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Hydrologic Engineering Center

New Developments in HEC Programs for Flood Control

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14. ABSTRACT

Since the Hydrologic engineering Center (HEC) started in 1964, it has been developing and distributing computer programs. The evolution has been toward packaged programs that perform a variety of computation options, often with a choice of methods. Two examples are the flood runoff computation options of the HEC-1 Flood Hydrograph Package (HEC, 1981) and the variety of capabilities in the HEC-2 Water Surface Profile Program (HEC, 1982). The increased speed and memory available on the microcomputer makes these programs practical to use in this environment. Now that these batch programs have been converted for use on micros, what new developments are underway and what might be the next direction for new computer programs? The Center's current program development for flood control, with an emphasis on water surface profile computation, is presented.

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NEW DEVELOPMENTS IN HEC PROGRAMS FOR FLOOD CONTROL

Vernon Bonner, M. ASCE*

Since the Hydrologic Engineering Center (HEC) started in 1964, it has been developing and distributing computer programs. The evolution has been toward packaged programs that perform a variety of computation options, often with a choice of methods. Two examples are the flood runoff computation options of the HEC-1 Flood Hydrograph Package (HEC,1981) and the variety of capabilities in the HEC-2 Water Surface Profile Program (HEC,1982). The increased speed and memory available on the microcomputer makes these programs practical to use in this environment. Now that these batch programs have been converted for use on micros, what new developments are underway and what might be the next direction for new computer programs? The Center's current program development for flood control, with an emphasis on water surface profile computation, is presented.

Introduction

The HEC-2 computer program was developed at HEC by Bill S. Eichert (Eichert,1968). The present version is the product of development involving several HEC engineers. The basic computational capabilities for calculating water surface profiles remain essentially unchanged; however, supplemental capabilities have been added over the years.

In response to a high demand from both the Corps and private engineering sectors, the HEC implemented HEC-2 for MS-DOS compatible microcomputers (PC) in 1984. The edit program for HEC-2 data (EDIT2) was also implemented at that time. The PC program distribution started in the fall of that year. The programs were modified to meet Fortran 77 standards. The PC versions maintained all the capabilities of the original mainframe version of the programs, except for internal trace and comment information.

For the past two years, HEC program development has focussed on providing a more convenient set of programs

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for PC use. The package of programs described here reflects our attempt to bring together all the necessary tools to accomplish a complete computation and display of water surface profiles on a personal computer. Refinements to the programs, to take advantage of the unique capabilities of the PC, will continue as funds are available.

Overview of the HEC-2 Package

The basic steps for computing water surface profiles include: (1) develop a data file representing the physical reach under study, (2) check the data file for proper format and data errors, (3) compute water surface profiles, (4) review and evaluate computed results, and (5) produce required displays of computed results. The computational process is illustrated in Figure 1. The programs provided with the HEC-2 package provide the necessary tools to accomplish all the basic steps on a PC.

Almost any computer file text editor can be used to create and modify an input data file for the HEC-2 program. The Corps' editor, COED (HEC,1982), has been develped with some features specifically designed around the HEC format for computer program input. COED will take data in free-format and place the input data in the format expected for HEC-2. It also has a HELP file for documenting available commands and a file for HEC-2 input variables.

Checking an HEC-2 input data file is facilitated with the EDIT2 computer program. The program provides tests for proper input sequence, format, and data ranges. Running the input data file with EDIT2 is recommended to assist in locating input errors. Also, the program can convert a "Free-Format" input file to the "Fixed-Format" required by the HEC-2 program.

The HEC-2 program operates with the input data file to compute the water surface profiles. The optional capabilities, provided in the program, can also be used to solve many flood plain hydraulic problems. The PC version of the program provides the full range of capabilities available on the mainframe version of the program.

