Katie McKnight
LA 222 – Hydrology
Lab #5 – Channel Cross-Section Survey and Flow Measurement
02-23-15

Problem Statement:

The characteristics of a healthy stream greatly depend on the intrinsic elements of the watershed. For example, an intensely braided stream may be natural in one area whereas a straight and occasionally sinuous stream is appropriate for another. These characteristics form as a product of runoff loads, topography, vegetative cover, storm frequencies and durations as well as many other factors. However, streams within or close to urban areas are often greatly impacted by restricted flooding regimes, lack of sedimentation and debris (due to structures, culverts and other human infrastructure blocking sediment transport) and so forth. In the case of Strawberry Creek, the stream exhibits a great amount of down cutting by "hungry" sediment-deprived water funneling in at high energies during large flood events from the steep Strawberry Canyon where the headwaters originate. Down cutting can lead to scour on banks, loss of vegetation and degraded fish and wildlife habitats. In order to adequately evaluate the state of the stream, it is necessary to take detailed surveys along the long profile to understand the gradients that the water travels along as a result of intensity and frequency of rainfall events. Observations of high water marks, bank vegetation, number and depths of pools, obstructions in the bank (logs, dams, etc.) and bank tops and toes are also critical to fully understand the factors influencing the characteristics of survey data. This lab walks through the basics of technical surveying procedures, from how to set up and use survey equipment to how to plot cross-sections and long profiles to understand stream gradients.

1. **Long Profiles and Cross Sections:**

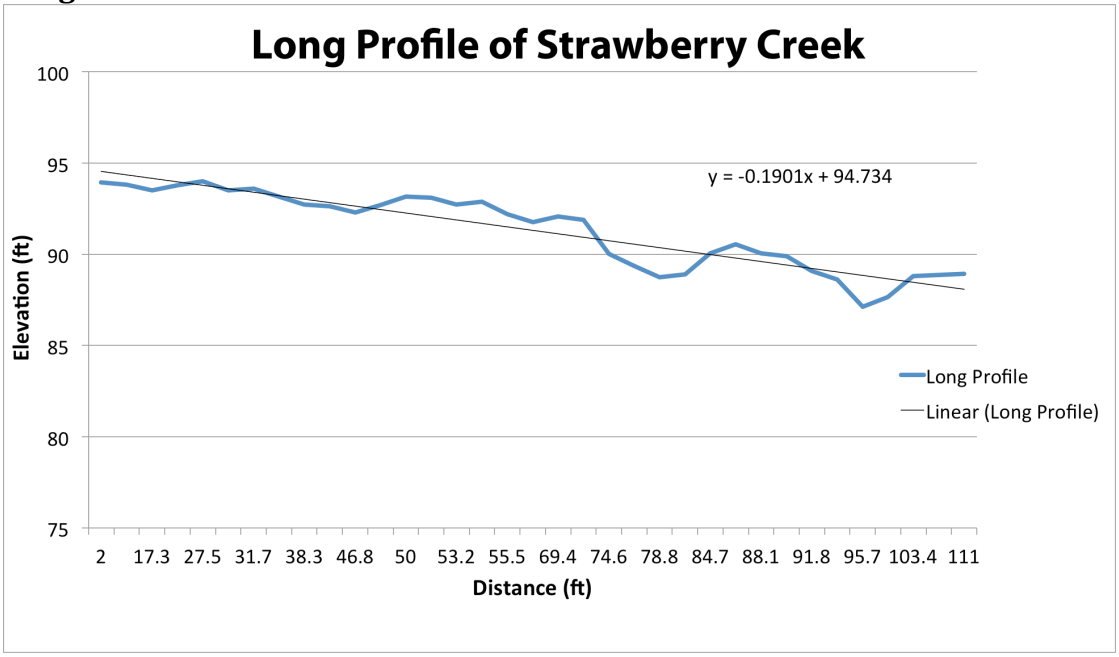

Figure 1. The long profile of strawberry creek reveals an average slope of approximately -19% over the study site (upstream to downstream from left to right).

