
USE OF A DISTRIBUTED-PARAMETER SOLUTE TRANSPORT MODEL FOR A RISK/COST ANALYSIS OF A PROPOSED HAZARDOUS WASTE SITE GROUNDWATER CLEANUP

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ABSTRACT

Bruno, Nebraska, is a small community that relied on two wells, 36-1 and 65-1, built in 1936 and 1965. Well 36-1 is located in the same area as a grain storage facility with grain bins within 100 meters on either side of the well. Containers of carbon tetrachloride used as a fumigant in the grain bins would be placed in the top of the bin and then punctured with a bullet from a firearm. The lid on the bin was then shut and the fumigant allowed to filter through the grain. The fumigant also escaped from the bins. As a result, groundwater used by both wells became contaminated and unfit for public consumption. Carbon tetrachloride was detected at a level of 37 micrograms per liter in well 36-1. The maximum contaminant level for carbon tetrachloride is set at 5 micrograms per liter. Groundwater quality models can be basically divided into three groups: lumped parameter models, analytic equations, and distributed parameter models. A lumped parameter model was developed to simulate cleanup of the upper aquifer using well 36-1. The model area boundaries were the plume boundaries. It was assumed the well would only capture the groundwater within the plume boundaries. The objective of this research was to develop a distributed parameter model to locate the most optimum well location in the model area grid network that covers a larger area than the plume. The optimum well location would be judged in terms of a risk/cost analysis.

A computer program was written to model the transport of the contaminant using a Monte Carlo simulation to generate risk and cost for different well locations and pumping rates. The model included a stochastic groundwater recharge variable to reflect variability of recharge with annual rainfall. Risk values were computed for different grid network cells where well pumpage was simulated. The cell with coordinates (3,2) has three of the four lowest risk values. This is the cell with well 36-1. For a given cell location simulated for well pumpage, each pumping rate can be a different point plotted on a graph of risk versus cost. The ideal point on a risk/cost plot is zero risk and normalized cost, or the origin of the graph. Distance from each plotted point to the origin was computed for each cell simulated for well pumpage. These distance values were plotted where each curve was a different cell location, and each plotted point was a different pumpage rate. The curve with the closest distance to the horizontal axis would be the optimum well location. This curve proved to be for the cell with well 36-1. The plotted point on this curve with the shortest distance was a pumping rate of 76.56 liters/minute. Simulation of using well 36-1 to remove the contaminant plume reveals that well 36-1 might be the best option for doing so.

Key words: carbon tetrachloride, groundwater quality model, hazardous waste, risk/cost analysis