A Rationale for Phased San Francisquito Creek Flood Control Implementation

By: TC Rindfleisch

On June 10, the Board of Directors of the Santa Clara Valley Water District (SCVWD) held a public hearing on a proposed modification to the San Francisquito Creek (SFC) flood protection project being developed jointly with the San Francisquito Creek Joint Powers Authority (SFCJPA) – see Exhibits A, B, and C for more details. The driving issue is one of funding – there is not enough money available to expeditiously implement a Preferred Plan, which would include upgrades to the creek to contain at least a 100-year flow (9,200 cubic feet per second (cfs)) from Middlefield bridge to the bay.

The dilemma is whether or not we should wait an indeterminate amount of time for enough federal, state, and local funding to be available to start the Preferred Project, or should we move ahead immediately with a lesser Modified Project using available state and local funding. The Modified Project would still raise the capacity of the reach from Hwy 101 to the bay to 9,200 cfs, but would only raise the capacity of the reach from Pope-Chaucer bridge to Hwy 101 to about 7,200 cfs, the peak flow of record for the creek in the 1998 flood.

Following considerable public comment, the SCVWD Board voted unanimously (Director LeZotte was absent) to adopt the resolution to implement the Modified Plan. I believe this to be an advantageous and well-justified decision that goes a long way toward protecting the neighborhoods near the creek. I try to explain why in the following paragraphs.

Terminology:

I will use the following SCVWD terminology to refer to three different alternative plans:

1. **Preferred Plan:** Includes (a) SFCJPA/SCVWD upgrades being planned to raise the capacity of the Hwy 101 to bay reach to 9,200 cfs and to accommodate a projected 50-year sea level rise; (b) an upgrade for the Hwy 101 bridge/culvert system with an added 4th barrel and closure of culvert openings near the highway; and (c) upgrades to bridges from Newell Road to Middlefield Road, widening 4-5 pinch points in the Pope-Chaucer to Hwy 101 reach, and some combination of bypass channel, bank/floodwall improvements, and/or upstream detention to contain flows up to the 100-year flood level (9,200 cfs) throughout the creek below El Camino Real.
2. **Modified Plan:** Includes (a) the Preferred Plan upgrades in the reach from and including the Hwy 101 bridge to the bay and (b) maximally permissible upgrades to the Newell and Pope-Chaucer bridges, widening of 4-5 pinch points in the Pope-Chaucer to Hwy 101 reach, and bank/floodwall improvements up to Pope-Chaucer so that at least 7,200 cfs is safely contained all the way from Pope-Chaucer to the bay. The capacities of the Middlefield and University bridges would remain at their current values, about 7,200 cfs and 7,500 cfs respectively.
3. **Deferred Plan (my term):** Includes all of the upgrades in the Preferred Plan, but implemented in two steps: the Preferred Plan upgrades in the reach from and including the Hwy 101 bridge to the bay would be implemented immediately but the creek upstream of Hwy 101 would remain as is while we wait for sufficient funding to implement the rest of the Preferred Plan upgrades. This means that during the waiting period, Middlefield bridge followed by Pope-Chaucer bridge would continue to determine the creek capacity at about 7,200 cfs and 5,200-5,400 cfs, respectively.

For me, the best way to assess the Modified Plan is to measure its strengths and weaknesses in terms of the flood protection it offers. We can do that by using data from previous actual flood

events, e.g., Feb 1998 and Dec 2012, along with an estimated 100-year, 9,200 cfs flood profile developed by SCVWD. This analysis is a bit complicated to explain in full detail here, but I give an overview below[1].

Calculating creek overflow volume vs peak flood flow:

A "hydrograph" is a profile of the volume of water flowing down the creek over time (cfs versus time). In the following, I refer to three bad-case hydrographs for well-documented flood events:

1. The SCVWD estimated 100-year hydrograph for a 9,200 cfs peak flow.
2. The actual USGS Stanford flow gauge hydrograph from the February 3, 1998 flood (7,200 cfs).
3. The actual USGS Stanford gauge data from the December 23, 2012 near-flood (peak flow 5,400 cfs) that nearly topped Pope-Chaucer. This is included just to illustrate its shape relative to the other hydrographs, but I won't use it in the calculations.

These hydrographs can be scaled to approximate arbitrary peak flood flows and examples are shown in Figure 1. In that plot, I have centered each hydrograph around the time the 1998 flood occurred (February 3, 1998 between about 12:00 AM and 4:00 AM). I've also overlaid indicators of the important flow capacities for each of the three implementation plans above. We note that the hydrographs are similar in shape except that the upper part of the SCVWD 100-yr curve extends over about twice as much time as the 1998 and 2012 USGS flow profiles.