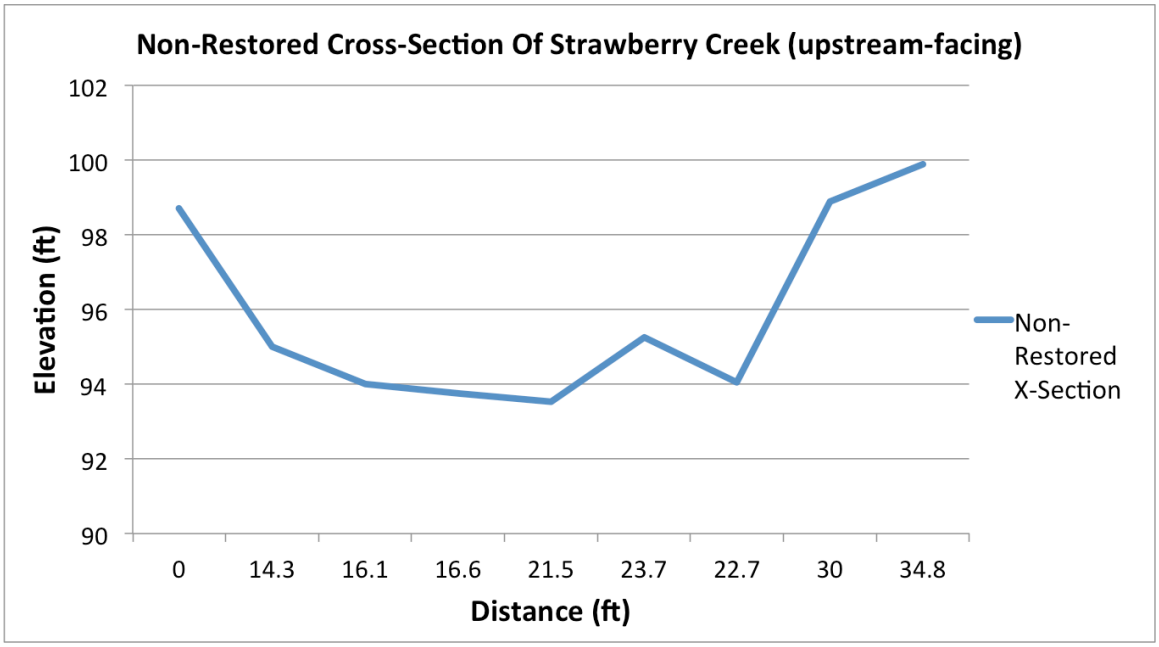

Figure 2. The cross-section of the creek upsteam of the restored site shows abrupt changes in elevation, which may be a product of the crude data points taken or the rugged characteristics resulting from continuous down cutting.

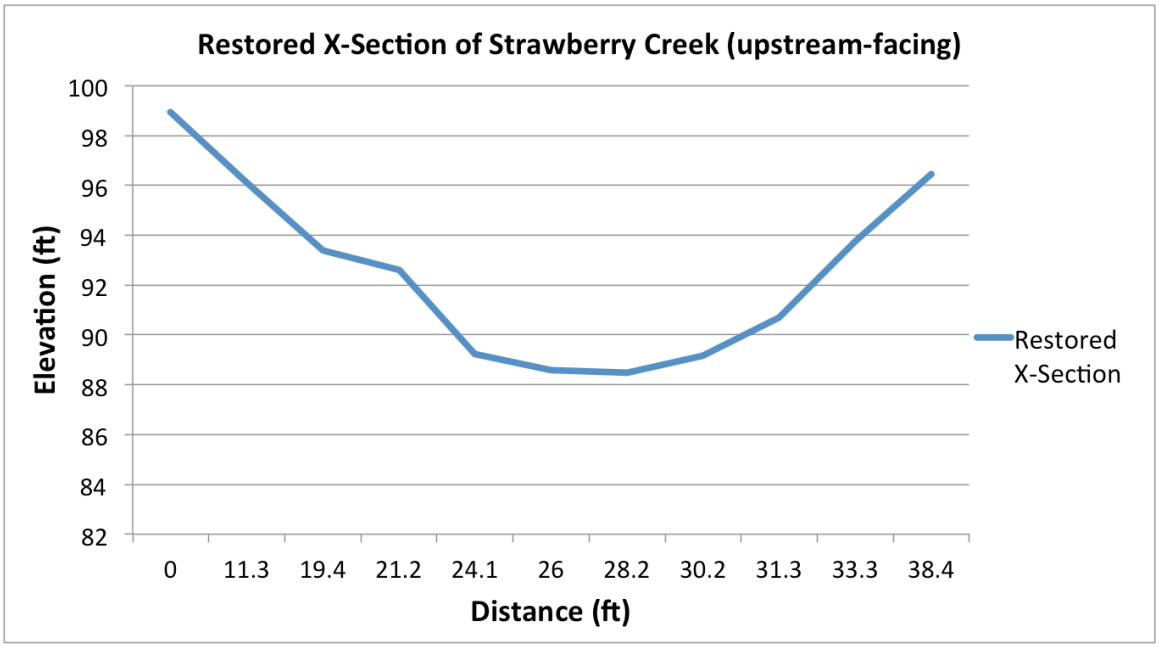

Figure 3. The cross-section of the restored segment of the creek reveals a relatively deep pool, with a depth of roughly 10 feet, and a uniform slope change from bank to bank.

