G-TR-G-00002, REVISION 0

Key Words:
Performance Assessment
Tank Closure
Software Quality Assurance

Retention:
Permanent

Software Testing and Verification for PORFLOW Version 6.10.3

Author: Tad Whiteside

October, 2007

Savannah River National Laboratory
Washington Savannah River Company
Savannah River Site
Aiken, SC 29808

Prepared for the U.S. Department of Energy Under
Contract Number DE-AC09-96SR18500

SRNL™

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REVIEWS AND APPROVALS

10/23/2007

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Date

10/23/07

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Date

10/30/07

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Date

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LIST OF ACRONYMS

ACRONYMS

DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
PA	Performance Assessment
QA	Quality Assurance
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
WSRC	Washington Savannah River Company

1.0 SUMMARY

This report identifies the differences between PORFLOW version 5.97.0 and PORFLOW version 6.10.3 using WSRC-STI-2007-00150 Rev 0 as a baseline for developing the tests used in this comparison. Please refer to that report for full descriptions of each test problem.

All of the tests described in WSRC-STI-2007-00150 Rev 0 are implemented here with the exception of that report's Problem 7.2 which was redefined to better test the features found in PORFLOW version 6.10.3. In this report, Section 6.5 Problem 2 and Section 8.2 Problems 1-5 are new.

These additional problems are due to differences found between PORFLOW version 5.97.0 and PORFLOW version 6.10.3. Where these differences did occur, all of the features necessary for the current PA work were available and were providing the correct results.

There is no difference between PORFLOW version 6.10.3 and PORFLOW version 5.97.0 for all problems except for:

- Section 6.5 Problem 1(wc): This problem attempts to calculate retardation using water content. PORFLOW version 6.10.3 does not calculate this correctly, PORFLOW version 5.97.0 does. This method is not used in the current PA work.
- Section 6.5 Problem 2 (wc): This problem attempts to calculate retardation using the PROP TOTA command. PORFLOW version 6.10.3 calculates this correctly, PORFLOW version 5.97.0 can not because this command was unavailable in that version.
- Section 8.2 Problem 1: This problem uses the DIST (Mode 3) command. PORFLOW version 6.10.3 implements this correctly, PORFLOW version 5.97.0 does not.
- Section 8.2 Problem 2: This problem uses the DIST (Mode 1) command. Neither PORFLOW version 6.10.3 nor PORFLOW version 5.97.0 implements this command properly, but both versions implement it in the same way. This command is not used in the current PA work.
- Section 8.2 Problem 3: This problem uses the RETA command. Neither PORFLOW version 6.10.3 nor PORFLOW version 5.97.0 implements this properly, and both versions implement it in different ways. This command is not used in the current PA work.
- Section 8.2 Problem 5 This problem uses the PROP TOTAl command. PORFLOW version 6.10.3 calculates this correctly, PORFLOW version 5.97.0 can not because this command was unavailable in that version.

No difference between versions means the reported results from each version is identical.

The above tests confirm PORFLOW version 6.10.3 meets the needs of the tank closure application. Solubility control should be implemented using the DIST (Mode 3) command. PROP TOTAl should be used to implement the preferred retardation definition. The DIST (Mode 1) and RETA functions do not perform correctly and are not used in this application.

2.0 OBJECTIVE

This report identifies the differences between PORFLOW version 5.97.0 and PORFLOW version 6.10.3 using WSRC-STI-2007-00150 Rev 0 as a baseline for developing the tests used in this comparison. Please refer to that report for full descriptions of each test problem. In addition I have attempted to note all typos and unclear statements found in WSRC-STI-2007-00150. These are documented in Appendix A. Appendix B contains the tabulated output of the test problems.

There were a few differences found between PORFLOW version 5.97.0 and PORFLOW version 6.10.3. We determined these differences did not impact the current modeling effort and all of the features necessary for the current tank closure application were available and were providing the correct results.

3.0 METHOD

A collection of shell scripts and Perl programs were developed to run the test problems enumerated in this report. This collection of QA programs was designed to be portable, and can be installed and run on any computer which uses Windows XP, Services for UNIX, Perl, and PORFLOW. To test PORFLOW we used the same input file for both PORFLOW version 6.10.3 and PORFLOW version 5.97.0 and compared the output. We also compared both output sets with the information reported in WSRC-STI-2007-00150.

The input and output files are located on the computer named *t-whiteside* and are under configuration management via the "Subversion" software, this machine is backed up nightly to winsan1. Version 5 in the repository (D:\documents\svn_repository\porflowqa) is the version that contains all the input and output files used in this report. Subversion is a popular revision control program used by many projects and companies such as the Apache Software Foundation, KDE, and Hobby Lobby. Please see http://subversion.tigris.org/testimonials.html for more information.

4.0 SCOPE OF TEST PROBLEMS

The test problems were selected based on analytical solutions (or code-to-code comparisons) that definitively establish the code accuracy and the resulting impact of mesh and control parameter settings on the accuracy of results. Four groups of test problems are described to verify the capability of the software to represent the physical phenomena characteristic of groundwater flow and transport applications at the Savannah River Site.

They are:

Group 1: Saturated and variably saturated groundwater flow in one and two dimensions (steady-state and transient conditions).

Group 2: Contaminant transport in one, two and three dimensions (transient).

Group 3: Numerical dispersion.

Group 4: Keyword Commands (e.g. STATistics).

5.0 GROUP 1: GROUNDWATER FLOW PROBLEMS

5.1 STEADY-STATE, ONE-DIMENSIONAL FLOW IN A CONFINED AQUIFER

Problem description:
Problem 1: A confined aquifer experiencing steady, one-dimensional flow with the general head boundary condition.
Problem 2: A confined aquifer experiencing steady, one-dimensional flow with the river bed boundary condition.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.
Problem 2: There are no differences between versions.

Comments:
None

5.2 STEADY-STATE, ONE-DIMENSIONAL FLOW IN AN UNCONFINED AQUIFER

Problem description:
Problem 1: An unconfined aquifer with no recharge and constant head boundary conditions.
Problem 2: An unconfined aquifer with recharge and mixed boundary conditions.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.
Problem 2: There are no differences between versions.

Comments:
The mesh for Problem 1 contains 101 nodes in the x-direction and 61 nodes in the y-direction. The mesh for Problem 2 contains 165 nodes in the x-direction and 25 nodes in the y-direction. The hydraulic head at one y-value and various x-values was reported, however WSRC-STI-2007-00150 Rev 0 did not state which y-value was chosen as the stationary node. For both problems I chose the node y = 10 since this returns the same results as those reported in WSRC-STI-2007-00150 Rev 0.

If the input file (4.2-p2.inp) is changed so it does not use the restart file:
"`DEFIne INIT=1`"
to:
"`DEFIne INIT=0`"

Then the output from PORFLOW version 5.97.0 and PORFLOW version 6.10.3 differ when x = 960.

When using the original input file from WSRC-STI-2007-00150 in PORFLOW version 6.10.3, 4.2-p2.sav is not output as a plain text file. 4.2-p2.sav is saved as plain text file if PORFLOW version 5.97.0 is used. This is because in PORFLOW version 6.10.3 the SAVE and OUTPUT command modifiers, once specified, stay in effect unless explicit specification occurs otherwise. In order to correct this I commented out the line:
`“SAVE P S MOIS to “INIT.sav” UNFOrmatted using COMPact NOW”`
The INIT.sav file is not used to produce the information necessary to compare the two versions.

5.3 STEADY-STATE, TWO-DIMENSIONAL FLOW THROUGH A HETEROGENEOUS AQUIFER SYSTEM

Problem description:
There are two aquifer systems: an unconfined aquifer with no recharge and constant head difference on top of a confining unit. The confining unit is on top of a confined aquifer which has a constant head difference.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.
Problem 2: There are no differences between versions.

Comments:
None

5.4 UNCONFINED AQUIFER SUBJECT TO COMBINED RECHARGE/DRAIN BC

Problem description:
Problem 1: An unconfined aquifer with recharge and drainage at the ground surface. It is to test the implementation of a combined recharge/drain Cauchy boundary condition.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.

Comments:
The mesh contains 21 nodes in the x-direction for a mesh spacing of 50 feet and 21 nodes in the y-direction. The mesh is non-orthogonal in y and has a mesh spacing of 5 feet at the left boundary and a mesh spacing of 2.5 feet at the right boundary. WSRC-STI-2007-00150 Rev 0 did not state which y-value was used when reporting the horizontal distance versus head. I chose y = 5 because the majority of the results are close to those reported in WSRC-STI-2007-00150 Rev 0.

If the original 4.4.inp file is used (using 4.4.ini) then the output from both versions of PORFLOW is not the same. I changed the input file (4.4.inp) to not use the archive file (4.4.ini):
```
DEFIne INIT=1
```
to:
```
DEFIne INIT=0
```
By doing this the output from both versions of PORFLOW are identical.

The results reported in WSRC-STI-2007-00150 Rev 0 Table 4.4.1 do not match these results, which are generally lower. When the 4.4.ini file is used in the input file, the results still do not match those in Table 4.4.1 (and the two versions of PORFLOW give different output). Since the results have to be averaged to get the correct distances, the points chosen for averaging could differ.

5.5 TRANSIENT, ONE-DIMENSIONAL FLOW TO A WELL IN A CONFINED AQUIFER (THEIS, 1935)

Problem description:
Problem 1: Radial flow to a pumping well in a confined aquifer with a drawdown time of 0-1 hour.
Problem 2: Radial flow to a pumping well in a confined aquifer with a drawdown time of 0-1 day.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.
Problem 2: There are no differences between versions.

Comments:
None

5.6 TRANSIENT, TWO-DIMENSIONAL FLOW TO A WELL IN AN ANISOTROPIC CONFINED AQUIFER (HANTUSH AND THOMAS, 1966)

Problem description:
This is the same problem as 5.5 except that the hydraulic conductivity is anisotropic in the horizontal plane.
Problem 1 shows the drawdown at x = 55m.
Problem 2 shows the drawdown at y = 55m.
Problem 3 shows the drawdown at x = y = 55m

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.
Problem 2: There are no differences between versions.
Problem 3: There are no differences between versions.

Comments:

None

5.7 TRANSIENT, ONE-DIMENSIONAL FLOW TO A WELL IN A LEAKY CONFINED AQUIFER (HANTUSH AND JACOB, 1955)

Problem description:
This is the same problem as 5.5 except the aquifer is recharged from an overlying constant head aquifer through an aquitard separating them.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.

Comments:
None

5.8 FREE-SURFACE BOUSSINESQ FLOW WITH RECHARGE

Problem description:
This problem attempts to determine the phreatic surface at specified times. The phreatic surface is initially at 10 m everywhere. At time zero the water level at the left boundary is suddenly raised to 11 m.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.

Comments:
None

5.9 FREE-SURFACE BOUSSINESQ FLOW WITH SEEPAGE

Problem description:
This problem attempts to determine the phreatic surface at specified times. The phreatic surface is initially at 10 m everywhere. At time zero the water level at the left boundary is suddenly lowered to 9 m.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.

Comments:
None

5.10 UNSATURATED VERTICAL SOIL COLUMN

Problem description:

These problems were designed to confirm correct implementation of soil characteristic curves and Richard's equation.
Problem 1 reproduces the water retention curve under no flow conditions.
Problem 2 involves steady-state unsaturated flow at constant saturation.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.
Problem 2: There are no differences between versions.

Comments:
The values in Table 11-16 differ from those presented in WSRC-STI-2007-00150 Rev 0. In that report, the Darcy Velocity is graphed at -0.00703 (Figure 4.10.4), this value is the negative of the analytical solution described on page 57 of WSRC-STI-2007-00150 Rev 0 and is twice the value of what was computed during this run (-0.0035015), except at the column height of 0, where these two values are the same.

6.0 GROUP 2: CONTAMINANT TRANSPORT PROBLEMS

6.1 ONE-DIMENSIONAL SATURATED SOLUTE TRANSPORT IN A UNIFORM FLOW FIELD

Problem description:
This problem deals with one-dimensional advection-dispersion of a non-conservative solute species through a semi-infinite porous medium and is used to demonstrate the impact various numerical approximations have on its solution. This includes various mesh sizes, radioactive decay rates, and solute distribution coefficients.

PORFLOW simulation and comparison:

Case Basecase:	There are no differences between versions.
Case A:	There are no differences between versions.
Case B:	There are no differences between versions.
Case C:	There are no differences between versions.
Case D:	There are no differences between versions.
Case E:	There are no differences between versions.
Case F:	There are no differences between versions.
Case G:	There are no differences between versions.
Case H:	There are no differences between versions.
Case I:	There are no differences between versions.
Case J:	There are no differences between versions.
Case K:	There are no differences between versions.
Case L:	There are no differences between versions.

Comments:
None

6.2 TWO-DIMENSIONAL SATURATED SOLUTE TRANSPORT IN A UNIFORM FLOW FIELD

Problem description:
This problem deals with two-dimensional advection-dispersion of a non-conservative solute species from a point source through an infinite porous medium. It is used to demonstrate the impact grid orientation with transverse dispersion and various numerical approximations have on the solution. This includes mesh options and various values for physical parameters.

PORFLOW simulation and comparison:

Case A (parallel):	There are no differences between versions.
Case A (transverse):	There are no differences between versions.
Case B (parallel):	There are no differences between versions.
Case B (transverse):	There are no differences between versions.
Case C (parallel):	There are no differences between versions.
Case C (transverse):	There are no differences between versions.
Case D (parallel):	There are no differences between versions.
Case D (transverse):	There are no differences between versions.

Comments:
The analytical solutions for these problems should be (re)done for ease of comparison.

6.3 THREE-DIMENSIONAL SATURATED SOLUTE TRANSPORT IN A UNIFORM FLOW FIELD

Problem description:
This problem demonstrates the capability of PORFLOW to solve 3D transport problems and to yield 3D results that are axisymmetric. This problem also tests PORFLOW's formulation of transverse dispersion in more than one dimension. The physical schematic is essentially the as for the 2D transport problem (6.2).

PORFLOW simulation and comparison:

Problem 1 ($y = 0, z = 0$):	There are no differences between versions.
Problem 2 ($x = 120, y = 0$):	There are no differences between versions.
Problem 3 ($x = 120, z = 0$):	There are no differences between versions.

Comments:
None

6.4 SLIT AND ENGINEERED TRENCH RADON AIR PATHWAY TRANSPORT SIMULATION

Problem description:
This problem simulates Rn-222 concentration profiles and fluxes from the Slit and Engineered Trenches over a 1000 year period. The potential nuclides that can contribute to

the formation of Rn-222 are modeled (Th-230, Ra-226, and Rn-222). The flux of Rn-222 at the land surface is also simulated.

PORFLOW simulation and comparison:

Problem 1 (Th-230):	There are no differences between versions.
Problem 2 (Ra-226):	There are no differences between versions.
Problem 3 (Rn-222):	There are no differences between versions.
Problem 4 (Rn-222 Flux):	There are no differences between versions.

Comments:

The program saves the decay concentrations in 100 year steps; we only analyzed the 1000 year step, because this allows a direct comparison with COMSOL.

The program ACRi2Tecplot.exe incorrectly reformats numbers with very large or small exponents; e.g. it turns 2.54468075E-124 into 2.5447-124. The program is apparently attempting to make the number 10 characters long. This was verified by finding the data in the Th-230.sav file and then again after this data was processed by ACRi2Tecplot.

The data shown in WSRC-STI-2007-00150 Rev 0 is reported in PCi/sec, the data in this report is in Ci/yr.

6.5 IMPACT OF PORFLOW RETARDATION MODEL ON VARIABLY SATURATED SOLUTE TRANSPORT

Problem description:

The conventional definition of the retardation factor as generally used by the groundwater modeling community for a linear adsorption isotherm is shown in Equation 1 as

Equation 1

$$R = 1 + \frac{\rho_s (1-\phi) K_d}{\theta} = 1 + \frac{\rho_s (1-\phi) K_d}{S\phi}$$

Equation 1 is based on the assumption that the solid substrate available for sorption remains fully wetted when the medium is unsaturated. Even if θ = 0, Equation 1 can be derived as follows:

Defining porosity as $\phi = V_\phi / V_T$; solid density as ρ_s; distribution coefficient as $K_d = c_S / c_L$; saturation as $S = V_L / V_\phi$; water content as $\theta = V_L / V_T = \phi * S$; M_L is mass of contaminant in liquid; and M_S is mass of contaminant in solid

Derivation of Equation 1:

$$\frac{M_L}{V_T} = \frac{c_L V_L}{V_T} = c_L \frac{V_L}{V_\phi} \frac{V_\phi}{V_T} = c_L S \phi$$

$$\frac{M_L}{V_T} = \frac{c_L V_L}{V_T} = c_L \frac{V_L}{V_\phi}\frac{V_\phi}{V_T} = c_L S\phi$$

$$\frac{M_S}{V_T} = \frac{c_S \rho_S V_S}{V_T} = \frac{K_d c_L \rho_S (V_T - V_\phi)}{V_T} = c_L K_d \rho_S (1-\phi)$$

$$\frac{M_T}{V_T} = \frac{M_S}{V_T} + \frac{M_L}{V_T} = c_L\left[S\phi + K_d \rho_S (1-\phi)\right] = S\phi c_L\left[1 + \frac{K_d \rho_S (1-\phi)}{S\phi}\right] = \theta c_L\left[1 + \frac{K_d \rho_S (1-\phi)}{\theta}\right]$$

Equation 2 assumes the fraction of solid available for sorption is proportional to saturation. It can be derived as follows:

Equation 2

$$R = 1 + \frac{\rho_s (S_w - \theta_e) K_d}{\theta_e} = 1 + \frac{\rho_s (1-\phi) K_d}{\phi}$$

Derivation of Equation 2:

$$\frac{M_L}{V_T} = \frac{c_L V_L}{V_T} = c_L \frac{V_L}{V_\phi}\frac{V_\phi}{V_T} = c_L S\phi$$

$$\frac{M_S}{V_T} = \frac{c_S \rho_S V_S S}{V_T} = \frac{K_d c_L \rho_S V_S S}{V_T}$$

$$\frac{M_T}{V_T} = \frac{M_S}{V_T} + \frac{M_L}{V_T} = c_L\left[S\phi + \frac{K_d \rho_S V_S S}{V_T}\right] = \theta c_L\left[1 + \frac{K_d \rho_S S (V_T - V_\phi)}{V_T S\phi}\right] = \theta c_L\left[1 + \frac{K_d \rho_S (1-\phi)}{\phi}\right]$$

The only difference between Equation 1 and Equation 2 is in the denominator. These equations are identical under saturated conditions, when S=1 then θ = ϕ. Equation 1 computes retardation based on water content and Equation 2 is dependant on the porosity of the material.

Each test problem has two cases: A is water content and B is porosity. These cases use the physical setup as described in WSRC-STI-2007-00150 Rev 0. They use Equation 1 and Equation 2, for water content (wc) and porosity (phi), respectively, to determine the solute concentration at a specified distance. This is calculated for the Parent and Daughter species at 25 and 50 years. Water content uses Equation 1 by making the retardation factor a function of moisture control.

Problem 1 is the same as described in WSRC-STI-2007-00150 Rev 0 section 5.5.

Problem 2 is a new problem that tests the PROP TOTA command which became available in PORFLOW 6.10.3 and is an alternative way to implement Equation 1. The input file for Problem 2 is listed in Table 6-1.

PORFLOW simulation and comparison:
Problem 1A (wc - Equation 1): Version 5.97.0 implements this correctly, version 6.10.3 does not.
Problem 1B (phi - Equation 2): There are no differences between versions.
Problem 2A (wc - Equation 1): Version 6.10.3 implements this correctly, version 5.97.0 can not.
Problem 2B (phi - Equation 2): There are no differences between versions.

Comments:
The input program saves the decay concentrations in 100 year steps; we analyzed the 1000 year output, because this is the available COMSOL output.

Problem 1A (wc), we expected PORFLOW version 6.10.3 to perform identically to PORFLOW version 5.97.0 but it did not, see Figure 6-1 and Figure 6-2. The reason for this performance difference is unknown. We assume PORFLOW version 5.97.0 is performing correctly because it produces the same results as COMSOL. This difference is not a concern because this modeling effort uses the PROP TOTA command to determine the retardation.

Problem 2A (wc), PORFLOW version 5.97.0 cannot implement this correctly because the PROP TOTA command was not present in that version of PORFLOW, it was tested in order to determine what would happen if PORFLOW received a command it should not have understood. By using the PROP TOTA command, PORFLOW version 6.10.3 produces a solution that agrees with the COMSOL result.

Table 6-1 Input commands for Problem 2

```
************************************************************************
TITLe 1-D unsaturated solute transport in a uniform flow field
************************************************************************
! steady-state flow at constant saturation of 50% (PROPerty TOTAl)
************************************************************************

!================ retardation factor based on porosity =================
GRID is 201 NODEs
COORdinate NODEs X: MINImum=0.0, MAXImum=4.e2

! Material types and subregions
MATErial type  1 ! total domain

! Material and nuclide properties
PROPerty for C  is HARMonic
PROPerty for C2 is HARMonic

FOR material type 1:
MATErial DENSITY 2.0
MATErial POROsity 3*0.5
TRANsport for C  Kd=0.5 Da=0 aL=4 aT=0
```

```
TRANsport for C2 Kd=0.5 Da=0 aL=4 aT=0

! Flow conditions
SET S = 0.5
SET U = 4.0

! Boundary conditions
BOUNdary C  at X- in VALUe = 1
BOUNdary C  at X+ in GRAD  = 0
BOUNdary C2 at X- in VALUe = 0
BOUNdary C2 at X+ in GRAD  = 0

! Decaying species
DECAy half LIFE for C   is 25 years

REGEneration of C2 from C is 1.

SET C2 0.

! Diagnostic information
DIAGnostic output: TIME DTIME C for node 200 every 10 steps

! Time history
SAVE for C C2 at TIME every 25 years to '5.6-phi.sav'

! Solution controls
MATRix in X for C C2 3 3 sweeps using ADI
CONVergence for C  REFErence LOCAl 1.e-6, max iterations = 30
CONVergence for C2 REFErence LOCAl 1.e-6, max iterations = 30

! Solve transient transport
! Time period: 0 to 500 years
TIME = 0.

SOLVe C C2 for 50 years in steps of 0.01 years

END
!================ retardation factor based on porosity =================

!============== retardation factor based on water content ==============
GRID is 201 NODEs
COORdinate NODEs X: MINImum=0.0, MAXImum=4.e2

! Material types and subregions
MATErial type  1 ! total domain

! Material and nuclide properties
PROPerty for C  is HARMonic
PROPerty for C2 is HARMonic

FOR material type 1:
MATErial DENSITY 2.0
MATErial POROsity 3*0.5
TRANsport for C  Kd=0.5 Da=0 aL=4 aT=0
TRANsport for C2 Kd=0.5 Da=0 aL=4 aT=0
```

```
! Flow conditions
SET S = 0.5
SET U = 4.0
SET MOIS as LINEar function: 0. + (0.5)(S)

! Boundary conditions
BOUNdary C  at X- in VALUe = 1
BOUNdary C  at X+ in GRAD  = 0
BOUNdary C2 at X- in VALUe = 0
BOUNdary C2 at X+ in GRAD  = 0

! Decaying species
DECAy half LIFE for C   is 25 years

REGEneration of C2 from C is 1.

SET C2 0.

!Compute retardation factor based on water content
PROPerty C TOTAl
PROPerty C2 TOTAl

! Diagnostic information
DIAGnostic output: TIME DTIME C for node 200 every 10 steps

! Time history
SAVE for C C2 at TIME every 25 years to '5.6-wc.sav'

! Solution controls
MATRix in X for C C2 3 3 sweeps using ADI
CONVergence for C  REFErence LOCAl 1.e-6, max iterations = 30
CONVergence for C2 REFErence LOCAl 1.e-6, max iterations = 30

! Solve transient transport
! Time period: 0 to 500 years
TIME = 0.

SOLVe C C2 for 50 years in steps of 0.01 years

END
!============== retardation factor based on water content ==============

QUIT
```

Figure 6-1 COMSOL vs 6.10.3 vs 5.97.0 at 25 years using Equation 1

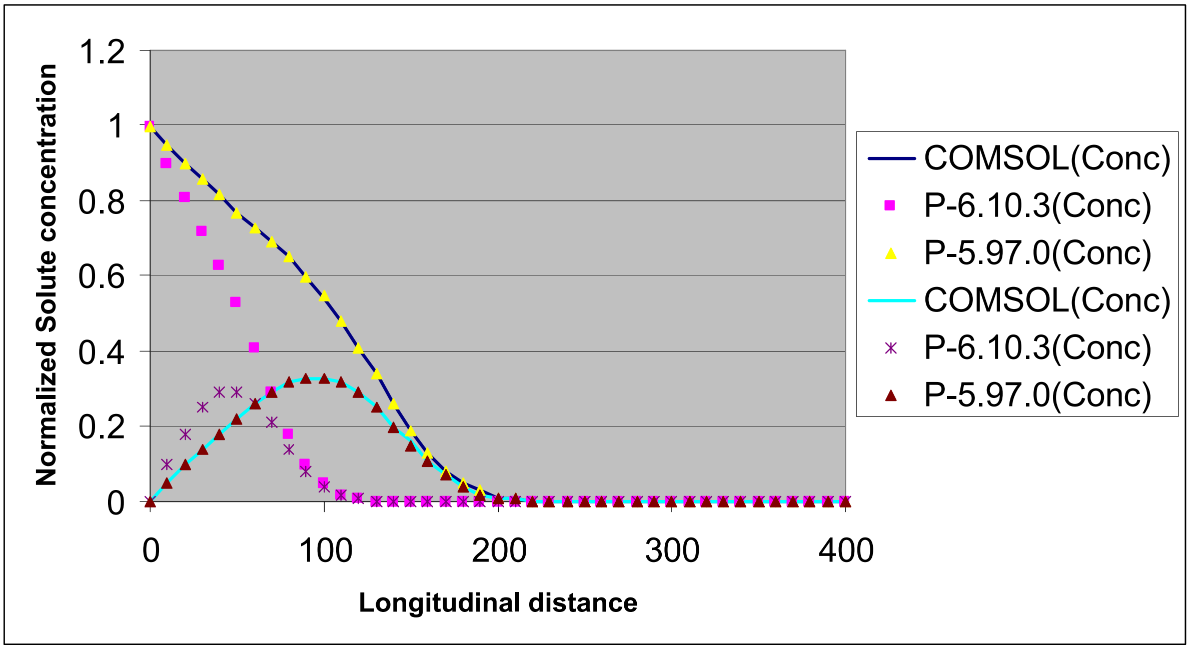
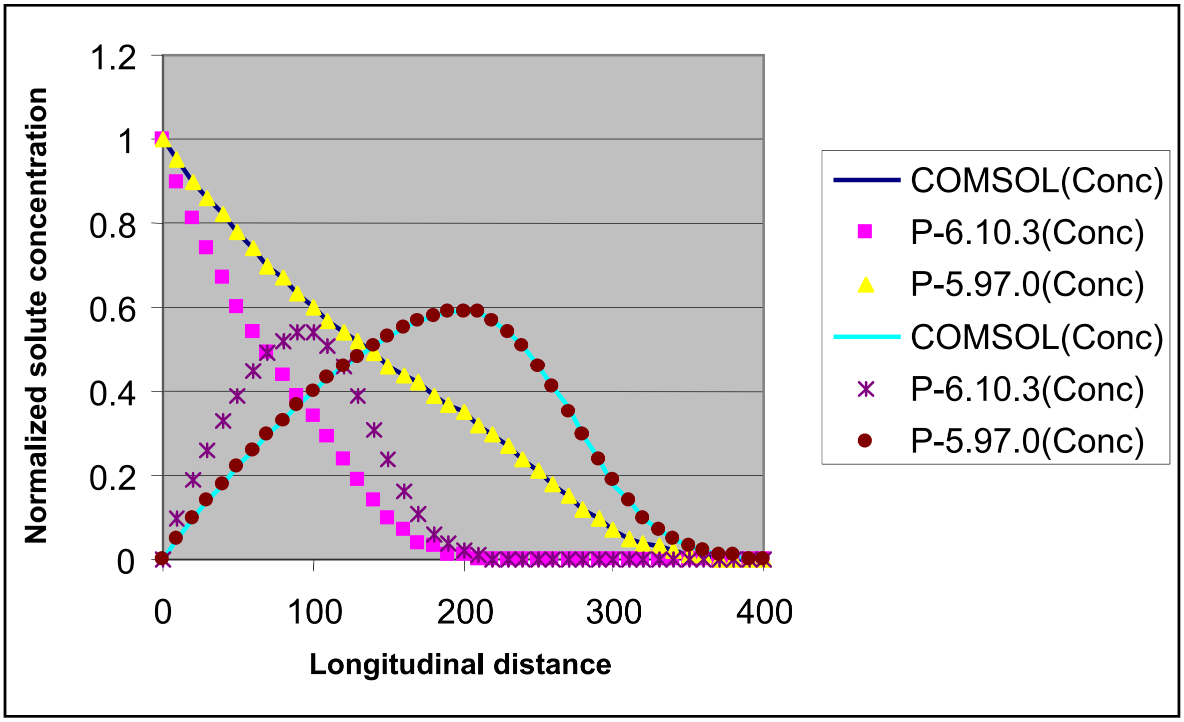

Normalized Solute concentration
1.2
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
Longitudinal distance
COMSOL(Conc)
P-6.10.3(Conc)
P-5.97.0(Conc)
COMSOL(Conc)
P-6.10.3(Conc)
P-5.97.0(Conc)

Figure 6-2 COMSOL vs 6.10.3 vs 5.97.0 at 50 years using Equation 1



7.0 GROUP 3: NUMERICAL DISPERSION

7.1 NUMERICAL AND MECHANICAL DISPERSION IN A ONE-DIMENSIONAL SATURATED SOIL COLUMN

Problem description:
A series of one-dimensional solute transport simulations under saturated conditions and 10 meters per year Darcy velocity were executed in PORFLOW. Ten grids were generated with equally sized mesh spacing ranging from 0.1 to 60 meters. In Problem 1 only numerical dispersion was used. In Problem 2 mechanical dispersion was also turned on to see it's impact on the solute concentration profiles.

