LA12 Fall 2022:

Environmental Science for Sustainable Development

Lab Week 4: Urban Streams - Strawberry Creek Tour

Introduction

In this week's lab we will walk the length of Strawberry Creek on campus, learning about the streams history and observing features of the channel and adjacent banks. As you learned in lecture and from our overview of campus two weeks ago, Strawberry Creek drains a bowl-shaped basin in the Berkeley Hills east of campus (Strawberry Canyon), and flows across campus and the city of Berkeley down to San Francisco Bay. After damage from a flood in 1962, engineers built a dam across the creek in Strawberry Canyon, and diverted all the creek's flow into a tunnel (a concrete box culvert appx 8x8 ft, the so-called "Big-Inch" Culvert) that conveys water for 0.8mi (1.3 km) past the stadium and Haas Business School to emerge near the Men's Faculty Club. A smaller culvert (called the "Little-Inch" Culvert) was constructed to drain stormwater runoff from the area below dam: the area of lower Strawberry Canyon (including the swimming pools) and the area around the football stadium. Strawberry Creek flows across the Berkeley campus until it enters a large tunnel under Oxford Street on the west edge of campus, and it flows underground most of the way to its outlet in San Francisco Bay. (Exceptions are a short reach near Acton Crescent and a formerly buried reach in Strawberry Creek Park, about a mile above San Francisco Bay.

Like other urban streams, Strawberry Creek receives greatly increased runoff from its drainage basin resulting from the paved surfaces and stormdrains, which prevent infiltration of rainwater and quickly route runoff into the stream. Thus runoff from typical rainstorms can be increased by a factor of five in many cases, which increases the erosive energy of the stream, in turn causing erosion of the bed (termed *incision* or downcutting) and erosion of the banks (and undercutting).

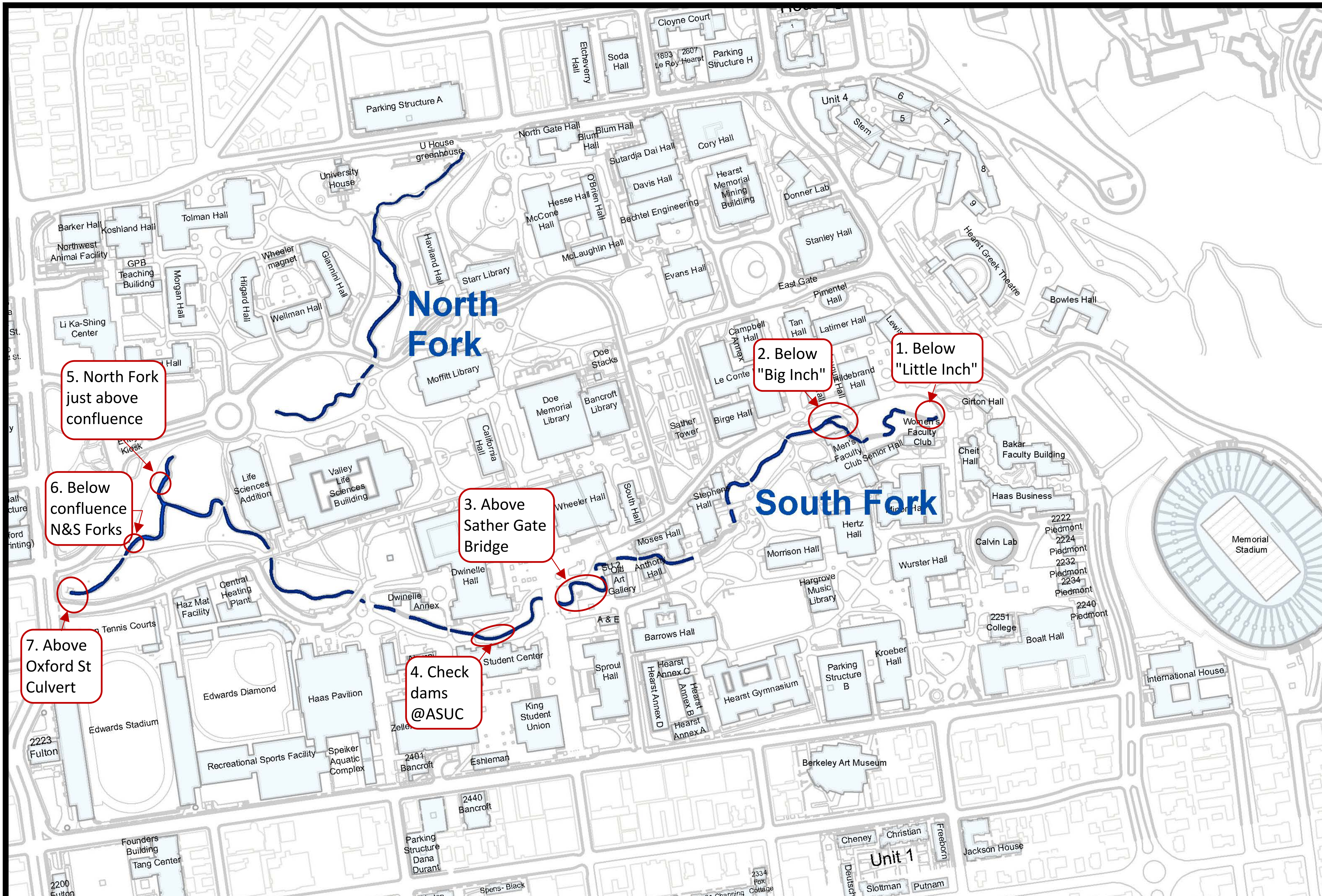
We'll look at the creek where it emerges first from the "Little-Inch" Culvert, then from the "Big-Inch" Culvert, and then at several points as we progress downstream. At two sites along the creek, we'll measure dimensions of the channel and draw cross sections. At one site we will measure flow using the measured dimensions of the channel and a float to estimate velocity.

