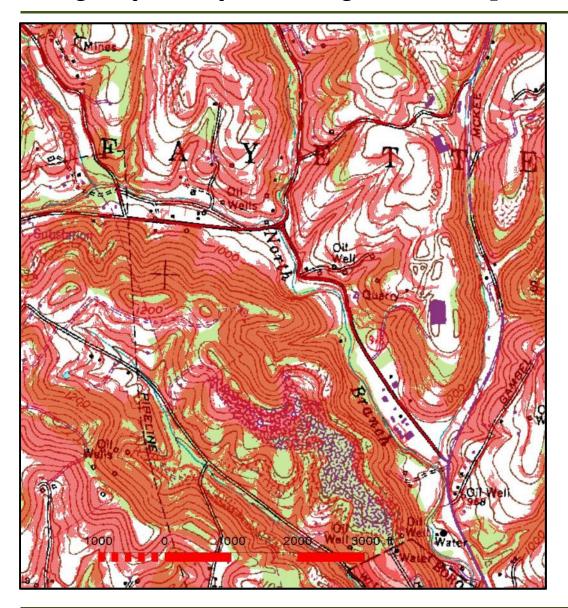


300' setback from a "blueline stream or wetland



Topographic restrictions on construction of pads and roads

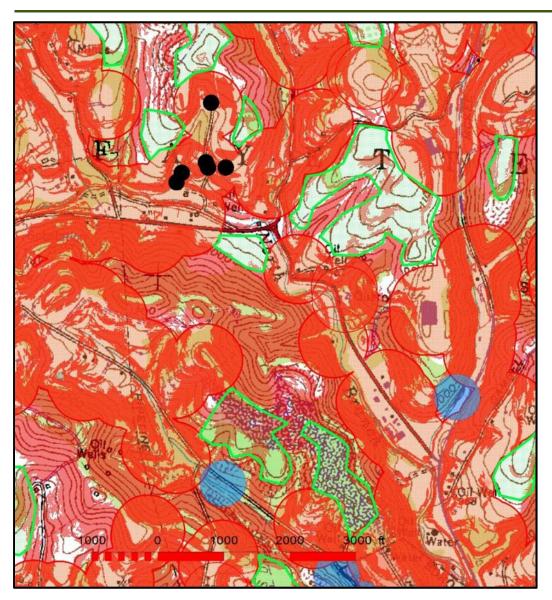
Estimated maximum 15% slope for construction of a 400 x 400' pad



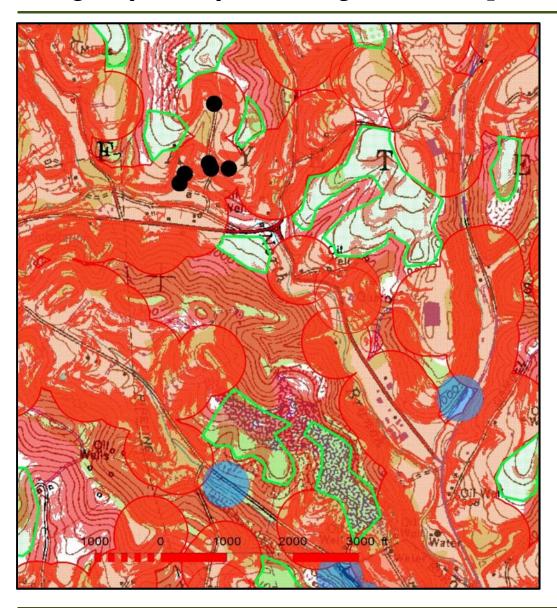
Digital elevation model used to ID areas w/ >15% slope

Many thanks to intern Justin Skaggs for the GIS work on this.

