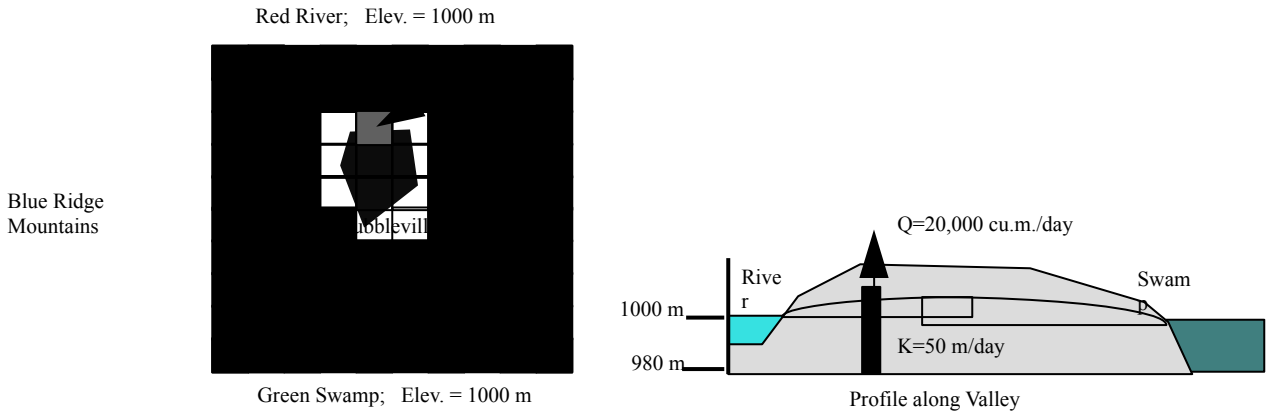
CIVE 7332 Project #2 Hydraulic Modeling and Particle Tracking

The town of Hubbleville is planning to expand its water supply pumping from a well in the unconfined sand gravel aquifer depicted below. The average grade elevation is 1020 meters, with gentle slope from the center of the aquifer towards both the river and swamp. The State Fish and Game Service, managers of Green Swamp Conservation area is concerned that pumping will significantly reduce groundwater discharge to the swamp and threaten wildlife habitat. The town claims that the well is located sufficiently close to the Red River so that induced recharge will contribute the significant portion of water that flows to the well and none will come from the swamp.



The well is designed to pump at 20,000 cubic meters/day; Each cell is 1000 x 1000 meters. The average long term recharge is 0.001 m/day. The hydraulic conductivity of the aquifer is approximately 50 m/day. The apparent hydraulic conductivity of Green Swamp is 500 m/day. The porosity of the aquifer is 0.35. Using the concepts of multiple cell balance modeling develop a computer model that can calculate steady state head distribution and velocity field for the Hubbleville Aquifer.

Determine the net groundwater flow from the aquifer into the swamp for pre-pumping conditions. Determine the maximum pumpage rate if the reduction in average groundwater inflow to the swamp cannot exceede 15% of the pre-pumping case.

Using the concepts of particle tracking develop a computer model that can track the position of a particle in a fluid. Use your particle tracking model to show the pathlines of water flowing in the aquifer. Illustrate the effect of the water divide in the system under different pumping conditions.

Perform a sensitivity analysis and determine the effect of small changes in input parameters (hydraulic conductivity and recharge rate) on the predicted impact to the swamp.

Assume cloud seeding doubles the average recharge rate. Show what effect this weather modification will have on the flow lines and average groundwater inflow into the swamp.

Assume a slurry trench is installed across the valley one cell south of the well field that reduces the hydraulic conductivity in the trenched area to 0.5 m/day. Show what effect this wall will have on the flow lines and average groundwater inflow into the swamp.

Without regard to cost, design a system that can produce the desired groundwater discharge that minimizes the reduction in average groundwater flow to the swamp.

Prepare a report on your findings.

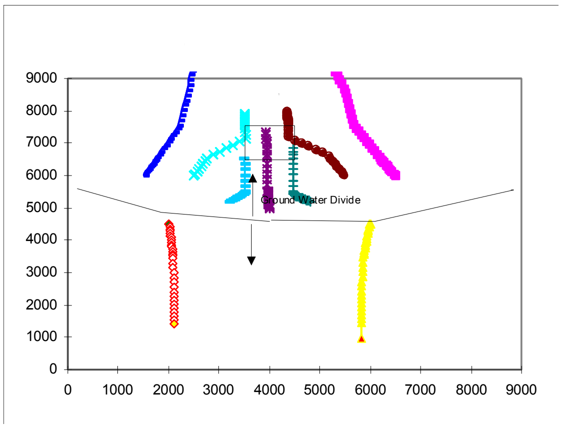
Solution(s)

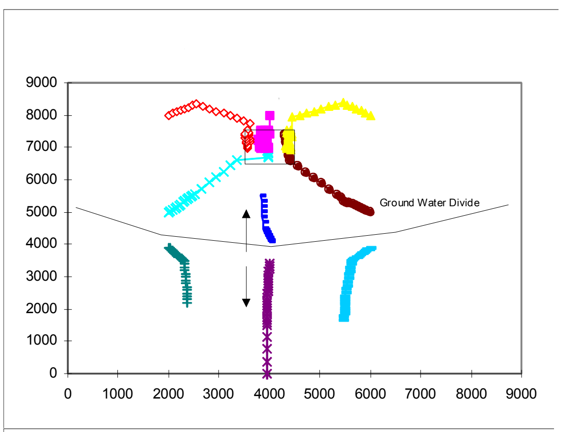
Set 1: Hydraulics Calculations:

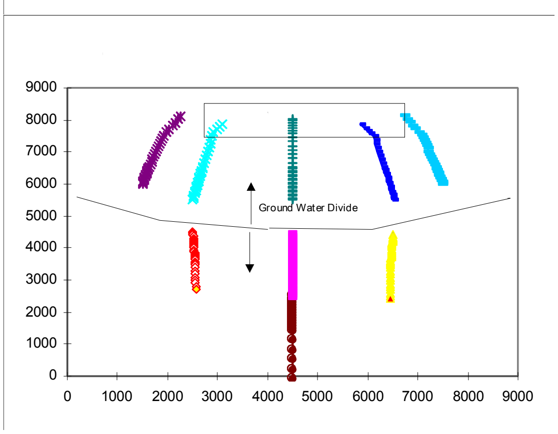
		Average	DAvg
Q=0	SwampFlux	0.03389263	
Q=10,000	SwampFlux	0.03131265	0.07612221
Q=20,000	SwampFlux	0.02844247	0.16080682
Q=30,000	SwampFlux	0.02517659	0.25716642

Pumping between 10,000 and 20,000 satisfies hydraulic requirement of causing average reduction in swamp flux not to exceed 15% of pre-pumping. Probably 18,000 is correct.

Flow Paths:







Reduction in discharge to swamp is less than 8%.