

Calibration of a Steady Flow Hydraulics Model Workshop

Introduction

This workshop will help students learn how to use HEC-RAS to calibrate a steady flow hydraulics model. Students will learn how to adjust parameters to replicate observed water surface elevations for three different observed events. *While this data is from an actual study, the model and results of this workshop do not represent current or future conditions of the river system. This data is provided as a teaching example for purposes of instruction only.*

Background

In 1958, a plan was developed to increase water supplies and generate power for California's Central Valley in part by transferring water from the Trinity River into the Sacramento River. Completed in 1964 for these socially and economically important purposes, the Trinity River Division (TRD) of the Central Valley Project began a decades-long era wherein up to 75-90% of the inflow to Trinity Lake was exported from the river each year. Figure 1 shows the Trinity River below Lewiston Lake near Weaverville, CA. Lewiston Lake is a flow re-regulation lake that is just below Trinity Dam (Trinity Lake).

As you would expect, the natural flows in the Trinity river have changed dramatically since 1964. While sediment supply was being cut off from upstream, more importantly, natural annual flood flows were being cut off from the Trinity river. Prior to the TRD, stream flows varied greatly between and within each year. In a given year, flows could range from as low as 100 cubic feet per second (cfs) during the summer up to over 100,000 cfs during rare rain-on-snow floods. After the TRD was complete, flows were held between 150 cfs and 300 cfs year-round except for occasional storm-response reservoir releases, the largest of which was 14,500 cfs in 1974.

There are many downstream tributaries that come into the Trinity river below Lewiston Dam. Because of the dramatic decrease in flow rates, finer sediments have deposited and filled in the gravel beds that use to support spawning grounds for Chinook salmon and Steelhead. These finer sediments have also allowed tremendous riparian vegetation to take hold on the banks of the main channel, as can be seen in the photos in Figure 2 and Figure 3.

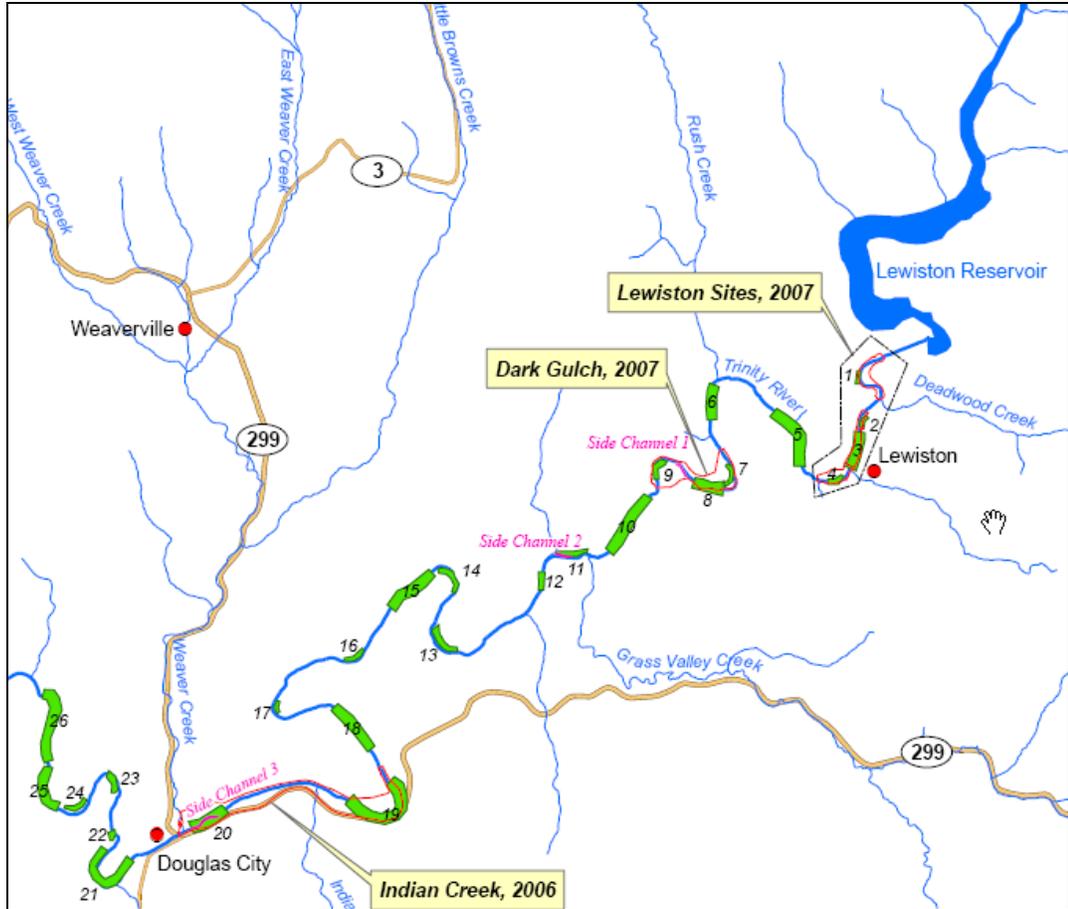


Figure 1. Trinity River below Lewiston Lake near Weaverville CA.



