Chapter 7

Reviewing the HEC-2 Formatted Output File

The HEC-2 output file contains information that cannot be obtained from the TAPE95 file. This chapter describes the HEC-2 output file and gives some guidelines for the review of output. Because the program is basically designed to continue computations if possible, the fact that the program executes a complete job does not necessarily mean that the results are good. The user must carefully review the results to ensure that they represent the study reach and that they are reasonable and consistent.

7.1 Printout Sequence

The HEC-2 output file starts with a banner blocked off with an asterisk (*). The banner gives the program's release date, last update, and an error corrections and modifications list. The error corrections represent updates that corrected deficiencies or errors in the program. As errors are discovered, they are corrected and documented. After several have been found, the program is updated, and all program users are notified. The modifications represent enhancements to the program. The Foreword in the User's Manual gives a summary of the program modifications.

The data input for the first profile (T1 through EJ records) is listed below the banner. There is an input option to suppress the input listing, but this is discouraged. Most problems with the program execution come from input problems. Therefore, it is extremely helpful to have the input data for the job listed with the output.

Following the input listing, the output for the first profile is printed, starting with the ***PROF 1** note. The printout for each section consists of a block of forty variables that are displayed at the top of the page. The values for those variables are displayed in the same spatial arrangement as the variable list. Appendix VI Output Data Description, gives the definition of all the variables displayed. The section number (SECNO) is listed in the upper left-hand corner for easy reference; also ***SECNO #** is printed before the output display for each section.

Following the printout for each section, the program provides a printer plot of the profile. Output for Test 1 gives an example of the profile printer plot. With the availability of PLOT2 to plot profiles graphically, there is little added value to the printer plots. They can be suppressed by setting the variable PRFVS (J2.3) to minus one for each profile computed.

The second and subsequent profiles start with an input listing for that profile, which consists of the title and job records. There are no other data for the subsequent profiles; the remainder of the data are the same as the data listed at the beginning. After the input listing, the sequential output for the second, or subsequent, profile is printed. The sequence is repeated until the last profile output is printed.

Following the last profile, the summary printout is provided. The summary tables are defined by the data provided on the J3 record, or there is a default table if the J3 record is omitted. For

additional summary tables, the program SUMPO can provide the same tables interactively using the TAPE95 file from HEC-2.

The output file will also contain printer plots of cross sections, if requested. The IPLOT variable (J2.2

or X1.10) requests the cross section plot for all the sections in a profile or a single section, respectively. However, with the graphic cross section plots available from PLOT2, the printer plots are not usually requested.

7.2 Special Notes

Throughout the sequential cross section printout there may be informational notes. Some notes provide general comments like the initialization of contraction and expansion coefficients (e.g., CCHV= 0.100 CEHV= 0.300) or use of the NH record (1490 NH RECORD USED). Other notes indicate potential computation problems (e.g., 1340 RECORD NOT RECOGNIZED).

The notes are usually printed with a number and message. The number is the statement number in the HEC-2 program where the message is generated. To locate the message source, the program source listing would be required. However, the User's Manual Appendix V, Special Note Listing, explains special notes that commonly appear as part of the normal sequential output. The notes are listed in the order of their statement number.

The Special Notes should be carefully reviewed to assure there are no computational problems identified by the program. If the note message and the explanation in Appendix V are not sufficient for you to understand the problem, contact HEC for additional explanation.

7.3 Reviewing Output File with Program LIST

The LIST program is a public domain utility that provides a convenient way of viewing text (ASCII) files on the screen. It has the advantage of allowing you to shift your view of the output from left to right, as well as up and down. Because the standard output file from HEC-2 is 132 characters wide, the ability to shift your view of the output file in all four directions makes it easy to scan an entire output file on an eighty-character screen.

The program uses the cursor control keys in a logical manner. **<Page Up>** and **<Page Down>** moves you up and down through the file in blocks of text. **<Up>** and **<Down Arrows>** move you one line at a time. **<Left>** and **<Right Arrows>** shift the text left and right twenty columns. **<Home>** and **<End>** keys move you to the beginning and to the end of the file.

