CONVERSION OF THE LOWER HASSAYAMPA HEC-6 SEDIMENT TRANSPORT MODEL TO HEC-6T

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Date: July 18, 2012

To: Bing Zhao – District

Cc: Richard Waskowsky – District

From: Brian Wahlin – WEST
Brent Travis – WEST
Chuck Davis – WEST

WEST CONSULTANTS, INC.

INTRODUCTION

The existing HEC-6 sediment transport model for the Lower Hassayampa River was converted to HEC-6T for use in Monte Carlo simulations. This memorandum outlines some of the issues encountered during the conversion process and documents the results.

NOTES ON THE CONVERSION PROCESS

The following are some general notes designed to documents some changes to the model during the conversion between HEC-6 to HEC-6T.

1. HEC-6T uses the $SEG record to describe how to link the branches of the network together while HEC6 uses QT records to indicate a tributary control point. This is a single reach model; however, this change was included anyway.
2. HEC-6T uses the $SEG record to define new tributary locations while HEC6 uses the $TRIB record and the follow-up CP record describe tributaries and their respective control points.
3. The last PFC records for both RS's 0.35 and 27.89 had some extra spaces or tabs after the 4th field. These spaces or tabs worked with HEC-6 but did not with HEC-6T. The extra spaces/tabs were removed.
4. In the NV record in HEC-6T to specify an *n*-value vs. discharge table, only the **first** *n*-value placed in Field 2 should be listed as "negative" (note that the negative sign just alerts HEC-6T that it is an *n*-value vs. discharge table and not *n*-value vs. stage table).

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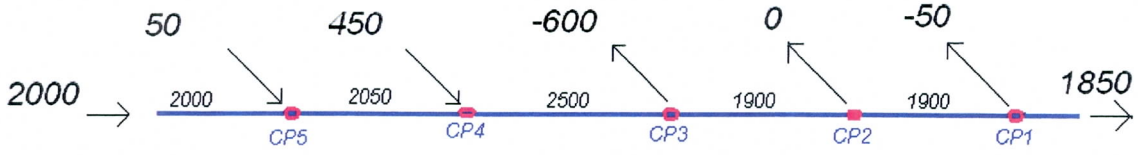
The rest of the *n*-values in the row should be entered as positive numbers. In HEC-6, all of the *n*-values (in each of fields 2, 4, 6, and 8) need to have the "negative" sign.

5. In HEC-6, conveyance limits are prescribed using the XL record. This limits the hydraulic conveyance as well as the erosion within the defined conveyance limits. In HEC-6T, the XL record **only** limits the hydraulic conveyance. To limit erosion, the HE record must be used. To match HEC-6 erosion limits, the HE record (in HEC-6T) were changed to have same limits prescribed in the XL record.
6. The only noticeable difference in sediment data entry between HEC-6 and HEC-6T is on the LFL record for diversions. In HEC-6T, the second and third fields get a "fraction of the approaching concentration to assign to the outflow". In HEC-6, these fields get a "diversion coefficient" which is defined as "the ratio of diverted sediment concentration to the ambient channel concentration." We believe this means the same thing. Thus, no changes were made to this record during the conversion. Note that for the Lower Hassayampa HEC-6 model, all of the diversions are set to "1", which indicates that the original user wants **all** of the sediment concentration to leave with the diversion.
7. The Q record was the biggest change when converting from HEC-6 to HEC-6T. In HEC-6, the first field retrieves the discharge at the downstream end of the model. The successive fields retrieve the local inflow or diversion for the next upstream control point. In HEC-6T, the first field is the inflow at the first (downstream most) control point. The second field is the inflow at the second control point, etc. So the last field should have the flow entering the upstream end of the model. For example, let's say we have this setup:



In HEC-6, this would be coded in the Q record as follows:

Q 1850 -50 0 -600 450 50

In HEC- 6T, this would be coded in the Q record as follows:

Q -50 0 -600 450 50 2000

This change was made to all of the Q records in the input file.

8. The T records are slightly different in HEC-6T. They correspond to the discharges entering a branch at the upstream end. HEC-6 applied the temperatures to the outflow locations of each branch. In the case of Lower Hassayampa River, all temperature values are set to 67°, so the T records will look the same between HEC-6 and HEC-6T.
9. For HEC-6T, in the X3 records, if an encroachment elevation is given at a station that does not exist in the GR records, that station is created and the elevation is applied to it

for an adjusted station-elevation set. If the elevation entered in the X3 card is mistyped, this can lead to major problems. HEC-6 does not appear to copy the bad elevation into the new set of station elevation points, so it does not have this issue. In the Lower Hassayampa River HEC-6 model, cross-section 6.42 and 6.33 both have an elevation of 130 ft set in the X3 card. This is well below the natural bed elevation. Based on the existing geometry, we believe the intent was for this elevation to be 930 ft, not 130 ft. The cross-sections where this was a problem, and how they were changed on the X3 record are shown below:

6.33	130	→	930
6.42	130	→	930
7.66	930	→	980
7.75	930	→	981
10.02	995.5	→	1001
17.29	1151	→	1161
23.63	1293	→	1298
24.01	1293	→	1330

COMPARISON BETWEEN HEC-6 AND HEC-6T MODELS

Results for the simulations of the Lower Hassayampa River using HEC-6 and HEC-6T are not identical; however, they are close. A check on the $VOL table reveals that most of the cross sections have sediment passing, and sediment deposition quantities within 10%. In the downstream end of the reach, these percent differences approach 20%. In examining the output, we believe that most of these differences are due to differences in hydraulic computation schemes between HEC-6 and HEC-6T; however, we have not been able to find documentation of the computational differences (other than the ones discussed above). It is also possible that there are round-off errors that, over the entire simulation, build upon each other to more significant differences. The output file for HEC-6 tends to present numbers with generally less significant digits than what is presented in the HEC-6T output. This is quite possibly only a display issue, but if the numbers stored in internal memory during the respective simulations are stored with a different number of significant digits, that could very well explain the differences.