Layer: Slope small 23



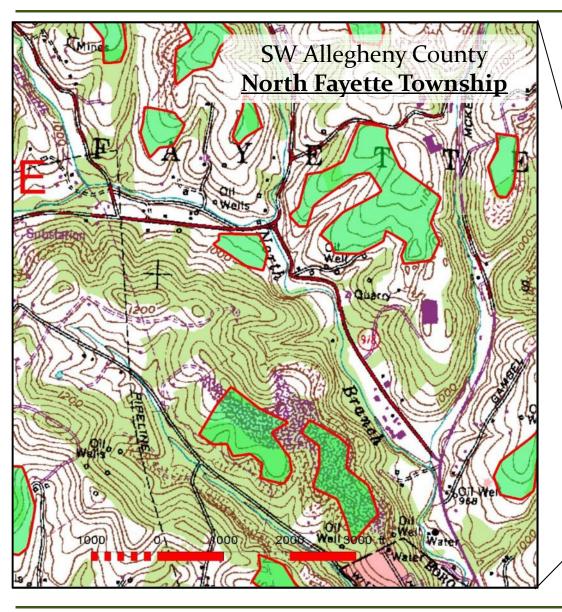
Drillable areas



Drillable areas

Semi-rurual North Fayette Township

Fairly accessible with opportunities

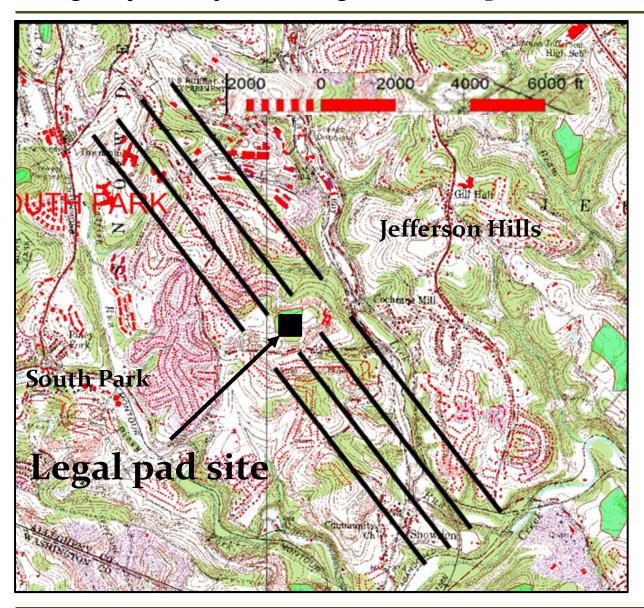


Drillable areas

Peripheral, semi-rural areas provide moderate to good opportunities

- Fairly accessible
- \ Good # of possible sites





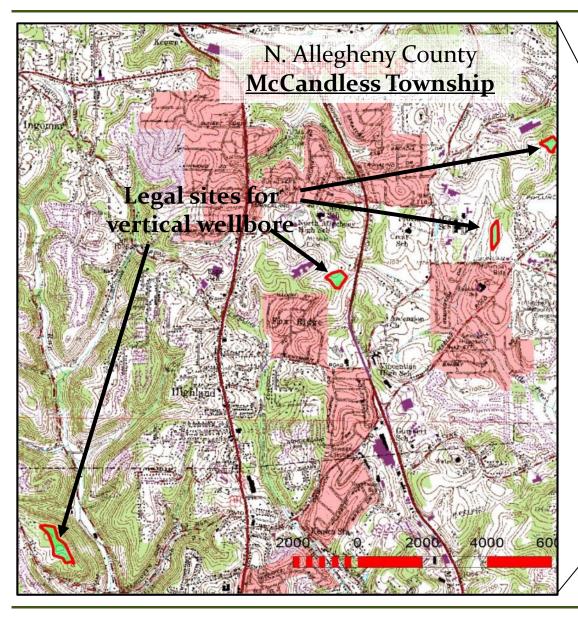
Legal issues:

Marcellus & Burket/Geneseo:

- No force pooling
- Required to lease every royalty owner under each lateral
- Likely 100's of agreements needed for each pad

Utica:

- Force pooling in effect
- Easing likelihood of minor holdouts preventing drilling

