SOFTWARE RELEASE NOTICE

01. SRN Number: PA-SRN-157

02. Project Title: Revision to EPA & NRC Rule Technical Assistance.	Project No. 20-5708-771
03. SRN Title: STRIPI Version 1.1	
04. Originator/Requestor: Randy Fedors	Date: 8/6/97

05. Summary of Actions

- ■ Release of new software
- ☐ Release of modified software:
  - ☐ Enhancements made
  - ☐ Corrections made
- ☐ Change of access software
- ☑ Software Retirement Gordon Wittmeyer 12/5/2001

06. Persons Authorized Access

Name	RO/RW	A/C/D
Randy Fedors	Read/Write	A
Amit Armstrong	Read/Write	A
Gordon Wittmeyer	Read/Write	A
James Winterle	Read/Write	A
Robert Baca	Read/Write	A

07. Element Manager Approval: RG Baca Date: 9/10/97

08. Remarks:

CNWRA Form TOP-6 (06/95)

SOFTWARE SUMMARY FORM

01. Summary Date: 9/9/97	02. Summary prepared by (Name and phone) Randy Fedors (210)522-6818	03. Summary Action: New
04. Software Date: 3/27/96	05. Short Title: STRIPI	
06. Software Title: STRIPI version 1.1 (dated 3/27/96)		07. Internal Software ID: N/A

08. Software Type: ☐ Automated Data System ■ Computer Program ☐ Subroutine/Module	09. Processing Mode: ☐ Interactive ■ Batch ☐ Combination	10. APPLICATION AREA a. General: ■ Scientific/Engineering ☐ Auxiliary Analyses ☐ Total System PA ☐ Subsystem PA ☐ Other b. Specific:

11. Submitting Organization and Address: CNWRA/SwRI	12. Technical Contact(s) and Phone: Randy Fedors (CNWRA) (210)522-6818

13. Narrative:
Analytical solution for the advection/dispertion equation for transport solution is for 1-D advection and 2-D dispertion with absorption decay from a line source of constant concentration.

14. Computer Platform SUN	15. Computer Operating System: Solaris	16. Programming Language(s): FORTRAN 77	17. Number of Source Program Statements: 1,042
18. Computer Memory Requirements: N/A	19. Tape Drives: N/A	20. Disk/Drum Units: N/A	21. Graphics: N/A (see item 22)

22. Other Operational Requirements
DISSPLA graphic calls commented out; this may change if DISSPLA is acquired.

23. Software Availability: ■ Available ☐ Limited ☐ In-House ONLY	24. Documentation Availability: ■ Available ☐ Inadequate ☐ In-House ONLY

Software Custodian: [signature] Date: 9/10/97

CNWRA Form TOP-4-1

CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

SOFTWARE CONTROL CHECKLIST

Name of Software: STRIPI **Version:** 1.1
Primary User: Randy Fedors

☐	SOFTWARE REQUIREMENTS DESCRIPTION	
	Documentation	☐
☒	DESIGN AND DEVELOPMENT	
	Documentation: Scientific Notebook #232	☒
☐	DESIGN VERIFICATION	
	Computer runs uniquely identified	☐
	Software analysis tools have been applied and discrepancies resolved	☐
	Design Verification Report	☐
☒	INSTALLATION TESTING	
	Installation test documentation: See memo enclosed	☒
	Discrepancy resolution: See memo	☒
☒	CONFIGURATION CONTROL	
	Software Summary Form	☒
	User's Manual: R. Fedors has User's Manual	☒
	Technical Description: See User's Manual	☒
	Source Code: N/A	☐
	Version Control: N/A	☐
	Software Release Notice	☒
☐	SOFTWARE PROBLEM REPORTING AND RESOLUTION	
	Software Problem and Change Request	☐
☐	SOFTWARE VALIDATION	
	Software Validation Test Plan	☐
	Software Validation Test Report	☐
	Software Validation Review	☐
☐	SOFTWARE RETIREMENT	
	Software Release Notice	☐

TO: Bruce Mabrito
FROM: R. Fedors
SUBJECT: Installation and Modifications for STRIPI
DATE: September 9, 1997

STRIPI is one of a series of Fortran source codes made available by the U.S. Geological Survey (USGS) for analytical solutions to the advection-dispersion transport equation. All of the codes are fully documented in Wexler (1992); pertinent pages are attached to the TOP-018 folder. The printout of a readme file which comes with the distribution is also included here. STRIPI is the solution for a line source of constant concentration perpendicular to a 1-dimensional flow field. The solution is for 1-dimensional advection and 2-dimensional dispersion along with decay and first order kinetics.

The floppy diskette contains the original source files in UNIX tar and gzip compression form as obtained from the USGS software internet web site: http://water.usgs.gov/software/ground_water.html. Also contained on the diskette are the modifications made to the make file and two of the source code modules (title.f and subs2.f). The modifications are necessary in order to compile the software on a CNWRA SUN workstation. The modifications to the source code are commented, dated, initialed, and described in the source code. The modifications are:

1. Edit the make file so that only the stripi.f code is compiled and add the compile option "-lv77" to the Fortran command to get the VMS extensions for date and time system calls;
2. Change the system calls for date and time in the "title.f" file;
3. Comment out the graphics call for DISSPLA in the pltnc2 subroutine of the "subs2.f" file.

Note that CNWRA does not have a license for the DISSPLA program.

The installation test included here is "sample7" from the U.S. Geological Survey distribution. The input file is labeled sample7.dat, the USGS output file is labeled sample7.prt, and my installation test output is labeled rfedors.sample7. The output files match exactly indicating a proper installation of the STRIPI code.

5/23

Techniques of Water-Resources Investigations of the United States Geological Survey

Chapter B7

ANALYTICAL SOLUTIONS FOR ONE-, TWO-, AND THREE-DIMENSIONAL SOLUTE TRANSPORT IN GROUND-WATER SYSTEMS WITH UNIFORM FLOW

By Eliezer J. Wexler

Book 3

APPLICATIONS OF HYDRAULICS

6/23

PREFACE

The series of manuals on techniques describes procedures for planning and executing specialized work in water-resources investigations. The material is grouped under major subject headings called books and further subdivided into sections and chapters; section B of book 3 is on ground-water techniques.

The unit of publication, the chapter, is limited to a narrow field of subject matter. This format permits flexibility in revision and publication as the need arises. Chapter 3B7 deals with analytical solutions to the solute-transport equation for a variety of boundary condition types and solute-source configurations in one-, two-, and three-dimensional systems with uniform ground-water flow.

Provisional drafts of chapters are distributed to field offices of the U.S. Geological Survey for their use. These drafts are subject to revision because of experience in use or because of advancement of knowledge, techniques, or equipment. After the technique described in a chapter is sufficiently developed, the chapter is published and is for sale from the U.S. Geological Survey, Book and Open-File Report Sales, Federal Center, Box 25425, Denver, CO 80225.

Copies of the computer codes and sample data sets described in this report are available on diskette from Book and Open-File Report Sales as USGS Open File Report 92–78. They are on a 5.25" (360K) double-density diskette formatted for the IBM PC. The computer programs were originally written for a Prime minicomputer but all programs should run using IBM-PC Fortrans with minor modifications as described in the report. The plot routines were written with DISSPLA software calls and can be used on the PC only with the PC version of the DISSPLA library. Alternatively, data can be easily extracted from the program output and plotted using PC graphics presentation programs.

Reference to trade names, commercial products, manufacturers, or distributors in this manual constitutes neither endorsement by the U.S. Geological Survey nor recommendation for use.

problem is presented in attachment 4. Sample problem 6 required 52 s of CPU time on a Prime model 9955 Mod II.

Aquifer of infinite width with finite-width solute source

Governing equation

Two-dimensional solute-transport equation:

$$\frac{\partial C}{\partial t}=D_x\frac{\partial^2 C}{\partial x^2}+D_y\frac{\partial^2 C}{\partial y^2}-V\frac{\partial C}{\partial x}-\lambda C \qquad (86)$$

Boundary conditions:

$$C=C_o, \qquad x=0 \text{ and } Y_1<y<Y_2 \qquad (87a)$$

$$C=0, \qquad x=0 \text{ and } y<Y_1 \text{ or } y>Y_2 \qquad (87b)$$

$$C,\ \frac{\partial C}{\partial y}=0, \qquad y=\pm\infty \qquad (88)$$

$$C,\ \frac{\partial C}{\partial x}=0, \qquad x=\infty, \qquad (89)$$

where

V = velocity in x-direction,

Y_1 = y-coordinate of lower limit of solute source at $x=0$, and

Y_2 = y-coordinate of upper limit of solute source at $x=0$.

Initial condition:

$$C=0, \qquad 0<x<\infty \text{ and } -\infty<y<+\infty \qquad \text{at } t=0 \qquad (90)$$

Assumptions:

1. Fluid is of constant density and viscosity.
2. Solute may be subject to first-order chemical transformation (for a conservative solute, $\lambda=0$).
3. Flow is in x-direction only, and velocity is constant.
4. The longitudinal and transverse dispersion coefficients (D_x, D_y) are constant.

