# A Combined Hydrologic/Geochemical Investigation of Groundwater Conditions in the Waukesha County Area, WI

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## Project Approach

The federally-mandated limit of 5 pCi/L of radium in drinking water represents a vanishingly small concentration of radium ions in the water. Five pCi/L is equivalent to $5x10^{-9}$ ppm ($^{226}Ra$) or $2x10^{-11}$ ppm ($^{228}Ra$). Unraveling the behavior of these ultra-trace ions in the context of a regional aquifer system is a daunting task that depends upon a clear understanding of both the physical and chemical dynamics of the aquifer itself. In pursuit of this goal, this project took advantage of the fact that a large amount of information was already available including previous regional geochemical studies, an extensive groundwater flow model of the entire region, and chemical data from over 50 wells in Waukesha county alone. The intellectual approach taken was to first assemble the previously available regionalized data and apply it to the Waukesha county area specifically. This effort was undertaken to understand the generic flow and chemical conditions currently in existence in the aquifer. It focused on using the regional ground water flow model to assess details of the flow regime within Waukesha county as well as collecting and modeling the major ion data that resides in the Wisconsin Department of Natural Resources (WDNR) drinking water data base. Secondly, a series of individual investigations was undertaken to assess the efficacy of specific processes that could supply radium to aquifer water. This included investigations into the mineralogy of aquifer solids, colloidal material, radium versus depth relations and radium versus vertical head relations. Thirdly, isotope and noble gas techniques were employed to refine the understanding of aquifer dynamics over long periods of time (thousands of years). This was needed in order to be confident extrapolating currently active processes into the past. The result is a cohesive picture of the aquifer dynamics obtained by applying a wide variety of tools, including numerical flow modeling, geochemical modeling (based on both major ion chemistry and solids information), isotope and noble gas data.