

An Assessment of a Stacked Shale Gas Play and the Effect on Forest Fragmentation in Pennsylvania

Ben Ogle

**Advisor: Dr. Patrick Drohan
GEOG596A**



Personal Background

- Working as GIS Analyst in the oil & gas industry for 6+ years
 - Leasehold development
 - Oversaw the mapping of surveyed subsurface mineral and leasehold tracts
 - Performed analysis & provide quality review of GPS data collected buried pipelines and gas facilities at a natural gas utility
 - GIS application development
- GIS Analyst III at CONSOL Energy
- Completed PSU GIS Certificate in Fall 2010 & began MGIS program in Fall 2015.

Outline

1. Project Background

- A. History of Oil & Gas Production in Pennsylvania
- B. Shale Gas Exploration in the State
- C. Facilities and Structures Involved in Extraction of Shale Gas
- D. Shale Formations in Pennsylvania (Marcellus, Utica, Burket/Geneseo)
- E. Oil & Gas Documents (Oil & Gas Leases, Surface Agreements, Declaration of Unitization)
- F. What is a Stacked Shale Play?
- G. Forest Fragmentation
 - i. Why is Forest Fragmentation an issue?
 - ii. Forest Fragmentation Studies
 - iii. Current Pipeline Regulations

2. Project Framework

- A. Objectives & Key Research Questions
- B. Methodology
 - i. Process 1: Forest Fragmentation Analysis
 - ii. Process 2: Well Production Data Analysis
 - iii. Process 3: Develop Tool based on Findings
- C. Study Area
- D. Data Sources
- E. Sharing Developed Tools and Datasets
- F. Expected Outcomes
- G. Project Timeline
- H. Challenges
- I. References



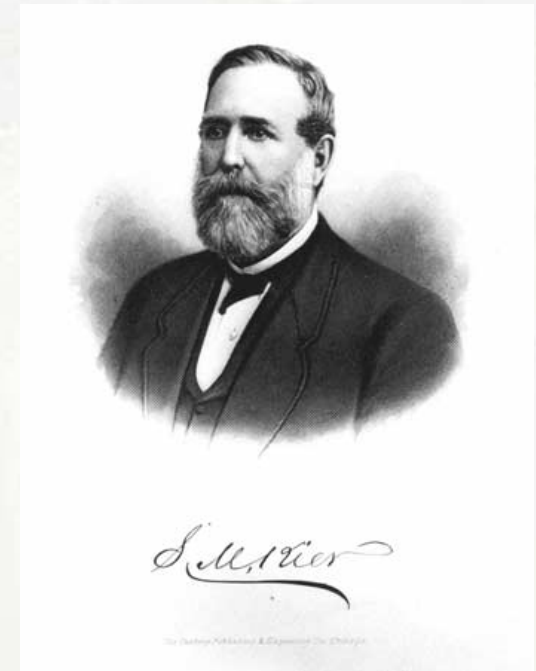
Source: Edward Todd

Project Background



History of Oil & Gas in Pennsylvania

- Seneca Indians told early explorers about the oil seeps they found along the banks of Oil Creek in Venango County, PA.
- In the early 1800's, Samuel M. Kier operated a salt well near Tarentum, Pa. Salty water was pumped out of the well and distilled to create rock salt (PA DNR, n.d.).
- At the time, salt drillers became discouraged when their wells produced greasy crude oil with their desired salt water.
- Kier experimented with refining crude oil he produced into kerosene and is credited as the founder of the American oil refining industry.
- Kerosene burned brightly in lamps, provided good heat for warmth or cooking, was considerably cheaper than whale oil.



Samuel M. Kier

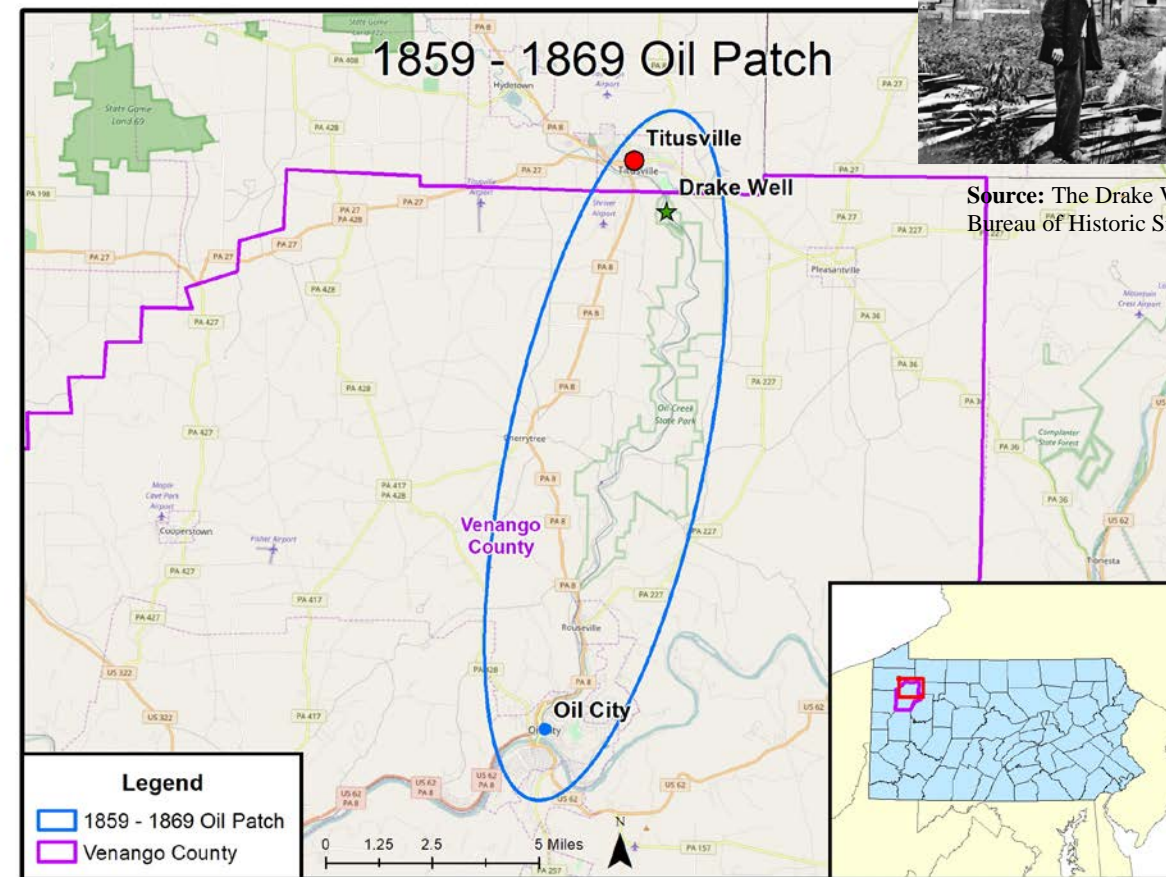
Source: The Drake Well Museum, PHMC Bureau of Historic Sites and Museums

History of Oil & Gas in Pennsylvania

- With Kier's discovery, there was an increased demand for crude oil, which caught the attention of East Coast investors.
- "Colonel" Edwin Drake, funded by such investors, drilled the first oil well in 1859 in Venango County, near Titusville. Oil was found at 69.5 feet ushering in the modern oil industry (PA DNR, n.d.).
- More than 350,000 oil and gas wells have been drilled in Pennsylvania since that time.
- The frenzy around oil in Northwest Pennsylvania eventually slowed and was overshadowed by discoveries in Texas and California.
- From 1930 to 1980, deep vertical gas drilling in Pennsylvania continued, and one of the main targets was the Lower Devonian Oriskany Sandstone, below the Marcellus Shale formation.
- Oftentimes, while drilling, numerous gas shows occurred while penetrating the Marcellus Shale.

