



SURFACE ISSUES: WELL PAD AND FACILITIES CONSTRUCTION, ENVIRONMENTAL ISSUES

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Audience and Date
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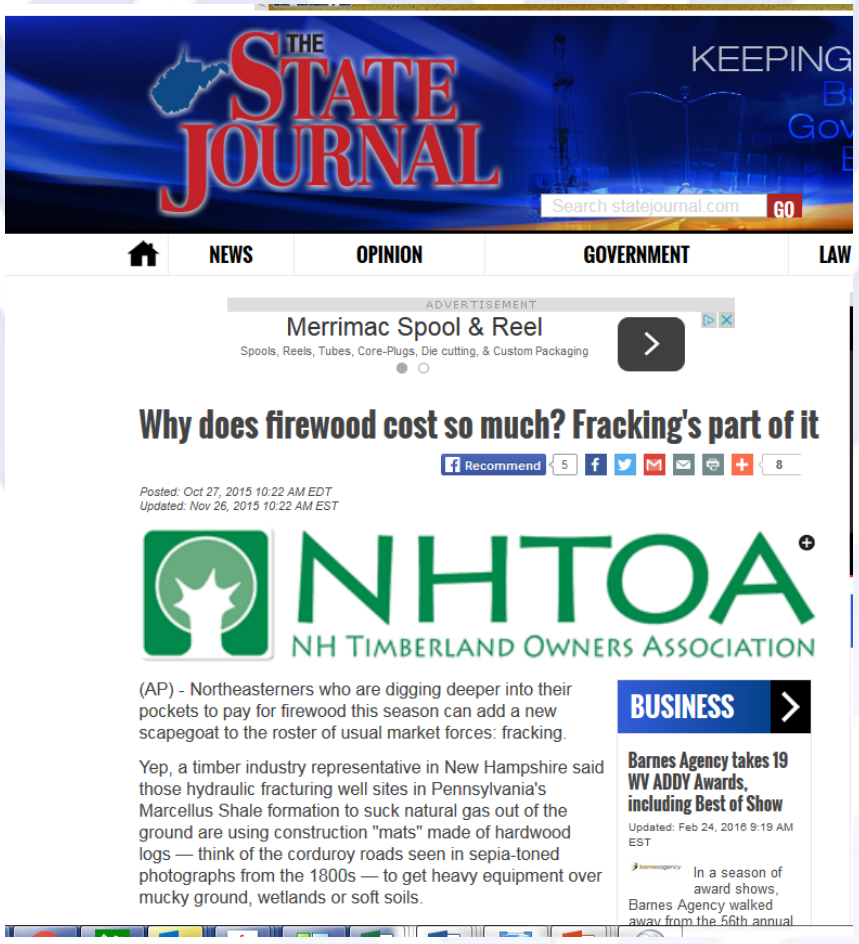
Overview of Siting in WV

- Public opinion – nontechnical risk
- Terrain/Environment
- Regulatory
  - Wetlands
  - Streams
  - Endangered Species
- Ownership

Nontechnical risk

- Greater than risk associated with drilling and completion
- Must be cognizant of risk before siting
- Best companies understand concerns and work with local communities



Terrain

- Narrow ridges
- Steep slopes
- Soil prone to slipping
- Surface water
- Coal development

Regulatory

- Wetlands – must limit encroachment
- Can not impound streams, discharge into streams, fill or discharge into wetlands
- Jurisdiction of WV DEP and Federal EPA
- Must also follow erosion and sediment control regulations

The West Virginia-based Marcellus Shale pure-play company admitted that it dumped pollutants into waterways in Marshall County. It agreed to a plea agreement calling for a $600,000 fine, at $200,000 for each conviction, according to the U.S. Attorney's Office for the Northern District of West Virginia, which issued a press release after the deal was reached.

For Drilling Fluid Migration, Other Violations

Pennsylvania DEP Again Fines Sunoco For Mariner East Violations

Those penalties, and the $3 million in fines issued earlier this month, come on top of what federal regulators said will likely cost more than $13 million to complete restoration and mitigation work required under a consent order the company reached with the U.S. Environmental Protection Agency (EPA), the U.S. Department of Justice and the West Virginia Department of Environmental Protection (see *Shale Daily*, Sept. 3).