Skills and Learning Objectives
Field observations are critical for building awareness of environmental systems. Training your eye to look for and notice certain elements of the natural and urban worlds is one way to improve your skills in this field. Some of you may feel comfortable drawing or sketching to process information. Some of you feel more comfortable with words. Either way, take some time during this lab to connect what you see to different ways of representing information. There's not necessarily a "right way", so have fun! Pay attention to attributes such as water flow, water quality, channel depth, channel width, bank slope, what kinds of stones or other material is on the bed, and vegetation along the creek banks.

A *cross section* is a powerful way to visualize multiple elements and their relationship across a transect of space. It's like cutting a cake in half and seeing all of the layers inside. During this lab, we encourage you to experiment with sketching cross sections that show the relationships between different elements of a stream.

Learning objectives include understanding:

    - how urbanization affects stormwater runoff
    - how various runoff volumes impact a stream's flow / discharge
    - How runoff impacts channel size and shape
    - What a hydrograph shows
- Recognizing elements of urban creek degradation and restoration
- Skill development:
    - Field Observations
    - Sketching stream profiles and channel cross sections
    - Measuring stream flow (discharge)



Strawberry Creek
University of Caliornia, Berkeley
Central Campus
Berkeley, CA

N E S W

0 250 500 1,000 Feet

LD ARCH 12 Fall 2022
Base map source:
UC Regents.
UC Berkeley, 2012

Strawberry Creek Tour

Site 1. Below the "Little inch" Culvert

The first stop on our tour of Strawberry Creek is below the outlet of the 'Little Inch' Culvert, near the. Womens Faculty Club. Because most of its drainage area was cut off by the dam in Strawberry Canyon, this part of the creek (draining only the area around the swimming pools and stadium) is said to be beheaded, and this reach of the creek has not been experiencing the full force of the creek's flowing water for about 60 years. This reach of the creek occupies the original bed of Strawberry Ck, which has not been eroded as much as downstream reaches because it has been protected from flood flows by the diversion of high flows into the tunnel. This reach receives only a fraction of its natural flow, not enough to flush out the leaves and branches that accumulate on the bed. Reflecting its relative lack of incision, the stream bed here is only about 3 ft below the level of the surrounding ground surface.

The left bank is protected by a vertical, cemented rock wall (Figure 1). We shall see that this kind of bank treatment is typical along the creek.