Once the profile computations are complete, the job of reviewing the results begins. Besides the HEC-2 printed output file, computer program SUMPO can provide summary tables of results and computer program PLOT2 can provide graphical displays. Both programs operate interactively with an unformatted file from HEC-2. SUMPO provides the summary table capability of HEC-2. The PLOT2 program duplicates most of the capabilities of the Hydraulics Graphics Package (HEC,1980), which produces HEC-2 cross

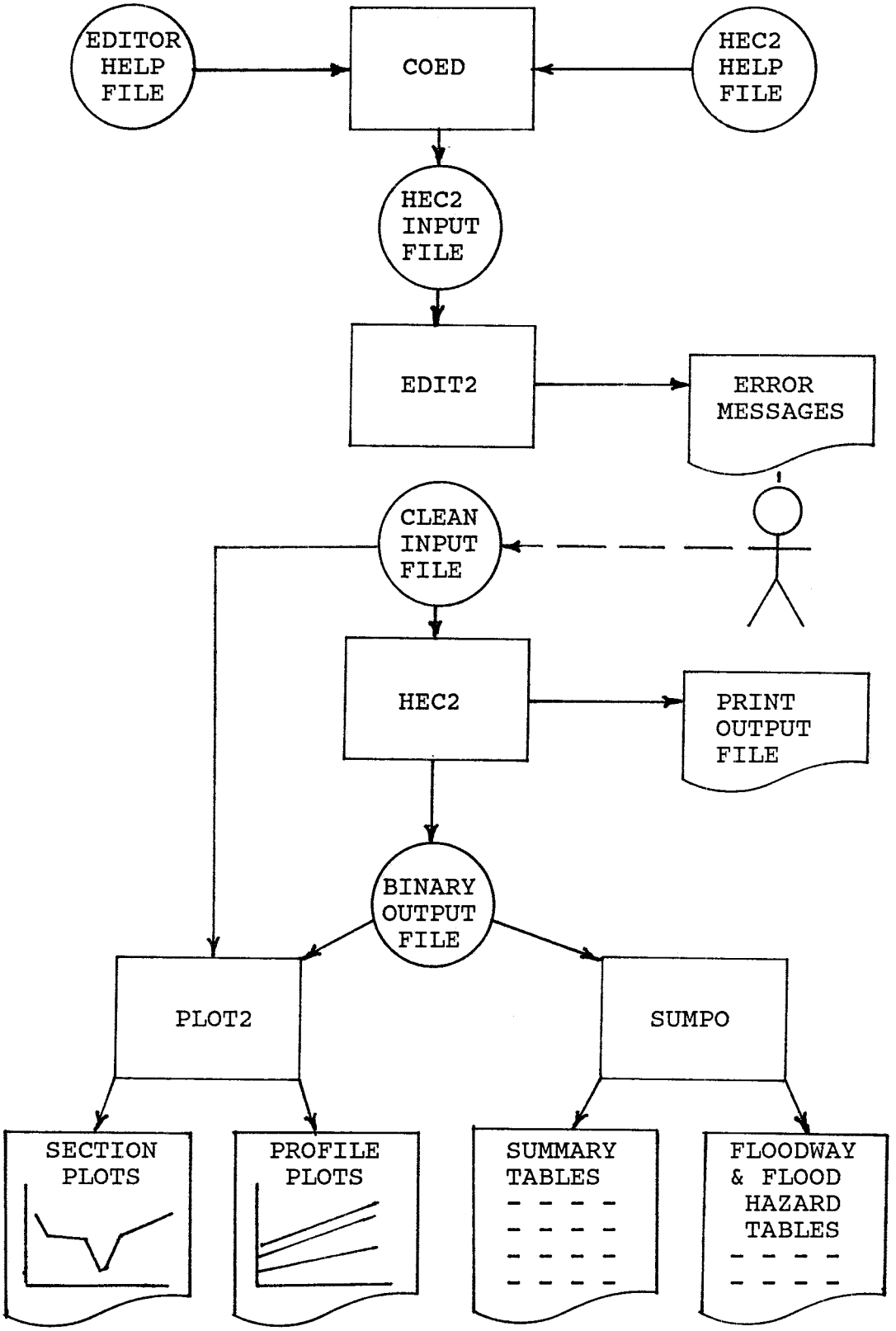

Figure 1. HEC-2 Computational Process

section and profile plots in interactive or batch modes on the Corps' mainframe computers.

