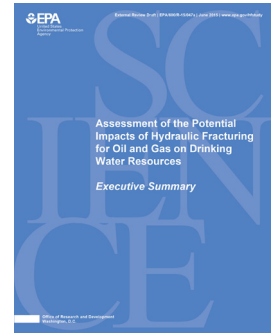


Quantitative Support For EPA's Finding of No Widespread, Systemic Effects to Drinking Water Resources from Hydraulic Fracturing

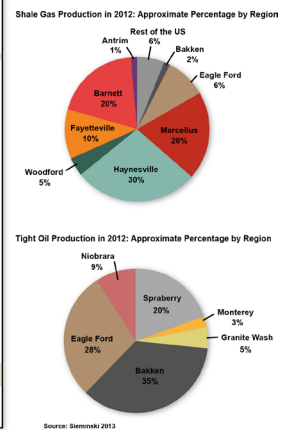
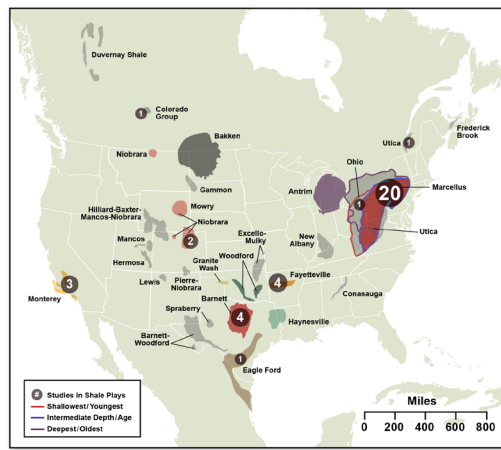
The US EPA published its draft assessment of the impacts of hydraulic fracturing on drinking water resources. The assessment identified potential causes of drinking water impairment, and evaluated the extent to which hydraulic fracturing has been identified as a cause of impairment. EPA concluded that there is **no evidence of widespread, systemic impacts on drinking water resources in the United States**, and that the number of identified cases was small compared to the number of hydraulically fractured wells.

In its review of the EPA study, the Scientific Advisory Board commented that EPA should provide **quantitative support** for its finding, including, that it more clearly describe the **systems of interest, the scale of impacts, and definitions of terms**.



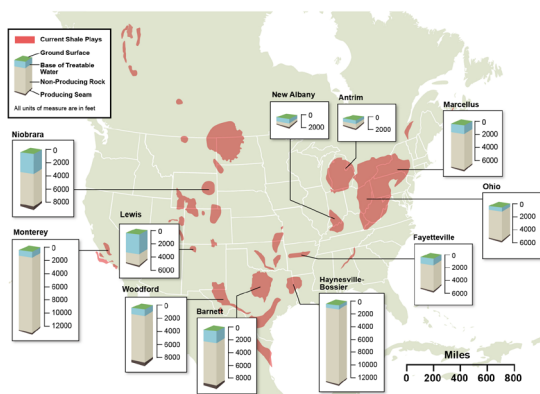
Case Studies & Research Quantitatively Support EPA's Finding

EPA reviewed state-of-the-science studies and employed a structured and logical method of analysis to reach its conclusions by focusing on those areas where hydraulic fracturing was conducted in close proximity to drinking water supplies and/or residents. With this approach, if a significant correlation between impaired drinking water resources and hydraulic fracturing existed, EPA would have identified it; however, the results did not support this finding. Further quantitative support comes from a large, credible body of case studies and peer-reviewed scientific literature from around the country that conducted quantitative analysis and modeling of potential causative mechanisms for hydraulic fracturing fluids to come into contact with drinking water resources. Incorporation of these studies into their analysis further demonstrates that there are no widespread effects to drinking water resources from hydraulic fracturing.



Quantitative support for EPA's finding comes from studies in all the major oil and natural gas producing shale basins in the country, with an emphasis on those states with the most hydraulic fracturing.

Basis of Terms & Definitions Used by EPA

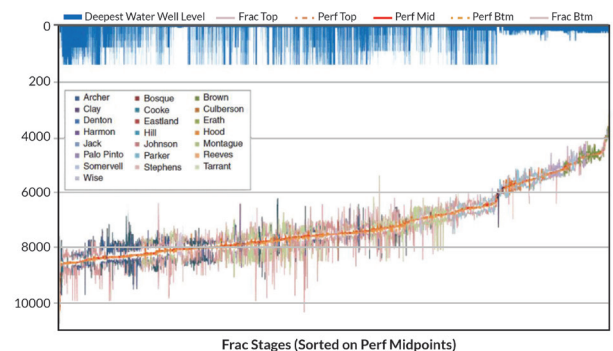


Scale of Impacts: EPA considered that, at the scale of 25,000-30,000 new hydraulically fractured wells annually, the few instances of potential impairment are neither systemic nor widespread.

At a geographic scale, the study addresses impacts from the national to the county level. Local impacts, at the scale of a well pad, occur rarely.