2. Sketch Maps:

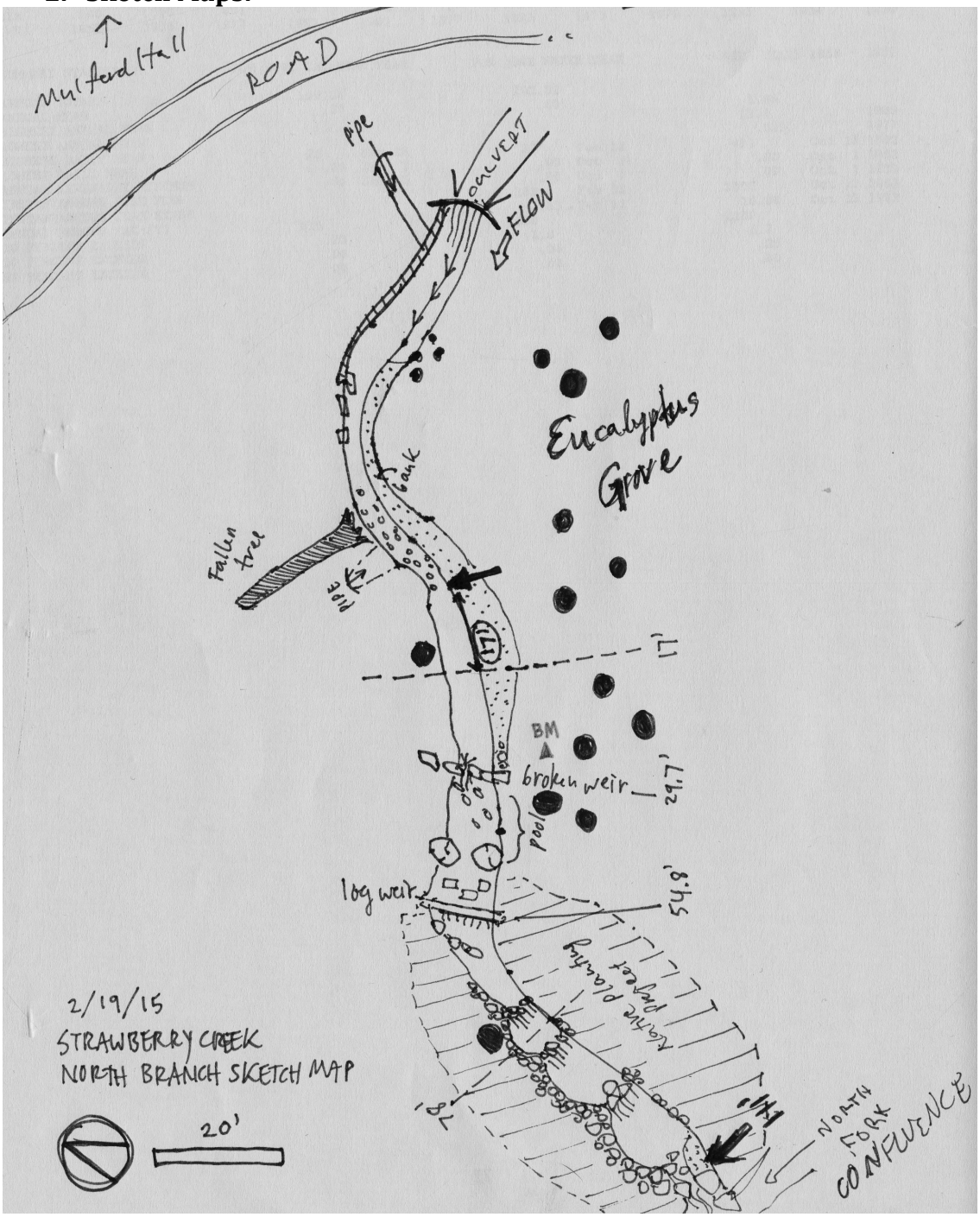

Figure 4. A plan view sketch of the overall segment of Strawberry Creek surveyed reveals the areas where section cuts are taken as well as the surrounding vegetative cover types. The majority of vegetation around this segment is mature Eucalyptus trees, which drop debris in and around the stream banks.