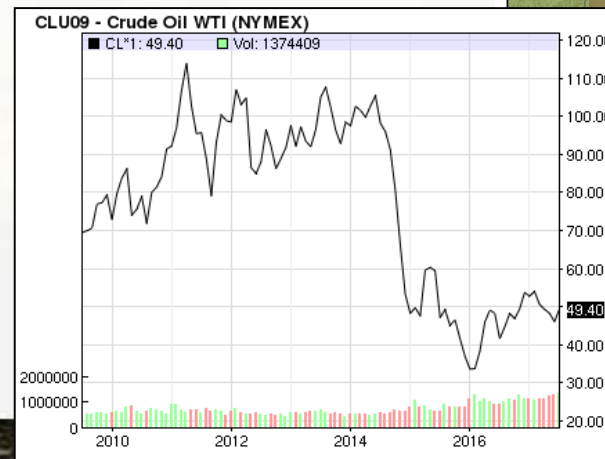


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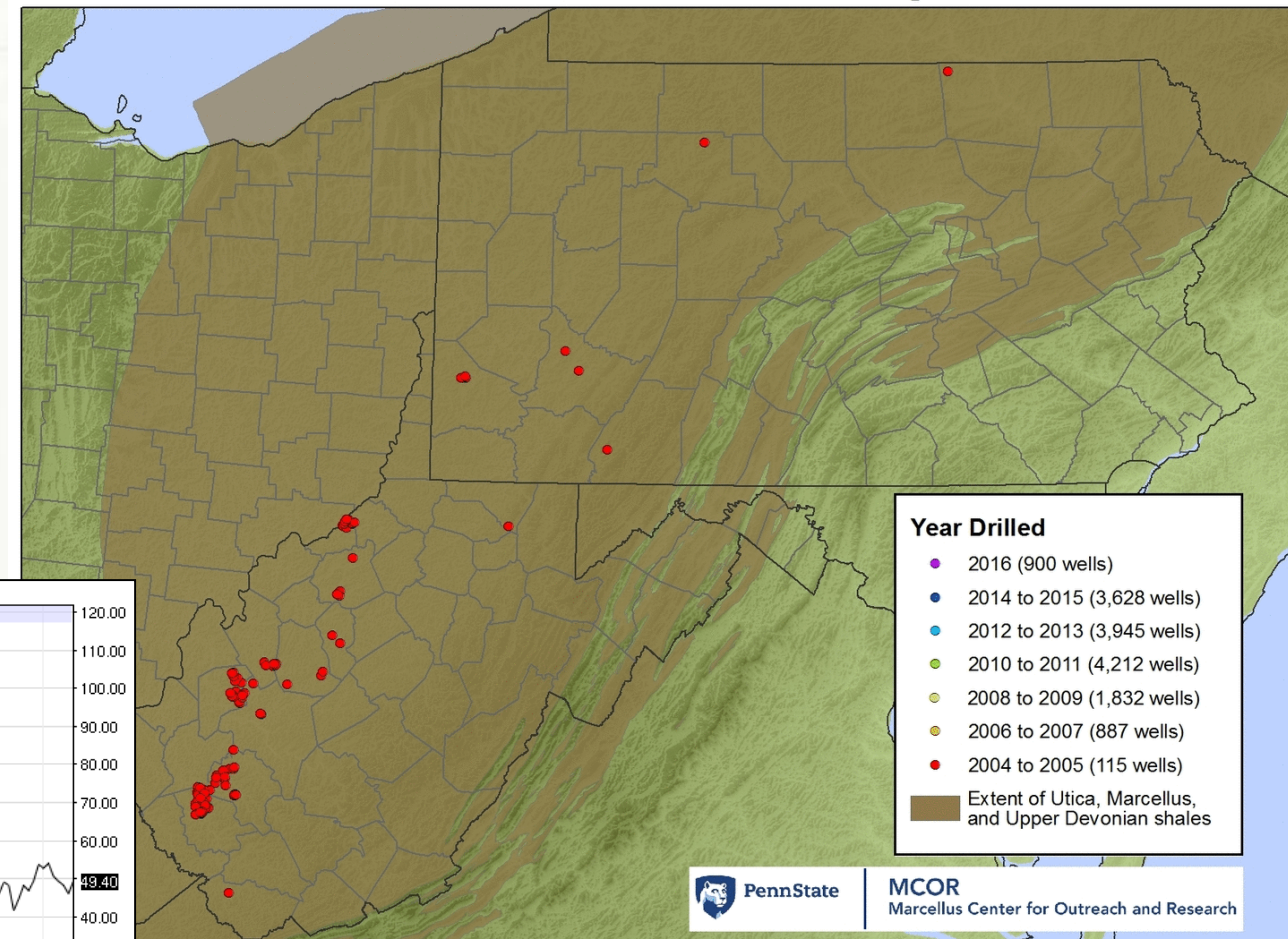


Shale Gas Exploration in the State

- The Marcellus shale play began in 2003, when Range Resources drilled through the Marcellus to the Lower Silurian in Washington County, PA (Zagorski, Wrightstone, & Bowman, 2012, p. 174-177).
- Range Resources drilled additional wells in Washington County and experimented with drilling and hydraulic fracturing techniques first used in the Burkett Shale in Texas.
- The company began to successfully produce Marcellus gas in 2005. Many other gas exploration companies followed suit and began leasing acreage.
- The price of oil and natural gas fell dramatically in mid-2014. The pace of newly permitted wells slowed.
- Exploration companies need to remain focused on returns on investment, rather than production growth, as the most significant metric for success in the industry.



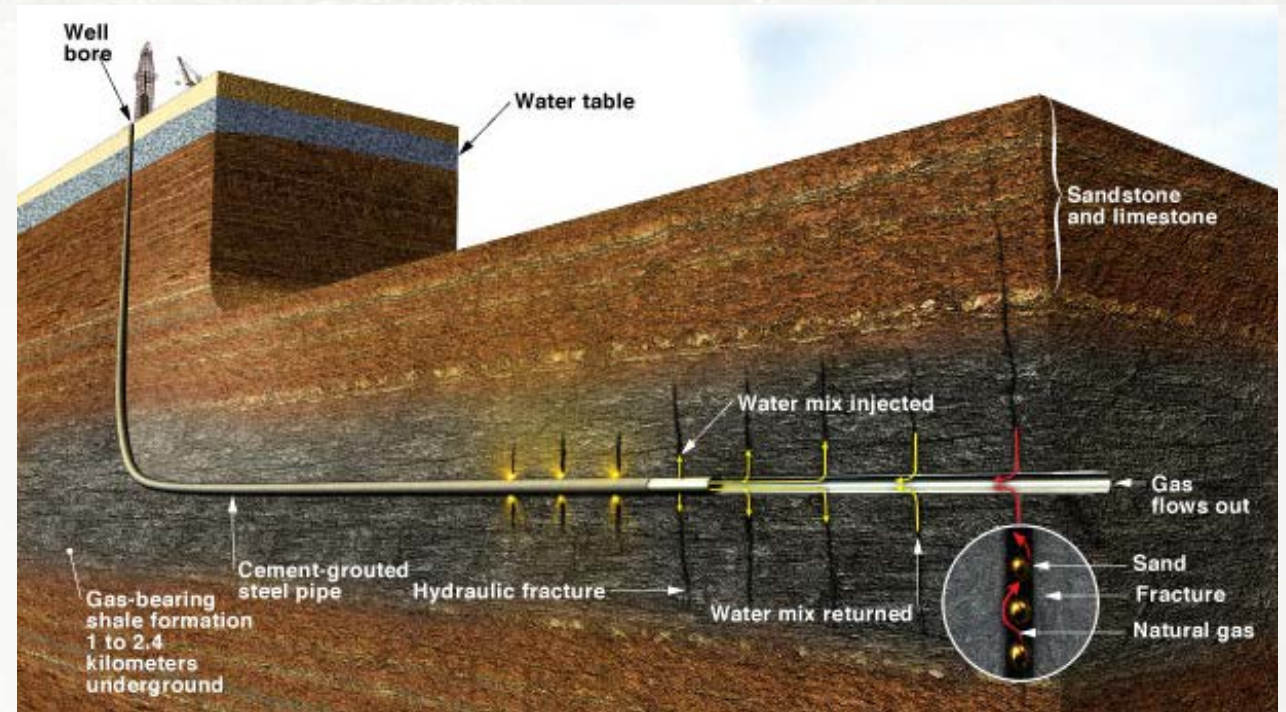
Unconventional Wells Drilled by Year



Source: Penn State Center for Outreach and Research

Directional Drilling & Hydraulic Fracturing

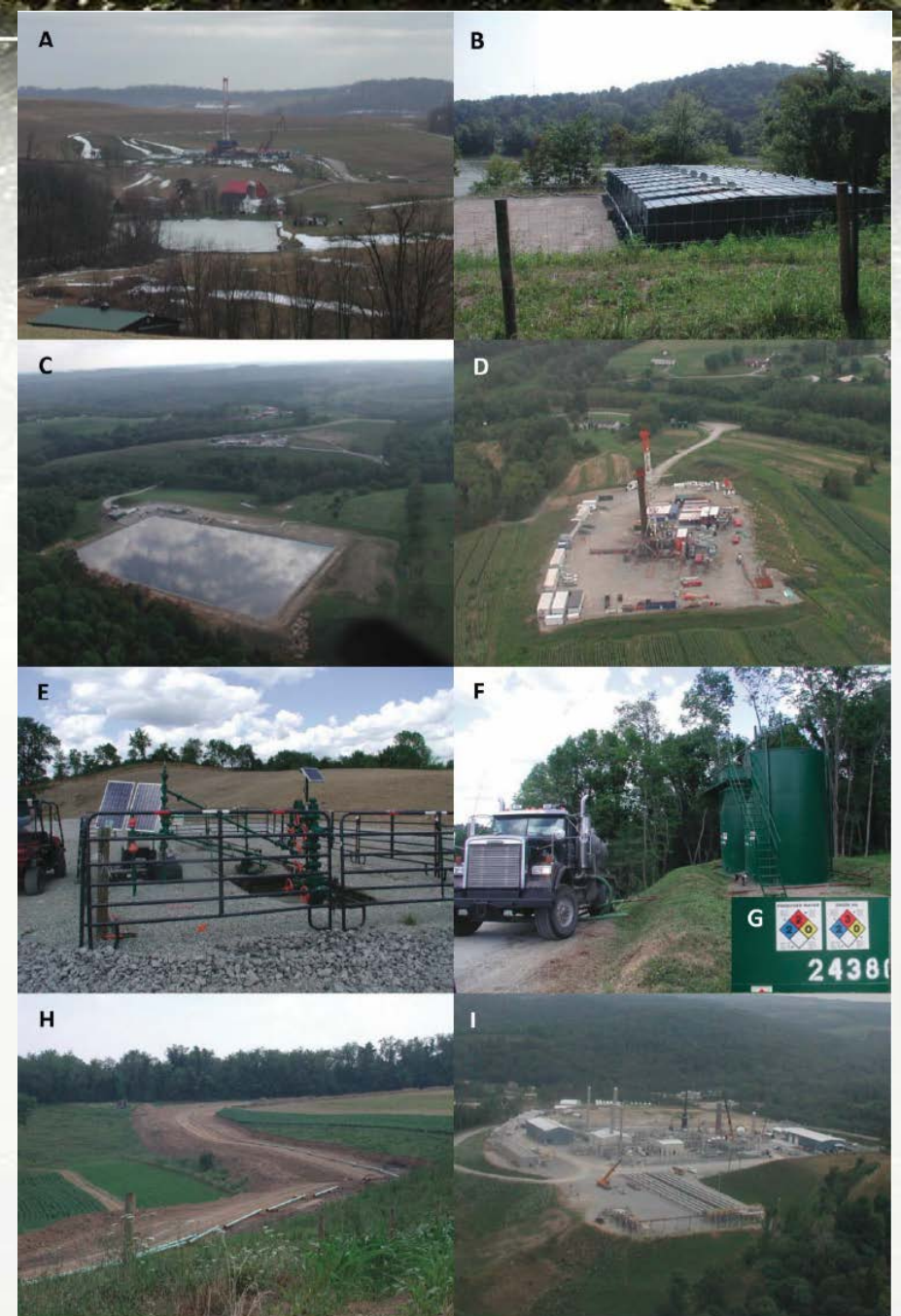
- Pioneered in the Barnett Shale (Texas) by George Mitchell in the early 1980's.
- Step 1 – Directional Drill
 - First drilled vertically, once it reaches the “kickoff point” where the bit begins curving to become horizontal.
 - A steel casing is cemented along the vertical length to prevent water contamination.
 - The horizontal section of the well is drilled. An additional steel casing with cement is inserted into the horizontal length.
- Step 2 - Hydraulic Fracturing
 - A Perforating gun is fired along a section of the horizontal length of the well lateral, creating holes into the casing, cement, and into the target formation.
 - A mixture of water, sand, and chemicals that are injected into the well and through the perforations at high pressures (5–10,000 psi) creating fractures into the formation.
 - This section is isolated with a plug, and these steps are repeated along the horizontal length of the well lateral
 - Once stimulation is complete, the plugs are drilled out and production begins.
 - During the initial production, 15% to 50% of the fracturing fluid is recovered. These fluids are recycled or safely disposed of per government regulations.



