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memorandum

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to Tim Pine, UC Berkeley EH&S

from Scott Stoller, PE

subject Strawberry Creek Confluence Ecological Stabilization Project Basis of Design

Setting

The project site is located on the North Fork of Strawberry Creek immediately upstream of the confluence with the South Fork. The project site is located on the west side of the University of California, Berkeley campus. The Strawberry Creek watershed upstream of the confluence encompasses approximately 1147 acres (1.8 square miles) and the land use is comprised of a mixture of university facilities, residential housing, and undeveloped steeper slopes in the upper watershed and natural areas within the main campus.

Since the site is located just upstream of the confluence flows from the South Fork have also been included in our hydraulic analysis.The North Fork of Strawberry Creek drains about 388 acres (0.6 square miles) and the South Fork drains about 759 acres (1.2 square miles).

Historically, Strawberry Creek supported about 13 species of fish, including coldwater salmonids, anadromous steelhead and coho salmon (Office of Environment, Health and Safety, UC Berkeley 2006). The current altered hydrologic regime, physical disturbances in the watershed, and presence of fish species limit the restoration potential. Beginning in 1989, some native fish began to be reintroduced to Strawberry Creek under a coordinated University effort to improve riparian diversity and habitat. In the following years, three populations of fish species have survived, including the California Roach Minnow, the Three Spined Stickleback and the Sacramento Sucker.

Project Description

The project site extends from the confluence of the North and South Forks of Strawberry Creek to 80 feet up the North Fork, which encompasses an area that includes one failed check dam (CD1) and another failing check dam (CD2). CD1 is a decades-old check dam constructed on the north fork of Strawberry Creek located immediately upstream of the confluence of the North and South Forks. The failure of this check dam in 2006 caused the main concrete body of the dam to orient stream-wise in the center of the channel (Photo 1) and the channel bed to incise upstream, undermining CD2 (Photo 2). Additionally, remnants of CD1 deflect flow into the right bank causing a near vertical 6-foot scarp (Photo 3). CD2 is the same vintage and is located 35 feet upstream of CD1; it is at risk of failure due to undercutting of the support structure on the right bank and the water piping through the dam.

PHOTO 1. Failed Check Dam #1

PHOTO 2. Failing Check Dam #2

PHOTO 3. Erosion on Right Bank

The Project proposes to remove the remnants of CD1 and the failing check dam CD2, and install three in-stream grade control structures. Two step-pool structures and one log drop structure will be constructed within the project area. The step pools will be constructed of ungrouted rock and will be flexible to adjust to modest changes in channel conditions. The structures and grading of adjacent banks will impact a total of 80 linear feet of channel bed and approximately 1000 square feet of channel and bank area. The grade control structures consist of a crest, a cascading drop, and a pool feature which transitions into the channel design grade. The typical step-pool structure is 15 feet long, measured along the channel. The crests (measured at the low flow channel) will range from 5-8 feet wide. The crest is keyed 4-5 feet into the adjacent channel banks to capture and direct flows to the channel as well as to provide protection against flanking in larger storm events. Each rock structure has a drop of 1.5 feet and the log drop structure has a drop of 1.0 feet. Grading and revegetation elements will integrate the step-pools with the channel banks. In addition to the installation of the grade control structures, steep adjacent banks will be graded to a stable slope and planted with native vegetation.

Project Hydrology

Summary of Past Efforts

The Strawberry Creek watershed hydrology was summarized in a 2006 Hydrology Status Report by the Office of Environment, Health and Safety (EH&S) at UC Berkeley. This report summarizes historical measured and calculated flows on campus. The report estimates a 100-yr peak flow on the North Fork (at the confluence) of 440 cfs, which references a 1988 bank stabilization study by PWA.

The report does not contain the typical suite of flows used for hydraulic structure design (2 through 25-yr peak discharge). To obtain these flows, the team conducted a flow frequency analysis on a nearby gaged watershed and used the Drainage Basin Area-Ratio Method to translate and scale discharges to the Strawberry Creek watershed.

Flow Frequency Analysis

The flow frequency analysis was conducted on data on Rheem Creek downloaded from the USGS gage number 11182030 (IACWD, 1982). The State Water Resource Control Board (SWRCB) Drainage Basin Area-Ratio Method was used to translate the flows between the creeks (Mann et. al., 2004).

