Geology 101 Name(s):

Lab 9: Streams and floods

Geomorphology is the study of the way in which the environment is continually reshaping the Puget Sound (and the world's) landscape. Running water is a major shaper of the land. Water on land is divided into two components: **groundwater**, which is underground (and we will study at a later date) and **surface water**, which includes rivers and lakes.

Running surface water in rivers and streams can be a **depositional** or **erosional** force (sometimes both simultaneously). The grain size terms you will use in this lab are: **clay, silt, sand, gravel** (which is both pebble and cobble) and **boulder**.

The slope of a streambed is important in determining the stream's speed (velocity). **Slope gradients** can be expressed in two ways: **degrees off of horizontal** and **percent grades**. The former is used typically in research science, and the latter is used primarily by civil and environmental engineers. They are calculated in different ways:

$$gradient\,(\mathrm{deg}rees) = \tan^{-1}\left(\frac{elevation\,gain}{lateral\,dis\tan ce}\right)$$

$$gradient\,(percent) = \frac{elevation\,gain}{lateral\,dis\tan ce}\times 100\%$$

Note that, for any given slope, you will get two different gradients depending on which equation you use, but that the two values ought to represent the same thing! Also, note that while both slope gradients will be zero for a level surface, the maximum slope is 90° in one case and an infinite percent slope in the other. Think about what a 100% slope's degree equivalent would be.

Information about King County rivers can be found at http://www-old.golder.com/ekcrwa/Aquifer/Hydrogeology.asp

The Mount Rainier National Park quadrangle (1955)

Find the White River, as it emerges from Emmons Glacier, high on the north-east flank of Mt. Rainier, and heads off toward the northeast corner of the map.

1. a. Obviously, is the White River, as shown on the map, closer to its **headwaters** or to its **delta**?

b. Would the White River be considered more of a **braided** river or a **meandering** river?

Remember the correlation between parts a and b.

2. a. Notice that there are multiple **channels** (blue lines) within the riverbed area. Notice also that there is a brown dotted pattern in this area. Does this area experience a high rate of **erosion** or a low rate of erosion?

b. From your experience of streams high up in the mountains, would the material at the bottom of this riverbed be coarse (boulder, cobble and sand) or fine (silt and clay)?

3. To calculate the **stream gradient** (in percent) of the White River, cut off a piece of string that represents 10,000 feet (use the scale at the bottom of the map). Lay it carefully along the path of the White River, starting at any point where the river crosses one of the brown **contour lines**.

a. Count how many contour lines the string crosses, then use the **contour interval** given on the map to calculate the **elevation change** from the front of the string to the back of the string.

b. Use the gradient (percent) formula given at the beginning of this handout to calculate the gradient in percent of the White River here.

The Vicksburg, MS, quadrangle (1964)

4. a. Is the Mississippi River in this quadrangle closer to its **headwaters** or to its **delta**? How can you tell? Hint: is the river meandering or braided here?

b. How often, roughly, do the channels of the Mississippi seem to change? Hint: look for pairs of red dotted "Meander lines" and along the river itself for "Cutoffs", both of which are dated. Is this more or less often than you would expect the White River channels to change?

c. From your experience of rivers of this type, would the material at the bottom of this riverbed be coarse (boulder, cobble and sand) or fine (silt and clay)?

d. Without doing any heavy calculations, what is the approximate percent stream gradient of the Mississippi River here? Hint: note how many contour lines it seems to cross.

5. a. Even in this part of the river, the processes of erosion and deposition continue. What feature in the Vicksburg area of the map shows that **erosion** by the river is an active force here (think back to your US history: the capture of Vicksburg by Union forces in 1863 — was this an easy battle or a difficult one? What made the battle harder for Union forces?)?

b. If the side of the river where Vicksburg lies is erosional, name the corresponding area (on the map) that is **depositional** in nature.

c. What **two** different structures have humans done to try and **channelize** the Mississippi River here? Have they been successful (before you answer look at a black dotted line structure on the former Kents Island in the southwestern corner of the map)?

d. What are features such as Thompson Lake and Goose Lake in the northern part of the map? They're called **oxbow lakes**, but what are they really?

