

## **Steady-State Simulation of Regional Ground-Water Flow Using a Finite-Difference Scheme**

### **Introduction**

In GEY 674--Hydrogeology you were introduced to the concepts of geologic (permeability) and topographic (water-level elevation) control of regional ground-water flow patterns, as first described by Josef Toth in his sequence of benchmark papers. In this assignment, you will repeat some of Toth's work by modifying the FORTRAN program listed on Figure 2.10 (pages 34 and 35) in Wang and Anderson (1982).

### **Problem No. 1**

Using the FORTRAN compiler on the UNIXs (or PCs) in the Hydrology Computing Lab, type in the code listed on Figure 2.10 and run the program. Check to see if the output matches that listed on Figure 2.11, i.e., benchmark your program. Then, either save these heads in a file and write a program to reformat them for use with SURFER (or other 2-dimensional graphic software, i.e. ARCVIEW), or modify the print statements in the program to output the data in x, y, z (i, j, h) format, or type in the i, j, and h values directly into SURFER (or other 2-dimensional graphic software). Contour the heads with SURFER, then manually draw several flow lines.

### **Problem No. 2**

Modify your FORTRAN program and recompile it to incorporate the water-table boundary conditions analyzed by Toth, as shown on Figure 2.12 and described in problem 2.4 on page 38 in Wang and Anderson (1982).

- Make one run based on the conditions stated in problem 2.4 and use SURFER to contour the head data.
- Make a second run using an "a" value of 4.0 m and contour the head data.
- Make a third run using the new "a" value and increase the depth of the basin ( $y_0$ ) by a factor of two. (This will require you to redimension the H array to (13, 13) and to make other appropriate changes to the program). Contour these head data.
- Make a final run using the old "a" value of 2.0 m and the new  $y_0$  value and contour these data,

### **Questions**

- (1). Explain how basin depth and topography influence regional flow patterns? Cite your plots to exemplify your arguments.
- (2). How would doubling the permeability of the flow system affect the flow pattern? What other effects would it have, if any?