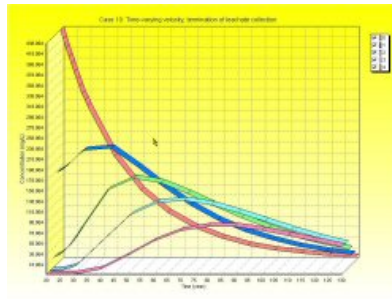


POLLUTE

Professional Version



Introduction to POLLUTE

POLLUTE v7 program provides fast, accurate, and comprehensive contaminant migration analysis capabilities. This program implements a one and a half dimensional solution to the advection-dispersion equation. Unlike finite element and finite difference formulations, POLLUTEv7 does not require a time-marching procedure, and thus involves relatively little computational effort while also avoiding the numerical problems of alternate approaches.

With more than fifteen years utilization in industry, POLLUTEv7 is a well tested contaminant migration analysis program which is widely used in landfill design and remediation. Landfill designs that can be considered range from simple systems on a natural clayey aquitard to composite liners, multiple barriers and multiple aquifers.

In addition to advective-dispersive transport, POLLUTEv7 can consider

- non-linear sorption
- radioactive and biological decay
- transport through fractures
- passive sinks
- phase changes, and
- time-varying properties.

Feature Comparison

Feature	Professional	Standard
Wizards and pre-created models	Yes	Yes
Unlimited number of models	Yes	Yes
Up to 200 layers	Yes	Yes
Constant concentration boundary conditions	Yes	Yes
Finite mass boundary condition	Yes	Yes
Fixed outflow boundary condition	Yes	Yes
Passive Sinks	Yes	Yes
Linear sorption	Yes	Yes
Non-linear sorption	Yes	No
Fractures in layers	Yes	No
Radioactive and biological decay	Yes	No
Initial concentration profile	Yes	No
Time-varying properties	Yes	No
Monte Carlo Simulation	Yes	Yes
Sensitivity Analysis	Yes	Yes

POLLUTE Data Entry

Using the main menu bar at the top of the screen, datasets can be created, edited, and executed. The output from these datasets can then be displayed and printed.

POLLUTE Deposit Data

Datasets can be created or edited using the Data Menu. A dataset consists of general deposit data, layer data, boundary conditions, and optional special features.

First, general data is entered about the model, such as:

- Title of the Dataset
- Number of Soil Layers (each layer can have different properties)
- Darcy Velocity through the soil layers
- Laplace Transform Parameters (defaults are usually sufficient)

POLLUTE Layer Data

For each layer, the following may be specified:

- Number of Sublayers

- Thickness
- Dry Density
- Coefficient of Hydrodynamic Dispersion
- Distribution Coefficient
- Type of Fractures (if present)

Any or all of the layers may be fractured. These fractures may be one, two, or three dimensional. In a fractured layer, the program considers advective-dispersive transport along the fractures coupled with diffusion into the matrix on either side of the fracture.

POLLUTE Boundary Conditions

There are two boundaries for each dataset, one at the top and one at the bottom of the layers. The top boundary is usually the point of contact with the contaminant source (finite mass or constant concentration), and the bottom boundary is usually the point of contact with an aquifer (fixed outflow) or bedrock (zero flux).

Finite Mass Boundary Condition

The finite mass boundary condition may be used to represent contaminant sources such as landfills. Where the mass of contaminant is finite, the concentration of contaminant at the source will decline as contaminant mass is transported into the layers below or is removed by a leachate collection system.

Fixed Outflow Velocity Boundary Condition

This boundary condition may be used to represent an aquifer below the layers in the dataset. The concentration in this aquifer will vary with time as mass is transported into the aquifer from the layers above and is then transported away by the horizontal velocity in the base strata.

POLLUTE Special Features

In addition to the basic data parameters, many special features can also be used in the model. One or more of these special features may be selected from the multiple choice menu.

Radioactive/Biological Decay

Radioactive or biological decay can be modeled. First-order decay is considered by specifying

the half lives for the source, layers, and base aquifer. The layers may have the same half-life, or the half-life can be specified as a function of depth.

Depth Interval Concentration Profile

To model background concentration in the layers, an initial concentration profile may be used. Using this option, the initial concentration in the layers can be specified as a function of depth. In addition, the flux into the soil and the base can be specified at the start time of the model.

Freundlich and Langmuir Nonlinear Sorption

Either Freundlich or Langmuir nonlinear sorption may be considered. When nonlinear sorption is used, the program splits the layers into sublayers and uses an iterative technique to determine the equivalent linear distribution coefficient for each sublayer.