Program Support

The primary documentation for the HEC-2 program is the User's Manual (HEC,1982). The manual provides a complete description of the HEC-2 program capabilities, theoretical basis for computations, program input and program output. There is no user's manual for the EDIT2, SUMPO, or PLOT2 computer programs. Those programs are described in a new Description and User Guidance Manual (Bonner,1986) for the program package. COED is treated as a separate program. It has an internal HELP file and a new user instruction manual is being developed to reflect its new capabilities.

There are several university extension short courses on the use of the HEC-2 program. A one-week course provides a good overview of the basic program capabilities. For those unable to attend a course, there are video tapes of most lectures given in HEC training courses on HEC-2. The tapes are distributed by a contractor, Modern Talking Picture Service, St. Petersburg, FL.

Computer Program, Video Tape, and Publications Catalogs are available from the HEC at no charge. To obtain the Catalogs, which provide ordering information and prices, write:

The Hydrologic Engineering Center
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Computer Equipment Requirements

The following equipment is required to run the HEC-2 package of programs on MS DOS microcomputers.

DOS 2.0 (or later) Operation System
512K-byte (or more) RAM Memory
Two 360K-byte floppy-disk drives

OR,

One 360K-byte floppy-disk drive and one 10M-byte (or larger) hard-disk drive

The graphic displays from PLOT2 can be directed to the screen or an HP 7475 pen plotter. Either of the following graphics cards (or their equivalent) are required:

IBM Color Graphics Adapter

OR,

IBM Enhanced Color Graphics Adapter

The programs will take advantage of the Intel 8087 math coprocessor, if present in your computer. This coprocessor greatly speeds up program run time and is recommended, but it is not necessary for program accuracy.

New Input/Output Programs

COED is a text editor that has been in use within the Corps on mainframe computers. The program has been converted to run on a PC and modified to include a full screen edit capability. With its HELP file, the program can provide onscreen documentation. It also has several features to greatly facilitate the data input process for HEC programs.

COED, in the input mode, will take "Free-Format" input and place it into the standard format for HEC programs. There is no need to count columns in order to get the data into the right location. To assist the program user with input requirements, the variables for any card type are displayed on the screen by entering the card identifier. Additionally, an on-line variable description can be obtained for any of the variables. Initially, only the input data descriptions for HEC-1 and HEC-2 are available, but any program data description set can be added.

Besides the HEC-2 batch print file, the program user can interactively obtain summary tables and plots of computed profile results and cross section data using the input data file and a binary output file from HEC-2. The program SUMPO is a stand-alone version of the summary output routines in HEC-2. Menus have been developed and linked with SUMPO to provide a convenient interactive output display program. All HEC-2 summary table options are available in SUMPO.

There are two SUMPO operation menus; one to create summary tables and one to select predefined tables. The CREATE menu provides the list of output variables available. The cursor can be used to move through the list to select the variables to be printed in the summary table. The user can also save a defined variable list to use again. The SELECT menu provides the available predefined tables in HEC-2 and the option to recall a saved variable list.

PLOT2 is a menu driven program that provides cross section and profile plots to the screen or an HP pen plotter. The MAIN menu allows the user to select menu colors and to call the PROFILE or CROSS SECTION menus for those two plot options. For both, there are options to provide titles, axis labels, and a plotting grid. Also, input and output files are defined. The input file for profile plots is the HEC-2 binary output file (TAPE95), while the input

file for cross section plots is the input data file for the HEC-2 run. Figure 2 provides an example cross section and profile plot.

For profile plots, any variable can be plotted; the default is water surface elevation. Options allow you to add the invert profile, landmarks, and cross section locations and labels. Cross section plots can be developed from the input data file for a single section or a range of sections. For cross sections, there is optional plotting of water surface elevation, bridge data, n-values, encroachments, and channel modifications.