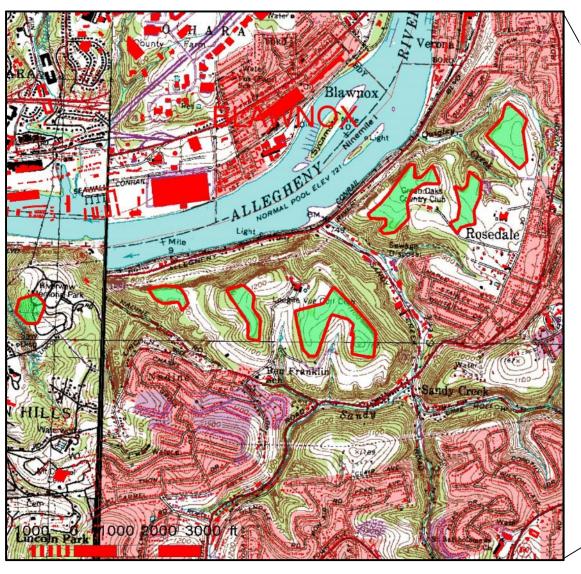


Drillable areas

Heavily populated areas through the central part of Allegheny County:

- isolated "legal" suburban drill pads
- County parks
- Golf courses

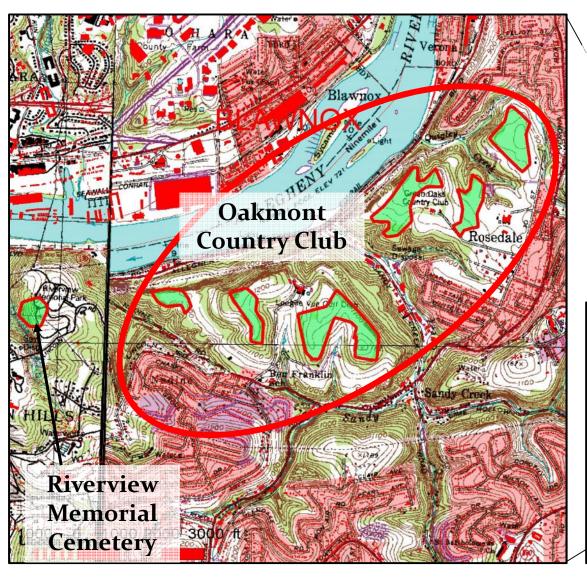




Drillable areas

Heavily populated areas through the central part of Allegheny County:





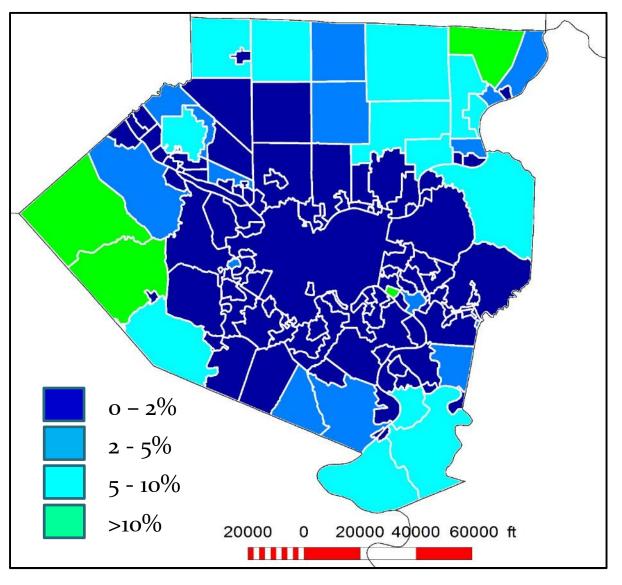
Drillable areas

Heavily populated areas through the central part of Allegheny County:

Golf courses



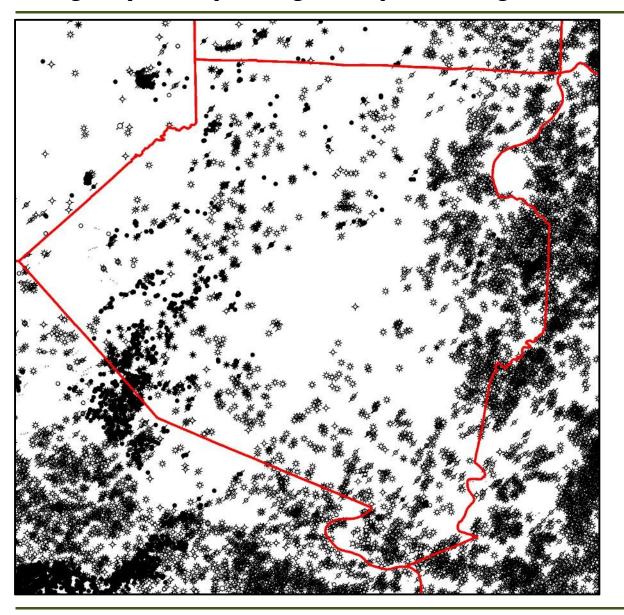




Drillable areas

- Densely populated core of county o – 2% of area has possible locations
- Peripheral semi-rural areas have increasing availability for pads

