

**Reading Guide for
Chapter 16: Groundwater and Chapter 15: Streams and Floods**

When precipitation falls on the Earth, how does it get to the ocean? In our last chapter we learned about the importance of ice in the Earth's water budget. In these two chapters we will learn about how water moves toward the ocean and shapes the land. An understanding of these processes is critical to understand some of the important environment issues in western Washington.

Groundwater Recharge and Flow (p.502)

Movement and Distribution of Groundwater: (p. 503)

As water soaks into the ground, it flows almost vertically through the zone of _____. At some point all of the spaces between the grains or along fractures will be filled with water, this is the zone of _____. The upper surface of this zone is called the _____.

Later in the chapter, the author defines aquifer, but to understand the importance of the next terms, we need to understand aquifer. An aquifer is a zone within the earth which transports and stores water (also it is implied is that there is enough water to make it worth our while to drill to it).

For an aquifer to be success it must have porosity. Why?

For an aquifer to be successful it must also have permeability. Why?

The terms permeability and hydraulic conductivity are not the same, but they refer to aspects of the same property, so you may use either permeability or hydraulic conductivity.

► The _____ is the elevation difference between two points on the water table. Water tends to flow _____ (faster, slower) when this gradient is higher.

Tapping the Groundwater Reservoir (p. 505)

The water table normally follows the landscape, although its highs and lows are _____ pronounced that those of the landscape. The depth of the water table is due to the balance between _____ and _____.

The diagrams in this chapter show the water in blue. Remember that the water is contained in sand, gravel, and rocks layers, not in open cavities. The diagrams in this chapter ignore the layers and tend to show only the water.

► A local impermeable layer, such as clay or impermeable rock, may create a local water table that is higher in elevation by trapping the water above the impermeable layer. This is called a _____ water table. What is necessary for a “confined” aquifer?

You should be familiar with the properties of an aquifer, but I will not ask you about artesian aquifers.

Natural Springs and Geysers (p. 508)

I suggest that you read this section, but I will not test you over the material directly. I enjoy visiting Yellowstone National Park, so I find the geysers, hot springs, and fumaroles an interesting topic, but you will not be tested over this material.

Finding and Managing Groundwater (p. 512)

Locating Groundwater (p. 512)

You should read this section, but I will not test you on this information.

Threats to the Groundwater Supply (p. 513)

When groundwater is withdrawn from a well, the water table around the well is drawn down into what is called a _____. What is groundwater mining?

Some of the environmental issues contained in this section are important, such as ground water mining and salt-water intrusion are important. The salt-water intrusion is especially important in this area-- please read this part.

From page 518 to the end of the chapter—I encourage you to read this material, but you will not be tested of this information.

Chapter 15: Streams and Floods (p. 467)

The concept of the hydrologic cycle is important, but I will not ask you to draw it. Make sure you understand the overall idea and the various paths water takes.

Streams (p. 467)

Stream Flow and Discharge (p. 467)

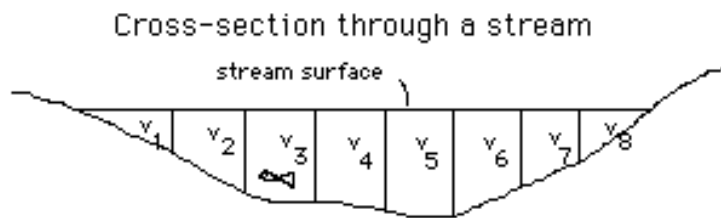
The speed or velocity of a stream is determined by several factors. The steepness or _____ of the stream channel is one factor that determines the speed of the water; the steeper the slope, the faster

the stream. This seems very straight forward, but it turns out that friction slows the water and this makes it more complicated and interesting.

The following influences the friction between the water and the channel:

- 1) if there are large rocks in the channel the water is very turbulent, but the more turbulent the water the more friction there will be and the slower the water will go.
- 2) a channel that is wide and flat will have more friction than a more U-shaped channel. So channel shape is another factor.
- 3) the amount of water in the channel will also determine the amount of friction. As the water level is increased (to bankfull) the amount of added friction is less than the volume of water added, so the water goes faster. So, rivers with lots of water in the channel will flow faster than the same river with less water.

The discharge of a stream is the amount of water (usually measured in cubic feet) in the stream passing a point over time (usually measured in seconds). The field measurement of the discharge of a stream is measured by first dividing the stream into a series of cells



The width, depth and average velocity of each cell is measured. The discharge for each cell is calculated by multiplying the width and depth of each cell times the average cell velocity. The sum of all the cell discharges is the stream discharge.

A web site that may be helpful in learning about calculating stream discharges is given below. I recommend that you visit this site if possible.