PORFLOW simulation and comparison:
Numerical Dispersion
Problem 1 (mesh spacing 0.1): There are no differences between versions.
Problem 1 (mesh spacing 1): There are no differences between versions.
Problem 1 (mesh spacing 5): There are no differences between versions.
Problem 1 (mesh spacing 10): There are no differences between versions.
Problem 1 (mesh spacing 15): There are no differences between versions.
Problem 1 (mesh spacing 20): There are no differences between versions.
Problem 1 (mesh spacing 30): There are no differences between versions.
Problem 1 (mesh spacing 40): There are no differences between versions.
Problem 1 (mesh spacing 50): There are no differences between versions.

Problem 1 (mesh spacing 60): There are no differences between versions.

Mechanical Dispersion
Problem 2 (mesh spacing 0.1): There are no differences between versions.
Problem 2 (mesh spacing 1): There are no differences between versions.
Problem 2 (mesh spacing 5): There are no differences between versions.
Problem 2 (mesh spacing 10): There are no differences between versions.
Problem 2 (mesh spacing 15): There are no differences between versions.
Problem 2 (mesh spacing 20): There are no differences between versions.
Problem 2 (mesh spacing 30): There are no differences between versions.
Problem 2 (mesh spacing 40): There are no differences between versions.
Problem 2 (mesh spacing 50): There are no differences between versions.
Problem 2 (mesh spacing 60): There are no differences between versions.

Comments:
None

8.0 GROUP 4: KEYWORD COMMANDS

This section deals with the testing of several PORFLOW keyword commands of interest to the Performance Assessment modelers at SRNL. The list of keywords tested will continue to grow as needed by this modeling community.

8.1 DECAY AND REGENERATION

Problem description:
The DECAy command is used to specify rate constants and mode of decay of a dependent variable due to physical, chemical, or radioactive decay. The REGEneration command is used to specify the regeneration rate of one species from another in the decay chain. This problem uses the U-230 decay chain to verify that PORFLOW correctly computes transient concentrations of the parent and progeny species undergoing radioactive decay.

PORFLOW simulation and comparison:
Problem 1: There are no differences between versions.

Comments:
None

8.2 DISTRIBUTION AND RETARDATION

Problem description:

The original test problems described in WSRC-STI-2007-00150 section 7.2 were inadequate for the proper testing of the DIST and RETA commands. We have rewritten these test cases as described below.

Problem 1
The PORFLOW command DIST (Mode 3) was used to impose a solubility limit of 1 μg/mL. The test case simulates injection and then extraction of 2 μg of contaminant mass into a closed system with a saturation of 1, a volume of 1 mL, porosity of 0.5, a solid density of 2.5 g/mL, and Kd is 0.4 mL/g. The solubility limit is reached at 1 μg of contaminant mass addition (at 100 years).

Problem 2
The PORFLOW command DIST (Mode 1) was used to impose a solubility limit of 1 μg/mL. The same parameters were used as in Problem 1.

Problem 3
The PORFLOW command RETA was used to impose a solubility limit of 1 μg/mL. The same parameters were used as in Problem 1.

Problem 4
This test case simulates unsaturated transport using the PORFLOW default definition of retardation factor and the same parameters described in Problem 1 with a saturation of 0.5 and no solubility constraints. The retardation factor is defined in Equation 2.

Problem 5
This test case is the same as Problem 4 except the PROP TOTA command is specified in order to invoke the alternative definition of retardation factor as defined by Equation 1.

The PORFLOW input commands are shown in Table 8-1 through Table 8-5.

PORFLOW simulation and comparison:
Problem 1 (DISTribution command mode 3): PORFLOW 6.10.3 implements this correctly; PORFLOW 5.97.0 does not.
Problem 2 (DISTribution command mode 1): Neither version implements correctly, but each produce the same output.
Problem 3 (RETArdation command): Neither version implements this command correctly and each produce different output.
Problem 4 Retardation independent of saturation (PORFLOW default): Both versions implement correctly.
Problem 5 Retardation dependent on saturation (PROPerty TOTAl command): PORFLOW 6.10.3 implements this correctly; PORFLOW 5.97.0 cannot implement this correctly because the PROP TOTA command was not present in that version of PORFLOW.

Comments:
The DISTribution command mode 1, as shown in Problem 2, is not implemented properly in either version of PORFLOW, see Figure 8-1, however, both produce the same output.

The RETArdation command, Problem 3, is not implemented properly in either version of PORFLOW, see Figure 8-2, and both produce different output.

When there is a need to implement solubility conditions the DISTribution command in mode 3 should be used. As noted in problem 6.5, RETArdation should be implemented using the PROP TOTAl command.

Figure 8-1 Analytical vs. PORFLOW 6.10.3 vs. PORFLOW 5.97.0

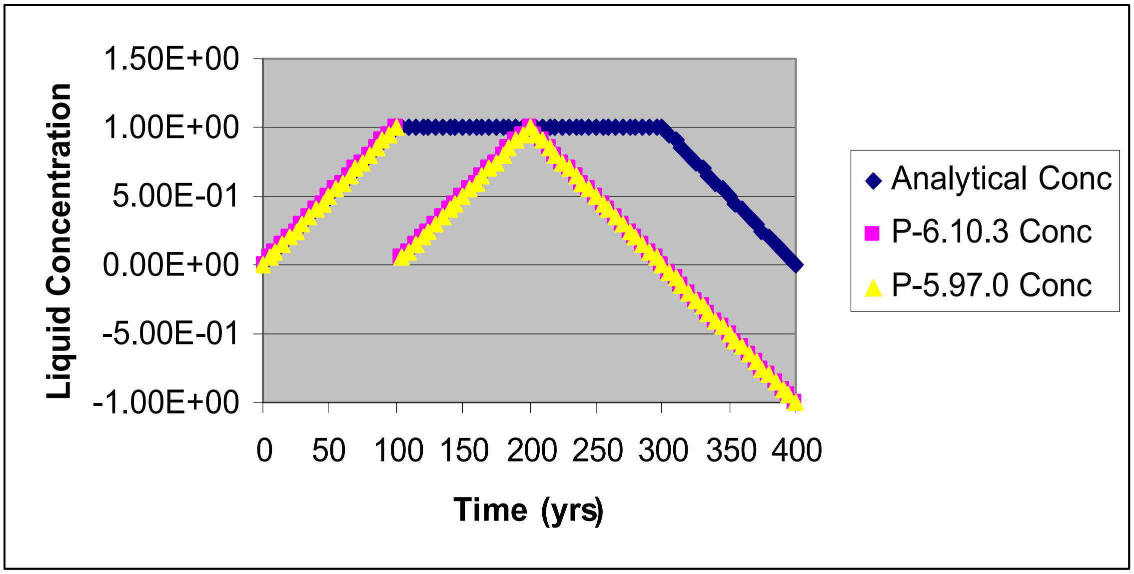


Figure 8-2 Analytical vs. PORFLOW 6.10.3 vs. PORFLOW 5.97.0

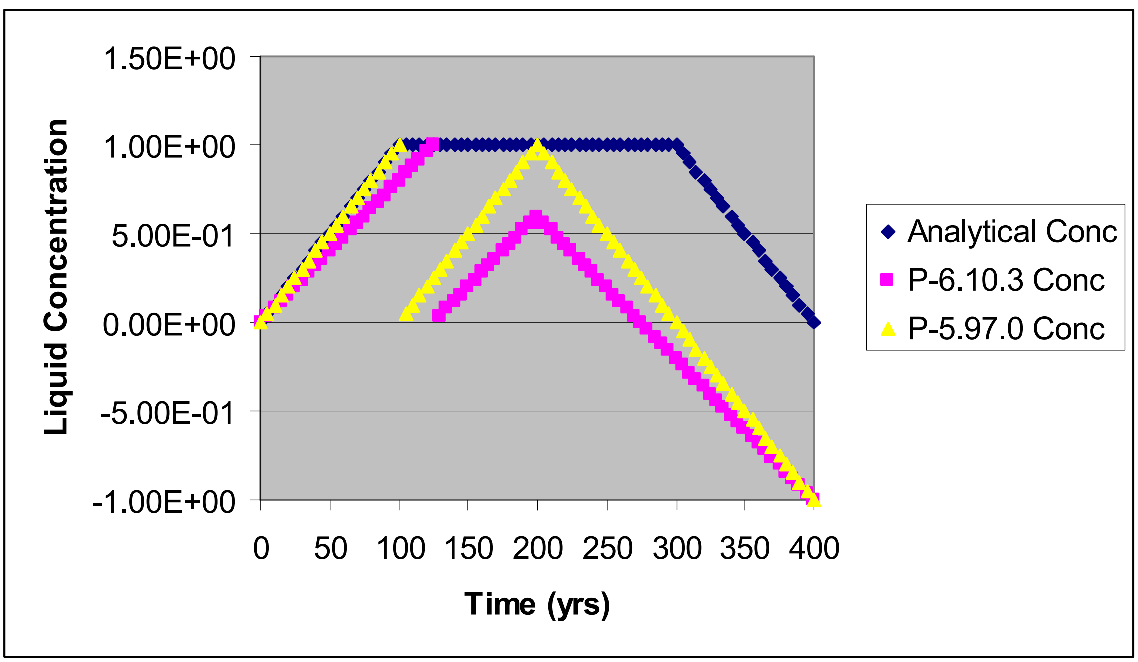


Table 8-1 PORFLOW input commands for Problem 1.

```
***********************************************************************
TITLE: DISTribution command (Mode 3)
!      TESTING SOLUBILITY LIMITED SOURCE
***********************************************************************

GRID 3
COORDINATE X RANGE = 1

MATErial dry solid DENSity  = 2.5  !g/cm3
MATErial POROsity = 0.5

DENSITY = 1

TRANsport for C  Kd=0., Dm=0 !m2/year

BOUNdary FOR C:  at X- FLUX = 0
BOUNdary FOR C:  at X+ FLUX = 0

SET C to 0
SET S to 1

DISTribution of C as CONCentration TABLe of cL vs cS values: with 3 sets:
 (0, 0) (0.4, 1) (1000000, 1)

DIAgnostics for TIME C at: (2,2) every 10 steps

! Solution controls
MATRix in X for C 3 sweeps using ADI
CONVergence for C  REFErence LOCAl 1.e-6, max iterations = 30

FLUX of C for at TIME interval of 0.1 years to 'DIST.flx'
HISTORY of STORage for C at TIME interval of 0.1 years to 'DIST-STOR.his'

SELEct (2,2)
HISTORY for C at TIME interval of 0.1 years to 'DIST-C.his' for SELEcted

SELEct (2,2)
SOURce for C by VOLUme: 0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

SOURce for C by VOLUme: -0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

END
QUIT
```

Table 8-2 PORFLOW input commands for Problem 2

```
**********************************************************************
TITLE: DISTribution command (Mode 1)
!      TESTING SOLUBILITY LIMITED SOURCE
**********************************************************************

GRID 3
COORDINATE X RANGE = 1

MATErial dry solid DENSity  = 2.5  !g/cm3
MATErial POROsity = 0.5

DENSITY = 1

TRANsport for C  Kd=0., Dm=0 !m2/year

BOUNdary FOR C:  at X- FLUX = 0
BOUNdary FOR C:  at X+ FLUX = 0

SET C to 0
SET S to 1

DISTribution of C as (C,kd) TABLe of values: with 3 sets:
 (0., 0.4) (1., 0.4) (2, 1000000)

DIAgnostics for TIME C at: (2,2) every 10 steps

! Solution controls
MATRix in X for C 3 sweeps using ADI
CONVergence for C  REFErence LOCAl 1.e-6, max iterations = 30

FLUX of C for at TIME interval of 0.1 years to 'DIST2.flx'
HISTORY of STORage for C at TIME interval of 0.1 years to 'DIST2-STOR.his'

SELEct (2,2)
HISTORY for C at TIME interval of 0.1 years to 'DIST2-C.his' for SELEcted

SELEct (2,2)
SOURce for C by VOLUme: 0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

SOURce for C by VOLUme: -0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

END
QUIT
```

Table 8-3 PORFLOW input commands for Problem 3

```
***********************************************************************
TITLE: RETArdation command (Mode 1)
!      TESTING SOLUBILITY LIMITED SOURCE
***********************************************************************

GRID 3
COORDINATE X RANGE = 1

MATErial dry solid DENSity  = 2.5  !g/cm3
MATErial POROsity = 0.5

DENSITY = 1

TRANsport for C  Kd=0., Dm=0 !m2/year

BOUNdary FOR C:  at X- FLUX = 0
BOUNdary FOR C:  at X+ FLUX = 0

SET C to 0
SET S to 1

RETArdation of C as (C,Rvalue) TABLe of values: with 3 sets:
(0, 2) (1, 2) (2, 2500001)

DIAgnostics for TIME C at: (2,2) every 10 steps

! Solution controls
MATRix in X for C 3 sweeps using ADI
CONVergence for C  REFErence LOCAl 1.e-6, max iterations = 30

FLUX of C for at TIME interval of 0.1 years to 'RETA.flx'
HISTORY of STORage for C at TIME interval of 0.1 years to 'RETA-STOR.his'

SELEct (2,2)
HISTORY for C at TIME interval of 0.1 years to 'RETA-C.his' for SELEcted

SELEct (2,2)
SOURce for C by VOLUme: 0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

SOURce for C by VOLUme: -0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

END
QUIT
```

Table 8-4 PORFLOW input commands for Problem 4.

```
**********************************************************************
TITLE: Retardation independent of saturation
**********************************************************************

GRID 3
COORDINATE X RANGE = 1

MATErial dry solid DENSity  = 2.5  !g/cm3
MATErial POROsity = 0.5

DENSITY = 1

TRANsport for C  Kd=0.4, Dm=0 !m2/year

BOUNdary FOR C:  at X- FLUX = 0
BOUNdary FOR C:  at X+ FLUX = 0

SET C to 0
SET S to 0.5

DIAgnostics for TIME C at: (2,2) every 10 steps

! Solution controls
MATRix in X for C 3 sweeps using ADI
CONVergence for C  REFErence LOCAl 1.e-6, max iterations = 30

FLUX of C for at TIME interval of 0.1 years to 'TRAN.flx'
HISTORY of STORage for C at TIME interval of 0.1 years to 'TRAN-STOR.his'

SELEct (2,2)
HISTORY for C at TIME interval of 0.1 years to 'TRAN-C.his' for SELEcted

SELEct (2,2)
SOURce for C by VOLUme: 0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

SOURce for C by VOLUme: -0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

END
QUIT
```

Table 8-5 PORFLOW input commands for Problem 5

```
***********************************************************************
TITLE: Retardation independent of saturation
!      TESTING PROPerty TOTAl
***********************************************************************

GRID 3
COORDINATE X RANGE = 1

MATErial dry solid DENSity  = 2.5  !g/cm3
MATErial POROsity = 0.5

DENSITY = 1

TRANsport for C  Kd=0.4, Dm=0 !m2/year

PROPerty C is TOTAl

BOUNdary FOR C:  at X- FLUX = 0
BOUNdary FOR C:  at X+ FLUX = 0

SET C to 0
SET S to 0.5

DIAgnostics for TIME C at: (2,2) every 10 steps

! Solution controls
MATRix in X for C 3 sweeps using ADI
CONVergence for C  REFErence LOCAl 1.e-6, max iterations = 30

FLUX of C for at TIME interval of 0.1 years to 'TRAN2.flx'
HISTORY of STORage for C at TIME interval of 0.1 years to 'TRAN2-STOR.his'

SELEct (2,2)
HISTORY for C at TIME interval of 0.1 years to 'TRAN2-C.his' for SELEcted

SELEct (2,2)
SOURce for C by VOLUme: 0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

SOURce for C by VOLUme: -0.01 per year
SOLVE C 200 years in steps of 0.1
SOURce is OFF for C

END
QUIT
```

8.3 DISTRIBUTION (MODE 3)

Problem description:
These problems are a more involved test of the DISTribution (Mode 3) command. They were only run using PORFLOW version 6.10.3 and the comparisons made were to additional PORFLOW commands that should give similar results.

The physical layout of the problem is as a 1000cm by 1000cm plain with a downward Darcy velocity of 10cm/yr; porosity is 0.4; density of the material is 2.6. We are modeling the Pu-239 decay chain. The initial inventory is 1 mol of Pu-239, which produces a concentration of 4.0E-8 mol/mL in the WASTE zone if there are no solubility controls. The contaminant is located in a 400cm by 400cm area at 500cm by 700cm.

Problem 1: There are no solubility controls.
- -SorptionKd: TRANsport Kd specification
- -SorptionDIST: DISTribution CONCentration

Problem 2: There is solubility control on Pu-239 this is set at 1.0e-10 mol/mL
- -SolubilitySOUR: SOURce SOLUbility
- -SolubilityDIST: DISTribution CONCentration

Problem 3: There is solubility control on Pu-239 at 1.0e-8 mol/mL
- -SolubilitySOUR: SOURce SOLUbility
- -SolubilityDIST: DISTribution CONCentration

Problem 4: There is solubility control on Pu-239 at 3.99e-8 mol/mL (barely limiting)
- -SolubilitySOUR: SOURce SOLUbility
- -SolubilityDIST: DISTribution CONCentration

PORFLOW simulation and comparison:
Problem 1: There is little difference between using the TRANsport Kd specification and the DISTribution CONCentration. They only differ at early times.
Problem 2 and Problem 3: The two problems differ in their progeny, apparently because SOURce does not introduce the entire parent inventory at time zero. Problem 3 SOURce produces ~4x (4.e-8/1.e-8) less progeny than DIST. Problem 2 produces ~400x (4.e-8/1.e-10) less progeny.
Problem 4: There are no differences when using a barely limiting solvent solution.

Comments:
The input files can be found in

Table 8-6 through Table 8-13.

This distribution concentration approach is preferred over SOURce SOLUbility when daughter ingrowth is present.

Table 8-6 PORFLOW input commands for Problem 1 DIST

```
/ Main input file
TITLe Pu-239 chain, sorption only, with DISTribution
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!        C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
BOUNdary C3 Y+ in FLOW concentration = 0
!
```

```
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SET C INVEntory in ID=WASTE to  1 mol per unit cm with UNIForm conc
!
/ Transport properties
!
FOR material type 1:                            !SOIL
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
```

```
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
DIST of C  in ID=SOIL as CONCentration TABLe with 3 sets
 (0,0) (1.0e-2, 1.0e-4) (1e+20, 1.0e-4)               !Pu-239
!
DIST of C2 in ID=SOIL as CONCentration TABLe with 3 sets
 (0,0) (1.0e-3, 1.0e-4) (1e+20, 1.0e-4)               !U-235
!
DIST of C3 in ID=SOIL as CONCentration TABLe with 3 sets
 (0,0) (1.0e-4, 1.0e-4) (1e+20, 1.0e-4)               !Pa-231
!
DIST of C4 in ID=SOIL as CONCentration TABLe with 3 sets
 (0,0) (1.0e-5, 1.0e-4) (1e+20, 1.0e-4)               !Ac-227
!
FOR material type 2:                            !WASTE
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
DIST of C  in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (1.0e-2, 1.0e-4) (1e+20, 1.0e-4)               !Pu-239
!
DIST of C2 in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (1.0e-3, 1.0e-4) (1e+20, 1.0e-4)               !U-235
!
DIST of C3 in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (1.0e-4, 1.0e-4) (1e+20, 1.0e-4)               !Pa-231
!
DIST of C4 in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (1.0e-5, 1.0e-4) (1e+20, 1.0e-4)               !Ac-227
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1      !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW       !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

Table 8-7 PORFLOW input commands for Problem 1 Kd

```
/ Main input file
TITLe Pu-239 chain, sorption only, no DISTribution
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!        C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
BOUNdary C3 Y+ in FLOW concentration = 0
!
```

```
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SET C INVEntory in ID=WASTE to  1 mol per unit cm with UNIForm conc
!
/ Transport properties
!
FOR material type 1:                            !SOIL
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
```

```
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
FOR material type 2:                            !WASTE
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1      !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW       !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

Table 8-8 PORFLOW input commands for Problem 2 DIST

```
/ Main input file
TITLe Pu-239 chain, solubility limit for Pu, using DISTribution
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!        C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
BOUNdary C3 Y+ in FLOW concentration = 0
!
```

```
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SET C INVEntory in ID=WASTE to  1 mol per unit cm with UNIForm conc
!
/ Transport properties
!
FOR material type 1:                            !SOIL
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
```

```
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
FOR material type 2:                            !WASTE
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
DIST of C  in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (1.0e-8, 1.0e-10) (1e+20, 1.0e-10)       !Pu-239
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1      !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW       !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

Table 8-9 PORFLOW input commands for Problem 2 SOUR

```
/ Main input file
TITLe Pu-239 chain, solubility limit for Pu, using SOURce
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!       C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
```

```
BOUNdary C3 Y+ in FLOW concentration = 0
!
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SOURce C SOLU limited at 1.0E-10 mol per mL in ID=WASTE; 1 mol per unit cm inventory
!
/ Transport properties
!
FOR material type 1:                                    !SOIL
MATErial DENSity   2.6                                  !rock grain density (g/cm^3)
ROCK POROsity   0.4                                     !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0     !Pu-239
```

```
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0       !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0       !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0       !Ac-227
!
FOR material type 2:                                      !WASTE
MATErial DENSity   2.6                                    !rock grain density (g/cm^3)
ROCK POROsity   0.4                                       !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0       !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0       !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0       !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0       !Ac-227
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1          !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW                  !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

Table 8-10 PORFLOW input commands for Problem 3 DIST

```
/ Main input file
TITLe Pu-239 chain, solubility limit for Pu, using DISTribution
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!        C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
BOUNdary C3 Y+ in FLOW concentration = 0
!
```

```
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SET C INVEntory in ID=WASTE to  1 mol per unit cm with UNIForm conc
!
/ Transport properties
!
FOR material type 1:                             !SOIL
MATErial DENSity   2.6                           !rock grain density
(g/cm^3)
ROCK POROsity   0.4                              !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
```

```
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
FOR material type 2:                             !WASTE
MATErial DENSity   2.6                           !rock grain density
(g/cm^3)
ROCK POROsity   0.4                              !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
DIST of C  in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (1.0e-6, 1.0e-8) (1e+20, 1.0e-8)               !Pu-239
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1      !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW       !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

Table 8-11 PORFLOW input commands for Problem 3 SOUR

```
/ Main input file
TITLe Pu-239 chain, solubility limit for Pu, using SOURce
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!        C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
BOUNdary C3 Y+ in FLOW concentration = 0
!
```

```
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SOURce C SOLU limited at 1.0E-8 mol per mL in ID=WASTE; 1 mol per unit cm
inventory
!
/ Transport properties
!
FOR material type 1:                              !SOIL
MATErial DENSity   2.6                            !rock grain density
(g/cm^3)
ROCK POROsity   0.4                               !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
```

```
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
FOR material type 2:                            !WASTE
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1      !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW       !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

Table 8-12 PORFLOW input commands for Problem 4 DIST

```
/ Main input file
TITLe Pu-239 chain, solubility limit for Pu, using DISTribution
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!        C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
BOUNdary C3 Y+ in FLOW concentration = 0
!
```

```
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SET C INVEntory in ID=WASTE to  1 mol per unit cm with UNIForm conc
!
/ Transport properties
!
FOR material type 1:                            !SOIL
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
```

```
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
FOR material type 2:                             !WASTE
MATErial DENSity   2.6                           !rock grain density
(g/cm^3)
ROCK POROsity   0.4                              !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
DIST of C  in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (3.99e-6, 3.99e-8) (1e+20, 3.99e-8)            !Pu-239
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1      !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW       !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

Table 8-13 PORFLOW input commands for Problem 4 SOUR

```
/ Main input file
TITLe Pu-239 chain, solubility limit for Pu, using DISTribution
!
/ Allocate space for user-defined variables as needed
ALLOcate space for 1000000 words in user input TABLes
!        C  !Pu-239
ALLOCATE C2 !U-235
ALLOCATE C3 !Pa-231
ALLOCATE C4 !Ac-227
!
/ Finite-element mesh
GRID is 22 by 22 NODEs
COORdinate X RANGe is 1000 cm
COORdinate Y RANGe is 1000 cm
LOCAte ID=DOMAIN as nodes (1,1) to (22,22)
LOCAte ID=INSIDE as nodes (1,1) to (22,22), FIELd only
!
/ Material types
MATErial TYPE 1
MATErial TYPE 2 from COORdinate (300,500) to (700,900)
!
/ Subregions
LOCAte MATErial type  1 as subregion ID=SOIL
LOCAte MATErial type  2 as subregion ID=WASTE
!
/ Material and nuclide properties
PROPerty for  C  C2 C3 C4 is HARMonic
PROPerty for  C  C2 C3 C4 is TOTAl
!
/ Nuclide properties
DECAy half LIFE for C   is 2.4100E+04 years ! Pu-239
DECAy half LIFE for C2  is 7.0400E+08 years ! U-235
DECAy half LIFE for C3  is 3.2700E+04 years ! Pa-231
DECAy half LIFE for C4  is 2.1772E+01 years ! Ac-227
REGEneration of C2  from C   is 1.00000E+00 ! U-235   from Pu-239
REGEneration of C3  from C2  is 1.00000E+00 ! Pa-231  from U-235
REGEneration of C4  from C3  is 1.00000E+00 ! Ac-227  from Pa-231
!
/ Boundary conditions
BOUNdary C  X- FLUX = 0
BOUNdary C  X+ FLUX = 0
BOUNdary C  Y- in FLOW concentration = 0
BOUNdary C  Y+ in FLOW concentration = 0
!
BOUNdary C2 X- FLUX = 0
BOUNdary C2 X+ FLUX = 0
BOUNdary C2 Y- in FLOW concentration = 0
BOUNdary C2 Y+ in FLOW concentration = 0
!
BOUNdary C3 X- FLUX = 0
BOUNdary C3 X+ FLUX = 0
BOUNdary C3 Y- in FLOW concentration = 0
BOUNdary C3 Y+ in FLOW concentration = 0
!
```

```
BOUNdary C4 X- FLUX = 0
BOUNdary C4 X+ FLUX = 0
BOUNdary C4 Y- in FLOW concentration = 0
BOUNdary C4 Y+ in FLOW concentration = 0
!
/ Diagnostic information
DIAGnostic output: TIME  C  C2 C3 C4 for node (11,11) every 100 steps
!
/ Flux output
FLUX C  for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C  for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C  for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C2 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C2 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C2 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C3 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C3 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C3 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
FLUX C4 for ID=DOMAIN by TIME every 1 years to 'FLUX.out'
FLUX C4 for ID=WASTE  by TIME every 1 years to 'FLUX.out'
STAT C4 for ID=WASTE  by TIME every 1 years to 'STAT.out'
!
SAVE  C  C2 C3 C4 for ID=INSIDE to 'C.sav'  at TIME interval of 25 years
!
LOCAte ID=OBSNOD as nodes (11,2) through (11,21)
HIST  C  C2 C3 C4 for ID=OBSNOD by TIME every 1 years to 'HIST.out'
!
/ Solution controls
MATRix LUDE for C
MATRix LUDE for C2
MATRix LUDE for C3
MATRix LUDE for C4
LIMIt for C  0.0
LIMIt for C2 0.0
LIMIt for C3 0.0
LIMIt for C4 0.0
!
/ No flow calculation
SET U =   0 cm per yr
SET V = -10 cm per yr
DISAble FLOW
!
/ Inventory
SET C INVEntory in ID=WASTE to  1 mol per unit cm with UNIForm conc
!
/ Transport properties
!
FOR material type 1:                            !SOIL
MATErial DENSity   2.6                          !rock grain density
(g/cm^3)
ROCK POROsity   0.4                             !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
```

