# Biological Reduction of Chromate, Nitrate, Chlorate and Perchlorate in the Presence of High Levels of Salinity

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**Background/Objectives.** Biological reduction of perchlorate has been studied intensively in the last two decades. An unresolved issue is the biodegradation of perchlorate under high salinity conditions, such as those found in ion-exchange brines and in areas where perchlorate contamination is associated with high levels of other salts. The impact of high total dissolved solids (TDS) levels on bacterial growth and biological degradation of perchlorate has been extensively studied and a decrease in microbial growth with an increase in salinity has been observed. Although there are at least two reports of perchlorate degradation at 3% (30,000 mg/L) salinity, most reports have found that at salinity levels between 0.5% -1%, perchlorate reducing bacteria growth reduces by at least 50%. Some researchers have reported that salt concentrations exceeding 4% inhibits perchlorate reduction completely. In this research, the biological reduction of several co-occurring contaminants (COCs) (e.g., chromate= 110 mg/L, nitrate= 300 mg/L, chlorate=30,000 mg/L and perchlorate=3000 mg/L)) in the presence of > 5% salinity is investigated using various substrates and conditions.

**Approach/Activities.** Both batch microcosm and column testing were performed using molasses, emulsified oil, and acetate as substrates. Borehole soil cuttings and groundwater obtained from an actual contaminated site was used in the testing. Soil consists of fine clayey material with extremely low hydraulic conductivity, collected between 85-105 ft depth. Microcosm testing explored the impact of various dilution factors and substrate type on the biodegradation of the COCs. Bioaugmentation was needed as the number of bacteria found at the depth studied was very low. Microcosms used soils and groundwater from the site implemented with needed macronutrients and vitamin B12. Sludge from a fluidized bed reactor, that treats perchlorate contaminated water, was used as the bacterial seed. For the column tests, two two-inch diameter transparent PVC columns were used and packed with 3 Kg of dried soil each. Columns were packed to mimic groundwater velocities found in the field. In-house built pressure valves were used to pressurized the columns at 5-15 psi.

**Results/Lessons Learned.** The results revealed that, without bio-augmentation, the contaminants could not be biologically reduced after 172 days of incubation. Bio-augmented microcosm where the contaminated groundwater was not dilute (4.6% salinity) showed minimal degradation. Diluting the groundwater with tap water to 3X (2 parts tap water and 1 part groundwater- 1.8% salinity), 4X (1.43% salinity), and 5X (1.2%) promoted complete degradation of chromate within 11 days and nitrate and chromate within 22 days for the 1.8% salinity water. For the higher dilutions, degradation was more than twice as fast. Perchlorate degraded more than 70% within 25 days. Molasses and acetate were found to be the best substrates. Emulsified oil did not work well because a large amount (1.5 g/g soil) of oil absorbs to the soil and not sufficient is released into solution for bacteria use.