

**Science Olympiad  
Mentor Invitational  
Hydrogeology**

Team Number: \_\_\_\_\_

Raw Score: \_\_\_\_\_ Rank: \_\_\_\_\_

Name(s): \_\_\_\_\_

School Name: \_\_\_\_\_



**Point Totals**

	Possible	Total
Part 1: Groundwater Concepts and Vocabulary	30	
Part 2: The Hydrogeology Challenge – Static Conditions	10	
Part 3: Contamination Risk and Remediation	60	
Total		
1 <sup>st</sup> Tiebreaker: Highest score on part 3.	.5	
2 <sup>nd</sup> Tiebreaker: Highest score on pre-selected test questions-.01pt per question.	.01	
<b>TOTAL POINTS</b>		

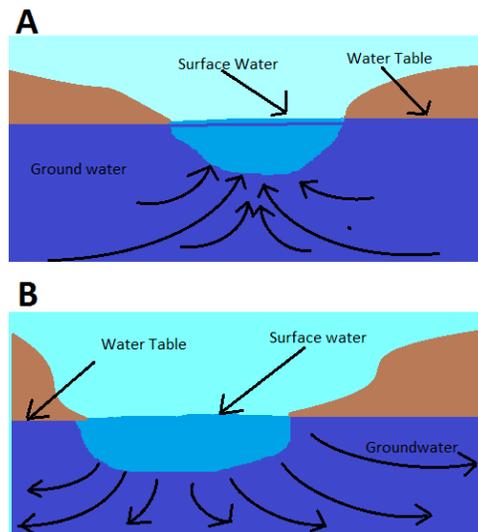
Hydrogeology: Water for the World

**Part 1: GROUNDWATER CONCEPTS AND VOCABULARY**

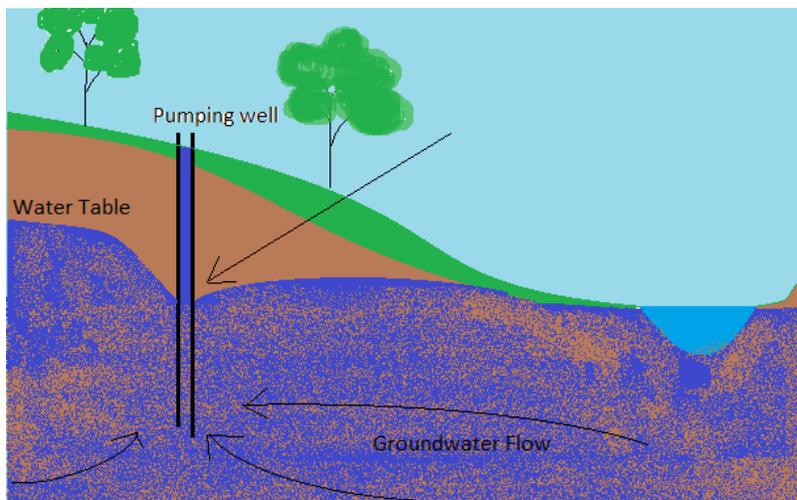
There are 30 points possible. Possible points are labeled next to each question.

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- 1) Choose the best definition for: Area of Influence (1 point)
  - a. An area in which productive wells are drilled.
  - b. A protected surface and subsurface zone surrounding a well or well field supplying a public water system to keep contaminants from reaching the well water
  - c. The land surface overlying the cone of depression
  - d. The zone around a well in a confined aquifer that is normally saturated but becomes unsaturated as a well is pumped
  
- 2) \_\_\_\_\_type soils have larger pore spaces and allow for greater infiltration and percolation than \_\_\_\_\_-type soils, which have more pore space and can hold more water. (1 point)
  - a. clay, sandy
  - b. sandy, clay
  - c. sandy, sandy
  - d. clay , clay
  
- 3) \_\_\_\_\_ is a measure of how well the spaces in soil or rock are connected. (1 point)
  - a. Flow
  - b. Permeability
  - c. Particulate Density
  - d. Volume
  
- 4) True or False: An aquifer cannot discharge water naturally. (1 point)
  