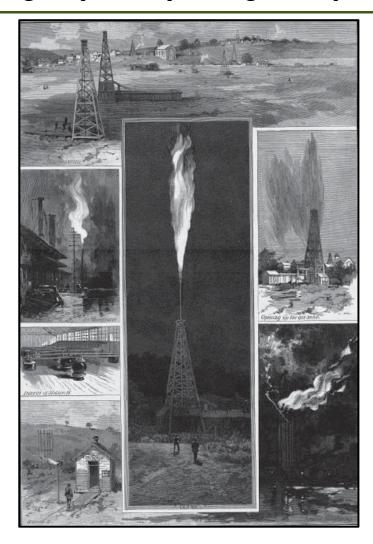
Allegheny County – Long history of drilling



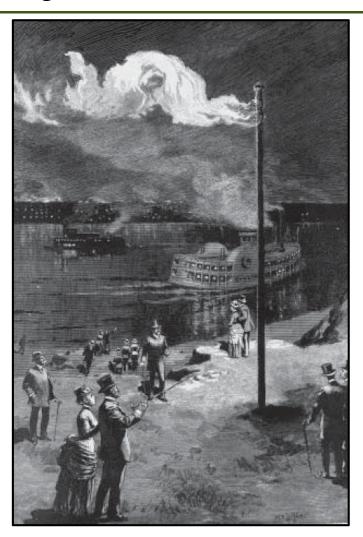
Historic drilling

- Old drilling dating back to late 1800's
- Lots of unlocated shallow vertical wells
- Nightmare of severed oil & gas rights likely

Allegheny County – Long history of drilling

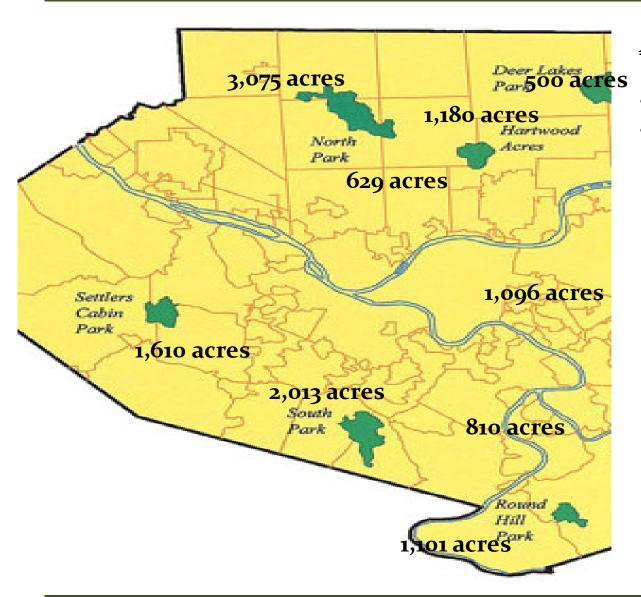


Pittsburgh's First Natural Gas Boom. Source: "Harper's Weekly, Nov. 7, 1885, 744-45



A Pittsburgh Standpipe, 1885. Source: "Outlet of Natural Gas Well Near Pittsburgh: "Harper's Weekly, Nov. 7, 1885, 731

