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Enhanced Denitrification for Treatment of Nitrate Plumes Associated with Fertilizers

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Background/Objectives. Nitrates are produced for use as fertilizers in agriculture. Nitrate can be toxic and causes methemoglobinemia in infants. Nitrate when ingested is converted in the stomach to form N-Nitroso compounds that can be carcinogenic in humans. Nitrates can also disrupt thyroid function and cause birth defects.

Nitrate can be converted to nitrogen gas by denitrifying bacteria. Anaerobic conditions are required for denitrification to occur therefore removal of nitrate can be achieved by enhancing anaerobic conditions.

Three separate sites contained nitrate at elevated levels. These sites are located in New Mexico, Nebraska, and Manitoba Canada. The site in Nebraska also contained elevated levels of ammonia-nitrogen.

Approach/Activities. A treatability study was performed for each site to assess the potential for enhanced in situ biodegradation (EISB) to treat the nitrate and ammonia-nitrogen in the groundwater at the sites.

EISB is a treatment process whereby the compounds of concern are metabolized into nonhazardous compounds by naturally occurring microorganisms. EISB is a passive, low impact treatment strategy that can achieve clean up goals within a relatively short time in a cost effective manner. Denitrification occurs under anaerobic conditions. A carbon source such as emulsified vegetable oil (EVO) can be used to enhance anaerobic conditions.

Results/Lessons Learned. The assessment of the three sites showed that the addition of a carbon substrate can stimulate denitrification. The Nebraska site required a two-step approach. First, an initial aerobic treatment with the addition of sodium phosphate and oxygen to treat the ammonia-nitrogen then a second anaerobic treatment to treat the nitrate by denitrification with the use of EVO. The New Mexico site required the addition of EVO and sodium phosphate to reduce the nitrate concentration and the Manitoba Canada site required only the addition of EVO to reduce the nitrate.

A pilot study was performed at the Manitoba Canada site. A a greater than 99 percent reduction in the concentration of nitrate was in the area of the injection well and of one monitoring well; therefore, the pilot study has been successful. The decrease in nitrate was observed at the monitoring well which is 3 meters (m) away from the injection well but not at a second monitoring well which is located 6 m away from the injection well, therefore the downgradient range of the injection is between 3 and 6 m. Based on these results, the treatment of nitrate by the injection of EVO was recommended for full scale application.