- 5) A is an example of a \_\_\_\_\_ stream; B is an example of a \_\_\_\_\_ stream. (2 points)



- 6) Overwithdrawal can have serious negative impacts including (2 points)
- Subsidence
  - Loss of inputs to surface water causing loss of habitat
  - Drying up another well in the area
  - All of the above
- 7) Plants called \_\_\_\_\_ extend their roots down into the saturated zone and pump water out at drastic rates. \_\_\_\_\_, which are shallow rooted plants that live in desert areas and require little water, and \_\_\_\_\_ which are aquatic plants that live directly in water. (2 points)
- xerophytes, phreatophytes, hydrophytes
  - phreatophytes, hydrophytes, xerophytes,
  - phreatophytes, xerophytes, hydrophytes
  - None of the above
- 8) In one or two sentences describe a confining layer. (2 points)
- 9) During transpiration plants take up water for their own use (i.e., for building plant tissue), but \_\_\_\_\_ of what they suck up gets used; the rest is released to the atmosphere through leaves. (1 point)
- <10%
  - 50%
  - 75%
  - >90%
- 10) The area around a pumping well indicated by the arrow is known as the \_\_\_\_\_ . (1 points)



- 11) The loss of water from groundwater aquifers at a rate equal to that of recharge is known as:  
(1 point)
- Safe Yield
  - Depletion
  - Drawdown
  - Water use
- 12) Good aquifers are usually developed in \_\_\_\_\_. (1 point)
- peat bogs
  - sands, gravels, solutionally-weathered limestones and fractured sandstones
  - clays, shales and metamorphic rocks.
  - All of the above
- 13) DNAPL (1 point)
- dense, non-acidic phase liquids
  - direct, nitrate, phase liquids
  - dense, nitrate, phase liquids
  - dense, non-aqueous phase liquids
- 14) LNAPL (1 point)
- light non-acidic phase liquids
  - low, non-nitrate phase liquids
  - light, non-aqueous phase liquids
  - low, nitrate phase liquids
- 15) Henri Darcy, a French hydraulic engineer, concluded that the rate of flow of a fluid through a porous media is directly proportional to the \_\_\_\_\_ and \_\_\_\_\_ proportional to the length of the path of flow. (1 point)
- energy loss, inversely
  - energy gain, inversely
  - elevation, directly
  - elevation, inversely
- 16) \_\_\_\_\_ is used widely to describe the distinctive landforms that develop on rock types such as limestones, gypsum and halite that are readily dissolved by water. (1 point)
- Darcy
  - minerals
  - deposits
  - Karst
- 17) Porosity available for fluid flow. (2 points)
- Secondary
  - Effective
  - Primary
  - None of the above

- 18) A rock bed has large pore spaces. Describe its capillary action (1 point)
- Capillary action is weak
  - Capillary action is strong
  - Capillary action is negative
  - Capillary action is not a thing
- 19) Permeable Reactive Barriers Techniques are considered: (1 point)
- Low Maintenance
  - Passive
  - In-Situ
  - Cost Effective
  - b, c and d
  - a, b and c
  - a, b, c and d
- 20) Groundwater flow map is also known as: (1 point)
- Isopach map.
  - Isocontour map.
  - Potentiometric map.
  - Flydraulic map.
- 21) Apparatus for determining the hydraulic conductivity of saturated porous material using Darcy's Law. (1 point)
- permeameter
  - vacuum gauge
  - hydro level
  - protimeter
- 22) The High Plains Aquifer consists mainly of near-surface deposits of late Tertiary or Quaternary age forming one \_\_\_\_\_ aquifer and underlies 450 660 km<sup>2</sup> in parts of eight States within the Great Plains physiographic province. (1 point)
- Confined
  - Perched
  - Unconfined
  - None of the above
- 23) An aquifer is \_\_\_\_\_. (1 point)
- an underground volume of rock and sand that contains water
  - a reservoir of water occurring in underground caves and caverns
  - not a significant source of drinking water
  - composed of water, soil, the void space within the soil, and subsurface material
  - a and d
  - a, b and d

