Civ E 676
Case Studies in Groundwater Management
Assignment 4

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The objective of this assignment is the simulation of groundwater flow at the Union Carbide Corporation Texas City Off-Plant Disposal Area (OPDA) and the adjacent Gulf Coast Waste Disposal Authority - 40 Acre Facility (GCWDA-40). The three-dimensional finite difference models SWIFT III and MODFLOW (Visual MODFLOW) will be used for the analyses. SWIFTW.EXE was compiled using the Microsoft/Intel Fortran; the executable for your DOS window and all other files required to complete this assignment can be downloaded from the class web site. Instructions on the use of the SWIFT III code and Visual MODFLOW will be given in class.

PART 1: SWIFT III

A SWIFT III data set, TEXAS.D, for the Texas City site has been prepared for you. Selected figures of the OPDA and GCWDA-40 site are also attached. Note that the contaminants at the site are DNAPLs and that they have migrated to the -30 foot aquifer and possibly to the -100 foot aquifer.

To facilitate post-processing, use COMB.EXE (in your DOS window) to convert SWIFT III output of grid block pressures to a format that can be used in SURFER. VECSURF2.EXE reads the SWIFT III unformatted velocity records and generates velocity vector data that can be plotted in SURFER using MAP > LOAD BASE MAP. The output from VECSURF2.EXE should be given a *.BLN file name. The input data set for VECSURF2.EXE is available as VECSURF2.D.

STEPS

1. **Determine the head distribution in the -30 foot aquifer and the -100 foot aquifer.** Notes: Change the well specification option from -4 to 1 (lines 243 and 245) and the flows to 0.0 (line 242). Calculate the well index for both wells (????.) on lines 244 and 246). Change the ?.????? in lines 37 and 39 to 5.66 ft/day. Calibrate the model by determining the remaining missing data (i.e., the hydraulic conductivities for the aquitards). **Calibrate by visual comparison only.**

2. **For the calibrated model, determine the yields at the two wells assuming pressure limited flow. Notes: T**his requires a well specification option of -4. The pressure of 3.90 psi for both wells results in a drawdown to the top of the -30 foot aquifer (note that the aquifer is 18 feet thick at the location of the wells and that the conversion is 0.4333 psi/foot).

3. **Determine the yield at the two wells if a 3 foot thick grout curtain is installed in the -30 foot aquifer at the location indicated in lines 36-37 and 38-39. Plot the heads in both aquifers.** Notes: Assume a hydraulic conductivity of 1 X 10^{-8} cm/sec for the grout (note that

the K's in the TEXAS.D SWIFT III data set are in feet/day). Use a harmonic mean to estimate the K.

4. **Determine the sensitivity of the yield to the hydraulic conductivity for the upper aquitard/fill for the case with pressure limited flow and the grout curtain.** Notes: The sensitivity can be estimated by perturbing the K and calculating both $\Delta q/\Delta K$ and $(\Delta q/\Delta K)(K/Q)$

5. **Change the well specification option to specified rate (i.e., 1), set the flows to the wells as 5 times the yield with pressure limited flow and comment on the obtained results.**

6. **Note that both wells are in the -30 foot aquifer. Comment on the ability of the wells to prevent leakage from the -30 foot aquifer to the -100 foot aquifer. How does the pumping effect flow from the basins to the -30 foot aquifer through the zone 1 aquitard. Discuss the significance of the analyses (base case system and remedial alternatives) from both a flow and a contaminant perspective.**

PART 2: MODFLOW

Develop a MODFLOW analysis of the Texas City flow domain that includes the base case flow domain using Visual MODFLOW. For this problem, the outer row/column of grid blocks have been subdivided to create a mesh with 28 columns and 18 rows. Note that the origin for grid block numbering in MODFLOW is the upper left corner whereas SWIFT III has the origin in the lower left corner. Also note that in MODFLOW, positive is upwards whereas SWIFT default is positive downward. For clarity in plotting, do not include the outer two columns/rows.

1. Qualitatively compare the results to those obtained using SWIFT III.

2. Revise the MODFLOW data set to include the two wells and grout walls. Qualitatively compare the results to those obtained using SWIFT III.

MODFLOW Grid

Grid lines: defined in texas_rows.txt and texas_columns.txt

Ground surface and Layer Bottoms: files named tex_bot?.txt and tex_ground.txt

Hydraulic conductivity distribution (ft/day)

Layer Ks

Layer	Kx	Ky	Kz
1	?	?	?
2	?	?	?
3	2.83	2.83	0.283
4	?	?	?
5	2.83	2.83	0.283

Revised K

I1	I2	J1	J2	layer	Kx	Ky	Kz
10	14	3	15	3	5.66	5.66	0.566
10	13	10	15	5	5.66	5.66	0.566
11	14	3	9	5	5.66	5.66	0.566
10	14	3	3	3	5.66	Grout ?	0.566
15	15	4	7	3	Grout ?	5.66	0.566

High K zone in layer 4

I1	I2	J1	J2	layer	Kx	Ky	Kz
10	10	13	13	4	10000.	10000.	10000.

Hurricane outflow channel (head 0.53 feet)

I1	I2	J1	J2	layer	Kx	Ky	Kz
1	28	12	12	1			

Barge marshalling area and turning basin

I1	I2	J1	J2	layer	Kx	Ky	Kz
5	7	2	6	1-3	10000.	10000.	10000.
8	28	2	2	1-3	10000.	10000.	10000.
16	17	3	6	1-2	10000.	10000.	10000.
4	4	2	2	1-3	10000.	10000.	10000.

Boundary conditions (ft water)

Layer 3	0.53 feet	on left, right and bottom edges
Layer 5	7.0 feet	on all edges
Layer 1	0.53 feet	Hurricane outflow channel (row 7)
Layer 1 - 3	0.53 feet	Ship channel

Pond surfaces as shown on map

Recharge: 0.000114 ft/day for non specified blocks

Wells: grid blocks 12 5 3 and in 12 7 3