This document was prepared in conjunction with work accomplished under Contract No. DE-AC09-96SR18500 with the U. S. Department of Energy.

High Level Waste Tank Closure Modeling with Geographic Information Systems (GIS)

James S. Bollinger
Jeff Newman
Leonard Collard

Savannah River National Laboratory
Aiken, SC 29808

INTRODUCTION

From the mid-1950's through the 1980's, the U.S. Department of Energy's Savannah River Site (SRS) produced nuclear materials for the weapons stockpile, for medical and industrial applications, and for space exploration. Although SRS has a continuing defense-related mission, the overall site mission is now oriented toward environmental restoration and management of legacy chemical and nuclear waste. A critically important part of SRS environmental management involves the safe disposition of approximately 36 million gallons of high level waste (HLW) residing in 49 underground storage tanks located in two tank farms.

Waste removal from these tanks involves three steps: bulk waste removal, water washing to remove residual waste, and in some cases chemical cleaning to remove additional residual waste. Not all waste can be completely removed by these processes—resulting in some residual waste loading following cleaning. Completely removing this residual waste would not be technically or economically viable; therefore, it will be stabilized by filling the tanks with grout. Acceptable residual waste loading inventories were determined using one-dimensional groundwater transport modeling to predict future human exposure based on several scenarios. These modeling results have been incorporated into a geographic information systems (GIS) application for rapid evaluation of various tank closure options.

DESCRIPTION

Developing and implementing tank closure plans at SRS will require rapid evaluation of varying closure scenarios specifying the residual waste loading of different radionuclides in each tank. Acceptable levels of residual waste loading must be determined based on state and federal exposure limits combined with computational modeling to predict the potential future human exposure resulting from the residual inventory. After waste removal, tanks will be grouted to stabilize the remaining radionuclide inventory. It is assumed that the tanks will fail during the 10,000 year period after closure, releasing their radionuclide inventory to the surrounding groundwater.

One-dimensional transport modeling was performed with estimated radionuclide source terms for all 51 tanks (2 of which have been grouted and closed already). Groundwater flow path lines for the one-dimensional model were based on results from 3-dimensional transport models previously developed for the tank farms and surrounding area. The three-dimensional models incorporated the detailed geology and hydrogeology of the formations underlying the tank farms and also considered groundwater discharge at nearby seeps and streams. These transport path lines originate at each tank grouping and terminate at seep points adjacent to nearby streams, at the streams, or at hypothetical domestic wells. It is at these termination points that potential human exposure is evaluated. Along each path line in the one-dimensional model, radionuclide decay, dispersion, and adsorption are simulated. Simulations are run for 10,000 years following tank closure.

Many dozens of one-dimensional simulations were performed to determine the effect on human health and the environment via various groundwater pathways using the residual waste inventory for each tank. Performing these simulations for specific tank closure scenarios is both time consuming and expensive. A prototype rapid screening tool (RST), therefore, was developed using ArcView® allowing various tank closure scenarios to be rapidly evaluated without having to re-run the one-dimensional simulations. The RST allows users to interactively enter the radionuclides for each tank along with the corresponding inventory. The RST then computes the resulting exposures based on the existing normalized one-dimensional fate and transport calculations. Since the RST was developed using GIS software, the spatial and temporal distribution of exposure predictions can be viewed in their geographic context.

RESULTS

Development of the RST prototype demonstrated the ability to use normalized one-dimensional transport results to rapidly evaluate tank closure scenarios. This capability will be critical to the tank closure efforts at SRS due to the rapidly changing regulatory and technical environment. The RST approach may also be extended to the utilization of three-dimensional fate and transport models to provide more realistic predictions of radionuclide dispersion and adsorption in the groundwater flow system underlying the tanks.