SECTION 5
TIME AND MANPOWER REQUIREMENTS

Reconnaissance Level

It is difficult to estimate a generalized time and manpower requirement for the hydrologic and hydraulic aspects of study tasks schematically displayed in Figure 1-1 of this volume. Often a great deal is known about a project or is learned during discussions about managements interest in having the engineering staff conduct the study. A reasonably accurate estimate covering items on the reconnaissance limb of the Figure 1-1 diagram could be accomplished with 3 to 5 man-days of office time by an experienced hydrologic engineer. Time and cost of a field trip to the site should be added to the office time.

Feasibility Level

There is even a greater range of time requirements in the feasibility level of hydrological investigations. This conclusion is based on the great variability in availability of detailed site data, and in the wide variation in spillway and stilling basin evaluation and redesign requirements. Also, the number of alternatives relating to the size, type, number of generator-turbine units, and placement has a great impact on time and cost estimates of conducting these studies. A reasonable range of time required to accomplish hydrologic-hydraulic items on the feasibility limb of Figure 1-1 would be 4 to 8 man-weeks by experienced engineers. The greatest efficiencies can be accomplished by this work being done by no more than one or two engineers.

Documentation

Data sources, assumptions, and study procedures must be well documented in order to be of any lasting value. Some review requirements are typically required, either by the project owner or his representative and by the licensing authority.

Statistical displays and certain minimum basic data should be included in reports or appendices to reports. These would include:

- Pertinent site data.
- Monthly flow data.
- Flow duration curve.
- Average annual energy versus installed capacity table or curve.
- Maximum and minimum annual energy generation.
- Duration frequency data on monthly energy generation including zero generation.
- Spillway design flood.
- Tailwater rating curve.
- Plant efficiency versus head curve.

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EXHIBIT I

NET LAKE EVAPORATION ESTIMATES

TABLE NO. 1
PRECIPITATION MINUS EVAPORATION

Station	Dec Jan Feb	Mar Apr Nov	May Oct	Jun Sep	Jul Aug	Average Annual	Critical Year Corrections (1) (Deduct from Avg Annual)
	Rate of Gain or Loss in c.f.s. per 1000 Acres of Designated Period						
Alabama							
Birmingham	+4.7	+1.8	-1.7	-3.0	-1.4	+0.6	-3.1
Mobile	+5.3	+2.9	-0.2	-0.6	+1.8	+2.3	-3.3
Montgomery	+4.8	+1.9	-2.6	-3.8	-2.3	+0.2	-3.3
Arizona							
Phoenix	-3.3	-7.4	-12.2	-17.1	-17.9	-10.6	-3.2
Yuma	-5.5	-9.2	-11.9	-15.2	-17.3	-11.1	-1.7
Arkansas							
Fort Smith	+1.2	-0.6	-1.4	-4.6	-7.2	-2.1	-5.0
Little Rock	+3.7	+1.2	-2.0	-4.7	-5.5	-0.8	-3.7
California							
Eureka	+7.4	+4.6	+0.8	-0.9	-1.6	+2.7	-2.0
Fresno	+0.6	-2.5	-6.7	-12.0	-16.0	-6.3	-1.4
Los Angeles	-0.8	-3.3	-5.0	-5.9	-6.4	-3.9	-2.3
Sacramento	-2.6	-1.7	-5.7	-9.6	-11.9	-4.3	-3.2
San Diego	-0.6	-2.4	-3.3	-4.0	-3.9	-2.6	-1.7
San Francisco	+3.5	-0.4	-2.7	-3.7	-3.5	-0.9	-2.0
Colorado							
Denver	-1.7	-2.5	-4.4	-8.1	-9.6	-4.7	-2.8
Grand Junction	-0.4	-3.5	-7.0	-12.8	-15.5	-6.9	-3.1
Pueblo	1.8	-3.7	-6.0	-10.0	-10.5	-5.8	-3.0
Connecticut							
Hartford	+2.8	+2.1	+0.7	+0.6	+0.2	+1.5	-1.4
New Haven	+3.9	+2.8	+0.7	+0.2	-1.0	+1.7	-1.5
Dist of Columbia							
Washington	+2.8	+0.7	-0.2	-0.7	-1.0	+0.6	-4.0
Florida							
Jacksonville	+0.8	-1.7	-0.3	+1.4	+0.7	+0.8	-2.3
Miami	-1.4	-2.0	+4.7	+5.0	+0.9	+0.9	-3.1
Pensacola	+4.1	+2.1	+0.3	+0.1	+3.0	+2.1	-2.8
Tampa	-0.4	-2.8	-2.8	+1.8	+3.1	-0.5	-2.0
Georgia							
Atlanta	+4.6	+1.5	-1.5	-3.0	-1.7	+0.5	-2.9
Augusta	+2.6	-0.2	-2.4	-2.7	-1.9	-0.6	-3.0
Macon	+2.9	+0.2	-2.6	-3.2	-1.9	-0.5	-2.7
Savannah	+0.8	-1.4	-1.9	+0.6	+1.5	-0.1	-2.8
Idaho							
Boise	+0.6	-1.8	-4.4	-8.5	-13.7	-4.7	-1.6
Pocatello	+0.5	-1.6	-4.2	-8.7	-13.0	-4.6	-2.5