Figure 2. Typical Stream photos of the Trinity Below Lewiston Dam.



Figure 3. Additional photos of the Trinity River Below Lewiston Dam.

Problem Description

A project file (**CalibrationWorkshop.prj**) with the title “**Calibration Workshop – Trinity River CA**” has been loaded on your workshop computers. This file contains all the data for this workshop. This model is a short reach of the Trinity River (about 5 miles) below Lewiston Dam, in the area from just above the Indian Creek tributary down to the confluence with Weaver Creek, near Douglas City. All of the Geometry and flow data are already in the project file.

The flow data file contains three events: 450 cfs (a typical summer low flow); 4500 cfs and 7000 cfs, both of which were controlled releases from Lewiston Dam. Observed high water marks were surveyed for all three events, and have already been entered into the flow data editor.

This model was originally calibrated to all three of these events. For the purpose of this workshop, all of the main channel Manning’s n values have been set to 0.02 (which is lower than the true final calibrated values). Some hydraulic information about the main channel is as follows:

1. Average Stream Bed Slope = 0.0023 ft/ft
2. Typical Hydraulic Radius values for the main channel at bank full stage range from approximately 4.0 to 6.0 feet.
3. D₈₄ of the bed material in this region has been measured around 80 mm (0.262 ft)
4. Main channel banks contain thick stands of trees and vegetations as shown in the pictures above.

Tasks

1. **Make initial estimates of the main channel Manning’s n values using the Limerinos and Jarret equations:**

Limerinos Equation:

$$n = \frac{0.0926 R^{1/6}}{1.16 + 2.0 \log \left(\frac{R}{d_{84}} \right)}$$

Where: R = Main Channel Hydraulic Radius in feet
D₈₄ = Material size of which 84% of the bed is finer (feet)

Jarrett's Equation:

$$n = 0.39 S^{0.38} R^{-1.6}$$

Where: S = Average Bed Slope (ft/ft)
R = Main Channel Hydraulic Radius (feet)

Calculate a Manning's n value for the main channel from both equations, but select a single value to start with as your initial estimate that you put into the HEC-RAS model.

2. Adjust the main channel Manning's n Values based on your calculations from Task 1, run the model and review the results, then answer some questions.

Note: The easiest method of adjusting Manning's n values for multiple cross sections is the **Manning's n or k values...** table located in the **Geometric Data Editor** under the **Tables** menu. See Figure 4 below.

	River Station	Frctn (n/K)	n #1	n #2	n #3
1	97.35	n	0.031		
2	97.29	n	0.031		
3	97.22	n	0.031	0.09	0.031
4	97.16	n	0.031	0.09	0.031
5	97.11	n	0.031		
6	97.04	n	0.031		
7	96.95	n	0.031		
8	96.89	n	0.031		
9	96.82	n	0.031		
10	96.75	n	0.031		
11	96.66	n	0.031		
12	96.6	n	0.031		
13	96.53	n	0.031		
14	96.45	n	0.031		
15	96.31	n	0.031		
16	96.2	n	0.031		
17	96.12	n	0.031		

Figure 4. Manning's n value Editor Table.

Note: The easiest way to use the Manning's n value table to change the main channel n values is to first select to view "Main Channel Only" from the drop down box at the top of the editor. Also, once any changes are made in this editor, you must press the "OK" button to close the editor and have the changes accepted before running the model.

Run the model with your initial set of main channel manning's n values. Then answer the following questions:

Question 1: What Manning's n value did you use for an initial estimate for the main channel?

Question 2: How well does the model calibrate to your initial run? Is it predicting too high or too low of water surfaces compared to the observed data?

Question 3: Given the results of your initial run, what you were told about the river, and from viewing the pictures above, in which direction do you think the main channel n values need to be changed, and why?

3. Calibrate the main channel n values to match the observed data.

Adjust the main channel Manning's n values to better match the observed data. Concentrate mostly on trying to match the 4500 and 7000 cfs profiles. Start downstream and work your way upstream. Remember to change Manning's n values over a reasonable range of cross sections, not just one cross section at a time.

After you think you have the model calibrated reasonably, answer the following questions:

Question 4: What was the final range of main channel Manning's n values that you ended up with in order to calibrate the model?

Question 5: Did you have to vary the Manning's n values from upstream to downstream in order to calibrate the model? If so, explain why?

Question 6: Were there any areas of the model that you feel could benefit from using a variable roughness coefficient, such as the Flow vs. Roughness factors option?