SUMMARY OF U.S. GEOLOGICAL SURVEY STUDIES OF IRON GEOCHEMISTRY AND MICROBIOLOGY IN THE AQUIFER SYSTEM ON LONG ISLAND, NEW YORK

By Craig J. Brown[1], Donald A. Walter[2], and Steven Colabufo[3]

[1]U.S. Geological Survey, 2045 Route 112, Coram, N.Y., 11727
[2]U.S. Geological Survey, 28 Lord Road, Marlborough, MA, 01752
[3]Suffolk County Water Authority, P.O. Box 37, Oakdale, N.Y., 11769

High concentrations of dissolved iron (> 0.5 mg/L) in ground water contribute to the biofouling of public-supply wells, for which treatment and remediation is costly. On Long Island, N.Y., water companies spend several million dollars annually for (1) reconditioning and replacing biofouled supply wells; (2) backflushing distribution lines; (3) treating dissolved iron with sequestering agents or by filtration; and (4) responding to iron-related complaints by customers. This paper summarizes the results of U.S. Geological Survey (USGS) studies of iron geochemistry and microbiology in the Long Island aquifer system that could be useful for siting and operation of supply wells. The studies were done by the USGS during 1990-1998 in cooperation with the Suffolk County Water Authority.

Dissolved iron concentrations in ground water, and iron biofouling of wells, are highest in ground-water discharge zones, particularly near the south shore. Ground water along a deep north-south Magothy flow path in southwestern Suffolk County becomes anaerobic and Fe(III) reducing at a distance of 8 to 10 km south of the ground-water divide. This redox environment corresponds to the downgradient increase in dissolved iron concentrations. The varying availability of organic carbon and microbially reducible Fe(III) in Magothy aquifer sediments has resulted in localized redox environments, in which either Fe(III)-reducing or sulfate-reducing microrganisms predominate. Fe(III)-reducing zones are associated with anoxic conditions, where relatively large amounts of amounts of Fe(III) oxyhydroxide grain coatings are present. Localized sulfate- reducing zones are generally near lignite-rich, silt-and-clay lenses and appear to have developed in response to the depletion of available Fe(III) oxyhydroxides. The sulfate-reducing zones are characterized by low concentrations of dissolved iron (through iron disulfide precipitation) and these zones may be extensive enough for water-supply development.

Specific-capacity and water-quality data for production wells screened in the Magothy aquifer indicate higher median concentrations of iron and manganese, phosphate, and sulfate, and lower median concentrations of dissolved oxygen and alkalinity, and lower pH, in biofouled wells than in unaffected wells. Data from the upper glacial aquifer indicate higher median concentrations of manganese and sulfate, and lower pH, in biofouled wells than in unaffected wells.

Both aerobic and anaerobic bacteria can proliferate in and around production wells in areas of high dissolved iron concentrations. Analysis of 43 samples of biofouling material indicates that Fe(III) hydroxide is the predominant mineral phase, and most (72 percent)

of the samples contain filamentous bacteria. The predominant filamentous organism associated with iron-related biofouling of production wells in the upper glacial and Magothy aquifers of Suffolk County is *Gallionella ferruginea*, which is subaerophilic. Mineral-saturation indices indicate that most of the well-encrusting material is deposited when the wells are shut down. Furthermore, the use of treated water, which has a high pH (~7) and sometimes high concentrations of dissolved iron, as lubrication water when wells are shut down could greatly increase the rate of iron oxidation.