Source: (Lampe & Stolz, 2015, p.437-440)

Facilities and Structures Involved in Extraction of Shale Gas

- A. Well pad with horizontal drilling rig
- B. Water storage tanks at a water withdrawal station
- C. Water impoundment
- D. Well pad with horizontal drilling rig
- E. Completed well with “Christmas Tree”
- F. Condensate tanks to store produced water
- G. Hazard placards on the condensate tanks
- H. Pipeline construction in Washington County
- I. Pipeline construction liquids processing (“cryo”) plant

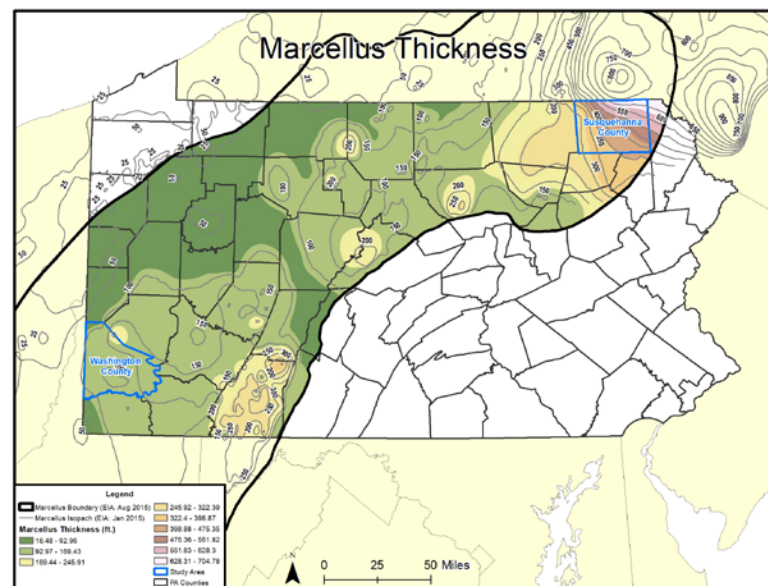
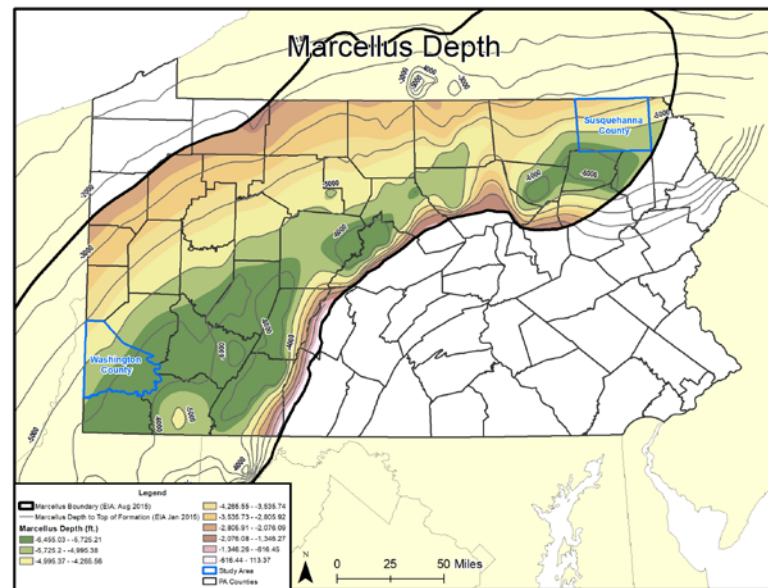
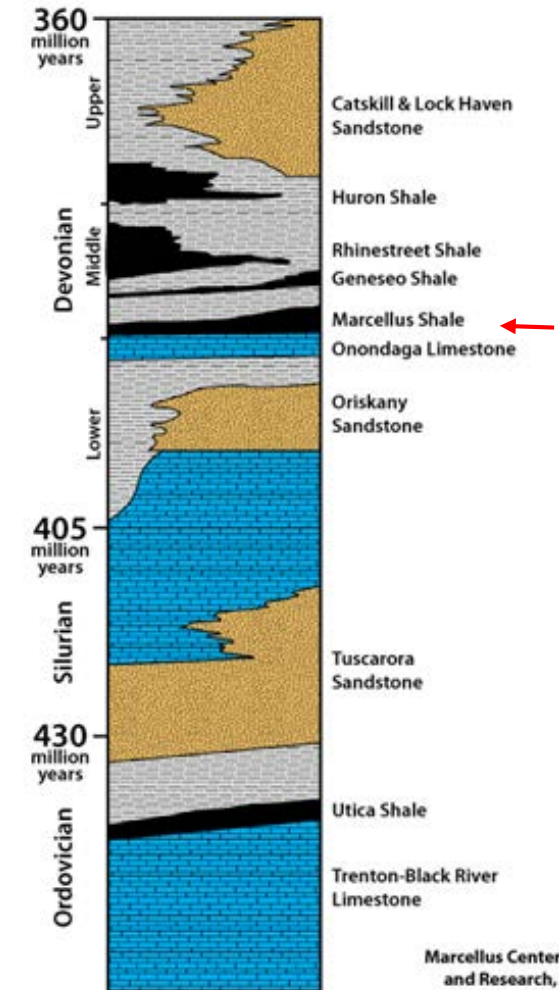


Source: (Lampe & Stolz, 2015, p.438)

Marcellus Shale in Pennsylvania

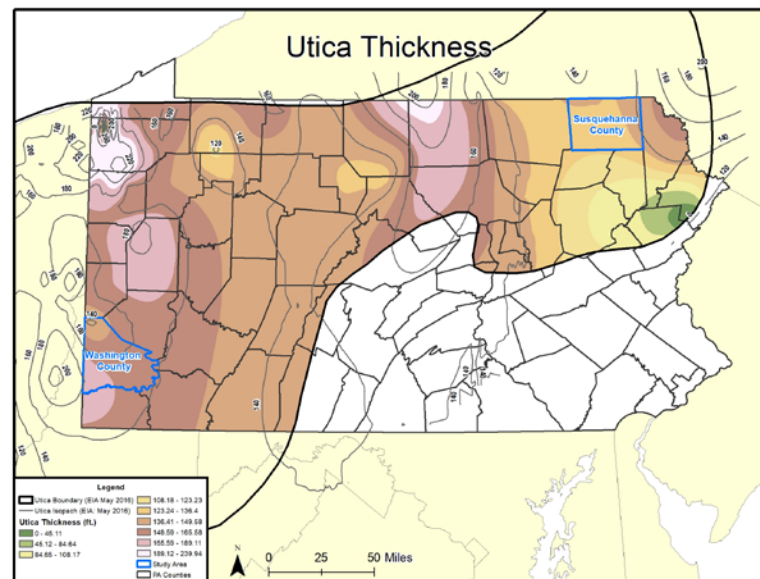
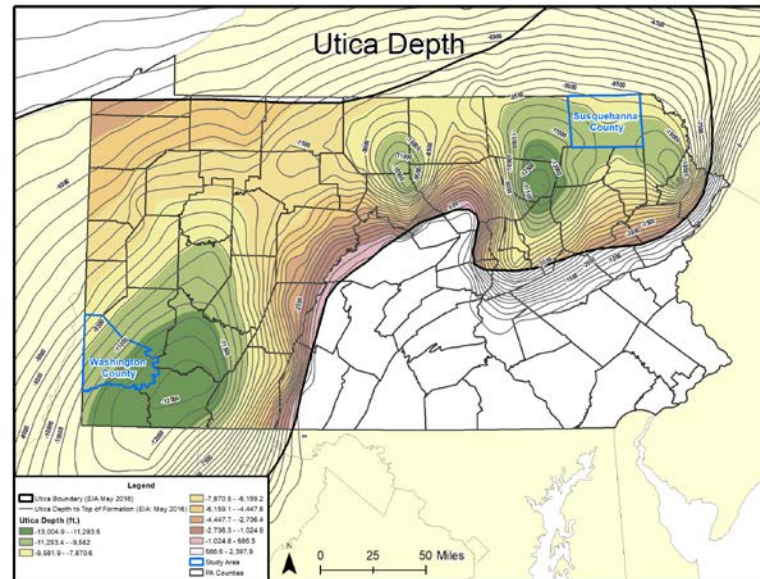
- The Marcellus Shale is a sedimentary rock formation deposited over 350 million years ago, in a shallow inland sea located in the eastern United States (de Witt et al, 1993).
- The Marcellus Shale forms the bottom part of a thick sequence of Devonian age, sedimentary rocks in the Appalachian Basin.
- EIA (2015) estimates proven reserves in the Marcellus Play of 77.2 trillion cubic feet (Tcf), which makes it one of the largest natural gas plays in the U.S.
- Key geologic and technical criteria that control play boundaries include thermal maturity, total organic carbon (TOC), formation thickness, porosity, depth, pressure, and the ability to be fractured.
- Total Organic Carbon (TOC) content in the Marcellus formation ranges from less than 1% to 20% (Zielinski and Mciver, 1982; Nyahay et al., 2007; Reed and Dunbar, 2008).

