George Lilly owns a nice home just north of Crossroads. Over a several-week period, his water acquired an unusual taste, and became slightly discolored. He thought that something was wrong with his well and called a local driller. The driller checked the well and found everything to be working properly. The driller encouraged Lilly to have his water analyzed.
Lilly called Winston Labs, a water chemistry laboratory offering analytical services to industry, government, and citizens. They gave him instructions for taking a sample of his water and transporting it to their lab. The analysis revealed high levels of barium that greatly exceeded the state drinking water standards. The Chief Chemist at Winston reported these results to Mr. Lilly and obtained his permission to release them to the County Health Department.

The County Health Department, concerned about contamination of additional wells, responded by contacting all homeowners in the area of the Lilly property. The letter sent to these homeowners explained the potential contamination problem, offered free water-quality testing, and requested homeowner cooperation in a potential investigation.

Following recommendations from state regulatory agencies, the county began collecting information to investigate this problem. You have been hired to supervise this investigation. Your job will be to map ground water levels throughout the county, determine the direction of ground water flow, and prepare a map of the contaminant plume.
Before start working on your assignment read and understand the “Principles of Groundwater Flow”
A water level meter is an important tool of the hydrogeologist. It is a long measuring tape with a heavy metal probe on one end and a buzzer or light on the other end. The tape may be several hundred feet long and is stored on a reel as shown in the photo below. Water level meters are used to measure the depth of the water table below the top of the well casing.

The operator lowers the tape, sensor end first, down the well. When the sensor touches water, a circuit is connected and the light or buzzer on the reel is activated. The operator then very carefully reads the tape to determine the depth to water.
Hydrologists using a water level meter to measure the depth to the water table.
In many instances, the *elevation* of the water table is more important than the depth to water. In the illustration on the right, look at how the numbers to the left of the well increase from the bottom to the top. These numbers represent elevations in feet above sea level. The elevation of water in a well cannot be measured directly. Instead, it is calculated by first measuring the elevation of the top of the well casing (this is usually done by a surveyor), then using a water level meter to measure the depth to water. Finally, the depth to water is subtracted from the elevation of the top of the well. In this example, the math would be:

- Elevation at top of casing: 834 feet
- Depth to water: -10 feet
- Elevation of the water table: 824 feet
Let's imagine that we have two wells, Well "A" and Well "B," that are located a short distance from one another. We would like to know the elevation of the water table at each of these two wells, so we hire a surveyor to measure the elevation of the top of the casing at each well. The surveyor finds the elevation of the casing top at Well "A" to be 439 feet above sea level and the elevation of the top of the casing at Well "B" to be 437 feet above sea level. Next, we use a water level meter to measure the depth to water from the top of the well casing. The depth to water in Well "A" is 15 feet and in Well "B" it is 11 feet.

Using subtraction, we can determine that the elevation of the water table in Well "A" is 424 feet and the elevation of the water table in Well "B" is 426 feet. Our results are summarized below:

<table>
<thead>
<tr>
<th></th>
<th>Well A</th>
<th>Well B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation at top of casing</td>
<td>439 feet</td>
<td>437 feet</td>
</tr>
<tr>
<td>Depth to water</td>
<td>- 15 feet</td>
<td>- 11 feet</td>
</tr>
<tr>
<td>Elevation of the water table</td>
<td>424 feet</td>
<td>426 feet</td>
</tr>
</tbody>
</table>
Plotting this on our diagram, we can see that the water level in Well "B" is higher than the water level in Well "A." Because we know that ground water flows from areas of high water table elevation to areas of lower water table elevation, we can infer that the general direction of ground water flow in this area is to the left.

Determining the direction of ground water flow is one of the most important jobs of the hydrogeologist. In the event of a contaminant release, the direction of ground water flow must be determined to identify the area at risk and plan for any cleanup operations.
You have already learned that ground water moves down the slope of the water table. If the ground water contains dissolved contaminants, they will be carried along in the direction of ground water flow. The contaminants spread in a subsurface "cloud" known as a "plume." The illustration to the right shows a plume in map view. Note how it is narrow near the source and gets wider in the direction of flow. Also, note that the concentration of contaminants (represented by color intensity) is highest near the source and decreases with transport distance.
To solve this problem, you should print a copy of the detailed location map and plot the following information on it:

1. water table elevations at each water well
2. contour lines showing the elevation of the water table
3. arrows showing the direction of ground water flow
4. a contaminant plume drawn with the proper shape and size
Location Map
Print a copy of the following worksheet and circle the best answer to each question below:

1) What is the elevation of the water table at the Lilly well?
   - 355.3 feet
   - 427.5 feet
   - 501.3 feet

2) Which of the maps below shows a trend of contour lines that is similar to the map that you made for this area? (North is at the top.)
   - [Map A]
   - [Map B]
   - [Map C]
   - [Map D]

3) What is the direction of ground water flow near the Lilly water well?
   - north
   - south
   - east
   - west
   - northeast
   - southeast
   - southwest
   - northwest
4) Which of the plumes below best matches the shape and orientation of the ground water contamination plume near the Lilly well?

A B C D

5) Which of these residences is in the greatest danger of future contamination?

Jones
Dixon
Simon
Nestor
Scott