Analytical solution

The following equation is modified from Cleary and Ungs (1978, p. 17):

$$C(x,y,t)=\frac{C_0x}{4\sqrt{\pi D_x}}\exp\left(\frac{Vx}{2D_x}\right)\cdot\int_{\tau=0}^{\tau=t}\tau^{-\frac{3}{2}}\exp\left[-\left(\frac{V^2}{4D_x}+\lambda\right)\tau-\frac{x^2}{4D_x\tau}\right]\cdot\left\{\operatorname{erfc}\left[\frac{(Y_1-y)}{2\sqrt{D_y\tau}}\right]-\operatorname{erfc}\left[\frac{Y_2-y)}{\sqrt{D_y\tau}}\right]\right\}d\tau, \qquad (91a)$$

To improve the accuracy of the numerical integration, a variable substitution can be made where $\tau=Z^4$, yielding

$$C(x,y,t)=\frac{C_0x}{\sqrt{\pi D_x}}\exp\left[\frac{Vx}{2D_x}\right]\cdot\int_0^{t^{1/4}}\frac{1}{Z^3}\exp\left[-\left(\frac{V^2}{4D_x}+\lambda\right)Z^4-\frac{x^2}{4D_xZ^4}\right]\cdot\left\{\operatorname{erfc}\left[\frac{(Y_1-y)}{2Z^2\sqrt{Dy}}\right]-\operatorname{erfc}\left[\frac{(Y_2-y)}{2Z^2\sqrt{Dy}}\right]\right\}dz \qquad (91b)$$

Comments:

The integral in equation 91b cannot be simplified further and must be evaluated numerically. A Gauss-Legendre numerical integration technique was used in the computer program written to evaluate the analytical solution and is described later. Round-off errors may still occur when evaluating the solution for very small values of x at late times.

Linear equilibrium adsorption and ion exchange can be simulated by dividing the coefficients D_x, D_y, and V by the retardation factor, R (eq. 15). Temporal variations in solute concentration and odd-shaped source configurations can be simulated through the principle of superposition.

Description of program STRIPI

The program STRIPI computes the analytical solution to the two-dimensional solute-transport equation for an aquifer of infinite width with a finite-width or "strip" solute source at the inflow boundary. It consists of a main program and the subroutine CNRMLI. The functions of the main program and subroutine are outlined below; the program code listing is presented in attachment 2.

The program also calls subroutines EXERFC and GLQPTS and the output subroutines TITLE, OFILE, PLOT2D, and CNTOUR, which are common to most programs described in this report. These subroutines are described in detail later.

Main program

The main program reads and prints all input data needed to specify model variables. The required input data and the format used in preparing a data file are shown in table 5. The routine then calls the subroutine GLQPTS, which reads the data file GLQ.PTS containing values of the positive roots and weighting functions used in the Gauss-Legendre numerical integration technique.

Table 5.—Input data format for the program STRIPI

Data set	Columns	Format	Variable name	Description
1	1 - 60	A60	TITLE	Data to be printed in a title box on the first page of program output. Last line in data set must have an "=" in column 1. First four lines are also used as title for plot.
2	1 - 4	I4	NX	Number of x-coordinates at which solution will be evaluated.
	5 - 8	I4	NY	Number of y-coordinates at which solution will be evaluated.
	9 - 12	I4	NT	Number of time values at which solution will be evaluated.
	13 - 16	I4	NMAX	Number of terms used in the numerical integration techniques (must be equal to 4, 20, 60, 104, or 256).
	17 - 20	I4	IPLT	Plot control variable. Contours of normalized concentration will be plotted if IPLT is greater than 0.
3	1 - 10	A10	CUNITS	Character variable used as label for units of concentration in program output.
	11 - 20	A10	VUNITS	Units of ground-water velocity.
	21 - 30	A10	DUNITS	Units of dispersion coefficient.
	31 - 40	A10	KUNITS	Units of solute-decay coefficient.
	41 - 50	A10	LUNITS	Units of length.
	51 - 60	A10	TUNITS	Units of time.
4	1 - 10	F10.0	CO	Solute concentration at inflow boundary.
	11 - 20	F10.0	VX	Ground-water velocity in x-direction.
	21 - 30	F10.0	DX	Longitudinal dispersion coefficient.
	31 - 40	F10.0	DY	Transverse dispersion coefficient.
	41 - 50	F10.0	DK	First-order solute-decay coefficient.
5	1 - 10	F10.0	Y1	Y-coordinate of lower limit of finite-width solute source.
	11 - 20	F10.0	Y2	Y-coordinate of upper limit of finite-width solute source.
6	1 - 80	8F10.0	X(I)	X-coordinates at which solution will be evaluated (eight values per line).
7	1 - 80	8F10.0	Y(I)	Y-coordinates at which solution will be evaluated (eight values per line).
8	1 - 80	8F10.0	T(I)	Time values at which solution will be evaluated (eight values per line).
[1]9	1 - 10	F10.0	XSCLP	Scaling factor by which x-coordinate values are divided to convert them to plotter inches.
	11 - 20	F10.0	YSCLP	Scaling factor used to convert y-coordinates into plotter inches.
	21 - 30	F10.0	DELTA	Contour increment for plot of normalized concentration (must be between 0.0 and 1.0).

[1]Data line is needed only if IPLT (in data set 2) is greater than 0.

The program next executes a set of three nested loops. The inner loop calls subroutine CNRMLI to calculate the concentration at all specified y-coordinate values for a particular x-coordinate value and time. The middle loop cycles through all x-coordinate values. The outer loop cycles through all specified time values and prints a table of concentration in relation to distance for each time. Model output can also be plotted as a map showing lines of equal solute concentration.

Subroutine CNRMLI

Subroutine CNRMLI calculates the normalized concentrations (C/C_0) for a particular time value and distance. The integral in equation 91 is evaluated through a Gauss-Legendre numerical integration technique. The normalized roots of the Legendre polynomial and the corresponding weighting functions are passed by subroutine GLQPTS and scaled in the subroutine to account for the non-normalized limits of integration (from 0 to $t^{1/4}$ rather than from -1 to $+1$).

The number of terms summed in the numerical integration (equivalent to the order of the polynomial) is specified by the user. Roots of the Legendre polynomial of order 4, 20, 60, 104, and 256 are provided in data file GLQ.PTS. In general, the more terms used in the integration, the more accurate the approximation; however, this must be weighed against the corresponding increase in computational effort and time. Additional discussions of the numerical integration technique are presented in a later section describing subroutine GLQPTS.

Sample problem 7

In sample problem 7, contaminant migration from a waste-disposal pond through the upper glacial aquifer of Long Island, N.Y., is simulated. Data are from a numerical modeling study by Pinder (1973). Model variables are

Lower limit of solute source (Y_1)	=635 ft
Upper limit of solute source (Y_2)	=865 ft
Ground-water velocity (V)	=1.42 ft/d
Longitudinal dispersivity (α_l)	=70 ft
Transverse dispersivity (α_t)	=14 ft
Source concentration (C_o)	=40 mg/L.

Lateral boundaries are far enough from the area of interest that the aquifer can be treated as being infinite in width. From these values, the terms obtained are

Dispersion in x-direction (D_x)	=100 ft²/d
Dispersion in y-direction (D_y)	= 20 ft²/d.

Concentrations are calculated at 100-ft intervals along the x-axis for 3,000 ft, and at 50-ft intervals on the y-axis for 1,500 ft. Concentration distributions after 5 years (1,826 days) are simulated.

The input data set for sample problem 7 is shown in figure 14*A*. A computer-generated contour plot of normalized concentration (C/C_o) is shown in figure 14*B*. Program output for this sample problem is presented in attachment 4. Sample problem 7 required 1 min (minute) 25 s of CPU time on a Prime model 9955 Mod II.

Aquifer of infinite width with solute source having gaussian concentration distribution

Governing equation

Two-dimensional solute-transport equation:

$$\frac{\partial C}{\partial t}=D_x\frac{\partial^2 C}{\partial x^2}+D_y\frac{\partial^2 C}{\partial y^2}-V\frac{\partial C}{\partial x}-\lambda C \qquad (92)$$

Boundary conditions:

$$C=C_m\exp\left[\frac{-(y-Y_c)^2}{2\sigma^2}\right], \qquad x=0 \qquad (93)$$

$$C,\ \frac{\partial C}{\partial y}=0, \qquad y=\pm\infty \qquad (94)$$

$$C,\ \frac{\partial C}{\partial x}=0, \qquad x=\infty, \qquad (95)$$

where

C_m =maximum concentration at center of gaussian solute source,
Y_c =y-coordinate of center of solute source at x = 0, and
σ =standard deviation of gaussian distribution.

Initial condition:

$$C=0, \quad 0<x<\infty \text{ and } -\infty<y<+\infty \quad \text{at } t=0 \qquad (96)$$

Assumptions:

1. Fluid is of constant density and viscosity.
2. Solute may be subject to first-order chemical transformation (for a conservative solute, $\lambda=0$).
3. Flow is in x-direction only ($V_y=0$), and velocity is constant.
4. The longitudinal and transverse dispersion coefficients (D_x, D_y) are constant.

Analytical solution

The following equation is modified from Gureghian and others (1980, p. 905):

$$C(x,y,t)=\frac{C_m x\sigma}{\sqrt{8\pi D_x}}\exp\left[\frac{Vx}{2D_x}\right]$$

$$\cdot\int_0^t \frac{\exp\left[-\beta\tau-\frac{x^2}{4D_x\tau}-\frac{(y-Y_c)^2}{4(D_y\tau+\frac{\sigma^2}{2})}\right]d\tau}{\tau^{\frac{3}{2}}\sqrt{D_y\tau+\frac{\sigma^2}{2}}}, \qquad (97)$$

where

$$\beta=\frac{V^2}{4D_x}+\lambda$$

and τ is a dummy variable of integration for the time integral.

