Fracking: Implications and Impacts on Illinois Highways

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Engineer of Materials and Physical Research
Illinois Department of Transportation

• Overview of fracking and horizontal drilling
Why the Black Gold Rush?

- Science of detecting oil bearing formations have greatly improved
- Combination of Horizontal Drilling (first in 1929) and Fracking (60+ year old technology)
- Techniques and economical production equipment (down hole and surface) fully developed in past 10+/- years
- Successful recoveries spur more use
Proppants

• Sands
  – Quartz
  – Silica
• Ceramics

• Needed properties
  – 4K to 8K crushing strength
  – Round to allow fluids/gasses to move around material
  – Specific sizes
Fracking: Implications and Impacts on Illinois Highways

- Overview of fracking and horizontal drilling
- Illinois Oil and Gas resources

Where is the oil and gas in Illinois?

- >90,000 historic producing wells in Illinois (green shapes, includes gas storage fields.)
- Over 3.4 Billion barrels produced in IL, IN, KY. Majority of production from Illinois.
- 2006, ISGS estimated 14.1 Billion Barrels total Illinois Basin Oil
- Fracs here for past 60 years.
- Recent Leasing Estimate: Over 250,000 acres have been leased, at a cost of $30 Million, before drilling a single new well.
Paleozoic rocks produce in ILL. Upper Left are youngest rocks. Columns, looking left to right show older strata—you drill through glacial deposits and potentially all these formations to get to crystalline basement (Precambrian.)

**NEW ALBANY** is source for about 95% of Illinois oil and gas. Dots indicate oil productive rocks.

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**STRATIGRAPHIC COLUMN, ILLINOIS OIL PAY ZONES**

Youngest 280 m yr

Oldest > 525 m yr

Glacial drift: thin blanket sediments from glaciers, covers most of the state.
Bedrock layers below dip down to the south, into the “basin.”
New Albany, our primary hydrocarbon source rock, is not interpreted to be matured into the oil window north of the **green arrow**. We do not think oil shale exploration will occur north of there.

**South**

**North**

**Starved Rock Suburbs**

However, not all horizontal drilling & fracking will be in the shale. It might be considered in any oil or gas field in the state.

Shaded area generally defines “oil shale play” boundaries. Better areas are inside orange contour, where shale is more mature, or “intense oil generation” is interpreted to occur. OIL is the target.

Red stars = gas wells, mainly shallow biogenically-altered shale; mostly in Indiana. Map modified from GRI 2000.

Producing oil from shale probably will require HZ wells and high volume hydraulic fracturing. It is a SPECULATIVE or UNCERTAIN “play” or model at this time.

Many people think the hunt is on for SHALE GAS in our New Albany Shale. Shale gas has received a lot of publicity lately in other areas. Research suggests that in the Illinois Basin, the main source rock is generally not matured enough to produce thermogenic gas (except in small area in purple in SE IL).

Red stars = gas wells, mainly shallow biogenically-altered shale; mostly in Indiana. Map modified from GRI 2000.
Horizontal Oil & Gas Wells in Illinois, December, 2012. It’s not all about shale!

Count: 141 HZ wells, 12/2012.
Main pay zones:
19 Cypress
18 St. Louis
16 Trenton
15 Ullin-Warsaw
14 Devonian
11 Waltersburg
10 Ste. Genevieve
Single digits for all other pays.
Most horizontal production is from traditional sandstone or carbonate Reservoirs. Only 1 or 2 produce in shale.

Colors indicate producing or “pay” zones. Many horizontal wells do not use hydraulic fracturing method to stimulate production.

Imagine an oil reservoir: Stratigraphic Trap. Sandstone bar in an ancient river system, pinches out to shale.

Imagine a vertical well here. It might have 10 feet of “pay,” (usually oil & water mix, ) then brine zone below. Now imagine a horizontal well. It could go hundreds of feet laterally within that “payzone,” and produce a lot more oil or gas and water. Horizontal wells may “reach” hundreds to thousands of feet into the formation. Here: Reservoir boundaries: sand bar pinching out to shale on right.
What goes in to frac water? A “cocktail,” or mix.

Slickwater Hydraulic Fracturing Fluids
(example from a nine-stage treatment of a Fayetteville Shale (Arkansas) horizontal well.)

Make-up varies with each area and company. A number of compounds with similar function are available. Service companies proprietary formulations.

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• Pavement damage from trucks
Why Is Oil Field Traffic a Concern?

- Amount of goods movement needed in states such as North Dakota has been phenomenal.
- Limited roadway infrastructure - so when new fields are developed very large increase in traffic on system not built to withstand large numbers of heavy trucks.
- Could same be true in Illinois?

18K Equivalent Single Axle Load (ESAL)

- Common Unit for pavement Damage
- Take mixed weight axles and convert to equivalent 18K axles

\[
\begin{align*}
18 \text{ K} &= 1.0 \text{ ESAL} \\
12 \text{ K} &= 0.19 \text{ ESAL} \\
24 \text{ K} &= 3.03 \text{ ESAL}
\end{align*}
\]

For Flexible Pavement:
Follows approximately the 4th power rule…

\[
\begin{align*}
(12/18)^{4.0} &= 0.20 \text{ ESAL} \\
(24/18)^{4.0} &= 3.16 \text{ ESAL}
\end{align*}
\]