TABLE NO. 1 (Continued)
PRECIPITATION MINUS EVAPORATION

Station	Dec Jan Feb	Mar Apr Nov	May Oct	Jun Sep	Jul Aug	Average Annual	Critical Year Corrections (1) (Deduct from Avg Annual)
	Rate of Gain or Loss in c.f.s. per 1000 Acres of Designated Period						
Illinois							
Cairo	+3.4	+1.7	-0.9	-2.2	-3.4	+0.2	-3.0
Chicago	+1.5	+1.3	-0.2	-1.1	-2.8	0	-2.2
Peoria	+1.7	+1.5	+0.2	-0.2	-2.7	+0.3	-3.0
Springfield	+1.6	+1.2	-0.5	-1.8	-4.6	-0.5	-3.1
Indiana							
Evansville	+3.3	+1.4	-0.9	-2.6	-4.5	-0.2	-3.1
Ft Wayne	+2.3	+2.0	+0.3	-1.1	-3.0	+0.4	-2.4
Indianapolis	+2.7	+2.2	-0.5	-1.7	-3.4	+0.3	-2.6
Terre Haute	+2.8	+2.0	-0.1	-1.8	-4.1	+0.2	-2.4
Iowa							
Charles City	+1.1	+0.8	+0.3	-0.4	2.7	0	-2.4
Davenport	+1.2	+1.1	-0.8	-1.3	-4.1	-0.5	-2.6
Des Moines	+0.5	+0.1	-1.0	-2.0	-5.0	-1.2	-3.5
Dubuque	+1.1	+1.0	0.1	-0.5	-2.9	0	-2.9
Keokuk	+1.0	+0.9	-0.9	-1.2	-4.4	-0.6	-3.6
Sioux City	+0.2	-0.5	-2.0	-3.0	-5.2	-1.7	-3.1
Kansas							
Concordia	-0.6	-1.8	-2.5	-5.0	-8.2	-3.2	-4.8
Dodge City	-1.6	-3.2	-4.9	-8.3	-11.5	-5.3	-4.8
Wichita	-0.6	-1.5	-2.0	-5.2	-9.0	-3.2	-5.4
Kentucky							
Louisville	+3.6	+1.7	-1.0	-2.9	-4.0	0	-2.7
Louisiana							
New Orleans	+4.0	+1.8	-0.3	-0.6	+1.0	+1.5	-3.5
Shreveport	+2.7	+0.3	-2.5	-6.1	-6.0	-1.7	-3.9
Maine							
Eastport	+3.5	+2.6	+1.8	+1.4	+1.0	+2.2	-1.6
Portland	+4.6	+3.1	+0.8	+0.1	-1.1	+1.9	-1.6
Maryland							
Baltimore	+2.7	+1.1	-0.8	-1.8	-1.9	+0.2	-3.7
Massachusetts							
Boston	+3.1	+2.1	-0.2	-0.8	-2.0	+0.8	-1.4
Michigan							
Alpena	+1.6	+1.7	+1.1	+0.7	-0.9	+1.0	-1.3
Detroit	+2.4	+1.6	+0.1	-0.9	-2.9	+0.4	-2.2
Grand Haven	+2.2	+2.0	+1.4	+0.5	-1.4	+1.1	-1.4
Lansing	+2.1	+1.8	+1.0	+0.4	-2.5	+0.8	-1.6
Minnesota							
Duluth	+1.0	+0.8	+0.4	+0.7	-0.9	+0.5	-1.7
Minneapolis	+0.7	+0.4	-0.4	-0.9	-3.5	-0.5	-2.4
Moorhead	+0.6	+0.5	-1.0	-1.9	-3.0	-0.7	-2.9
Mississippi							
Meridian	+5.4	+2.4	-1.1	-2.1	-0.8	+1.3	-2.3
Vicksburg	+4.8	+2.0	-1.8	-3.6	-2.6	+0.4	-2.6