The Bed Change Plot (see Figure 1) shows that the overall trend in scour and deposition is captured consistently by both models.

There are some odd cross-sections in the Lower Hassayampa River HEC-6 model that could also explain some differences. An example of a poorly constructed cross-section is shown in Figure 2. It could be that HEC-6 and HEC-6T handle poorly constructed cross sections like this differently.

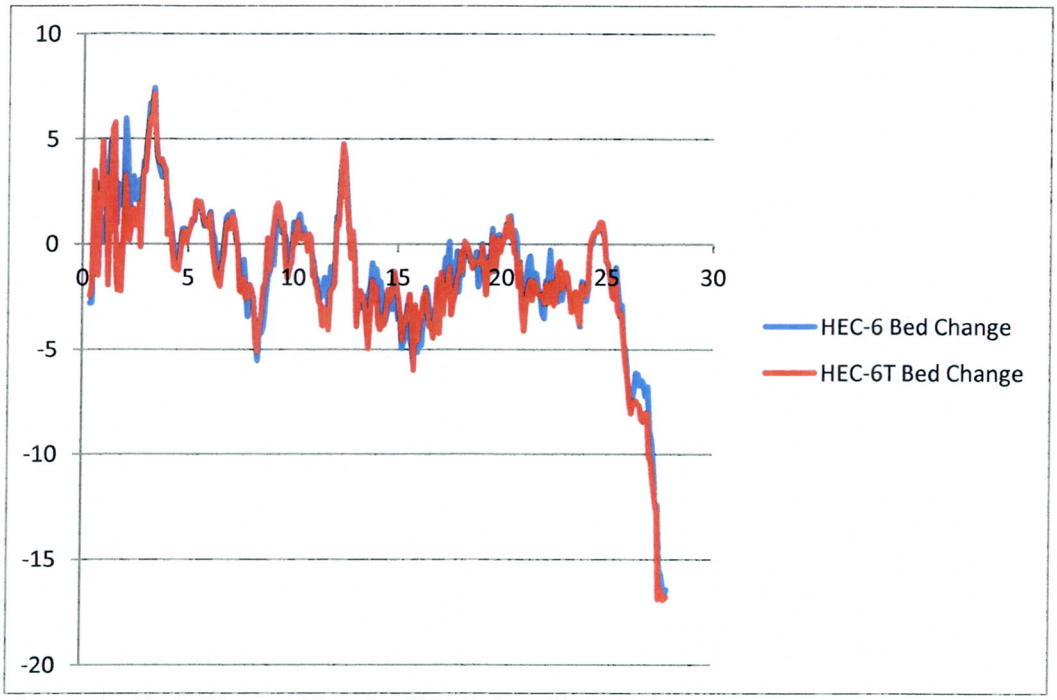


Figure 1. Bed Change Plot for HEC-6 and HEC-6T

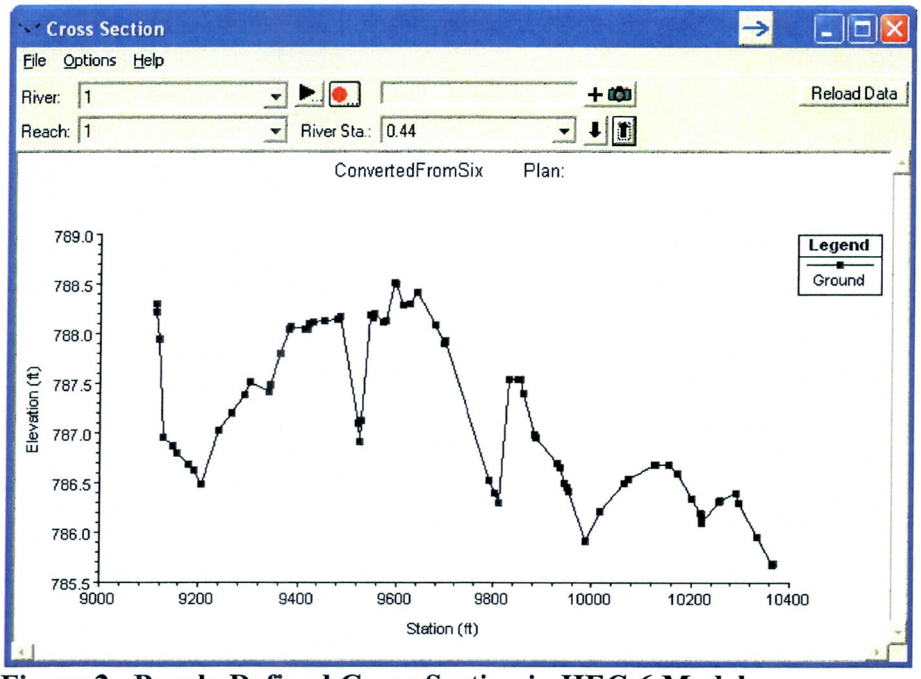


Figure 2. Poorly Defined Cross-Section in HEC-6 Model