A GIS BASED VULNERABILITY ASSESSMENT OF CONTAMINATION TO AQUATIC RESOURCES FROM OIL AND GAS DEVELOPMENT IN EASTERN SHERIDAN COUNTY, MT

Todd M. Preston*, Tara L. Chesley-Preston**, Joanna Thamke***

The Prairie Pothole Region (PPR), characterized by glacial sediments and numerous wetlands, overlies the north and east portions of the Williston Basin. Produced water (brine) from the oil-producing Williston Basin is some of the most saline in the nation with total dissolved solids values that can exceed 300,000 mg/L. Brine contamination has been documented in parts of the PPR. The presence and magnitude of brine contamination can be determined by the Contamination Index (CI), originally developed by the Montana Bureau of Mines and Geology. The CI is the ratio of chloride concentration to specific conductance in a water sample, with a value greater than 0.035 indicating possible brine contamination.

To evaluate potential brine contamination to surface water and shallow groundwater, we created a GIS-based vulnerability assessment based on oil well and hydrogeological variables. This assessment was conducted on the Public Land Survey System section grid (~1 mi^2) and used the age and density of oil wells, percent of glacial outwash, percent of wetlands, and length of stream reach. Scores from 780 modeled sections in eastern Sheridan County, MT were divided into ten equal interval bins representing similar contamination probabilities. The section with the greatest acreage of Federal land in each bin was selected for sampling, with two surface water and two groundwater samples collected from each section. Nineteen of the forty water samples, and at least one sample from seven of the ten sections, had CI values indicating contamination. CI values generally increased with increasing vulnerability assessment score, with a stronger correlation for groundwater samples ($R^2 = 0.78$) than surface water samples ($R^2 = 0.53$). These methods have recently been applied to the Lostwood National Wildlife Refuge Complex in Montana and North Dakota and are now being expanded to the remainder of the PPR of the Williston Basin.

* Parallel Inc. Denver, CO, tmpreston@usgs.gov
** Montana Institute for Ecosystems at Montana State University, Bozeman, MT, tchesley-preston@usgs.gov
*** USGS Montana Water Science Center, Helena MT, jothamke@usgs.gov