TABLE NO. 1 (Continued)
PRECIPITATION MINUS EVAPORATION

Station	Dec Jan Feb	Mar Apr Nov	May Oct	Jun Sep	Jul Aug	Average Annual	Critical Year Corrections (1) (Deduct from Avg Annual)
	Rate of Gain or Loss in c.f.s. per 1000 Acres of Designated Period						
Missouri							
Columbia	+1.0	+0.6	-0.2	-0.1	-3.8	-0.3	-4.6
Kansas City	+0.5	+0.2	-0.9	-2.2	-5.7	-1.3	-4.8
St Joseph	+0.2	-0.4	-1.3	-1.6	-6.2	-1.6	-3.7
St Louis	+1.7	+1.4	-0.5	-2.3	-4.9	-0.5	-3.0
Springfield	+1.4	+0.9	0	-1.1	-3.2	-0.1	-3.9
Montana							
Havre	0	-1.5	-3.6	-5.4	-9.3	-3.4	-3.2
Helena	-0.3	-1.7	-2.6	-5.0	-9.6	-3.4	-1.4
Kalispell	+1.1	-0.8	-2.2	-4.2	-8.5	-2.4	-1.2
Miles City	+0.1	-1.5	-4.0	-7.0	-11.5	-4.1	-3.7
Nebraska							
Lincoln	-0.2	-1.3	-2.5	-3.9	-6.6	-2.5	-4.6
N. Platte	-0.8	-2.3	-3.8	-6.2	-8.2	-3.8	-3.7
Omaha	+0.1	-1.1	-2.4	-2.9	-5.8	-2.1	-4.3
Valentine	-0.4	-1.5	-3.1	-6.0	-8.0	-3.3	-3.2
Nevada							
Reno	-0.2	-3.4	-6.0	-10.1	-13.7	-6.9	-2.2
Winnemucca	-0.2	-2.9	-5.6	-9.8	-14.6	-6.8	-3.6
New Hampshire							
Concord	+2.9	+2.2	+0.8	+1.1	+0.2	+1.6	-1.6
New Jersey							
Trenton	+3.0	+1.7	+0.3	-0.2	+0.2	+1.2	-1.8
New Mexico							
Roswell	-3.0	-5.9	-7.9	-9.1	-9.6	-6.7	-2.8
Santa Fe	-1.2	-3.7	-5.9	-8.9	-8.0	-5.0	-2.2
New York							
Albany	+2.2	+1.6	-0.2	-0.7	-2.2	+0.4	-1.6
Binghamton	+2.2	+1.6	+0.7	+0.2	-0.9	+0.9	-1.8
Buffalo	+3.3	+2.0	+0.8	-0.5	-1.6	+1.1	-1.3
Canton	+2.9	+2.5	+1.4	+0.8	-1.0	+1.5	-1.6
New York	+3.0	+1.6	+0.2	-0.5	-0.8	+1.0	-1.3
Oswego	+3.0	+2.1	+1.2	+0.1	-1.4	+1.3	-1.5
Syracuse	+2.7	+1.8	+0.1	-0.5	-1.9	+0.7	-1.4
North Carolina							
Asheville	+2.2	+0.8	0	+0.1	+0.4	+0.8	-2.5
Charlotte	+2.9	+0.1	-1.7	-2.4	-1.0	-0.1	-2.4
Raleigh	+2.9	+0.4	-1.2	-0.7	+0.1	+0.5	-2.8
Wilmington	+2.1	-0.1	-0.8	+0.8	+2.7	+1.0	-2.1
North Dakota							
Bismarck	0	-1.0	-2.8	-4.5	-7.6	-2.7	-3.1
Devils Lake	+0.4	-0.3	-1.9	-2.6	-4.6	-1.5	-1.9
Williston	+0.2	-1.0	-3.0	-4.5	-7.6	-2.7	-2.3