Fully loaded Semi on Flex Pavement = 2.37 ESAL
## Road Sections

<table>
<thead>
<tr>
<th>Facility</th>
<th>Interstate</th>
<th>Primary</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross Section</td>
<td>![3.5&quot; HMA Overlay 8&quot; CR Concrete 4&quot; Stabilized Base]</td>
<td>![2.5&quot; HMA Overlay 9-6-9 Concrete]</td>
<td>![2.3&quot; Built up Seal Coats or HMA 8-10&quot; Aggregate Base]</td>
</tr>
<tr>
<td>Material</td>
<td>3.5&quot; HMA Overlay 8&quot; CR Concrete 4&quot; Stabilized Base</td>
<td>2.5&quot; HMA Overlay 9-6-9 Concrete</td>
<td>2.3&quot; Built up Seal Coats or HMA 8-10&quot; Aggregate Base</td>
</tr>
<tr>
<td>Design ESAL</td>
<td>35,000,000</td>
<td>6,000,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Pavement Cost/ESAL Mile</td>
<td>$0.086</td>
<td>$0.206</td>
<td>$1.021</td>
</tr>
<tr>
<td>$/Semi-Mile</td>
<td>$0.20</td>
<td>$0.49</td>
<td>$2.42</td>
</tr>
</tbody>
</table>

## Fracking: Implications and Impacts on Illinois Highways

- **Overview of fracking and horizontal drilling**
- **Illinois Oil and Gas resources**
- **Pavement damage from trucks**
- **Estimated traffic generation from drilling**
Estimated Illinois Well and Frack

- To well head
  - 1 Acre Aggregate Pad 8"
    - 2,940 tons - 82 loaded trucks
  - 1,000,000 Gal water
    - 4,165 tons - 175 loaded trucks
  - Sand
    - 500 tons - 21 loaded trucks
  - Equipment
    - 20 legal + 20 permit = 40 loaded trucks
  - Other (Casing, pipe, fuel, etc)
    - 50 legal
- From well head
  - Empty trucks and fully loaded trucks with “Back flow” fluids
- ESAL to well head = 872

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- Pavement damage from trucks
- Estimated traffic generation from drilling
- Estimated traffic from production
- Compare with other users
Oil Production Traffic

<table>
<thead>
<tr>
<th>Well Production Barrels/Day</th>
<th>Trucks/yr 80K Semis</th>
<th>10 year Truck Count</th>
<th>ESAL's over 10 yr Period (Flex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>14</td>
<td>140</td>
<td>332</td>
</tr>
<tr>
<td>50</td>
<td>140</td>
<td>1,400</td>
<td>3,320</td>
</tr>
<tr>
<td>150</td>
<td>405</td>
<td>4,050</td>
<td>9,600</td>
</tr>
</tbody>
</table>

Frack Traffic

<table>
<thead>
<tr>
<th>Trucks/Well 80K Semis</th>
<th>Time Period Weeks</th>
<th>ESAL's</th>
</tr>
</thead>
<tbody>
<tr>
<td>368</td>
<td>2</td>
<td>872</td>
</tr>
</tbody>
</table>

Grain Harvest Traffic

<table>
<thead>
<tr>
<th>Acreage</th>
<th>Trucks 80K Semis</th>
<th>Harvest Period Weeks</th>
<th>ESAL's</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>105</td>
<td>8</td>
<td>249</td>
</tr>
</tbody>
</table>

Hauling Rate ESAL/Wk

[Graph showing ESAL/wk for different activities]
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• Estimated traffic generation from drilling
• Estimated traffic from production
• Compare with other users
• DNR Rule making

DNR Rule Making

• DNR – Home Page: http://www.dnr.illinois.gov/Pages/default.aspx

• DNR Proposed Fracturing Regulation:
Rule Making Provisions

Article 245.210

15) Traffic Management Plan

A traffic management plan that is developed by the applicant, preferably in coordination with the impacted highway authorities (county, township, road district system, and municipal street system) to identify the anticipated roads, streets, and highways that will be used (Section 1-35(b)(15) of the Act) to facilitate the well site construction, drilling operations, high volume horizontal hydraulic fracturing operations, production, and continued operations of the well site. The traffic management plan shall include the following:

A) a scaled map of the proposed routes the applicant intends to use to construct the well site, perform high volume horizontal hydraulic fracturing operations, production and continued operations, for at least a 10 mile radius around the well site, identifying all the different highway jurisdictions;
B) anticipated well site construction and drilling operations start and end dates, high volume hydraulic fracturing operations start and end dates, and other high traffic operations start and end dates;
C) contact information for the applicant’s representative with knowledge of the traffic management plan; and
D) contact information for a representative of each impacted highway authority;
UPCOMING HEARINGS

Tuesday, December 17, 2013
6:30pm-8:30pm (Doors open at 5:30pm)
Decatur Civic Center, Auditorium
#1 Gary K. Anderson Plaza
Decatur, IL 62523

Thursday, December 19, 2013
6:00pm-8:00pm (Doors open at 5:00pm)
Southern Illinois University at Carbondale (SIUC)
Student Center, Ballroom B
1255 Lincoln Drive
Carbondale, IL 62901

DNR Rulemaking

• Input via public hearings
• Written comments by mail received through Friday, January 3, 2014, at the DNR Headquarters in Springfield, or through an online submittal form.
Conclusions

• From Indiana experience – Frack volumes likely under 1M gallons
• If Limited activities – Likely only local roads will have issues in isolated areas
  – Roadways able to support infrequent heavy trucks and harvest traffic may not hold up well to “hauling” to well heads over short periods
• If Wide spread success and Fracks routinely reach over 1M gallons
  – Issues for Township, County and State Roads
• Hearing and Comment Period Open

Resources

Designing for Heavily Loaded Vehicles

Temporary Load Limits on Local Roads
Thanks
Joan Crockett, Geologist
Coal and Petroleum Section
Illinois State Geological Survey

Herschel McDivitt, Director
Division of Oil and Gas
Indiana Department of Natural Resources

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Questions?