<http://www.sciencecourseware.com/VirtualRiver/Files/page10a.html>

Imagine the data below are from the stream illustrate above:

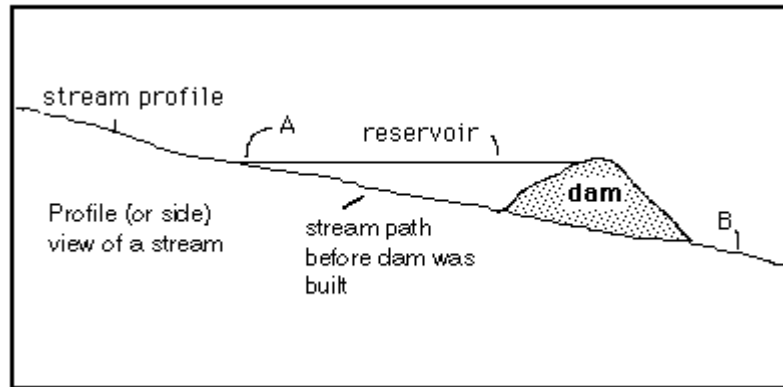
Cell number	Cell width (ft)	Cell depth (ft)	Average velocity of the water in the cell (ft/sec)	
1	2	1.4	2	
2	2	1.5	2.2	
3	2	1.8	2.5	
4	2	2.0	2.8	
5	2	2.4	3.1	
6	2	1.9	2.7	
7	2	1.5	2.2	
8	2	1.2	1.8	

What is the discharge of this stream? Show your work.

The Geological Work of Streams (p. 469)

The lowest elevation to which a stream can erode is the stream's _____ . When a stream enters the ocean, its velocity and ability erode drops to almost zero.

The same principle applies to a stream entering a reservoir. See the cross-section illustration to the right. In this illustration, a stream enters a reservoir at point A and leaves the dam at point B. The reservoir forms a local base level and the velocity of the stream goes to almost zero as it enters the reservoir.



Graded Streams (p. 469)

The concept of a graded stream is helpful because we can use it to anticipate how a stream will react to a change. You will not be asked to define a graded stream, but need to understand the idea and how a stream would react if, for instance, a landslide dumped sediment into the stream or if regional uplift causes the gradient of the stream to increase.

If the coarse sediment in a stream channel settles in the channel, this is termed _____, while if a stream scours its channel eroding more sediment, this is termed _____.

Processes of Stream Erosion (p. 471)

► If we trace the drainage patterns created by streams we can use that information to determine some information about the underlying geology. The most common drainage pattern is a _____ or tree-like pattern that develops on rocks that erode more or less uniformly. _____ drainage patterns are primarily due to a high topographic point that causes the water to flow in all directions away from the high point.

► Trellis and rectangular drainage patterns develop in part because hard rocks (granites, sandstones and in some climates, limestones) will erode slower than weak rocks, such as shales and other highly fractured rocks. _____ drainage pattern is found in rocks that have been folded, while rectangular is more common in fractured rocks such as granites or where a stream crosses a fault, such as the San Andreas fault in California.

That type of drainage pattern is illustrated in the photo to the right?



Defend your answer.

What does this pattern tell us about the underlying geology of this region?

The Columbia River is an antecedent river where it crosses the Cascades between Washington and Oregon. What does that mean?

I will not expect that you will be able to determine whether a river is superposed or antecedent. These concepts of superposed and antecedent streams are important because they are the primary reason that canyons are formed, however I will not test you on the differences.

A stream that has a series of converging and diverging channels separated by narrow sand and gravel bars, is termed a _____ stream. You should be familiar with the conditions that tend to form this type of stream pattern.

The stable form of a stream is a meandering form. Your text makes you think that only in meandering streams does the water flow faster on the outside of the channel, but this is also true of braided streams as well.

If over time a looping meander is cut-off during a period of higher flow, a small crescent-shaped lake is formed, called an _____.

As a result of changes in the discharge or sediment load of a stream a floodplain may be stranded at a higher elevation as the stream degrades. This old floodplain is called a _____.

Stream Transport (p. 477)

What are the three types of sediment load in a stream?

► If the water in a stream stops moving (in something like a lake or the ocean) which of these types will be deposited due to the drop in velocity of the water?

Stream Deposition (p. 481)

The sediment deposited by a stream is termed _____.

If these sediments are deposited in a fan shape at the base of a slope, we termed this an _____.

A _____ is formed when sediment is deposited when a stream enters a standing body of water.

Controlling Floods (p. 485)

Flood Prediction (p. 488)

► A graph that relates the discharge of a stream to time is called a hydrograph. Study the three hydrographs on (Figure 15.29 on page 488) and the types of land-use for each hydrograph. What is the effect to the discharge of a stream of increasing the amount of impervious cover on the land?

What does a 100-year flood mean?

Stream Evolution and Plate Tectonics and Extraterrestrial Stream Activity: Evidence from Mars (p. 496)

Read these sections if you have time, but you will not be tested over this information.