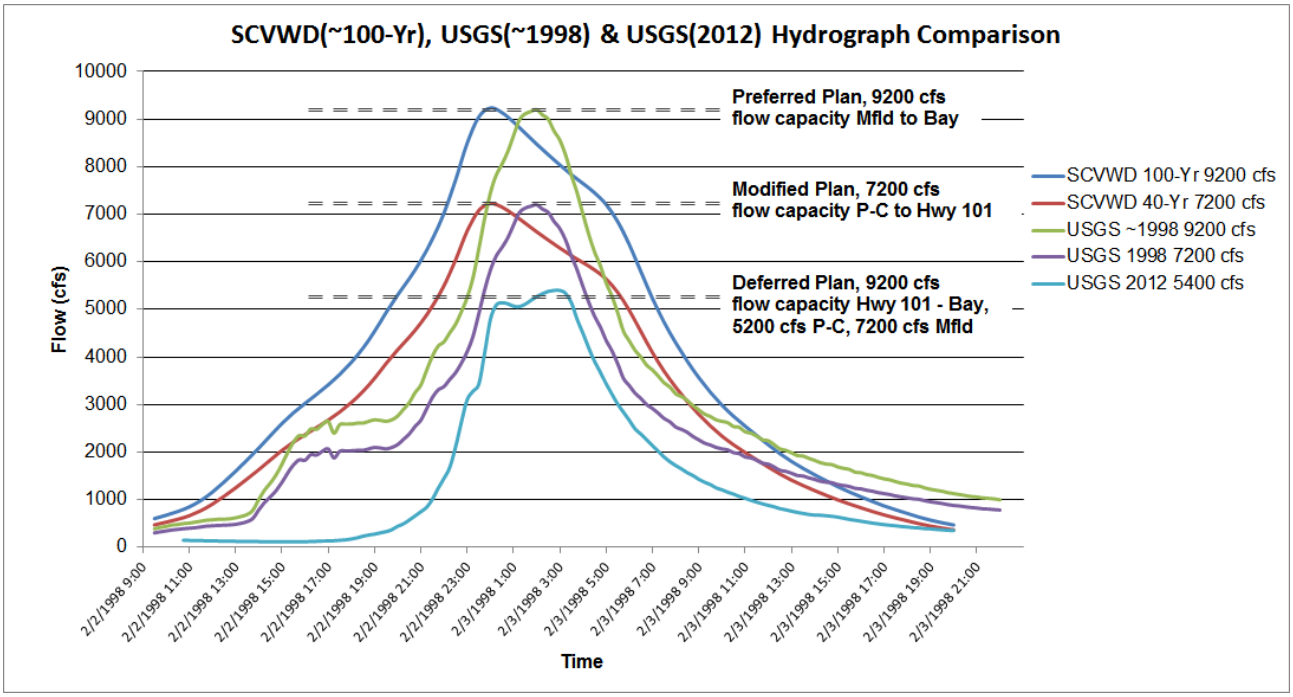

Figure 1: Comparison of model hydrographs for 9,200 cfs, 7,200 cfs, and 5,400 cfs flows in San Francisquito Creek

So to estimate the effects of various flooding scenarios on creek communities in simple terms, I first analyzed the Deferred Plan. I used the first and second hydrographs above (SCVWD and

[1] I'm glad to share with anyone interested the spreadsheet I have developed to do the numerical integrations of the hydrographs and to plot the results.

USGS - 1998) to calculate the overflow volume at the Pope-Chaucer and Middlefield bridges for varying peak flood flows. This was done by scaling each hydrograph to various peak flow values (x axis), and then integrating the area under the resulting curves above the capacity thresholds for each bridge (5,200 and 7,200 cfs respectively). The overflow volumes (in acre-feet) are plotted along the y axis.

Having done this calculation for each of the SCVWD and the USGS - 1998 hydrographs, I then averaged the overflow volumes for each peak flow value and plotted the results in Figure 2.

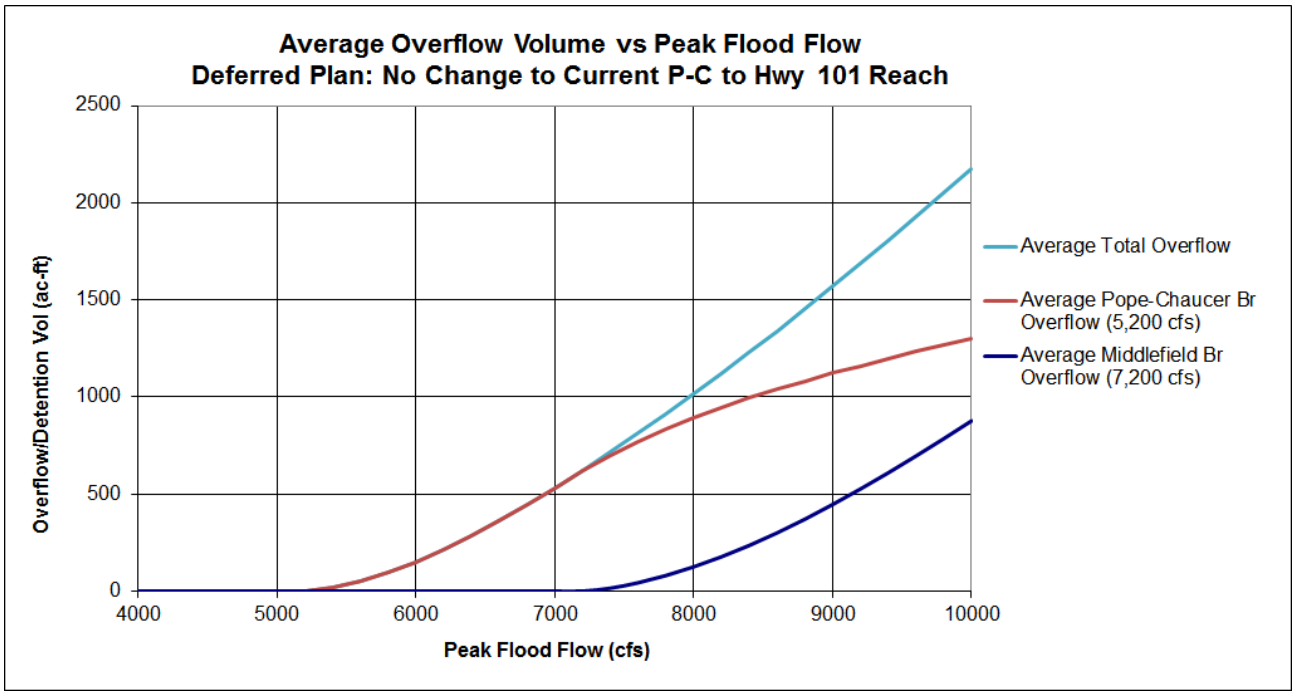

Figure 2: Estimates of the average creek overflow volumes (or required detention volumes) as a function of flooding event peak flow using the SCVWD and USGS(1998) hydrographs

One can see that the overflow volume at Pope-Chaucer (orange curve) begins to rise strongly at its overflow capacity of 5,200 cfs, but then rises more gradually for peak flows above 7,200 cfs. This is because Pope-Chaucer is in the hydrological "shadow" of the Middlefield bridge, which passes a maximum of 7,200 cfs downstream. The Pope-Chaucer overflow volume continues to rise, albeit more slowly, because as the hydrograph for the flood is scaled to higher and higher peak flows, the width of the bell-shaped hydrograph curve at the 7,200 cfs flow level becomes broader and broader, i.e., the downstream 7,200 cfs flow lasts longer at Pope-Chaucer.

We can also see from Figure 2 what the overflow behavior would be for the Modified Plan. There would no longer be ANY overflow at Pope-Chaucer (upgraded to at least 7,200 cfs capacity). Since Middlefield is unchanged, the lower dark blue curve in Figure 2 then would represent both the overflow at Middlefield bridge and the total overflow volume for the Modified Plan.

Conclusion:

This analysis has led me to believe that the advantages of the Modified Plan over the Deferred Plan are clear as shown in Figure 2. For large flows, the total overflow volume into neighborhoods

near the creek is reduced by somewhat over 1,000 acre-feet[2]. Up to 7,200 cfs flows, the peak flow of record for the 1998 flood, there would be no neighborhood flooding under the Modified Plan. Above 7,200 cfs, the overflow would occur entirely at the Middlefield bridge. While that overflow is considerable and I don't want to minimize the potential for damage, at a 100-year flow (9,200 cfs), the overflow at Middlefield bridge would be about 15% less than the estimated average overflow at Pope-Chaucer during a much smaller 7,200 cfs peak flow. Under the Modified Plan, the flooding risk at Middlefield would be no greater than it has been since the bridge was replaced during the 1940s.

Thus, I conclude that the Modified Plan is an excellent intermediate step toward protecting the creek and its neighboring communities from relatively high and infrequent flows. Because the maximum contained flow is less than that of a 100-year flood, these fixes will not remove the FEMA requirement for carrying flood insurance. However, because of the smaller overflow volumes and locations, we might hope that FEMA would reduce flood insurance rates for some properties after the Modified Plan is completed.

During the first decade of the SFCJPA's existence, we spent a great deal of effort trying to obtain substantial federal funding for an Army Corps of Engineers "General Investigation" project and smaller "Continuing Appropriation Projects" – all to little avail. The likelihood of success in obtaining the timely federal funding component needed for the Preferred Plan seems to me to be very small. Sixteen years have now gone by since 1998 without any substantial reduction in the risk of flood damage – in fact we had another near miss on December 23, 2012. I have come to believe that we must take effective action now to protect as much as we can against further SFC flooding.

To paraphrase Voltaire, "We must not let the quest for the perfect that is beyond our reach get in the way of actually achieving the good that is within our reach".

Tom Rindfleisch
(tcr@stanford.edu)

[2] Note that about 625 acre-feet overflow at Pope-Chaucer during a 1998-like flood (7,200 cfs), using the average overflow from the SCVWD and USGS – 1998 hydrographs.