Key Gas-Producing Formations in Pennsylvania

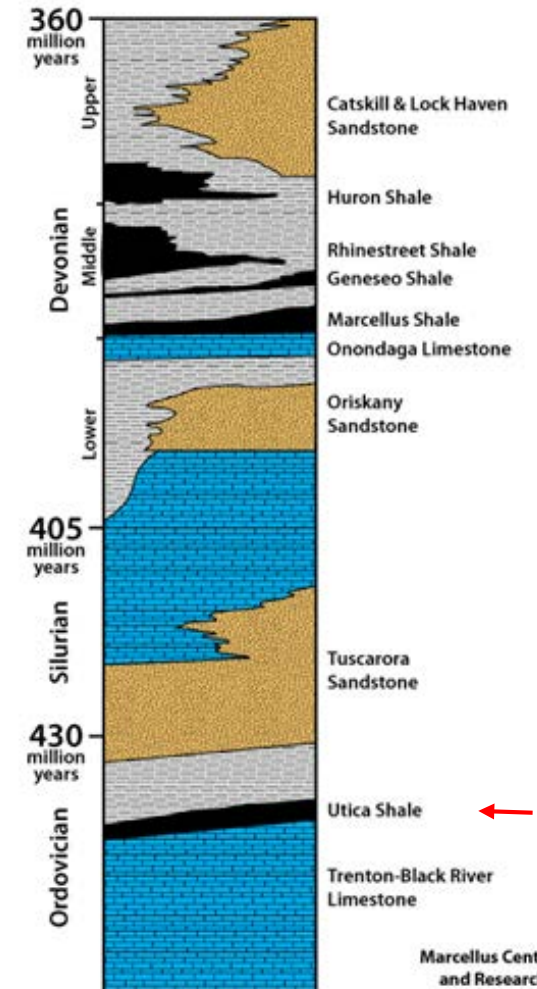


Utica Shale in Pennsylvania

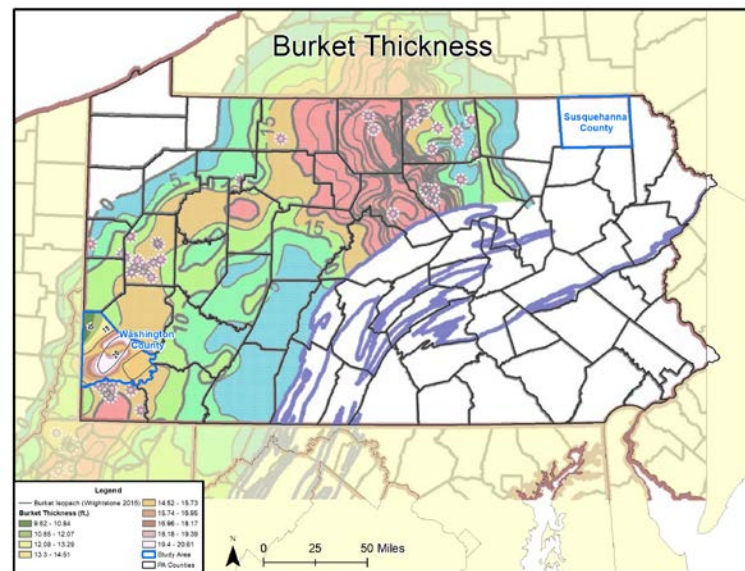
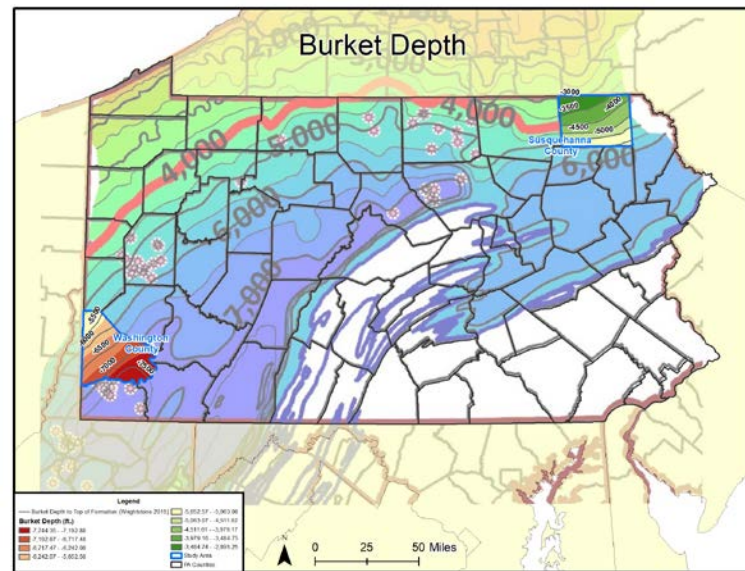
- The Utica Shale is a black, calcareous, organic-rich shale of Middle Ordovician age.
- The Utica Shale is located a few thousand feet below the Marcellus Shale.
- WVU's Appalachian Oil and Natural Gas Research Consortium said in 2015 the Utica contains technically recoverable resources of an astounding 782 Tcf of natural gas (Hohn, Pool, & Moore, 2015, p. 168).
- Most of well drilled into the Utica Shale are in eastern Ohio.
- Total organic content (TOC) from 1% to 3% (U.S. Energy Information Administration, 2017)



Key Gas-Producing Formations in Pennsylvania

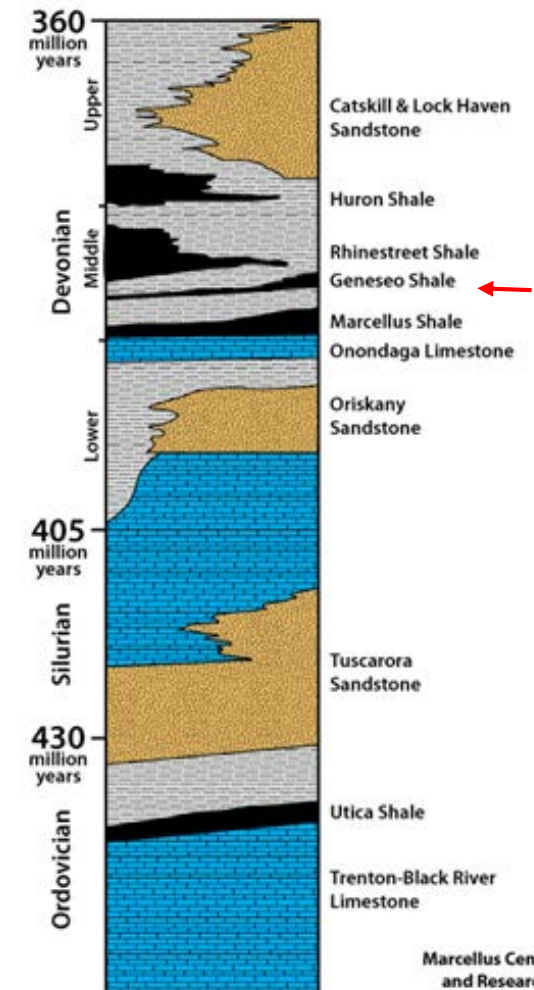


Burket/Geneseo Shale in Pennsylvania



- The organic-rich mudstone immediately above Tully Limestone is called Burket across most of PA and WV and Geneseo in northwest PA and NY.
- The distance from the Burket down to the Marcellus ranges from 20 ft. in southwestern PA and WV to more than 800 ft. in northeastern PA.
- It is estimated that 33 TCF of recoverable gas reserves in the Burket
- Wrightstone (2015) states that high volume production appears closely related to thicker, high-TOC quality areas (Washington County). Because the Burket is not as deep in Susquehanna County, it may not be economically viable in the county.
- Max total organic content (TOC) of 3.8% (Arnold, 2015)
- There were 85 productive wells drilled by April 2015 in the Burket (Wrightstone, 2015)
- Drilling and completion costs can likely be reduced by utilizing existing drilling pads and infrastructure

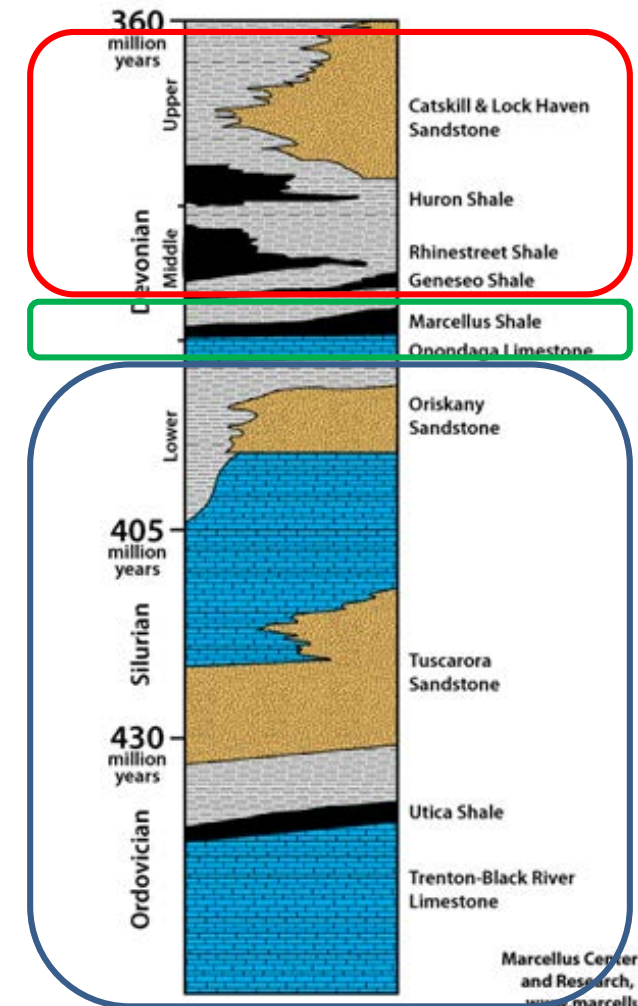
Key Gas-Producing Formations in Pennsylvania



Oil & Gas Leases

- Landman contacts a mineral owner, if no prior lease is signed, the owner can sign with the company (there is oftentimes a monetary per acre bonus when a lease is signed).
- Leases often last 5 years (and can be renewed with an additional bonus) and have a gas royalty 12.5% to 22%.
- A mineral tract could have an active well (horizontal or vertical), coal mining activities, or underground storage facility from a previously signed lease. In this case, the property is “Held by Production” (HBP) by the gas company. After one year of production inactivity, the property is no longer held by the lease and can be leased again.
- Frequently, the owner of the minerals is different than the owner of the surface. There may also be multiple owners of the minerals (example: a mineral owner leaves the rights to his mineral tract to his 20 grandchildren).
- Some Leases will only include mineral rights at certain depths or formations.
- Mineral owners may only own rights at certain depths or formations.

Key Gas-Producing Formations in Pennsylvania



Surface Agreements

- **Surface Use Agreements (SUA)** - An agreement that is signed between the drilling company and the surface owner of land where oil and gas development, such as a well pad, is proposed to take place. A Surface Use Agreements (SUA) typically involves which monetary payment upon signing and an additional payment for damages to the surface owner's property.
- **Right-of-Way Agreements** - In most cases, a natural gas pipeline right-of-way agreement (or "Easement Agreement") is used to construct, maintain, operate, protect, inspect, and/or replace one or more pipelines. The surface owner, who signs the agreement with the Pipeline Company, is typically compensated for the easement by payment per linear foot. Pipeline companies typically seek a 50 ft. or wider easement; the payment is based on the length of the easement.