To improve the accuracy of the numerical integration, a variable substitution (modified from Cleary and Ungs, 1978, p. 20) can be made where $\tau=Z^4$, yielding

NAME
stripi - An analytical solution for two-dimensional ground-water solute transport in an infinite-width system with uniform flow and a finite-width solute source

ABSTRACT
The program STRIPI computes the analytical solution to the two-dimensional solute-transport equation for an infinite-width system with a finite-width solute source.

METHOD
The computer program calculates the concentration for the two-dimensional system based on the equation given in Wexler (1992a, p. 36). The concentration can be calculated for different times and spatial locations.

HISTORY
Version 1.1 1996/04/03 - Code restructuring and clean up: use of consistent spacing; use of upper and lower case variable names; statement labels renumbered; comment statements altered to be consistent; use of Hollerinth data in FORMAT statements removed; all variables and routines declared; duplicate code placed in new routines; interactive prompting for graphics output devices added. Bug fixed in contour routine related to contours at the left edge of the plot.

Version 1.0 1990/04/03 - Initial published version.

DATA REQUIREMENTS
The program requires data on advective velocity, dispersion coefficient, spatial information, temporal information, and boundary concentrations. Optional data may include a first-order solute-decay coefficient.

OUTPUT OPTIONS
Output is the calculated concentrations at specified points in time and space. A plotting option exists to view the output as graphs.

SYSTEM REQUIREMENTS
The computer programs are written in Fortran. The computer programs were originally written for a Prime minicomputer but all programs should run on IBM-compatible personal computers with minor modifications as described in Wexler (1992a). The plot routines were written with DISSPLA software calls and can be used on the PC only with the PC version of the DISSPLA library. Alternatively, data can be easily extracted from the program output and plotted using PC graphic presentation programs. They have also been compiled and run on the Data General AViiON UNIX workstations.

DOCUMENTATION
Wexler, E.J., 1992a, Analytical solutions for one-, two-, and three-dimensional solute transport in ground-water systems with uniform flow: U.S. Geological Survey Techniques of Water-Resources Investigations, book 3, chap. B7, 190 p.

Wexler, E.J., 1992b, Analytical solutions for one-, two-, and three-dimensional solute transport in ground-water systems with uniform flow -- Supplemental Report: Source codes for computer programs and sample data sets: U.S. Geological Survey Open-File Report 92-78, 3 p., 1 computer diskette.

TRAINING
Some of the programs are introduced in the class Ground-Water Solute-Transport Concepts for Field Investigations (G0051), offered annually at the USGS National Training Center.

CONTACTS
Operation:
U.S. Geological Survey
Office of Ground Water
Thomas E. Reilly
411 National Center
Reston, VA 22092

tereilly@usgs.gov

Distribution:
U.S. Geological Survey
Hydrologic Analysis Software Support Team
R. Steven Regan
437 National Center
Reston, VA 22092

h2osoft@usgs.gov

Latest version by anonymous ftp from:
h2o.usgs.gov
/pub/software/ground_water/analgwst

10/23

May 15, 1996

ANALGWST

Analytical solution for one-, two-, and three-dimensional solute transport in ground-water systems with uniform flow

FINITE - Version: 1.1 1996/04/03
GAUSS - Version: 1.1 1996/04/03
PATCHF - Version: 1.1 1996/04/03
PATCHI - Version: 1.1 1996/04/03
POINT2 - Version: 1.1 1996/04/03
POINT3 - Version: 1.1 1996/04/03
POINT3 - Version: 1.1 1996/04/03
SEMINF - Version: 1.1 1996/04/03
STRIPF - Version: 1.1 1996/04/03
STRIPI - Version: 1.1 1996/04/03

analgwst.1.DGUX.tar.gz - Distribution prepared on a Data General AViiON under DG/UX 5.4
analgwst.1.source.tar.gz - Distribution that includes the source code but no compiled software

TABLE OF CONTENTS

A. DESCRIPTION

The program FINITE computes the analytical solution to the one-dimensional solute-transport equation for a finite system with a first-type or third-type boundary condition at the inflow end.

The program GAUSS computes the analytical solution to the two-dimensional solute-transport equation for an infinite-width system with a solute source having a gaussian concentration distribution.

The program PATCHF computes the analytical solution to the three-dimensional solute-transport equation for a finite-width and finite-height system with a finite-width and finite-height solute source.

The program PATCHI computes the analytical solution to the three-dimensional solute-transport equation for an infinite-width and infinite-height system with a finite-width and finite-height solute source.

The program POINT2 computes the analytical solution to the two-dimensional solute-transport equation for an infinite system with a continuous point source.

The program POINT3 computes the analytical solution to the three-dimensional solute-transport equation for an infinite system with a continuous point solute source.

The program SEMINF computes the analytical solution to the one-dimensional solute-transport equation for a semi-infinite system

with a first-type or third-type boundary condition at the inflow end.

The program STRIPF computes the analytical solution to the two-dimensional solute-transport equation for a finite-width system with a finite-width solute source.

The program STRIPI computes the analytical solution to the two-dimensional solute-transport equation for an infinite-width system with a finite-width solute source.

B. DOCUMENTATION

Wexler, E.J., 1992a, Analytical solutions for one-, two-, and three-dimensional solute transport in ground-water systems with uniform flow: Techniques of Water-Resources Investigations of the U.S. Geological Survey, book 3, chap. B7, 190 p.

Wexler, E.J., 1992b, Analytical solutions for one-, two-, and three-dimensional solute transport in ground-water systems with uniform flow -- Supplemental Report: Source codes for computer programs and sample data sets: U.S. Geological Survey Open-File Report 92-78, 3 p., 1 computer diskette.

C. MODIFICATIONS

The program has been modified from the published code. The modifications involved code restructuring and clean up. The clean up involved use of consistent spacing, use of upper and lower case variable names, statement labels are renumbered, comment statements are altered to be consistent, use of Hollerinth data in FORMAT statements removed, all variables and routines are declared, duplicate code placed in new routines. Interactive prompting for graphics output devices is added. Bug fixed in contour routine related to contours at the left edge of the plot.

D. EXTRACTING FILES

The compressed tar file, named analgwst.1.OS.tar.gz, contains all the files needed to install and test ANALGWST on a computer with a particular operating system, where OS is a string indicating the operating system the distribution is intended for. If a version is not available for your operating system, the file analgwst.1.source.tar.gz contains the source code and all other files needed to compile, install, and test the software on a UNIX-based computer. For either type of distribution, the directory analgwst.1 is created (or overwritten) when the files are extracted from the tar file. If the analgw directory already exists, you may want to delete or rename it before extracting the files. The following are the steps to extract the files from a distribution tar file.

1. If the tar file is not already in the directory under which you want the distribution installed, move it there. For example:
   mv analgwst.1.____.tar.gz /usr/opt/wrdapp

2. If you are not in the directory where the tar file is located, go there. For example:
   cd /usr/opt/wrdapp

3. Uncompress the distribution file. For example:
   gunzip analgwst.1.____.tar.gz

4. Extract the distribution files from the tar file. For example:
   tar -xof analgwst.1.___.tar

   This creates the following directory structure (the contents of each directory are shown to the right):

   analgwst.1 ; copy of this README file

```
        `-----bin        ; compiled executables
        `-----bin_data   ; data file required by GAUSS, PATCHI, POINT2, STRIPI
        `-----doc        ; documentation files
        `-----src        ; Makefile and source code
        `-----test       ; scripts to run verification tests
        `-----data       ; standard data sets used in verification tests
```

Notes:
a) The bin directory is not included in the analgwst.1.source.tar.gz distribution (it is created during compilation).
b) Source code is included only with the analgwst.1.source.tar.gz distribution.
c) It is recommended that no user files be kept in the analgwst.1 directory structure. If you do plan to put files in the analgwst.1 directory structure, do so only by creating subdirectories of analgwst.1.

E. COMPILING

If a compiled version of the software is not available for your computer, or if you want to build the executables yourself, follow the instructions in this section. If you have retrieved a pre-compiled distribution of the software, skip to the Installing section below.

The source code is provided in the analgwst.1.source.tar.gz distribution so that users can generate the executables themselves. No support can be provided for users generating their own versions of the software. In general, the requirements are a Fortran compiler, DISSPLA graphics library, and a minimal level of knowledge of the compiler and the UNIX operating system. As provided, the Makefile and source code are set up for use on Data General AViiON workstations running the DG/UX operating system.

To generate new executables, do the following:

1. Change directory to the source directory:
   ```
   cd analgwst.1/src
   ```

2. Modify the beginning of the file named Makefile to correctly specify system-dependent variables:

GraphLib	Graphics library pathname
F77	Fortran compiler name
FFLAGS	Fortran compiler flags
OS	Operating system name

3. Use the make program to initiate compilation of the source code and installation of the software:
   ```
   make [BINDIR=directory_for_links]
   ```

   See the Installing instructions below for an explanation of BINDIR.

   The make will:
   a. create the directories analgwst.1/bin and BINDIR if they do not already exist,
   b. compile the source code,
   c. place the executables (seminf, finite, point2.exe, stripf, stripi.exe, gauss.exe, point3, patchf, patchi, point3_mod) in analgwst.1/bin, and
   d. place a link to the executables in BINDIR if specified.

