Who is Northeast Natural Energy?

- NNE was founded in 2010 by Mike John, Mark Williams, John Adams and Jo Ellen Yeary, they all had previously worked together at Columbia Natural Resources and Triana Energy Prior to forming NNE.
- NNE drilled its first Wells in 2011 at the MIP location just outside of Morgantown.
- NNE has drilled and operates 23 Marcellus Shale wells in West Virginia and Pennsylvania.
- We currently have 9 more wells drilled and waiting on Completion.
- NNE is a Charleston West Virginia based company with decades of Appalachian Basin experience.
Well Planning

- Before we move a blade of grass, there are years of planning that go into each and every well
  1. Geology – a gas or oil bearing formation needs to be identified
  2. Acreage Acquisition – in order to drill a well, oil and gas rights need to be secured, most often done through mineral leasing, assignment of lease interest, or selling of HBP rights
  3. Permitting- WV DEP and PA DEP regulate oil and gas development, and are responsible for issuing most of the necessary permits. There are some permits that require federal agency approval such as US Army Corps of Engineers and US Fish and Wildlife
    - Average WV DEP permit 90-100 days
    - Average PA DEP permit 180-270 days
Site

Construction

- Once all of the necessary permits have been acquired, construction can begin.
- Normal pad size is 200’ x 300’.
- Construction takes 6-8 weeks, depending on season and terrain.
Drilling – (Phase 1) Spudder Rig

- NNE takes a phased approach to drilling to maximize efficiency
- First rig drills the cellar and conductor casing string
Top Hole Drilling
A top hole rig is used to drill the surface casing, which is designed to protect the deepest fresh water bearing zone, and the intermediate casing string, designed to isolate non-target pressurized zones from the well bore. Usually drilled on air with a hammer bit.
Horizontal Drilling
Drilling – (Phase 3) Horizontal Rig

- Larger rig designed to more efficiently add and remove drill pipe to the drill string
- Capable of handling a heavier load, which is needed as we drill to depths of 15,000’ to 18,000’
- Horizontal rig is used to drill from the kick off point (KOP) to the toe of the well, utilizing a synthetic based drilling mud and a PDC drill bit
Directional Drilling-Rotary Steerable

- Smoother wellbores
- Longer laterals
- Eliminates tripping to surface for bit replacement
- Directional tools are closer to the drill bit making geo-steering more accurate
Horizontal vs. Vertical Development

Traditional Vertical Well Spacing: 32 Separate Padsites Needed For 32 Wells.

Idealized Horizontal Well Spacing: 1 Padsite Yields Up To 32 Wells.
Longer Laterals Lessen the Surface Impacts
Casing Program

- **Conductor Casing**
  - 20” Pipe drilled to 40’
  - Provides structural support for the well and wellhead

- **Surface Casing**
  - 13 3/8” Pipe drilled to 50’ below the deepest fresh water bearing zone

- **Intermediate Casing**
  - 9 5/8” Pipe
  - Isolates any non-targeted pressurized formations from the well bore

- **Production Casing**
  - 5 ½” Pipe drilled to Total Measured depth
Hydraulic Fracturing
Hydraulic Fracturing

- Production casing is perforated in stages throughout the horizontal section of the well.
- A combination of water, sand and other additives is pumped at high pressure through the perforations into the target formation to create a fracture network, allowing gas to flow from the formation into the casing and up to the surface.
- This process is completed in stages ranging from 150’ to 500’.
- Each stage is isolated with a bridge plug.
- Stages can be engineered to alter the distance between perforations, amounts of water, and types of sand to optimize production.
Hydraulic Fracturing – Plug and Perf
Hydraulic Fracturing Fluid

Typical Solution Used in Hydraulic Fracturing

**0.49% ADDITIVES**

- Potassium chloride 0.06%
- Guar gum/Hydroxyethyl cellulose 0.056%
- Ethylene glycol 0.043%
- Sodium/Potassium carbonate 0.011%
- Sodium Chloride 0.01%
- Borate salts 0.007%
- Citric acid 0.004%
- N,N-dimethyl formamide 0.002%
- Acid 0.123%
- Glutaraldehyde 0.001%
- Petroleum citrate 0.088%
- Isopropanol 0.085%


**Table: Compound, Purpose, Common Application**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Purpose</th>
<th>Common application</th>
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<tbody>
<tr>
<td>Acids</td>
<td>Helps dissolve minerals and initiate fissure in rock (pre-fracture)</td>
<td>Swimming pool cleaner</td>
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<tr>
<td>Sodium Chloride</td>
<td>Allows a delayed breakdown of the gel polymer chains</td>
<td>Table salt</td>
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<tr>
<td>Polyacrylamide</td>
<td>Minimizes the friction between fluid and pipe</td>
<td>Water treatment, soil conditioner</td>
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<tr>
<td>Ethylene Glycol</td>
<td>Prevents scale deposits in the pipe</td>
<td>Automotive anti-freeze, deicing agent, household cleaners</td>
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<tr>
<td>Borate Salts</td>
<td>Maintains fluid viscosity as temperature increases</td>
<td>Laundry detergent, hand soap, cosmetics</td>
</tr>
<tr>
<td>Sodium/Potassium Carbonate</td>
<td>Maintains effectiveness of other components, such as crosslinkers</td>
<td>Washing soda, detergent, soap, water softener, glass, ceramics</td>
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<tr>
<td>Glutaraldehyde</td>
<td>Eliminates bacteria in the water</td>
<td>Disinfectant, sterilization of medical and dental equipment</td>
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<tr>
<td>Guar Gum</td>
<td>Thickens the water to suspend the sand</td>
<td>Thicker in cosmetics, baked goods, ice cream, toothpaste, sauces</td>
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<tr>
<td>Citric Acid</td>
<td>Prevents precipitation of metal oxides</td>
<td>Food additive, food and beverages; lemon juice</td>
</tr>
<tr>
<td>Isopropanol</td>
<td>Used to increase the viscosity of the fracture fluid</td>
<td>Glass cleaner, antiperspirant, hair coloring</td>
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Drill Out

- Bridge plugs are drilled out using a service rig or coil tubing unit, allowing water and gas to flow back to surface.
Flow Back

- Flow back equipment is designed to handle large volumes of water and gas at high pressure while the well is conditioned to start production.
The production phase is longest phase and is expected to continue for decades.
Hydraulic Fracturing – Microseismic
Questions?