Regulatory - spacing

- 30.5 meters to stream, natural or artificial lake, or wetland
- 91.4 meters to trout stream
- 304.8 meters from public water intake/supply
- 76.2 meters from water well
- 190.5 meters from pad to occupied dwelling or agricultural building

Endangered Species – Indiana Bat

- One factor of decline – loss of summer roosting
- Regulations on clearing
  - April through Nov
  - Nov through Mar
- Different regulations for each

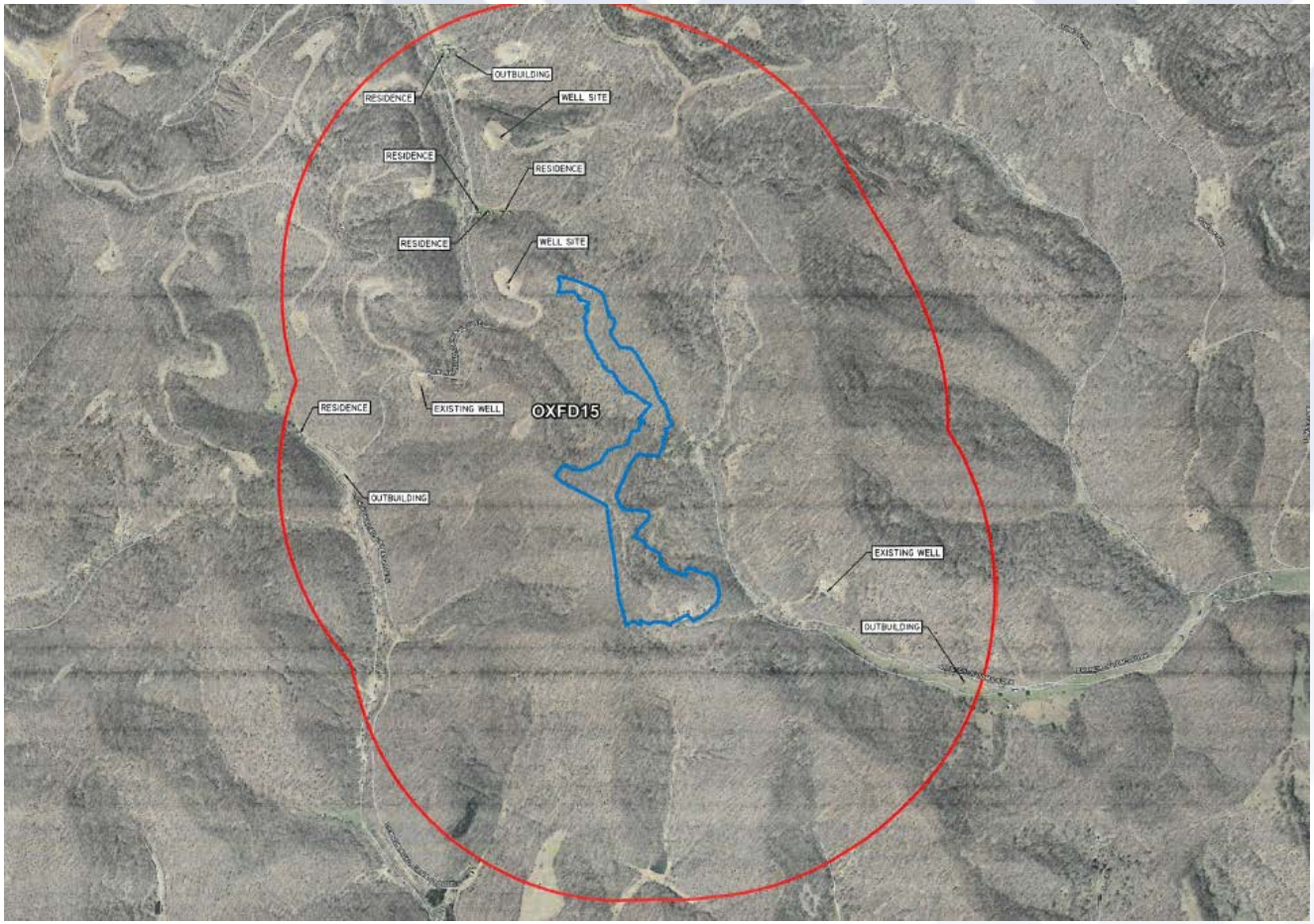
Indiana Bat

- Summer clearing
  - Hire environmental firm
  - Develop/conduct mist net plan
  - Report to USFWS
  - If you catch bat – must use transmitter to determine if roosting location near
  - 2.5 mile buffer around if roost tree found, 5 mile if no roost tree found
  - No removal of trees in buffer during summer
- Winter clearing
  - Consult with USFWS
  - Locate any roosting trees
  - Submit report
  - Clear trees
  - Create artificial habitat