6. Summary — Connect two lines through each column of terms

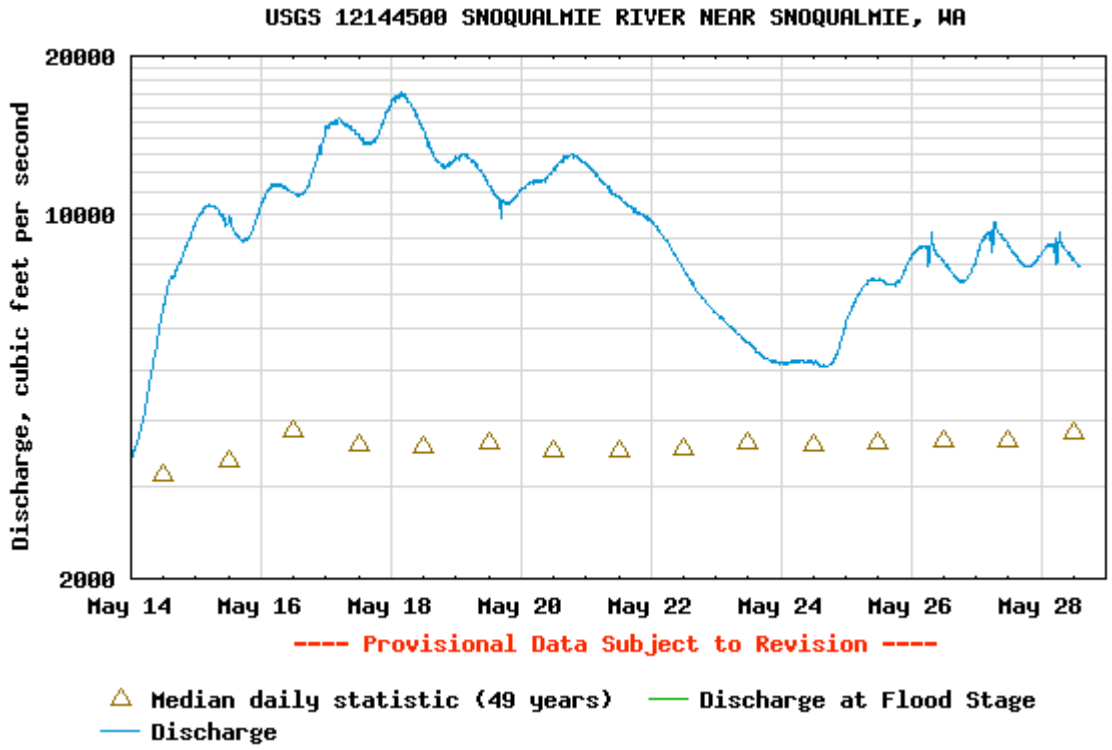
High stream gradient	Mostly depositional	Coarse riverbed grains	Slow stream
Low stream gradient	Mostly erosional	Fine riverbed grains	Fast stream

