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Project Summary

Interactive Simulation of the Fate of Hazardous Chemicals During Land Treatment of Oily Wastes: RITZ User's Guide

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An interactive software system was developed to enable decision makers to simulate the movement and fate of hazardous chemicals during land treatment of oily wastes. The mathematical model known as the Regulatory and Investigative Treatment Zone Model or RITZ was developed and published earlier by Short (1985). The model incorporates the influence of oil in the sludge, water movement, volatilization, and degradation upon the transport and fate of a hazardous chemical. This manual describes the conceptual framework and assumptions used by Short (1985) in developing the model. It then explains the micro-computer hardware and software requirements, the input parameters for the model, and the graphical and tabular outputs which can be selected. Illustrations of the use of the software are also included. The computational equations developed by Short (1985) are presented for completeness but are not derived.

This Project Summary was developed by EPA's Robert S. Kerr Environmental Research Laboratory, Ada, OK, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The Regulatory and Investigative Treatment Zone Model, RITZ, (Short, 1985) was developed to help decision makers systematically estimate the movement and fate of hazardous chemicals during land treatment of oily wastes. The model considers the downward movement of the pollutant with the soil solution, volatilization and loss to the atmosphere, and degradation. The model incorporates the influence of oil upon the transport and fate of the pollutant. This RITZ model forms the basis of this interactive software system. The software enables users to conveniently enter the required soil, chemical, environmental, and management parameters and checks the validity of these entries. The user may then select graphical and tabular outputs of the quantities of interest.

This manual describes the basic concepts of RITZ and lists the inherent assumptions. The manual also describes the use of the interactive software and the hardware and software requirements for it. Illustrative examples of the software are presented. The appendix includes a list of the mathematical equations used in the software.

Basic Concepts, Assumptions, and Limitations

A land treatment site is illustrated in Figure 1. The treatment site consists of two soil layers called the plow zone and the treatment zone. The sludge (waste material) containing oil and pollutant is applied to the plow zone. It is thoroughly mixed with the soil in that layer. As time passes the pollutant and oil are degraded. Some of the pollutant is carried down

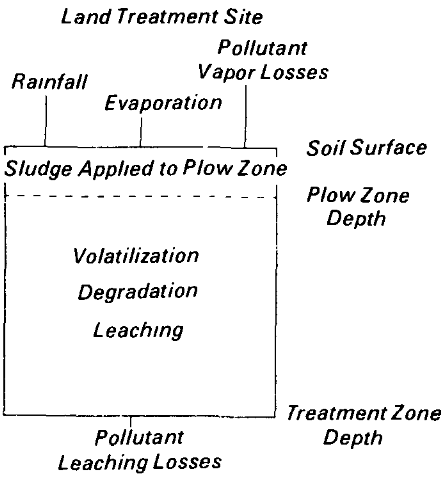

Figure 1. *Diagram of land treatment site.*

through the soil with percolating water. Some of the pollutant is volatilized and moves into the air above the treatment site.

The following assumptions were made by Short (1985) in developing this model:

1. Waste material is uniformly mixed in the plow zone.

2. The oil in the waste material is immobile. It never leaves the plow zone. Only the pollutant moves with the soil water.

3. The soil properties are uniform from the soil surface to the bottom of the treatment zone. This assumption will rarely, if ever, be met in the field. The user can estimate the impact of non-uniform soils by comparing results for several simulations covering the range of soil properties present at the site. The user can estimate the impact of non-uniform soils by using the averaging techniques provided in the program and/or by comparing results for several simulations covering the range of soil properties present at the site. This is referred to again in the last paragraph of the summary.

4. The flux of water is uniform throughout the treatment site and throughout time. This assumption will rarely be met in the field.

5. Hydrodynamic dispersion is insignificant and can be neglected. This assumption gives rise to sharp leading and trailing edges in the pollutant slug. These sharp fronts will not exist in soils. As a result, the pollutant will likely reach any depth in the treatment zone before the time predicted and it will remain at that depth longer than predicted by the model.

6. Linear isotherms describe the partitioning of the pollutant between the liquid, soil, vapor, and oil phases. Local equilibrium between phases is assumed.

7. First order degradation of the pollutant and oil are assumed. Degradation constants do not change with soil depth or time. This assumption ignores changes in biological activity with soil depth. It also ignores the influence of loading rate, temperature, and the quality of the environment for microorganisms upon the degradation rate.

8. The pollutant partitions between the soil, oil, water, and soil vapor and does not partition to the remaining fractions of the sludge.

9. The sludge does not measurably change the properties of the soil water or the soil so the pore liquid behaves as water.

10. The water content of the soil is related to the hydraulic conductivity as described by Clapp and Hornberger (1978). That is,

    $k/k_s = (\theta/\theta_s)^{2b+3}$

    where k is the hydraulic conductivity at a volumetric water content of θ, k_s is the saturated hydraulic conductivity or the conductivity of the soil at the saturated water content, θ_s, and b is the Clapp and Hornberger constant for the soil.

Field validation of the model is in progress. The user is cautioned to consider the assumptions in the model and to apply the model only where appropriate. The writers are aware the assumptions are only simplistic approximations to the continuum of nature. Many of the assumptions were made to either simplify the mathematical solution or because there was insufficient experimental data to permit more realistic descriptions of the system.

The model presents results for the specific parameters entered without any measure of uncertainty in the calculated values. The user is encouraged to compare results for a series of simulations using parameters in the expected ranges for the site to obtain an estimate of this uncertainty. For example, if the site contains two soil layers, the user may want to run the simulation twice, once for the soil properties of each layer.

References Cited

1. Clapp, Roger B. and George M. Hornberger. 1978. Empirical equations for some soil hydraulic properties. Water Resources Research 14: 601-604.

2. Short, Thomas E. 1985. Movement of contaminants from oily wastes during land treatment. Proceedings of Conference on Environmental and Public Health Effects of Soils Contaminated with Petroleum Products, Amherst, MA.

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The complete report, entitled "Interactive Simulation of the Fate of Hazardous Chemicals During Land Treatment of Oily Wastes: RITZ User's Guide," (Order No. PB 88-195 540/AS; Cost: $14.95, subject to change) will be available only from:

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