F. INSTALLING

To make the executables (seminf, finite, point2.exe, stripf, stripi.exe, gauss.exe, point3, patchf, patchi, point3_mod) easy to use, it should be installed in a directory included in the user's search path. The Makefile (input instructions to the UNIX make program--located in analgwst.1/src) contains instructions to optionally place a link in a specified directory to the executables contained in analgwst.1/bin. Use the following two commands

to do this:

```
      cd analgwst.1/src
      make install [BINDIR=directory_for_links]
```

If BINDIR is specified, a link to each executable is placed in the specified directory. For example, if your search path consists of:
```
      /usr/bin:/usr/opt/bin:/usr/local/bin
```
use the command:
```
      make install BINDIR=/usr/local/bin
```
to make the executables accessible from any directory without requiring the full pathname of the software's location.

Notes:
a) Brackets "[xxx]" are used to indicate optional arguments to commands.
b) To create and delete a link to the ANALGWST executable files, the installer must have sufficient rights in the directory that BINDIR is set to.

G. RUNNING THE SOFTWARE

ANALGWST prompts for the input and output file names. If plotting is selec[illegible], the programs prompt for the graphics device (X11 display, PostScript, Meta file, TAB 132/15 graphics display, or Tektronix 4114 graphics display). If PostScript is selected, the program prompts for the file name for this output. Note that the DISSPLA graphics requires the specified file not exist prior to execution. The last prompt requests the color to use to generate the plots. Enter values such as BLACK, YELLOW, RED, GREEN, or BLUE.

H. TESTING

Test data sets are provided to verify that the program is correctly installed and running on the system. The tests may also be looked at as examples of how to use the program. The directory "analgwst.1/test" contains the scripts to run the tests. The directory "analgwst.1/data" contains the input data and expected results for each test. Tests are usually run in the directory analgwst.1/test, but they can be run in any user directory if the installation procedure was completed (make install performed). Run the tests using any of the commands in the table below. To test the installation, change to the analgwst.1/test directory and type the command:
```
     ./test.sh [m [n]]
```

If running from another directory, specify the full path to the script; for example:
```
     /usr/opt/wrdapp/ncalc_2.6/test/test.sh [m [n]]
```

where:
    m = the number of the first test to perform, default=1
    n = the number of the last test to perform, default=12

For example:

command	what happens
./test.sh	runs all of the tests
./test.sh n	runs test 'n' through the last test
./test.sh n m	runs test 'n' through 'm'

After the tests are completed, the results are compared to the expected results. If all goes well, the only differences will be due to different processing times or pathnames. To clean up after the tests, type the command:
```
     ./clean.sh
```

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NOTE: the standard data sets were created on a Data General AViiON workstation. You may notice slight numeric differences in the results on other computers. These are generally due to different round-off algorithms and the different architecture of the central processing unit chip.

```
The tests are described in the table below.  Test is the test number, program
is the program used to run the test, and the usage column indicates how a file
is used, with i for input, o for output, and i/o for both input and output.

test  program   description of test and files      file name & usage
----  -------   --------------------------------   -----------------
  1   finite    Sample Problem 1a -- Solute transport in a finite-length
                soil column with a first-type boundary condition at x=0
                Model Parameters:  L=12 in, V=0.6 in/h, D=0.6 in**2/h
                                   K1=0.0 per h, C0=1.0 mg/L

                program data                       sample1a.dat    i
                program results                    sample1a.prt    o
                screen output log file             sample1a.log    o

                Sample Problem 1b -- Solute transport in a finite-length
                soil column with a first-type boundary condition at x=0
                Model Parameters:  L=12 in, V=0.072 in/h, D=0.072 in**2/h
                                   K1=0.0 per h, C0=1.0 mg/L
                Solute is subject to linear adsorption


                program data                       sample1b.dat    i
                program results                    sample1b.prt    o
                screen output log file             sample1b.log    o
  2   finite    Sample Problem 2 -- Solute transport in a finite-length
                soil column with a third-type boundary condition at x=0
                Model Parameters:  L=12 in, V=0.6 in/h, D=0.6 in**2/h
                                   K1=0.0 per h, C0=1.0 mg/L

                program data                       sample2.dat     i
                program results                    sample2.prt     o
                screen output log file             sample2.log     o


  3   seminf    Sample Problem 3a -- Solute transport in a semi-infinite
                soil column with a first-type boundary condition at x=0
                Model Parameters:  V=0.6 in/h, D=0.6 in**2/h
                                   K1=0.0 per h, C0=1.0 mg/L

                program data                       sample3a.dat    i
                program results                    sample3a.prt    o
                screen output log file             sample3a.log    o

                Sample Problem 3b -- Solute transport in a semi-infinite
                soil column with a first-type boundary condition at x=0
                Model Parameters:  V=0.072 in/h, D=0.072 in**2/h
                                   K1=0.0038 per h, C0=1.0 mg/L
                Solute is subject to first-order decay and linear adsorption

                program data                       sample3b.dat    i
                program results                    sample3b.prt    o
                screen output log file             sample3b.log    o
  4   seminf    Sample Problem 4 -- Solute transport in a semi-infinite
                soil column with a third-type boundary condition at x=0
                Model Parameters:  V=0.6 in/h, D=0.6 in**2/h
                                   K1=0.0 per h, C0=1.0 mg/L

                program data                       sample4.dat     i
                program results                    sample4.prt     o
                screen output log file             sample4.log     o

  5   point2    Sample Problem 5 -- Solute transport in an aquifer of
                infinite areal extent with a continuous point source
                Model Data:  V=2.0 ft/d, DX=60.0 ft**2/d, DY=12.0 ft**2/d
                             QM=12.5 ft**2/d, C0=1000.0 mg/L, N=0.25
```



```
                program data                       sample5.dat     i
                program results                    sample5.prt     o
                screen output log file             sample5.log     o

  6   stripf    Sample Problem 6 -- Solute transport in a semi-infinite
                aquifer of finite width with a continuous 'strip' source
                Model Data:  V=1.0 ft/d, DX=200.0 ft**2/d, DY=60.0 ft**2/d
                        W=3000 ft, Y1=400 ft, Y2=2000 ft, C0=1000.0 mg/L

                program data                       sample6.dat     i
                program results                    sample6.prt     o
                screen output log file             sample6.log     o

  7   stripi    Sample Problem 6 -- Solute transport in a semi-infinite
                aquifer of finite width with a continuous 'strip' source
                Model Data:  V=1.0 ft/d, DX=200.0 ft**2/d, DY=60.0 ft**2/d
                        W=3000 ft, Y1=400 ft, Y2=2000 ft, C0=1000.0 mg/L

                program data                       sample7.dat     i
                program results                    sample7.prt     o
                screen output log file             sample7.log     o

  8   gauss     Sample Problem 8a -- Solute transport in a semi-infinite
                aquifer of infinite width with a continuous gaussian source
                Model Data:  V=4.0 ft/d, DX=150.0 ft**2/d, DY=30.0 ft**2/d
                             WS=130 ft, YC=450 ft, C0=1000.0 mg/L

                program data                       sample8a.dat    i
                program results                    sample8a.prt    o
                screen output log file             sample8a.log    o

                Sample Problem 8b -- Solute transport in a semi-infinite
                aquifer of infinite width with a continuous gaussian source
                Model Data:  V=4.0 ft/d, DX=150.0 ft**2/d, DY=30.0 ft**2/d
                             WS=65 ft, YC=450 ft, C0=1000.0 mg/L

                program data                       sample8b.dat    i
                program results                    sample8b.prt    o
                screen output log file             sample8b.log    o

  9   point3    Sample Problem 9 -- Solute transport in an infinite aquifer
                with multiple point sources of finite duration
                Model Data:  V=0.1 ft/d, DX=0.06 ft**2/d, DY=0.003 ft**2/d
                DZ=0.0006 ft**2/d, QM=1.0 ft**3/d, C0=1000.0 mg/L, n=0.25

                program data                       sample9a.dat    i
                program results                    sample9a.prt    o
                screen output log file             sample9a.log    o

 10   patchf    Sample Problem 10 -- Solute transport in a semi-infinite
                aquifer of finite width and height with a 'patch' source
                Model Data:  Y1=400 ft, Y2=2000 ft, Z1=50 ft, Z2=100 ft
                V=1 ft/d, DX=200, DY=60, DZ=10 ft**2/d, W=3000 ft, H=100 ft

                program data                       sample10.dat    i
                program results                    sample10.prt    o
                screen output log file             sample10.log    o

 11   patchi    Sample Problem 11 -- Solute transport in a semi-infinite
                aquifer of infinite width and height with a 'patch' source
                Model Data:  Y1=900 ft, Y2=2100 ft, Z1=1350 ft, Z2=1650 ft
                V=1 ft/d, DX=100, DY=20, DZ=20 ft**2/d, DK=6.78E-05 per day
                C0=100.0 mg/L

                program data                       sample11.dat    i
                program results                    sample11.prt    o
                screen output log file             sample11.log    o
```

```
 12 point3_mod Sample Problem 9 -- Solute transport in an infinite aquifer
               with multiple point sources of finite duration
               Model Data:  V=0.1 ft/d, DX=0.06 ft**2/d, DY=0.003 ft**2/d
               DZ=0.0006 ft**2/d, QM=1.0 ft**3/d, C0=1000.0 mg/L, n=0.25
               Note that this program is the point3 program modified to
               reproduce result as described in Wexler (1992a) page 49.

               program data                        sample9.dat     i
               program results                     sample9.prt     o
               screen output log file              sample9.log     o


I. CONTACTS

Inquiries about this software distribution should be directed to:

U.S. Geological Survey                    Electronic mail: h2osoft@usgs.gov
Hydrologic Analysis Software Support Team Fax:        703-648-5722
R. Steve Regan                            Phone:      703-648-5896
437 National Center
Reston, VA  22092

For questions on program content, application, and (or) theory, contact:

U.S. Geological Survey                    Electronic mail: tereilly@usgs.gov
Office of Ground Water                    Fax:        703-648-5295
Thomas Reilly                             Phone:      703-648-5006
411 National Center
Reston, VA  22092


* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

                             Good Luck!

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

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```
Sample Problem 7 -- Solute transport in a semi-infinite
aquifer of infinite width with a continuous 'strip' source
Model Data:  V=1.42 ft/d, DX=100.0 ft**2/d, DY=20.0 ft**2/d
             Y1=635 ft, Y2=865 ft, C0=40.0 mg/L
====
  31  31   1 104   1
MG/L      FT/D      FT**2/D   PER DAY   FEET      DAYS
     40.0      1.42     100.0      20.0       0.0
    635.0     865.0
      0.0     100.0     200.0     300.0     400.0     500.0     600.0     700.0
    800.0     900.0    1000.0    1100.0    1200.0    1300.0    1400.0    1500.0
   1600.0    1700.0    1800.0    1900.0    2000.0    2100.0    2200.0    2300.0
   2400.0    2500.0    2600.0    2700.0    2800.0    2900.0    3000.0
      0.0      50.0     100.0     150.0     200.0     250.0     300.0     350.0
    400.0     450.0     500.0     550.0     600.0     650.0     700.0     750.0
    800.0     850.0     900.0     950.0    1000.0    1050.0    1100.0    1150.0
   1200.0    1250.0    1300.0    1350.0    1400.0    1450.0    1500.0
   1826.0
     500.      500.       0.1
```

