Name ______________________________

Rivers and Streams

Of all the processes operating at the earth's surface, running water in the form of rivers and streams may have the greatest impact on what we do and how we live. Virtually all cities with populations exceeding 150,000 people are located near rivers. In the western United States, we depend on rivers as a source of drinking water, irrigation, to supply us with hydroelectric power, and as a means of transportation. Fertile farmland in northern California is located along or near the Sacramento River.

Part 1: STREAM MEASUREMENT

The most important property of a stream is its **discharge** – that is, how much water does it carry and how quickly does it carry it? The discharge of a river or stream is the *volume of water that passes a point over a specific period of time*. Discharge is generally reported in cubic feet per second or cubic meters per second. The amount of water that a stream discharges can be determined from the size of the stream and the velocity of the water moving through it. In equation form:

$$Q = W * D * V$$

where: Q = discharge
W = width of stream
D = depth of stream
V = velocity of stream

1. In groups assigned by your instructor, measure the width and depth of Big Chico Creek and record your measurements in the Table 1 of your homework (pg 85).
2. Sketch the cross-sectional profile of Big Chico Creek below. Include the approximate location of each bank, each location where depth was measured, and the location of the bridge.

Stream width and depth

3. What is the width of the creek along this cross-section?

4. Do you think the creek has a constant width upstream and downstream? How could you make the width measurement more accurate if you noticed that the width of the channel varied significantly upstream and downstream?

5. Is the depth of the creek constant along the cross-section? In order to calculate discharge, we need a single, representative depth, so we use the average. Calculate the average depth along this stream profile.

Stream Velocity

6. There are a number of ways to measure the velocity of a stream, some of which require rather sophisticated equipment. We took velocity measurements at the beginning of the semester by timing how long it took a stick to travel a 50-ft distance.

6a. Average time (***from week 1)*****:** 50 feet in _______ seconds → average velocity: ____________ ______

The stream's energy may have changed since that time, so, we will compare measurements from week 1 to this week in Table 1 (from Homework pg 102). Enter today's measured values in the blanks below.

Distance (ft)	**Today's Measurements: Time (s)**	**Velocity (ft/s)**
50		
50		
50		
50		
50		

6b. Now calculate the **average** stream velocity, in ft/sec: ________________________ ft/s show work below (record this on Table 1 of the homework in the column titled "This Week's data").

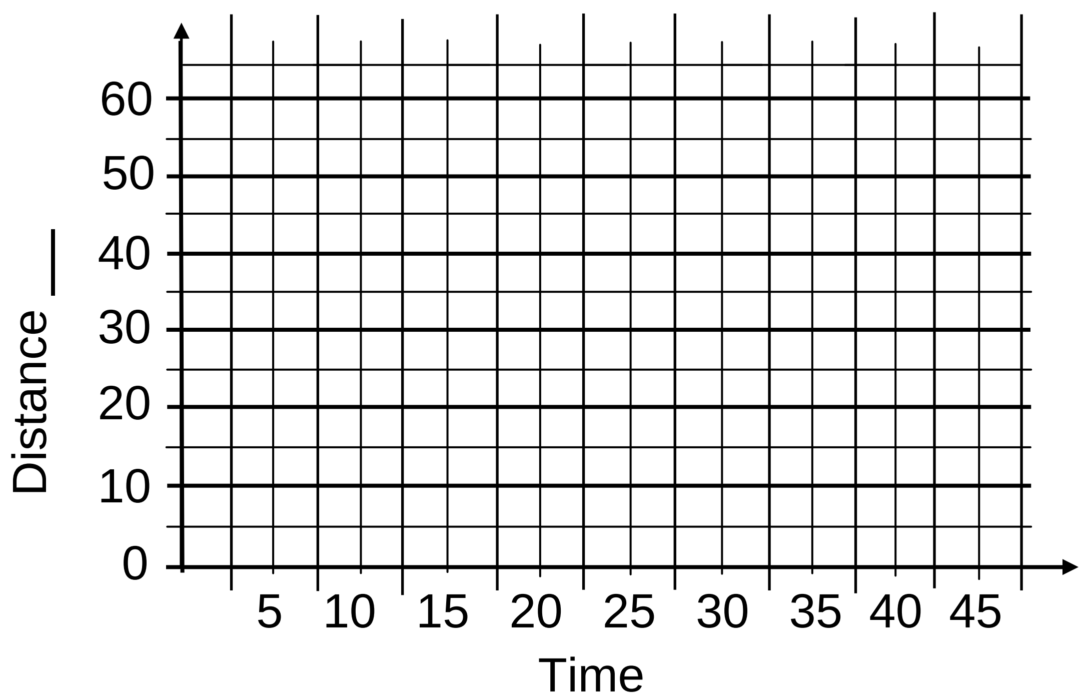
6c. You now have measurements for width, depth, and velocity of Big Chico Creek to calculate the discharge. Show all work *with units*. Check your work to make sure your answer has the right units (ft^3/s). *Also* record this value in the Table 1.