TABLE NO. 1 (Continued)
PRECIPITATION MINUS EVAPORATION

Station	Dec Jan Feb	Mar Apr Nov	May Oct	Jun Sep	Jul Aug	Average Annual	Critical Year Corrections (1) (Deduct from Avg Annual)
	Rate of Gain or Loss in c.f.s. per 1000 Acres of Designated Period						
Ohio							
Cincinnati	+2.7	+1.4	-0.8	-2.4	-3.3	-0.1	-2.9
Cleveland	+2.2	+1.5	-0.3	-1.1	-2.1	+0.3	-1.8
Columbus	+2.6	+1.6	-0.7	-2.0	-2.7	+0.2	-2.9
Dayton	+2.8	+1.8	-0.1	-1.5	-3.0	+0.4	-3.4
Toledo	+2.2	+1.5	-0.5	-1.4	-3.4	0	-2.2
Oklahoma							
Oklahoma City	-0.8	-1.7	-2.7	-6.8	-10.7	-4.0	-4.7
Oregon							
Baker	+0.6	-1.1	-3.0	-5.3	-9.0	-3.0	-1.7
Portland	+7.0	+3.5	-0.2	-2.9	-6.0	+1.1	-2.1
Roseburg	+5.5	+2.4	-0.5	-3.8	-7.4	0	-2.4
Pennsylvania							
Erie	+2.1	+2.0	+0.7	-0.6	-1.9	+0.7	-1.6
Harrisburg	+2.3	+0.8	-0.6	-1.1	-2.4	+0.1	-2.4
Philadelphia	+2.8	+1.4	-0.8	-1.5	-1.7	+0.4	-1.6
Pittsburg	+2.4	+1.2	-0.8	-1.9	-2.6	0	-2.0
Reading	+2.7	+1.4	-0.4	-1.1	-1.3	+0.6	-2.3
Scranton	+2.6	+1.8	+0.3	+0.1	-0.7	+1.1	-2.0
Rhode Island							
Providence	+3.5	+2.2	+0.2	-0.1	-1.3	+1.2	-1.7
South Carolina							
Charleston	+1.0	-1.0	-1.7	-1.4	+0.5	-0.4	-1.0
Columbia	+1.9	-1.1	-2.8	-2.9	-1.5	-1.0	-2.3
South Dakota							
Huron	+0.1	-0.7	-2.5	-4.6	-6.6	-2.4	-3.1
Pierre	-0.3	-1.5	-3.6	-7.0	-9.3	-3.8	-2.8
Rapid City	-0.9	-1.6	-2.7	-6.5	-9.6	-3.8	-3.1
Yankton	+0.3	-0.9	-1.6	-2.7	-4.8	-1.7	-2.3
Tennessee							
Chattanooga	+4.9	+2.6	-0.7	-2.7	-1.8	+1.0	-2.9
Knoxville	+4.5	+2.0	-1.0	-1.7	-1.6	+0.9	-2.5
Memphis	+4.4	+2.1	-1.4	-3.9	-4.2	0	-2.6
Nashville	+4.1	+2.2	-0.8	-2.2	-2.7	+0.6	-1.8
Texas							
Abilene	-2.4	-5.4	-5.4	-10.9	-14.6	-7.1	-4.4
Amarillo	-2.9	-5.3	-6.6	-10.3	-12.0	-6.9	-5.3
Brownsville	-0.7	-3.0	-3.1	-2.7	-6.7	-3.0	-1.0
Corpus Christi	-0.2	-1.6	-2.5	-3.1	-6.5	-2.5	-2.1
Dallas	+0.2	-1.7	-3.2	-7.4	-10.6	-3.9	-2.8
Del Rio	-3.2	-6.2	-7.1	-10.7	-14.0	-7.7	-3.7
El Paso	-4.3	-8.4	-11.0	-13.2	-11.9	-9.2	-2.4
Houston	+2.4	-0.2	-1.2	-3.1	-3.2	-0.7	-4.0
Palestine	+1.9	0	-2.2	-5.3	-7.6	-2.0	-3.5
San Antonio	-1.4	-3.2	-4.4	-7.4	-10.0	-4.8	-3.3

