Project Title: Modeling Emissions and Environmental Impacts of Transportation Activities Associated with High Volume Horizontal Hydraulic Fracturing Operations in the Marcellus Shale Formation

Principal Investigator: Dr. Karl Korfmacher, Rochester Institute of Technology

Prior research using the GIFT model generated annual emission totals and truck count estimates for routes and road segments associated with the transport of materials and wastes from natural gas wells in the Marcellus Shale region. Road segments with the highest estimated truck counts (> 25,000) were identified and used to select 72 regions, representing the boundaries of 72 USGS quadsheets, for further analysis using the emission dispersion model AERMOD. Four sets of simulations were generated for the year 2011, utilizing GIFT and PADOT road networks, modelling 2008 USEPA Average In-use Heavy Duty Diesel Engine emission rates and more stringent Model Year 2007 Heavy Duty Diesel Engine emission rates for PM_{10}. The project developed a detailed methodology for transferring shapefiles and associated emission attribute data into AERMOD compatible source files (excel format).

Results indicate that the maximum average daily truck induced emission concentrations for PM_{10} are 2.845 $\mu g/m^3$ for the PADOT roads and 0.082 $\mu g/m^3$ for the GIFT roads, the differences primarily due to overall truck counts. Subtracting the output files from the 2007 rate simulations from the 2008 rate simulations, if MY 2007 emission standards had been in place, pollution concentrations would have been reduced anywhere from 0.0625 - 0.00002 $\mu g/m^3$ in the GIFT network analysis, and PADOT network reductions would have ranged from 2.1917 – 0.1165 $\mu g/m^3$. Overall, however, model results suggest truck emissions are a small part of the average daily PM pollution, as determined by limited PADEP monitoring station data. In 2011, the average daily PM_{10} emission concentrations ranged from 7.37 to 25.12 $\mu g/m^3$, and 5.97 to 14.50 $\mu g/m^3$ for $PM_{2.5}$.

In the PADOT analysis, the highest emissions were seen around the major cities of Pittsburgh and Scranton and along major transportation corridors, corresponding with the high volume of truck traffic along these corridors from both internal and out of state transportation. In the GIFT analysis, focusing on trucks supporting HVHF activities, the highest rates correspond to not only major roads, but smaller towns such as Williamsport that act as transport hubs and rural road segments situated around high concentrations of wells. Hotspots emerging from the two databases are useful in identifying differences in the two networks, such as small unmonitored rural roads with high truck counts, and comparative impacts, such as areas where much of the truck traffic is related to natural gas extraction activities.

Results are considered to underestimate the true emission concentrations, however, due to temporal limitations of the truck count and total PM_{10} emissions (both are annual values distributed evenly throughout the year as a model requirement). Despite lower than expected concentrations, model results do highlight areas within the Marcellus Shale region that are predicted to have higher relative emission concentrations as a result of increased HVHF truck traffic. These show where roads with higher truck counts may be impacting environmental and human health and may be used to help site monitoring stations. Using the AERMOD emission contour intervals to select 2010 US Census block data, model results suggest that over 1.2 million people are exposed at some level to elevated PM pollution due to trucks supporting HVHF activities, although the vast majority of the population experiences low level exposure.

Next steps will use AERMOD emission output and census data as input for the computer model BENMAP CE to generate health impact and cost estimates.

Sponsors: UTRC Region 2

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University: Rochester Institute of Technology