Discharge: ______________

To plot the velocities of Big Chico Creek that we measured this semester, plot a line on the grid below from the origin (0,0) to the point on the graph that represents the intersection of the time and distance measured for Big Chico Creek. This line represents the velocity of Big Chico Creek.

7a. Plot the velocity of the creek measured during the Campus Walk lab (week 1) with a ***dashed line*** and label this with the month the data was collected.
7b. Plot the velocity of the creek measured during the Bidwell Park fieldtrip using a ***solid line*** and label this with the month the data was collected.
7c. Plot the velocity of the creek measured during the Rivers & Streams Lab (today) using a ***heavy solid line*** and label this with the month the data was collected.

Be sure to *fill in the units for each axis of the graph*. As a class, you will decide the unit divisions for each axis, be sure to label these on your graph.



8. Compare the slope of each line. Which is steepest? Which has the lowest slope? What does the steepness of the slope tell you about the stream conditions at the time the data was collected? Explain how your graph shows the relationship between the time of year and the stream conditions.

Part 2: STREAM GRADIENTS
Use the ***Chico, CA Quadrangle*** to answer the following questions:

9. Determine the gradient (in ft/mile) of Little Chico Creek between the following two locations:
   - where the 325-foot contour line crosses the creek (the first index contour to cross the creek near the east edge of the map);
   - where the 275 foot contour crosses the creek just to the left of the red numeral 29.

Show all your work including the numbers you used for your calculations; carry through all units.

Gradient of Little Chico Creek: __________ft/mile

10. In the "Campus Walk" lab, you determined that the gradient (in ft/mile) of Big Chico Creek is approximately 20.8 ft/mi between the following two locations:
   - where the 225-foot contour line crosses the creek (i.e. where the creek takes a major bend a few inches from the northern edge of the map, below the word "Vallombrosa").
   - where the 200 foot contour line crosses the creek about an inch west of the word *"Big"* of *"Big Chico Creek"* (for those familiar with Bidwell Park, this location is just east of 1-mile recreation area (not marked on the map).

Give the value of this gradient from your work in the Campus Walk lab: ______________________ (include units). If you do not have the information from the Campus Walk lab, calculate the gradient below:

11. Now compare the relative gradient of streams in the valley (Big Chico Creek) with major streams in the foothills (Little Chico Creek). Describe any pattern that emerges from the gradients of the two streams knowing one is in the valley (Big Chico Creek) and the other is in the foothills (Little Chico Creek).

Part 3: STREAM EROSION AND DEPOSITION

From the homework, it is obvious that Big Chico Creek carries an incredible amount of dissolved solids from the mountains to the ocean. But it carries an even greater quantity of weathered rock particles including mud, sand, and gravel. Your next task is to analyze the sizes of particles than can be transported and eroded by Big Chico Creek today. We will do this using the Hjulstrom diagram shown below.

12. First, convert the velocity of Big Chico Creek that you determined today from ft/sec to cm/sec. (Hint, you will need to convert feet → cm and you know that 2.54 cm = 1 in)

_______________________________ cm/s

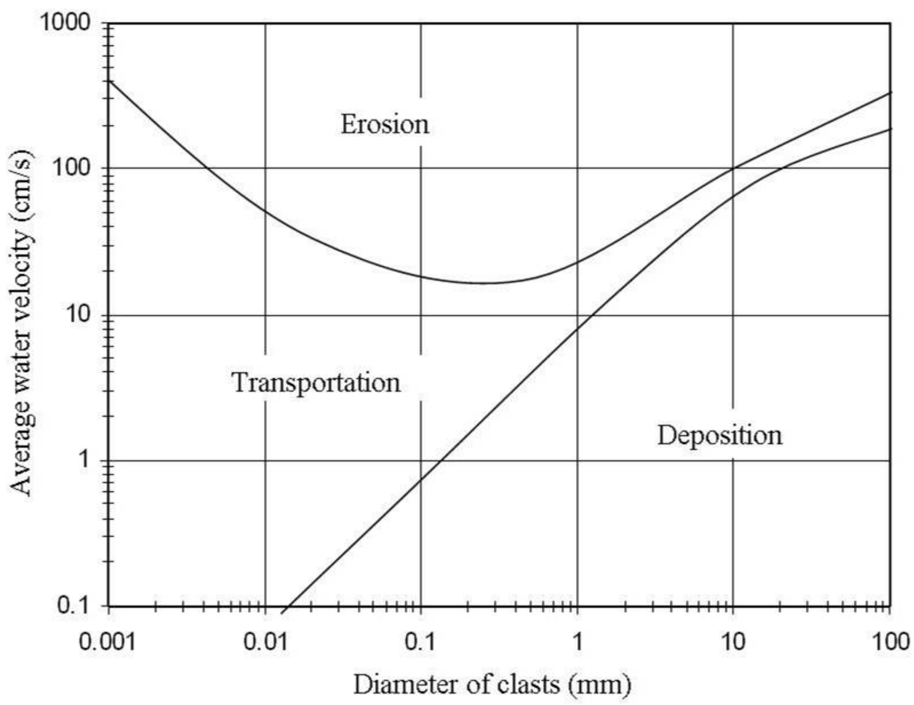
13. Using this velocity and the **Hjulstrom diagram** below, determine the transportation and erosion capabilities of Big Chico Creek today.