Current Program Developments

The development of HEC programs for the PC are proceeding in two basic areas: more user-oriented, interactive input and modular program structure for a more flexible building block program construction. A recent input example is INFIVE, an Interactive Input Preparation Program for HEC-5 (HEC,1985). HEC-5 is a batch-processing, multiple-purpose, reservoir simulation program with many input options (HEC,1982). INFIVE and the companion CKHEC5 Input Data Checking Program for HEC5 (HEC,1985) provide a more convenient user interface with the HEC-5 program. Both input programs are operational on the PC and the HEC-5 program is being converted for PC execution.

New interactive input routines for HEC-1 and HEC-2 will be simular to INFIVE, in that they will generate traditional card-image input data files. However, the input routines will likely become the input structure for new versions of those programs. The planned new input structure will be more of a menu driven, file based system which will allow the basic information to be stored, retrieved, and assembled to do a variety of computations. Data checking will be provided as data are entered. For data, like cross sections, plots of the information will be available directly from the input as it is defined. Concerns about card identifiers, variable names, field locations, and input data sequence should become a thing of the past.

The next major change to HEC-2 will be the addition of the Federal Highway bridge loss computations for low flow (Shearman, et al,1984). This may be the last major modification to the existing HEC-2 program. A new structure of the operating program has been designed to provide functional subprogram building blocks. The new design will more easily allow added capabilities like divided flow analysis, mixed subcritical and supercritical flow, and sediment transport.

