# #32 Team Exercise: Hydrology I

### BACKGROUND

The water table is the surface of the saturated zone, below which all soil pores or rock fractures are filled with water. Ground water moves through the subsurface much like water on the ground surface, except that it travels a great deal more slowly. If the soil is mostly sand and gravel, ground water can move as much as five feet per day. But, more often than not, ground water moves at speeds of a few inches per day (or less). Like streams and rivers, ground water moves from high areas to low areas. In this exercise, you will draw the contours of the water table to show how ground water moves beneath the ground, down the sides of a valley, to a river that flows to the sea.

Before you begin this exercise, however, it is important that you understand three main principles.

- First, ground water and surface water share a strong connection in the area. In such areas streams continue to flow even when it hasn’t rained for days? Where does the water come from? In such areas, water is discharged to surface waters from ground water at the point where the water table intersects the surface of the land. In this situation, the surface water is called a gaining stream or gaining pond.

- Second, because the water table is at the land surface adjacent to “gaining” surface waters, the elevation of ground water is generally the same as that of the river, especially between rain storms.

- Third, ground water is assumed to flow at right angles to water table contours. This is because ground water moves downhill in the path of least resistance due to gravity.

- In this exercise, you’ll use all three of these principles.

During this activity you will learn how to draw a water table contour map. Water table measurements that are taken at the same time of year (What could be the problem using measurements taken throughout the year?) can be used to develop a water table contour map to show the direction of ground water flow. Monitoring wells are typically used to determine the elevation of the water table. The elevation of the water table is determined at several locations throughout the area of interest. Like topographic map contours, water table contours represent lines of equal elevation. The difference between the maps is that water table elevations are measured in wells and at the river channel, not on the ground surface. Thus, just as surface water flow is downhill and perpendicular to topographic contours, the direction of ground water flow is also downhill and perpendicular to the water table contours.

### DIRECTIONS

Using the “Contouring the Water Table” worksheet, take a pencil (in case you make mistakes), and lightly draw in 3 or 4 arrows to show your prediction for the direction(s) of ground water flow.

Draw contours at 50-foot intervals. The pencil lines can always be inked-in later. Begin at 50 feet (the shoreline along the ocean will be sea level), then draw the other contours for 100, 150, 200, and 250 feet.

To get started, draw the 50-foot contour. Find the 50-foot elevation on the river. Draw a line from that point through the 50-foot elevation at the well just southwest of the river. Don’t go much past the well, because there are no more data to tell you where to go!

Draw the contour on the other side of the river. When locating a contour between two points, you will have to interpolate—that is, figure out the proportional distance between the points.The 50-foot contour between the 30- and 80-foot elevations should be drawn closer to the 30-foot value (20 feet difference) than the 80-foot value (30 feet difference). You can do this by hand after a little practice, or measure it precisely with a ruler and calculator. For the other two wells, draw the contour exactly between the 30-and 70-foot elevations, because they are both 20 feet different from the 50-foot contour’s value.

When you are finished, you will notice that the contours form V’s with the river and its tributaries. That’s because the river is a “gaining” river. It is receiving recharge from the aquifer. The contours show that ground water is moving down the sides of the valley and into the river channel. The opposite of a gaining stream is a “losing” stream. It arises when the water table at the stream channel is lower than the stream’s elevation, or stage, and stream water flows downward through the channel to the water table. This is very common in dryer regions of the Southwest. In the case of a losing stream, the V will point downstream, instead of upstream.

Note: When making a water table map, it’s important that your well and stream elevations are accurate. All elevations should be referenced to a standard datum, such as mean sea level. This means that all elevations are either above or below the standard datum (e.g., 50 feet above mean sea level datum). It’s also very important to measure all of the water table elevations within a short period of time, such as one day, so that you have a “snapshot” of what’s going on. Because the water table rises and falls over time, your map will be more accurate if readings are made before these changes occur. Understanding how ground water flows is important when you want to know where to drill a well for a water supply, to estimate a well’s recharge area, or to predict the direction contamination is likely to take once it reaches the water table. Water table contouring can help you do all these things!

### ANALYZING FLOWS FROM DANSIH AQUIFERS

In this second part of the exercise we will look at potentiometric maps from the area we will be working with for the rest of the afternoon. We are in the northern part of the island of Funen in Denmark see figure below. In the area we have 3 major aquifer separate by confining clay units. The two upper sand aquifers named KS2 an KS3 (se geological cross section on Figure 3).

Map

Description automatically generated

Figure 1: Location of area in Denmark

Map

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Figure 2: Cross section through area with geological profile shown in

Chart, diagram

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Figure 3: Hydrogeological cross section through area. Red units are the sand aquifers and the green unit is the deep chalk aquifer. Remaining units are confining clay units

In the appendices 2-4 the potentiometric maps are found. A small version of the potentiometric map for aquifer KS2 is shown in Figure 4.

Background pattern

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Figure 4: Potentiometric map for aquifer KS2.

Exercises:

1. For each of the potentiometric maps. Draw flowlines going from the highest potentiometric level to low potentiometric levels. Does the flow pattern change between aquifers? Remember that flow are perpendicular to the groundwater potential lines.
2. Find the same location on each of the 3 potentiometric maps. Look at the contours and decide if the flow direction in the groundwater system is upwards or downwards. Does it change if you look further inland compared to closer to the coast?
3. With focus on aquifer KS2 can you find any locations where the potentiometric map is affected by groundwater abstraction (local depression in the potentiometric map)
4. By looking at the potentiometric map and the geological cross section. How do you think the interaction is between groundwater and surface water in the aquifer?
5. The deeper the aquifers are located the further there is between the potentiometric lines. What could be the explanation for this?

### ADDITIONAL EXERCISES (if time allows):

Go to http://tgms.dgr.go.th/#/home and look at the boreholes. Chose a small area with several boreholes. Is It possible to extract data and draw a potentiometric map of the groundwater? This can be done by taking a screenshot from the homepage and putting it into e.g. Word. Add labels to the boreholes based on their water table elevation. Use the information to try to contour a map of the potentiometric head.

Based on the datasets is it possible to se how the interaction is between groundwater and surface water? Are streams and wetlands loosing or gaining water in the specific area?

If you can find boreholes with screens in different aquifers. Based on the head elevations are the groundwater flowing upwards or downwards?