a. Largest size particle that could be eroded by Big Chico Creek today:

________________ mm

b. Largest size particle that could be transported by Big Chico Creek today:

_________________mm



Note that this diagram is plotted with a log scale.

The winter of 2005-2006 was a very wet one for Chico; rainfall was approximately twice normal. In the spring of 2006, the creek flooded the amphitheater, submerging several rows of seats; the stage on the opposite side of the creek was under several feet of water. Tremendous amounts of sediment were carried downstream; even a few tree trunks floated by. After the water receded, the amphitheater was full of sediment. Consider what this would have done to the size and volume of sediment carried by Big Chico Creek at that time.

A sample of sediment, collected from the creek recently, is displayed at the front of the room.

14. Examine the sediment with a hand lens. Using the ruler provided, measure the largest particle you can find (ignore any pieces of wood or other organic matter).

_____________________________ mm

15. Using this number and the Hjulstrom diagram, estimate the minimum velocity of water needed to transport particles this large.

______________________________________ cm/s

16. What was the velocity of the water when these sediment particles were deposited?

______________________________________ cm/s

17. Explain how you arrived at your answers.

18. These particles must have been eroded from a creek bank upstream. Estimate the minimum velocity of water needed to erode particles this large.

______________________________________ cm/s

19. On the day that the amphitheater was flooded, the maximum velocity of the creek was 240 cm/sec, measured on the surface midway between its banks. What was the maximum size of particle that could have been carried at that velocity?

______________________________________ mm

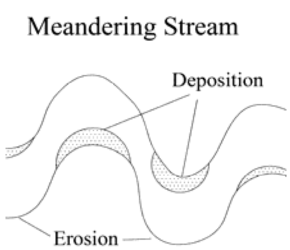
20. Why are there no particles this large in the sediment collected from the Bidwell Amphitheater? Hint: think about the velocity of the water in different parts of the stream (center vs. outside; upper surface vs. bottom, etc.)

Part 4: FLUVIAL LANDFORMS

The **deposition** of sediment produces bars, levees, floodplains, deltas and alluvial fans. The physical sedimentary structures recorded in these deposits are so consistent that, by studying modern analogues, sedimentary geologists can recognize ancient river systems in rocks millions of years old.

Meandering Rivers

Rivers flowing over a gently inclined gradient commonly develop a meandering pattern and deposit part of their sediment load to form point bars, natural levees, and backswamp deposits. Look at the **Ord Ferry, CA** quadrangle. It shows classic meanders that have developed along the Sacramento River. Note the deposition of point bars on the insides of the curves.



21. If sediment is being deposited on the inside of the bends, where do you suppose erosion is taking place?

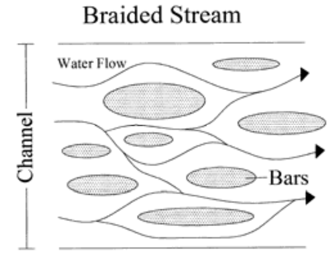
22. Calculate the gradient of the Sacramento River from this map from the north edge to the south edge of the map.

Meandering streams have a habit of becoming progressively sinuous (curvy) and then suddenly cutting off their own meanders. The resulting feature is called an **oxbow lake**.

23. Give the name of two of the oxbow lakes depicted on this map.

Braided Rivers

Braided rivers are characterized by the division of a single trunk channel into a network of anastomosing branches and the growth and stabilization of intervening islands. For rivers to become braided generally requires that the channel have erodible banks, an abundant sediment supply, and rapid and frequent fluctuations in discharge. On the **Ennis**, **MT** quadrangle, the Madison River is braided above Ennis Lake.



24. Describe three differences between the channel and floodplain of the Madison River compared to those of the Sacramento River.

25. Calculate the gradient of the Madison River from the south edge of the lake to the south edge of the map. Is it greater or less than that of the Sacramento River?

26. Briefly describe the relationships between the stream gradient and type of river of the Madison and Sacramento Rivers.