```
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
FOR material type 2:                             !WASTE
MATErial DENSity   2.6                           !rock grain density
(g/cm^3)
ROCK POROsity   0.4                              !all porosities
TRANsport for C  Kd= 100.   De=1.6726E+02 aL=0 aT=0   !Pu-239
TRANsport for C2 Kd=  10.   De=1.6726E+02 aL=0 aT=0   !U-235
TRANsport for C3 Kd=   1.   De=1.6726E+02 aL=0 aT=0   !Pa-231
TRANsport for C4 Kd=   0.1  De=1.6726E+02 aL=0 aT=0   !Ac-227
!
DIST of C  in ID=WASTE as CONCentration TABLe with 3 sets
 (0,0) (3.99e-6, 3.99e-8) (1e+20, 3.99e-8)            !Pu-239
!
/ Transport simulation
TIME -0.000001
SOLVE C  C2 C3 C4  0.000001 yrs dt=1 inc=1 max=1      !to get an initial
SAVE C  C2 C3 C4  for ID=INSIDE to 'C.sav'  NOW       !concentration
!
TIME 0
SOLVE C  C2 C3 C4  1000 yrs dt=1 inc=1 max=1
!
END
QUIT
```

8.4 STATISTICS

Problem description:
The STATistics command provides a means to compute and obtain output of the statistics for an independent variable for a selected subregion. The LOCAte command determines the element number for the point source. The LOCAte EXCLude POLYgon command locates a subregion of the simulation. The STATistics command in the RECT subregion locates the maximum concentration. These commands were tested on the 3D saturated solute transport problem (6.3).

PORFLOW simulation and comparison:
LOCAte command: There are no differences between versions.
STATistics command: There are no differences between versions.
LOCAte EXCLude POLYgon command: There are no differences between versions.
STATistics command in the RECT subregion: There are no differences between versions.

Comments:
None

9.0 REFERENCES

Aleman, S. E., 2007, PORFLOW Testing and Verification Document, WSRC-STI-2007-00150, Rev. 0.

10.0 APPENDIX A

This appendix contains the typos and unclear statements found in WSRC-STI-2007-00150 Revision 0.

Typo 1
Equation 4.1.6 in WSRC-STI-2007-00150 is incorrect, it should be written as:

$$h = \begin{cases} h_0 + \dfrac{h_L - h_0}{1 + \dfrac{K}{C_L L}} \dfrac{x}{L} & h \geq z_L \\ h_0 + C_L (h_L - z_L) \dfrac{x}{K} & h < z_L \end{cases}$$

Typo 2
In WSRC-STI-2007-00150 Rev 0 Table 4.2.1 Problem1 at x = 20, the PORFLOW result is reported as 36.878, however all the other PORFLOW results match the current results, so this is probably a typo (36.878 vs. 36.738).

Typo 3
The results reported in WSRC-STI-2007-00150 Rev 0 Table 4.3.1 do not match the output of the PORFLOW v.5.97.0; however information in a spreadsheet (Analytic Solution.xls) that was in the same folder as the original output files do match these results.

Typo 4
The information reported in WSRC-STI-2007-00150 Rev 0 Table 4.7.1, which looks like it came from the file *Drawdown.xls*, does not match the data in *4.7.OUT* (looking at the last set of numbers at the bottom of the file. These files are the original files.

Typo5
The Darcy Velocity is graphed at -0.00703 (WSRC-STI-2007-00150 Rev 0 Figure 4.10.4), this value is the negative of the analytical solution described on page 57 of WSRC-STI-2007-00150 Rev 0.

Typo6
The input files for problem 5.5 (p152-153 WSRC-STI-2007-00150 Rev 0) should be in years. The SOLVe commands are in days (this has no effect on the problem’s solution).

11.0 APPENDIX B

This appendix has all of the tables, labeled for the appropriate section, which display the results of the comparison between PORFLOW versions and the analytical solution.

Table 11-1 Steady-state, One-Dimensional Flow in a Confined Aquifer (5.1-Problem 1)

		H_L=25 ft			h_L=50 ft			h_L=100 ft	
x (ft)	Analytic (ft)	P-6.10.3 (ft)	P-5.97.0 (ft)	Analytic (ft)	P-6.10.3 (ft)	P-5.97.0 (ft)	Analytic (ft)	P-6.10.3 (ft)	P-5.97.0 (ft)
0	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
20	48.75	48.75	48.75	50.00	50.00	50.00	52.50	52.51	52.51
40	47.50	47.49	47.49	50.00	50.00	50.00	55.00	55.01	55.01
60	46.25	46.24	46.24	50.00	50.00	50.00	57.50	57.52	57.52
80	45.00	44.99	44.99	50.00	50.00	50.00	60.00	60.02	60.02
100	43.75	43.73	43.73	50.00	50.00	50.00	62.50	62.53	62.53
120	42.50	42.48	42.48	50.00	50.00	50.00	65.00	65.04	65.04
140	41.25	41.23	41.23	50.00	50.00	50.00	67.50	67.54	67.54
160	40.00	39.98	39.98	50.00	50.00	50.00	70.00	70.05	70.05
180	38.75	38.72	38.72	50.00	50.00	50.00	72.50	72.56	72.56
199	37.56	37.53	37.53	50.00	50.00	50.00	74.88	74.94	74.94
200	37.50	25.00	25.00	50.00	50.00	50.00	75.00	100.00	100.00

Table 11-2 Steady-state, One-Dimensional Flow in a Confined Aquifer (5.1-Problem 2)

	Analytic		P-6.10.3		P-5.97.0	
h_0 (ft)	$h_{x=L}$ (ft)	U (ft/day)	$h_{x=L}$ (ft)	U (ft/day)	$h_{x=L}$ (ft)	U (ft/day)
140	120	0.0200	120	0.0200	120	0.0200
110	105	0.0050	105	0.0050	105	0.0050
100	100	0.0000	105	0.0050	100	0.0000
90	95	-0.0050	95	-0.0050	95	-0.0050
75	87.5	-0.0125	87.5	-0.0125	87.5	-0.0125
60	80	-0.0200	80	-0.0200	80	-0.0200
50	75	-0.0250	75	-0.0250	75	-0.0250
45	70	-0.0250	70	-0.0250	70	-0.0250
41	66	-0.0250	66	-0.0250	66	-0.0250

Table 11-3 Steady-state, One-Dimensional Flow in an Unconfined Aquifer (5.2-Problem 1)

	Analytic	P-6.10.3	P-5.97.0
x (ft)	hx (ft)	Hx (ft)	hx (ft)
0	40.000	40.000	40.000
10	38.471	38.383	38.383
20	36.878	36.738	36.738
30	35.214	35.041	35.041
40	33.466	33.271	33.271
40	33.466	31.410	31.410

x (ft)	Analytic hx (ft)	P-6.10.3 Hx (ft)	P-5.97.0 hx (ft)
60	29.665	29.438	29.438
70	27.568	27.330	27.331
80	25.298	25.060	25.060
90	22.804	22.604	22.605
100	20.000	20.000	20.000

Table 11-4 Steady-state, One-Dimensional Flow in an Unconfined Aquifer (5.2-Problem 2)

x(ft)	Analytic(ft)	P-6.10.3(ft)	P-5.97.0(ft)
0	164.000	164.000	164.000
40	167.905	167.660	167.660
80	171.628	171.250	171.250
120	175.180	174.750	174.750
160	178.572	178.110	178.110
200	181.813	181.340	181.340
240	184.911	184.440	184.440
300	189.304	188.830	188.830
360	193.411	192.940	192.940
400	196.000	195.540	195.540
480	200.838	200.380	200.380
560	205.251	204.800	204.800
640	209.265	208.820	208.820
720	212.904	212.460	212.460
800	216.185	215.750	215.750
880	219.126	218.690	218.690
960	221.739	221.310	221.310
1040	224.036	223.600	223.600
1120	226.027	225.600	225.600
1200	227.719	227.300	227.300
1290	229.275	228.850	228.850
1380	230.469	230.030	230.030
1460	231.231	230.780	230.780
1550	231.756	231.290	231.290
1630	231.929	231.460	231.460

Table 11-5 Steady-state, Two-Dimensional Flow through a Heterogeneous Aquifer System (5.3-Unconfined and Confined Aquifers)

	Unconfined aquifer head			Confined aquifer head		
X (ft)	Analytical (ft)	P-6.10.3 @ y=160' (ft)	P-5.97.0 @ y=160' (ft)	Analytical (ft)	P-6.10.3 @ y=50' (ft)	P-5.97.0 @ y=50' (ft)
0	170.000	170.000	170.000	160.000	160.000	160.000
50	168.226	168.135	168.135	158.271	158.310	158.310
100	166.433	166.260	166.260	156.514	156.590	156.590
150	164.621	164.360	164.360	154.728	154.840	154.840

X (ft)	Unconfined aquifer head Analytical (ft)	P-6.10.3 @ y=160' (ft)	P-5.97.0 @ y=160' (ft)	Confined aquifer head Analytical (ft)	P-6.10.3 @ y=50' (ft)	P-5.97.0 @ y=50' (ft)
200	162.788	162.480	162.480	152.914	153.050	153.050
250	160.935	160.570	160.570	151.071	151.235	151.235
300	159.060	158.650	158.650	149.199	149.380	149.380
350	157.162	156.755	156.755	147.299	147.500	147.500
400	155.242	154.810	154.810	145.370	145.580	145.580
450	153.297	152.885	152.885	143.413	143.630	143.630
500	151.327	150.920	150.920	141.428	141.650	141.650
550	149.332	148.960	148.960	139.413	139.635	139.635
600	147.309	146.960	146.960	137.370	137.590	137.590
650	145.258	144.965	144.965	135.299	135.510	135.510
700	143.178	142.930	142.930	133.199	133.390	133.390
750	141.067	140.880	140.880	131.071	131.245	131.245
800	138.924	138.790	138.790	128.914	129.070	129.070
850	136.748	136.685	136.685	126.728	126.850	126.850
900	134.536	134.520	134.520	124.514	124.600	124.600
950	132.288	132.290	132.290	122.271	122.320	122.320
1000	130.000	130.000	130.000	120.000	120.000	120.000

Table 11-6 Unconfined Aquifer Subject to Combined Recharge/Drain BC (5.4-Problem 1)

x (ft)	Anal_1 (ft)	Anal_2 (ft)	P-6.10.3 (ft)	P-5.97.0 (ft)
0	80.000	80.000	80.000	80.000
50	79.850	79.532	79.576	79.576
100	79.575	78.976	79.030	79.030
150	79.173	78.331	78.386	78.386
200	78.642	77.594	77.647	77.647
250	77.980	76.762	76.821	76.821
300	77.184	75.833	75.889	75.889
350	76.248	74.803	74.851	74.851
400	75.168	73.667	73.723	73.723
450	73.938	72.420	72.476	72.476
500	72.549	71.058	71.101	71.101
550	70.994	69.572	69.615	69.615
600	69.259	67.956	68.039	68.039
650	67.333	66.198	66.320	66.320
700	65.196	64.289	64.437	64.437
750	62.829	62.213	62.376	62.376
800	60.204	59.953	60.136	60.136
850	57.500	57.500	57.785	57.785
900	55.000	55.000	55.330	55.330
950	52.500	52.500	52.761	52.761
1000	50.000	50.000	50.000	50.000

Table 11-7 Transient, One-Dimensional Flow to a Well in a Confined Aquifer (Theis, 1935) (5.5-Problem 1)

Time (sec)	Theis (m)	P-6.10.3 (m)	P-5.97.0 (m)
0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
1.2000E+02	6.2764E-03	5.6947E-03	5.6947E-03
2.4000E+02	2.9013E-02	2.7228E-02	2.7228E-02
3.6000E+02	5.3206E-02	5.1300E-02	5.1300E-02
4.8000E+02	7.5200E-02	7.3423E-02	7.3423E-02
6.0000E+02	9.4700E-02	9.3116E-02	9.3116E-02
7.2000E+02	1.1203E-01	1.1064E-01	1.1064E-01
8.4000E+02	1.2757E-01	1.2635E-01	1.2635E-01
9.6000E+02	1.4161E-01	1.4054E-01	1.4054E-01
1.0800E+03	1.5440E-01	1.5346E-01	1.5346E-01
1.2000E+03	1.6614E-01	1.6532E-01	1.6532E-01
1.3200E+03	1.7699E-01	1.7626E-01	1.7626E-01
1.4400E+03	1.8706E-01	1.8641E-01	1.8641E-01
1.5600E+03	1.9645E-01	1.9589E-01	1.9589E-01
1.6800E+03	2.0526E-01	2.0476E-01	2.0476E-01
1.8000E+03	2.1355E-01	2.1311E-01	2.1311E-01
1.9200E+03	2.2137E-01	2.2098E-01	2.2098E-01
2.0400E+03	2.2877E-01	2.2844E-01	2.2844E-01
2.1600E+03	2.3581E-01	2.3552E-01	2.3552E-01
2.2800E+03	2.4250E-01	2.4225E-01	2.4225E-01
2.4000E+03	2.4889E-01	2.4868E-01	2.4868E-01
2.5200E+03	2.5500E-01	2.5482E-01	2.5482E-01
2.6400E+03	2.6085E-01	2.6070E-01	2.6070E-01
2.7600E+03	2.6647E-01	2.6635E-01	2.6635E-01
2.8800E+03	2.7186E-01	2.7177E-01	2.7177E-01
3.0000E+03	2.7706E-01	2.7699E-01	2.7699E-01
3.1200E+03	2.8207E-01	2.8202E-01	2.8202E-01
3.2400E+03	2.8690E-01	2.8688E-01	2.8688E-01
3.3600E+03	2.9157E-01	2.9157E-01	2.9157E-01
3.4800E+03	2.9609E-01	2.9611E-01	2.9611E-01
3.6000E+03	3.0046E-01	3.0050E-01	3.0050E-01

Table 11-8 Transient, One-Dimensional Flow to a Well in a Confined Aquifer (Theis, 1935) (5.5-Problem 2)

Time (sec)	Theis (m)	P-6.10.3 (m)	P-5.97.0 (m)
0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
3.6000E+03	3.0046E-01	3.0050E-01	3.0050E-01
7.2000E+03	3.9177E-01	3.9208E-01	3.9208E-01
1.0800E+04	4.4633E-01	4.4673E-01	4.4673E-01
1.4400E+04	4.8536E-01	4.8581E-01	4.8581E-01
1.8000E+04	5.1577E-01	5.1626E-01	5.1626E-01
2.1600E+04	5.4069E-01	5.4119E-01	5.4119E-01
2.5200E+04	5.6180E-01	5.6232E-01	5.6232E-01

Time (sec)	Theis (m)	P-6.10.3 (m)	P-5.97.0 (m)
2.8800E+04	5.8011E-01	5.8064E-01	5.8064E-01
3.2400E+04	5.9628E-01	5.9682E-01	5.9682E-01
3.6000E+04	6.1076E-01	6.1130E-01	6.1130E-01
3.9600E+04	6.2386E-01	6.2441E-01	6.2441E-01
4.3200E+04	6.3583E-01	6.3639E-01	6.3639E-01
4.6800E+04	6.4685E-01	6.4741E-01	6.4741E-01
5.0400E+04	6.5705E-01	6.5762E-01	6.5762E-01
5.4000E+04	6.6656E-01	6.6712E-01	6.6712E-01
5.7600E+04	6.7545E-01	6.7602E-01	6.7602E-01
6.1200E+04	6.8381E-01	6.8438E-01	6.8438E-01
6.4800E+04	6.9168E-01	6.9226E-01	6.9226E-01
6.8400E+04	6.9914E-01	6.9971E-01	6.9971E-01
7.2000E+04	7.0621E-01	7.0679E-01	7.0679E-01
7.5600E+04	7.1294E-01	7.1352E-01	7.1352E-01
7.9200E+04	7.1936E-01	7.1994E-01	7.1994E-01
8.2800E+04	7.2549E-01	7.2607E-01	7.2607E-01
8.6400E+04	7.3137E-01	7.3195E-01	7.3195E-01

Table 11-9 Transient, Two-Dimensional Flow to a Well in an Anisotropic Confined Aquifer (Hantush and Thomas, 1966) (5.6-Problem 1 x = 55)

Time (sec)	Hantush & Thomas (m)	P-6.10.3 (m)	P-5.97.0 (m)
1.7280E+02	4.8846E-02	2.5966E-02	2.5966E-02
3.4560E+02	1.5936E-01	1.0499E-01	1.0499E-01
5.1840E+02	2.5835E-01	2.0017E-01	2.0017E-01
7.7760E+02	3.7851E-01	3.2893E-01	3.2893E-01
1.2096E+03	5.2824E-01	4.9368E-01	4.9368E-01
1.7280E+03	6.5976E-01	6.3681E-01	6.3681E-01
2.4192E+03	7.9022E-01	7.7654E-01	7.7654E-01
3.1968E+03	9.0181E-01	8.9443E-01	8.9443E-01
4.3200E+03	1.0251E+00	1.0232E+00	1.0232E+00
5.7888E+03	1.1470E+00	1.1493E+00	1.1493E+00
7.6896E+03	1.2667E+00	1.2723E+00	1.2723E+00
1.0022E+04	1.3795E+00	1.3874E+00	1.3874E+00
1.3306E+04	1.5009E+00	1.5108E+00	1.5108E+00
1.7539E+04	1.6198E+00	1.6313E+00	1.6313E+00
2.2896E+04	1.7350E+00	1.7477E+00	1.7477E+00
3.0067E+04	1.8532E+00	1.8667E+00	1.8667E+00
3.9053E+04	1.9668E+00	1.9810E+00	1.9810E+00
5.0026E+04	2.0745E+00	2.0893E+00	2.0893E+00
6.6010E+04	2.1954E+00	2.2105E+00	2.2105E+00
8.6400E+04	2.3128E+00	2.3277E+00	2.3277E+00

Table 11-10 Transient, Two-Dimensional Flow to a Well in an Anisotropic Confined Aquifer (Hantush and Thomas, 1966) (5.6-Problem 2 y = 55)

Time (sec)	Hantush & Thomas (m)	P-6.10.3 (m)	P-5.97.0 (m)
1.7280E+02	1.8251E-08	8.3667E-10	8.3667E-10
3.4560E+02	4.3407E-05	1.2249E-06	1.2249E-06
5.1840E+02	6.6941E-04	6.8076E-05	6.8076E-05
7.7760E+02	4.6002E-03	1.5563E-03	1.5563E-03
1.2096E+03	2.0298E-02	1.2984E-02	1.2984E-02
1.7280E+03	4.8846E-02	3.9031E-02	3.9031E-02
2.4192E+03	9.3000E-02	8.2556E-02	8.2556E-02
3.1968E+03	1.4309E-01	1.3346E-01	1.3346E-01
4.3200E+03	2.1097E-01	2.0278E-01	2.0278E-01
5.7888E+03	2.8914E-01	2.8279E-01	2.8279E-01
7.6896E+03	3.7495E-01	3.7047E-01	3.7047E-01
1.0022E+04	4.6247E-01	4.5963E-01	4.5963E-01
1.3306E+04	5.6258E-01	5.6132E-01	5.6132E-01
1.7539E+04	6.6541E-01	6.6548E-01	6.6548E-01
2.2896E+04	7.6852E-01	7.6965E-01	7.6965E-01
3.0067E+04	8.7704E-01	8.7907E-01	8.7907E-01
3.9053E+04	9.8351E-01	9.8624E-01	9.8624E-01
5.0026E+04	1.0860E+00	1.0892E+00	1.0892E+00
6.6010E+04	1.2022E+00	1.2059E+00	1.2059E+00
8.6400E+04	1.3162E+00	1.3198E+00	1.3198E+00

Table 11-11 Transient, Two-Dimensional Flow to a Well in an Anisotropic Confined Aquifer (Hantush and Thomas, 1966) (5.6-Problem 3 x = y = 55)

Time (sec)	Hantush & Thomas (m)	P-6.10.3 (m)	P-5.97.0 (m)
1.7280E+02	4.0034E-09	2.0199E-08	2.0199E-08
3.4560E+02	1.9514E-05	4.9338E-06	4.9338E-06
5.1840E+02	3.8299E-04	1.1264E-04	1.1264E-04
7.7760E+02	3.0962E-03	1.4715E-03	1.4715E-03
1.2096E+03	1.5375E-02	1.0586E-02	1.0586E-02
1.7280E+03	3.9502E-02	3.2179E-02	3.2179E-02
2.4192E+03	7.8673E-02	7.0160E-02	7.0160E-02
3.1968E+03	1.2448E-01	1.1626E-01	1.1626E-01
4.3200E+03	1.8803E-01	1.8071E-01	1.8071E-01
5.7888E+03	2.6246E-01	2.5659E-01	2.5659E-01
7.6896E+03	3.4516E-01	3.4091E-01	3.4091E-01
1.0022E+04	4.3024E-01	4.2750E-01	4.2750E-01
1.3306E+04	5.2824E-01	5.2697E-01	5.2697E-01
1.7539E+04	6.2942E-01	6.2943E-01	6.2943E-01
2.2896E+04	7.3126E-01	7.3231E-01	7.3231E-01
3.0067E+04	8.3876E-01	8.4069E-01	8.4069E-01
3.9053E+04	9.4447E-01	9.4709E-01	9.4709E-01
5.0026E+04	1.0464E+00	1.0495E+00	1.0495E+00
6.6010E+04	1.1621E+00	1.1657E+00	1.1657E+00
8.6400E+04	1.2757E+00	1.2791E+00	1.2791E+00

Table 11-12 Transient, One-Dimensional Flow to a Well in a Leaky Confined Aquifer (Hantush and Jacob, 1955) (5.7-Problem 1)

Time (sec)	Hntush & Jacob (ft)	P-6.10.3 (ft)	P-5.97.0 (ft)
1.00E+00	5.0675E-09	1.7213E-08	1.7213E-08
2.00E+00	7.7806E-05	9.1780E-05	9.1780E-05
3.00E+00	2.2324E-03	2.3733E-03	2.3733E-03
4.00E+00	1.2755E-02	1.3331E-02	1.3331E-02
5.00E+00	3.7615E-02	3.9307E-02	3.9307E-02
6.00E+00	7.9104E-02	8.3028E-02	8.3028E-02
8.00E+00	2.0790E-01	2.2087E-01	2.2087E-01
1.00E+01	3.8210E-01	4.1115E-01	4.1115E-01
1.50E+01	9.0814E-01	1.0069E+00	1.0069E+00
1.60E+01	1.0182E+00	1.1354E+00	1.1354E+00
2.00E+01	1.4521E+00	1.6545E+00	1.6545E+00
2.60E+01	2.0547E+00	2.4124E+00	2.4124E+00
3.50E+01	2.8231E+00	3.4534E+00	3.4534E+00
4.30E+01	3.3813E+00	4.2771E+00	4.2771E+00
5.50E+01	4.0453E+00	5.3587E+00	5.3587E+00
6.70E+01	4.5536E+00	6.2925E+00	6.2925E+00
8.00E+01	4.9778E+00	7.1752E+00	7.1752E+00
1.01E+02	5.4715E+00	8.3895E+00	8.3895E+00
1.20E+02	5.7812E+00	9.3212E+00	9.3212E+00
1.49E+02	6.0975E+00	1.0525E+01	1.0525E+01
1.70E+02	6.2502E+00	1.1275E+01	1.1275E+01
2.00E+02	6.3988E+00	1.2213E+01	1.2213E+01
2.17E+02	6.4582E+00	1.2690E+01	1.2690E+01
2.50E+02	6.5396E+00	1.3524E+01	1.3524E+01

Table 11-13 Free-Surface Boussinesq Flow with Recharge (5.8-Problem 1)

	t=9			t=36			t=81			t=144			t=225			t=324		
Distance (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)
0.0	11.00	10.98	10.98	11.00	10.99	10.99	11.00	10.99	10.99	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
1.0	10.91	10.95	10.95	10.95	10.97	10.97	10.97	10.98	10.98	10.98	10.99	10.99	10.98	10.99	10.99	10.98	10.99	10.99
1.0	10.91	10.91	10.91	10.95	10.96	10.96	10.97	10.97	10.97	10.98	10.98	10.98	10.98	10.98	10.98	10.98	10.99	10.99
1.0	10.91	10.87	10.87	10.95	10.93	10.93	10.97	10.96	10.96	10.98	10.97	10.97	10.98	10.97	10.97	10.98	10.98	10.98
2.0	10.81	10.82	10.82	10.91	10.91	10.91	10.94	10.94	10.94	10.95	10.96	10.96	10.96	10.96	10.96	10.97	10.97	10.97
3.0	10.72	10.77	10.77	10.86	10.89	10.89	10.91	10.92	10.92	10.93	10.94	10.94	10.94	10.95	10.95	10.95	10.96	10.96
3.0	10.72	10.72	10.72	10.86	10.86	10.86	10.91	10.91	10.91	10.93	10.93	10.93	10.94	10.94	10.94	10.95	10.95	10.95
4.0	10.64	10.66	10.66	10.81	10.83	10.83	10.88	10.89	10.89	10.91	10.91	10.91	10.93	10.93	10.93	10.94	10.94	10.94
5.0	10.56	10.60	10.60	10.77	10.79	10.79	10.85	10.86	10.86	10.88	10.90	10.90	10.91	10.92	10.92	10.92	10.93	10.93
5.0	10.56	10.54	10.54	10.77	10.76	10.76	10.85	10.84	10.84	10.88	10.88	10.88	10.91	10.90	10.90	10.92	10.92	10.92
6.0	10.48	10.47	10.47	10.72	10.72	10.72	10.81	10.81	10.81	10.86	10.86	10.86	10.89	10.89	10.89	10.91	10.90	10.90
7.0	10.41	10.41	10.41	10.68	10.68	10.68	10.78	10.78	10.78	10.84	10.84	10.84	10.87	10.87	10.87	10.89	10.89	10.89
9.0	10.29	10.34	10.34	10.60	10.63	10.63	10.72	10.75	10.75	10.79	10.81	10.81	10.83	10.85	10.85	10.86	10.87	10.87

	t=9			t=36			t=81			t=144			t=225			t=324		
Distance (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)
10.0	10.24	10.28	10.28	10.56	10.58	10.58	10.70	10.71	10.71	10.77	10.78	10.78	10.81	10.83	10.83	10.84	10.86	10.86
11.0	10.20	10.22	10.22	10.52	10.53	10.53	10.67	10.68	10.68	10.75	10.75	10.75	10.80	10.80	10.80	10.83	10.84	10.84
13.0	10.13	10.16	10.16	10.44	10.47	10.47	10.61	10.64	10.64	10.70	10.72	10.72	10.76	10.78	10.78	10.80	10.81	10.81
14.0	10.10	10.12	10.12	10.41	10.42	10.42	10.58	10.59	10.59	10.68	10.69	10.69	10.74	10.75	10.75	10.78	10.79	10.79
16.0	10.06	10.08	10.08	10.35	10.36	10.36	10.53	10.54	10.54	10.64	10.65	10.65	10.71	10.72	10.72	10.75	10.76	10.76
18.0	10.03	10.05	10.05	10.29	10.30	10.30	10.48	10.50	10.50	10.60	10.61	10.61	10.67	10.68	10.68	10.72	10.73	10.73
