

I am Anthony Ingraffea, the Dwight C. Baum Professor Emeritus at Cornell University. I have followed the development of this EPA draft final report closely and participated in three of the workshops associated with it. I would first like to thank the EPA for its work under trying circumstances. It was clear from the beginning of the study's scoping activity that the oil/gas industry wanted to severely limit the project to potential impacts on drinking water from hydraulic fracturing alone. I applaud the EPA for resisting this pressure and defining and executing its study within the scope of the entire hydraulic fracturing water cycle.

My major criticism of the draft final report is that it currently fails to address problems of scale and spatial intensity in this complete water cycle. There have been over 3.5 million oil and gas wells developed in the U.S., and over a million of those were fracked long before public concern about "fracking" became manifest and the Congress mandated this study. Why the intense concern 70 years after the commercial application of fracking? I assert that the answer, not yet properly regarded in the draft report, is the approximately 70,000 shale gas and oil wells developed over the last 20 years, and especially the majority of those developed over the last decade. Why should there be so much concern over so few wells? The answer is shale, not fracking per se.

First, shale gas and oil wells redefine the scale of the problem: the total amount of water and chemicals used in fracking those 70,000 wells far exceeds the total amount used in the million conventional wells previously fracked. Concomitantly, the total amount of waste flowback and so-called produced water emanating from those 70,000 wells far exceeds the total from those previous million fracked wells.

Consequently, one should expect that the risks and impacts associated with such prodigious volumes being handled over such a relatively short time period, and in such relatively small enclaves, would be elevated beyond those previously seen.

Second, the geology and geochemistry of shale require markedly increased well spatial intensity, typically 8 or more wells per square surface mile. Each well is a potential leak path of hydrocarbons to USDW, and our research has shown that the rate of leakage from faulty casing and cement jobs in modern shale gas wells is no better than historical leak rates. One should therefore expect large numbers of incidents of water well contamination within counties of intense shale hydrocarbon development.

The most recent EIA natural gas supply projection has shale gas alone increasing by 93% between 2012 and 2040. Given historical decline rates in shale gas wells, there will need to be *hundreds of thousands of producing shale gas wells in 2040*, and *millions of wells drilled before then*. The draft report utterly fails to project the scale and spatial intensity issues I just described onto this incredible number of projected wells.

The draft report is a wanting snapshot of the present impacts on the hydraulic fracturing water cycle, it fails completely to credibly address the future impacts.