USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Investigation of sorption, desorption, and bioregeneration of natural organic matter and pesticides on granular activated carbon used to treat contaminated drinking water.

Duration: August 1, 1996 to July 31, 1997

FY 1996 Federal Funds: $30,000

FY 1996 Non-Federal Funds: $60,000

Principal Investigator: Roger Babcock, Jr.

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Statement of Critical Regional or State Water Problems:

The island of Oahu has a population of approximately 850,000. Over 90 percent of the water supplied for drinking water and agriculture is of groundwater origin. Currently, approximately 375 million gallons per day (MGD) of groundwater are removed from the aquifers on Oahu and utilized. Approximately 175 MGD of the total is used for the potable water supply, and about half of this is supplied by the Pearl Harbor aquifer. Due to past agricultural application of pesticides and perhaps past fuel spills or improper disposal of waste chemicals, the Pearl Harbor aquifer is contaminated with trace concentrations of ethylene dibromide (EDB), l,2-dibromo-3-chloropropane (DBCP) and 1,2,3-trichloropropane (TCP) (Lau and Mink, 1987). Since the discovery and characterization of the extent of the contamination in the late 1970's and early 1980's. the concentrations detected have not decreased. In addition, there is evidence that the contamination is spreading rather than subsiding (Lau, et. al., 1995). In order to meet regulatory requirements designed to protect public health. the Board of Water Supply (BWS) of the City and County of Honolulu (which includes all of the island of Oahu) treats all water containing EDB and/or TCP and/or DBCP from the Pearl Harbor aquifer using granular activated carbon (GAC) contactors.

Adsorption onto GAC is an effective removal method for most synthetic organic compounds (SOCs) including EDB, TCP, and DBCP as well as background dissolved natural organic matter (NOM). All adsorbable organics passed through a GAC column compete for adsorption sites on the carbon, Generally, competition reduces the adsorptive capacity for any individual compound, and often the reductions are very significant (Jain and Snoeyink, 1973). It has been hypothesized that background NOM is responsible for observed full scale GAC exhaustion rates which have been 3 to 5 times greater than

predicted during the design phase (Oki, et. al., 1994). However, this hypothesis has apparently not been born out from previous investigations which seemed to show that NOM was not significantly

removed doing treatment using rapid small-scale column tests (RSSCTs)(Dugan, et.al., 1995). Carbon is currently used at a rate of approximately 150 tons/year. Costs associated with replacement of the GAC are estimated at $320,000 per year based upon data given by Leon-Guerrero et. al. (1994) and Kawata (1996). The BWS would like to reduce their operating costs associated, with GAC treatment. In order to reduce costs for the BWS, several fundamental issues that are also of interest to water treatment professionals and researchers on a national scale will be investigated in this study. These include the broad issue of sorption and desorption phenomena of NOM on GAC, competition of NOM and target SOCs for adsorption sites, and the non-thermal regeneration of spent GAC to prolong service life. These are important topics for any water treatment operation that uses GAC including treatment for disinfection byproduct (DBP) control and any number of contaminated water cleanup schemes. The results of this study will ultimately be used to design new additional treatment facilities to regenerate the GAC used to treat Oahu's contaminated groundwater.

Statement of Results or Benefits

This research will lead to improved understanding of NOM, EDB, TCP, and DBCP sorption, desorption, and competition phenomena on GAC and associated knowledge on methods to improve GAC treatment system performance and to reduce life-cycle costs. The results will consist of measurements of the breakthrough phenomena of EDB, TCP, and DBCP in the presence of NOM from minicolumns that have been subjected to various regeneration schemes. Also measured will be the adsorbed mass of the target SOCs on spent GAC before and after being subjected to various desorption methods to directly quantify their effectiveness. Attempts will also be made to quantify the adsorbed mass of NOM on the spent GAC, to determine effective methods to desorb NOM from spent GAC, and methods to render it amenable to biodegradation-

The information gained regarding NOM sorption and desorption phenomena will be used to design a method or methods to extend the useful life of GAC used either to purposefully remove NOM for DBP reduction during subsequent disinfection or to remove other target contaminants (SOCs) with unavoidable concurrent removal of NOM. The methods determined will have practical application for the design of a treatment system to regenerate the spent GAC from the full-scale GAC contactors used for wellhead treatment of contaminated water from the Pearl Harbor aquifer. Currently the GAC is loaded until breakthrough only once and then disposed of as waste. Regeneration of the spent GAC will extend its useful life by allowing multiple loading cycles. Extending the useful life of GAC is directly related to reducing GAC adsorption treatment system operating cost.