Properties Increment Within Groups

This option is used to vary properties of the model with time. The user may vary the source concentration, contaminant mass, volume of leachate collected, Darcy velocity, dispersivity and aquifer velocity. For example, this option can be used to simulate the progressive failure of the leachate collection system in a landfill. Time is divided into groups. In each group the properties may be constant with time or may increment linearly with time. The concentration in the source at the beginning of each time group may be specified or the concentration at the end of the last group may be used.

Passive Sink

One or more passive sinks may be used in the model. A passive sink is a layer where there is a horizontal velocity. This will have the effect of removing contaminants. Typically, a passive sink is used to represent secondary leachate collection systems or multiple aquifers.

Monte Carlo Variable Entry

Monte Carlo simulation may be used to evaluate the effects of uncertainty in the values of some of the model data. Using this approach, the uncertain data values are described using a probability distribution. After numerous simulations, a probability distribution is generated for the peak concentration of the contaminant at any depth.

Primary Liner (Subtitle D) Landfill

There are options to create and customize predefined models quickly and easily. These models include landfills with primary leachate collection and composite liners (*Subtitle D*).

Primary and Secondary Liner Landfill

There are options to create and customize predefined models quickly and easily. These models include landfills with primary leachate collection and composite liners (*Subtitle D*) and landfills with primary and secondary leachate collection and composite liners (*Subtitle C*). In these quick landfill entry options, layers such as the geomembrane, clay liner, aquitard, and aquifer can be included or discarded simply by the selecting Yes or No beside the layer name.

Leakage Rate (Subtitle D) Landfill

The leakage rate through the composite liner may be calculated using the method proposed by Giroud et al., 1992, and Giroud and Bonaparte, 1989. These calculations consider leakage due to permeation and defects in the geomembrane.

Geomembrane Hole Data

In addition to the type of contact between the geomembrane and the clay liner, the leakage will also depend on the type, size, and frequency of the defects.

Finite Mass Source

The landfill contaminant source can be either finite mass or constant concentration. If the source type is finite mass, the waste thickness and density, infiltration through the cover, and percentage of mass can be specified for the contaminant.

Primary Clay Liner or GCL

For each layer present in the model, the parameters may be specified in any units; the program will automatically convert all units to either SI or US. The liner can be either clay or a geosynthetic clay liner.

Aquifer

If an aquifer is present beneath the landfill, the thickness and porosity of the aquifer can be specified. The program will automatically calculate the minimum outflow velocity in the aquifer. This value or a higher value can be specified.

POLLUTE Model Execution

Calculate Concentrations

After the dataset has been created, the model can be executed. The concentration of the contaminant can be calculated at any number of specific depths or the maximum concentration can be determined automatically at any selected depth. Unlike other techniques that may take hours or days to prepare and execute models, the finite-layer technique is very quick. It typically takes only minutes to prepare and execute a model making it ideal for examining design alternatives and for sensitivity analysis.

POLLUTE Result Output

After the model has been executed, the output file can be displayed, graphed, and printed. Graphs can be concentration versus time, concentration versus depth, flux versus time, and color concentration. All of these graphs can also be easily printed on several types of printers. Default values for the graphs are automatically determined. These values can be easily changed to allow complete customization of the graph. For the concentration versus time graph, one or all of the depths may be plotted; likewise for time in the concentration versus depth graph.

Concentration Versus Time

Concentration with time graphs show the variation in the calculated concentration of the contaminant with time for the depths studied. Using these graphs, the peak concentration at a specific depth can be easily identified. This value is also automatically displayed at the top of the graph.

Concentration Versus Depth

Concentration versus depth graphs show the change in contaminant concentration with depth, either for a specific time or for all the times that were calculated.

Flux Versus Time

The total flux into the top of the soil layers and out of the bottom of the soil layers with time can be graphed.

Color Concentration Plot

The change in concentration with time and depth graph can be used to illustrate the movement of the contaminant plume into deeper depths over time.

Print Options

Graphs can be printed by pressing 'P' while they are displayed. Many of the features of the printed graph can be controlled such as the size, titles and fonts.

POLLUTE Tools

Tools are available to aid in creating and checking datasets.

Calculator

These tools include a calculator that can be used to determine Darcy velocity and contaminant mass.

Help

Context-sensitive help can be accessed any time by pressing the F1 key. The information displayed contains many cross-references which can be displayed by clicking on the highlighted text.

POLLUTE Preferences

The display colors, mouse buttons, and program environment can all be adjusted as desired. Many of the program features can be customized such as directories, file extensions, screen display type, and printer type.

Most popular screen types are supported, including Super VGA, VGA, and EGA, or the screen type can be automatically detected.

A large variety of printers are also supported such as Epson 9 and 24 pin, HP LaserJet, HP Pen Plotters, HP Paint Jet, and Postscript. Graphs can also be converted into PCX file format.