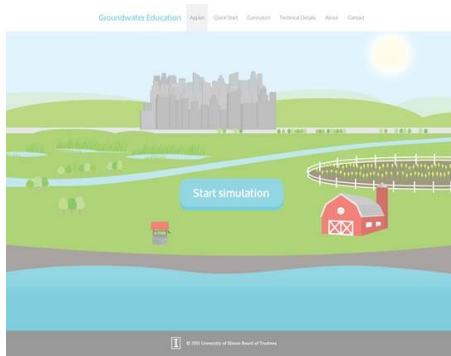# Aquifer Exploration
Task 1: The Groundwater Simulation

Engineers use models to help them test solutions, make predictions, and draw conclusions. In this activity, you will be using an online simulations that models the relationships between an aquifer, human activity, and natural disasters. After exploring the simulation, you'll be collecting and analyzing data so that you can create your own model to explain how to keep the aquifer healthy and stable.

Open the Groundwater Simulation in a web browser. Click on *Start Simulation* and load the **No Development** scenario. http://groundwater.cee.illinois.edu/

A **map** will load showing the water table of a region in which *no human activity* or development has occurred. Each cell represents an area of 0.2 km by 0.2 km and is measured to a depth of 100 meters. Each cell on the map is a color that indicates how far beneath the surface the water table is found, as shown by the key on the right side of the map. Cells that are black are not part of the aquifer.
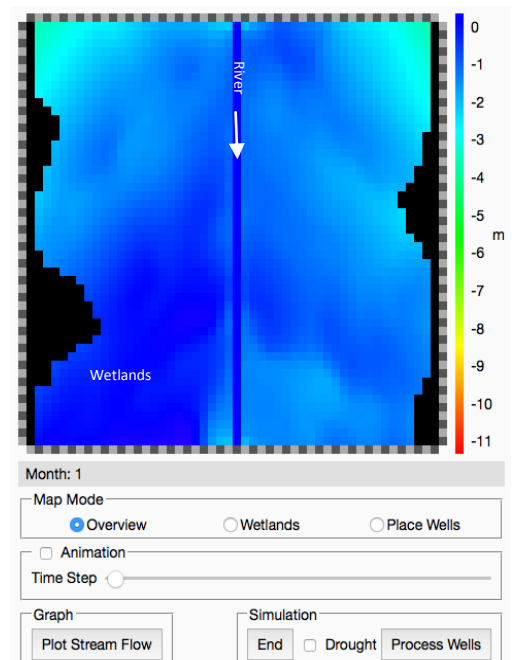
- Click the *Animate* box to observe the changes that occur to the aquifer over the course of 60 months. The animation will continuously loop, until you uncheck *Animate*.

- Record your initial observations below:

Part I: City Scenario

Load the **City** scenario. In this scenario, three city wells have been drilled to meet society's needs. The city wells in this scenario pump a constant $-15,000$ m^3/day.
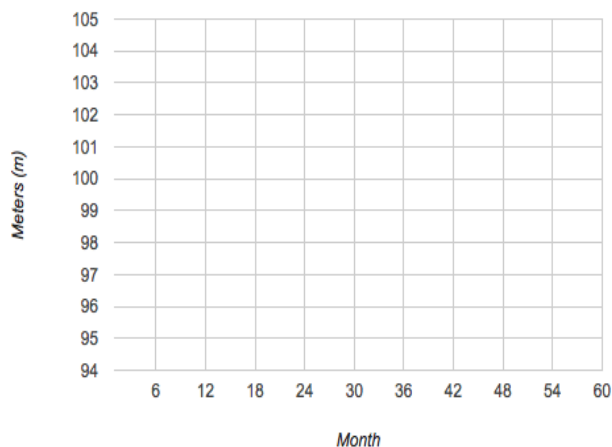
- What does the negative sign mean?

- Look for **patterns** as you watch the model animate. Stop the model at any point and describe your observations below:

- How are these patterns and observations different than those you observed in the *No Development* scenario?

Click on any cell in the **City** scenario.

Cell: (_____ , _____)

- Sketch the graph that is displayed on your screen on the axes to the right. Be sure to label all lines—refer to the *Data Bar* under the map for help.

- Using the information in the *Data Bar* or the graph, explain how you can find the depth a well must be drilled in order to reach the aquifer. Write this in words and as an equation. Draw a picture.

(Graph: vertical axis labeled "Meters (m)" ranging from 94 to 105; horizontal axis labeled "Month" with values 6, 12, 18, 24, 30, 36, 42, 48, 54, 60)

- Find the water table depth from the surface for the cell above for months 6, 12, 18, 30, 26, 54, and 60. Is there a pattern in this data? Is it similar to the pattern you described earlier?   If yes, how?

- What causes the pattern(s) you observed in this scenario? List all ideas.

Part II: City + Farm Scenario

In this scenario, two farm wells are added to the city wells, which continue to pump at −15,000 m³/day. The wells on the farm pump only during the growing season, and the amount that is pumped varies each month as shown in the table below.

	May	June	July	August	Sept	Oct
Farm Pumping Rate (m³/day)	-203.20	-4836.16	-8717.28	-6238.24	-1930.40	-772.16

Load the **City + Farm** Scenario and watch the five-year animation loop.

- Click on the same cell as you did in Part I, and compare the graph on your screen to the graph you sketched on your paper. List all similarities and differences that you observe.

- Are the pattern(s) you observed in the **City** scenarios present in this scenario? Explain.

- Make the same calculations in this scenario (using the same cell as before) that you did on the previous pages for months 6, 12, 18, 30, 26, 54, and 60. Is there a pattern in this data?

- Let the animation cycle again. Pause when you see a cell turn red. How far below the surface is the water table for a red cell? What does this tell you?

- In *Map Mode* select *Wetlands*. All wetland cells are highlighted in bright blue in the simulation. Select any wetland cell and calculate how depth of the water table. Using this information, write a definition for *wetland*.

Part III: No Development

This scenario starts with no human activity, and allows you to experiment so that you can observe the cause and effect of pumping water for the city, the farm, or both.

Add A Well

Select *Place Wells*. The city and the farm area will be highlighted. Click on any cell in one of these regions to place a well there. To remove a well, click on it again. Choose a pumping rate between 5,000 and 15,000 gallons a day for city wells. Farm wells pump at different rates throughout the growing season as shown in the table on the previous page.

After placing a well, click *Update* so that the simulation can make changes to the data.

Pump It Up

- Add two more wells, click *Update*, and then check *Animate.* Record some observations below:

- Add as many wells as possible. What did you choose the city pumping rates to be? What looks different when you have 8 wells pumping at the same time? Record your observations below.