24) Secondary Porosity: Which item is not true (1 point)

- a. generally greater storage but less flow
- b. void space that forms post-diagenesis
- c. fractures, dissolution features
- d. generally less storage, but more flow

25) A well that is designed and installed for the sole purpose of measuring water levels in an aquifer is called a \_\_\_\_\_. (1 point)

- a. piezometer
- b. head well
- c. hydraulic well
- d. monitoring well
- e. a and c
- f. a and d

**Part 2: THE HYDROGEOLOGY CHALLENGE – STATIC CONDITIONS**

Please 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 just in case you need to refresh the page or have computer issues.**

This section is worth a total of 10 points

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**Directions:**

1. Complete the Deuel Regional Scenario in static (non-pumping) conditions **using wells A, C, D**. The Scenario can be found at URL:

<http://groundwater.beehere.net/#test/a0ea73ff-f612-4b84-b00a-655f4e076e71>

2. When submitting your answers:

Name: [Team Name or Number]

Location: **To Be Determined by the Event Proctor**

**Part 3: CONTAMINATION RISK AND REMEDIATION**

There are 60 points possible.

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The Situation:

After finding petroleum byproducts in well C, an investigation into the source uncovered a leak in a crude oil pipeline northeast of well C. The owners of the well want to know what options they have for cleaning up their water source. The surrounding community has become concerned with potential contamination of their wells as well. You are tasked with determining strategies for remediation and potential risks within the area.

The Facts:

Well C has found contamination of petroleum byproducts

Wells A, C, D and E are currently pumping water

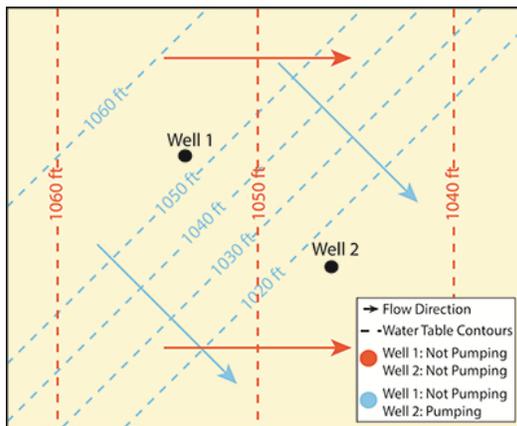
Your mission:

Answer the questions that the community wants you to address and complete the remediation table. You may use the Hydrogeology Challenge to help you complete your work.

- 1) From well C which direction is the contaminant plume most likely moving? (North, Southeast, West, etc.) (4 points)
  
- 2) If the assumptions of the Hydrogeology Challenge are correct, which wells are at risk of contamination from the leak (other than Well C)? (4 points)
  
- 3) Under current conditions, approximately how long will it take the contaminant to reach well D? (4 point)
  - a. 1 week
  - b. 1 year
  - c. 8 years
  - d. 28 years

4) Assuming the Hydrogeology challenge assumptions are correct will the rate of travel of the contaminant slow down if wells E and D discontinue pumping, why? Will it eliminate all risk of contamination, why? (6 points)

5) The picture below depict the change in groundwater flow direction when Well 2 begins pumping. Is this representation accurate to what occurs in real life? If not please redraw the picture to more accurately represent the effects of pumping on groundwater flow direction. (4 points)



<b>Remediation Technique (4 points)</b>	<b>Definition (4 points)</b>	<b>In-situ or Ex-situ (2 points)</b>	<b>Type (Biological, Physical, Chemical, Thermal, Containment only or Other) (2 points)</b>	<b>Cost (low, medium, high) (2 points)</b>	<b>Applicable to petroleum byproducts? (yes, no) (2 points)</b>
Phytoremediation	6)	In-situ	7)	8)	9)
Air Stripping	10)	11)	12)	13)	14)
Bioremediation	15)	16)	17)	High Ex-situ Low In-situ	Yes
18)	Relies on natural process to decrease concentrations of contaminants in soil and groundwater	In-situ	19)	Low	20)