Energy Impacted Roads: How to preserve and protect your road system

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Wind/Oil
Coal
Natural gas

- Drill Rig
- Drilling Mud Lagoon
- Fracking Water and Flowback Lagoon
- Pumps and Power
Gas well heads
One thing in common: hauling equipment in and out

Ed Wade
Pa. gas well blows out; drilling fluid spews 75 feet

DEP vows complete investigation of site

By Marc Levy and Jennifer C. Yates
The Associated Press

PENFIELD, Pa. — An out-of-control natural gas well in a remote area of Pennsylvania shot explosive...
The Marcellus Shale

- Largest basin in United States
  - 95,000 square miles
  - Depth of 4,000 feet to 8,500 feet
  - Thickness from 50’ to 200’
  - 1,500 tcf gas in-place
  - 262 tcf gas recoverable
  - Potential commercial value at least $1 trillion
Question

- In 2008
  - New York State
  - ~8,000,000 housing units

- How long could we heat all New York State housing with the recoverable gas from the Marcellus Shale?

http://quickfacts.census.gov
- 25 years
- 140 years
- 300 years
Gas well pads in Oklahoma

Those white "spots" are not houses, they're gas wells
Development of energy resources is not going to go away, so what are the problems and how do we deal with them?
Topics

- What causes road failure?
- Seasonality of road strength
- High volumes of traffic versus heavy loads – which is worse?
- Design by experience
- Evaluating your roads
- The legal basis for protecting roads
- What can you do to protect your roads?
What causes road failure?

- Heavy loads
- Lots of traffic
- Seasonally weak materials
- Poor drainage
- Passage of time – cumulative damage
Heavy loads bend the roads

Heavy loads cause big deflections
Weak roads are susceptible to rutting and cracking, especially during spring thaw.
The paper clip analogy

UP - DOWN

Bend it repeatedly and it breaks
Bend the clips through an angle until they break – plot the results

Start with a dozen clips

Big ones are better

45°

90°

135°
Fatigue damage

![Graph showing the relationship between Repetitions to Failure and Deflection Angle. The graph indicates a downward trend as the Repetitions to Failure increase, suggesting increased fatigue damage.](image-url)
Cumulative damage

Let's bend a paper clip 16 times at 90° and 12 times at 45° -- will it break?
Cumulative damage

One clip, 80% damage – it probably wouldn't break.
Seasonality of road strength
Seasonality

- Roads are very strong when they are frozen
- Roads are weakest during spring thaw
  - Good quality materials retain their strength
- Roads gradually gain strength during late spring, summer and fall

The damage per pass of the same truck at different times of the year is not the same.
Driller keeps road open
Got dust?
Which is worse – a high volume of truck traffic or heavy loads?

- The answer is **both**
- Heavy loads make big deflections
- High traffic volumes add lots of load repetitions
- Both consume fatigue life faster
Good quality materials that are the proper thickness can stand up to heavy truck traffic through all seasons.

Main roads will not be adversely affected by gas drilling traffic.
Effect of gas well drilling

- Not much effect on the durability of adequately thick roads built with good materials
  - State highways
  - Most county roads
  - Many city/village streets
  - Some town highways
Potential for problems

Roads like this could be badly damaged by heavy trucks.
Effect of gas well drilling

900-1300 truck loads per well site*

- Could do significant damage on weak roads that do not last very long – especially during spring thaw
- These roads are typically designed by experience

*NYSDEC, Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program, September 2009
Design by experience

- Road thickness determined by "what works"
  - Traffic volume assumed to remain constant
  - Vehicle weights not known
  - Local materials used
  - Climate only considered empirically
- These roads may be adversely affected by a change in truck traffic volume
Engineered pavements

- Required layer thicknesses (base and surface) can be designed to last a certain period of time
- Based on predicted traffic (volume and loads), quality of materials, and known environmental parameters
- This is normally how main roads are engineered
Road performance

Condition

Very good
Good
Fair
Poor
Very poor

Time, years

New road

Minor pavement distress
Major pavement distress

Reconstruct
Road user cost

- It costs more per mile to drive on a road that is in poor condition versus one that is in good condition.
- Road user costs are 90% of the total cost of roads.
  - The other 10% is the cost of building and maintaining the road.
  - Ultimately all costs are paid by the public.
Road user cost