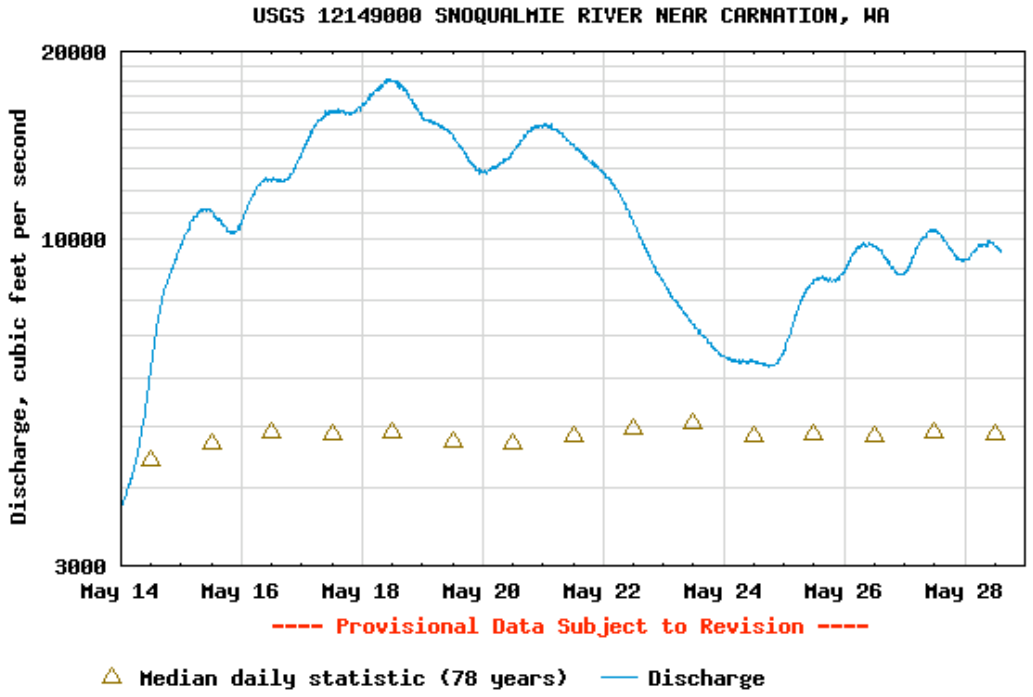
Floods

Floods occur when the stream flow exceeds the banks of the stream. Fortunately, there are many good Internet resources concerning local rivers such as http://dnr.metrokc.gov/topics/flooding/FLDtopic.htm for King County. For this part of the lab, go to the website: http://wa.water.usgs.gov/data/realtime/rt_latest_map.html, then click on the Snoqualmie drainage. You should see a map of the drainage. Scroll down and find the "Snoqualmie River near Snoqualmie" entry and click on the "graph" link. On the next screen, scroll down to the "Available Parameters" menu. Change the "Days" parameter to 14 days and click "go". When the page reloads, scroll past this window to the "Discharge, cubic feet per second" graph.

Open **another** window and go to the same King County map, but this time click on the "graph" link of the Snoqualmie River near Carnation. Set the Days parameter to 14 days. Scroll down to the "Discharge, cubic feet per second" graph and line up the graphs on both windows so the dates line up vertically.

These are what the graphs should look like:





7. Though you may not know the geography of this area at all, which town is further **downstream**, Snoqualmie or Carnation? *Just* from the flood graphs, how can you tell this?

8. From the flood graphs, were these floods due to snowmelt or to a rainstorm? Again, just from the graphs, how can you tell?

9. a. On the next page are some detailed data from the two stream gage sites. The gage height is measured in feet and the discharge is measured in cubic feet per second (cfs). Find the peak discharge (the greatest number of cfs) for both the Snoqualmie gage and the Carnation gage. Write down the date and time for each below.

b. What is the difference in time between the crest of the flood (peak discharge) passing at Snoqualmie and then at Carnation (in hours)?

10. a. The distance between Snoqualmie and Carnation is 9.2 miles along the river. What is the speed of the flood crest in miles per hour?

b. Go to the streamflow measurements page of the Snoqualmie gage site at http://waterdata.usgs.gov/nwis/measurements/?site_no=12144500. Find a stream flow (ft^3/s = cfs) discharge that is similar to the peak flow on May 18. How **fast** was the river (in ft/s) on average at that time? Convert this number to miles per hour by multiplying the feet per second number by 0.68.

c. How does the flood crest speed (in a) compare to the river water speed (in b)? Why would there be a difference between the two?