TABLE NO. 1 (Continued)
PRECIPITATION MINUS EVAPORATION

Station	Dec Jan Feb	Mar Apr Nov	May Oct	Jun Sep	Jul Aug	Average Annual	Critical Year Corrections (1) (Deduct from Avg Annual)
	Rate of Gain or Loss in c.f.s. per 1000 Acres of Designated Period						
Utah							
Modena	-0.3	-3.2	-6.3	-12.0	-13.2	-6.1	-2.9
Salt Lake City	+0.6	-1.1	-3.8	-9.5	-13.2	-4.5	-3.0
Virginia							
Norfolk	+2.1	+0.3	-1.1	-1.3	-0.3	+0.2	-2.0
Richmond	+2.5	+0.5	-0.8	-1.2	-0.7	+0.3	-2.5
Wytheville	+2.4	+0.8	+1.2	+0.9	+0.7	+1.3	-2.8
Vermont							
Burlington	+1.8	+1.7	+0.9	+0.5	-1.2	+0.9	-1.7
Northfield	+2.5	+2.2	+1.2	+1.3	+0.8	+1.7	-1.0
Washington							
North Head	+9.2	+5.5	+2.6	+1.0	-0.8	+4.1	-2.2
Seattle	+5.2	+2.3	+0.1	-2.1	-4.1	+0.9	-1.8
Spokane	+1.7	-0.7	-2.9	-6.1	-9.9	-2.9	-1.7
Walla Walla	+1.2	-0.8	-3.4	-7.2	-12.6	-3.8	-2.5
West Virginia							
Elkins	+3.9	+2.6	+1.7	+2.1	+2.0	+2.6	-2.9
Parkersburg	+2.8	+1.3	-0.4	-1.3	-1.6	+0.5	-3.9
Wisconsin							
Green Bay	+1.1	+1.2	+0.2	-0.9	-2.7	0	-1.7
LaCrosse	+0.9	+0.6	+0.1	-0.1	-1.9	+0.1	-2.3
Madison	+1.2	+1.2	+0.3	-0.5	-2.9	+0.1	-1.6
Milwaukee	+1.4	+1.4	+0.4	-0.9	-3.5	0	-1.8
Wyoming							
Cheyenne	-1.7	-1.8	-2.9	-6.2	-7.9	-3.7	-2.5
Lander	-0.1	-1.1	-2.4	-7.3	-10.6	-3.7	-1.5
Sheridan	-0.1	-1.4	-2.9	-5.9	-10.3	-3.6	-2.6
Yellowstone	+0.6	-0.4	-1.8	-4.4	-7.2	2.2	+1.6

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(1) The following values are amounts to be deducted from the average annual gain or loss to obtain the critical year values. To obtain the gain or loss for a shorter critical period, multiply the critical year correction by the constant for the period, as given below, and add this correction algebraically to the value for the period.