20.0	10.02	10.03	10.03	10.24	10.25	10.25	10.43	10.44	10.44	10.56	10.57	10.57	10.64	10.65	10.65	10.69	10.70	10.70
23.0	10.01	10.02	10.02	10.18	10.20	10.20	10.37	10.39	10.39	10.50	10.52	10.52	10.59	10.61	10.61	10.65	10.67	10.67
25.0	10.00	10.01	10.01	10.14	10.15	10.15	10.33	10.34	10.34	10.46	10.47	10.47	10.56	10.57	10.57	10.62	10.63	10.63
28.0	10.00	10.00	10.00	10.10	10.11	10.11	10.27	10.28	10.28	10.41	10.42	10.42	10.51	10.52	10.52	10.58	10.59	10.59
31.0	10.00	10.00	10.00	10.07	10.07	10.07	10.22	10.23	10.23	10.36	10.37	10.37	10.47	10.47	10.47	10.54	10.55	10.55
35.0	10.00	10.00	10.00	10.04	10.05	10.05	10.17	10.18	10.18	10.30	10.32	10.32	10.41	10.43	10.43	10.49	10.51	10.51
39.0	10.00	10.00	10.00	10.02	10.03	10.03	10.13	10.14	10.14	10.25	10.26	10.26	10.36	10.37	10.37	10.44	10.46	10.46
43.0	10.00	10.00	10.00	10.01	10.02	10.02	10.09	10.10	10.10	10.21	10.21	10.21	10.31	10.32	10.32	10.40	10.41	10.41
47.0	10.00	10.00	10.00	10.01	10.01	10.01	10.07	10.07	10.07	10.17	10.17	10.17	10.27	10.27	10.27	10.36	10.36	10.36
53.0	10.00	10.00	10.00	10.00	10.00	10.00	10.04	10.04	10.04	10.12	10.13	10.13	10.21	10.22	10.22	10.30	10.31	10.31
58.0	10.00	10.00	10.00	10.00	10.00	10.00	10.02	10.02	10.02	10.09	10.09	10.09	10.17	10.17	10.17	10.26	10.26	10.26
64.0	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01	10.06	10.06	10.06	10.13	10.13	10.13	10.21	10.21	10.21
71.0	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01	10.04	10.04	10.04	10.09	10.09	10.09	10.16	10.16	10.16
79.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.02	10.02	10.02	10.06	10.06	10.06	10.12	10.12	10.12
87.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01	10.04	10.04	10.04	10.09	10.09	10.09
96.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01	10.02	10.02	10.02	10.06	10.06	10.06
106.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01	10.04	10.04	10.04
117.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01	10.02	10.02	10.02
129.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01
142.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.01	10.01	10.01
157.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
173.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
191.0	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
200.0	10.00	10.00	8.00	10.00	10.00	8.00	10.00	10.00	8.00	10.00	10.00	8.00	10.00	10.00	8.00	10.00	10.00	8.00

Table 11-14 Free-Surface Boussinesq Flow with Seepage (5.9-Problem 1)

	t=9			t=36			t=81			t=144			t=225			t=324		
Distance (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)
0	9.00	9.02	9.02	9.00	9.01	9.01	9.00	9.01	9.01	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
1	9.09	9.06	9.06	9.05	9.03	9.03	9.03	9.02	9.02	9.02	9.01	9.01	9.02	9.01	9.01	9.02	9.01	9.01
1	9.09	9.10	9.10	9.05	9.05	9.05	9.03	9.03	9.03	9.02	9.03	9.03	9.02	9.02	9.02	9.02	9.02	9.02
1	9.09	9.15	9.15	9.05	9.08	9.08	9.03	9.05	9.05	9.02	9.04	9.04	9.02	9.03	9.03	9.02	9.03	9.03
2	9.19	9.20	9.20	9.09	9.10	9.10	9.06	9.07	9.07	9.05	9.05	9.05	9.04	9.04	9.04	9.03	9.03	9.03
3	9.28	9.25	9.25	9.14	9.13	9.13	9.09	9.09	9.09	9.07	9.07	9.07	9.06	9.05	9.05	9.05	9.04	9.04
3	9.28	9.31	9.31	9.14	9.16	9.16	9.09	9.11	9.11	9.07	9.08	9.08	9.06	9.07	9.07	9.05	9.06	9.06
4	9.36	9.37	9.37	9.19	9.19	9.19	9.13	9.13	9.13	9.09	9.10	9.10	9.08	9.08	9.08	9.06	9.07	9.07
5	9.44	9.43	9.43	9.23	9.23	9.23	9.16	9.16	9.16	9.12	9.12	9.12	9.09	9.10	9.10	9.08	9.08	9.08
5	9.44	9.50	9.50	9.23	9.27	9.27	9.16	9.18	9.18	9.12	9.14	9.14	9.09	9.11	9.11	9.08	9.09	9.09
6	9.52	9.56	9.56	9.28	9.31	9.31	9.19	9.21	9.21	9.14	9.16	9.16	9.11	9.13	9.13	9.09	9.11	9.11

	t=9			t=36			t=81			t=144			t=225			t=324		
Distance (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)	COMSOL (m)	P-6.10.3 (m)	P-5.97.0 (m)
7	9.59	9.63	9.63	9.32	9.36	9.36	9.22	9.25	9.25	9.16	9.19	9.19	9.13	9.15	9.15	9.11	9.13	9.13
9	9.71	9.69	9.69	9.40	9.41	9.41	9.28	9.28	9.28	9.21	9.21	9.21	9.17	9.17	9.17	9.14	9.15	9.15
10	9.76	9.75	9.75	9.44	9.46	9.46	9.31	9.32	9.32	9.23	9.24	9.24	9.19	9.20	9.20	9.16	9.17	9.17
11	9.81	9.81	9.81	9.48	9.51	9.51	9.33	9.36	9.36	9.25	9.28	9.28	9.20	9.22	9.22	9.17	9.19	9.19
13	9.88	9.85	9.85	9.56	9.56	9.56	9.39	9.40	9.40	9.30	9.31	9.31	9.24	9.25	9.25	9.20	9.21	9.21
14	9.90	9.89	9.89	9.59	9.62	9.62	9.42	9.45	9.45	9.32	9.35	9.35	9.26	9.28	9.28	9.22	9.24	9.24
16	9.94	9.93	9.93	9.65	9.67	9.67	9.47	9.49	9.49	9.36	9.39	9.39	9.29	9.32	9.32	9.25	9.27	9.27
18	9.97	9.95	9.95	9.71	9.73	9.73	9.52	9.54	9.54	9.40	9.43	9.43	9.33	9.35	9.35	9.28	9.30	9.30
20	9.98	9.97	9.97	9.76	9.78	9.78	9.57	9.59	9.59	9.44	9.47	9.47	9.36	9.39	9.39	9.31	9.33	9.33
23	9.99	9.98	9.98	9.83	9.83	9.83	9.63	9.64	9.64	9.50	9.52	9.52	9.41	9.43	9.43	9.35	9.37	9.37
25	10.00	9.99	9.99	9.86	9.87	9.87	9.67	9.70	9.70	9.54	9.57	9.57	9.44	9.47	9.47	9.38	9.40	9.40
28	10.00	10.00	10.00	9.90	9.90	9.90	9.73	9.75	9.75	9.59	9.61	9.61	9.49	9.52	9.52	9.42	9.45	9.45
31	10.00	10.00	10.00	9.93	9.93	9.93	9.78	9.79	9.79	9.64	9.66	9.66	9.53	9.56	9.56	9.46	9.49	9.49
35	10.00	10.00	10.00	9.96	9.96	9.96	9.83	9.84	9.84	9.70	9.71	9.71	9.59	9.61	9.61	9.51	9.53	9.53
39	10.00	10.00	10.00	9.98	9.98	9.98	9.87	9.88	9.88	9.75	9.76	9.76	9.64	9.66	9.66	9.56	9.58	9.58
43	10.00	10.00	10.00	9.99	9.99	9.99	9.91	9.91	9.91	9.80	9.81	9.81	9.69	9.71	9.71	9.60	9.62	9.62
47	10.00	10.00	10.00	9.99	9.99	9.99	9.94	9.94	9.94	9.83	9.85	9.85	9.73	9.75	9.75	9.64	9.67	9.67
53	10.00	10.00	10.00	10.00	10.00	10.00	9.96	9.96	9.96	9.88	9.89	9.89	9.79	9.80	9.80	9.70	9.72	9.72
58	10.00	10.00	10.00	10.00	10.00	10.00	9.98	9.98	9.98	9.91	9.92	9.92	9.83	9.84	9.84	9.75	9.77	9.77
64	10.00	10.00	10.00	10.00	10.00	10.00	9.99	9.99	9.99	9.94	9.95	9.95	9.87	9.88	9.88	9.79	9.81	9.81
71	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.99	9.99	9.96	9.97	9.97	9.91	9.91	9.91	9.84	9.85	9.85
79	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.98	9.98	9.98	9.94	9.94	9.94	9.88	9.89	9.89
87	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.99	9.99	9.99	9.96	9.96	9.96	9.91	9.92	9.92
96	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.98	9.98	9.98	9.94	9.95	9.95
106	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.99	9.99	9.99	9.96	9.97	9.97
117	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.99	9.99	9.99	9.98	9.98	9.98
129	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.99	9.99	9.99
142	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	9.99	9.99
157	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
173	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
191	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
200	10.00	10.00	8.50	10.00	10.00	8.50	10.00	10.00	8.50	10.00	10.00	8.50	10.00	10.00	8.50	10.00	10.00	8.50

Table 11-15 Unsaturated Vertical Soil Column (5.10-Problem 1)

Column Elevation	Water Saturation	P-6.10.3 Saturation	P-5.97.0 Saturation
0	1.000	0.807	0.807
0.5	0.999	0.998	0.998
1.5	0.989	0.977	0.977
2.5	0.969	0.937	0.937
3.5	0.941	0.889	0.889
4.5	0.909	0.841	0.841
5.5	0.874	0.796	0.796
6.5	0.840	0.756	0.756
7.5	0.806	0.720	0.720
8.5	0.774	0.689	0.689
9.5	0.745	0.661	0.661

Column Elevation	Water Saturation	P-6.10.3 Saturation	P-5.97.0 Saturation
10.6	0.718	0.636	0.636
11.6	0.694	0.615	0.615
12.6	0.672	0.596	0.596
13.6	0.652	0.579	0.579
14.6	0.633	0.564	0.564
15.6	0.617	0.550	0.550
16.6	0.602	0.538	0.538
17.6	0.588	0.527	0.527
18.6	0.575	0.517	0.517
19.6	0.564	0.508	0.508
20.6	0.553	0.499	0.499
22.9	0.532	0.485	0.485
24.4	0.520	0.472	0.472
26.4	0.506	0.733	0.733
28.4	0.494	0.662	0.662
30.4	0.483	0.597	0.597
32.4	0.474	0.551	0.551
34.4	0.465	0.519	0.519
36.4	0.458	0.495	0.495
38.4	0.451	0.477	0.477
40.5	0.445	0.463	0.463
42.5	0.439	0.451	0.451
44.5	0.434	0.442	0.442
46.5	0.430	0.434	0.434
48.5	0.425	0.427	0.427

Table 11-16 Unsaturated Vertical Soil Column (5.10-Problem 2)

	P-6.10.3		P-5.97.0	
Column Elevation	Saturation	Darcy Velocity	Saturation	Darcy Velocity
0	0.75	-0.00703	0.75	-0.00703
10.5	0.75	-0.00351	0.75	-0.00351
20.5	0.75	-0.00351	0.75	-0.00351
30.5	0.75	-0.00351	0.75	-0.00351
40.5	0.75	-0.00351	0.75	-0.00351
48.5	0.75	-0.00351	0.75	-0.00351

Table 11-17 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Baseline Case)

Longitudinal Distance, x(m)	P-6.10.3 (25)	P-5.97.0 (25)	P-6.10.3 (50)	P-5.97.0 (50)
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	1.00E+00	1.00E+00	1.00E+00	1.00E+00
20	9.98E-01	9.98E-01	1.00E+00	1.00E+00

Longitudinal Distance, x(m)	P-6.10.3 (25)	P-5.97.0 (25)	P-6.10.3 (50)	P-5.97.0 (50)
30	9.94E-01	9.94E-01	1.00E+00	1.00E+00
40	9.85E-01	9.85E-01	1.00E+00	1.00E+00
50	9.65E-01	9.65E-01	1.00E+00	1.00E+00
60	9.28E-01	9.28E-01	1.00E+00	1.00E+00
70	8.70E-01	8.70E-01	9.99E-01	9.99E-01
80	7.87E-01	7.87E-01	9.98E-01	9.98E-01
90	6.80E-01	6.80E-01	9.96E-01	9.96E-01
100	5.57E-01	5.57E-01	9.92E-01	9.92E-01
110	4.30E-01	4.30E-01	9.84E-01	9.84E-01
120	3.11E-01	3.11E-01	9.73E-01	9.73E-01
130	2.09E-01	2.09E-01	9.55E-01	9.55E-01
140	1.31E-01	1.31E-01	9.28E-01	9.28E-01
150	7.65E-02	7.65E-02	8.91E-01	8.91E-01
160	4.13E-02	4.13E-02	8.42E-01	8.42E-01
170	2.07E-02	2.07E-02	7.82E-01	7.82E-01
180	9.60E-03	9.60E-03	7.09E-01	7.09E-01
190	4.14E-03	4.14E-03	6.28E-01	6.28E-01
200	1.65E-03	1.65E-03	5.41E-01	5.41E-01
210	6.15E-04	6.15E-04	4.52E-01	4.52E-01
220	2.12E-04	2.12E-04	3.66E-01	3.66E-01
230	6.84E-05	6.84E-05	2.86E-01	2.86E-01
240	2.05E-05	2.05E-05	2.16E-01	2.16E-01
250	5.76E-06	5.76E-06	1.58E-01	1.58E-01
260	1.51E-06	1.51E-06	1.11E-01	1.11E-01
270	3.71E-07	3.71E-07	7.47E-02	7.47E-02
280	8.53E-08	8.53E-08	4.85E-02	4.85E-02
290	1.85E-08	1.85E-08	3.03E-02	3.03E-02
300	3.75E-09	3.75E-09	1.82E-02	1.82E-02
310	7.19E-10	7.19E-10	1.05E-02	1.05E-02
320	1.30E-10	1.30E-10	5.85E-03	5.85E-03
330	2.21E-11	2.21E-11	3.13E-03	3.13E-03
340	3.57E-12	3.57E-12	1.60E-03	1.60E-03
350	5.45E-13	5.45E-13	7.92E-04	7.92E-04
360	7.90E-14	7.90E-14	3.76E-04	3.76E-04
370	1.09E-14	1.09E-14	1.72E-04	1.72E-04
380	1.42E-15	1.42E-15	7.53E-05	7.53E-05
390	1.77E-16	1.77E-16	3.20E-05	3.20E-05
400	3.47E-17	3.47E-17	1.74E-05	1.74E-05

Table 11-18 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case A)

Longitudinal Distance, x(m)	P-6.10.3 (25)	P-5.97.0 (25)	P-6.10.3 (50)	P-5.97.0 (50)
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	9.90E-01	9.90E-01	1.00E+00	1.00E+00
20	9.57E-01	9.57E-01	9.98E-01	9.98E-01

Longitudinal Distance, x(m)	P-6.10.3 (25)	P-5.97.0 (25)	P-6.10.3 (50)	P-5.97.0 (50)
30	8.83E-01	8.83E-01	9.95E-01	9.95E-01
40	7.54E-01	7.54E-01	9.85E-01	9.85E-01
50	5.82E-01	5.82E-01	9.66E-01	9.66E-01
60	3.96E-01	3.96E-01	9.30E-01	9.30E-01
70	2.35E-01	2.35E-01	8.72E-01	8.72E-01
80	1.20E-01	1.20E-01	7.89E-01	7.89E-01
90	5.25E-02	5.25E-02	6.83E-01	6.83E-01
100	1.97E-02	1.97E-02	5.59E-01	5.59E-01
110	6.33E-03	6.33E-03	4.31E-01	4.31E-01
120	1.74E-03	1.74E-03	3.10E-01	3.10E-01
130	4.14E-04	4.14E-04	2.08E-01	2.08E-01
140	8.49E-05	8.49E-05	1.29E-01	1.29E-01
150	1.51E-05	1.51E-05	7.40E-02	7.40E-02
160	2.34E-06	2.34E-06	3.93E-02	3.93E-02
170	3.18E-07	3.18E-07	1.92E-02	1.92E-02
180	3.79E-08	3.79E-08	8.68E-03	8.68E-03
190	3.99E-09	3.99E-09	3.61E-03	3.61E-03
200	3.73E-10	3.73E-10	1.39E-03	1.39E-03
210	3.10E-11	3.10E-11	4.91E-04	4.91E-04
220	2.31E-12	2.31E-12	1.61E-04	1.61E-04
230	1.54E-13	1.54E-13	4.86E-05	4.86E-05
240	9.28E-15	9.28E-15	1.36E-05	1.36E-05
250	5.05E-16	5.05E-16	3.51E-06	3.51E-06
260	2.50E-17	2.50E-17	8.43E-07	8.43E-07
270	1.12E-18	1.12E-18	1.88E-07	1.88E-07
280	4.63E-20	4.63E-20	3.88E-08	3.88E-08
290	1.75E-21	1.75E-21	7.45E-09	7.45E-09
300	6.05E-23	6.05E-23	1.33E-09	1.33E-09
310	1.94E-24	1.94E-24	2.23E-10	2.23E-10
320	5.72E-26	5.72E-26	3.46E-11	3.46E-11
330	1.57E-27	1.57E-27	5.04E-12	5.04E-12
340	4.00E-29	4.00E-29	6.85E-13	6.85E-13
350	9.48E-31	9.48E-31	8.73E-14	8.73E-14
360	2.10E-32	2.10E-32	1.04E-14	1.04E-14
370	4.36E-34	4.36E-34	1.17E-15	1.17E-15
380	8.47E-36	8.47E-36	1.23E-16	1.23E-16
390	1.55E-37	1.55E-37	1.22E-17	1.22E-17
400	5.80E-39	5.80E-39	1.97E-18	1.97E-18

Table 11-19 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case B)

Longitudinal Distance, x(m)	P-6.10.3 (25)	P-5.97.0 (25)	P-6.10.3 (50)	P-5.97.0 (50)
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	9.75E-01	9.75E-01	9.76E-01	9.76E-01
20	9.51E-01	9.51E-01	9.52E-01	9.52E-01

Longitudinal Distance, x(m)	P-6.10.3 (25)	P-5.97.0 (25)	P-6.10.3 (50)	P-5.97.0 (50)
30	9.24E-01	9.24E-01	9.29E-01	9.29E-01
40	8.94E-01	8.94E-01	9.06E-01	9.06E-01
50	8.57E-01	8.57E-01	8.84E-01	8.84E-01
60	8.09E-01	8.09E-01	8.62E-01	8.62E-01
70	7.45E-01	7.45E-01	8.41E-01	8.41E-01
80	6.63E-01	6.63E-01	8.20E-01	8.20E-01
90	5.66E-01	5.66E-01	7.98E-01	7.98E-01
100	4.58E-01	4.58E-01	7.76E-01	7.76E-01
110	3.50E-01	3.50E-01	7.53E-01	7.53E-01
120	2.51E-01	2.51E-01	7.28E-01	7.28E-01
130	1.68E-01	1.68E-01	6.99E-01	6.99E-01
140	1.05E-01	1.05E-01	6.66E-01	6.66E-01
150	6.08E-02	6.08E-02	6.28E-01	6.28E-01
160	3.27E-02	3.27E-02	5.84E-01	5.84E-01
170	1.63E-02	1.63E-02	5.34E-01	5.34E-01
180	7.54E-03	7.54E-03	4.78E-01	4.78E-01
190	3.24E-03	3.24E-03	4.18E-01	4.18E-01
200	1.29E-03	1.29E-03	3.56E-01	3.56E-01
210	4.78E-04	4.78E-04	2.95E-01	2.95E-01
220	1.65E-04	1.65E-04	2.37E-01	2.37E-01
230	5.29E-05	5.29E-05	1.84E-01	1.84E-01
240	1.58E-05	1.58E-05	1.38E-01	1.38E-01
250	4.43E-06	4.43E-06	9.98E-02	9.98E-02
260	1.16E-06	1.16E-06	6.96E-02	6.96E-02
270	2.84E-07	2.84E-07	4.68E-02	4.68E-02
280	6.51E-08	6.51E-08	3.03E-02	3.03E-02
290	1.41E-08	1.41E-08	1.89E-02	1.89E-02
300	2.85E-09	2.85E-09	1.13E-02	1.13E-02
310	5.44E-10	5.44E-10	6.50E-03	6.50E-03
320	9.81E-11	9.81E-11	3.60E-03	3.60E-03
330	1.67E-11	1.67E-11	1.91E-03	1.91E-03
340	2.69E-12	2.69E-12	9.79E-04	9.79E-04
350	4.09E-13	4.09E-13	4.82E-04	4.82E-04
360	5.91E-14	5.91E-14	2.28E-04	2.28E-04
370	8.11E-15	8.11E-15	1.04E-04	1.04E-04
380	1.06E-15	1.06E-15	4.55E-05	4.55E-05
390	1.31E-16	1.31E-16	1.93E-05	1.93E-05
400	2.57E-17	2.57E-17	1.04E-05	1.04E-05

Table 11-20 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case C)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	9.45E-01	9.45E-01	9.52E-01	9.52E-01

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
20	8.76E-01	8.76E-01	9.06E-01	9.06E-01
30	7.79E-01	7.79E-01	8.61E-01	8.61E-01
40	6.47E-01	6.47E-01	8.14E-01	8.14E-01
50	4.88E-01	4.88E-01	7.64E-01	7.64E-01
60	3.26E-01	3.26E-01	7.07E-01	7.07E-01
70	1.91E-01	1.91E-01	6.40E-01	6.40E-01
80	9.65E-02	9.65E-02	5.62E-01	5.62E-01
90	4.19E-02	4.19E-02	4.73E-01	4.73E-01
100	1.56E-02	1.56E-02	3.79E-01	3.79E-01
110	4.99E-03	4.99E-03	2.87E-01	2.87E-01
120	1.37E-03	1.37E-03	2.03E-01	2.03E-01
130	3.24E-04	3.24E-04	1.34E-01	1.34E-01
140	6.61E-05	6.61E-05	8.26E-02	8.26E-02
150	1.17E-05	1.17E-05	4.70E-02	4.70E-02
160	1.81E-06	1.81E-06	2.48E-02	2.48E-02
170	2.45E-07	2.45E-07	1.20E-02	1.20E-02
180	2.91E-08	2.91E-08	5.40E-03	5.40E-03
190	3.05E-09	3.05E-09	2.24E-03	2.24E-03
200	2.84E-10	2.84E-10	8.54E-04	8.54E-04
210	2.36E-11	2.36E-11	3.01E-04	3.01E-04
220	1.75E-12	1.75E-12	9.81E-05	9.81E-05
230	1.16E-13	1.16E-13	2.95E-05	2.95E-05
240	6.98E-15	6.98E-15	8.23E-06	8.23E-06
250	3.79E-16	3.79E-16	2.12E-06	2.12E-06
260	1.87E-17	1.87E-17	5.07E-07	5.07E-07
270	8.38E-19	8.38E-19	1.13E-07	1.13E-07
280	3.44E-20	3.44E-20	2.32E-08	2.32E-08
290	1.29E-21	1.29E-21	4.44E-09	4.44E-09
300	4.47E-23	4.47E-23	7.92E-10	7.92E-10
310	1.42E-24	1.42E-24	1.32E-10	1.32E-10
320	4.20E-26	4.20E-26	2.05E-11	2.05E-11
330	1.15E-27	1.15E-27	2.97E-12	2.97E-12
340	2.91E-29	2.91E-29	4.02E-13	4.02E-13
350	6.88E-31	6.88E-31	5.11E-14	5.11E-14
360	1.52E-32	1.52E-32	6.09E-15	6.09E-15
370	3.14E-34	3.14E-34	6.81E-16	6.81E-16
380	6.08E-36	6.08E-36	7.15E-17	7.15E-17
390	1.11E-37	1.11E-37	7.07E-18	7.07E-18
400	4.14E-39	4.14E-39	1.13E-18	1.13E-18

Table 11-21 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case D)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
20	9.84E-01	9.84E-01	1.00E+00	1.00E+00
40	9.39E-01	9.39E-01	9.99E-01	9.99E-01
60	8.44E-01	8.44E-01	9.95E-01	9.95E-01
80	6.98E-01	6.98E-01	9.84E-01	9.84E-01
100	5.24E-01	5.24E-01	9.61E-01	9.61E-01
120	3.57E-01	3.57E-01	9.17E-01	9.17E-01
140	2.20E-01	2.20E-01	8.49E-01	8.49E-01
160	1.23E-01	1.23E-01	7.54E-01	7.54E-01
180	6.34E-02	6.34E-02	6.40E-01	6.40E-01
200	2.99E-02	2.99E-02	5.17E-01	5.17E-01
220	1.31E-02	1.31E-02	3.95E-01	3.95E-01
240	5.30E-03	5.30E-03	2.86E-01	2.86E-01
260	2.01E-03	2.01E-03	1.97E-01	1.97E-01
280	7.14E-04	7.14E-04	1.28E-01	1.28E-01
300	2.39E-04	2.39E-04	7.90E-02	7.90E-02
320	7.55E-05	7.55E-05	4.64E-02	4.64E-02
340	2.26E-05	2.26E-05	2.59E-02	2.59E-02
360	6.44E-06	6.44E-06	1.38E-02	1.38E-02
380	1.28E-06	1.28E-06	5.60E-03	5.60E-03
400	1.28E-06	1.28E-06	5.60E-03	5.60E-03

Table 11-22 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case E)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
40	8.46E-01	8.46E-01	9.76E-01	9.76E-01
80	6.32E-01	6.32E-01	9.25E-01	9.25E-01
120	3.93E-01	3.93E-01	8.25E-01	8.25E-01
160	2.05E-01	2.05E-01	6.76E-01	6.76E-01
200	9.11E-02	9.11E-02	5.04E-01	5.04E-01
240	3.51E-02	3.51E-02	3.40E-01	3.40E-01
280	1.19E-02	1.19E-02	2.08E-01	2.08E-01
320	3.60E-03	3.60E-03	1.16E-01	1.16E-01
360	7.13E-04	7.13E-04	4.62E-02	4.62E-02
400	7.13E-04	7.13E-04	4.62E-02	4.62E-02

Table 11-23 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case F)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
80	5.87E-01	5.87E-01	8.29E-01	8.29E-01
160	2.81E-01	2.81E-01	6.15E-01	6.15E-01
240	1.02E-01	1.02E-01	3.81E-01	3.81E-01
320	2.13E-02	2.13E-02	1.54E-01	1.54E-01
400	2.13E-02	2.13E-02	1.54E-01	1.54E-01

Table 11-24 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case G)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	9.95E-01	9.95E-01	1.00E+00	1.00E+00
20	9.82E-01	9.82E-01	1.00E+00	1.00E+00
30	9.56E-01	9.56E-01	9.99E-01	9.99E-01
40	9.14E-01	9.14E-01	9.98E-01	9.98E-01
50	8.58E-01	8.58E-01	9.95E-01	9.95E-01
60	7.91E-01	7.91E-01	9.91E-01	9.91E-01
70	7.15E-01	7.15E-01	9.83E-01	9.83E-01
80	6.35E-01	6.35E-01	9.72E-01	9.72E-01
90	5.55E-01	5.55E-01	9.56E-01	9.56E-01
100	4.78E-01	4.78E-01	9.35E-01	9.35E-01
110	4.05E-01	4.05E-01	9.09E-01	9.09E-01
120	3.39E-01	3.39E-01	8.76E-01	8.76E-01
130	2.81E-01	2.81E-01	8.39E-01	8.39E-01
140	2.30E-01	2.30E-01	7.96E-01	7.96E-01
150	1.86E-01	1.86E-01	7.49E-01	7.49E-01
160	1.50E-01	1.50E-01	6.98E-01	6.98E-01
170	1.19E-01	1.19E-01	6.46E-01	6.46E-01
180	9.41E-02	9.41E-02	5.92E-01	5.92E-01
190	7.38E-02	7.38E-02	5.38E-01	5.38E-01
200	5.75E-02	5.75E-02	4.85E-01	4.85E-01
210	4.45E-02	4.45E-02	4.33E-01	4.33E-01
220	3.43E-02	3.43E-02	3.84E-01	3.84E-01
230	2.63E-02	2.63E-02	3.38E-01	3.38E-01
240	2.00E-02	2.00E-02	2.96E-01	2.96E-01
250	1.52E-02	1.52E-02	2.56E-01	2.56E-01
260	1.15E-02	1.15E-02	2.21E-01	2.21E-01
270	8.61E-03	8.61E-03	1.89E-01	1.89E-01
