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Engineering – Hydrology – Stream Restoration – Water Resources

TECHNICAL MEMORANDUM

Date: 25 November 2014

To: Caroline Christman
Project Coordinator

Golden Gate National Parks Conservancy
Building 201 Fort Mason, 3rd Floor
San Francisco, CA 94123

From: Corin Pilkington, Bonnie Pryor, and Jeffrey K. Anderson, P.E.

Re: Bridge 1: 100-year water surface elevation

Introduction

The purpose of this work is to provide a rough estimate the 100-year peak water surface elevation at Bridge 1 (Figure 1). Bridge 1 is located on the Redwood Creek Trail within the Mount Tamalpais State Park in Marin County, California, approximately 15 miles north of San Francisco. Bridge 1 is an existing pedestrian bridge which will be replaced with an 80 foot clear span pedestrian bridge as part of the Redwood Creek Trails project. The new bridge is proposed to be constructed at the same location and elevation as the existing bridge. This estimate of the 100-year peak water surface elevation is provided for informational purposes only, and will not be used in engineering designs for the bridge. Topographic survey data and computed water surface elevations are in an assumed coordinate system and datum.

Figure 1. Bridge 1 looking upstream (A) and downstream (B).

Estimated 100-year Water Surface Elevation

The 100-year peak water surface elevation was estimated using the Hydraulic Design Uniform Flow tool in the U.S. Army Corp of Engineers (COE) River Modeling System, HEC-RAS V4.1 (COE, 2010). The Hydraulic Design tool requires input parameters of discharge, cross-section geometry, and channel slope to estimate water surface elevation. The tool assumes steady state flow, uniform channel dimensions with

no abrupt contractions or expansions and an energy slope equal to the channel bed slope. Contractions and expansions occur in the vicinity of the bridge and are likely occur downstream, which may increase water levels above this estimate. An estimate that includes these effects is beyond the scope of this work.

The 100-yr peak flow was estimated using the USGS California Regional Equations (Gotvald et. al., 2012). The equations require input parameters of watershed area and mean annual precipitation. Watershed area and mean annual precipitation were estimated using the USGS online StreamStats software (water.usgs.gov/osw/streamstats). The watershed area upstream of Bridge 1 is 4.8 square miles and mean annual precipitation is 49 inches. The 100-year peak flow for Redwood Creek at Bridge 1 is estimated to be 1,640 cubic feet per second (cfs).

A longitudinal profile was surveyed between riffle crests from 470 feet upstream of the bridge to 310 feet downstream of the bridge to estimate the channel slope (Figure 2). The average bed slope is estimated to be 0.86%.

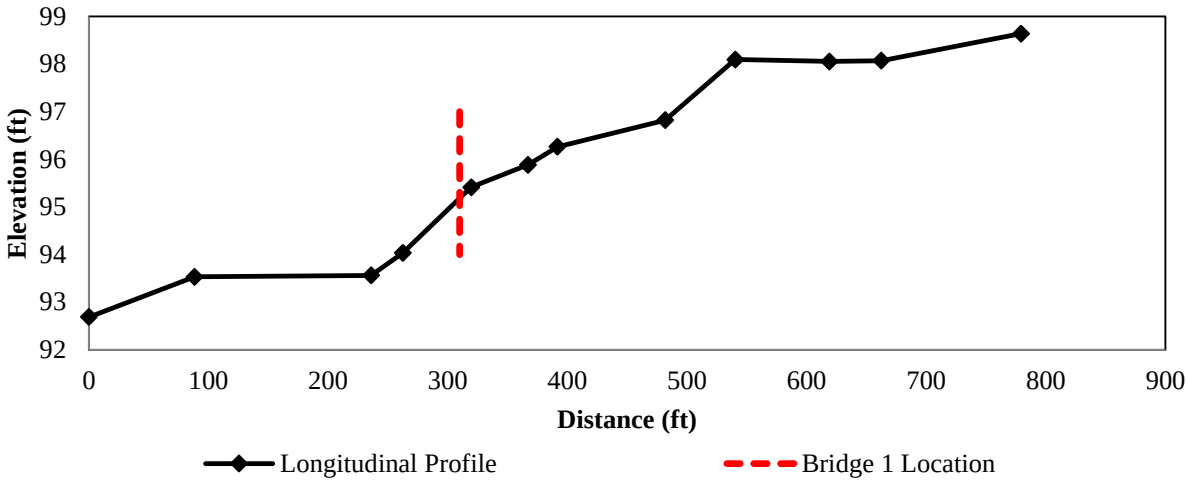

Figure 2. Longitudinal profile of Redwood Creek in the vicinity of Bridge 1.