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installation test
Output from U.S.G.S.

```
1
    ******************************************************************
    *     Sample Problem 7 -- Solute transport in a semi-infinite    *
    *    aquifer of infinite width with a continuous 'strip' source  *
    *   Model Data:  V=1.42 ft/d, DX=100.0 ft**2/d, DY=20.0 ft**2/d  *
    *                   Y1=635 ft, Y2=865 ft, C0=40.0 mg/L           *
    *                                                                *
    *              PROGRAM RUN ON  96/04/02 AT 11:04:27              *
    *                                                                *
    ******************************************************************
1

              ANALYTICAL SOLUTION TO THE TWO-DIMENSIONAL
             ADVECTIVE-DISPERSIVE SOLUTE TRANSPORT EQUATION
              FOR A SEMI-INFINITE AQUIFER OF INFINITE WIDTH
            WITH A FINITE-WIDTH (STRIP) SOLUTE SOURCE AT X=0.0


                           INPUT DATA
                           ----------

          NUMBER OF X-COORDINATES (NX) =   31
          NUMBER OF Y-COORDINATES (NY) =   31
          NUMBER OF TIME VALUES (NT) =    1
          NUMBER OF POINTS FOR NUMERICAL INTEGRATION (NMAX) =  104

          SOLUTE CONCENTRATION ON MODEL BOUNDARY (C0) = 4.000000E+01 MG/L
          GROUND-WATER VELOCITY IN X-DIRECTION (VX) = 1.420000E+00 FT/D
          DISPERSION IN THE X-DIRECTION (DX) = 1.000000E+02 FT**2/D
          DISPERSION IN THE Y-DIRECTION (DY) = 2.000000E+01 FT**2/D
          FIRST-ORDER SOLUTE DECAY RATE (DK) = 0.000000E+00 PER DAY

          AQUIFER WIDTH (W) IS INFINITE
          SOLUTE SOURCE IS LOCATED BETWEEN Y1 = 6.350000E+02 FEET
                                       AND Y2 = 8.650000E+02 FEET

          X-COORDINATES AT WHICH SOLUTE CONCENTRATIONS WILL BE CALCULATED, IN FEET
          ------------------------------------------------------------------------

     0.0000    100.0000    200.0000    300.0000    400.0000    500.0000    600.0000    700.0000
   800.0000    900.0000   1000.0000   1100.0000   1200.0000   1300.0000   1400.0000   1500.0000
  1600.0000   1700.0000   1800.0000   1900.0000   2000.0000   2100.0000   2200.0000   2300.0000
  2400.0000   2500.0000   2600.0000   2700.0000   2800.0000   2900.0000   3000.0000

          Y-COORDINATES AT WHICH SOLUTE CONCENTRATIONS WILL BE CALCULATED, IN FEET
          ------------------------------------------------------------------------

     0.0000     50.0000    100.0000    150.0000    200.0000    250.0000    300.0000    350.0000
   400.0000    450.0000    500.0000    550.0000    600.0000    650.0000    700.0000    750.0000
   800.0000    850.0000    900.0000    950.0000   1000.0000   1050.0000   1100.0000   1150.0000
  1200.0000   1250.0000   1300.0000   1350.0000   1400.0000   1450.0000   1500.0000

          TIMES AT WHICH SOLUTE CONCENTRATIONS WILL BE CALCULATED, IN DAYS
          ----------------------------------------------------------------

  1826.0000


          PLOT SCALING FACTOR FOR X (XSCLP) = 5.000000E+02
          PLOT SCALING FACTOR FOR Y (YSCLP) = 5.000000E+02
```

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CONTOUR INCREMENT (DELTA) = 1.000000E-01 MG/L

1

SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS

Y-COORDINATE, IN FEET; SOLUTE CONCENTRATION, IN MG/L

X-COORDINATE, IN FEET	0.0000	50.0000	100.0000	150.0000	200.0000	250.0000	300.0000	350.0000	400.0000
0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100.0000	0.00003	0.00006	0.00016	0.00041	0.00105	0.00275	0.00731	0.01998	0.05651
200.0000	0.00010	0.00024	0.00060	0.00150	0.00381	0.00978	0.02548	0.06763	0.18345
300.0000	0.00026	0.00063	0.00156	0.00385	0.00958	0.02400	0.06058	0.15403	0.39397
400.0000	0.00058	0.00141	0.00341	0.00826	0.02002	0.04858	0.11779	0.28462	0.68123
500.0000	0.00118	0.00279	0.00663	0.01565	0.03684	0.08621	0.20006	0.45793	1.02530
600.0000	0.00218	0.00508	0.01176	0.02702	0.06158	0.13870	0.30759	0.66727	1.40286
700.0000	0.00376	0.00858	0.01938	0.04328	0.09536	0.20664	0.43823	0.90335	1.79335
800.0000	0.00611	0.01364	0.03003	0.06511	0.13874	0.28944	0.58818	1.15645	2.18102
900.0000	0.00943	0.02057	0.04413	0.09295	0.19167	0.38557	0.75282	1.41763	2.55477
1000.0000	0.01390	0.02963	0.06196	0.12685	0.25350	0.49276	0.92722	1.67921	2.90706
1100.0000	0.01965	0.04097	0.08358	0.16651	0.32305	0.60823	1.10646	1.93476	3.23286
1200.0000	0.02675	0.05460	0.10880	0.21126	0.39868	0.72887	1.28580	2.17882	3.52855
1300.0000	0.03519	0.07039	0.13718	0.26006	0.47837	0.85133	1.46067	2.40661	3.79123
1400.0000	0.04486	0.08802	0.16803	0.31153	0.55974	0.97206	1.62659	2.61369	4.01810
1500.0000	0.05553	0.10702	0.20040	0.36402	0.64017	1.08736	1.77911	2.79571	4.20618
1600.0000	0.06684	0.12670	0.23310	0.41559	0.71678	1.19344	1.91380	2.94835	4.35206
1700.0000	0.07835	0.14628	0.26480	0.46416	0.78660	1.28645	2.02630	3.06727	4.45206
1800.0000	0.08952	0.16483	0.29403	0.50755	0.84666	1.36269	2.11244	3.14829	4.50241
1900.0000	0.09978	0.18141	0.31933	0.54366	0.89416	1.41875	2.16846	3.18769	4.49967
2000.0000	0.10855	0.19509	0.33932	0.57058	0.92666	1.45178	2.19137	3.18257	4.44125
2100.0000	0.11529	0.20507	0.35283	0.58676	0.94228	1.45976	2.17919	3.13134	4.32604
2200.0000	0.11957	0.21070	0.35902	0.59118	0.93993	1.44171	2.13137	3.03407	4.15490
2300.0000	0.12111	0.21161	0.35746	0.58344	0.91943	1.39792	2.04897	2.89288	3.93111
2400.0000	0.11979	0.20772	0.34819	0.56385	0.88160	1.33002	1.93478	2.71202	3.66054
2500.0000	0.11570	0.19927	0.33172	0.53343	0.82824	1.24097	1.79327	2.49780	3.35154
2600.0000	0.10912	0.18679	0.30901	0.49383	0.76203	1.13486	1.63036	2.25829	3.01453
2700.0000	0.10046	0.17104	0.28139	0.44720	0.68629	1.01661	1.45296	2.00275	2.66133
2800.0000	0.09029	0.15296	0.25040	0.39599	0.60475	0.89158	1.26847	1.74096	2.30425
2900.0000	0.07920	0.13357	0.21769	0.34275	0.52117	0.76513	1.08420	1.48242	1.95521
3000.0000	0.06778	0.11387	0.18484	0.28988	0.43908	0.64221	0.90678	1.23569	1.62478

1

SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS (CONTINUED)