280	6.45E-03	6.45E-03	1.61E-01	1.61E-01
290	4.81E-03	4.81E-03	1.36E-01	1.36E-01
300	3.58E-03	3.58E-03	1.14E-01	1.14E-01
310	2.65E-03	2.65E-03	9.52E-02	9.52E-02
320	1.96E-03	1.96E-03	7.91E-02	7.91E-02
330	1.44E-03	1.44E-03	6.54E-02	6.54E-02

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
340	1.06E-03	1.06E-03	5.38E-02	5.38E-02
350	7.76E-04	7.76E-04	4.40E-02	4.40E-02
360	5.67E-04	5.67E-04	3.59E-02	3.59E-02
370	4.15E-04	4.15E-04	2.92E-02	2.92E-02
380	3.11E-04	3.11E-04	2.51E-02	2.51E-02
390	3.31E-04	3.31E-04	3.49E-02	3.49E-02
400	9.16E-04	9.16E-04	1.14E-01	1.14E-01

Table 11-25 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case H)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	9.92E-01	9.92E-01	1.00E+00	1.00E+00
20	9.73E-01	9.73E-01	9.98E-01	9.98E-01
30	9.43E-01	9.43E-01	9.95E-01	9.95E-01
40	9.03E-01	9.03E-01	9.89E-01	9.89E-01
50	8.54E-01	8.54E-01	9.80E-01	9.80E-01
60	7.99E-01	7.99E-01	9.67E-01	9.67E-01
70	7.40E-01	7.40E-01	9.50E-01	9.50E-01
80	6.79E-01	6.79E-01	9.28E-01	9.28E-01
90	6.19E-01	6.19E-01	9.02E-01	9.02E-01
100	5.59E-01	5.59E-01	8.71E-01	8.71E-01
110	5.02E-01	5.02E-01	8.37E-01	8.37E-01
120	4.49E-01	4.49E-01	8.00E-01	8.00E-01
130	3.98E-01	3.98E-01	7.60E-01	7.60E-01
140	3.52E-01	3.52E-01	7.18E-01	7.18E-01
150	3.09E-01	3.09E-01	6.75E-01	6.75E-01
160	2.71E-01	2.71E-01	6.31E-01	6.31E-01
170	2.36E-01	2.36E-01	5.87E-01	5.87E-01
180	2.05E-01	2.05E-01	5.44E-01	5.44E-01
190	1.78E-01	1.78E-01	5.02E-01	5.02E-01
200	1.54E-01	1.54E-01	4.61E-01	4.61E-01
210	1.32E-01	1.32E-01	4.21E-01	4.21E-01
220	1.14E-01	1.14E-01	3.84E-01	3.84E-01
230	9.73E-02	9.73E-02	3.48E-01	3.48E-01
240	8.32E-02	8.32E-02	3.15E-01	3.15E-01
250	7.10E-02	7.10E-02	2.84E-01	2.84E-01
260	6.04E-02	6.04E-02	2.55E-01	2.55E-01
270	5.13E-02	5.13E-02	2.28E-01	2.28E-01
280	4.35E-02	4.35E-02	2.04E-01	2.04E-01
290	3.69E-02	3.69E-02	1.82E-01	1.82E-01
300	3.11E-02	3.11E-02	1.61E-01	1.61E-01
310	2.63E-02	2.63E-02	1.43E-01	1.43E-01

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
320	2.22E-02	2.22E-02	1.26E-01	1.26E-01
330	1.86E-02	1.86E-02	1.11E-01	1.11E-01
340	1.57E-02	1.57E-02	9.79E-02	9.79E-02
350	1.32E-02	1.32E-02	8.59E-02	8.59E-02
360	1.10E-02	1.10E-02	7.53E-02	7.53E-02
370	9.23E-03	9.23E-03	6.58E-02	6.58E-02
380	7.73E-03	7.73E-03	5.75E-02	5.75E-02
390	6.50E-03	6.50E-03	5.03E-02	5.03E-02
400	5.84E-03	5.84E-03	4.64E-02	4.64E-02

Table 11-26 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case I)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	9.09E-01	9.09E-01	9.92E-01	9.92E-01
20	8.26E-01	8.26E-01	9.77E-01	9.77E-01
30	7.51E-01	7.51E-01	9.57E-01	9.57E-01
40	6.83E-01	6.83E-01	9.32E-01	9.32E-01
50	6.21E-01	6.21E-01	9.04E-01	9.04E-01
60	5.64E-01	5.64E-01	8.73E-01	8.73E-01
70	5.13E-01	5.13E-01	8.40E-01	8.40E-01
80	4.66E-01	4.66E-01	8.06E-01	8.06E-01
90	4.24E-01	4.24E-01	7.72E-01	7.72E-01
100	3.85E-01	3.85E-01	7.37E-01	7.37E-01
110	3.50E-01	3.50E-01	7.01E-01	7.01E-01
120	3.18E-01	3.18E-01	6.67E-01	6.67E-01
130	2.89E-01	2.89E-01	6.32E-01	6.32E-01
140	2.63E-01	2.63E-01	5.99E-01	5.99E-01
150	2.39E-01	2.39E-01	5.66E-01	5.66E-01
160	2.17E-01	2.17E-01	5.34E-01	5.34E-01
170	1.97E-01	1.97E-01	5.04E-01	5.04E-01
180	1.79E-01	1.79E-01	4.74E-01	4.74E-01
190	1.63E-01	1.63E-01	4.46E-01	4.46E-01
200	1.48E-01	1.48E-01	4.19E-01	4.19E-01
210	1.35E-01	1.35E-01	3.93E-01	3.93E-01
220	1.23E-01	1.23E-01	3.69E-01	3.69E-01
230	1.11E-01	1.11E-01	3.45E-01	3.45E-01
240	1.01E-01	1.01E-01	3.23E-01	3.23E-01
250	9.20E-02	9.20E-02	3.02E-01	3.02E-01
260	8.36E-02	8.36E-02	2.82E-01	2.82E-01
270	7.60E-02	7.60E-02	2.63E-01	2.63E-01
280	6.91E-02	6.91E-02	2.46E-01	2.46E-01
290	6.28E-02	6.28E-02	2.29E-01	2.29E-01
300	5.71E-02	5.71E-02	2.13E-01	2.13E-01

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
310	5.19E-02	5.19E-02	1.99E-01	1.99E-01
320	4.72E-02	4.72E-02	1.85E-01	1.85E-01
330	4.29E-02	4.29E-02	1.72E-01	1.72E-01
340	3.90E-02	3.90E-02	1.60E-01	1.60E-01
350	3.54E-02	3.54E-02	1.49E-01	1.49E-01
360	3.22E-02	3.22E-02	1.38E-01	1.38E-01
370	2.93E-02	2.93E-02	1.28E-01	1.28E-01
380	2.66E-02	2.66E-02	1.19E-01	1.19E-01
390	2.43E-02	2.43E-02	1.11E-01	1.11E-01
400	2.30E-02	2.30E-02	1.06E-01	1.06E-01

Table 11-27 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case J)

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	1.00E+00	1.00E+00	1.00E+00	1.00E+00
20	1.00E+00	1.00E+00	1.00E+00	1.00E+00
30	1.00E+00	1.00E+00	1.00E+00	1.00E+00
40	1.00E+00	1.00E+00	1.00E+00	1.00E+00
50	1.00E+00	1.00E+00	1.00E+00	1.00E+00
60	9.98E-01	9.98E-01	1.00E+00	1.00E+00
70	9.98E-01	9.98E-01	1.00E+00	1.00E+00
80	1.02E+00	1.02E+00	1.00E+00	1.00E+00
90	9.41E-01	9.41E-01	1.00E+00	1.00E+00
100	4.35E-01	4.35E-01	1.00E+00	1.00E+00
110	9.59E-02	9.59E-02	1.00E+00	1.00E+00
120	1.13E-02	1.13E-02	1.00E+00	1.00E+00
130	7.95E-04	7.95E-04	1.00E+00	1.00E+00
140	3.58E-05	3.58E-05	1.00E+00	1.00E+00
150	1.10E-06	1.10E-06	1.00E+00	1.00E+00
160	2.40E-08	2.40E-08	9.99E-01	9.99E-01
170	3.87E-10	3.87E-10	1.00E+00	1.00E+00
180	4.75E-12	4.75E-12	1.03E+00	1.03E+00
190	4.55E-14	4.55E-14	8.36E-01	8.36E-01
200	3.47E-16	3.47E-16	4.46E-01	4.46E-01
210	2.15E-18	2.15E-18	1.53E-01	1.53E-01
220	1.10E-20	1.10E-20	3.53E-02	3.53E-02
230	4.66E-23	4.66E-23	5.71E-03	5.71E-03
240	1.67E-25	1.67E-25	6.75E-04	6.75E-04
250	5.14E-28	5.14E-28	6.01E-05	6.01E-05
260	1.36E-30	1.36E-30	4.14E-06	4.14E-06
270	3.12E-33	3.12E-33	2.26E-07	2.26E-07
280	6.30E-36	6.30E-36	9.92E-09	9.92E-09
290	1.12E-38	1.12E-38	3.56E-10	3.56E-10

Longitudinal Distance	25		50	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
300	1.77E-41	1.77E-41	1.06E-11	1.06E-11
310	2.50E-44	2.50E-44	2.66E-13	2.66E-13
320	3.17E-47	3.17E-47	5.64E-15	5.64E-15
330	3.63E-50	3.63E-50	1.02E-16	1.02E-16
340	3.77E-53	3.77E-53	1.61E-18	1.61E-18
350	3.57E-56	3.57E-56	2.19E-20	2.19E-20
360	3.09E-59	3.09E-59	2.62E-22	2.62E-22
370	2.45E-62	2.45E-62	2.76E-24	2.76E-24
380	1.80E-65	1.80E-65	2.57E-26	2.57E-26
390	1.22E-68	1.22E-68	2.14E-28	2.14E-28
400	2.08E-71	2.08E-71	2.71E-30	2.71E-30

Table 11-28 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case K 25)

Longitudinal distance	Hybrid		Condif		Modified Quick		Central difference	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
20	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
30	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
40	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
50	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
60	9.97E-01	9.97E-01	9.97E-01	9.97E-01	1.00E+00	1.00E+00	9.98E-01	9.98E-01
70	9.78E-01	9.78E-01	9.78E-01	9.78E-01	1.00E+00	1.00E+00	9.98E-01	9.98E-01
80	9.04E-01	9.04E-01	9.04E-01	9.04E-01	1.00E+00	1.00E+00	1.02E+00	1.02E+00
90	7.34E-01	7.34E-01	7.34E-01	7.34E-01	9.35E-01	9.35E-01	9.41E-01	9.41E-01
100	4.89E-01	4.89E-01	4.89E-01	4.89E-01	4.79E-01	4.79E-01	4.35E-01	4.35E-01
110	2.55E-01	2.55E-01	2.55E-01	2.55E-01	8.43E-02	8.43E-02	9.59E-02	9.59E-02
120	1.03E-01	1.03E-01	1.03E-01	1.03E-01	3.40E-03	3.40E-03	1.13E-02	1.13E-02
130	3.18E-02	3.18E-02	3.18E-02	3.18E-02	3.08E-07	3.08E-07	7.95E-04	7.95E-04
140	7.62E-03	7.62E-03	7.62E-03	7.62E-03	0.00E+00	0.00E+00	3.58E-05	3.58E-05
150	1.43E-03	1.43E-03	1.43E-03	1.43E-03	0.00E+00	0.00E+00	1.10E-06	1.10E-06
160	2.14E-04	2.14E-04	2.14E-04	2.14E-04	0.00E+00	0.00E+00	2.40E-08	2.40E-08
170	2.58E-05	2.58E-05	2.58E-05	2.58E-05	0.00E+00	0.00E+00	3.87E-10	3.87E-10
180	2.53E-06	2.53E-06	2.53E-06	2.53E-06	0.00E+00	0.00E+00	4.75E-12	4.75E-12
190	2.05E-07	2.05E-07	2.05E-07	2.05E-07	0.00E+00	0.00E+00	4.55E-14	4.55E-14
200	1.39E-08	1.39E-08	1.39E-08	1.39E-08	0.00E+00	0.00E+00	3.47E-16	3.47E-16
210	7.90E-10	7.90E-10	7.90E-10	7.90E-10	0.00E+00	0.00E+00	2.15E-18	2.15E-18
220	3.84E-11	3.84E-11	3.84E-11	3.84E-11	0.00E+00	0.00E+00	1.10E-20	1.10E-20
230	1.60E-12	1.60E-12	1.60E-12	1.60E-12	0.00E+00	0.00E+00	4.66E-23	4.66E-23
240	5.79E-14	5.79E-14	5.79E-14	5.79E-14	0.00E+00	0.00E+00	1.67E-25	1.67E-25
250	1.83E-15	1.83E-15	1.83E-15	1.83E-15	0.00E+00	0.00E+00	5.14E-28	5.14E-28
260	5.06E-17	5.06E-17	5.06E-17	5.06E-17	0.00E+00	0.00E+00	1.36E-30	1.36E-30
270	1.24E-18	1.24E-18	1.24E-18	1.24E-18	0.00E+00	0.00E+00	3.12E-33	3.12E-33
280	2.70E-20	2.70E-20	2.70E-20	2.70E-20	0.00E+00	0.00E+00	6.30E-36	6.30E-36

Longitudinal distance	Hybrid		Condif		Modified Quick		Central difference	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
290	5.26E-22	5.26E-22	5.26E-22	5.26E-22	0.00E+00	0.00E+00	1.12E-38	1.12E-38
300	9.20E-24	9.20E-24	9.20E-24	9.20E-24	0.00E+00	0.00E+00	1.77E-41	1.77E-41
310	1.46E-25	1.46E-25	1.46E-25	1.46E-25	0.00E+00	0.00E+00	2.50E-44	2.50E-44
320	2.09E-27	2.09E-27	2.09E-27	2.09E-27	0.00E+00	0.00E+00	3.17E-47	3.17E-47
330	2.72E-29	2.72E-29	2.72E-29	2.72E-29	0.00E+00	0.00E+00	3.63E-50	3.63E-50
340	3.25E-31	3.25E-31	3.25E-31	3.25E-31	0.00E+00	0.00E+00	3.77E-53	3.77E-53
350	3.56E-33	3.56E-33	3.56E-33	3.56E-33	0.00E+00	0.00E+00	3.57E-56	3.57E-56
360	3.59E-35	3.59E-35	3.59E-35	3.59E-35	0.00E+00	0.00E+00	3.09E-59	3.09E-59
370	3.34E-37	3.34E-37	3.34E-37	3.34E-37	0.00E+00	0.00E+00	2.45E-62	2.45E-62
380	2.89E-39	2.89E-39	2.89E-39	2.89E-39	0.00E+00	0.00E+00	1.80E-65	1.80E-65
390	2.31E-41	2.31E-41	2.31E-41	2.31E-41	0.00E+00	0.00E+00	1.22E-68	1.22E-68
400	3.52E-43	3.52E-43	3.52E-43	3.52E-43	0.00E+00	0.00E+00	2.08E-71	2.08E-71

Table 11-29 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case K 50)

Longitudinal distance	Hybrid		Condif		Modified Quick		Central difference	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
20	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
30	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
40	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
50	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
60	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
70	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
80	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
90	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
100	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
110	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
120	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
130	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
140	9.98E-01	9.98E-01	9.98E-01	9.98E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
150	9.91E-01	9.91E-01	9.91E-01	9.91E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
160	9.70E-01	9.70E-01	9.70E-01	9.70E-01	1.00E+00	1.00E+00	9.99E-01	9.99E-01
170	9.17E-01	9.17E-01	9.17E-01	9.17E-01	1.00E+00	1.00E+00	1.00E+00	1.00E+00
180	8.18E-01	8.18E-01	8.18E-01	8.18E-01	9.95E-01	9.95E-01	1.03E+00	1.03E+00
190	6.70E-01	6.70E-01	6.70E-01	6.70E-01	8.52E-01	8.52E-01	8.36E-01	8.36E-01
200	4.92E-01	4.92E-01	4.92E-01	4.92E-01	4.83E-01	4.83E-01	4.46E-01	4.46E-01
210	3.19E-01	3.19E-01	3.19E-01	3.19E-01	1.51E-01	1.51E-01	1.53E-01	1.53E-01
220	1.81E-01	1.81E-01	1.81E-01	1.81E-01	2.32E-02	2.32E-02	3.53E-02	3.53E-02
230	8.88E-02	8.88E-02	8.88E-02	8.88E-02	1.49E-03	1.49E-03	5.71E-03	5.71E-03
240	3.79E-02	3.79E-02	3.79E-02	3.79E-02	2.19E-05	2.19E-05	6.75E-04	6.75E-04
250	1.40E-02	1.40E-02	1.40E-02	1.40E-02	0.00E+00	0.00E+00	6.01E-05	6.01E-05
260	4.53E-03	4.53E-03	4.53E-03	4.53E-03	0.00E+00	0.00E+00	4.14E-06	4.14E-06

Longitudinal distance	Hybrid		Condif		Modified Quick		Central difference	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
270	1.27E-03	1.27E-03	1.27E-03	1.27E-03	0.00E+00	0.00E+00	2.26E-07	2.26E-07
280	3.14E-04	3.14E-04	3.14E-04	3.14E-04	0.00E+00	0.00E+00	9.92E-09	9.92E-09
290	6.81E-05	6.81E-05	6.81E-05	6.81E-05	0.00E+00	0.00E+00	3.56E-10	3.56E-10
300	1.30E-05	1.30E-05	1.30E-05	1.30E-05	0.00E+00	0.00E+00	1.06E-11	1.06E-11
310	2.21E-06	2.21E-06	2.21E-06	2.21E-06	0.00E+00	0.00E+00	2.66E-13	2.66E-13
320	3.35E-07	3.35E-07	3.35E-07	3.35E-07	0.00E+00	0.00E+00	5.64E-15	5.64E-15
330	4.52E-08	4.52E-08	4.52E-08	4.52E-08	0.00E+00	0.00E+00	1.02E-16	1.02E-16
340	5.47E-09	5.47E-09	5.47E-09	5.47E-09	0.00E+00	0.00E+00	1.61E-18	1.61E-18
350	5.97E-10	5.97E-10	5.97E-10	5.97E-10	0.00E+00	0.00E+00	2.19E-20	2.19E-20
360	5.87E-11	5.87E-11	5.87E-11	5.87E-11	0.00E+00	0.00E+00	2.62E-22	2.62E-22
370	5.24E-12	5.24E-12	5.24E-12	5.24E-12	0.00E+00	0.00E+00	2.76E-24	2.76E-24
380	4.25E-13	4.25E-13	4.25E-13	4.25E-13	0.00E+00	0.00E+00	2.57E-26	2.57E-26
390	3.14E-14	3.14E-14	3.14E-14	3.14E-14	0.00E+00	0.00E+00	2.14E-28	2.14E-28
400	3.02E-15	3.02E-15	3.02E-15	3.02E-15	0.00E+00	0.00E+00	2.71E-30	2.71E-30

Table 11-30 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case L 25)

Longitudinal distance	Arithmetic		Harmonic		Geometric		Upwind	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
20	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01
30	9.94E-01	9.94E-01	9.94E-01	9.94E-01	9.94E-01	9.94E-01	9.94E-01	9.94E-01
40	9.85E-01	9.85E-01	9.85E-01	9.85E-01	9.85E-01	9.85E-01	9.85E-01	9.85E-01
50	9.65E-01	9.65E-01	9.65E-01	9.65E-01	9.65E-01	9.65E-01	9.65E-01	9.65E-01
60	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01
70	8.70E-01	8.70E-01	8.70E-01	8.70E-01	8.70E-01	8.70E-01	8.70E-01	8.70E-01
80	7.87E-01	7.87E-01	7.87E-01	7.87E-01	7.87E-01	7.87E-01	7.87E-01	7.87E-01
90	6.80E-01	6.80E-01	6.80E-01	6.80E-01	6.80E-01	6.80E-01	6.80E-01	6.80E-01
100	5.57E-01	5.57E-01	5.57E-01	5.57E-01	5.57E-01	5.57E-01	5.57E-01	5.57E-01
110	4.30E-01	4.30E-01	4.30E-01	4.30E-01	4.30E-01	4.30E-01	4.30E-01	4.30E-01
120	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01	3.11E-01
130	2.09E-01	2.09E-01	2.09E-01	2.09E-01	2.09E-01	2.09E-01	2.09E-01	2.09E-01
140	1.31E-01	1.31E-01	1.31E-01	1.31E-01	1.31E-01	1.31E-01	1.31E-01	1.31E-01
150	7.65E-02	7.65E-02	7.65E-02	7.65E-02	7.65E-02	7.65E-02	7.65E-02	7.65E-02
160	4.13E-02	4.13E-02	4.13E-02	4.13E-02	4.13E-02	4.13E-02	4.13E-02	4.13E-02
170	2.07E-02	2.07E-02	2.07E-02	2.07E-02	2.07E-02	2.07E-02	2.07E-02	2.07E-02
180	9.60E-03	9.60E-03	9.60E-03	9.60E-03	9.60E-03	9.60E-03	9.60E-03	9.60E-03
190	4.14E-03	4.14E-03	4.14E-03	4.14E-03	4.14E-03	4.14E-03	4.14E-03	4.14E-03
200	1.65E-03	1.65E-03	1.65E-03	1.65E-03	1.65E-03	1.65E-03	1.65E-03	1.65E-03
210	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04	6.15E-04
220	2.12E-04	2.12E-04	2.12E-04	2.12E-04	2.12E-04	2.12E-04	2.12E-04	2.12E-04
230	6.84E-05	6.84E-05	6.84E-05	6.84E-05	6.84E-05	6.84E-05	6.84E-05	6.84E-05
240	2.05E-05	2.05E-05	2.05E-05	2.05E-05	2.05E-05	2.05E-05	2.05E-05	2.05E-05
250	5.76E-06	5.76E-06	5.76E-06	5.76E-06	5.76E-06	5.76E-06	5.76E-06	5.76E-06

Longitudinal distance	Arithmetic		Harmonic		Geometric		Upwind	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
260	1.51E-06	1.51E-06	1.51E-06	1.51E-06	1.51E-06	1.51E-06	1.51E-06	1.51E-06
270	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07	3.71E-07
280	8.53E-08	8.53E-08	8.53E-08	8.53E-08	8.53E-08	8.53E-08	8.53E-08	8.53E-08
290	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08	1.85E-08
300	3.75E-09	3.75E-09	3.75E-09	3.75E-09	3.75E-09	3.75E-09	3.75E-09	3.75E-09
310	7.19E-10	7.19E-10	7.19E-10	7.19E-10	7.19E-10	7.19E-10	7.19E-10	7.19E-10
320	1.30E-10	1.30E-10	1.30E-10	1.30E-10	1.30E-10	1.30E-10	1.30E-10	1.30E-10
330	2.21E-11	2.21E-11	2.21E-11	2.21E-11	2.21E-11	2.21E-11	2.21E-11	2.21E-11
340	3.57E-12	3.57E-12	3.57E-12	3.57E-12	3.57E-12	3.57E-12	3.57E-12	3.57E-12
350	5.45E-13	5.45E-13	5.45E-13	5.45E-13	5.45E-13	5.45E-13	5.45E-13	5.45E-13
360	7.90E-14	7.90E-14	7.90E-14	7.90E-14	7.90E-14	7.90E-14	7.90E-14	7.90E-14
370	1.09E-14	1.09E-14	1.09E-14	1.09E-14	1.09E-14	1.09E-14	1.09E-14	1.09E-14
380	1.42E-15	1.42E-15	1.42E-15	1.42E-15	1.42E-15	1.42E-15	1.42E-15	1.42E-15
390	1.77E-16	1.77E-16	1.77E-16	1.77E-16	1.77E-16	1.77E-16	1.77E-16	1.77E-16
400	3.47E-17	3.47E-17	3.47E-17	3.47E-17	3.47E-17	3.47E-17	3.47E-17	3.47E-17

Table 11-31 One-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.1-Problem 1 Case L 50)

Longitudinal distance	Arithmetic		Harmonic		Geometric		Upwind	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
0	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
10	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
20	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
30	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
40	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
50	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
60	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00	1.00E+00
70	9.99E-01	9.99E-01	9.99E-01	9.99E-01	9.99E-01	9.99E-01	9.99E-01	9.99E-01
80	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01	9.98E-01
90	9.96E-01	9.96E-01	9.96E-01	9.96E-01	9.96E-01	9.96E-01	9.96E-01	9.96E-01
100	9.92E-01	9.92E-01	9.92E-01	9.92E-01	9.92E-01	9.92E-01	9.92E-01	9.92E-01
110	9.84E-01	9.84E-01	9.84E-01	9.84E-01	9.84E-01	9.84E-01	9.84E-01	9.84E-01
120	9.73E-01	9.73E-01	9.73E-01	9.73E-01	9.73E-01	9.73E-01	9.73E-01	9.73E-01
130	9.55E-01	9.55E-01	9.55E-01	9.55E-01	9.55E-01	9.55E-01	9.55E-01	9.55E-01
140	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01	9.28E-01
150	8.91E-01	8.91E-01	8.91E-01	8.91E-01	8.91E-01	8.91E-01	8.91E-01	8.91E-01
160	8.42E-01	8.42E-01	8.42E-01	8.42E-01	8.42E-01	8.42E-01	8.42E-01	8.42E-01
170	7.82E-01	7.82E-01	7.82E-01	7.82E-01	7.82E-01	7.82E-01	7.82E-01	7.82E-01
180	7.09E-01	7.09E-01	7.09E-01	7.09E-01	7.09E-01	7.09E-01	7.09E-01	7.09E-01
190	6.28E-01	6.28E-01	6.28E-01	6.28E-01	6.28E-01	6.28E-01	6.28E-01	6.28E-01
200	5.41E-01	5.41E-01	5.41E-01	5.41E-01	5.41E-01	5.41E-01	5.41E-01	5.41E-01
210	4.52E-01	4.52E-01	4.52E-01	4.52E-01	4.52E-01	4.52E-01	4.52E-01	4.52E-01
220	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01	3.66E-01

Longitudinal distance	Arithmetic		Harmonic		Geometric		Upwind	
x(m)	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0	P-6.10.3	P-5.97.0
230	2.86E-01	2.86E-01	2.86E-01	2.86E-01	2.86E-01	2.86E-01	2.86E-01	2.86E-01
240	2.16E-01	2.16E-01	2.16E-01	2.16E-01	2.16E-01	2.16E-01	2.16E-01	2.16E-01
250	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01	1.58E-01
260	1.11E-01	1.11E-01	1.11E-01	1.11E-01	1.11E-01	1.11E-01	1.11E-01	1.11E-01
270	7.47E-02	7.47E-02	7.47E-02	7.47E-02	7.47E-02	7.47E-02	7.47E-02	7.47E-02
280	4.85E-02	4.85E-02	4.85E-02	4.85E-02	4.85E-02	4.85E-02	4.85E-02	4.85E-02
290	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02	3.03E-02
300	1.82E-02	1.82E-02	1.82E-02	1.82E-02	1.82E-02	1.82E-02	1.82E-02	1.82E-02
310	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02	1.05E-02
320	5.85E-03	5.85E-03	5.85E-03	5.85E-03	5.85E-03	5.85E-03	5.85E-03	5.85E-03
330	3.13E-03	3.13E-03	3.13E-03	3.13E-03	3.13E-03	3.13E-03	3.13E-03	3.13E-03
340	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03	1.60E-03
350	7.92E-04	7.92E-04	7.92E-04	7.92E-04	7.92E-04	7.92E-04	7.92E-04	7.92E-04