Help is called with the **<F1>** key or a question mark **<?>**. The Help file list includes the commands and the control keys to call the commands. Often, several logical choices of control keys are used to call a command.

Escape key **<ESC>**, as well as the letters **<Q>** and **<X>**, will terminate the program.

MENU2 calls LIST when you select **"4. Display output to console"**. To execute LIST as a separate program, from the DOS prompt enter:

LIST "filename" (also enter: drive: and \pathname\ if required)

If you don't include the "filename", the program will respond:

Enter file name:

Input the filename, and the program will display the first block of text in the file. Also, there is a partial list of program commands shown at the bottom of the screen. The program makes it easy to view the output file on the screen. There is also a print on/off switch, called by the letter **<P>**, which sends the viewed output to the printer. This feature makes it easy to print selected portions of the output file.

7.4 Output Review

Generally, **the summary tables are the first place to review output** for a large job. The summary gives a total view of the multiple profile job; it would also show whether the entire job executed. If you did not request a summary table, the program SUMPO can be used to generate summary tables from the TAPE95 written by the HEC-2 run. See Chapter 8 for a description of the SUMPO program.

The end of the summary table has the **SUMMARY OF ERRORS**. This listing provides some of the more important error messages and notes from the sequential output. The notes are written with the section number, profile number and error message. These error messages are the same as the special notes provided in the sequential cross section printout. **Review the notes** to see if there are computational problems. Some notes, like "**Critical Depth Assumed**," may be an indication that there are problems with some of the section solutions.

From the data provided by **Summary Table 150**, review the computed water surface elevations (CWSEL), the CWSEL difference for each profile (DIFWSP), and the CWSEL difference between sections (DIFWSX). If increasing discharges were used in each profile, one would expect to see the water surface elevation at a section increasing. As the solution steps upstream, for a subcritical profile, the water surface should generally increase. The increase between sections should be similar for the profiles. The review process should look for inconsistencies. The reviewer should be able to predict and explain the solution obtained.

Top width (TOPWID) is another important variable to review. The HEC-2 program does not check on consistency of top width between cross sections. It is possible to obtain a solution that shows a width of 5,000 feet at one section and five hundred feet at the next section, a short distance away. Often the varying top width is a result of the flow being in the channel at one section and in the overbanks at the next section. The reviewer must decide whether the transition is physically possible.

In cases where the overbank flow only appears at one section, and not at the adjacent upstream or downstream sections, it is obvious that the flow cannot be fully utilizing the overbank area at the one section. At locations where radical changes in top width occur, determine with the aid of a topographic map the path that the flow is likely to follow. Compare the mapped path with the cross section location and orientation used in the model. There may be a need to add or modify the cross section definition based on the initial model results. Remember that the model should only have the conveyance portion of the cross section. Ponding areas should not be included unless developing storage-outflow data for flow routing.

Another way to check the continuity of flow between sections is by comparing the flows in the three flow elements (QLOB, QCH, QROB) from section to section. An alternative approach is to look at the percentage of flow (QLOBP, QCHP, QROBP). Flow distribution should not vary too greatly from one cross section to the next. It would be unreasonable for seventy percent of the flow to be in the left overbank portion of one cross section and none of the flow in the left overbank of an adjacent section. If that occurs because of ponding, then that area should not be included in the conveyance calculations. The effective area option, IEARA (X3.10 = 10), is often used to eliminate ineffective overbank areas from conveyance calculations.

Review the energy loss computation. A good variable to review, from section to section, is the energy slope (SLOPE). The slope is very sensitive to changes in conveyance. No matter which method is used for averaging energy slope between sections, the change of slope between sections should not be too large. If, from one cross section to the next one upstream, SLOPE decreases by more than fifty percent, or increases by more than one hundred percent, the reach length may be too long for accurate determination of energy losses. Adding more cross sections would be advisable.