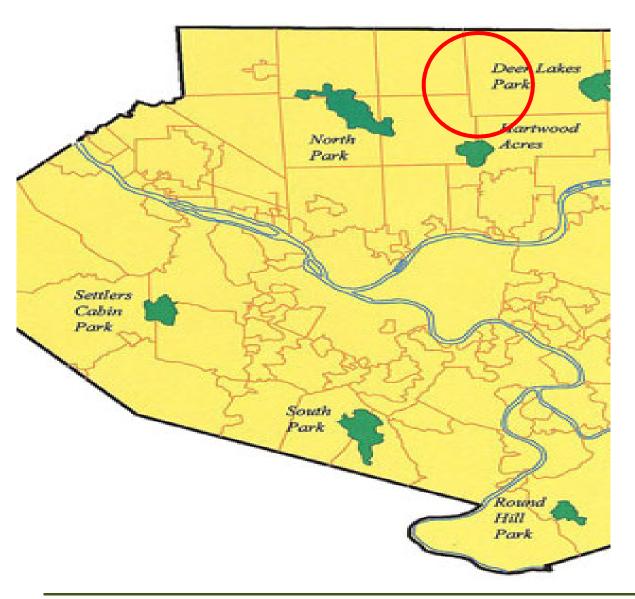
Allegheny County - County owned parks



Allegheny County

- Nine (9) parks
- Total 12,000 acres

Allegheny County - County owned parks



Deer Lakes Park

- 1,180 acres
- Only County park to be leased
- Range negotiated contract in May 2014
- Wells drilled from pad on adjoining private lands

Allegheny County





VALLEY NEWS DISPATCH

Deer Lakes Park boasts \$2.2M in upgrades from fracking revenue

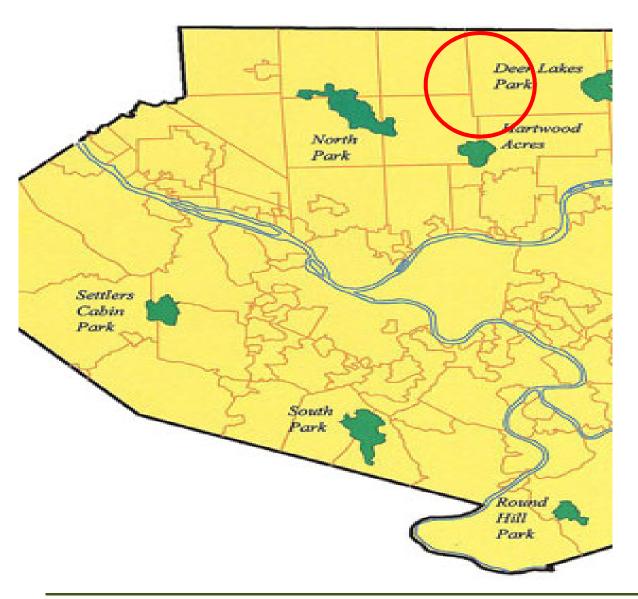


MADASYN CZEBINIAK * | Friday, Dec. 2, 2016, 12:54 a.m.

Range Resources

- Upfront payment of \$4.7 million
- Donated \$3.0 million to park improvement fund
- 18% royalty has earned \$503,000 since March 2015
- 24 new benches
- Cleaned up lake waters
- Added bathrooms
- Upgraded pavilions
- Trail improvements