360	3.76E-04	3.76E-04	3.76E-04	3.76E-04	3.76E-04	3.76E-04	3.76E-04	3.76E-04
370	1.72E-04	1.72E-04	1.72E-04	1.72E-04	1.72E-04	1.72E-04	1.72E-04	1.72E-04
380	7.53E-05	7.53E-05	7.53E-05	7.53E-05	7.53E-05	7.53E-05	7.53E-05	7.53E-05
390	3.20E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05	3.20E-05
400	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05	1.74E-05

Table 11-32 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case A parallel)

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
-270	0.00E+00	0.00E+00
-255	5.93E-10	5.93E-10
-240	2.19E-09	2.19E-09
-225	5.61E-09	5.61E-09
-210	1.30E-08	1.30E-08
-195	2.90E-08	2.90E-08
-180	6.39E-08	6.39E-08
-165	1.40E-07	1.40E-07
-150	3.08E-07	3.08E-07
-135	6.80E-07	6.80E-07
-120	1.51E-06	1.51E-06
-105	3.38E-06	3.38E-06
-90	7.64E-06	7.64E-06
-75	1.75E-05	1.75E-05
-60	4.09E-05	4.09E-05
-45	9.76E-05	9.76E-05
-30	2.40E-04	2.40E-04
-15	6.09E-04	6.09E-04
0	1.61E-03	1.61E-03

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
15	1.27E-03	1.27E-03
30	1.04E-03	1.04E-03
45	8.87E-04	8.87E-04
60	7.76E-04	7.76E-04
75	6.94E-04	6.94E-04
90	6.31E-04	6.31E-04
105	5.83E-04	5.83E-04
120	5.43E-04	5.43E-04
135	5.11E-04	5.11E-04
150	4.84E-04	4.84E-04
165	4.61E-04	4.61E-04
180	4.41E-04	4.41E-04
195	4.23E-04	4.23E-04
210	4.07E-04	4.07E-04
225	3.93E-04	3.93E-04
240	3.80E-04	3.80E-04
255	3.68E-04	3.68E-04
270	3.57E-04	3.57E-04
285	3.46E-04	3.46E-04
300	3.36E-04	3.36E-04
315	3.27E-04	3.27E-04
330	3.17E-04	3.17E-04
345	3.08E-04	3.08E-04
360	3.00E-04	3.00E-04
375	2.91E-04	2.91E-04
390	2.82E-04	2.82E-04
405	2.73E-04	2.73E-04
420	2.64E-04	2.64E-04
435	2.55E-04	2.55E-04
450	2.46E-04	2.46E-04
465	2.37E-04	2.37E-04
480	2.28E-04	2.28E-04
495	2.18E-04	2.18E-04
510	2.08E-04	2.08E-04
525	1.98E-04	1.98E-04
540	1.88E-04	1.88E-04
555	1.77E-04	1.77E-04
570	1.67E-04	1.67E-04
585	1.57E-04	1.57E-04
600	1.46E-04	1.46E-04
615	1.36E-04	1.36E-04
630	1.26E-04	1.26E-04
645	1.16E-04	1.16E-04
660	1.06E-04	1.06E-04
675	9.67E-05	9.67E-05
690	8.78E-05	8.78E-05
705	7.92E-05	7.92E-05

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
720	7.11E-05	7.11E-05
735	6.34E-05	6.34E-05
750	5.63E-05	5.63E-05
765	4.97E-05	4.97E-05
780	4.36E-05	4.36E-05
795	3.80E-05	3.80E-05
810	3.30E-05	3.30E-05
825	2.84E-05	2.84E-05
840	2.44E-05	2.44E-05
855	2.07E-05	2.07E-05
870	1.75E-05	1.75E-05
885	1.48E-05	1.48E-05
900	1.23E-05	1.23E-05
915	1.03E-05	1.03E-05
930	8.52E-06	8.52E-06
945	7.12E-06	7.12E-06
960	7.12E-06	7.12E-06

Table 11-33 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case A transverse)

Distance transverse, y (m)	P-6.10.3	P-5.97.0
-270	1.37E-07	1.37E-07
-240	2.62E-07	2.62E-07
-210	1.06E-06	1.06E-06
-180	3.87E-06	3.87E-06
-150	1.24E-05	1.24E-05
-120	3.44E-05	3.44E-05
-90	8.01E-05	8.01E-05
-60	1.53E-04	1.53E-04
-30	2.30E-04	2.30E-04
0	2.64E-04	2.64E-04
30	2.30E-04	2.30E-04
60	1.53E-04	1.53E-04
90	8.01E-05	8.01E-05
120	3.44E-05	3.44E-05
150	1.24E-05	1.24E-05
180	3.87E-06	3.87E-06
210	1.06E-06	1.06E-06
240	2.62E-07	2.62E-07
270	1.37E-07	1.37E-07

Table 11-34 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case B parallel)

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
-270	0.00E+00	0.00E+00
-255	-8.47E-13	-8.47E-13
-240	-6.44E-13	-6.44E-13
-225	1.25E-11	1.25E-11
-210	8.00E-11	8.00E-11
-195	3.42E-10	3.42E-10
-180	1.26E-09	1.26E-09
-165	4.33E-09	4.33E-09
-150	1.43E-08	1.43E-08
-135	4.66E-08	4.66E-08
-120	1.50E-07	1.50E-07
-105	4.79E-07	4.79E-07
-90	1.52E-06	1.52E-06
-75	4.83E-06	4.83E-06
-60	1.53E-05	1.53E-05
-45	4.82E-05	4.82E-05
-30	1.52E-04	1.52E-04
-15	4.78E-04	4.78E-04
0	1.50E-03	1.50E-03
15	8.44E-04	8.44E-04
30	4.74E-04	4.74E-04
45	2.66E-04	2.66E-04
60	1.49E-04	1.49E-04
75	8.34E-05	8.34E-05
90	4.66E-05	4.66E-05
105	2.60E-05	2.60E-05
120	1.45E-05	1.45E-05
135	8.02E-06	8.02E-06
150	4.42E-06	4.42E-06
165	2.42E-06	2.42E-06
180	1.31E-06	1.31E-06
195	7.01E-07	7.01E-07
210	3.64E-07	3.64E-07
225	1.81E-07	1.81E-07
240	8.37E-08	8.37E-08
255	3.34E-08	3.34E-08
270	8.80E-09	8.80E-09
285	-2.13E-09	-2.13E-09
300	-6.01E-09	-6.01E-09
315	-6.50E-09	-6.50E-09
330	-5.56E-09	-5.56E-09
345	-4.20E-09	-4.20E-09
360	-2.90E-09	-2.90E-09
375	-1.86E-09	-1.86E-09
390	-1.10E-09	-1.10E-09
405	-5.90E-10	-5.90E-10

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
420	-2.79E-10	-2.79E-10
435	-1.05E-10	-1.05E-10
450	-1.85E-11	-1.85E-11
465	1.67E-11	1.67E-11
480	2.53E-11	2.53E-11
495	2.23E-11	2.23E-11
510	1.58E-11	1.58E-11
525	9.62E-12	9.62E-12
540	5.08E-12	5.08E-12
555	2.24E-12	2.24E-12
570	7.06E-13	7.06E-13
585	1.82E-14	1.82E-14
600	-2.07E-13	-2.07E-13
615	-2.19E-13	-2.19E-13
630	-1.60E-13	-1.60E-13
645	-9.48E-14	-9.48E-14
660	-4.68E-14	-4.68E-14
675	-1.83E-14	-1.83E-14
690	-4.25E-15	-4.25E-15
705	1.17E-15	1.17E-15
720	2.36E-15	2.36E-15
735	1.94E-15	1.94E-15
750	1.19E-15	1.19E-15
765	5.90E-16	5.90E-16
780	2.30E-16	2.30E-16
795	5.52E-17	5.52E-17
810	-1.01E-17	-1.01E-17
825	-2.37E-17	-2.37E-17
840	-1.90E-17	-1.90E-17
855	-1.10E-17	-1.10E-17
870	-5.10E-18	-5.10E-18
885	-1.77E-18	-1.77E-18
900	-3.08E-19	-3.08E-19
915	1.60E-19	1.60E-19
930	2.05E-19	2.05E-19
945	1.18E-19	1.18E-19
960	1.18E-19	1.18E-19

Table 11-35 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case B transverse)

Distance transverse, y (m)	P-6.10.3	P-5.97.0
-270	0.00E+00	0.00E+00
-240	1.43E-16	1.43E-16
-210	-1.37E-16	-1.37E-16
-180	-9.86E-15	-9.86E-15

Distance transverse, y (m)	P-6.10.3	P-5.97.0
-150	-5.24E-14	-5.24E-14
-120	5.18E-14	5.18E-14
-90	2.08E-12	2.08E-12
-60	1.13E-11	1.13E-11
-30	8.89E-12	8.89E-12
0	-2.79E-10	-2.79E-10
30	-2.19E-09	-2.19E-09
60	-7.32E-09	-7.32E-09
90	6.55E-09	6.55E-09
120	2.10E-07	2.10E-07
150	1.26E-06	1.26E-06
180	4.78E-06	4.78E-06
210	1.34E-05	1.34E-05
240	3.00E-05	3.00E-05
270	5.55E-05	5.55E-05

Table 11-36 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case C parallel)

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
-270	0.00E+00	0.00E+00
-255	4.75E-10	4.75E-10
-240	1.79E-09	1.79E-09
-225	4.69E-09	4.69E-09
-210	1.11E-08	1.11E-08
-195	2.55E-08	2.55E-08
-180	5.76E-08	5.76E-08
-165	1.29E-07	1.29E-07
-150	2.89E-07	2.89E-07
-135	6.48E-07	6.48E-07
-120	1.46E-06	1.46E-06
-105	3.29E-06	3.29E-06
-90	7.50E-06	7.50E-06
-75	1.73E-05	1.73E-05
-60	4.06E-05	4.06E-05
-45	9.71E-05	9.71E-05
-30	2.39E-04	2.39E-04
-15	6.08E-04	6.08E-04
0	1.61E-03	1.61E-03
15	1.27E-03	1.27E-03
30	1.04E-03	1.04E-03
45	8.83E-04	8.83E-04
60	7.69E-04	7.69E-04
75	6.85E-04	6.85E-04
90	6.20E-04	6.20E-04

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
105	5.68E-04	5.68E-04
120	5.24E-04	5.24E-04
135	4.87E-04	4.87E-04
150	4.54E-04	4.54E-04
165	4.24E-04	4.24E-04
180	3.95E-04	3.95E-04
195	3.68E-04	3.68E-04
210	3.42E-04	3.42E-04
225	3.16E-04	3.16E-04
240	2.91E-04	2.91E-04
255	2.67E-04	2.67E-04
270	2.43E-04	2.43E-04
285	2.19E-04	2.19E-04
300	1.96E-04	1.96E-04
315	1.74E-04	1.74E-04
330	1.53E-04	1.53E-04
345	1.34E-04	1.34E-04
360	1.16E-04	1.16E-04
375	9.86E-05	9.86E-05
390	8.34E-05	8.34E-05
405	6.97E-05	6.97E-05
420	5.76E-05	5.76E-05
435	4.71E-05	4.71E-05
450	3.80E-05	3.80E-05
465	3.04E-05	3.04E-05
480	2.40E-05	2.40E-05
495	1.87E-05	1.87E-05
510	1.44E-05	1.44E-05
525	1.10E-05	1.10E-05
540	8.23E-06	8.23E-06
555	6.11E-06	6.11E-06
570	4.48E-06	4.48E-06
585	3.25E-06	3.25E-06
600	2.33E-06	2.33E-06
615	1.64E-06	1.64E-06
630	1.15E-06	1.15E-06
645	7.93E-07	7.93E-07
660	5.40E-07	5.40E-07
675	3.64E-07	3.64E-07
690	2.42E-07	2.42E-07
705	1.59E-07	1.59E-07
720	1.04E-07	1.04E-07
735	6.65E-08	6.65E-08
750	4.22E-08	4.22E-08
765	2.65E-08	2.65E-08
780	1.64E-08	1.64E-08
795	1.01E-08	1.01E-08

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
810	6.09E-09	6.09E-09
825	3.65E-09	3.65E-09
840	2.16E-09	2.16E-09
855	1.27E-09	1.27E-09
870	7.32E-10	7.32E-10
885	4.19E-10	4.19E-10
900	2.38E-10	2.38E-10
915	1.33E-10	1.33E-10
930	7.32E-11	7.32E-11
945	3.82E-11	3.82E-11
960	3.82E-11	3.82E-11

Table 11-37 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case C transverse)

Distance transverse, y (m)	P-6.10.3	P-5.97.0
-270	4.25E-10	4.25E-10
-240	1.44E-09	1.44E-09
-210	1.33E-08	1.33E-08
-180	9.94E-08	9.94E-08
-150	5.96E-07	5.96E-07
-120	2.80E-06	2.80E-06
-90	9.93E-06	9.93E-06
-60	2.58E-05	2.58E-05
-30	4.69E-05	4.69E-05
0	5.76E-05	5.76E-05
30	4.69E-05	4.69E-05
60	2.58E-05	2.58E-05
90	9.93E-06	9.93E-06
120	2.80E-06	2.80E-06
150	5.96E-07	5.96E-07
180	9.94E-08	9.94E-08
210	1.33E-08	1.33E-08
240	1.44E-09	1.44E-09
270	4.25E-10	4.25E-10

Table 11-38 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case D parallel)

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
-270	0.00E+00	0.00E+00
-255	5.99E-11	5.99E-11

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
-240	2.38E-10	2.38E-10
-225	6.66E-10	6.66E-10
-210	1.72E-09	1.72E-09
-195	4.32E-09	4.32E-09
-180	1.08E-08	1.08E-08
-165	2.71E-08	2.71E-08
-150	6.83E-08	6.83E-08
-135	1.73E-07	1.73E-07
-120	4.41E-07	4.41E-07
-105	1.13E-06	1.13E-06
-90	2.94E-06	2.94E-06
-75	7.75E-06	7.75E-06
-60	2.07E-05	2.07E-05
-45	5.66E-05	5.66E-05
-30	1.58E-04	1.58E-04
-15	4.55E-04	4.55E-04
0	1.35E-03	1.35E-03
15	9.49E-04	9.49E-04
30	6.90E-04	6.90E-04
45	5.15E-04	5.15E-04
60	3.94E-04	3.94E-04
75	3.07E-04	3.07E-04
90	2.43E-04	2.43E-04
105	1.95E-04	1.95E-04
120	1.59E-04	1.59E-04
135	1.30E-04	1.30E-04
150	1.07E-04	1.07E-04
165	8.88E-05	8.88E-05
180	7.41E-05	7.41E-05
195	6.20E-05	6.20E-05
210	5.20E-05	5.20E-05
225	4.38E-05	4.38E-05
240	3.70E-05	3.70E-05
255	3.13E-05	3.13E-05
270	2.65E-05	2.65E-05
285	2.25E-05	2.25E-05
300	1.91E-05	1.91E-05
315	1.63E-05	1.63E-05
330	1.39E-05	1.39E-05
345	1.18E-05	1.18E-05
360	1.01E-05	1.01E-05
375	8.64E-06	8.64E-06
390	7.39E-06	7.39E-06
405	6.33E-06	6.33E-06
420	5.42E-06	5.42E-06
435	4.64E-06	4.64E-06
450	3.98E-06	3.98E-06

Distance downstream, parallel x (m)	P-6.10.3	P-5.97.0
465	3.41E-06	3.41E-06
480	2.93E-06	2.93E-06
495	2.51E-06	2.51E-06
510	2.15E-06	2.15E-06
525	1.85E-06	1.85E-06
540	1.58E-06	1.58E-06
555	1.36E-06	1.36E-06
570	1.16E-06	1.16E-06
585	9.95E-07	9.95E-07
600	8.51E-07	8.51E-07
615	7.27E-07	7.27E-07
630	6.21E-07	6.21E-07
645	5.29E-07	5.29E-07
660	4.51E-07	4.51E-07
675	3.83E-07	3.83E-07
690	3.25E-07	3.25E-07
705	2.75E-07	2.75E-07
720	2.32E-07	2.32E-07
735	1.95E-07	1.95E-07
750	1.64E-07	1.64E-07
765	1.37E-07	1.37E-07
780	1.15E-07	1.15E-07
795	9.53E-08	9.53E-08
810	7.89E-08	7.89E-08
825	6.52E-08	6.52E-08
840	5.36E-08	5.36E-08
855	4.39E-08	4.39E-08
870	3.58E-08	3.58E-08
885	2.91E-08	2.91E-08
900	2.35E-08	2.35E-08
915	1.90E-08	1.90E-08
930	1.53E-08	1.53E-08
945	1.24E-08	1.24E-08
960	1.24E-08	1.24E-08

Table 11-39 Two-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.2-Problem 1 Case D transverse)

Distance transverse, y (m)	P-6.10.3	P-5.97.0
-270	5.08E-10	5.08E-10
-240	1.11E-09	1.11E-09
-210	5.69E-09	5.69E-09
-180	2.65E-08	2.65E-08
-150	1.09E-07	1.09E-07
-120	3.86E-07	3.86E-07

Distance transverse, y (m)	P-6.10.3	P-5.97.0
-90	1.13E-06	1.13E-06
-60	2.61E-06	2.61E-06
-30	4.49E-06	4.49E-06
0	5.42E-06	5.42E-06
30	4.49E-06	4.49E-06
60	2.61E-06	2.61E-06
90	1.13E-06	1.13E-06
120	3.86E-07	3.86E-07
150	1.09E-07	1.09E-07
180	2.65E-08	2.65E-08
210	5.69E-09	5.69E-09
240	1.11E-09	1.11E-09
270	5.08E-10	5.08E-10

Table 11-40 Three-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.3-Problem 1)

Distance downstream (m)	P-6.10.3	P-5.97.0
-270	0.0000E+00	0.0000E+00
-255	9.2070E-11	9.2070E-11
-240	3.4620E-10	3.4620E-10
-225	9.0800E-10	9.0800E-10
-210	2.1680E-09	2.1680E-09
-195	5.0200E-09	5.0200E-09
-180	1.1540E-08	1.1540E-08
-165	2.6590E-08	2.6590E-08
-150	6.1730E-08	6.1730E-08
-135	1.4500E-07	1.4500E-07
-120	3.4600E-07	3.4600E-07
-105	8.4190E-07	8.4190E-07
-90	2.1000E-06	2.1000E-06
-75	5.4080E-06	5.4080E-06
-60	1.4470E-05	1.4470E-05
-45	4.0550E-05	4.0550E-05
-30	1.1970E-04	1.1970E-04
-15	3.7390E-04	3.7390E-04
0	1.2360E-03	1.2360E-03
15	7.8030E-04	7.8030E-04
30	5.2140E-04	5.2140E-04
45	3.6860E-04	3.6860E-04
60	2.7450E-04	2.7450E-04
75	2.1410E-04	2.1410E-04
90	1.7350E-04	1.7350E-04
105	1.4520E-04	1.4520E-04
120	1.2450E-04	1.2450E-04
135	1.0900E-04	1.0900E-04

Distance downstream (m)	P-6.10.3	P-5.97.0
150	9.6870E-05	9.6870E-05
165	8.7220E-05	8.7220E-05
180	7.9330E-05	7.9330E-05
195	7.2770E-05	7.2770E-05
210	6.7210E-05	6.7210E-05
225	6.2430E-05	6.2430E-05
240	5.8270E-05	5.8270E-05
255	5.4620E-05	5.4620E-05
270	5.1370E-05	5.1370E-05
285	4.8450E-05	4.8450E-05
300	4.5810E-05	4.5810E-05
315	4.3400E-05	4.3400E-05
330	4.1190E-05	4.1190E-05
345	3.9140E-05	3.9140E-05
360	3.7220E-05	3.7220E-05
375	3.5410E-05	3.5410E-05
390	3.3700E-05	3.3700E-05
405	3.2070E-05	3.2070E-05
420	3.0510E-05	3.0510E-05
435	2.9000E-05	2.9000E-05
450	2.7540E-05	2.7540E-05
465	2.6120E-05	2.6120E-05
480	2.4740E-05	2.4740E-05
495	2.3390E-05	2.3390E-05
510	2.2060E-05	2.2060E-05
525	2.0760E-05	2.0760E-05
540	1.9490E-05	1.9490E-05
555	1.8250E-05	1.8250E-05
570	1.7040E-05	1.7040E-05
585	1.5850E-05	1.5850E-05
600	1.4700E-05	1.4700E-05
615	1.3580E-05	1.3580E-05
630	1.2510E-05	1.2510E-05
645	1.1470E-05	1.1470E-05
660	1.0480E-05	1.0480E-05
675	9.5320E-06	9.5320E-06
690	8.6350E-06	8.6350E-06
705	7.7890E-06	7.7890E-06
720	6.9950E-06	6.9950E-06
735	6.2530E-06	6.2530E-06
750	5.5650E-06	5.5650E-06
765	4.9290E-06	4.9290E-06
780	4.3460E-06	4.3460E-06
795	3.8130E-06	3.8130E-06
810	3.3300E-06	3.3300E-06
825	2.8940E-06	2.8940E-06
840	2.5020E-06	2.5020E-06
855	2.1540E-06	2.1540E-06
870	1.8450E-06	1.8450E-06

Distance downstream (m)	P-6.10.3	P-5.97.0
885	1.5720E-06	1.5720E-06
900	1.3340E-06	1.3340E-06
915	1.1280E-06	1.1280E-06
930	9.5320E-07	9.5320E-07
945	8.1150E-07	8.1150E-07
960	8.1150E-07	8.1150E-07

Table 11-41 Three-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.3-Problem 2)

Distance transverse, y (m)	P-6.10.3	P-5.97.0
0	1.2450E-04	1.2450E-04
30	6.6050E-05	6.6050E-05
60	1.8830E-05	1.8830E-05
90	4.2600E-06	4.2600E-06
120	8.7710E-07	8.7710E-07
150	1.7270E-07	1.7270E-07
180	3.3030E-08	3.3030E-08
210	6.1340E-09	6.1340E-09
240	1.1130E-09	1.1130E-09
270	4.9760E-10	4.9760E-10

Table 11-42 Three-Dimensional Saturated Solute Transport in a Uniform Flow Field (6.3-Problem 3)

Distance transverse, z (m)	P-6.10.3	P-5.97.0
0	1.2450E-04	1.2450E-04
30	6.6050E-05	6.6050E-05
60	1.8830E-05	1.8830E-05
90	4.2600E-06	4.2600E-06
120	8.7710E-07	8.7710E-07
150	1.7270E-07	1.7270E-07
180	3.3030E-08	3.3030E-08
210	6.1340E-09	6.1340E-09
240	1.1130E-09	1.1130E-09
270	4.9760E-10	4.9760E-10

Table 11-43 Slit and Engineered Trench Radon Air Pathway Transport Simulation (6.4-Problem 1)

Distance (m)	COMSOL (Ci/m3)	P-6.10.3 (Ci/m3)	P-5.97.0 (Ci/m3)
0	0.37	0.37	0.37
0.15	0.37	0.37	0.37
0.46	0.37	0.37	0.37
0.76	0.37	0.37	0.37
1.06	0.37	0.37	0.37
1.36	0.37	0.37	0.37
1.67	0.37	0.37	0.37
1.97	0.37	0.37	0.37
2.29	0.37	0.37	0.37
2.58	0.37	0.37	0.37
2.91	0.37	0.37	0.37
3.2	0.37	0.37	0.37
3.44	0.37	0.37	0.37
3.66	0.37	0.37	0.37
3.79	0.37	0.37	0.37
3.9	0.37	0.37	0.37
4	0.37	0.37	0.37
4.08	0.37	0.37	0.37
4.16	1.19	2.01	2.01
4.23	2.01	2.01	2.01
4.3	2.01	2.01	2.01
4.39	2.01	2.01	2.01
4.46	2.01	2.01	2.01
4.54	2.01	2.01	2.01
4.61	2.01	2.01	2.01
4.67	2.01	2.01	2.01
4.74	2.01	2.01	2.01
4.84	2.01	2.01	2.01
4.92	1.01	0	0
5	0	0	0
5.05	0	0	0
5.13	0	0	0
5.22	0	0	0
5.3	0	0	0
5.37	0	0	0
5.46	0	0	0
5.54	0	0	0
5.61	0	0	0
5.69	0	0	0
5.73	0	0	0
5.79	0	0	0
5.9	0	0	0
6.08	0	0	0
6.17	0	0	0
6.28	0	0	0
6.32	0	0	0

Distance (m)	COMSOL (Ci/m3)	P-6.10.3 (Ci/m3)	P-5.97.0 (Ci/m3)
6.49	0	0	0
6.69	0	0	0
6.9	0	0	0
7.11	0	0	0
7.53	0	0	0
7.73	0	0	0
7.9	0	0	0
7.97	0	0	0

Table 11-44 Slit and Engineered Trench Radon Air Pathway Transport Simulation (6.4-Problem 2)

Distance (m)	COMSOL (Ci/m3)	P-6.10.3 (Ci/m3)	P-5.97.0 (Ci/m3)
0	0.13	0.13	0.13
0.15	0.13	0.13	0.13
0.46	0.13	0.13	0.13
0.76	0.13	0.13	0.13
1.06	0.13	0.13	0.13
1.36	0.13	0.13	0.13
1.67	0.13	0.13	0.13
1.97	0.13	0.13	0.13
2.29	0.13	0.13	0.13
2.58	0.13	0.13	0.13
2.91	0.13	0.13	0.13
3.2	0.13	0.13	0.13
3.44	0.13	0.13	0.13
3.66	0.13	0.13	0.13
3.79	0.13	0.13	0.13
3.9	0.13	0.13	0.13
4	0.13	0.13	0.13
4.08	0.13	0.13	0.13
4.16	0.42	0.71	0.71
4.23	0.71	0.71	0.71
4.3	0.71	0.71	0.71
4.39	0.71	0.71	0.71
4.46	0.71	0.71	0.71
4.54	0.71	0.71	0.71
4.61	0.71	0.71	0.71
4.67	0.71	0.71	0.71
4.74	0.71	0.71	0.71
4.84	0.71	0.71	0.71
4.92	0.35	0	0
5	0	0	0
5.05	0	0	0
5.13	0	0	0
5.22	0	0	0
5.3	0	0	0
5.37	0	0	0

Distance (m)	COMSOL (Ci/m3)	P-6.10.3 (Ci/m3)	P-5.97.0 (Ci/m3)
5.46	0	0	0
5.54	0	0	0
5.61	0	0	0
5.69	0	0	0
5.73	0	0	0
5.79	0	0	0
5.9	0	0	0
6.08	0	0	0
6.17	0	0	0
6.28	0	0	0
6.32	0	0	0
6.49	0	0	0
6.69	0	0	0
6.9	0	0	0
7.11	0	0	0
7.53	0	0	0
7.73	0	0	0
7.9	0	0	0
7.97	0	0	0

Table 11-45 Slit and Engineered Trench Radon Air Pathway Transport Simulation (6.4-Problem 3)

Distance (m)	COMSOL (Ci/m3)	P-6.10.3 (Ci/m3)	P-5.97.0 (Ci/m3)
0	0.13	0.13	0.13
0.15	0.13	0.13	0.13
0.46	0.13	0.13	0.13
0.76	0.13	0.13	0.13
1.06	0.13	0.13	0.13
1.36	0.13	0.13	0.13
1.67	0.13	0.13	0.13
1.97	0.13	0.13	0.13
2.29	0.13	0.13	0.13
2.58	0.13	0.13	0.13
2.91	0.13	0.13	0.13
3.2	0.13	0.13	0.13
3.44	0.13	0.13	0.13
3.66	0.14	0.14	0.14
3.79	0.15	0.16	0.16
3.9	0.17	0.19	0.19
4	0.22	0.25	0.25
4.08	0.29	0.34	0.34
4.16	0.42	0.49	0.49
4.23	0.53	0.58	0.58
4.3	0.6	0.63	0.63
4.39	0.64	0.66	0.66
4.46	0.66	0.67	0.67
4.54	0.66	0.67	0.67

Distance (m)	COMSOL (Ci/m3)	P-6.10.3 (Ci/m3)	P-5.97.0 (Ci/m3)
4.61	0.66	0.65	0.65
4.67	0.64	0.62	0.62
4.74	0.6	0.56	0.56
4.84	0.51	0.45	0.45
4.92	0.35	0.27	0.27
5	0.2	0.15	0.15
5.05	0.14	0.09	0.09
5.13	0.07	0.05	0.05
5.22	0.04	0.03	0.03
5.3	0.02	0.02	0.02
5.37	0.01	0.01	0.01
5.46	0.01	0.01	0.01
5.54	0	0	0
5.61	0	0	0
5.69	0	0	0
5.73	0	0	0
5.79	0	0	0
5.9	0	0	0
6.08	0	0	0
6.17	0	0	0
6.28	0	0	0
6.32	0	0	0
6.49	0	0	0
6.69	0	0	0
6.9	0	0	0
7.11	0	0	0
7.53	0	0	0
7.73	0	0	0
7.9	0	0	0
7.97	0	0	0

Table 11-46 Slit and Engineered Trench Radon Air Pathway Transport Simulation (6.4-Problem 4)

Time (years)	COMSOL (Ci/yr)	P-6.10.3 (Ci/yr)	P-5.97.0 (Ci/yr)
0	0.00E+00	6.99E-08	6.99E-08
20	1.46E-06	1.50E-06	1.50E-06
40	2.90E-06	2.99E-06	2.99E-06
60	4.33E-06	4.46E-06	4.46E-06
80	5.73E-06	5.93E-06	5.93E-06
100	7.12E-06	7.39E-06	7.39E-06
120	8.51E-06	8.81E-06	8.81E-06
140	9.88E-06	1.02E-05	1.02E-05
160	1.12E-05	1.17E-05	1.17E-05
180	1.26E-05	1.30E-05	1.30E-05
200	1.39E-05	1.44E-05	1.44E-05
240	1.65E-05	1.71E-05	1.71E-05

Time (years)	COMSOL (Ci/yr)	P-6.10.3 (Ci/yr)	P-5.97.0 (Ci/yr)
280	1.91E-05	1.98E-05	1.98E-05
320	2.16E-05	2.25E-05	2.25E-05
360	2.41E-05	2.51E-05	2.51E-05
400	2.66E-05	2.76E-05	2.76E-05
440	2.90E-05	3.01E-05	3.01E-05
480	3.14E-05	3.26E-05	3.26E-05
520	3.38E-05	3.50E-05	3.50E-05
560	3.61E-05	3.74E-05	3.74E-05
600	3.84E-05	3.97E-05	3.97E-05
640	4.06E-05	4.20E-05	4.20E-05
680	4.28E-05	4.42E-05	4.42E-05