RECORD OF DEEDS Row COMPARED BY 6 467
BOOK No. 341 DC 341/167
PORTAGE COUNTY, OHIO

NO. 59799
G R A N T

Joe & Mrs. Dora Luli

To Ohio Edison Co. For and in consideration of One DOLLARS (\$1.00) to us in hand paid, the receipt of which is hereby acknowledged, we for ourselves and successors in title, hereby grant and warrant unto Ohio Edison Company, its successors, grantees, lessees, licensees, and assigns, the right, privilege and authority to construct, operate and maintain lines for the transmission and distribution of electric energy, and the operation of telegraph and telephone lines, including the necessary poles, wires, guys, anchors and other appurtenances upon, over and across the property which we own or in which we have any interest in the Township of Rootstown, County of Portage, and State of Ohio situated along the Rootstown-Hartville Road, in Rootstown Township and along the roads, streets and highways adjoining the said property, said poles to be set within two feet of the highway limits as now established, or as may hereafter be established due to highway improvements, unless otherwise specified, with the right to cut down any dead trees within falling distance of said lines and the right to trim any trees necessary to give a minimum clearance of four feet from any electric or telephone wire, and together with the right to place any necessary side guys and anchors on our property not more than fifteen feet from any of said poles.

We represent that we are the owners of the property hereinbefore described and that the same is free and clear from all encumbrances, except Mrs. J. B. Renfrew

WITNESS my-our hand and seal this 21st day of February, 1935. at Rootstown Township.

WITNESSES: Joe Luli
W. B. Russell Mrs. Dora Luli
Dan H. Stein

STATE OF OHIO
COUNTY OF PORTAGE, SS.

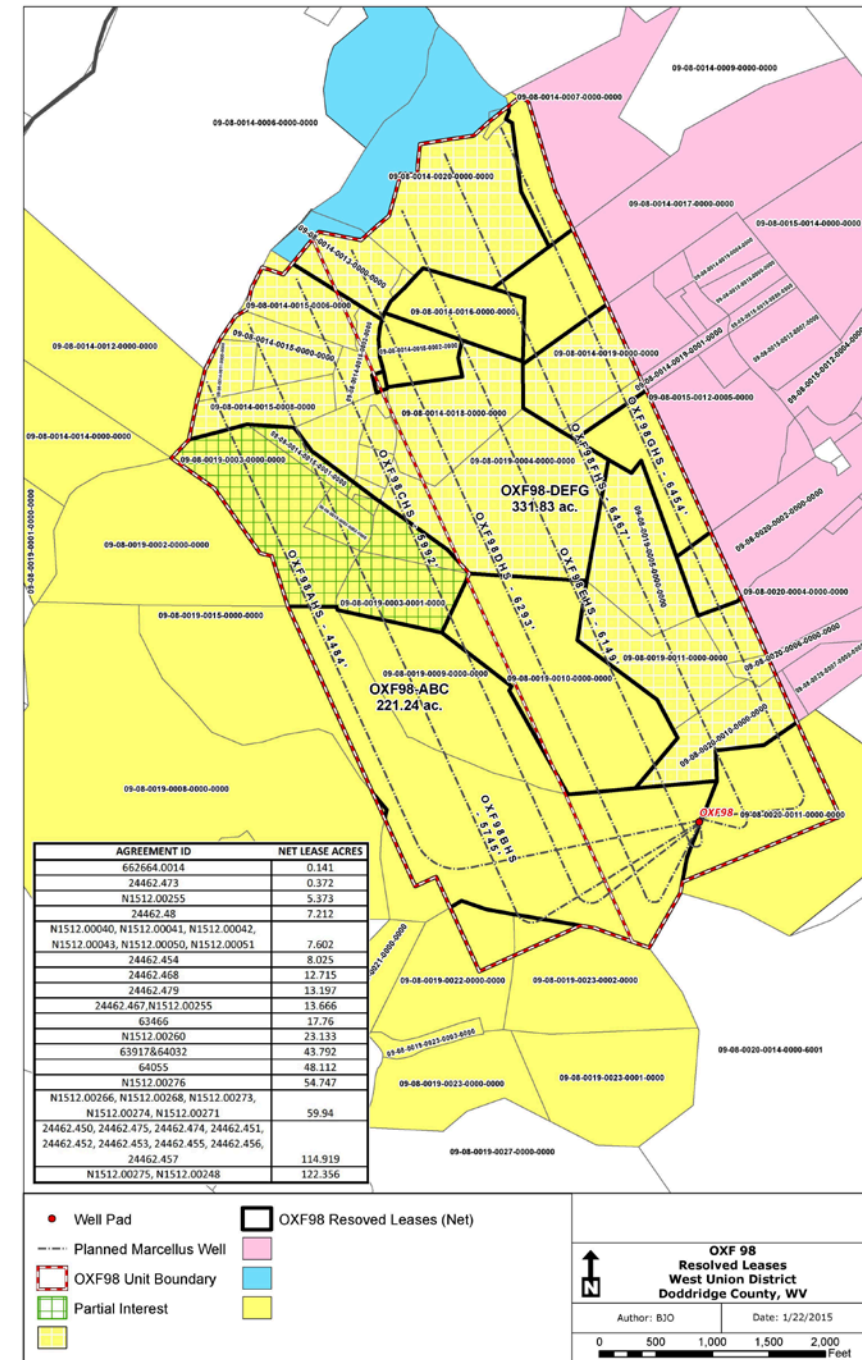
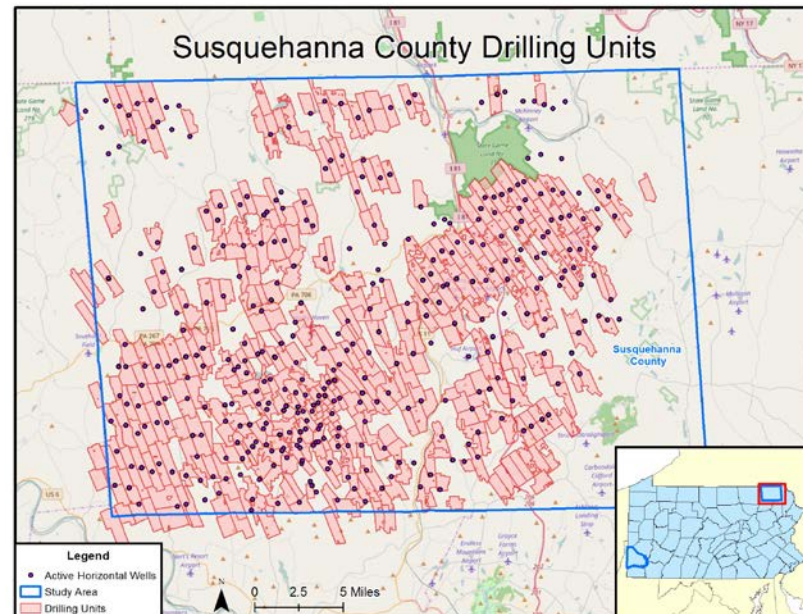
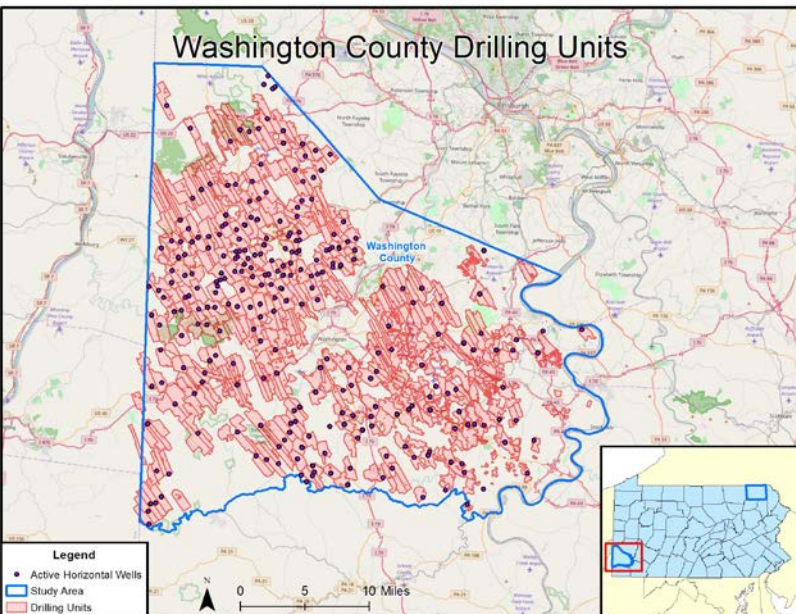
Before me, a Notary Public in and for said State and County, personally appeared the above named Joe Luli and Mrs. D. Luli who acknowledged that they did sign the foregoing instrument and that the same is their free act and deed. IN TESTIMONY WHEREOF, I have hereunto set my hand and official seal this 1st day of March, 1935.

William B. Russell Notary Public William B. Russell
(Seal)

Rec'd for Record May 2nd, 1935
at 12:56 P.M.
Recorded May 3rd, 1935 Fee - 50¢
Claude Watters, Portage County Recorder
RECORDED BY: ed

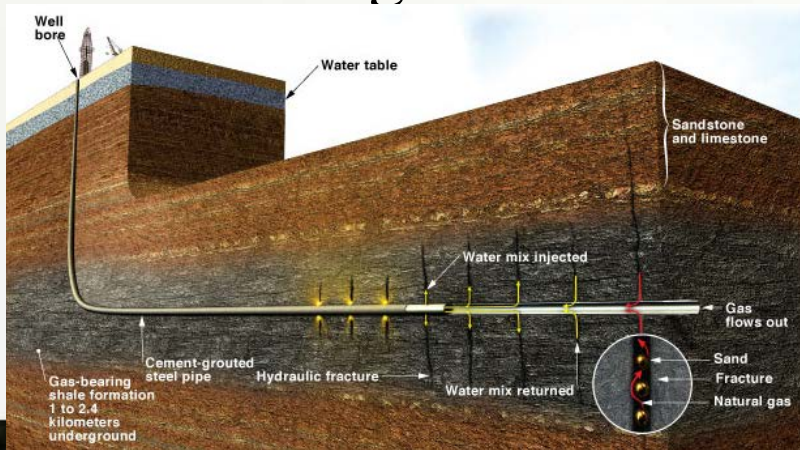
Declaration of Unitization

- The terms “pooling” and “unitization” are often used interchangeably. A pooled unit is the joining together or a combination of small tracts or portions of tracts for the purpose of having sufficient acreage to receive a well drilling permit, and for the purpose of sharing production by interest owners in such a pooled unit (Kramer & Martin, 2006, p. 1-3).
- In most cases, mineral ownership for a horizontal well or wells is not held by one individual – Declaration of Unitization (or Pooling) is required, signed, and recorded in the county courthouse.
- Example: If a unit produced \$100,000 in a month. An owner has mineral rights to 100 acres in a 1000 acre unit. Your lease pays 20% royalties. The monthly royalty check would be \$2000.