Allegheny County - County owned parks



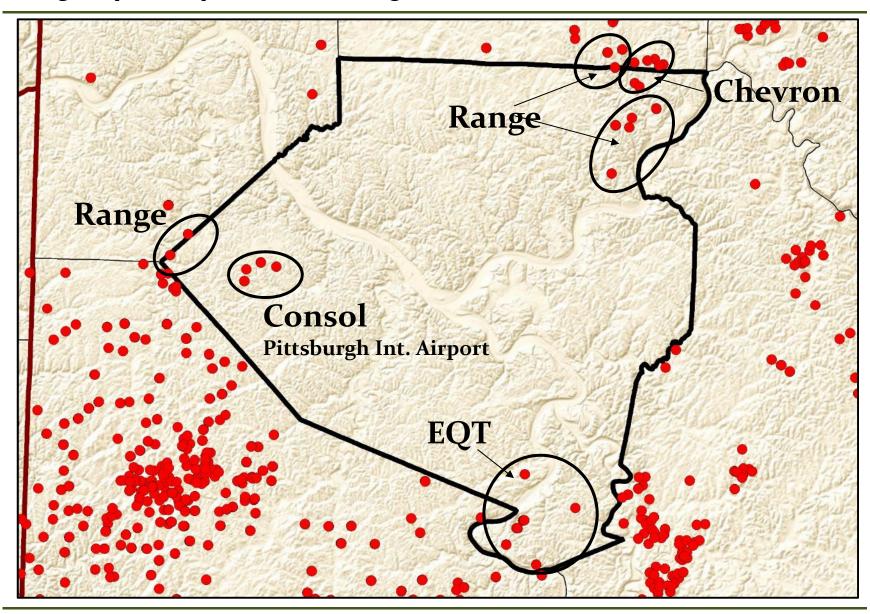
Remaining Parks

Most of other parks are not likely targets for drilling

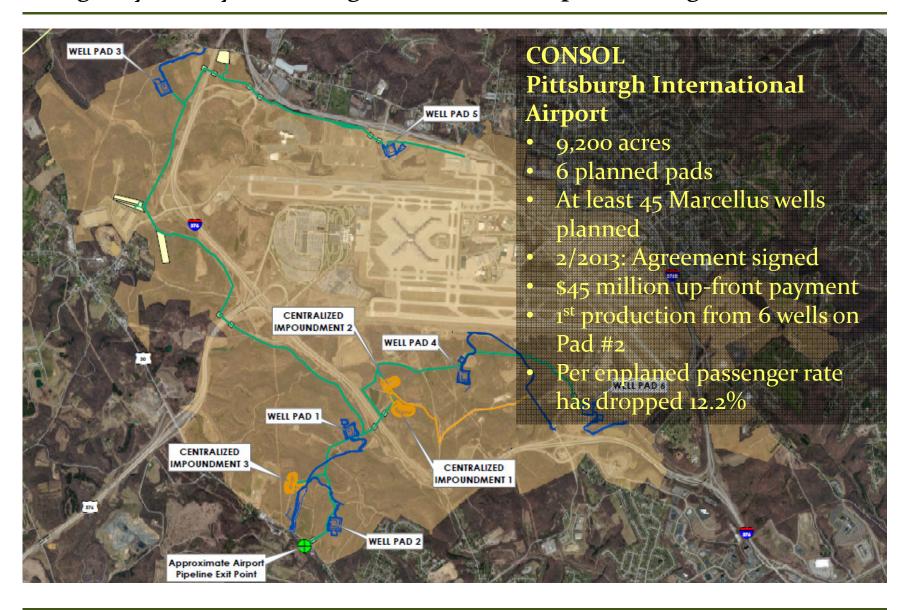
- Old field development
- No legal sites, too close to homes/businesses

Allegheny County Who is drilling and where....

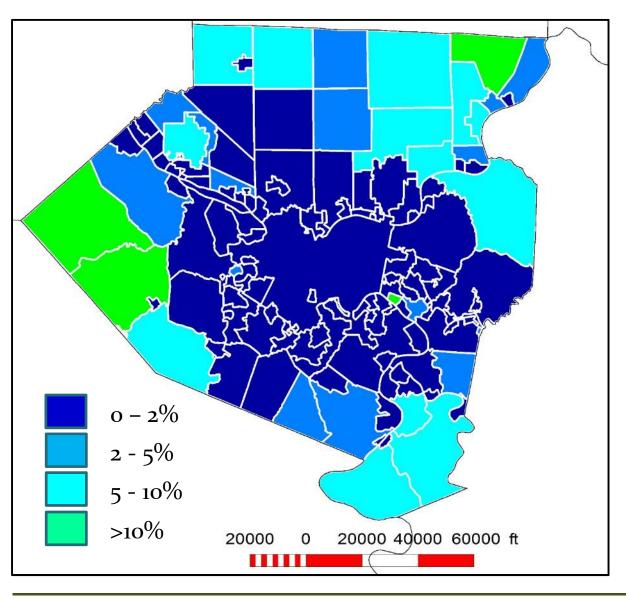
Allegheny County - Who is drilling?



Allegheny County - Pittsburgh Internationl Airport drilling



Allegheny County



Great potential but significant challenges to develop the resources.

Questions??