720	4.50E-05	4.65E-05	4.65E-05
760	4.71E-05	4.86E-05	4.86E-05
800	4.92E-05	5.08E-05	5.08E-05
840	5.12E-05	5.29E-05	5.29E-05
880	5.33E-05	5.49E-05	5.49E-05
920	5.52E-05	5.69E-05	5.69E-05
960	5.72E-05	5.89E-05	5.89E-05
1000	5.91E-05	6.09E-05	6.09E-05

Table 11-47 Parent and Daughter at 25 years using Equation 1 (6.5-Problem 1)

	Parent			Daughter		
Longitudinal Distance(m)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)
0	1	1	1	0	0	0
10	0.95	0.9	0.95	0.05	0.1	0.05
20	0.9	0.81	0.9	0.1	0.18	0.1
30	0.86	0.72	0.86	0.14	0.25	0.14
40	0.82	0.63	0.82	0.18	0.29	0.18
50	0.77	0.53	0.77	0.22	0.29	0.22
60	0.73	0.41	0.73	0.26	0.26	0.26
70	0.69	0.29	0.69	0.29	0.21	0.29
80	0.65	0.18	0.65	0.32	0.14	0.32
90	0.6	0.1	0.6	0.33	0.08	0.33
100	0.54	0.05	0.55	0.33	0.04	0.33
110	0.48	0.02	0.48	0.32	0.02	0.32
120	0.41	0.01	0.41	0.29	0.01	0.29
130	0.34	0	0.34	0.25	0	0.25
140	0.26	0	0.26	0.2	0	0.2
150	0.19	0	0.19	0.16	0	0.15
160	0.13	0	0.13	0.11	0	0.11
170	0.08	0	0.08	0.07	0	0.07
180	0.05	0	0.05	0.04	0	0.04
190	0.03	0	0.03	0.02	0	0.02
200	0.01	0	0.01	0.01	0	0.01
210	0.01	0	0.01	0.01	0	0.01
220	0	0	0	0	0	0
230	0	0	0	0	0	0

Longitudinal Distance(m)	Parent COMSOL (Conc)	Parent P-6.10.3 (Conc)	Parent P-5.97.0 (Conc)	Daughter COMSOL (Conc)	Daughter P-6.10.3 (Conc)	Daughter P-5.97.0 (Conc)
240	0	0	0	0	0	0
250	0	0	0	0	0	0
260	0	0	0	0	0	0
270	0	0	0	0	0	0
280	0	0	0	0	0	0
290	0	0	0	0	0	0
300	0	0	0	0	0	0
310	0	0	0	0	0	0
320	0	0	0	0	0	0
330	0	0	0	0	0	0
340	0	0	0	0	0	0
350	0	0	0	0	0	0
360	0	0	0	0	0	0
370	0	0	0	0	0	0
380	0	0	0	0	0	0
390	0	0	0	0	0	0
400	0	0	0	0	0	0

Table 11-48 Parent and Daughter at 50 years using Equation 1 (6.5-Problem 1)

Longitudinal Distance(m)	Parent COMSOL (Conc)	Parent P-6.10.3 (Conc)	Parent P-5.97.0 (Conc)	Daughter COMSOL (Conc)	Daughter P-6.10.3 (Conc)	Daughter P-5.97.0 (Conc)
0	1	1	1	0	0	0
10	0.95	0.9	0.95	0.05	0.1	0.05
20	0.9	0.81	0.9	0.1	0.19	0.1
30	0.86	0.74	0.86	0.14	0.26	0.14
40	0.82	0.67	0.82	0.18	0.33	0.18
50	0.78	0.6	0.78	0.22	0.39	0.22
60	0.74	0.54	0.74	0.26	0.45	0.26
70	0.7	0.49	0.7	0.3	0.49	0.3
80	0.67	0.44	0.67	0.33	0.52	0.33
90	0.63	0.39	0.63	0.37	0.54	0.37
100	0.6	0.34	0.6	0.4	0.54	0.4
110	0.57	0.29	0.57	0.43	0.51	0.43
120	0.54	0.24	0.54	0.46	0.46	0.46
130	0.52	0.19	0.52	0.48	0.39	0.48
140	0.49	0.14	0.49	0.51	0.31	0.51
150	0.46	0.1	0.46	0.53	0.24	0.53
160	0.44	0.07	0.44	0.55	0.16	0.55
170	0.42	0.04	0.42	0.57	0.11	0.57
180	0.39	0.03	0.39	0.58	0.06	0.58
190	0.37	0.01	0.37	0.59	0.04	0.59
200	0.35	0.01	0.35	0.59	0.02	0.59
210	0.32	0	0.32	0.59	0.01	0.59
220	0.3	0	0.3	0.57	0	0.57
230	0.27	0	0.27	0.54	0	0.54
240	0.24	0	0.24	0.51	0	0.51

Longitudinal Distance(m)	Parent COMSOL (Conc)	Parent P-6.10.3 (Conc)	Parent P-5.97.0 (Conc)	Daughter COMSOL (Conc)	Daughter P-6.10.3 (Conc)	Daughter P-5.97.0 (Conc)
250	0.21	0	0.21	0.46	0	0.46
260	0.18	0	0.18	0.41	0	0.41
270	0.15	0	0.15	0.36	0	0.35
280	0.12	0	0.12	0.3	0	0.3
290	0.1	0	0.1	0.24	0	0.24
300	0.07	0	0.07	0.18	0	0.19
310	0.05	0	0.05	0.14	0	0.14
320	0.04	0	0.04	0.1	0	0.1
330	0.03	0	0.03	0.07	0	0.07
340	0.02	0	0.02	0.05	0	0.05
350	0.01	0	0.01	0.03	0	0.03
360	0.01	0	0.01	0.02	0	0.02
370	0	0	0	0.01	0	0.01
380	0	0	0	0.01	0	0.01
390	0	0	0	0	0	0
400	0	0	0	0	0	0

Table 11-49 Parent and Daughter at 25 years using Equation 2 (6.5-Problem 1)

Longitudinal Distance(m)	Parent COMSOL (Conc)	Parent P-6.10.3 (Conc)	Parent P-5.97.0 (Conc)	Daughter COMSOL (Conc)	Daughter P-6.10.3 (Conc)	Daughter P-5.97.0 (Conc)
0	1	1	1	0	0	0
10	0.95	0.97	0.97	0.05	0.03	0.03
20	0.9	0.93	0.93	0.1	0.07	0.07
30	0.86	0.9	0.9	0.14	0.1	0.1
40	0.82	0.87	0.87	0.18	0.13	0.13
50	0.77	0.84	0.84	0.22	0.16	0.16
60	0.73	0.81	0.81	0.26	0.19	0.19
70	0.69	0.79	0.79	0.29	0.21	0.21
80	0.65	0.76	0.76	0.32	0.24	0.24
90	0.6	0.73	0.73	0.33	0.26	0.26
100	0.54	0.71	0.71	0.33	0.29	0.29
110	0.48	0.68	0.68	0.32	0.31	0.31
120	0.41	0.66	0.66	0.29	0.33	0.33
130	0.34	0.63	0.63	0.25	0.34	0.34
140	0.26	0.6	0.6	0.2	0.35	0.35
150	0.19	0.56	0.56	0.16	0.36	0.36
160	0.13	0.52	0.52	0.11	0.35	0.35
170	0.08	0.47	0.47	0.07	0.33	0.33
180	0.05	0.42	0.42	0.04	0.31	0.31
190	0.03	0.36	0.36	0.02	0.28	0.28
200	0.01	0.3	0.3	0.01	0.24	0.24
210	0.01	0.24	0.24	0.01	0.2	0.2
220	0	0.19	0.19	0	0.16	0.16
230	0	0.14	0.14	0	0.12	0.12
240	0	0.1	0.1	0	0.08	0.08
250	0	0.07	0.07	0	0.06	0.06

Longitudinal Distance(m)	Parent COMSOL (Conc)	Parent P-6.10.3 (Conc)	Parent P-5.97.0 (Conc)	Daughter COMSOL (Conc)	Daughter P-6.10.3 (Conc)	Daughter P-5.97.0 (Conc)
260	0	0.04	0.04	0	0.04	0.04
270	0	0.03	0.03	0	0.02	0.02
280	0	0.01	0.01	0	0.01	0.01
290	0	0.01	0.01	0	0.01	0.01
300	0	0	0	0	0	0
310	0	0	0	0	0	0
320	0	0	0	0	0	0
330	0	0	0	0	0	0
340	0	0	0	0	0	0
350	0	0	0	0	0	0
360	0	0	0	0	0	0
370	0	0	0	0	0	0
380	0	0	0	0	0	0
390	0	0	0	0	0	0
400	0	0	0	0	0	0

Table 11-50 Parent and daughter at 50 years using Equation 2 (6.5-Problem 1)

Longitudinal Distance(m)	Parent COMSOL(Conc)	Parent P-6.10.3(Conc)	Parent P-5.97.0(Conc)	Daughter COMSOL(Conc)	Daughter P-6.10.3(Conc)	Daughter P-5.97.0(Conc)
0	1	1	1	0	0	0
10	0.95	0.97	0.97	0.05	0.03	0.03
20	0.9	0.93	0.93	0.1	0.07	0.07
30	0.86	0.9	0.9	0.14	0.1	0.1
40	0.82	0.87	0.87	0.18	0.13	0.13
50	0.78	0.84	0.84	0.22	0.16	0.16
60	0.74	0.81	0.81	0.26	0.19	0.19
70	0.7	0.79	0.79	0.3	0.21	0.21
80	0.67	0.76	0.76	0.33	0.24	0.24
90	0.63	0.74	0.74	0.37	0.26	0.26
100	0.6	0.71	0.71	0.4	0.29	0.29
110	0.57	0.69	0.69	0.43	0.31	0.31
120	0.54	0.66	0.66	0.46	0.34	0.34
130	0.52	0.64	0.64	0.48	0.36	0.36
140	0.49	0.62	0.62	0.51	0.38	0.38
150	0.46	0.6	0.6	0.53	0.4	0.4
160	0.44	0.58	0.58	0.55	0.42	0.42
170	0.42	0.56	0.56	0.57	0.44	0.44
180	0.39	0.54	0.54	0.58	0.46	0.46
190	0.37	0.52	0.52	0.59	0.48	0.48
200	0.35	0.5	0.5	0.59	0.5	0.5
210	0.32	0.49	0.49	0.59	0.51	0.51
220	0.3	0.47	0.47	0.57	0.53	0.53
230	0.27	0.46	0.46	0.54	0.54	0.54
240	0.24	0.44	0.44	0.51	0.56	0.56
250	0.21	0.42	0.42	0.46	0.57	0.57
260	0.18	0.41	0.41	0.41	0.58	0.58

Longitudinal Distance(m)	Parent COMSOL(Conc)	P-6.10.3(Conc)	P-5.97.0(Conc)	Daughter COMSOL(Conc)	P-6.10.3(Conc)	P-5.97.0(Conc)
270	0.15	0.4	0.4	0.36	0.6	0.6
280	0.12	0.38	0.38	0.3	0.61	0.61
290	0.1	0.37	0.37	0.24	0.61	0.61
300	0.07	0.35	0.35	0.18	0.62	0.62
310	0.05	0.34	0.34	0.14	0.62	0.62
320	0.04	0.32	0.32	0.1	0.61	0.61
330	0.03	0.3	0.3	0.07	0.6	0.6
340	0.02	0.28	0.28	0.05	0.59	0.59
350	0.01	0.26	0.26	0.03	0.57	0.57
360	0.01	0.24	0.24	0.02	0.54	0.54
370	0	0.22	0.22	0.01	0.5	0.5
380	0	0.2	0.2	0.01	0.46	0.46
390	0	0.18	0.18	0	0.42	0.42
400	0	0.16	0.16	0	0.39	0.39

Table 11-51 Parent and Daughter at 25 years using Equation 1 (6.5-Problem 2)

Longitudinal Distance(m)	Parent COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)	Daughter COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)
0	1	1	1	0	0	0
10	0.95	0.95	0.97	0.05	0.05	0.03
20	0.9	0.9	0.93	0.1	0.1	0.07
30	0.86	0.86	0.9	0.14	0.14	0.1
40	0.82	0.82	0.87	0.18	0.18	0.13
50	0.77	0.77	0.84	0.22	0.22	0.16
60	0.73	0.73	0.81	0.26	0.26	0.19
70	0.69	0.69	0.79	0.29	0.29	0.21
80	0.65	0.65	0.76	0.32	0.32	0.24
90	0.6	0.6	0.73	0.33	0.33	0.26
100	0.54	0.55	0.71	0.33	0.33	0.29
110	0.48	0.48	0.68	0.32	0.32	0.31
120	0.41	0.41	0.66	0.29	0.29	0.33
130	0.34	0.34	0.63	0.25	0.25	0.34
140	0.26	0.26	0.6	0.2	0.2	0.35
150	0.19	0.19	0.56	0.16	0.15	0.36
160	0.13	0.13	0.52	0.11	0.11	0.35
170	0.08	0.08	0.47	0.07	0.07	0.33
180	0.05	0.05	0.42	0.04	0.04	0.31
190	0.03	0.03	0.36	0.02	0.02	0.28
200	0.01	0.01	0.3	0.01	0.01	0.24
210	0.01	0.01	0.24	0.01	0.01	0.2
220	0	0	0.19	0	0	0.16
230	0	0	0.14	0	0	0.12
240	0	0	0.1	0	0	0.08
250	0	0	0.07	0	0	0.06
260	0	0	0.04	0	0	0.04
270	0	0	0.03	0	0	0.02

		Parent			Daughter	
Longitudinal Distance(m)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)
280	0	0	0.01	0	0	0.01
290	0	0	0.01	0	0	0.01
300	0	0	0	0	0	0
310	0	0	0	0	0	0
320	0	0	0	0	0	0
330	0	0	0	0	0	0
340	0	0	0	0	0	0
350	0	0	0	0	0	0
360	0	0	0	0	0	0
370	0	0	0	0	0	0
380	0	0	0	0	0	0
390	0	0	0	0	0	0
400	0	0	0	0	0	0

Table 11-52 Parent and Daughter at 50 years using Equation 1 (6.5-Problem 2)

		Parent			Daughter	
Longitudinal Distance(m)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)
0	1	1	1	0	0	0
10	0.95	0.95	0.97	0.05	0.05	0.03
20	0.9	0.9	0.93	0.1	0.1	0.07
30	0.86	0.86	0.9	0.14	0.14	0.1
40	0.82	0.82	0.87	0.18	0.18	0.13
50	0.78	0.78	0.84	0.22	0.22	0.16
60	0.74	0.74	0.81	0.26	0.26	0.19
70	0.7	0.7	0.79	0.3	0.3	0.21
80	0.67	0.67	0.76	0.33	0.33	0.24
90	0.63	0.63	0.74	0.37	0.37	0.26
100	0.6	0.6	0.71	0.4	0.4	0.29
110	0.57	0.57	0.69	0.43	0.43	0.31
120	0.54	0.54	0.66	0.46	0.46	0.34
130	0.52	0.52	0.64	0.48	0.48	0.36
140	0.49	0.49	0.62	0.51	0.51	0.38
150	0.46	0.46	0.6	0.53	0.53	0.4
160	0.44	0.44	0.58	0.55	0.55	0.42
170	0.42	0.42	0.56	0.57	0.57	0.44
180	0.39	0.39	0.54	0.58	0.58	0.46
190	0.37	0.37	0.52	0.59	0.59	0.48
200	0.35	0.35	0.5	0.59	0.59	0.5
210	0.32	0.32	0.49	0.59	0.59	0.51
220	0.3	0.3	0.47	0.57	0.57	0.53
230	0.27	0.27	0.46	0.54	0.54	0.54
240	0.24	0.24	0.44	0.51	0.51	0.56
250	0.21	0.21	0.42	0.46	0.46	0.57
260	0.18	0.18	0.41	0.41	0.41	0.58
270	0.15	0.15	0.4	0.36	0.35	0.6
280	0.12	0.12	0.38	0.3	0.3	0.61

Longitudinal Distance(m)	Parent COMSOL (Conc)	Parent P-6.10.3 (Conc)	Parent P-5.97.0 (Conc)	Daughter COMSOL (Conc)	Daughter P-6.10.3 (Conc)	Daughter P-5.97.0 (Conc)
290	0.1	0.1	0.37	0.24	0.24	0.61
300	0.07	0.07	0.35	0.18	0.19	0.62
310	0.05	0.05	0.34	0.14	0.14	0.62
320	0.04	0.04	0.32	0.1	0.1	0.61
330	0.03	0.03	0.3	0.07	0.07	0.6
340	0.02	0.02	0.28	0.05	0.05	0.59
350	0.01	0.01	0.26	0.03	0.03	0.57
360	0.01	0.01	0.24	0.02	0.02	0.54
370	0	0	0.22	0.01	0.01	0.5
380	0	0	0.2	0.01	0.01	0.46
390	0	0	0.18	0	0	0.42
400	0	0	0.16	0	0	0.39

Table 11-53 Parent and Daughter at 25 years using Equation 2 (6.5-Problem 2)

Longitudinal Distance(m)	Parent COMSOL (Conc)	Parent P-6.10.3 (Conc)	Parent P-5.97.0 (Conc)	Daughter COMSOL (Conc)	Daughter P-6.10.3 (Conc)	Daughter P-5.97.0 (Conc)
0	1	1	1	0	0	0
10	0.95	0.97	0.97	0.05	0.03	0.03
20	0.9	0.93	0.93	0.1	0.07	0.07
30	0.86	0.9	0.9	0.14	0.1	0.1
40	0.82	0.87	0.87	0.18	0.13	0.13
50	0.77	0.84	0.84	0.22	0.16	0.16
60	0.73	0.81	0.81	0.26	0.19	0.19
70	0.69	0.79	0.79	0.29	0.21	0.21
80	0.65	0.76	0.76	0.32	0.24	0.24
90	0.6	0.73	0.73	0.33	0.26	0.26
100	0.54	0.71	0.71	0.33	0.29	0.29
110	0.48	0.68	0.68	0.32	0.31	0.31
120	0.41	0.66	0.66	0.29	0.33	0.33
130	0.34	0.63	0.63	0.25	0.34	0.34
140	0.26	0.6	0.6	0.2	0.35	0.35
150	0.19	0.56	0.56	0.16	0.36	0.36
160	0.13	0.52	0.52	0.11	0.35	0.35
170	0.08	0.47	0.47	0.07	0.33	0.33
180	0.05	0.42	0.42	0.04	0.31	0.31
190	0.03	0.36	0.36	0.02	0.28	0.28
200	0.01	0.3	0.3	0.01	0.24	0.24
210	0.01	0.24	0.24	0.01	0.2	0.2
220	0	0.19	0.19	0	0.16	0.16
230	0	0.14	0.14	0	0.12	0.12
240	0	0.1	0.1	0	0.08	0.08
250	0	0.07	0.07	0	0.06	0.06
260	0	0.04	0.04	0	0.04	0.04
270	0	0.03	0.03	0	0.02	0.02
280	0	0.01	0.01	0	0.01	0.01
290	0	0.01	0.01	0	0.01	0.01

	Parent			Daughter		
Longitudinal Distance(m)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)
300	0	0	0	0	0	0
310	0	0	0	0	0	0
320	0	0	0	0	0	0
330	0	0	0	0	0	0
340	0	0	0	0	0	0
350	0	0	0	0	0	0
360	0	0	0	0	0	0
370	0	0	0	0	0	0
380	0	0	0	0	0	0
390	0	0	0	0	0	0
400	0	0	0	0	0	0

Table 11-54 Parent and Daughter at 50 years using Equation 2 (6.5-Problem 2)

	Parent			Daughter		
Longitudinal Distance(m)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)
0	1	1	1	0	0	0
10	0.95	0.97	0.97	0.05	0.03	0.03
20	0.9	0.93	0.93	0.1	0.07	0.07
30	0.86	0.9	0.9	0.14	0.1	0.1
40	0.82	0.87	0.87	0.18	0.13	0.13
50	0.78	0.84	0.84	0.22	0.16	0.16
60	0.74	0.81	0.81	0.26	0.19	0.19
70	0.7	0.79	0.79	0.3	0.21	0.21
80	0.67	0.76	0.76	0.33	0.24	0.24
90	0.63	0.74	0.74	0.37	0.26	0.26
100	0.6	0.71	0.71	0.4	0.29	0.29
110	0.57	0.69	0.69	0.43	0.31	0.31
120	0.54	0.66	0.66	0.46	0.34	0.34
130	0.52	0.64	0.64	0.48	0.36	0.36
140	0.49	0.62	0.62	0.51	0.38	0.38
150	0.46	0.6	0.6	0.53	0.4	0.4
160	0.44	0.58	0.58	0.55	0.42	0.42
170	0.42	0.56	0.56	0.57	0.44	0.44
180	0.39	0.54	0.54	0.58	0.46	0.46
190	0.37	0.52	0.52	0.59	0.48	0.48
200	0.35	0.5	0.5	0.59	0.5	0.5
210	0.32	0.49	0.49	0.59	0.51	0.51
220	0.3	0.47	0.47	0.57	0.53	0.53
230	0.27	0.46	0.46	0.54	0.54	0.54
240	0.24	0.44	0.44	0.51	0.56	0.56
250	0.21	0.42	0.42	0.46	0.57	0.57
260	0.18	0.41	0.41	0.41	0.58	0.58
270	0.15	0.4	0.4	0.36	0.6	0.6
280	0.12	0.38	0.38	0.3	0.61	0.61
290	0.1	0.37	0.37	0.24	0.61	0.61
300	0.07	0.35	0.35	0.18	0.62	0.62

	Parent			Daughter		
Longitudinal Distance(m)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)	COMSOL (Conc)	P-6.10.3 (Conc)	P-5.97.0 (Conc)
310	0.05	0.34	0.34	0.14	0.62	0.62
320	0.04	0.32	0.32	0.1	0.61	0.61
330	0.03	0.3	0.3	0.07	0.6	0.6
340	0.02	0.28	0.28	0.05	0.59	0.59
350	0.01	0.26	0.26	0.03	0.57	0.57
360	0.01	0.24	0.24	0.02	0.54	0.54
370	0	0.22	0.22	0.01	0.5	0.5
380	0	0.2	0.2	0.01	0.46	0.46
390	0	0.18	0.18	0	0.42	0.42
400	0	0.16	0.16	0	0.39	0.39

Table 11-55 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 0.1)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0.0	0.00	0.00	0.00
25.0	0.00	0.00	0.00
50.0	0.00	0.00	0.00
75.0	0.00	0.00	0.00
100.0	0.00	0.00	0.00
125.0	0.00	0.00	0.00
150.0	0.00	0.00	0.00
175.0	0.00	0.16	0.16
180.0	1.00	0.51	0.51
182.5	1.00	0.70	0.70
185.0	1.00	0.84	0.84
187.5	1.00	0.93	0.93
190.0	1.00	0.98	0.98
192.5	1.00	0.99	0.99
195.0	1.00	1.00	1.00
197.5	1.00	1.00	1.00
200.0	1.00	1.00	1.00
202.5	1.00	1.00	1.00
205.0	1.00	1.00	1.00
207.5	1.00	0.99	0.99
210.0	1.00	0.96	0.96
212.5	1.00	0.91	0.91
215.0	1.00	0.81	0.81
217.5	1.00	0.67	0.67
220.0	1.00	0.49	0.49
225.0	0.00	0.18	0.18
250.0	0.00	0.00	0.00
275.0	0.00	0.00	0.00
300.0	0.00	0.00	0.00
325.0	0.00	0.00	0.00
350.0	0.00	0.00	0.00
375.0	0.00	0.00	0.00

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
400.0	0.00	0.00	0.00

Table 11-56 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 1)

Distance(m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.00	0.00
25	0.00	0.00	0.00
50	0.00	0.00	0.00
75	0.00	0.00	0.00
100	0.00	0.00	0.00
125	0.00	0.00	0.00
150	0.00	0.01	0.01
175	0.00	0.37	0.37
200	1.00	0.83	0.83
225	0.00	0.35	0.35
250	0.00	0.02	0.02
275	0.00	0.00	0.00
300	0.00	0.00	0.00
325	0.00	0.00	0.00
350	0.00	0.00	0.00
375	0.00	0.00	0.00
400	0.00	0.00	0.00

Table 11-57 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 5)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.00	0.00
50	0.00	0.00	0.00
100	0.00	0.00	0.00
150	0.00	0.16	0.16
200	1.00	0.47	0.47
250	0.00	0.15	0.15
300	0.00	0.01	0.01
350	0.00	0.00	0.00
400	0.00	0.00	0.00

Table 11-58 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 10)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.00	0.00
50	0.00	0.00	0.00
100	0.00	0.03	0.03
150	0.00	0.21	0.21

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
200	1.00	0.34	0.34
250	0.00	0.18	0.18
300	0.00	0.04	0.04
350	0.00	0.00	0.00
400	0.00	0.00	0.00

Table 11-59 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 15)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.00	0.00
30	0.00	0.00	0.00
60	0.00	0.01	0.01
90	0.00	0.04	0.04
120	0.00	0.11	0.11
150	0.00	0.21	0.21
180	1.00	0.28	0.28
210	1.00	0.27	0.27
240	0.00	0.20	0.20
270	0.00	0.12	0.12
300	0.00	0.06	0.06
330	0.00	0.02	0.02
360	0.00	0.01	0.01
390	0.00	0.00	0.00
405	0.00	0.00	0.00

Table 11-60 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 20)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.00	0.00
20	0.00	0.00	0.00
40	0.00	0.01	0.01
60	0.00	0.02	0.02
80	0.00	0.04	0.04
100	0.00	0.08	0.08
120	0.00	0.13	0.13
140	0.00	0.18	0.18
160	0.00	0.22	0.22
180	1.00	0.25	0.25
200	1.00	0.25	0.25
220	1.00	0.22	0.22
240	0.00	0.19	0.19
260	0.00	0.14	0.14
280	0.00	0.10	0.10
300	0.00	0.07	0.07
320	0.00	0.04	0.04

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
340	0.00	0.03	0.03
360	0.00	0.02	0.02
380	0.00	0.01	0.01
400	0.00	0.00	0.00

Table 11-61 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 30)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.00	0.00
30	0.00	0.01	0.01
60	0.00	0.04	0.04
90	0.00	0.09	0.09
120	0.00	0.14	0.14
150	0.00	0.19	0.19
180	1.00	0.20	0.20
210	1.00	0.19	0.19
240	0.00	0.16	0.16
270	0.00	0.12	0.12
300	0.00	0.08	0.08
330	0.00	0.05	0.05
360	0.00	0.03	0.03
390	0.00	0.01	0.01
420	0.00	0.01	0.01

Table 11-62 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 40)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.01	0.01
40	0.00	0.03	0.03
80	0.00	0.09	0.09
120	0.00	0.14	0.14
160	0.00	0.17	0.17
200	1.00	0.17	0.17
240	0.00	0.15	0.15
280	0.00	0.10	0.10
320	0.00	0.07	0.07
360	0.00	0.04	0.04
400	0.00	0.02	0.02

Table 11-63 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 50)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.02	0.02

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
50	0.00	0.06	0.06
100	0.00	0.12	0.12
150	0.00	0.16	0.16
200	1.00	0.16	0.16
250	0.00	0.12	0.12
300	0.00	0.08	0.08
350	0.00	0.05	0.05
400	0.00	0.02	0.02

Table 11-64 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 1 mesh spacing of 60)

Distance (m)	Analytical concentration	P-6.10.3	P-5.97.0
0	0.00	0.02	0.02
60	0.00	0.08	0.08
120	0.00	0.13	0.13
180	1.00	0.15	0.15
240	0.00	0.12	0.12
300	0.00	0.08	0.08
360	0.00	0.05	0.05
420	0.00	0.02	0.02

Table 11-65 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 0.1)

Distance (m)	P-6.10.3	P-5.97.0
0.0	0.01	0.01
25.0	0.03	0.03
50.0	0.04	0.04
75.0	0.07	0.07
100.0	0.10	0.10
125.0	0.13	0.13
150.0	0.15	0.15
175.0	0.17	0.17
180.0	0.17	0.17
182.5	0.17	0.17
185.0	0.17	0.17
187.5	0.18	0.18
190.0	0.18	0.18
192.5	0.18	0.18
195.0	0.18	0.18
197.5	0.18	0.18
200.0	0.18	0.18
202.5	0.18	0.18
205.0	0.18	0.18
207.5	0.18	0.18
210.0	0.18	0.18

Distance (m)	P-6.10.3	P-5.97.0
212.5	0.18	0.18
215.0	0.17	0.17
217.5	0.17	0.17
220.0	0.17	0.17
225.0	0.17	0.17
250.0	0.15	0.15
275.0	0.12	0.12
300.0	0.09	0.09
325.0	0.07	0.07
350.0	0.04	0.04
375.0	0.03	0.03
400.0	0.02	0.02

Table 11-66 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 1)

Distance (m)	P-6.10.3	P-5.97.0
0	0.01	0.01
25	0.03	0.03
50	0.04	0.04
75	0.07	0.07
100	0.10	0.10
125	0.13	0.13
150	0.15	0.15
175	0.17	0.17
200	0.18	0.18
225	0.17	0.17
250	0.15	0.15
275	0.12	0.12
300	0.09	0.09
325	0.07	0.07
350	0.04	0.04
375	0.03	0.03
400	0.02	0.02

Table 11-67 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 5)

Distance (m)	P-6.10.3	P-5.97.0
0	0.01	0.01
50	0.04	0.04
100	0.10	0.10
150	0.15	0.15
200	0.18	0.18
250	0.15	0.15
300	0.09	0.09
350	0.04	0.04

Distance (m)	P-6.10.3	P-5.97.0
400	0.02	0.02

Table 11-68 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 10)

Distance (m)	P-6.10.3	P-5.97.0
0	0.01	0.01
50	0.04	0.04
100	0.1	0.1
150	0.15	0.15
200	0.18	0.18
250	0.15	0.15
300	0.09	0.09
350	0.04	0.04
400	0.02	0.02

Table 11-69 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 15)

Distance (m)	P-6.10.3	P-5.97.0
0	0.01	0.01
30	0.03	0.03
60	0.05	0.05
90	0.09	0.09
120	0.12	0.12