Y-COORDINATE, IN FEET; SOLUTE CONCENTRATION, IN MG/L

X-COORDINATE, IN FEET	450.0000	500.0000	550.0000	600.0000	650.0000	700.0000	750.0000	800.0000	850.0000
0.0000	0.00000	0.00000	0.00000	0.00000	40.00000	40.00000	40.00000	40.00000	40.00000
100.0000	0.16767	0.53412	1.90013	7.86634	25.98618	36.42164	38.24162	36.42164	25.98618
200.0000	0.51060	1.45943	4.22045	11.42789	23.57398	32.76983	35.49065	32.76983	23.57398
300.0000	1.00810	2.54357	6.11176	13.02727	22.40683	29.94800	32.60906	29.94800	22.40683
400.0000	1.59727	3.59536	7.50817	13.85347	21.53500	27.72478	30.03286	27.72478	21.53500
500.0000	2.21592	4.53098	8.52497	14.28926	20.77006	25.90567	27.84477	25.90567	20.77006
600.0000	2.82091	5.33061	9.26630	14.49599	20.06362	24.37914	26.00439	24.37914	20.06362
700.0000	3.38768	6.00064	9.80615	14.55741	19.40258	23.07531	24.44807	23.07531	19.40258
800.0000	3.90442	6.55563	10.19584	14.52278	18.78257	21.94577	23.11782	21.94577	18.78257
900.0000	4.36686	7.01117	10.47132	14.42298	18.20055	20.95468	21.96653	20.95468	18.20055
1000.0000	4.77466	7.38120	10.65793	14.27763	17.65272	20.07411	20.95685	20.07411	17.65272
1100.0000	5.12920	7.67710	10.77337	14.09878	17.13409	19.28133	20.05874	19.28133	17.13409
1200.0000	5.43220	7.90748	10.82949	13.89303	16.63842	18.55689	19.24725	18.55689	16.63842

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1300.0000	5.68491	8.07822	10.83352	13.66276	16.15810	17.88327	18.50075	17.88327	16.15810
1400.0000	5.88766	8.19255	10.78883	13.40696	15.68425	17.24398	17.79962	17.24398	15.68425
1500.0000	6.03961	8.25134	10.69565	13.12185	15.20671	16.62294	17.12538	16.62294	15.20671
1600.0000	6.13882	8.25342	10.55167	12.80150	14.71430	16.00431	16.46030	16.00431	14.71430
1700.0000	6.18240	8.19609	10.35277	12.43850	14.19526	15.37254	15.78736	15.37254	14.19526
1800.0000	6.16702	8.07577	10.09388	12.02485	13.63796	14.71296	15.09067	14.71296	13.63796
1900.0000	6.08944	7.88883	9.76989	11.55296	13.03180	14.01252	14.35625	14.01252	13.03180
2000.0000	5.94727	7.63251	9.37685	11.01679	12.36836	13.26084	13.57297	13.26084	12.36836
2100.0000	5.73972	7.30590	8.91297	10.41305	11.64253	12.45135	12.73369	12.45135	11.64253
2200.0000	5.46833	6.91076	8.37966	9.74217	10.85354	11.58227	11.83623	11.58227	10.85354
2300.0000	5.13744	6.45216	7.78217	9.00912	10.00571	10.65732	10.88408	10.65732	10.00571
2400.0000	4.75448	5.93878	7.12996	8.22361	9.10868	9.68595	9.88658	9.68595	9.10868
2500.0000	4.32979	5.38272	6.43643	7.39988	8.17711	8.68294	8.85856	8.68294	8.17711
2600.0000	3.87617	4.79888	5.71826	6.55586	7.22969	7.66741	7.81924	7.66741	7.22969
2700.0000	3.40798	4.20403	4.99419	5.71181	6.28774	6.66125	6.79070	6.66125	6.28774
2800.0000	2.94013	3.61547	4.28358	4.88871	5.37335	5.68721	5.79591	5.68721	5.37335
2900.0000	2.48690	3.04969	3.60486	4.10648	4.50750	4.76689	4.85666	4.76689	4.50750
3000.0000	2.06088	2.52114	2.97400	3.38235	3.70828	3.91888	3.99173	3.91888	3.70828

1

SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS (CONTINUED)

X-COORDINATE, IN FEET	Y-COORDINATE, IN FEET 900.0000	950.0000	1000.0000	1050.0000	1100.0000	1150.0000	1200.0000	1250.0000	1300.0000
	SOLUTE CONCENTRATION, IN MG/L								
0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100.0000	7.86634	1.90013	0.53412	0.16767	0.05651	0.01998	0.00731	0.00275	0.00105
200.0000	11.42789	4.22045	1.45943	0.51060	0.18345	0.06763	0.02548	0.00978	0.00381
300.0000	13.02727	6.11176	2.54357	1.00810	0.39397	0.15403	0.06058	0.02400	0.00958
400.0000	13.85347	7.50817	3.59536	1.59727	0.68123	0.28462	0.11779	0.04858	0.02002
500.0000	14.28926	8.52497	4.53098	2.21592	1.02530	0.45793	0.20006	0.08621	0.03684
600.0000	14.49599	9.26630	5.33061	2.82091	1.40286	0.66727	0.30759	0.13870	0.06158
700.0000	14.55741	9.80615	6.00064	3.38768	1.79335	0.90335	0.43823	0.20664	0.09536
800.0000	14.52278	10.19584	6.55563	3.90442	2.18102	1.15645	0.58818	0.28944	0.13874
900.0000	14.42298	10.47132	7.01117	4.36686	2.55477	1.41763	0.75282	0.38557	0.19167
1000.0000	14.27763	10.65793	7.38120	4.77466	2.90706	1.67921	0.92722	0.49276	0.25350
1100.0000	14.09878	10.77337	7.67710	5.12920	3.23286	1.93476	1.10646	0.60823	0.32305
1200.0000	13.89303	10.82949	7.90748	5.43220	3.52855	2.17882	1.28580	0.72887	0.39868
1300.0000	13.66276	10.83352	8.07822	5.68491	3.79123	2.40661	1.46067	0.85133	0.47837
1400.0000	13.40696	10.78883	8.19255	5.88766	4.01810	2.61369	1.62659	0.97206	0.55974
1500.0000	13.12185	10.69565	8.25134	6.03961	4.20618	2.79571	1.77911	1.08736	0.64017
1600.0000	12.80150	10.55167	8.25342	6.13882	4.35206	2.94835	1.91380	1.19344	0.71678
1700.0000	12.43850	10.35277	8.19609	6.18240	4.45206	3.06727	2.02630	1.28645	0.78660
1800.0000	12.02485	10.09388	8.07577	6.16702	4.50241	3.14829	2.11244	1.36269	0.84666
1900.0000	11.55296	9.76989	7.88883	6.08944	4.49967	3.18769	2.16846	1.41875	0.89416
2000.0000	11.01679	9.37685	7.63251	5.94727	4.44125	3.18257	2.19137	1.45178	0.92666
2100.0000	10.41305	8.91297	7.30590	5.73972	4.32604	3.13134	2.17919	1.45976	0.94228
2200.0000	9.74217	8.37966	6.91076	5.46833	4.15490	3.03407	2.13137	1.44171	0.93993
2300.0000	9.00912	7.78217	6.45216	5.13744	3.93111	2.89288	2.04897	1.39792	0.91943
2400.0000	8.22361	7.12996	5.93878	4.75448	3.66054	2.71202	1.93478	1.33002	0.88160
2500.0000	7.39988	6.43643	5.38272	4.32979	3.35154	2.49780	1.79327	1.24097	0.82824
2600.0000	6.55586	5.71826	4.79888	3.87617	3.01453	2.25829	1.63036	1.13486	0.76203
2700.0000	5.71181	4.99419	4.20403	3.40798	2.66133	2.00275	1.45296	1.01661	0.68629
2800.0000	4.88871	4.28358	3.61547	2.94013	2.30425	1.74096	1.26847	0.89158	0.60475
2900.0000	4.10648	3.60486	3.04969	2.48690	1.95521	1.48242	1.08420	0.76513	0.52117
3000.0000	3.38235	2.97400	2.52114	2.06088	1.62478	1.23569	0.90678	0.64221	0.43908

1

SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS (CONTINUED)

Y-COORDINATE, IN FEET

SOLUTE CONCENTRATION, IN MG/L

X-COORDINATE, IN FEET	1350.0000	1400.0000	1450.0000	1500.0000
0.0000	0.00000	0.00000	0.00000	0.00000
100.0000	0.00041	0.00016	0.00006	0.00003
200.0000	0.00150	0.00060	0.00024	0.00010
300.0000	0.00385	0.00156	0.00063	0.00026
400.0000	0.00826	0.00341	0.00141	0.00058
500.0000	0.01565	0.00663	0.00279	0.00118
600.0000	0.02702	0.01176	0.00508	0.00218
700.0000	0.04328	0.01938	0.00858	0.00376
800.0000	0.06511	0.03003	0.01364	0.00611
900.0000	0.09295	0.04413	0.02057	0.00943
1000.0000	0.12685	0.06196	0.02963	0.01390
1100.0000	0.16651	0.08358	0.04097	0.01965
1200.0000	0.21126	0.10880	0.05460	0.02675
1300.0000	0.26006	0.13718	0.07039	0.03519
1400.0000	0.31153	0.16803	0.08802	0.04486
1500.0000	0.36402	0.20040	0.10702	0.05553
1600.0000	0.41559	0.23310	0.12670	0.06684
1700.0000	0.46416	0.26480	0.14628	0.07835
1800.0000	0.50755	0.29403	0.16483	0.08952
1900.0000	0.54366	0.31933	0.18141	0.09978
2000.0000	0.57058	0.33932	0.19509	0.10855
2100.0000	0.58676	0.35283	0.20507	0.11529
2200.0000	0.59118	0.35902	0.21070	0.11957
2300.0000	0.58344	0.35746	0.21161	0.12111
2400.0000	0.56385	0.34819	0.20772	0.11979
2500.0000	0.53343	0.33172	0.19927	0.11570
2600.0000	0.49383	0.30901	0.18679	0.10912
2700.0000	0.44720	0.28139	0.17104	0.10046
2800.0000	0.39599	0.25040	0.15296	0.09029
2900.0000	0.34275	0.21769	0.13357	0.07920
3000.0000	0.28988	0.18484	0.11387	0.06778