One channel cross-section was surveyed immediately upstream of the existing bridge extending from top of bank to top of bank (Figure 3). The existing bridge chord and deck elevations and proposed location of new abutments were also surveyed. The existing bridge location appears to be at a natural constriction in the river channel, however, artificial manipulation to the adjacent ground elevations could not be ruled out.

Manning's n was estimated in the field based on roughness elements such as channel bed grain size, vegetation and channel planform. The Manning's n value of the channel was estimated to be 0.03-0.04, and the floodplains between 0.06 and 0.1. Estimates of composite Manning's n values ranged from 0.04 to 0.08.

Water surface elevation estimates for the range of composite Manning n values (0.04 to 0.08) are 103.0 to 105.9 feet respectively. The estimated water surface elevations are all below the elevation of the existing bridge chord with 2.5 to 5.4 feet of freeboard (Table 1). The water surface elevation with a composite Manning's *n* of 0.06 is provided in Figure 2.

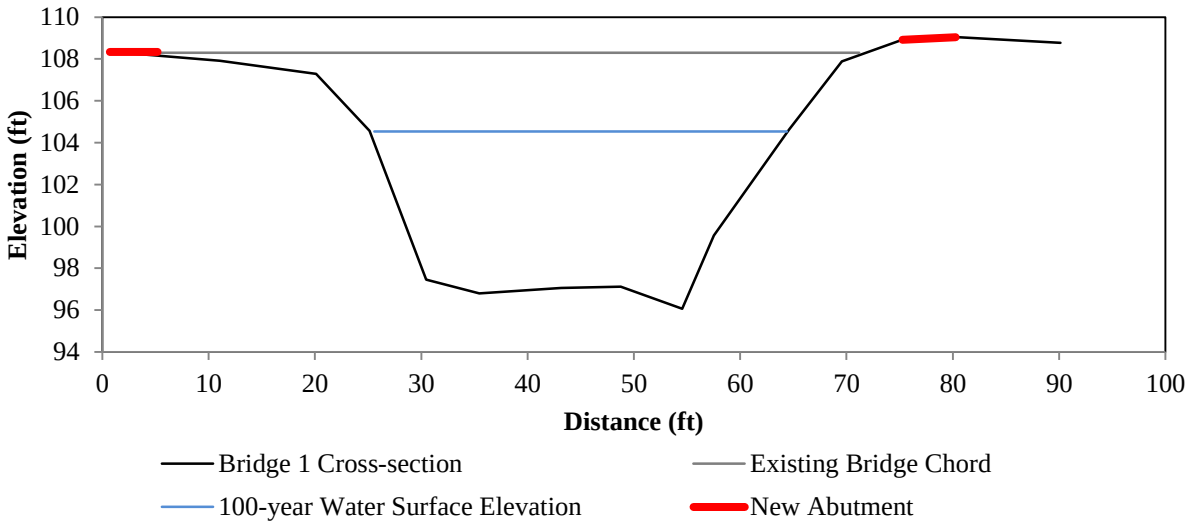

Figure 3. Bridge 1 cross-section with estimated 100-year peak flow water surface elevation (Manning's *n* = 0.06) and existing bridge chord.

Table 1. 100-year peak flow water surface elevation estimates based on variations in Manning's *n*.

Composite Manning's *n*	100-year Water Surface Elevation (feet)	Freeboard (feet)
0.04	103.0	5.4
0.05	103.8	4.5
0.06	104.5	3.8
0.07	105.3	3.0
0.08	105.9	2.4

References

Gotvald, A.J., Barth, N.A., Veilleux, A.G., and Parrett, Charles, 2012, Methods for determining magnitude and frequency of floods in California, based on data through water year 2006: U.S. Geological Survey Scientific Investigations Report 2012–5113, 38 p., 1 pl., available online only at http://pubs.usgs.gov/sir/2012/5113/.

U.S. States Army Corps of Engineers (COE), 2010. HEC-RAS, River Analysis System – User's Manual and Hydraulic Reference Manual. U.S. Army Corps of Engineers, Institute of Water Resources, Hydraulic Engineering Center, Davis, California, CPD-68 and CPD-69.