11. Examine the data on the next page again, and find the maximum gage height for the Snoqualmie River at Carnation on May 18.

a. Fill in the table below:

Snoqualmie station	Flood stage	Maximum discharge of May 18, 2008
Gage height (feet)	54.0	
Discharge (cubic feet per second)	22,000	

b. Fill in the blanks: By rising a mere _____ feet, the Middle Fork Snoqualmie River would have reached flood stage on May 18. In doing so, it would have

increased its discharge by _____ percent. I now have much respect for the river, and its floods.

date/time	Snoqualmie gage height	discharge	Carnation gage height	discharge
5/17/08 0:00	11.92	14600	51.68	13700
5/17/08 0:15	11.90	14600	51.74	13800
5/17/08 0:30	11.93	14700	51.78	13900
5/17/08 0:45	11.90	14600	51.81	14000
5/17/08 1:00	11.96	14800	51.86	14100
5/17/08 1:15	11.91	14600	51.84	14000
5/17/08 1:30	12.01	14900	51.90	14200
5/17/08 1:45	12.01	14900	51.92	14200
5/17/08 2:00	12.04	15000	51.96	14300
5/17/08 2:15	12.00	14900	51.98	14400
5/17/08 2:30	12.03	15000	51.98	14400
5/17/08 2:45	11.98	14800	52.07	14600
5/17/08 3:00	12.04	15000	52.08	14600
5/17/08 3:15	12.04	15000	52.07	14600
5/17/08 3:30	12.02	14900	52.12	14700
5/17/08 3:45	12.06	15100	52.21	14900
5/17/08 4:00	12.05	15000	52.17	14800
5/17/08 4:15	12.02	14900	52.18	14900
5/17/08 4:30	12.05	15000	52.24	15000
5/17/08 4:45	12.09	15200	52.28	15100
5/17/08 5:00	12.09	15200	52.31	15200
5/17/08 5:15	12.07	15100	52.30	15200
5/17/08 5:30	12.03	15000	52.33	15300
5/17/08 5:45	12.04	15000	52.34	15300
5/17/08 6:00	12.02	14900	52.38	15400
5/17/08 6:15	12.02	14900	52.39	15400
5/17/08 6:30	12.05	15000	52.41	15500
5/17/08 6:45	11.97	14800	52.44	15500
5/17/08 7:00	12.01	14900	52.46	15600
5/17/08 7:15	11.95	14700	52.45	15600
5/17/08 7:30	11.99	14900	52.49	15700
5/17/08 7:45	11.94	14700	52.47	15600
5/17/08 8:00	11.93	14700	52.46	15600
5/17/08 8:15	11.91	14600	52.52	15700
5/17/08 8:30	11.95	14700	52.54	15800
5/17/08 8:45	11.93	14700	52.53	15800
5/17/08 9:00	11.84	14400	52.54	15800
5/17/08 9:15	11.94	14700	52.60	15900
5/17/08 9:30	11.86	14500	52.66	16100
5/17/08 9:45	11.87	14500	52.59	15900
5/17/08 10:00	11.83	14400	52.59	15900
5/17/08 10:15	11.83	14400	52.60	15900
5/17/08 10:30	11.86	14500	52.63	16000
5/17/08 10:45	11.80	14300	52.60	15900
5/17/08 11:00	11.79	14200	52.67	16100
5/17/08 11:15	11.79	14200	52.66	16100
5/17/08 11:30	11.77	14200	52.64	16000