Condition

Very good
Good
Fair
Poor
Very poor

Base cost

Excess cost

Road user cost

Cents/vehicle-mile
Road user cost

Roads in poor condition cost nearly twice as much per mile to drive on than those in good condition.
Pavement evaluation

- Assess the functional condition
  - Quantify distresses
  - Can be done with municipal forces
- Assess the structural condition
  - Measure the response to dynamic load
  - Predict remaining life
  - Calculate the required strengthening
  - Requires engineering expertise
Assessing layer thickness and materials quality
Structural evaluation
Structural evaluation
## Effect of truck traffic on life of pavement

<table>
<thead>
<tr>
<th>Layer</th>
<th>County</th>
<th>Town</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>3”</td>
<td>2”</td>
</tr>
<tr>
<td>Base</td>
<td>6”</td>
<td>12”</td>
</tr>
<tr>
<td>Subbase</td>
<td>12”</td>
<td></td>
</tr>
<tr>
<td>Subgrade</td>
<td>∞</td>
<td>∞</td>
</tr>
</tbody>
</table>

1,000 extra trucks over 1 year
# Effect of truck traffic on life of pavement

<table>
<thead>
<tr>
<th></th>
<th>County (1,000 vehicles per day)</th>
<th>Town (200 vehicles per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Life (ESALs)</td>
<td>30 years (1,182,000)</td>
<td>13 years (92,000)</td>
</tr>
<tr>
<td>Life lost due to 1,000 trucks</td>
<td>0.13%</td>
<td>2%</td>
</tr>
</tbody>
</table>

This assumes good materials used in both roads. Poor materials, poorer results.
Preserve and protect your roads

1. Use load zoning
   - Keeps heavy truck traffic off your most vulnerable roads
   - Should be based on structural evaluation
     - Road strength varies seasonally
   - Has to be enforced

2. Designate truck routes
   - Strong, well-built roads will not be adversely affected by the additional well drilling traffic
Vehicle & Traffic Law §385

- Sets statewide maximum dimensions and gross vehicle weights (GVW) for all trucks
  - It is reasonable to assume that all mobile gas drilling equipment will adhere to the limits
- Limits may be superseded locally
  - Procedures are not uniform for counties, towns, cities, and villages.
Legal basis for access permits

- Highway Law §136: authorizes County Highway Superintendent to issue access permits allowing work in right-of-way to construct various types of improvements (including pipelines); also authorizes permits to allow driveway/access road entrances from private property.

- Town Law §130: authorizes Town Board to establish permit system similar to above.
Legal basis for access permits

- Municipal Home Rule Law §10: allows towns, villages and cities power to adopt local laws relating to "the management and use of its highways, roads, streets and property." The governing board could establish an access permit system by local law similar to Highway Law §136.
Legal basis for load limits

- Vehicle & Traffic (V&T) Law §1650(4, 4a): authorizes County Highway Supt. to exclude vehicles not less than 4 tons GVW from any portion of a county highway when such highway would be materially injured; allows issuance of exemption permits that may designate the route to be traversed and may set limits on the hours of operation of such vehicles.
Legal basis for load limits

- V&T Law §1640(a)(5, 10, 20): authorizes City Councils and Village Boards by local law, ordinance, etc., to set weight limits, designate truck routes, and set hours of operation of such vehicles.

- V&T Law §1660(a)(10, 11, 17, 28): authorizes Town Boards by local law, ordinance, etc., to set weight limits, designate truck routes, and set hours of operation of such vehicles.
What can you do?

- Evaluate your roads
- Identify the strong and weak portions of your road system
- Establish reasonable load limits for the roads that would be materially injured by a substantial increase in truck traffic
- Identify acceptable truck routes that utilize the strong portion of your road system
  - If necessary, strengthen some roads
Expect problems

West Virginia: No one was hurt
Consider sight distance and road width

Note the sharp curve coming up
Drilling equipment truck

What if the school bus and the truck had to pass?
Will a chip seal suffice?
Questions are welcome