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Developing water budgets for unconventional oil and gas production: a study in the Williston Basin, Montana and North Dakota

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New drilling and completion technologies have expanded domestic oil and gas production to include low-permeability sandstone and shale targets once considered inaccessible and/or uneconomic. Hydrocarbon production from these formations commonly requires considerable quantities of fresh water to increase conductivity through the process of hydraulic fracturing (fracing). This water must be removed prior to resource extraction (flowback water) and generally contains salts and minerals from the formation as well as the additives used to increase fracing efficiency. The large volumes of water involved in these practices have already led to supply and disposal problems in some areas. In order to address such issues and to help stakeholders prepare appropriately for future production scenarios, U.S. Geological Survey (USGS) scientists are developing water budget methods for oil and gas production on a regional scale. USGS oil and gas assessments provide estimates of technically recoverable resources and facilitate the determination of future hydrocarbon production scenarios. We extend these results to include volume estimates for the water involved.

The Williston Basin in Montana and North Dakota is the area of our initial focus due to (1) the large quantity of oil present in the Bakken Formation, and (2) the Prairie Pothole wetlands that host large numbers of migrating waterfowl. Current, rapidly escalating production of Bakken Formation oil requires a million or more gallons of fresh water per well for fracing. Historic and ongoing oil production from other Williston Basin formations has resulted in large volumes of highly saline co-produced waters; in the past some of these waters escaped into shallow aquifers and have impacted wetlands. We estimate the quantities of water (frac, flow-back, and co-produced) that could be involved in a range of future hydrocarbon production scenarios and compare these quantities with estimated total water budgets for the region. This will allow for an evaluation of water-related impacts of oil and gas production for a range of possible future production scenarios.