Characteristics of the Hanford Reach of the Columbia River Groundwater-Surface Water Interaction Zone for Investigating Hydro-Biogeochemical Process Dynamics

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The Pacific Northwest National Laboratory SBR Science Focus Area is conducting fundamental research on hydro-biogeochemical process dynamics in the subsurface interaction zone (SIZ), where groundwater and surface water mix. The initial site of investigation is a 65-kilometer section of the Hanford Reach of the Columbia River, adjacent to the U.S. DOE Hanford Site. The proposed study site has several characteristics making it an excellent choice for study. There is variable permeability in the riverbed and the adjacent aquifer, with complex heterogeneity throughout the study area. The width and thickness of the SIZ is highly dynamic, due to the heterogeneity of the riverbed and the aquifer, and complex variations in river discharge that occur on multiple time scales, a key feature for addressing SFA research objectives. Complex variations in river discharge, caused by seasonal variations and flow regulation at upstream dams, drive large incursions of river water into the alluvial aquifer system and result in a SIZ that can extend in excess of 250 m from the river bank. Preliminary studies indicate profound changes in contaminant biogeochemistry, microbial community structure, and fluxes of C and N due to mixing of groundwater and river water in this dynamic SIZ. Several contaminant plumes currently discharge into the study site, including uranium, Cr(VI), 90Sr, NO3, and 3H2O, with 129I and 99Tc plumes expected in the future. World class data and infrastructure are already in place, including > 500 aquifer tubes and > 250 nearshore wells with interpreted hydrogeology and well data. By taking advantage of the significant level of characterization already completed on the Hanford Site and adjacent Reach, high-impact research can be conducted on SIZ processes with no delay. Science questions addressed, multi-scale approaches, and models developed at the proposed study site would be relevant to a large class of glaciofluvial alluvial aquifers that are common in North America, Europe and Asia. These gravel-dominated systems tend to have high permeability and pronounced heterogeneity. While the alluvial aquifer in the Hanford Reach has high permeability and a wide SIZ, it is well within the range of properties displayed by other glaciofluvial aquifer systems. As a snowmelt-dominated river, the impact of climate change on the timing, magnitude, and temperature of river water intrusions into the Hanford Reach is a significant unknown, and the results of proposed studies on the potential impacts of climate change on SIZ processes would be relevant for many glaciofluvial aquifers.