15/23

1

installation test
Output from CNWRA computer, by R. Fedors

```
*****************************************************************
*     Sample Problem 7 -- Solute transport in a semi-infinite     *
*    aquifer of infinite width with a continuous 'strip' source    *
*   Model Data:  V=1.42 ft/d, DX=100.0 ft**2/d, DY=20.0 ft**2/d    *
*                  Y1=635 ft, Y2=865 ft, C0=40.0 mg/L               *
*                                                                  *
*               PROGRAM RUN ON  97/09/04 AT 07:53:34               *
*                                                                  *
*****************************************************************
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1

ANALYTICAL SOLUTION TO THE TWO-DIMENSIONAL
ADVECTIVE-DISPERSIVE SOLUTE TRANSPORT EQUATION
FOR A SEMI-INFINITE AQUIFER OF INFINITE WIDTH
WITH A FINITE-WIDTH (STRIP) SOLUTE SOURCE AT X=0.0

INPUT DATA

```
NUMBER OF X-COORDINATES (NX) =   31
NUMBER OF Y-COORDINATES (NY) =   31
NUMBER OF TIME VALUES (NT) =    1
NUMBER OF POINTS FOR NUMERICAL INTEGRATION (NMAX) =  104

SOLUTE CONCENTRATION ON MODEL BOUNDARY (C0) = 4.000000E+01 MG/L
GROUND-WATER VELOCITY IN X-DIRECTION (VX) = 1.420000E+00 FT/D
DISPERSION IN THE X-DIRECTION (DX) = 1.000000E+02 FT**2/D
DISPERSION IN THE Y-DIRECTION (DY) = 2.000000E+01 FT**2/D
FIRST-ORDER SOLUTE DECAY RATE (DK) = 0.000000E+00 PER DAY