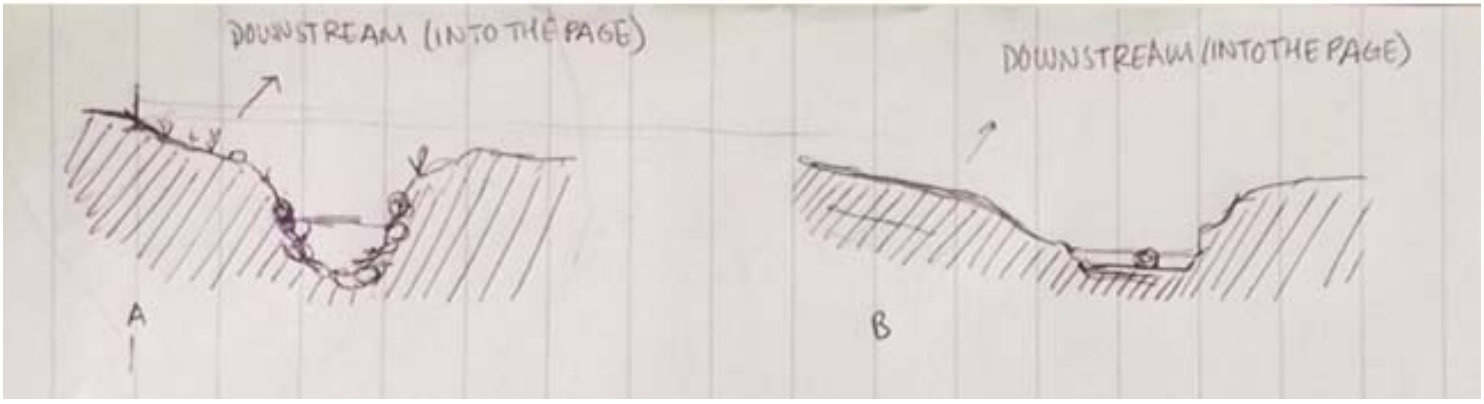

Figure 5. The section cuts show the difference in structure between the restored segment (A), which has a deeper pool and more vegetation and rocks along the banks, verses the non-restored, upstream segment (B) which has abrupt changes in elevation with little to no vegetation along the banks.

Appendix A. Raw data of the long profile and section cut profiles:

Long Profile of North Fork of Strawberry Creek					
Station	**Backsight (ft)**	**Height of Instrument (ft)**	**Foresight (ft)**	**Elevation (ft)**	**Notes**
BM	2.49	102.49		100	
2			8.54	93.95	Flat
11			8.67	93.82	
17.3			8.99	93.5	at 1st cross-section
23.6			8.71	93.78	broken rock on creek bed
27.5			8.485	94.005	above broken rock weir
29.7			8.99	93.5	mid-weir, in broken section
31.7			8.9	93.59	top of step, lower part of weir
32.1			9.33	93.16	below step, breach in weir
38.3			9.77	92.72	pool below rock weir
43.3			9.85	92.64	rock

46.8		10.2	92.29	boundary of restoration site, bottom of pool
49.3		9.8	92.69	in cement blocks
50		9.32	93.17	on the rock
52.6		9.4	93.09	on the cement block
53.2		9.77	92.72	below block, before log
54.8		9.62	92.87	on long
55.5		10.31	92.18	below log
63		10.72	91.77	bottom of pool
69.4		10.43	92.06	
74.4		10.6	91.89	top of rock step thing
74.6		12.48	90.01	below rock structure
75.5		13.13	89.36	pool below rock structure
78.8		13.75	88.74	bottom of pool
82.5		13.6	88.89	
84.7		12.43	90.06	
85.1		11.96	90.53	top rock structure
88.1		12.43	90.06	
89.8		12.61	89.88	top of 2nd rock step thing
91.8		13.42	89.07	bottom of 2nd rock step
91.5		13.88	88.61	
95.7		15.38	87.11	pool below rock step
99.5		14.85	87.64	pool
103.4		13.69	88.8	
108		13.64	88.85	placed rocks
111		13.55	88.94	