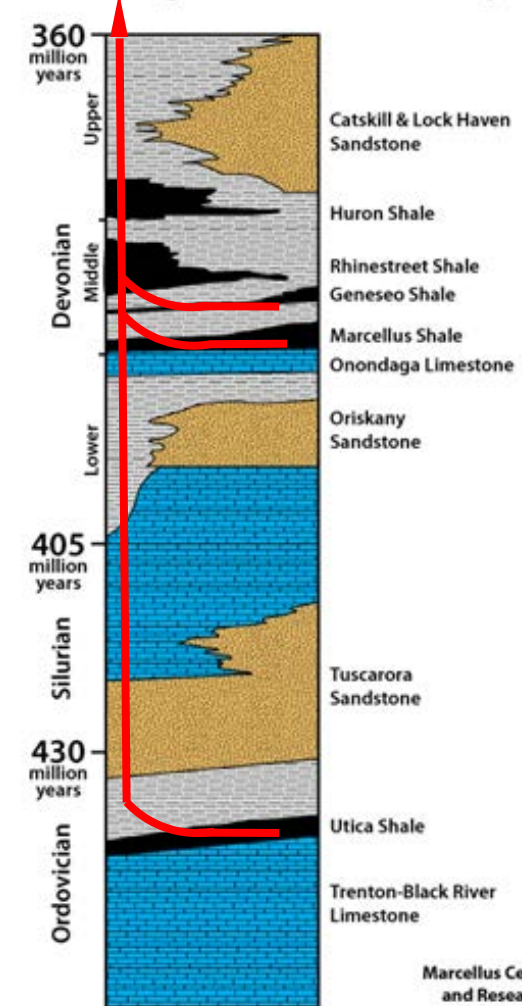


What is a Stacked Shale Play?

- Producing from multiple shale formations from the same well pad.
- **Hypothesis:** By producing from multiple shale formations, gas exploration companies can increase well pad productivity and reduce costs, while reducing surface disruptions and forest fragmentation.



Key Gas-Producing Formations in Pennsylvania



Why is Forest Fragmentation an issue?



- **Habitat conversion** from linear infrastructure (Langlois et al., 2017)
 - Barrier effects, created by linear corridors, can restrict movement for some wildlife species, alter home ranges, decrease gene flow and genetic diversity.
 - Linear corridors may also be used as travel corridors for some species or facilitate the invasion of exotic species into previously inaccessible habitat.
- **Plant invasions** from gas development facilitates (Barlow et al., 2017)
 - Invasive non-native plants are moving further into PA forests around gas facilities.
 - Non-native plants are becoming a dominant part of the plant community around well pads.
- **Biodiversity** in the Marcellus and Utica shales (Kiviat, 2013)
 - Organisms sensitive to biodiversity resulting from forest fragmentation include lichens and bryophytes, orchids, other herbs, the West Virginia white butterfly (*Pieris virginiensis*), amphibians, and birds.
 - Vegetation along pipelines right-of-way are maintained by mowing or spraying herbicide, which the runoff could affect neighboring habitats.

Forest Fragmentation Studies



- Abrahams, Griffin, and Matthews (2012) explored policies aimed at reducing core forest fragmentation from Marcellus shale development in Pennsylvania.
 - This study considered two regulatory measures that could potentially reduce forest fragmentation:
 - Reducing well pad density by increasing the number of wells per pad and horizontal lateral length.
 - Requiring gathering lines to follow the path of pre-existing roadways in forested regions.
 - Concluded that gathering lines to be the largest infrastructure contributor to fragmentation.
 - Recommended two regulated constraints, compulsory pooling and unitization laws and requiring comprehensive drilling plans (CDP), that if successfully implemented could significantly reduce the number of redundant gathering lines.
- Drohan, Brittingham, Bishop, and Yoder's (2011) paper researched shale-gas development in Pennsylvania and the potential to cause substantial landscape disturbance.
 - Used of the Landscape Fragmentation Tool ver. 2.0. This tool classified forested areas into four main categories (patch, edge, perforated, and core). Raster datasets from 2005 and 2011 were used to determine the amount of forest fragmentation occurred during this timeframe.
 - This paper concluded that a regional strategy should be developed to better manage habitat loss, farmland conservation and risk to waterways.

Are Current Pipeline Regulations Contributing to Fragmentation?

- The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) currently use the term “Location Class” to define levels of population density along a pipeline based upon the number of buildings intended for human occupancy within a fixed distance from the pipeline (PHMSA, 2010). The numbers of buildings are categorized per the summary below:
 - Class 1: refers to any location within 220 yards of the pipeline that contains 10 or fewer dwellings.
 - Class 2: refers to any location within 220 yards of the pipeline that contains more than 10 and fewer than 46 dwellings.
 - Class 3: refers to 1) any location within 220 yards of the pipeline that contains 46 or more dwellings, or 2) an area where the pipeline lies within 100 yards of a building or a small, well defined outside area (such as playgrounds, recreational areas, outdoor theater, or places of assembly) that is occupied for a specified number of days per year.
 - Class 4: refers to any location within 220 yards of the pipeline where buildings with four or more stories above ground are prevalent.
- Midstream companies will make efforts ensure pipelines are categorized as Class 1 or Class 2 if possible as there is less federal regulations associated with these location classes. This includes designing and building pipelines through forested areas.
- “Mega Rule”



Project Framework



Objectives & Key Research Questions

- Where are locations that a stacked well pad could be both viable and profitable in Pennsylvania?
- What impact does a stacked well pad have on reducing habitat fragmentation?
- Do current pipeline DOT regulations have a positive or negative effect on forest fragmentation?
- How can GIS be better utilized to ensure a stacked well pad is viable, developed on time, and within budget?

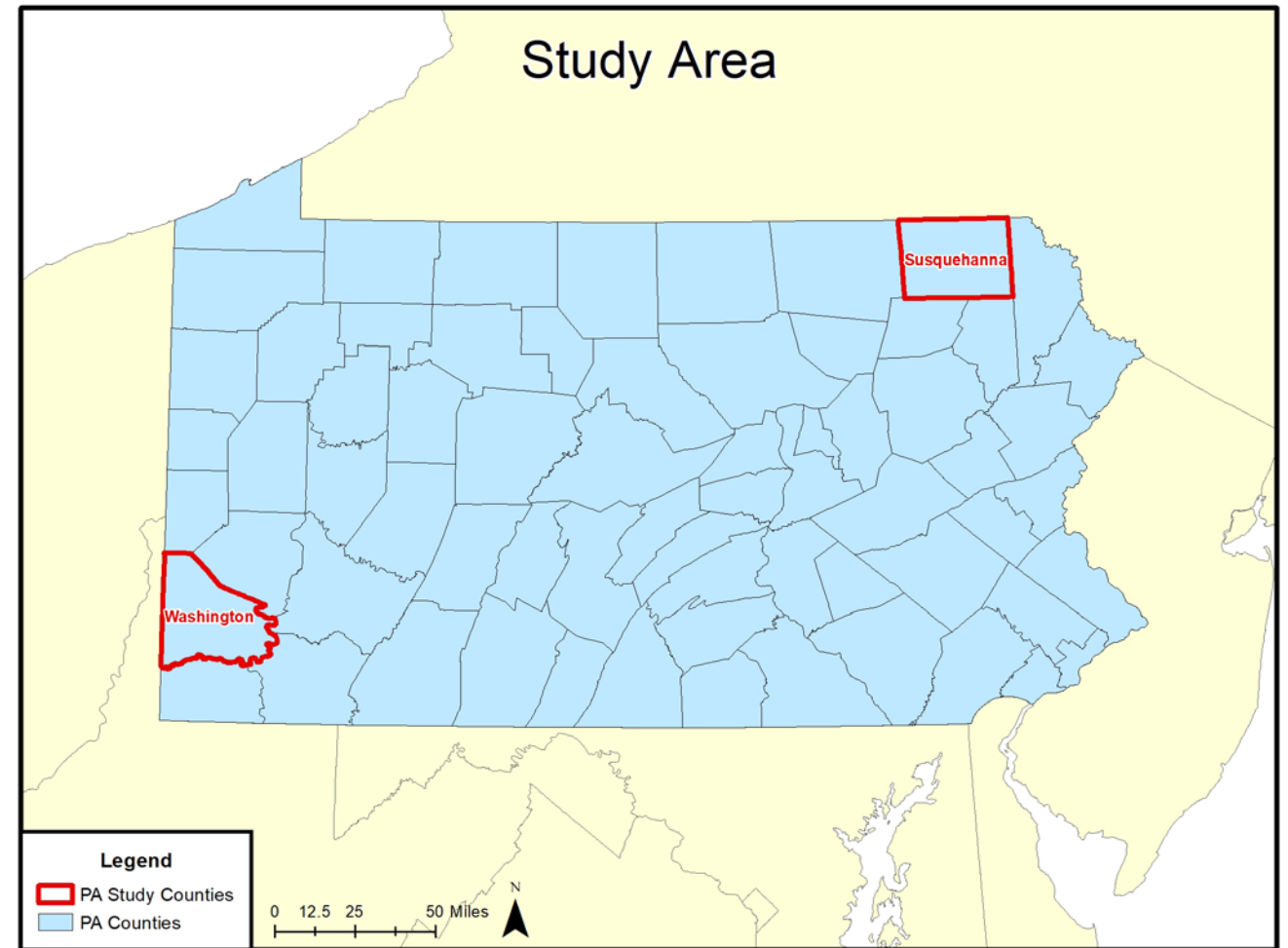
Methodology

- Process 1: Forest Fragmentation Analysis
- Process 2: Well Production Data Analysis
- Process 3: Develop Tool based on Findings



Study Area

- Process 1:
Susquehanna County,
PA
- Process 2 & 3:
Susquehanna and
Washington Counties

