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Friend or Foe?: Assessing the Effect of the Freshwater-Saltwater Interface on the Natural Attenuation of Chlorinated-Ethene and Chlorobenzene-Contaminated Groundwater

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Background/Objectives. Since the early 1990s, the U.S. Geological Survey (USGS) has been monitoring the effect of engineered and natural attenuation processes on concentrations of chlorinated ethene (CE)- and chlorobenzene (CB)-contaminated groundwater at a former waste-water treatment plant located at Naval Air Station Pensacola, FL (NAS Pensacola). These contaminants are transported toward saline Pensacola Bay by fresh groundwater. Contaminants have remained at low concentrations, however, in groundwater pumped from wells screened across the freshwater-saltwater interface near the Bay. This scenario provides the unique opportunity to understand an often overlooked aspect of natural attenuation in coastal systems, namely, the hydrologic and biologic role that the freshwater-saltwater interface plays on the natural attenuation of dense, nonaqueous phase liquids (DNAPLs) such as CE and CB. For example, 12 hours each day, nutrient-rich, uncontaminated, saline groundwater in contact with the hyporheic zone beneath Pensacola Bay flows landward. During this time, higher surface-water levels associated provides an effective hydrologic barrier that prevents the seaward flow of contaminated groundwater. Sulfate-rich saline water also is supplied to the contaminated aquifer, and provides a natural supply of an electron acceptor that can be used to enhance the reductive dechlorination of CEs. Conversely, during low tide, CE- and CB-contaminated groundwater flows seaward. The present study presents groundwater geochemistry, natural attenuation parameters, and passive-diffusion sampling data to provide an assessment of the natural attenuation capacity of the freshwater-saltwater interface near Pensacola Bay.

Approach/Activities. To understand the hydrologic and biologic effects of the freshwater-saltwater interface on the natural attenuation of CE and CB, concentrations of dissolved oxygen, dissolved hydrogen, natural attenuation parameters such as dissolved iron and sulfide, and concentrations of CE and CB have been measured in groundwater pumped from wells located along this interface between fresh and saline groundwater. Passive-diffusion samples were installed in the bed sediment in the surf zone of Pensacola Bay and analyzed for CE and CB contaminants. Water samples collected from wells and from Pensacola Bay were analyzed for stable isotopes of water.

Results/Lessons Learned. Concentrations of CE and CB were not detected in any passive-diffusion samplers installed in Pensacola Bay in areas expected to be locations of contaminated groundwater discharge. Only four samples had any detection at all, and these detections were limited to low concentrations of chlorinated ethanes. In two wells located closest to Pensacola Bay, the profile of specific conductance in each well indicated that during high tide, groundwater in the well was a mixture of fresh and saline groundwater, with no observable sharp interface, and no detections of CE or CB. Conversely, during low tide, freshwater was observed in these wells throughout the upper water column, with increasing specific conductance with depth. Moreover, sulfide concentrations in groundwater near the Bay were slightly higher during low tide compared to high tide, perhaps reflecting consumption of sulfate that had been delivered to the contaminated aquifer during the previous high tide cycle.