5/17/08 11:45	11.76	14200	52.65	16100
5/17/08 12:00	11.77	14200	52.65	16100
5/17/08 12:15	11.73	14100	52.64	16000
5/17/08 12:30	11.71	14000	52.65	16100
5/17/08 12:45	11.69	14000	52.64	16000
5/17/08 13:00	11.65	13800	52.66	16100
5/17/08 13:15	11.66	13900	52.66	16100
5/17/08 13:30	11.66	13900	52.64	16000
5/17/08 13:45	11.66	13900	52.67	16100
5/17/08 14:00	11.58	13600	52.63	16000
5/17/08 14:15	11.61	13700	52.65	16100
5/17/08 14:30	11.59	13700	52.62	16000
5/17/08 14:45	11.58	13600	52.69	16200
5/17/08 15:00	11.58	13600	52.61	16000
5/17/08 15:15	11.59	13700	52.61	16000
5/17/08 15:30	11.59	13700	52.66	16100
5/17/08 15:45	11.60	13700	52.65	16100
5/17/08 16:00	11.56	13600	52.65	16100
5/17/08 16:15	11.58	13600	52.67	16100
5/17/08 16:30	11.62	13700	52.67	16100
5/17/08 16:45	11.59	13700	52.65	16100
5/17/08 17:00	11.57	13600	52.64	16000
5/17/08 17:15	11.61	13700	52.57	15900
5/17/08 17:30	11.59	13700	52.64	16000
5/17/08 17:45	11.65	13800	52.60	15900
5/17/08 18:00	11.61	13700	52.62	16000
5/17/08 18:15	11.66	13900	52.61	16000
5/17/08 18:30	11.70	14000	52.62	16000
5/17/08 18:45	11.73	14100	52.62	16000
5/17/08 19:00	11.75	14100	52.61	16000
5/17/08 19:15	11.72	14000	52.58	15900
5/17/08 19:30	11.79	14200	52.63	16000
5/17/08 19:45	11.83	14400	52.60	15900
5/17/08 20:00	11.88	14500	52.59	15900
5/17/08 20:15	11.92	14600	52.64	16000
5/17/08 20:30	11.95	14700	52.62	16000
5/17/08 20:45	12.02	14900	52.64	16000
5/17/08 21:00	12.02	14900	52.65	16100
5/17/08 21:15	12.05	15000	52.63	16000
5/17/08 21:30	12.02	14900	52.63	16000
5/17/08 21:45	12.15	15400	52.68	16100
5/17/08 22:00	12.18	15400	52.69	16200
5/17/08 22:15	12.20	15500	52.67	16100
5/17/08 22:30	12.30	15800	52.74	16300
5/17/08 22:45	12.22	15600	52.77	16300
5/17/08 23:00	12.30	15800	52.73	16200
5/17/08 23:15	12.37	16100	52.67	16100
5/17/08 23:30	12.39	16100	52.74	16300
5/17/08 23:45	12.39	16100	52.79	16400

5/18/08 0:00	12.43	16200	52.83	16500
5/18/08 0:15	12.45	16300	52.78	16400
5/18/08 0:30	12.54	16600	52.84	16500
5/18/08 0:45	12.52	16500	52.81	16400
5/18/08 1:00	12.56	16700	52.84	16500
5/18/08 1:15	12.48	16400	52.88	16600
5/18/08 1:30	12.61	16800	52.89	16600
5/18/08 1:45	12.54	16600	52.84	16500
5/18/08 2:00	12.58	16700	52.94	16800
5/18/08 2:15	12.60	16800	52.97	16800
5/18/08 2:30	12.60	16800	53.02	16900
5/18/08 2:45	12.58	16700	52.94	16800
5/18/08 3:00	12.64	16900	52.98	16900
5/18/08 3:15	12.61	16800	53.08	17100
5/18/08 3:30	12.68	17100	53.06	17000
5/18/08 3:45	12.59	16800	53.04	17000
5/18/08 4:00	12.62	16900	53.03	17000
5/18/08 4:15	12.59	16800	53.13	17200
5/18/08 4:30	12.62	16900	53.10	17100
5/18/08 4:45	12.60	16800	53.11	17200
5/18/08 5:00	12.65	17000	53.16	17300
5/18/08 5:15	12.59	16800	53.16	17300
5/18/08 5:30	12.54	16600	53.17	17300
5/18/08 5:45	12.55	16600	53.24	17500
5/18/08 6:00	12.50	16500	53.19	17400
5/18/08 6:15	12.48	16400	53.22	17400
5/18/08 6:30	12.44	16300	53.23	17400
5/18/08 6:45	12.49	16400	53.26	17500
5/18/08 7:00	12.45	16300	53.31	17600
5/18/08 7:15	12.40	16200	53.30	17600
5/18/08 7:30	12.43	16200	53.32	17700
5/18/08 7:45	12.37	16100	53.26	17500
5/18/08 8:00	12.36	16000	53.31	17600
5/18/08 8:15	12.33	15900	53.31	17600
5/18/08 8:30	12.29	15800	53.35	17700
5/18/08 8:45	12.29	15800	53.38	17800
5/18/08 9:00	12.23	15600	53.42	17900
5/18/08 9:15	12.18	15400	53.41	17900
5/18/08 9:30	12.20	15500	53.38	17800
5/18/08 9:45	12.13	15300	53.48	18100
5/18/08 10:00	12.12	15300	53.46	18000
5/18/08 10:15	12.08	15100	53.41	17900
5/18/08 10:30	12.05	15000	53.40	17900
5/18/08 10:45	12.02	14900	53.48	18100
5/18/08 11:00	11.99	14900	53.47	18000
5/18/08 11:15	11.93	14700	53.48	18100
5/18/08 11:30	11.91	14600	53.45	18000
5/18/08 11:45	11.90	14600	53.44	18000
5/18/08 12:00	11.85	14400	53.47	18000