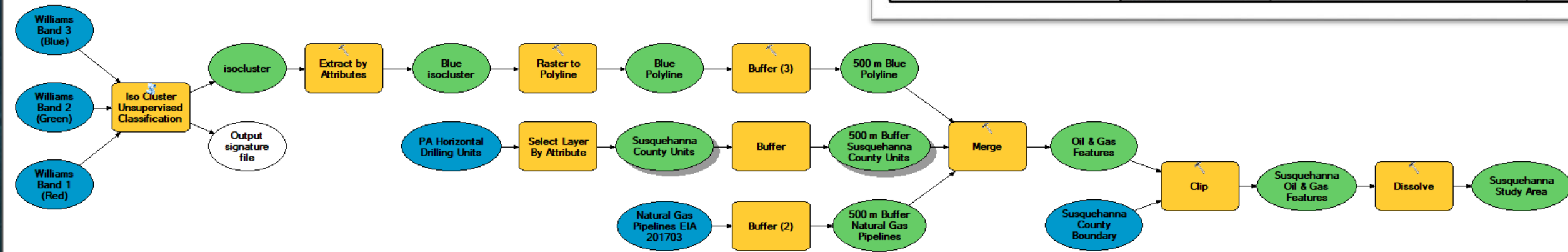
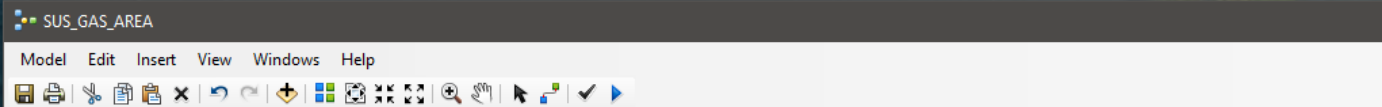
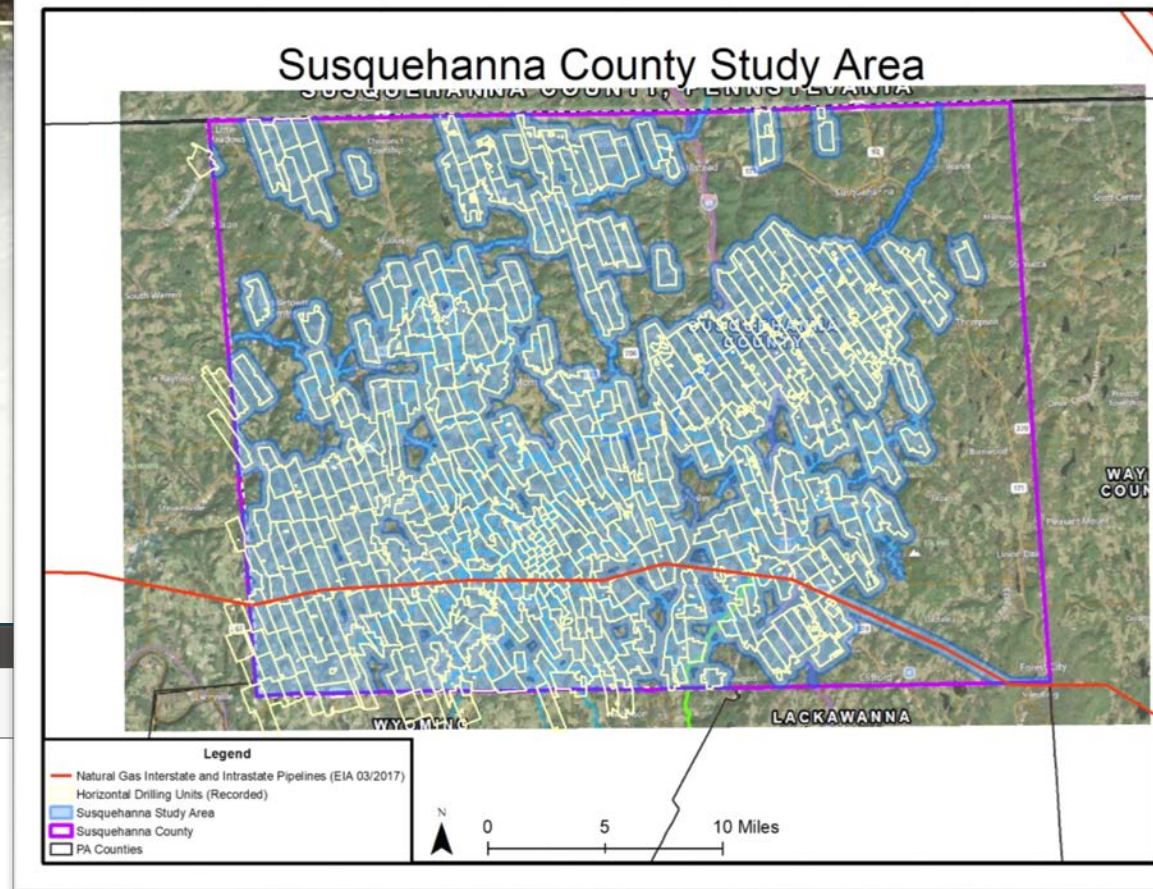


Process 1: Forest Fragmentation Analysis

- Export unconventional well data (.xls) from 2005 and 2013.
- Generate well production feature class from the reported production from the Pennsylvania DEP using FME Desktop (convert .xls to FileGDB).
- Develop a Python script the automate the process of joining and calculating the monthly production (or semi-annual) production data to the well feature class.
- Create a study area by buffering (500 m) around recorded drilling units of producing well pad locations, pipeline datasets using Esri ModelBuilder.
- Create a tool using Python that will:
 1. Reclassify both land cover datasets (0 = not analyzed, 1 = non-forest, 2 = forest) for both the 2005 and 2013 land cover datasets
 2. Categorize the forested areas into four main categories - patch, edge, perforated, and core (but only within areas within the buffer). The University of Connecticut's Landscape Fragmentation Tool (LTF) v 2.0 will be implemented into the Python script in this step.
 3. Calculates the acreages of each category
 4. Spatial statistics will be analyzed from the results
 - A. Forest fragmentation per drilling unit
 - B. Forest fragmentation per well
 - C. Forest loss per Susquehanna County municipality

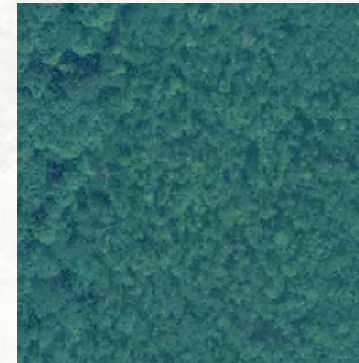


Process 1 Study Area



Landscape Fragmentation Tool (LFT) v 2.0

- Developed by Vogt et al. (2007), this tool classifies a land cover type of interest into 4 main categories - patch, edge, perforated, and core.
- The edge width for this analysis will be 100 meters, which is often used for general purpose analyses (Kiviat, 2013, p. 1-14) .
- The core category is further divided into small core, medium core, and large core based on the area of the core tract.
 - small core patches have an area of less than 250 acres
 - medium core patches have an area between 250 and 500 acres
 - large core patches have an area greater than 500 acres



Core (interior)