The range of conditions nationally, statewide, and locally were quantified by the EPA study

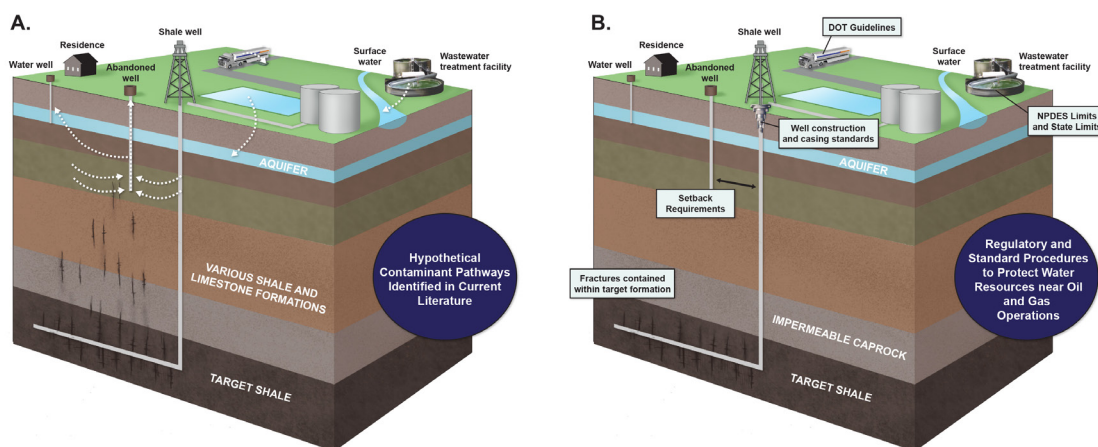
Systems of Interest: EPA defines drinking water resources as any body of ground water or surface water that now serves, or in the future could serve, as a source of drinking water for public or private use. This is broader than most federal and state regulatory definitions of drinking water and encompasses both fresh and non-fresh bodies of water.



Frac Stages (Sorted on Perf Midpoints)

Industry Practices and State Regulations Lower Risk, Limits Incidents

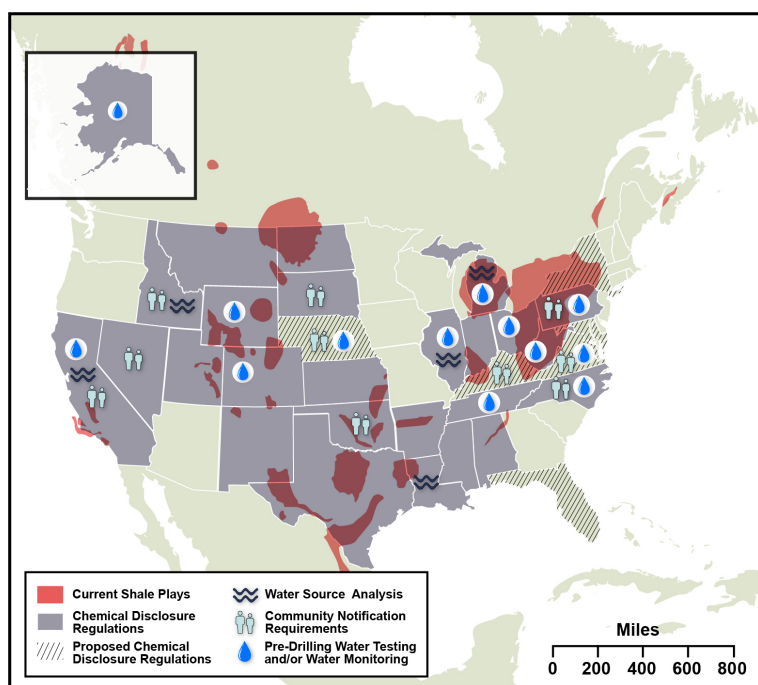
With an emphasis on **prevention** of an incident through the application of well design/construction and equipment safeguards, Industry, EPA and states have together systematically limited the level of risk of hydraulic fracturing fluids impairing drinking water resources. EPA's finding of no widespread effects to drinking water quality is a reflection of the effectiveness of these practices. Their finding makes sense. The California Council on Science and Technology's 2015 comprehensive study of the effects of hydraulic fracturing came to a similar conclusion as EPA, providing further quantitative validation.



Industry, EPA, and the States seek to prevent impairment of water resources through identification of potential impairment mechanisms (left), and the providing suitable controls (right)

Monitoring Provides Ongoing Quantitative Data Supporting EPA's Finding of No Widespread Effects to Drinking Water Resources

Recent State water monitoring requirements are **providing further quantitative support** that hydraulic fracturing is not leading to widespread, systemic effects to drinking water resources. For example, a comprehensive monitoring program has just been initiated in California, based on an extensive study by Lawrence Livermore National Labs, Lawrence Berkeley Lab, and other universities. Existing data quantitatively supports EPA's principal finding, and ongoing monitoring provides additional assurance and a growing database to further prove out the finding. These governmental requirements have kept oil and gas development as one of the most highly regulated industrial sectors in the US.



Monitoring is a relatively recent regulatory requirement and will provide data for EPA to prove out finding.