5/18/08 12:15	11.83	14400	53.42	17900
5/18/08 12:30	11.78	14200	53.41	17900
5/18/08 12:45	11.75	14100	53.42	17900
5/18/08 13:00	11.68	13900	53.41	17900
5/18/08 13:15	11.67	13900	53.40	17900
5/18/08 13:30	11.59	13700	53.43	17900
5/18/08 13:45	11.55	13500	53.38	17800
5/18/08 14:00	11.59	13700	53.39	17800
5/18/08 14:15	11.54	13500	53.31	17600
5/18/08 14:30	11.49	13400	53.40	17900
5/18/08 14:45	11.49	13400	53.37	17800
5/18/08 15:00	11.45	13300	53.37	17800
5/18/08 15:15	11.41	13100	53.27	17500
5/18/08 15:30	11.41	13100	53.31	17600
5/18/08 15:45	11.34	12900	53.32	17700
5/18/08 16:00	11.29	12800	53.23	17400
5/18/08 16:15	11.30	12800	53.24	17500
5/18/08 16:30	11.25	12700	53.28	17600
5/18/08 16:45	11.18	12500	53.18	17300
5/18/08 17:00	11.25	12700	53.22	17400
5/18/08 17:15	11.22	12600	53.17	17300
5/18/08 17:30	11.18	12500	53.16	17300
5/18/08 17:45	11.19	12500	53.10	17100
5/18/08 18:00	11.18	12500	53.08	17100
5/18/08 18:15	11.15	12400	53.07	17100
5/18/08 18:30	11.12	12300	53.07	17100
5/18/08 18:45	11.14	12400	52.99	16900
5/18/08 19:00	11.13	12400	52.96	16800
5/18/08 19:15	11.08	12200	52.95	16800
5/18/08 19:30	11.13	12400	52.94	16800
5/18/08 19:45	11.12	12300	52.95	16800
5/18/08 20:00	11.09	12200	52.86	16600
5/18/08 20:15	11.11	12300	52.83	16500
5/18/08 20:30	11.10	12300	52.85	16500
5/18/08 20:45	11.11	12300	52.83	16500
5/18/08 21:00	11.14	12400	52.75	16300
5/18/08 21:15	11.17	12500	52.78	16400
5/18/08 21:30	11.12	12300	52.75	16300
5/18/08 21:45	11.17	12500	52.71	16200
5/18/08 22:00	11.15	12400	52.71	16200
5/18/08 22:15	11.17	12500	52.65	16100
5/18/08 22:30	11.18	12500	52.65	16100
5/18/08 22:45	11.24	12700	52.63	16000
5/18/08 23:00	11.22	12600	52.64	16000
5/18/08 23:15	11.23	12600	52.58	15900
5/18/08 23:30	11.25	12700	52.61	16000
5/18/08 23:45	11.26	12700	52.53	15800

Human effects

12. Draw a **stream profile** (which is sort of a cross-sectional view – no details about the rocks is needed, however) from the headwaters of a stream to its mouth. Indicate the **base level**, and accurately reproduce the changes in **stream gradient** in your drawing. Under the profile, label the portion of the stream where **erosion** would dominate, and the portion where **deposition** would dominate.

13. Draw what happens to the stream profile when the stream is dammed. Specifically indicate where erosion and deposition due to the dam occur.