Perforated



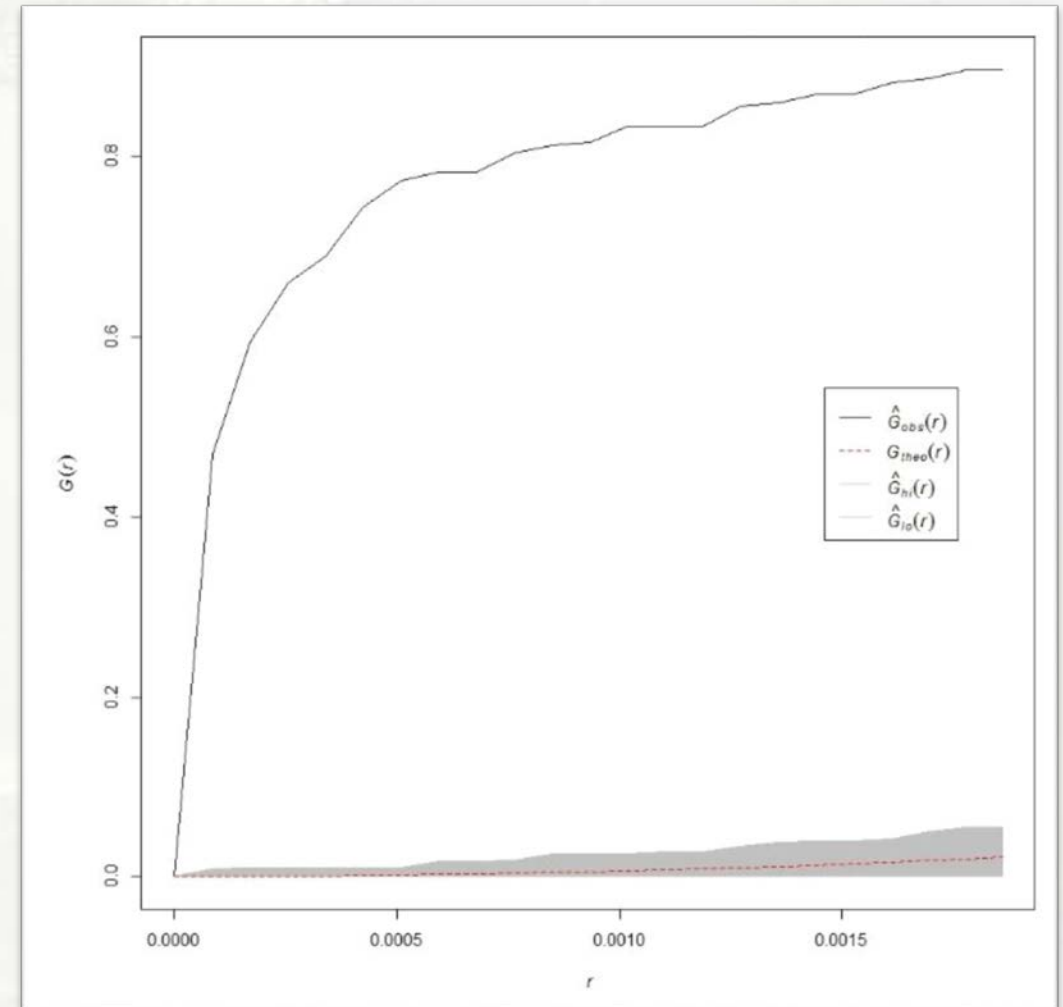
Patch



Edge

Process 2: Well Production Data Analysis

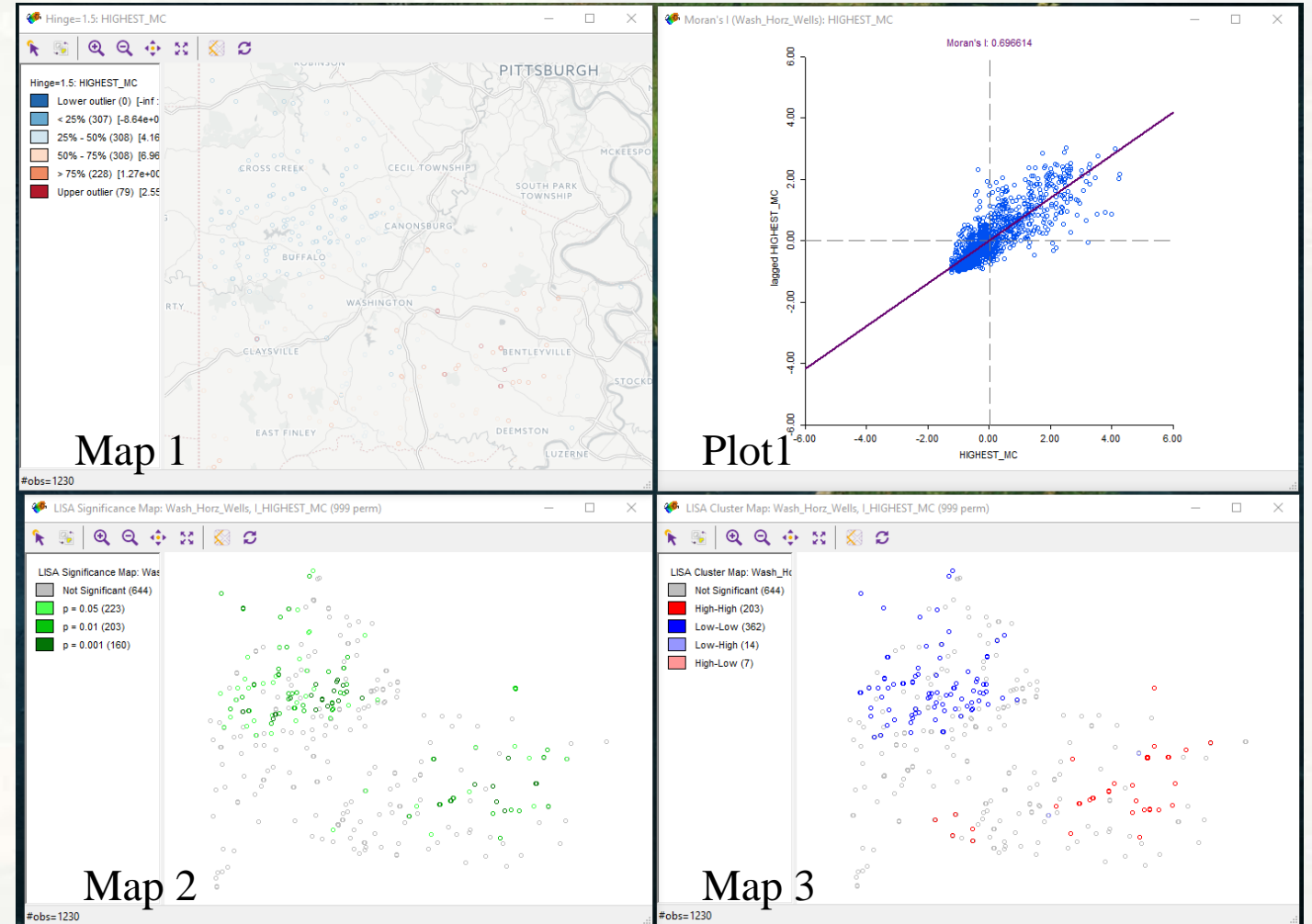
- Understand if there is a correlation between the production rates of wells using PA DEP production records and determine natural gas production and shale formation thickness and depth.
 1. Map shale formation thickness and depth layers
 2. Overlay well feature class (created using FME in process 1)
 3. Perform Monte Carlo Simulations of the G-function() using R to determine if production values are statically significant within shale formation thickness and depths.
- Kernel density analysis using R to understand the areas that were the most productive in the study area based on recorded data.



Process 2: Well Production Data Analysis

- Determine if there are local indicators of spatial association (LISA) using GeoDa (O'Sullivan, 2014, p. 150-151).
- Perform additional LISA analysis to understand:
 - Forest fragmentation per drilling unit
 - Well production per year
 - Well production per shale formation
 - Forest fragmentation by unit per maximum yearly production

Washington County, PA horizontal wells by highest yearly gas production



Process 3: Develop Tool based on Findings

- The tool was designed by identifying system requirements in the needs assessment phase.
- The prototype was initially developed using Balsamiq.
- Scores the viability and profitability of a well pad location.



Process 3: Develop Tool based on Findings

- A sampled 5% of horizontal drilling units will be treated as potential projects.
- A cost associated with topography at the well pad will also be determined. This will be generated by performing a slope analysis using the Digital Elevation Model from the 2006 - 2008 - DCNR PAMAP (Esri, 2017).

The screenshot shows the 'Empower' software interface. A 'Process 3 Tool' dialog box is open, overlaid on a map. The dialog box contains the following controls:

- Well Pad Size**: A dropdown menu.
- Access Road Distance (ft.)**: A text input field.
- Gathering Line Distance (ft.)**: A text input field.
- Henry Hub Spot Price**: A text input field.
- Marcellus**: A checkbox.
- Number of Marcellus Well Laterals**: A dropdown menu.
- Average Marcellus Well Lateral Length (ft.)**: A text input field.
- Percent of Marcellus Acreage Under Lease/Agreement**: A text input field.
- Utica**: A checkbox.
- Number of Utica Well Laterals**: A dropdown menu.
- Average Utica Well Lateral Length (ft.)**: A text input field.
- Percent of Utica Acreage Under Lease/Agreement**: A text input field.
- Burket**: A checkbox.
- Number of Burket Well Laterals**: A dropdown menu.
- Average Burket Well Lateral Length (ft.)**: A text input field.
- Percent of Utica Acreage Under Lease/Agreement**: A text input field.
- OK** and **Cancel**: Buttons at the bottom.

Process 3: Develop Tool based on Findings

- The user will input the following values into the tool
 - Well pad size (normal or “super pad”)
 - Drilling unit acreage
 - Gathering line length
 - Access road Length
 - Henry Hub Spot Price (this will default to \$3.025/mmBTU, but can be changed by the user as necessary)
 - Check if a formation will be explored at this pad site
 - Number a well laterals per shale formation
 - Average lateral length per shale formation
 - Percent of acreage under lease/agreement per formation

Empower

Process 3 Tool

Well Pad Size ▾ Access Road Distance (ft.)

Gathering Line Distance (ft.) Henry Hub Spot Price

Marcellus

Number of Marcellus Well Laterals ▾

Average Marcellus Well Lateral Length (ft.)

Percent of Marcellus Acreage Under Lease/Agreement

Utica

Number of Utica Well Laterals ▾

Average Utica Well Lateral Length (ft.)

Percent of Utica Acreage Under Lease/Agreement

Burket

Number of Burket Well Laterals ▾

Average Burket Well Lateral Length (ft.)

Percent of Utica Acreage Under Lease/Agreement

OK Cancel

Sharing Developed Tools and Datasets

- Datasets will be shared on CONSOL's ArcGIS Online organizational account
- A Web mapping application will be developed to display and share results using Esri Web AppBuilder
- This tool will be shared as a geoprocessing REST Service

The screenshot displays the ArcGIS Online dashboard for CONSOL Energy Inc. The browser address bar shows the URL `maps.arcgis.com/home/index.html`. The dashboard features a navigation menu with options: Home, Gallery, Map, Scene, Groups, Content, and Organization. A search bar is visible with the name "Benjamin J." and a search icon. The main content area is dominated by a large banner for the "EMPOWER" system, which includes a "50 YEARS" anniversary logo and the tagline "Efficiency Made Possible through Online Web Maps & Enterprise Reporting". Below the banner, there is a carousel of four application thumbnails: "CONSOL General Reference Map", "CONSOL General Reference Application", "Virginia Operations Map", and "Virginia Operations App". At the bottom of the dashboard, a text block states: "The EMPOWER system was created to deliver authoritative interactive web maps, analytics, and actionable information to the CONSOL community to facilitate faster and smarter business decisions." Below this text is a link "What is EMPOWER?" and a list of bullet points: "- Interactive Web Maps" and "- CONSOL, and third party operations & assets". A prominent "CLICK HERE FOR HELP" button is located in the bottom right corner.

Expected Outcomes



- Areas where wells producing from multiple shale formations from the same pad will be more productive and result in less forest fragmentation.
- Most forest fragmentation that occurred during the researched time frame resulted from oil & gas activities.
- If gas exploration companies work together (by forming joint owner agreements or trading leasehold so that only one company has full ownership at all depths) a drilling unit will be more efficient and result in less forest fragmentation.
- There may not be a direct link between shale thickness and depth and well productivity.
- Regions, where drilling units were once economically viable, will be less attractive today because of the lower natural gas price.

Project Timeline

July 2017

- Data Collection & Processing
- Generate well dataset using FME/Python
- Needs assessment discussions with end users

August 2017

- Peer Review Presentation on 8/2/17
- Edit & Revise Based on Feedback
- Process 1
- Process 2

September 2017

- Submit Abstract by 9/15/2017
- Process 3
- Finalize analysis and develop Web mapping application in ArcGIS Online

October 2017

- Prepare & Finalize Presentation
- Present at 12th Annual Northwest Pennsylvania GIS Conference at Clarion University of Pennsylvania October 19-20


Challenges

- Data is difficult to source
 - Pipeline data
 - Company access roads to well pads
- Lack of enthusiasm by users to incorporate developed tool into current workflow



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A photograph of a forest path. The path is a dirt road that curves through a dense forest of tall, green trees. In the foreground, there is a utility pole with a yellow top and a white bottom. The ground is covered in dry leaves and grass. The text "Questions?" and "bjo132@psu.edu" is overlaid on the image in a white, serif font with a blue outline.

Questions?
bjo132@psu.edu