



Hydrogeology Event



Names _____

Team Number and School _____

PART I: Groundwater Concepts and Vocabulary

Part I is worth 30% of your grade. There are 15 points possible in Part I.

MULTIPLE CHOICE: Circle one.

1. The removal of soluble or colloidal material from a porous medium by the flow of water through it is known as (1 pt)
 - a) Leaching
 - b) Reverse osmosis
 - c) Permeability
 - d) Diffusion
2. Which of the following groundwater pollutants is associated with manure? (1 pt)
 - a) Toluene
 - b) Polycyclic Aromatic Hydrocarbons (PAHs)
 - c) Nitrate
 - d) Methyl Tert-Butyl Ether (MTBE)
3. Which of the following types of bedrock is most permeable? (1 pt)
 - a) Fractured igneous rock
 - b) Unconsolidated gravel
 - c) Limestone
 - d) Shale
4. Which of the following is an in-situ remediation technique for an inorganic contaminant? (1 pt)
 - a) Activated Carbon Treatment
 - b) Phytoremediation
 - c) Air Stripping
 - d) Reverse Osmosis
5. The most common type of well installed for homes today is a(n) (1 pt.)
 - a) artesian well
 - b) driven well
 - c) injection well
 - d) drilled well

PART II – The Hydrology Challenge

Part II is worth 10% of your grade. There are 5 points possible in Part II.

You will submit your answers online for this portion of the event. It is a good idea to write down your calculated values as you work through the Hydrogeology Challenge in case you need to refresh the page or have computer issues. You may not visit other web pages for any reason during this event.

IMPORTANT: Please review your work before submitting as YOU MAY ONLY SUBMIT YOUR ANSWERS ONCE.

Directions:

1. Using wells B, C, and E, complete the Hydrogeology Challenge scenario *RegionalTest2* in static (non-pumping) conditions. If you accidentally close the browser tab, the *RegionalTest2* scenario can be found again at <http://tinyurl.com/boyceville>.
2. Use the following format when submitting your answers:
Name: Your Team # and School, e.g. "C1 Central High School"
Location: Boyceville

Part II is graded using the pre-graded score online: move decimal score to left one place for points score and divide in half for total out of 5. (ex. A 75% score would be 7.5, divide by half = 3.75). Show math used to calculate score on this page of student's exam in red pen.

NO POINTS will be awarded in Part II if students: 1) run the incorrect scenario, 2) use wells other than the ones specified, 3) turn pumping on for one or more wells, OR 4) submit multiple attempts.

PART III: Contamination Risk and Remediation

Part III is worth 60% of your grade. There are 30 points possible in Part III.

THE SITUATION

The small community of RegionalTest2* recently discovered a petroleum leak at a local oil refinery. This leak caused petroleum byproducts to leach into the soil and contaminate the groundwater near well C. Residents are now looking to your team to determine which wells are at risk of contamination and what options the community has for remediation of their groundwater.

*The RegionalTest2 scenario can be found at <http://tinyurl.com/boyceville>.

THE FACTS

- Petroleum byproducts were found at well C
- All five of the wells are drilled residential wells
- Residents are currently pumping water from wells A and D
- Wells B, C, and E belong to vacant homes and are not currently pumping water

YOUR MISSION

Answer the following questions posed by RegionalTest2's residents and complete the Remediation Table at the resident's request. You may use The Hydrogeology Challenge to help you complete your work.

1. From well C, which direction is the contaminant plume traveling? Give your answer in degrees. (2 pts)

197 +/- 10°

2. Which two wells are most at risk of contamination other than the source well? Explain your reasoning. (2 pt)

Wells D and E. They are both at a lower elevation from Well C and the plume is travelling toward them. Well D will be contaminated first.

3. Approximately how long will it take for the petroleum by-product to travel from the source well to the furthest well in danger of being contaminated? (2 pts)
 - a. Less than two weeks
 - b. Two to four weeks
 - c. One to four months
 - d. Four or more months (650 ft away, plume is travelling at 3.86 ft/day)
4. Assuming the Hydrogeology Challenge's assumptions are correct, if residents begin pumping water at well B, which of the following would be true? (2 pts)
 - a. The velocity of groundwater would increase in the direction of well E
 - b. The direction of the flow would shift towards well B
 - c. Conductivity near well D would increase
 - d. Well A would become contaminated by the petroleum by-product

5. Assuming the Hydrogeology Challenge's assumptions are correct, use one to two sentences to explain how the direction and velocity of the contaminant plume would be affected if the residents stop pumping from well D and start pumping from well E. (2 pts)

If residents stopped pumping from well D and started pumping from well E, the velocity would almost double, going from 3.86 ft/day to 6.86 ft/day. The direction would significantly change, going from SW (197°) to SE (138°). Well E would be contaminated quicker than in the previous pumping conditions.

6. Assuming the Hydrogeology Challenge's assumptions are correct, what would happen to the velocity of the contaminant plume if well E were an industrial high capacity drilled well operating under pumping conditions at a higher rate of withdrawal than a standard residential well? (2 pts)

A high capacity well will have a larger cone of depression and could lower the water table more than a standard well. This would result in a lower the pumping condition elevation and would increase the velocity of the plume in that direction.

7. The remediation team has discovered that the petroleum by-product spilled is an LNAPL. Could pumping rate or well depth be manipulated to avoid contamination? Explain your answer. (3 pts)

Yes. An LNAPL is lighter than water and floats on top. Drilling deeper wells or reducing the pumping rate to reduce drawdown allows the oil to float on the water surface, safely above the well's intake area (Waller, R.M., 1994. Groundwater and the rural homeowner. U.S. Geological Survey, Denver, CO, 36 p.)

Part III is continued on the following page

PART III (continued)

REMEDICATION TABLE

Complete the missing information in the table below. Each row is worth 5 points (15 points total).

Remediation Technique	Definition (1pt)	In-situ, ex-situ, or both (1 pt)	Type (Biological, Physical, Chemical, Thermal, Containment only, or other) (1 pt)	Cost (low, medium, high) (1 pt)	Applicable to petroleum byproducts? (yes/no) (1 pt)
6. Incineration	The process of <u>burning hazardous materials at temperatures high enough to destroy contaminants.</u>	Ex Situ	Thermal	High	Yes
7. Phytoremediation	<u>Uses plants to clean up contaminated environments.</u>	In-Situ	Biological	Low	Yes
8. Activated Carbon Treatment	Activated carbon is used to filter harmful chemicals from contaminated water. <u>Contaminates sorb (stick) to the surface of the carbon granules and are removed from the water.</u>	Ex Situ	Physical	High	No