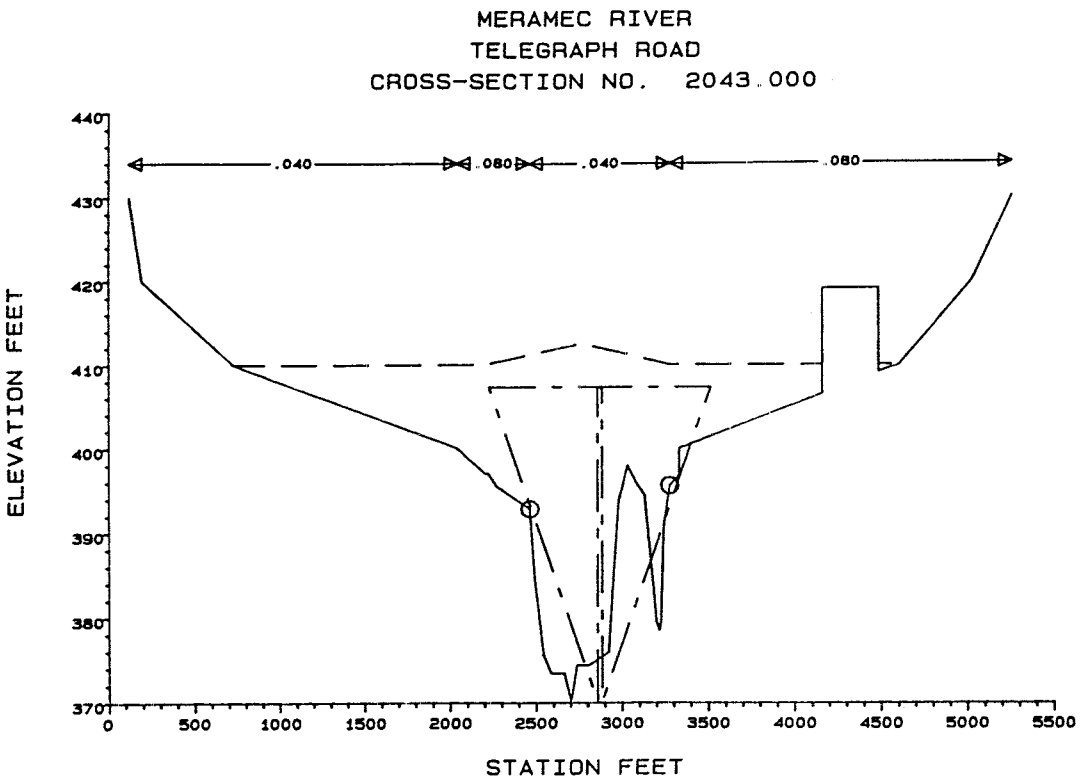

Figure 2a. Sample PLOT2 Cross Section Plot

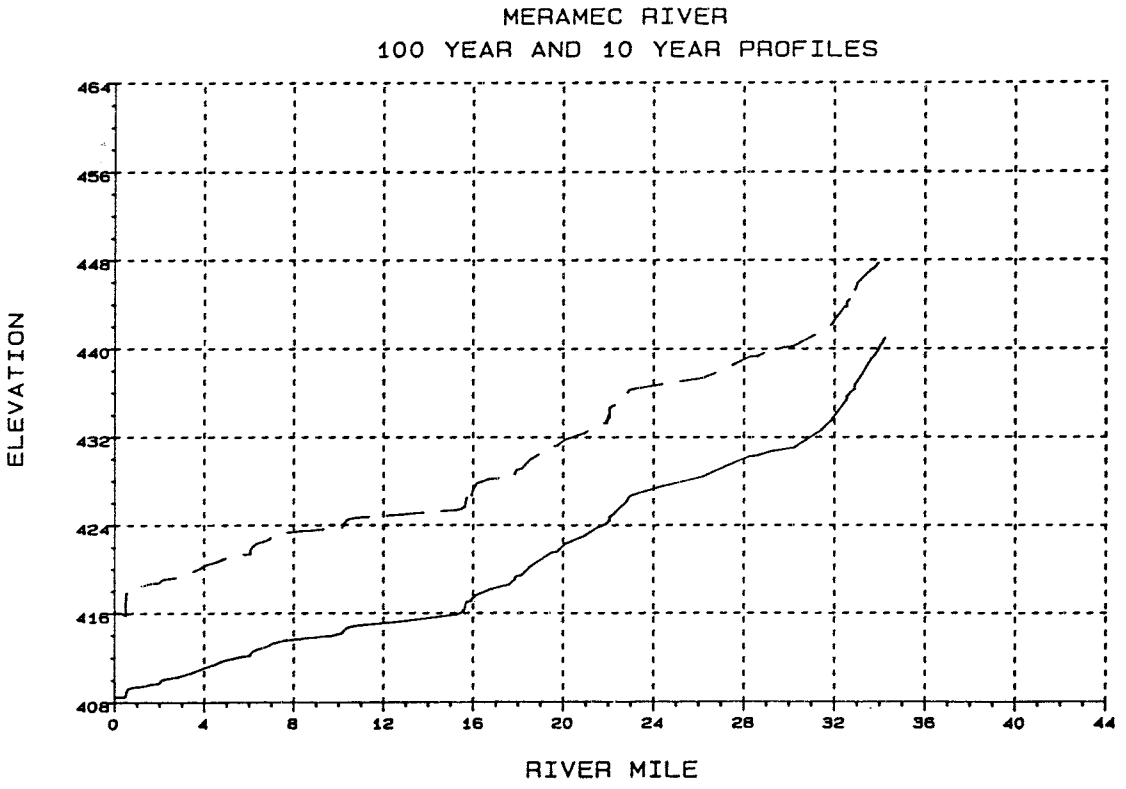

Figure 2b. Sample PLOT2 Water Surface Profile Plot

Flood damage computations are now available on the PC with several HEC programs. The integrated package of programs, referred to as the Flood Damage Analysis Package (HEC, 1986), is being converted and the data storage and linking system is being developed for the PC. When completed, the package will link the results from simulation programs (e.g., HEC-1, HEC-2, and HEC-5) with the flood damage computation programs to provide flood damage analysis in an automatic, file transfer system. Flood damage assessments of existing and proposed alternative flood plain development measures will be possible, and conveniently accomplished, on a PC.

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