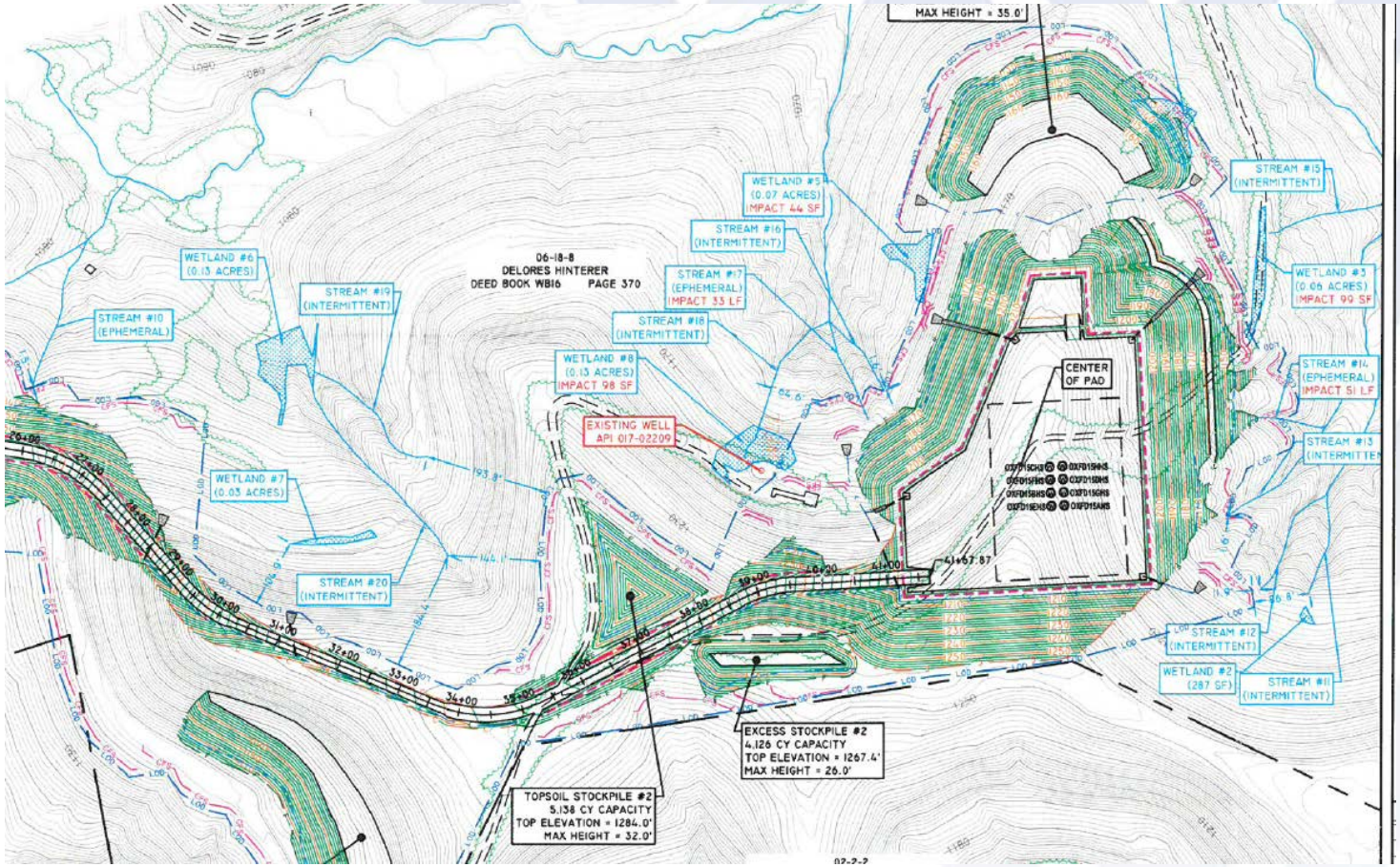
Other Regulatory

- Cultural Sites
- Coal
- Utilities
- Floodplain
- Trout stream
- Warm water stream
- Historic sites
- WVDEP 401 permit