Rheem Creek, located in the City of San Pablo, western Contra Costa County, was gauged by the U.S. Geological Survey (USGS) for thirty years (December 1960 to September 1990). The watershed is 1.49 square miles. The gauge is located at the Giant Road crossing, near the Richmond Parkway; its elevation is 13.63 feet NGVD29. The discharge record from water year 1961 to 1990 was used for the flow frequency analysis. The gauge indicated that there was a change in baseflow in water year 1983. This was disregarded for our calculations since we used annual peak flows, which the baseflow would have little effect upon. Annual peak flowrates for the 30-year period were ranked and used to calculate the recurrence interval for each year's flow. The Q1 to Q25 from Rheem Creek were translated to the Strawberry Creek watershed using the State Water Resource Control Board's (SWRCB) Drainage Basin Area-Ratio Method. Q50 and Q100 were estimated with fitted log curve to the data.

SWRCB Drainage Basin Area-Ratio Method

The drainage basin area-ratio method assumes that the streamflow at an ungauged site is the same per unit area as at a nearby hydrologically similar stream gaging station. The area-ratio method is used for transferring known flows from one point to another location where flow is not known. This method is generally best used for transferring flows within the same drainage basin; however, the SWRCB also used area-ratio methods to transfer flow statistics from one basin to another. The SWRCB method also incorporates a precipitation ratio in order to account for differences in precipitation between basins. The area-ratio equation used by the SWRCB to estimate streamflow statistics is:

$$Q_{ug} = Q_g * (A_{ug}/A_g) * (I_{ug}/I_g)$$

$Q_{ug,g}$: Flowrate (cfs) – ungaged and gaged
$A_{ug,g}$: Area (sq.mi.) – ungaged and gaged
$I_{ug,g}$: Mean Annual Precip. (in.) – ungaged and gaged

TABLE 1
DESIGN FLOWS (CFS) FOR STRAWBERRY CREEK

Recurrence Interval	North Fork	South Fork	Combined
1.5-Year	134	259	393
2-Year	147	283	429
5-Year	170	328	498
10-Year	188	363	551
25-Year	220	424	644
100-yr	259	498	757

HY-8

The 2006 Hydrology Status Report states that the West Circle Culvert capacity is 72 cfs as estimated by EH&S in 2004. An analysis by ESA PWA in 2013 (using HY-8) indicated that the culvert capacity was approximately 125 to 140 cfs.

Design Elements

Several elements of the Project site served to inform and constrain the design. A large Eucalyptus grove dominates the vegetation on the left bank. This grove is the oldest stand of Eucalyptus trees in North America, and the University is actively managing and removing trees when they pose a danger of falling. One Eucalyptus tree near our project site will be removed prior to construction. Specimen trees populate the right bank of the project site, including a California Buckeye, a Coastal Live Oak, and a small Gingko tree, all of which will be protected during the construction phase of the project.

The project footprint extends upstream from the confluence to approximately 15 feet upstream of a specimen double California Buckeye located on the right bank. The channel width at ordinary high water is approximately 12 feet. There are four grade control structures in vicinity of the work area:

1. Station 0+45 (approx) – just downstream of confluence, this grade control is near at grade with no signs of deterioration.
2. Station 0+65 (approx) – failed grade control structure (referenced as CD1) just upstream of confluence, and there is currently concrete debris in the creek causing erosion on the right bank.
3. Station 1+00 (approx) – failing grade control structure (referenced as CD2) to be removed and replaced by current project.
4. Station 1+45 (approx) – existing grade control with no signs of deterioration.

There are a few very minor storm drain outfalls that enter the creek upstream of the project location, in addition to the 3.5 ft culvert that delivers the North Fork to the project reach. The 3.5 ft culvert discharges at the upstream extent of the attached profile (Station 2+25).

Step Pool Sizing Methodology

The step pool sizing was based on several factors, including a paper by Thomas et al (2000), hydraulics for the design flows (Q25=220 cfs, see Hydrology section below), topographic constraints (8% slope), and experience with designing numerous similar projects.

Parameter	Thomas et al. (2000)	Strawberry Ck Design
Drop Height	1.5	1.5
Step Pool Length	13	15
Pool Depth	0.5	1.0

Rock Sizing

A gradation of rocks will be used in the construction of the step pool structures. Several methods were used to calculate a stable rock size for the step pool crests, including Robinson, et. al (1997), Abt et al (1988), and Chervet & Weiss (1992). Resulting stable rock sizes varied between 1 and 2-ton.

The step pool crests will be constructed with rocks in the 1- and 2-ton size class, as well as smaller rock used to seal the structure.

References

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