Channel depth (ft): 3.5 ft
Channel width (ft): 9 ft
Bed material: cobbles, blocks, covered by layer of redwood needles
Bank material: left bank: earth covered by leaves behind vertical wall of cemented rock;
right bank: earth covered by layer of redwood

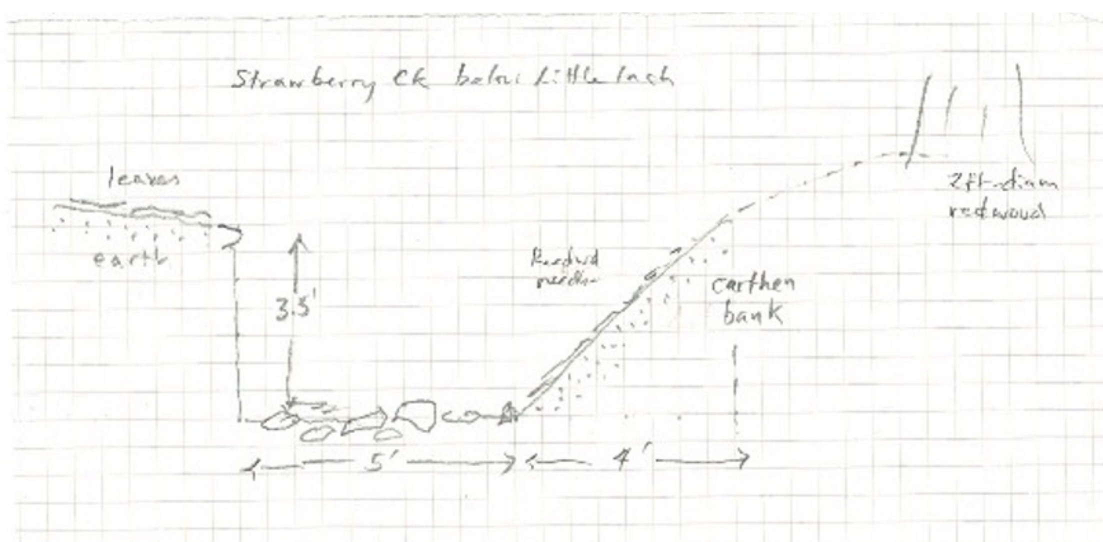


Figure 1. Cross section of Strawberry Creek below the Little Inch Culvert, September 2022. Looking downstream.

Site 2. Below "Big Inch"

Next stop on the tour is the outlet of the 'Big Inch' Culvert, the (appx 8ftx8ft) tunnel that carries flow from the watershed of Strawberry Creek, where it enters the creek here, the channel is much deeper than at the last stop. Moreover, the bed consists of boulders and large gravel. The boulders were placed in an effort to keep the bed from eroding and downcutting, and to dissipate stream energy. Strawberry Creek here experiences the full force of floods coming from the watershed, which have been increased by the impervious surfaces in the watershed. The right bank has been hardened to protect against erosion, a condition we shall see repeated as we continue down the creek.

Measure the depth of the channel here (from top of the bank down to the bed) and measure the width from bank top to bank top, and record these values. Then draw a cross section of the creek on the form near the back of your handout.

Site 3. Above Sather Gate Bridge

We next see Strawberry Creek above Sather Gate, the heart of campus. We first visit a meander bend (30m upstream of the bridge) that had been dry since the 1960s, when a straight tunnel was built to carry floodwaters more quickly. The reach with the meander bend was left dry until, in the 1990s, the creek was diverted from the tunnel back into its natural channel. (At flood flows, water still passes through the tunnel.) This is a relatively natural reach of the creek, and its outside bank has undercut banks (up to 1-ft of undercut), which provide habitat – especially a refuge from high velocities during floods - for small fish and other creatures. Restoring the flow to this meander bend was one of many *stream restoration* projects that were undertaken along Strawberry Creek over the past three decades.

Next we follow the channel 20m downstream, first noting the rock wall along the left bank (again a typical treatment to prevent erosion) and then to look at a *check dam*, where the bed of Strawberry Creek drops about 6 ft (2m). This is the biggest of dozens of check dams along Strawberry Ck, built over the years to control erosion of the bed. Looking downstream we see the bridge over Strawberry Ck under Sather Gate, and as we look downstream we see many pipes protruding from the left bank. These pipes all carry *stormwater*: rain that runs off from the roofs of nearby buildings, from the pavement under Sproul Plaza, etc.