150	0.16	0.16
180	0.17	0.17
210	0.18	0.18
240	0.16	0.16
270	0.13	0.13
300	0.09	0.09
330	0.06	0.06
360	0.04	0.04
390	0.02	0.02
405	0.01	0.01

Table 11-70 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 20)

Distance (m)	P-6.10.3	P-5.97.0
0	0.01	0.01
20	0.02	0.02
40	0.04	0.04
60	0.05	0.05
80	0.08	0.08
100	0.10	0.10

Distance (m)	P-6.10.3	P-5.97.0
120	0.12	0.12
140	0.15	0.15
160	0.17	0.17
180	0.18	0.18
200	0.18	0.18
220	0.17	0.17
240	0.16	0.16
260	0.14	0.14
280	0.11	0.11
300	0.09	0.09
320	0.07	0.07
340	0.05	0.05
360	0.04	0.04
380	0.02	0.02
400	0.02	0.02

Table 11-71 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 30)

Distance (m)	P-6.10.3	P-5.97.0
0	0.01	0.01
30	0.03	0.03
60	0.05	0.05
90	0.09	0.09
120	0.13	0.13
150	0.16	0.16
180	0.18	0.18
210	0.17	0.17
240	0.15	0.15
270	0.12	0.12
300	0.09	0.09
330	0.06	0.06
360	0.04	0.04
390	0.02	0.02
420	0.01	0.01

Table 11-72 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 40)

Distance (m)	P-6.10.3	P-5.97.0
0	0.01	0.01
40	0.03	0.03
80	0.09	0.09
120	0.14	0.14
160	0.17	0.17
200	0.17	0.17
240	0.15	0.15

Distance (m)	P-6.10.3	P-5.97.0
280	0.10	0.10
320	0.07	0.07
360	0.04	0.04
400	0.02	0.02

Table 11-73 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 50)

Distance (m)	P-6.10.3	P-5.97.0
0	0.02	0.02
50	0.06	0.06
100	0.12	0.12
150	0.16	0.16
200	0.16	0.16
250	0.12	0.12
300	0.08	0.08
350	0.05	0.05
400	0.02	0.02

Table 11-74 Numerical and Mechanical Dispersion in a One-Dimensional Saturated Soil Column (7.1-Problem 2 mesh spacing of 60)

Distance (m)	P-6.10.3	P-5.97.0
0	0.02	0.02
60	0.08	0.08
120	0.13	0.13
180	0.15	0.15
240	0.12	0.12
300	0.08	0.08
360	0.05	0.05
420	0.02	0.02

Table 11-75 DISTribution and RETArdation (8.2-Problem 1)

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
0	0.00E+00	0.00E+00	0.00E+00
5	5.00E-02	5.00E-02	5.00E-02
10	1.00E-01	1.00E-01	1.00E-01
15	1.50E-01	1.50E-01	1.50E-01
20	2.00E-01	2.00E-01	2.00E-01
25	2.50E-01	2.50E-01	2.50E-01
30	3.00E-01	3.00E-01	3.00E-01
35	3.50E-01	3.50E-01	3.50E-01
40	4.00E-01	4.00E-01	4.00E-01
45	4.50E-01	4.50E-01	4.50E-01
50	5.00E-01	5.00E-01	5.00E-01

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
55	5.50E-01	5.50E-01	5.50E-01
60	6.00E-01	6.00E-01	6.00E-01
65	6.50E-01	6.50E-01	6.50E-01
70	7.00E-01	7.00E-01	7.00E-01
75	7.50E-01	7.50E-01	7.50E-01
80	8.00E-01	8.00E-01	8.00E-01
85	8.50E-01	8.50E-01	8.50E-01
90	9.00E-01	9.00E-01	9.00E-01
95	9.50E-01	9.50E-01	9.50E-01
100	1.00E+00	1.00E+00	1.00E+00
105	1.00E+00	1.00E+00	1.05E+00
110	1.00E+00	1.00E+00	1.10E+00
115	1.00E+00	1.00E+00	1.15E+00
120	1.00E+00	1.00E+00	1.20E+00
125	1.00E+00	1.00E+00	1.25E+00
130	1.00E+00	1.00E+00	1.30E+00
135	1.00E+00	1.00E+00	1.35E+00
140	1.00E+00	1.00E+00	1.40E+00
145	1.00E+00	1.00E+00	1.45E+00
150	1.00E+00	1.00E+00	1.50E+00
155	1.00E+00	1.00E+00	1.55E+00
160	1.00E+00	1.00E+00	1.60E+00
165	1.00E+00	1.00E+00	1.65E+00
170	1.00E+00	1.00E+00	1.70E+00
175	1.00E+00	1.00E+00	1.75E+00
180	1.00E+00	1.00E+00	1.80E+00
185	1.00E+00	1.00E+00	1.85E+00
190	1.00E+00	1.00E+00	1.90E+00
195	1.00E+00	1.00E+00	1.95E+00
200	1.00E+00	1.00E+00	2.00E+00
205	1.00E+00	1.00E+00	1.95E+00
210	1.00E+00	1.00E+00	1.90E+00
215	1.00E+00	1.00E+00	1.85E+00
220	1.00E+00	1.00E+00	1.80E+00
225	1.00E+00	1.00E+00	1.75E+00
230	1.00E+00	1.00E+00	1.70E+00
235	1.00E+00	1.00E+00	1.65E+00
240	1.00E+00	1.00E+00	1.60E+00
245	1.00E+00	1.00E+00	1.55E+00
250	1.00E+00	1.00E+00	1.50E+00
255	1.00E+00	1.00E+00	1.45E+00
260	1.00E+00	1.00E+00	1.40E+00
265	1.00E+00	1.00E+00	1.35E+00
270	1.00E+00	1.00E+00	1.30E+00
275	1.00E+00	1.00E+00	1.25E+00
280	1.00E+00	1.00E+00	1.20E+00
285	1.00E+00	1.00E+00	1.15E+00
290	1.00E+00	1.00E+00	1.10E+00
295	1.00E+00	1.00E+00	1.05E+00

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
300	1.00E+00	1.00E+00	1.00E+00
305	9.50E-01	9.50E-01	9.50E-01
310	9.00E-01	9.00E-01	9.00E-01
315	8.50E-01	8.50E-01	8.50E-01
320	8.00E-01	8.00E-01	8.00E-01
325	7.50E-01	7.50E-01	7.50E-01
330	7.00E-01	7.00E-01	7.00E-01
335	6.50E-01	6.50E-01	6.50E-01
340	6.00E-01	6.00E-01	6.00E-01
345	5.50E-01	5.50E-01	5.50E-01
350	5.00E-01	5.00E-01	5.00E-01
355	4.50E-01	4.50E-01	4.50E-01
360	4.00E-01	4.00E-01	4.00E-01
365	3.50E-01	3.50E-01	3.50E-01
370	3.00E-01	3.00E-01	3.00E-01
375	2.50E-01	2.50E-01	2.50E-01
380	2.00E-01	2.00E-01	2.00E-01
385	1.50E-01	1.50E-01	1.50E-01
390	1.00E-01	1.00E-01	1.00E-01
395	5.00E-02	5.00E-02	5.00E-02
400	0.00E+00	3.09E-13	2.95E-13

Table 11-76 DISTribution and RETArdation (8.2-Problem 2)

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
0	0.00E+00	0.00E+00	0.00E+00
5	5.00E-02	5.00E-02	5.00E-02
10	1.00E-01	1.00E-01	1.00E-01
15	1.50E-01	1.50E-01	1.50E-01
20	2.00E-01	2.00E-01	2.00E-01
25	2.50E-01	2.50E-01	2.50E-01
30	3.00E-01	3.00E-01	3.00E-01
35	3.50E-01	3.50E-01	3.50E-01
40	4.00E-01	4.00E-01	4.00E-01
45	4.50E-01	4.50E-01	4.50E-01
50	5.00E-01	5.00E-01	5.00E-01
55	5.50E-01	5.50E-01	5.50E-01
60	6.00E-01	6.00E-01	6.00E-01
65	6.50E-01	6.50E-01	6.50E-01
70	7.00E-01	7.00E-01	7.00E-01
75	7.50E-01	7.50E-01	7.50E-01
80	8.00E-01	8.00E-01	8.00E-01
85	8.50E-01	8.50E-01	8.50E-01
90	9.00E-01	9.00E-01	9.00E-01
95	9.50E-01	9.50E-01	9.50E-01
100	1.00E+00	1.00E+00	1.00E+00
105	1.00E+00	4.98E-02	4.98E-02

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
110	1.00E+00	9.98E-02	9.98E-02
115	1.00E+00	1.50E-01	1.50E-01
120	1.00E+00	2.00E-01	2.00E-01
125	1.00E+00	2.50E-01	2.50E-01
130	1.00E+00	3.00E-01	3.00E-01
135	1.00E+00	3.50E-01	3.50E-01
140	1.00E+00	4.00E-01	4.00E-01
145	1.00E+00	4.50E-01	4.50E-01
150	1.00E+00	5.00E-01	5.00E-01
155	1.00E+00	5.50E-01	5.50E-01
160	1.00E+00	6.00E-01	6.00E-01
165	1.00E+00	6.50E-01	6.50E-01
170	1.00E+00	7.00E-01	7.00E-01
175	1.00E+00	7.50E-01	7.50E-01
180	1.00E+00	8.00E-01	8.00E-01
185	1.00E+00	8.50E-01	8.50E-01
190	1.00E+00	9.00E-01	9.00E-01
195	1.00E+00	9.50E-01	9.50E-01
200	1.00E+00	1.00E+00	1.00E+00
205	1.00E+00	9.50E-01	9.50E-01
210	1.00E+00	9.00E-01	9.00E-01
215	1.00E+00	8.50E-01	8.50E-01
220	1.00E+00	8.00E-01	8.00E-01
225	1.00E+00	7.50E-01	7.50E-01
230	1.00E+00	7.00E-01	7.00E-01
235	1.00E+00	6.50E-01	6.50E-01
240	1.00E+00	6.00E-01	6.00E-01
245	1.00E+00	5.50E-01	5.50E-01
250	1.00E+00	5.00E-01	5.00E-01
255	1.00E+00	4.50E-01	4.50E-01
260	1.00E+00	4.00E-01	4.00E-01
265	1.00E+00	3.50E-01	3.50E-01
270	1.00E+00	3.00E-01	3.00E-01
275	1.00E+00	2.50E-01	2.50E-01
280	1.00E+00	2.00E-01	2.00E-01
285	1.00E+00	1.50E-01	1.50E-01
290	1.00E+00	9.98E-02	9.98E-02
295	1.00E+00	4.98E-02	4.98E-02
300	1.00E+00	-2.00E-04	-2.00E-04
305	9.50E-01	-5.02E-02	-5.02E-02
310	9.00E-01	-1.00E-01	-1.00E-01
315	8.50E-01	-1.50E-01	-1.50E-01
320	8.00E-01	-2.00E-01	-2.00E-01
325	7.50E-01	-2.50E-01	-2.50E-01
330	7.00E-01	-3.00E-01	-3.00E-01
335	6.50E-01	-3.50E-01	-3.50E-01
340	6.00E-01	-4.00E-01	-4.00E-01
345	5.50E-01	-4.50E-01	-4.50E-01
350	5.00E-01	-5.00E-01	-5.00E-01

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
355	4.50E-01	-5.50E-01	-5.50E-01
360	4.00E-01	-6.00E-01	-6.00E-01
365	3.50E-01	-6.50E-01	-6.50E-01
370	3.00E-01	-7.00E-01	-7.00E-01
375	2.50E-01	-7.50E-01	-7.50E-01
380	2.00E-01	-8.00E-01	-8.00E-01
385	1.50E-01	-8.50E-01	-8.50E-01
390	1.00E-01	-9.00E-01	-9.00E-01
395	5.00E-02	-9.50E-01	-9.50E-01
400	0.00E+00	-1.00E+00	-1.00E+00

Table 11-77 DISTribution and RETArdation (8.2-Problem 3)

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
0	0.00E+00	0.00E+00	0.00E+00
5	5.00E-02	4.00E-02	5.00E-02
10	1.00E-01	8.00E-02	1.00E-01
15	1.50E-01	1.20E-01	1.50E-01
20	2.00E-01	1.60E-01	2.00E-01
25	2.50E-01	2.00E-01	2.50E-01
30	3.00E-01	2.40E-01	3.00E-01
35	3.50E-01	2.80E-01	3.50E-01
40	4.00E-01	3.20E-01	4.00E-01
45	4.50E-01	3.60E-01	4.50E-01
50	5.00E-01	4.00E-01	5.00E-01
55	5.50E-01	4.40E-01	5.50E-01
60	6.00E-01	4.80E-01	6.00E-01
65	6.50E-01	5.20E-01	6.50E-01
70	7.00E-01	5.60E-01	7.00E-01
75	7.50E-01	6.00E-01	7.50E-01
80	8.00E-01	6.40E-01	8.00E-01
85	8.50E-01	6.80E-01	8.50E-01
90	9.00E-01	7.20E-01	9.00E-01
95	9.50E-01	7.60E-01	9.50E-01
100	1.00E+00	8.00E-01	1.00E+00
105	1.00E+00	8.40E-01	4.98E-02
110	1.00E+00	8.80E-01	9.98E-02
115	1.00E+00	9.20E-01	1.50E-01
120	1.00E+00	9.60E-01	2.00E-01
125	1.00E+00	1.00E+00	2.50E-01
130	1.00E+00	4.02E-02	3.00E-01
135	1.00E+00	8.02E-02	3.50E-01
140	1.00E+00	1.20E-01	4.00E-01
145	1.00E+00	1.60E-01	4.50E-01
150	1.00E+00	2.00E-01	5.00E-01
155	1.00E+00	2.40E-01	5.50E-01
160	1.00E+00	2.80E-01	6.00E-01
165	1.00E+00	3.20E-01	6.50E-01
170	1.00E+00	3.60E-01	7.00E-01

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
175	1.00E+00	4.00E-01	7.50E-01
180	1.00E+00	4.40E-01	8.00E-01
185	1.00E+00	4.80E-01	8.50E-01
190	1.00E+00	5.20E-01	9.00E-01
195	1.00E+00	5.60E-01	9.50E-01
200	1.00E+00	6.00E-01	1.00E+00
205	1.00E+00	5.60E-01	9.50E-01
210	1.00E+00	5.20E-01	9.00E-01
215	1.00E+00	4.80E-01	8.50E-01
220	1.00E+00	4.40E-01	8.00E-01
225	1.00E+00	4.00E-01	7.50E-01
230	1.00E+00	3.60E-01	7.00E-01
235	1.00E+00	3.20E-01	6.50E-01
240	1.00E+00	2.80E-01	6.00E-01
245	1.00E+00	2.40E-01	5.50E-01
250	1.00E+00	2.00E-01	5.00E-01
255	1.00E+00	1.60E-01	4.50E-01
260	1.00E+00	1.20E-01	4.00E-01
265	1.00E+00	8.02E-02	3.50E-01
270	1.00E+00	4.02E-02	3.00E-01
275	1.00E+00	2.00E-04	2.50E-01
280	1.00E+00	-3.98E-02	2.00E-01
285	1.00E+00	-7.98E-02	1.50E-01
290	1.00E+00	-1.20E-01	9.98E-02
295	1.00E+00	-1.60E-01	4.98E-02
300	1.00E+00	-2.00E-01	-2.00E-04
305	9.50E-01	-2.40E-01	-5.02E-02
310	9.00E-01	-2.80E-01	-1.00E-01
315	8.50E-01	-3.20E-01	-1.50E-01
320	8.00E-01	-3.60E-01	-2.00E-01
325	7.50E-01	-4.00E-01	-2.50E-01
330	7.00E-01	-4.40E-01	-3.00E-01
335	6.50E-01	-4.80E-01	-3.50E-01
340	6.00E-01	-5.20E-01	-4.00E-01
345	5.50E-01	-5.60E-01	-4.50E-01
350	5.00E-01	-6.00E-01	-5.00E-01
355	4.50E-01	-6.40E-01	-5.50E-01
360	4.00E-01	-6.80E-01	-6.00E-01
365	3.50E-01	-7.20E-01	-6.50E-01
370	3.00E-01	-7.60E-01	-7.00E-01
375	2.50E-01	-8.00E-01	-7.50E-01
380	2.00E-01	-8.40E-01	-8.00E-01
385	1.50E-01	-8.80E-01	-8.50E-01
390	1.00E-01	-9.20E-01	-9.00E-01
395	5.00E-02	-9.60E-01	-9.50E-01
400	0.00E+00	-1.00E+00	-1.00E+00

Table 11-78 DISTribution and RETArdation (8.2-Problem 4)

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
0	0.00E+00	0.00E+00	0.00E+00
5	1.00E-01	1.00E-01	1.00E-01
10	2.00E-01	2.00E-01	2.00E-01
15	3.00E-01	3.00E-01	3.00E-01
20	4.00E-01	4.00E-01	4.00E-01
25	5.00E-01	5.00E-01	5.00E-01
30	6.00E-01	6.00E-01	6.00E-01
35	7.00E-01	7.00E-01	7.00E-01
40	8.00E-01	8.00E-01	8.00E-01
45	9.00E-01	9.00E-01	9.00E-01
50	1.00E+00	1.00E+00	1.00E+00
55	1.10E+00	1.10E+00	1.10E+00
60	1.20E+00	1.20E+00	1.20E+00
65	1.30E+00	1.30E+00	1.30E+00
70	1.40E+00	1.40E+00	1.40E+00
75	1.50E+00	1.50E+00	1.50E+00
80	1.60E+00	1.60E+00	1.60E+00
85	1.70E+00	1.70E+00	1.70E+00
90	1.80E+00	1.80E+00	1.80E+00
95	1.90E+00	1.90E+00	1.90E+00
100	2.00E+00	2.00E+00	2.00E+00
105	2.10E+00	2.10E+00	2.10E+00
110	2.20E+00	2.20E+00	2.20E+00
115	2.30E+00	2.30E+00	2.30E+00
120	2.40E+00	2.40E+00	2.40E+00
125	2.50E+00	2.50E+00	2.50E+00
130	2.60E+00	2.60E+00	2.60E+00
135	2.70E+00	2.70E+00	2.70E+00
140	2.80E+00	2.80E+00	2.80E+00
145	2.90E+00	2.90E+00	2.90E+00
150	3.00E+00	3.00E+00	3.00E+00
155	3.10E+00	3.10E+00	3.10E+00
160	3.20E+00	3.20E+00	3.20E+00
165	3.30E+00	3.30E+00	3.30E+00
170	3.40E+00	3.40E+00	3.40E+00
175	3.50E+00	3.50E+00	3.50E+00
180	3.60E+00	3.60E+00	3.60E+00
185	3.70E+00	3.70E+00	3.70E+00
190	3.80E+00	3.80E+00	3.80E+00
195	3.90E+00	3.90E+00	3.90E+00
200	4.00E+00	4.00E+00	4.00E+00
205	3.90E+00	3.90E+00	3.90E+00
210	3.80E+00	3.80E+00	3.80E+00
215	3.70E+00	3.70E+00	3.70E+00
220	3.60E+00	3.60E+00	3.60E+00
225	3.50E+00	3.50E+00	3.50E+00
230	3.40E+00	3.40E+00	3.40E+00

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
235	3.30E+00	3.30E+00	3.30E+00
240	3.20E+00	3.20E+00	3.20E+00
245	3.10E+00	3.10E+00	3.10E+00
250	3.00E+00	3.00E+00	3.00E+00
255	2.90E+00	2.90E+00	2.90E+00
260	2.80E+00	2.80E+00	2.80E+00
265	2.70E+00	2.70E+00	2.70E+00
270	2.60E+00	2.60E+00	2.60E+00
275	2.50E+00	2.50E+00	2.50E+00
280	2.40E+00	2.40E+00	2.40E+00
285	2.30E+00	2.30E+00	2.30E+00
290	2.20E+00	2.20E+00	2.20E+00
295	2.10E+00	2.10E+00	2.10E+00
300	2.00E+00	2.00E+00	2.00E+00
305	1.90E+00	1.90E+00	1.90E+00
310	1.80E+00	1.80E+00	1.80E+00
315	1.70E+00	1.70E+00	1.70E+00
320	1.60E+00	1.60E+00	1.60E+00
325	1.50E+00	1.50E+00	1.50E+00
330	1.40E+00	1.40E+00	1.40E+00
335	1.30E+00	1.30E+00	1.30E+00
340	1.20E+00	1.20E+00	1.20E+00
345	1.10E+00	1.10E+00	1.10E+00
350	1.00E+00	1.00E+00	1.00E+00
355	9.00E-01	9.00E-01	9.00E-01
360	8.00E-01	8.00E-01	8.00E-01
365	7.00E-01	7.00E-01	7.00E-01
370	6.00E-01	6.00E-01	6.00E-01
375	5.00E-01	5.00E-01	5.00E-01
380	4.00E-01	4.00E-01	4.00E-01
385	3.00E-01	3.00E-01	3.00E-01
390	2.00E-01	2.00E-01	2.00E-01
395	1.00E-01	1.00E-01	1.00E-01
400	-6.38E-16	5.89E-13	5.89E-13

Table 11-79 DISTribution and RETArdation (8.2-Problem 5)

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
0	0.00E+00	0.00E+00	0.00E+00
5	6.67E-02	6.67E-02	1.00E-01
10	1.33E-01	1.33E-01	2.00E-01
15	2.00E-01	2.00E-01	3.00E-01
20	2.67E-01	2.67E-01	4.00E-01
25	3.33E-01	3.33E-01	5.00E-01
30	4.00E-01	4.00E-01	6.00E-01
35	4.67E-01	4.67E-01	7.00E-01
40	5.33E-01	5.33E-01	8.00E-01
45	6.00E-01	6.00E-01	9.00E-01

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
50	6.67E-01	6.67E-01	1.00E+00
55	7.33E-01	7.33E-01	1.10E+00
60	8.00E-01	8.00E-01	1.20E+00
65	8.67E-01	8.67E-01	1.30E+00
70	9.33E-01	9.33E-01	1.40E+00
75	1.00E+00	1.00E+00	1.50E+00
80	1.07E+00	1.07E+00	1.60E+00
85	1.13E+00	1.13E+00	1.70E+00
90	1.20E+00	1.20E+00	1.80E+00
95	1.27E+00	1.27E+00	1.90E+00
100	1.33E+00	1.33E+00	2.00E+00
105	1.40E+00	1.40E+00	2.10E+00
110	1.47E+00	1.47E+00	2.20E+00
115	1.53E+00	1.53E+00	2.30E+00
120	1.60E+00	1.60E+00	2.40E+00
125	1.67E+00	1.67E+00	2.50E+00
130	1.73E+00	1.73E+00	2.60E+00
135	1.80E+00	1.80E+00	2.70E+00
140	1.87E+00	1.87E+00	2.80E+00
145	1.93E+00	1.93E+00	2.90E+00
150	2.00E+00	2.00E+00	3.00E+00
155	2.07E+00	2.07E+00	3.10E+00
160	2.13E+00	2.13E+00	3.20E+00
165	2.20E+00	2.20E+00	3.30E+00
170	2.27E+00	2.27E+00	3.40E+00
175	2.33E+00	2.33E+00	3.50E+00
180	2.40E+00	2.40E+00	3.60E+00
185	2.47E+00	2.47E+00	3.70E+00
190	2.53E+00	2.53E+00	3.80E+00
195	2.60E+00	2.60E+00	3.90E+00
200	2.67E+00	2.67E+00	4.00E+00
205	2.60E+00	2.60E+00	3.90E+00
210	2.53E+00	2.53E+00	3.80E+00
215	2.47E+00	2.47E+00	3.70E+00
220	2.40E+00	2.40E+00	3.60E+00
225	2.33E+00	2.33E+00	3.50E+00
230	2.27E+00	2.27E+00	3.40E+00
235	2.20E+00	2.20E+00	3.30E+00
240	2.13E+00	2.13E+00	3.20E+00
245	2.07E+00	2.07E+00	3.10E+00
250	2.00E+00	2.00E+00	3.00E+00
255	1.93E+00	1.93E+00	2.90E+00
260	1.87E+00	1.87E+00	2.80E+00
265	1.80E+00	1.80E+00	2.70E+00
270	1.73E+00	1.73E+00	2.60E+00
275	1.67E+00	1.67E+00	2.50E+00
280	1.60E+00	1.60E+00	2.40E+00
285	1.53E+00	1.53E+00	2.30E+00
290	1.47E+00	1.47E+00	2.20E+00

Time	Analytical Conc	P-6.10.3 Conc	P-5.97.0 Conc
295	1.40E+00	1.40E+00	2.10E+00
300	1.33E+00	1.33E+00	2.00E+00
305	1.27E+00	1.27E+00	1.90E+00
310	1.20E+00	1.20E+00	1.80E+00
315	1.13E+00	1.13E+00	1.70E+00
320	1.07E+00	1.07E+00	1.60E+00
325	1.00E+00	1.00E+00	1.50E+00
330	9.33E-01	9.33E-01	1.40E+00
335	8.67E-01	8.67E-01	1.30E+00
340	8.00E-01	8.00E-01	1.20E+00
345	7.33E-01	7.33E-01	1.10E+00
350	6.67E-01	6.67E-01	1.00E+00
355	6.00E-01	6.00E-01	9.00E-01
360	5.33E-01	5.33E-01	8.00E-01
365	4.67E-01	4.67E-01	7.00E-01
370	4.00E-01	4.00E-01	6.00E-01
375	3.33E-01	3.33E-01	5.00E-01
380	2.67E-01	2.67E-01	4.00E-01
385	2.00E-01	2.00E-01	3.00E-01
390	1.33E-01	1.33E-01	2.00E-01
395	6.67E-02	6.67E-02	1.00E-01
400	-4.26E-16	3.93E-13	5.89E-13

Table 11-80 DISTribution (Mode 3) (8.3-Problem 1)

Contam	Time (yrs)	Zone	DIST	Kd
C	1	DOMAIN	-1.65E-14	-1.85E-33
C	1	WASTE	-2.03E-04	-2.03E-04
C2	1	DOMAIN	-2.10E-14	-4.12E-27
C2	1	WASTE	-5.69E-08	-5.69E-08
C3	1	DOMAIN	-3.55E-20	-1.93E-26
C3	1	WASTE	-4.33E-16	-4.52E-16
C4	1	DOMAIN	-4.67E-24	-5.13E-26
C4	1	WASTE	-4.22E-20	-3.17E-20
C	1000	DOMAIN	-1.63E-10	-1.63E-10
C	1000	WASTE	-1.75E-04	-1.75E-04
C2	1000	DOMAIN	-1.13E-05	-1.13E-05
C2	1000	WASTE	-2.50E-05	-2.50E-05
C3	1000	DOMAIN	-2.51E-11	-2.51E-11
C3	1000	WASTE	-7.53E-12	-7.53E-12
C4	1000	DOMAIN	-2.88E-14	-2.88E-14
C4	1000	WASTE	-3.76E-15	-3.76E-15

Table 11-81 DISTribution (Mode 3) (8.3-Problem 2)

Contam	Time (yrs)	Zone	DIST	SOUR
C	1	DOMAIN	-4.62E-36	-4.62E-36
C	1	WASTE	-5.07E-07	-5.07E-07

Contam	Time (yrs)	Zone	DIST	SOUR
C2	1	DOMAIN	-3.70E-27	-1.03E-29
C2	1	WASTE	-5.69E-08	-1.42E-10
C3	1	DOMAIN	-1.91E-26	-4.83E-29
C3	1	WASTE	-4.52E-16	-1.13E-18
C4	1	DOMAIN	-5.11E-26	-1.28E-28
C4	1	WASTE	-3.17E-20	-7.93E-23
C	1000	DOMAIN	-4.10E-13	-4.10E-13
C	1000	WASTE	-4.93E-07	-4.93E-07
C2	1000	DOMAIN	-1.01E-05	-2.88E-08
C2	1000	WASTE	-2.78E-05	-7.09E-08
C3	1000	DOMAIN	-2.50E-11	-6.92E-14
C3	1000	WASTE	-9.23E-12	-2.37E-14
C4	1000	DOMAIN	-3.00E-14	-8.22E-17
C4	1000	WASTE	-4.96E-15	-1.28E-17

Table 11-82 DISTribution (Mode 3) (8.3-Problem 3)

Contam	Time (yrs)	Zone	DIST	SOUR
C	1	DOMAIN	-4.62E-34	-4.62E-34
C	1	WASTE	-5.07E-05	-5.07E-05
C2	1	DOMAIN	-3.80E-27	-1.03E-27
C2	1	WASTE	-5.69E-08	-1.42E-08
C3	1	DOMAIN	-1.91E-26	-4.83E-27
C3	1	WASTE	-4.52E-16	-1.13E-16
C4	1	DOMAIN	-5.11E-26	-1.28E-26
C4	1	WASTE	-3.17E-20	-7.93E-21
C	1000	DOMAIN	-4.10E-11	-4.10E-11
C	1000	WASTE	-4.93E-05	-4.93E-05
C2	1000	DOMAIN	-1.04E-05	-2.88E-06
C2	1000	WASTE	-2.71E-05	-7.09E-06
C3	1000	DOMAIN	-2.50E-11	-6.92E-12
C3	1000	WASTE	-8.78E-12	-2.37E-12
C4	1000	DOMAIN	-2.97E-14	-8.22E-15
C4	1000	WASTE	-4.63E-15	-1.28E-15

Table 11-83 DISTribution (Mode 3) (8.3-Problem 4)

Contam	Time (yrs)	Zone	DIST	SOUR
C	1	DOMAIN	-1.84E-33	-1.84E-33
C	1	WASTE	-2.02E-04	-2.02E-04
C2	1	DOMAIN	-4.12E-27	-4.12E-27
C2	1	WASTE	-5.69E-08	-5.69E-08
C3	1	DOMAIN	-1.93E-26	-1.93E-26
C3	1	WASTE	-4.52E-16	-4.52E-16
C4	1	DOMAIN	-5.13E-26	-5.13E-26
C4	1	WASTE	-3.17E-20	-3.17E-20
C	1000	DOMAIN	-1.63E-10	-1.63E-10
C	1000	WASTE	-1.75E-04	-1.75E-04
C2	1000	DOMAIN	-1.13E-05	-1.13E-05
C2	1000	WASTE	-2.50E-05	-2.50E-05

Contam	Time (yrs)	Zone	DIST	SOUR
C3	1000	DOMAIN	-2.51E-11	-2.51E-11
C3	1000	WASTE	-7.53E-12	-7.53E-12
C4	1000	DOMAIN	-2.88E-14	-2.88E-14
C4	1000	WASTE	-3.76E-15	-3.76E-15

Table 11-84 STATistics (8.4-Problem 1)

Analytical	P-6.10.3	P-5.97.0
49590	49590	49590

Table 11-85 STATistics (8.4-Problem 2)

Analytical	P-6.10.3	P-5.97.0
49590	49590	49590

Table 11-86 STATistics (8.4-Problem 3)

No difference found between versions.

Table 11-87 STATistics (8.4-Problem 4)

Analytical	P-6.10.3	P-5.97.0
49637	49637	49637

Distribution

T. S. Whiteside, 773-64A, Rm. 3
J. M. Jordan, 773-42A, Rm. 138
G. P. Flach, 773-42A, Rm. 211
K. H. Rosenberger, 766-H, Rm 2505
M. H. Layton, 766-H, Rm 2500
H. H. Burns, 999-W, Rm. 391
S. E. Aleman, 773-42A, Rm. 147
L. B. Collard, 773-43A, Rm. 207
J. J. Mayer, 773-42A, Rm. 219
B. T. Butcher, 773-43A, Rm. 216