The **conveyance for a section (.01K)** is also a good variable to review, in the manner described above for SLOPE. The conveyance ratio between upstream to downstream cross sections is provided by variable KRATIO. The 1988 version of HEC-2 provides a warning message if KRATIO is less than 0.7 or greater than 1.4. Additional cross sections should be added when the ratio is outside this range and the length between the sections is large. In some cases, such as near structures, this warning may be generated yet the solution may be valid; the engineer performing the application must make the final judgement.

The review of summary output often raises a number of questions. The sequential output file should be examined to determine the reasons for the observed inconsistencies. The review process must answer the "why did it happen" and "is it reasonable" questions.

The **Special Notes** should all be reviewed. Often they will provide clues to computational problems.

Critical Depth solutions should be examined. The program will often revert to a critical depth solution when the computation process cannot find a balance between the assumed and computed water surface elevation. Many times this is a result of large changes in conveyance between cross sections that are too far apart. The usual solution is to add more cross sections. Also, there is an option (J6.1) to have the program select the equation for computing the friction losses based on the flow conditions. Sometimes this approach will provide a solution balance, but it is not a substitute for a sufficient number of cross sections.

Interpolated cross sections should be carefully reviewed. Using the program option (J1.7) for providing interpolated cross sections is generally discouraged. The interpolated section is only provided when the change in velocity head between sections exceeds the given value for HVINS. This means that there may be interpolated sections in one profile and not in the next. The interpolated sections will be based on the current given section adjusted in elevation and width-based change in elevation between the two sections and the area ratios for the channel portion of the cross sections. Sometimes the adjustments are not reasonable. It is generally recommended that interpolated sections be inserted by the user.

Check the **velocities** in the cross sections. Very high velocities and large changes in velocities between sections may indicate problems with the model data. Are the velocities shown realistic for the study reach?

Review every bridge solution carefully. The sequential cross section output displays are the most complete presentation of the bridge solution. The HEC-2 predefined Tables 100 and 105 are helpful for a summary table review of special bridge solutions. Table 100 provides the variables associated with the energy loss computations at the special bridge. Table 105 provides the distribution of flow and energy losses for the four cross sections in the vicinity of the special bridge. Both tables will provide the information for every special bridge in the data set.

Special Bridge results in the sequential cross section output should be reviewed for the transition of flow up to and away from the bridge. The computation sequence and total structural losses, computed within the special bridge routine, should be reviewed. Appendix IV, in the HEC-2 User's Manual, describes the application of the bridge routines. Program users should be familiar with the material in that text. In Appendix IV, "Figure 3. Special Bridge Method General Logic Diagram", shows the solution process. By following the diagram, the special bridge solution can be traced. If there is a problem with the solution, the basis for the critical decision in the routine and the necessary input changes to alter the solution can be determined.

Normal Bridge solutions need to be carefully reviewed too. The bridge is processed as a cross section, and the output is essentially the same as any other section in the sequential output. There are no checks for pressure or weir flow conditions. Therefore, the user must carefully review the solution with respect to the water surface elevation and where it is within the bridge. The program distributes flow in the section based on the distribution of conveyance. The computed water surface elevation could be within the bridge or over the bridge deck. No special notes or messages are provided to indicate the pressure or weir flow condition.

Look at the input data first for the source of errors. If the data ran before, assume that some change you made caused the problem you see. With the input and editing process, it is easy to make mistakes. If there is a read error, look at your input file with program LIST. It will show illegal characters. Look at the input listing from HEC-2. That shows what the program used for the solution at hand. While a program error is possible, usually the source of your errors is in that listing.

Sketch the cross sections and the computed flow path on a topographic map. This will give a general picture of the model results. It is also a convenient way of checking the output from the program, by comparing it with the map representation of the study reach.

The program user should **treat the input data for the study reach as an initial model**. It is reasonable to expect several iterations before the data are properly assembled. The first level is usually based on the physical nature of the study reach. The basic input errors should be mostly found by the EDIT2 program. Then the HEC-2 results are reviewed for consistency and reasonable results. The initial model was based on the expected flow of water through the study reach. Sometimes the results are not consistent with the initial assumption. The model then must be redefined to reflect the added information gained from the initial results.