Site 4. At ASUC

In this brief stop, we can easily see a series of check dams, designed to dissipate stream energy without erosion of the bed or banks. The steps are designed so that energy is dissipated in the drops below the check dams, and the stream reaches in between the dams has a much lower gradient, which reduces the erosiveness of the flow. Check dams are ubiquitous along Strawberry Creek, and they have helped to prevent more extensive incision. Also note that the left bank is a smooth concrete channel and the right bank is mostly natural.

Site 5. North Fork of Strawberry Creek

Strawberry Creek's principal tributary is the North Fork, which drains around 0.2 square miles in North Berkeley. The North Fork emerges from a short tunnel under a traffic circle northwest of the Life Sciences Building and flows about 200 ft before joining the main stream (the South Fork). The right bank just downstream of the tunnel outlet is protected by a log cribwall. We'll discuss the advantages of this approach over the concrete and rock walls that we have seen along the creek upstream.

We also look at the confluence, and a restoration project that was completed a decade ago after a check dam on the North Fork at the confluence failed.

Site 6. Below confluence N&S Forks

We next look at Strawberry Ck downstream of the confluence of the North and South Fork. Here the drainage area has increased significantly. How do the channel dimensions here compare with upstream?

Measure the depth of the channel here (from top of the bank down to the bed) and measure the width from bank top to bank top, and record these values. Then draw a cross section of the creek on the form near the back of your handout. Next we will make a measurement of the streamflow in the creek, as explained in the next section.

Site 7. Above Oxford St Culvert

Our final stop is the creek above the entrance to the tunnel that will convey water under Oxford Street and thence about 1.8 miles (3km) under the city of Berkeley down to the Bay.

Flow Measurement

At site 6, we will measure water flow velocity, width, and depth, from which you can calculate the flow in Strawberry Creek below the confluence. We are measuring at *baseflow*, i.e., during the low-flow season. It hasn't rained in months, so the flowing water is occupying only a very small part of the larger creek channel.

Stream flow is measured by calculating the volume of water that passes a particular point in a stream within a specified amount of time. To calculate flow, you need either to measure how much water accumulates in some place over a given time, or multiply the cross sectional area of the stream by how fast that water is moving (velocity). The formula for flow in a channel:

$$Q = V \times A$$

where Q = flow, V = velocity, and A = cross sectional area of the stream (Figure 2).

In this lab, we measure the approximate cross-sectional area of the water in the channel and estimate velocity using the "float" method. The procedure:

a) To estimate velocity with a float:
   a. Measure the length of a reach with consistent velocity, depth, and width
   b. One person drops a float (eg, orange peels) at the upstream end of the reach.
   c. A second person times how long it takes for the orange peel to reach the downstream end.

b) To estimate the cross sectional area:
   a. Measure the width of flowing water
   b. Measure water depth at several points across the channel to estimate average depth.
   c. Multiply average depth by width to yield cross sectional area
   d. Multiply area by velocity to calculate flow (discharge)

Record values of wetted channel width, depth, average velocity, and calculate streamflow below:

Variable	
Width of flowing water (ft)	
Depth (ft)	
Velocity (ft/sec)	
Cross Sectional Area (ft^2)	
Flow (ft^3/sec)	

Note: the earlier measurement of channel depth and width refer to the larger stream channel form. Don't confuse these measurements with the measures of the flowing water (used to calculate flow). The flowing water is much smaller and occupies only a small part of the larger channel.

Cross Section Below “Big Inch” Culvert (Site 2)

Measure the channel depth and width, then draw a cross section roughly to scale (using your measurements) and annotate it by labeling features such as bed material boulders, concrete blocks, cobble, gravel, sand), bank material (natural/reinforced, gradual/steep, type of vegetation). Feel free to add other notes from your observations as you wish.

Channel depth (ft):

Channel width (ft):

Bed material:

Bank material:

Sketch cross section:

Below confluence N&S Forks (Site 6)

Measure the channel depth and width, then draw a cross section roughly to scale (using your measurements) and annotate it by labeling features such as bed material boulders, concrete blocks, cobble, gravel, sand), bank material (natural/reinforced, gradual/steep, type of vegetation). Feel free to add other notes from your observations as you wish.

Channel depth (ft):

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Sketch cross section: