



PAJARO RIVER WATERSHED  
FLOOD PREVENTION AUTHORITY  
Phase 3: Conceptual Design of Soap Lake Preservation Project  
Phase 4a: Design Level Mapping Technical Support



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## Technical Memorandum

Task: **The Value of Soap Lake and the Soap Lake Floodplain Preservation Project**

To: **PRWFPA Staff Working Group**

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The analysis and conclusions in this technical memorandum (TM) emphasize the importance of Soap Lake and the Soap Lake Floodplain Preservation Project. Soap Lake currently attenuates peak flows from the Upper Pajaro River Watershed, upstream of the confluence with the San Benito River. Estimates of the 100-year flood flow at Chittenden, just upstream of Watsonville, range from 40,000 cfs to 44,000 cfs. The Lower Pajaro Levee Project is being designed to pass up to this amount of water safely to the Monterey Bay. Without Soap Lake, the peak 100-year flow at Chittenden is expected to increase to 60,500 cfs, which is well above the current levee design capacity. The levee height would need to be raised significantly to accommodate the higher peak flows.

The remainder of this TM summarizes the analyses performed to quantify the impact that no attenuation in Soap Lake would have on the Lower Pajaro Levee Project. Data, as provided by the U.S. Army Corps of Engineers, is summarized. The additional volume of levee is calculated as a way to scale the estimated cost of the currently proposed levee design to what the cost of the levees would be without Soap Lake. The additional land required for the project is also calculated as a function of the increased height of the levees. At the end of the memorandum, the analyses are summarized and conclusions are drawn from those analyses.

### Data

The U.S. Army Corps of Engineers (Corps) was able to provide the Authority with the height and length of the four main reaches of the main stem of Alternative 2a. Table 1 is a summary of this levee data. The Corps was also able to model an increased flow scenario which represents the lower Pajaro River flow without Soap Lake attenuating the peak flows from the Upper Pajaro River Watershed. Based on work performed for the Pajaro River Watershed Study, this value is anticipated to be about 60,500 cfs. The increased levee height for each reach is also included in Table 1.

**Table 1:** Levee data based on current design of Lower Pajaro Levee Project and likely required levee height increases beyond the current design without Soap Lake. All data has been provided by Eric Thaut and William Firth of the Corps.

	Left Bank			Right Bank		
	Reach 1	Reaches 2-3	Reach 4	Reach 1	Reach 2-3	Reach 4
Length (ft)	14,668	12,628	25,162	18,943	12,306	27,616
Proposed Height (ft)	12.6	11.8	11.5	12.2	11.7	12.8
Add'l Height Required w/o Soap Lake (ft)	3	4	3.5	3	4	3.5

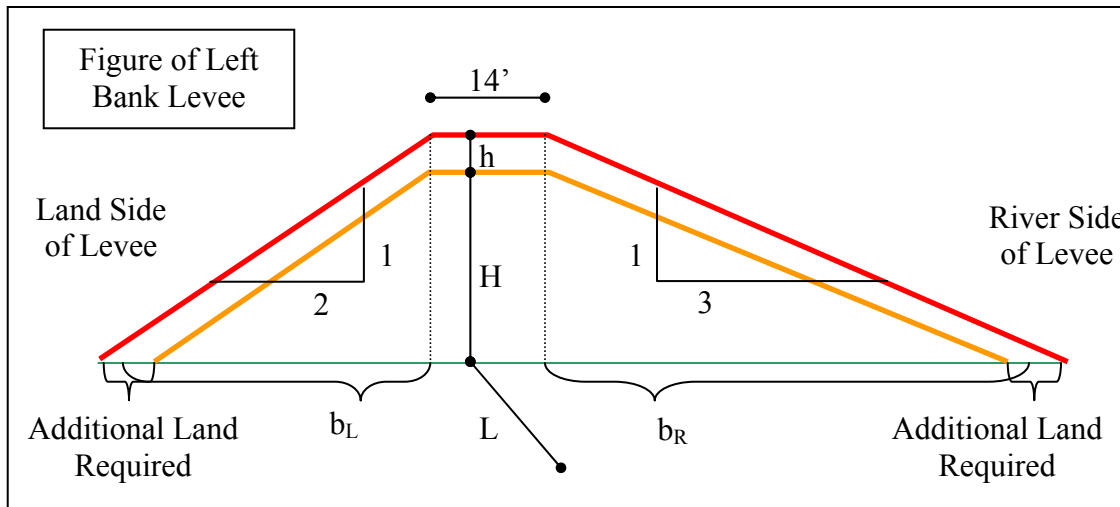
The Corps was also able to provide other important information for this analysis, including:

- Crown width - 14 ft
- Levee slope - 2:1 on the land side and 3:1 on the river side
- Cost as currently proposed - \$112,000,000
- Additional impacts without Soap Lake
  - Might need new bridge for Hwy 1
  - Would need new bridge for Main Street
  - Railroad bridge would need to be altered or abandoned

All of this information will be utilized to identify the value of Soap Lake and the Soap Lake Floodplain Preservation Project in the following sections.

**Analysis**

Before any analysis can be performed, there must be a physical understanding of the shape of the levee. Figure 1 below graphically portrays the shape of the levee and identifies all of the necessary levee dimensions that will be used for the analysis.



**Figure 1:** Graphical representation of the left bank levee shape and the analysis parameters. The right bank levee is a mirror image of left bank levee. H is the current design height of the levee, h is the increase in levee height required to contain the Pajaro River flow without Soap Lake, L is the length of the reach, and  $b_L$  and  $b_R$  are the width of the land-side and river-side levee wings respectively.

The volume of the levee will be calculated based on the levee data provided by the Corps with and without the increased height. The cost can then be scaled to yield an approximation of the cost that would be required to build the larger levee. The amount of extra land needed for the levee footprint will also be calculated.

### Levee Volume

The volume of the levee can be calculated by dividing a cross section of the levee into three pieces represented as simple geometric shapes (rectangles and triangles), determining their area, and multiplying those areas by the length of the reach. In equation form:

$$V = L\left(\frac{1}{2}b_L(H + h)\right) + 14L(H + h) + L\left(\frac{1}{2}b_R(H + h)\right)$$

$$b_L = 2(H + h) \quad b_R = 3(H + h)$$

h is 0 ft for the currently proposed levee design. This calculation needs to be performed for each reach of both banks.

Once the volumes of every reach have been calculated for both the current design and the required design without Soap Lake they can be compared to determine a relative comparison of sizes.

Table 2 is a summary of the above analyses.

**Table 2:** Volume of the levees with and without Soap Lake.

Levee Volume	Left Bank			Right Bank		
	Reach 1	Reaches 2-3	Reach 4	Reach 1	Reach 2-3	Reach 4
With Soap Lake	8.4x10 <sup>6</sup> cf	6.5x10 <sup>6</sup> cf	12.4x10 <sup>6</sup> cf	10.3x10 <sup>6</sup> cf	6.2x10 <sup>6</sup> cf	16.3x10 <sup>6</sup> cf
Without Soap Lake	12.1x10 <sup>6</sup> cf	10.7x10 <sup>6</sup> cf	19.4x10 <sup>6</sup> cf	15.0x10 <sup>6</sup> cf	10.2x10 <sup>6</sup> cf	24.6x10 <sup>6</sup> cf
Difference	3.7x10 <sup>6</sup> cf	4.2x10 <sup>6</sup> cf	5.0x10 <sup>6</sup> cf	4.7x10 <sup>6</sup> cf	4.0x10 <sup>6</sup> cf	8.3x10 <sup>6</sup> cf

The total increase in volume is approximately 30 million cubic feet. This represents an increase of 150 % over the current levee design.

### Cost

To determine the incremental and total cost of the levee without Soap Lake compared to the current design, the current cost estimate was scaled linearly with the increase in volume.

$$Cost = \frac{V[H + h]}{V[H]} * C_i$$

where  $C_i$  is the current proposed cost (\$112 million). The result of this calculation yields the total cost and the incremental cost is obtained by subtracting the two costs.

The incremental cost of the levees without Soap Lake is \$56 million. The total cost without Soap Lake is \$168 million.

### Footprint

In order to maintain the slopes of the current levee design, the footprint of the levee must increase proportionally to the increase in height. The figure above shows center aligned expansion but, in order to maintain hydraulic capacity in the Pajaro River, the levee expansion would more likely the river-side toe as a common point. The total burden of additional land for the levee would then fall to the land side.

The incremental amount of land required for the larger levee is the same as the area of overlap shown in the figure above. The sprawl of the levee is determined by subtracting the base length of the smaller levee cross section from the base length of the larger levee cross section. The land area required is determined by multiplying the levee sprawl by the length of the reach as shown below.

$$Area = L(b_L[H + h] - b_L[H]) + L(b_R[H + h] - b_R[H])$$

As with the volume analysis, this calculation needs to be performed for each reach of both banks. Table 3 below summarizes the results of this analysis.

**Table 3:** Additional land area required to accommodate increased levee footprint required to contain River flows without Soap Lake.

	Left Bank			Right Bank		
	Reach 1	Reach 2-3	Reach 4	Reach 1	Reach 2-3	Reach 4
Additional Land Required	220,000 sf	253,000 sf	440,000 sf	284,000 sf	246,000 sf	483,000 sf

The total additional land required is 1,926,000 sf, equivalent to 44 acres.

### Summary

If Soap Lake were not able to attenuate peak flows, the Lower Pajaro Levee Project would be impacted in the following ways:

- **Additional Cost** - \$60 million
- **Additional Land** - 44 acres
- **Other Impacts** - Might need new bridge and approach at Hwy 1; Would need new bridge and approach at Main Street; Railroad bridge would need to be modified to accommodate 4+ feet of levee on either side of the railroad line or be abandoned.

### Conclusion

The Lower Pajaro Project may not be feasible without the Soap Lake and its attenuation of large peak flows. The levee cost alone would be about 50% higher than the current estimate. The railroad bridge would need to be modified to accommodate levees on either side of the railroad line that are over four feet above grade. An alternative is to abandon or reroute the railroad line and remove the bridge completely. Rebuilding two of the major bridges in the area would add significantly to the cost and cause a huge public disruption as the bridges were rebuilt and the bridge approaches built-up and modified. Farmers and local residents would also need to give up an additional 44 acres of land to accommodate the increased levee height.