Cross Section of Restored Segment of Strawberry Creek					
Station	**Backsight (ft)**	**Height of Instrument (ft)**	**Foresight (ft)**	**Elevation (ft)**	**Notes**
BM	2.49	102.49		100	
0			3.54	98.95	
11.3			6.37	96.12	
19.4			9.1	93.39	
21.2			9.9	92.59	edge of water, left bank
24.1			13.25	89.24	
26			13.92	88.57	center of channel
28.2			14.01	88.48	
30.2			13.33	89.16	next to rock bank
31.3			11.78	90.71	on rock bank
33.3			8.72	93.77	on juke above bank
38.4			6.04	96.45	vegetation

Cross Section of Non-Restored Segment of Strawberry Creek					
Station	**Backsight (ft)**	**Height of Instrument (ft)**	**Foresight (ft)**	**Elevation (ft)**	**Notes**
BM	2.49	102.49		100	
0			3.78	98.71	
14.3			7.49	95	
16.1			8.49	94	edge in water of right bank (NOTE: I think I wrote this incorrectly; makes more sense that station 14.3 is edge in water of right bank)
16.6			8.73	93.76	middle of channel
21.5			8.96	93.53	edge in water of left bank
23.7			7.23	95.26	on right bank
22.7			8.43	94.06	toe of right bank
30			3.6	98.89	top of right bank

34.8		2.61	99.88	

Methods:
Data was collected between 4:00pm and 5:30pm on February 19, 2015. The benchmark surveyed was approximately 2.5 feet high and the elevation of the instrument is assumed to be 100 feet, therefore the height of the instrument was 102.5 feet. All surveyed elevations were adjusted to reflect this assumption. The creek was surveyed by placing a tape measure along the left bank over a 110-foot section upstream of the confluence between the North Fork and the South Fork of Strawberry Creek at the University of California Berkeley. The measurements made along the long profile were concentrated on the deepest points along the channel. The aim was to account for any breaks in elevation such as the point of the highest elevation of a rock and the bottom of the drop immediately after. The same logic was followed for surveying of the cross sections.

Results:
The long profile surveyed approximately 110 ft of Strawberry Creek. We surveyed the deepest portions of each station, covering approximately 18 stations in total. The graph of the profile shows about 5 pools, three of which are less than 2 feet in depth and two of which are between 3 – 5 feet in depth. The deeper pools exist on the downstream portion of the creek that was recently constructed through a student initiated creek enhancement project. The cross sections of non-restored and restored portions of the creek reveal a difference in depth of pools as well as change in slope from bank to bank. The elevation from toe to top of right bank on the non-restored cross-section increased by about 5 feet over a 7-foot distance. Mature Eucalyptus trees make up the main vegetative cover around the surveyed section, with Eucalyptus leaf litter dominating the left bank surface. The right bank had significantly more vegetation than the left bank but was still sparsely vegetated. Signs of scouring and high water marks were apparent on the left bank.

Discussion:
Due to a lack of data collection, it is unclear what the velocity estimates or water surface elevation was for this portion of the Creek during collection. The long profile revealed the somewhat steep gradient in which water flows along Strawberry Creek near the confluence of the North and South fork. The gradient, the culvert upstream and the degree of urbanization around this stream segment are all reasons that may reflect why there were so many signs of scouring and erosion. Less stations were surveyed along the cross-section of the non-enhanced portion of the creek compared to the enhanced portion due to a lack of time. In order to fully compare the differences in cross-sectional profiles, a more detailed survey would be needed. Overall, the enhanced portion of the stream reflected signs of a healthier stream but since the enhancement was done just a few months ago, it is unclear whether these interventions will continue to improve the health of Strawberry Creek. Future surveys are needed to determine if vegetation was successfully implemented and how the enhancements perform in the long term.

Figure 6. The measuring tape across the stream marks the non-restored cross-section that was surveyed (upstream-facing). The sandy area on the left bank reveals a potential high water mark from a recent flooding event.

Figure 7. The restored section of the creek that was surveyed reveals a "step" change in elevation through the use of an embedded log (on the left, middle portion of the photo). The log works to break up energy received from the culvert upstream and also enhances the aquatic ecosystem by mimicking pools found in nature in this type of creek. The banks were stabilized with rocks of varying sizes and vegetation was planted along the banks with staked mats to decrease erosion as plants become established.

Figure 8. The long profile was surveyed by running the measuring tape along the left stream bank to mark the station while using the survey stick to locate the deepest portion in the creek. Relative elevations were recorded through viewing the numbers on the meter stick through a survey tool which was stationed in a spot without any large obstructions. If we had continued to survey further along the stream, we would have needed to take a turning point eleveation measurement to relocate the survey tool to keep the measuring stick within view.