Biological Nitrate Removal Study in Acton

Many groundwater sources throughout North America have nitrate levels near or above the drinking water standard of 10 milligrams per liter (mg/L) as nitrogen. The major sources of nitrates in drinking water are runoff from fertilizer use, leaking septic tanks, sewage, and erosion of natural deposits. Infants below six months who drink water containing nitrate in excess of the drinking water standard could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue baby syndrome.

The Los Angeles County Department of Public Works, Waterworks Division (LACWD), operates several groundwater systems within unincorporated portions of Los Angeles County. Some of the groundwater contain nitrate at levels near or above the drinking water standard. LACWD currently blends groundwater with high nitrate concentrations with water containing low nitrate concentrations to maintain nitrate levels below the drinking water standard in the blended water. However, blending is not a sustainable long-term strategy, given the increasing trend of nitrate concentrations in groundwater over time. In addition, current groundwater wells high in nitrate are unable to run at full capacity and thus, are not operating efficiently. Therefore, LACWD has begun evaluating the application of well-head treatment systems for nitrate. Conventional nitrate treatment processes include ion exchange or reverse osmosis. Both treatment types are expensive, energy intensive, and produce waste brine that is very difficult and costly to dispose of.

In 2013, Waterworks partnered with the Water Research Foundation and Water Quality and Treatment Solutions, Inc. to conduct a comprehensive biological nitrate removal study in Acton. The study evaluated the effectiveness of a new biological process that removes nitrate from groundwater using natural bacteria.

The treatment system includes three unit processes in series (see figure 1). The first system is the biological reactor, which is a packed bed filter containing Granular Activated Carbon (GAC) as a medium for bacterial growth. The second system is an aeration process aimed at replenishing the dissolved oxygen in the water after it was consumed in the biological reactor. The third system is a filter process containing standard sand and anthracite filter media. The role of the filter is to capture bacteria present in the effluent of the biological reactor. Acetic acid is added to the influent of the treatment system to promote bacterial growth. In this process, no outside bacterial source is used. Instead, the system cultures the native bacteria present in the groundwater. The filtered water is then disinfected with chlorine to achieve a minimum of 99.99% virus inactivation in accordance with the requirements of the State of California's Division of Drinking Water.

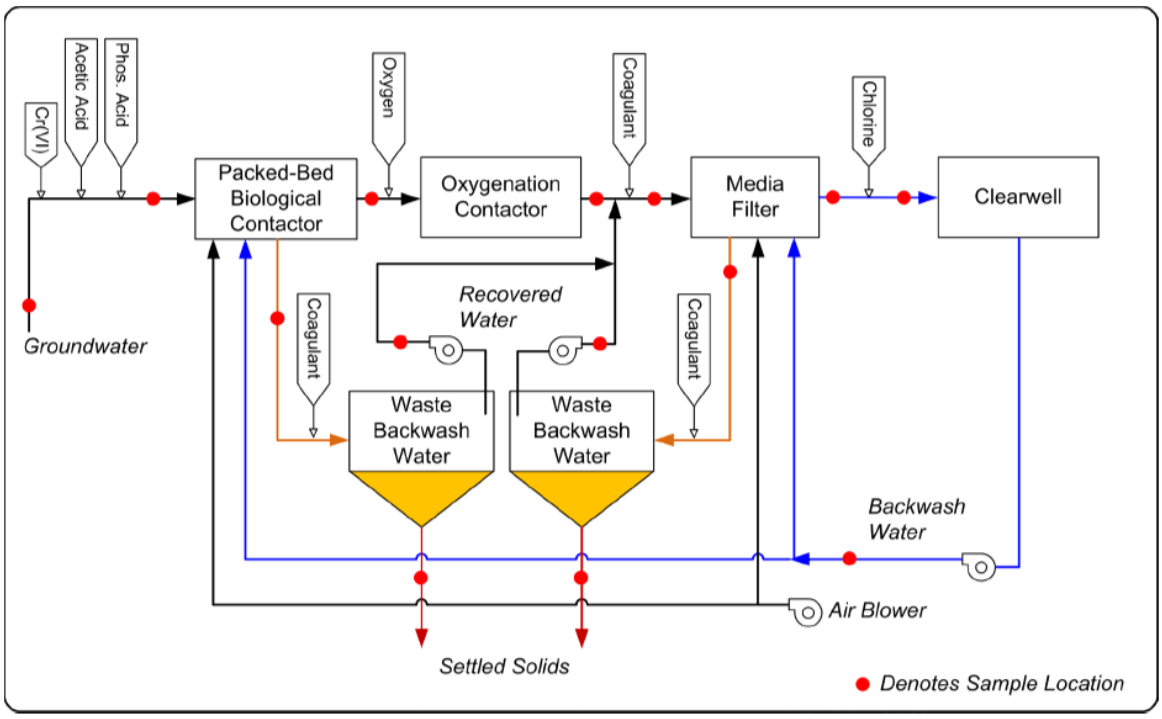

figure 1

Figure 1 depicts a schematic for the biological nitrate removal process. The black lines depict the movement of contaminated fluids, the blue lines depict the movement of clean water, and the mustard lines show the movement of bacterial colonies and contaminated fluids. The red dots signify sample locations where lab technicians can draw a sample to monitor the conditions of the process.

Figure 2 shows the pilot scale testing apparatus. The two nearest columns are filled with granular activated carbon which allows enough contact time for the bacteria to consume oxygen and reduce the nitrate. In the third column, air is to replenish the oxygen.

figure 2

The study demonstrated that the biological nitrate removal process is highly efficient at removing nitrate from the groundwater. This process was able to consistently produce water with nitrate concentrations below the requirements of the State of California's Division of Drinking Water. It also identifies any regulatory, operational, and maintenance requirements for a full-scale implementation of the treatment. In 2014, this study received the outstanding sustainability project award by the American Society of Civil Engineers Metropolitan Los Angeles Branch. Currently, the county is researching funding options to take this project to a full scale application.