AQUIFER WIDTH (W) IS INFINITE
SOLUTE SOURCE IS LOCATED BETWEEN Y1 = 6.350000E+02 FEET
                             AND Y2 = 8.650000E+02 FEET
```

X-COORDINATES AT WHICH SOLUTE CONCENTRATIONS WILL BE CALCULATED, IN FEET

0.0000	100.0000	200.0000	300.0000	400.0000	500.0000	600.0000	700.0000
800.0000	900.0000	1000.0000	1100.0000	1200.0000	1300.0000	1400.0000	1500.0000
1600.0000	1700.0000	1800.0000	1900.0000	2000.0000	2100.0000	2200.0000	2300.0000
2400.0000	2500.0000	2600.0000	2700.0000	2800.0000	2900.0000	3000.0000	

Y-COORDINATES AT WHICH SOLUTE CONCENTRATIONS WILL BE CALCULATED, IN FEET

0.0000	50.0000	100.0000	150.0000	200.0000	250.0000	300.0000	350.0000
400.0000	450.0000	500.0000	550.0000	600.0000	650.0000	700.0000	750.0000
800.0000	850.0000	900.0000	950.0000	1000.0000	1050.0000	1100.0000	1150.0000
1200.0000	1250.0000	1300.0000	1350.0000	1400.0000	1450.0000	1500.0000	

TIMES AT WHICH SOLUTE CONCENTRATIONS WILL BE CALCULATED, IN DAYS

1826.0000

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PLOT SCALING FACTOR FOR X (XSCLP) = 5.000000E+02
PLOT SCALING FACTOR FOR Y (YSCLP) = 5.000000E+02
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20/23

CONTOUR INCREMENT (DELTA) = 1.000000E-01 MG/L

1

SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS

X-COORDINATE, IN FEET	Y-COORDINATE, IN FEET: 0.0000	50.0000	100.0000	150.0000	200.0000	250.0000	300.0000	350.0000	400.0000
	SOLUTE CONCENTRATION, IN MG/L								
0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100.0000	0.00003	0.00006	0.00016	0.00041	0.00105	0.00275	0.00731	0.01998	0.05651
200.0000	0.00010	0.00024	0.00060	0.00150	0.00381	0.00978	0.02548	0.06763	0.18345
300.0000	0.00026	0.00063	0.00156	0.00385	0.00958	0.02400	0.06058	0.15403	0.39397
400.0000	0.00058	0.00141	0.00341	0.00826	0.02002	0.04858	0.11779	0.28462	0.68123
500.0000	0.00118	0.00279	0.00663	0.01565	0.03684	0.08621	0.20006	0.45793	1.02530
600.0000	0.00218	0.00508	0.01176	0.02702	0.06158	0.13870	0.30759	0.66727	1.40286
700.0000	0.00376	0.00858	0.01938	0.04328	0.09536	0.20664	0.43823	0.90335	1.79335
800.0000	0.00611	0.01364	0.03003	0.06511	0.13874	0.28944	0.58818	1.15645	2.18102
900.0000	0.00943	0.02057	0.04413	0.09295	0.19167	0.38557	0.75282	1.41763	2.55477
1000.0000	0.01390	0.02963	0.06196	0.12685	0.25350	0.49276	0.92722	1.67921	2.90706
1100.0000	0.01965	0.04097	0.08358	0.16651	0.32305	0.60823	1.10646	1.93476	3.23286
1200.0000	0.02675	0.05460	0.10880	0.21126	0.39868	0.72887	1.28580	2.17882	3.52855
1300.0000	0.03519	0.07039	0.13718	0.26006	0.47837	0.85133	1.46067	2.40661	3.79123
1400.0000	0.04486	0.08802	0.16803	0.31153	0.55974	0.97206	1.62659	2.61369	4.01810
1500.0000	0.05553	0.10702	0.20040	0.36402	0.64017	1.08736	1.77911	2.79571	4.20618
1600.0000	0.06684	0.12670	0.23310	0.41559	0.71678	1.19344	1.91380	2.94835	4.35206
1700.0000	0.07835	0.14628	0.26480	0.46416	0.78660	1.28645	2.02630	3.06727	4.45206
1800.0000	0.08952	0.16483	0.29403	0.50755	0.84666	1.36269	2.11244	3.14829	4.50241
1900.0000	0.09978	0.18141	0.31933	0.54366	0.89416	1.41875	2.16846	3.18769	4.49967
2000.0000	0.10855	0.19509	0.33932	0.57058	0.92666	1.45178	2.19137	3.18257	4.44125
2100.0000	0.11529	0.20507	0.35283	0.58676	0.94228	1.45976	2.17919	3.13134	4.32604
2200.0000	0.11957	0.21070	0.35902	0.59118	0.93993	1.44171	2.13137	3.03407	4.15490
2300.0000	0.12111	0.21161	0.35746	0.58344	0.91943	1.39792	2.04897	2.89288	3.93111
2400.0000	0.11979	0.20772	0.34819	0.56385	0.88160	1.33002	1.93478	2.71202	3.66054
2500.0000	0.11570	0.19927	0.33172	0.53343	0.82824	1.24097	1.79327	2.49780	3.35154
2600.0000	0.10912	0.18679	0.30901	0.49383	0.76203	1.13486	1.63036	2.25829	3.01453
2700.0000	0.10046	0.17104	0.28139	0.44720	0.68629	1.01661	1.45296	2.00275	2.66133
2800.0000	0.09029	0.15296	0.25040	0.39599	0.60475	0.89158	1.26847	1.74096	2.30425
2900.0000	0.07920	0.13357	0.21769	0.34275	0.52117	0.76513	1.08420	1.48242	1.95521
3000.0000	0.06778	0.11387	0.18484	0.28988	0.43908	0.64221	0.90678	1.23569	1.62478

1

SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS (CONTINUED)

X-COORDINATE, IN FEET	Y-COORDINATE, IN FEET: 450.0000	500.0000	550.0000	600.0000	650.0000	700.0000	750.0000	800.0000	850.0000
	SOLUTE CONCENTRATION, IN MG/L								
0.0000	0.00000	0.00000	0.00000	0.00000	40.00000	40.00000	40.00000	40.00000	40.00000
100.0000	0.16767	0.53412	1.90013	7.86634	25.98618	36.42164	38.24162	36.42164	25.98618
200.0000	0.51060	1.45943	4.22045	11.42789	23.57398	32.76983	35.49065	32.76983	23.57398
300.0000	1.00810	2.54357	6.11176	13.02727	22.40683	29.94800	32.60906	29.94800	22.40683
400.0000	1.59727	3.59536	7.50817	13.85347	21.53500	27.72478	30.03286	27.72478	21.53500
500.0000	2.21592	4.53098	8.52497	14.28926	20.77006	25.90567	27.84477	25.90567	20.77006
600.0000	2.82091	5.33061	9.26630	14.49599	20.06362	24.37914	26.00439	24.37914	20.06362
700.0000	3.38768	6.00064	9.80615	14.55741	19.40258	23.07531	24.44807	23.07531	19.40258
800.0000	3.90442	6.55563	10.19584	14.52278	18.78257	21.94577	23.11782	21.94577	18.78257
900.0000	4.36686	7.01117	10.47132	14.42298	18.20055	20.95468	21.96653	20.95468	18.20055
1000.0000	4.77466	7.38120	10.65793	14.27763	17.65272	20.07411	20.95685	20.07411	17.65272
1100.0000	5.12920	7.67710	10.77337	14.09878	17.13409	19.28133	20.05874	19.28133	17.13409
1200.0000	5.43220	7.90748	10.82949	13.89303	16.63842	18.55689	19.24725	18.55689	16.63842

1300.0000	5.68491	8.07822	10.83352	13.66276	16.15810	17.88327	18.50075	17.88327	16.15810
1400.0000	5.88766	8.19255	10.78883	13.40696	15.68425	17.24398	17.79962	17.24398	15.68425
1500.0000	6.03961	8.25134	10.69565	13.12185	15.20671	16.62294	17.12538	16.62294	15.20671
1600.0000	6.13882	8.25342	10.55167	12.80150	14.71430	16.00431	16.46030	16.00431	14.71430
1700.0000	6.18240	8.19609	10.35277	12.43850	14.19526	15.37254	15.78736	15.37254	14.19526
1800.0000	6.16702	8.07577	10.09388	12.02485	13.63796	14.71296	15.09067	14.71296	13.63796
1900.0000	6.08944	7.88883	9.76989	11.55296	13.03180	14.01252	14.35625	14.01252	13.03180
2000.0000	5.94727	7.63251	9.37685	11.01679	12.36836	13.26084	13.57297	13.26084	12.36836
2100.0000	5.73972	7.30590	8.91297	10.41305	11.64253	12.45135	12.73369	12.45135	11.64253
2200.0000	5.46833	6.91076	8.37966	9.74217	10.85354	11.58227	11.83623	11.58227	10.85354
2300.0000	5.13744	6.45216	7.78217	9.00912	10.00571	10.65732	10.88408	10.65732	10.00571
2400.0000	4.75448	5.93878	7.12996	8.22361	9.10868	9.68595	9.88658	9.68595	9.10868
2500.0000	4.32979	5.38272	6.43643	7.39988	8.17711	8.68294	8.85856	8.68294	8.17711
2600.0000	3.87617	4.79888	5.71826	6.55586	7.22969	7.66741	7.81924	7.66741	7.22969
2700.0000	3.40798	4.20403	4.99419	5.71181	6.28774	6.66125	6.79070	6.66125	6.28774
2800.0000	2.94013	3.61547	4.28358	4.88871	5.37335	5.68721	5.79591	5.68721	5.37335
2900.0000	2.48690	3.04969	3.60486	4.10648	4.50750	4.76689	4.85666	4.76689	4.50750
3000.0000	2.06088	2.52114	2.97400	3.38235	3.70828	3.91888	3.99173	3.91888	3.70828

1

SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS (CONTINUED)

X-COORDINATE, IN FEET	Y-COORDINATE, IN FEET 900.0000	950.0000	1000.0000	1050.0000	1100.0000	1150.0000	1200.0000	1250.0000	1300.0000
	SOLUTE CONCENTRATION, IN MG/L								
0.0000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100.0000	7.86634	1.90013	0.53412	0.16767	0.05651	0.01998	0.00731	0.00275	0.00105
200.0000	11.42789	4.22045	1.45943	0.51060	0.18345	0.06763	0.02548	0.00978	0.00381
300.0000	13.02727	6.11176	2.54357	1.00810	0.39397	0.15403	0.06058	0.02400	0.00958
400.0000	13.85347	7.50817	3.59536	1.59727	0.68123	0.28462	0.11779	0.04858	0.02002
500.0000	14.28926	8.52497	4.53098	2.21592	1.02530	0.45793	0.20006	0.08621	0.03684
600.0000	14.49599	9.26630	5.33061	2.82091	1.40286	0.66727	0.30759	0.13870	0.06158
700.0000	14.55741	9.80615	6.00064	3.38768	1.79335	0.90335	0.43823	0.20664	0.09536
800.0000	14.52278	10.19584	6.55563	3.90442	2.18102	1.15645	0.58818	0.28944	0.13874
900.0000	14.42298	10.47132	7.01117	4.36686	2.55477	1.41763	0.75282	0.38557	0.19167
1000.0000	14.27763	10.65793	7.38120	4.77466	2.90706	1.67921	0.92722	0.49276	0.25350
1100.0000	14.09878	10.77337	7.67710	5.12920	3.23286	1.93476	1.10646	0.60823	0.32305
1200.0000	13.89303	10.82949	7.90748	5.43220	3.52855	2.17882	1.28580	0.72887	0.39868
1300.0000	13.66276	10.83352	8.07822	5.68491	3.79123	2.40661	1.46067	0.85133	0.47837
1400.0000	13.40696	10.78883	8.19255	5.88766	4.01810	2.61369	1.62659	0.97206	0.55974
1500.0000	13.12185	10.69565	8.25134	6.03961	4.20618	2.79571	1.77911	1.08736	0.64017
1600.0000	12.80150	10.55167	8.25342	6.13882	4.35206	2.94835	1.91380	1.19344	0.71678
1700.0000	12.43850	10.35277	8.19609	6.18240	4.45206	3.06727	2.02630	1.28645	0.78660
1800.0000	12.02485	10.09388	8.07577	6.16702	4.50241	3.14829	2.11244	1.36269	0.84666
1900.0000	11.55296	9.76989	7.88883	6.08944	4.49967	3.18769	2.16846	1.41875	0.89416
2000.0000	11.01679	9.37685	7.63251	5.94727	4.44125	3.18257	2.19137	1.45178	0.92666
2100.0000	10.41305	8.91297	7.30590	5.73972	4.32604	3.13134	2.17919	1.45976	0.94228
2200.0000	9.74217	8.37966	6.91076	5.46833	4.15490	3.03407	2.13137	1.44171	0.93993
2300.0000	9.00912	7.78217	6.45216	5.13744	3.93111	2.89288	2.04897	1.39792	0.91943
2400.0000	8.22361	7.12996	5.93878	4.75448	3.66054	2.71202	1.93478	1.33002	0.88160
2500.0000	7.39988	6.43643	5.38272	4.32979	3.35154	2.49780	1.79327	1.24097	0.82824
2600.0000	6.55586	5.71826	4.79888	3.87617	3.01453	2.25829	1.63036	1.13486	0.76203
2700.0000	5.71181	4.99419	4.20403	3.40798	2.66133	2.00275	1.45296	1.01661	0.68629
2800.0000	4.88871	4.28358	3.61547	2.94013	2.30425	1.74096	1.26847	0.89158	0.60475
2900.0000	4.10648	3.60486	3.04969	2.48690	1.95521	1.48242	1.08420	0.76513	0.52117
3000.0000	3.38235	2.97400	2.52114	2.06088	1.62478	1.23569	0.90678	0.64221	0.43908

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SOLUTE CONCENTRATION AT TIME = 1826.0000 DAYS (CONTINUED)

X-COORDINATE, IN FEET	Y-COORDINATE, IN FEET 1350.0000	1400.0000	1450.0000	1500.0000
	SOLUTE CONCENTRATION, IN MG/L			
0.0000	0.00000	0.00000	0.00000	0.00000
100.0000	0.00041	0.00016	0.00006	0.00003
200.0000	0.00150	0.00060	0.00024	0.00010
300.0000	0.00385	0.00156	0.00063	0.00026
400.0000	0.00826	0.00341	0.00141	0.00058
500.0000	0.01565	0.00663	0.00279	0.00118
600.0000	0.02702	0.01176	0.00508	0.00218
700.0000	0.04328	0.01938	0.00858	0.00376
800.0000	0.06511	0.03003	0.01364	0.00611
900.0000	0.09295	0.04413	0.02057	0.00943
1000.0000	0.12685	0.06196	0.02963	0.01390
1100.0000	0.16651	0.08358	0.04097	0.01965
1200.0000	0.21126	0.10880	0.05460	0.02675
1300.0000	0.26006	0.13718	0.07039	0.03519
1400.0000	0.31153	0.16803	0.08802	0.04486
1500.0000	0.36402	0.20040	0.10702	0.05553
1600.0000	0.41559	0.23310	0.12670	0.06684
1700.0000	0.46416	0.26480	0.14628	0.07835
1800.0000	0.50755	0.29403	0.16483	0.08952
1900.0000	0.54366	0.31933	0.18141	0.09978
2000.0000	0.57058	0.33932	0.19509	0.10855
2100.0000	0.58676	0.35283	0.20507	0.11529
2200.0000	0.59118	0.35902	0.21070	0.11957
2300.0000	0.58344	0.35746	0.21161	0.12111
2400.0000	0.56385	0.34819	0.20772	0.11979
2500.0000	0.53343	0.33172	0.19927	0.11570
2600.0000	0.49383	0.30901	0.18679	0.10912
2700.0000	0.44720	0.28139	0.17104	0.10046
2800.0000	0.39599	0.25040	0.15296	0.09029
2900.0000	0.34275	0.21769	0.13357	0.07920
3000.0000	0.28988	0.18484	0.11387	0.06778

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