Example Site Location



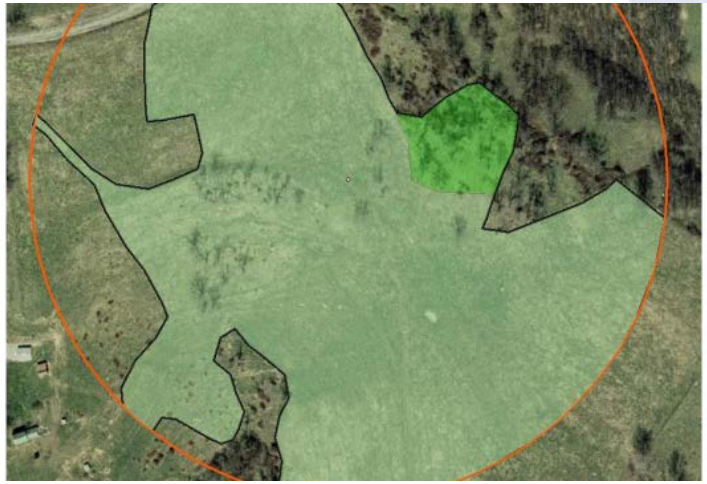
11 streams, 6 wetlands



Landscape changes

- Analyzed >400 unconventional wells drilled between 2009-2012
- At each site – buffered well location by 15ha
- Within 15ha buffer, quantified total disturbed area
- Also quantified pad, water impound, road, and pipeline

Comparison – pre/post imagery



Comparison – Pre/Post imagery

Results II & III - Landscape changes

- Total of 421 unconventional wells were analyzed
- On average total disturbed area was 3.5 ha (8.8 acres)

Results – Overall disturbance

Statistic	Disturbance (acres)	Disturbance (hectares)	Percent Forest
Avg.	8.8	3.6	43%
Min	1.2	0.49	0%
Max	25.2	10.2	100%
StDev	4.1	1.7	37.7%

- Higher than PA (Drohan et al. 2012) in size(2.7 hectares)
- Less forest disturbance than in PA (54% as opposed to 43% in this study)

Results – Pads, Pipelines, water, Roads

Statistic	Well Pad	Pipeline	Pond	Road
Avg.	0.93	0.49	0.38	0.24
Min	0.05	0.05	0.02	0.02
Max	4.90	1.86	2.11	0.97
StDev	0.49	0.36	0.28	0.16

Resource Removals

County	Total Private Acres	Total Forest Acres	Total Acres	Percent Forest	Board Feet /Acre	Total Tons/Acre
Marshall	179,399	179,399	195,475	92%	7071	53.3
Doddridge	175,638	175,638	204,620	86%	9666	75.8
Wetzel	187,716	199,528	229,158	87%	6991	60.7
Harrison	158,303	164,387	266,246	62%	6801	64.6
AVERAGE	***175,264***	***179,738***	***223,875***	***82%***	***7632***	***64***

Total removals : 2421 total forested acres impacted: >150,000 tons of biomass
$7.2 million in stumpage

Total removals : 979 total forested hectares impacted: >130,000 metric tons of biomass
$7.2 million in stumpage

Disturbance by well type (Ha)

Well Type	Average Disturbance	Min Disturbance	Max Disturbance
Conventional	1.0	0.04	4.0
Unconventional	3.6	0.5	10.2

Conventional Versus Unconventional

Well Type	MMCF/ month	MMCF/ Acre	MMCF/m/ Acre
C	896.9	12,055	0.8
UC	64,456	226,259	31.8
Change		↑18x	↑36x

Conclusions

- Many requirement must be met before D&C
- Shale related development increased substantially in WV over past 5 years
- Disturbs on average 3.6 ha per well PAD
- Individually, unconventional wells disturb more surface, however multiple wells on single pads decreases surface acreage required

Heading

- Bullets
  - State of West Virginia

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