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Bioreactors Remove Selenium from Water at Reduced Cost

Bioreactor cells reduce selenium without requiring attendance—improving water quality and saving money.

What Is The Problem?

Waterfowl deformities and mortalities at several Reclamation projects have been linked to selenium contamination of irrigation drain water. Selenium occurs naturally in certain Cretaceous and Eocene age marine shale derived soils throughout the Western United States. When mobilized by irrigation, selenium from these soils can contaminate water bodies and adversely impact fish and wildlife. Failure to remediate selenium contamination, in some cases, could result in violations of the Endangered Species Act and/or the Migratory Bird Treaty Act. Remediating selenium-contaminated areas has been problematic, in part because it is difficult to treat selenium-contaminated water. Conventional filtration type methods are expensive, inefficient, and generate large amounts of secondary waste.

What Is The Solution?

Reclamation's Western Colorado Area Office (WCAO) is working with Mesa State College, Golder Associates, Inc., and United Companies to develop a passive, low-tech bioreactor selenium removal process. We used existing bioreactor technology that successfully treats acid mine drainage to the challenge of selenium contamination. The bioreactor is constructed in a manner to create a favorable environment for microorganisms that consume selenium. Based on test results so far, it appears passive selenium-reducing bioreactors offer an efficient, cost-effective treatment method.

A bench-scale test was conducted in 2007 that demonstrated selenium removal rates of 92 to 98 percent. During the bench-scale tests, pretreatment concentration selenium ranged from 20 to 70 micrograms per liter. The pilot-scale test was conducted in 2008-09, and its primary objective was to achieve high selenium removal efficiency and determine the relationships between selenium removal efficiency, detention time, and ambient air temperatures for potential use in a larger scale project. The ongoing pilot-scale test cell covered a 60- by 60-foot area and contained 114 cubic yards of varying proportions of sawdust, hay, wood chips, limestone, and manure to grow the microorganisms. The pilot-scale bioreactor operated over a range of flow rates between 3 and 15 gallons per minute to determine the optimal detention time. The highest removal rates occurred when the water was detained in the cell for 12 hours.

Who Can Benefit?

Selenium-reducing bioreactors could be used at many locations where selenium-impaired surface waters are impacting fish and wildlife. The technology could also be applied to drainages and natural waterways where state and Federal regulatory agencies are advocating for the reduction of selenium loading. However, due to its low treatment (flow) rates, the best use would likely be where high-selenium concentration drainage could be isolated from cleaner waters. Pilot-scale testing showed that this concept will work for small seeps (2 to 24 gallons per minute). As larger volumes would require large amounts of land, this treatment would be most effective in treating smaller amounts in targeted areas such as tributaries.

Where Have We Applied This Solution?

The location of the bench- and pilot-scale test sites is at a gravel mining operation adjacent to the Colorado River near Grand Junction, Colorado. The site was chosen because of high selenium concentrations in discharge waters and the willingness of concerned parties to cooperate to address the problem.

Pilot-scale selenium passive bioreactor cell.

Future Development Plans

Reclamation will consider using this technology for small point sources of selenium. This technology would allow local entities to undertake remediation, which would benefit Reclamation and project water users. Using this technology could help avoid future water conflicts with the potential for significant cost savings over other treatment methods.

More Information

A report of findings is available at http://www.seleniumtaskforce.org/images/Se_Pilot_Bioreactor_Final_Report.pdf

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