Period	Constant	Period	Constant
Dec Jan Feb	0.25	Jun Sep	1.15
Mar Apr Nov	0.45	Jul Aug	2.35
May Oct	1.35		

TABLE NO. 2
RATES FOR GAIN OR LOSS - REGION OF WASHINGTON, D.C.
VALUES IN C.F.S. PER 1000 ACRES OF RESERVOIR AREA

Month	Average Year	Critical Year Correction	Critical Year
January	+2.8	-1.0	+1.8
February	+2.8	-1.0	+1.8
March	-0.7	-1.8	-1.1
April	+0.7	-1.8	-1.1
May	-0.2	-5.4	-5.6
June	-0.7	-4.6	-5.3
July	-1.0	-9.4	-10.4
August	-1.0	-9.4	-10.4
September	-0.7	-4.6	-5.3
October	-0.2	-5.4	-5.6
November	+0.7	-1.8	-1.1
December	+2.8	-1.0	+1.8
Annual	+0.6	-4.0	-3.4

Table No. 2 gives as an example the monthly values of gain or loss for an average annual and a critical year for Washington, D.C. Average annual values are taken direct from Table No. 1 and the monthly values for the critical year are computed by using the critical year correction value and the constants indicated in footnote 1 in Table No. 1.

EXHIBIT II

COMPUTER PROGRAM ABSTRACTS

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THE HYDROLOGIC ENGINEERING CENTER
LIST OF COMPUTER PROGRAMS

Flood Flow Frequency Analysis (723-X6-L7550)

The purpose of this program is to perform frequency computations of annual maximum flood peaks according to the Water Resource Council Guidelines for Determining Flood Flow Frequencies, Bulletin 17, March 1976. The program computes a long-Pearson Type III frequency curve. The mean, standard deviation and computed skew coefficient are computed by the method of moments. The adopted skew is based upon a weighting of the computed skew and a generalized skew, provided as input. The program develops preliminary information based on systematic record, then if required, automatically adjusts for zero flood years, incomplete records, or low outliers. Incorporation of high outliers and historical information is then made. Final frequency curve is automatically calculated with the expected probability. The program is dimensioned for 50 historic events. The sum of the historic events and the systematic events must not exceed 130. Any number of stations may be sequentially analyzed. The skew coefficient cannot be greater than 2.0 nor less than -2.0.

Regional Frequency Computation (723-X6-L7350)

The purpose of this program is to perform frequency computations of annual maximum hydrologic events necessary to a regional frequency study. Frequency statistics are computed for recorded events at each station and for each duration. Missing events are computed so that complete sets of events are obtained for all years at all stations while preserving all intercorrelations. The mean, standard deviation, and skew coefficients of the logarithms are computed for each station and each duration. An approximate Pearson Type III distribution is assumed. Missing events are computed by a regression equation which includes a random component whose influence is proportional to the unexplained error. The flows are then arranged in order of magnitude and tabulated with median plotting positions. Statistics are then adjusted, standard deviation may be smoothed and regional skew may be specified, and frequency curves computed. The program is dimensioned for a maximum of 10 stations, but more stations can be interrelated by saving key stations from previous runs. The number of durations times the number of years cannot exceed 400, but the number of durations cannot exceed 8.

HEC-4 Monthly Streamflow Simulation (723-X6-L2340)

This program will analyze monthly streamflows at a number of interrelated stations to determine their statistical characteristics and will generate a sequence of hypothetical streamflows of any desired length having those characteristics. It will reconstitute missing streamflows on the basis of concurrent flows observed at other locations. It will also use the generalized simulation model for generating monthly streamflows at ungaged locations based on regional studies. The mean, standard deviation, and skew coefficients of the logarithms are computed for each station and each month. Each flow is converted to a normalized standard deviate using an approximation of the Pearson Type III distribution. Missing and generated values are computed by a multiple regression equation which includes a random component whose influence is proportional to the unexplained error. The previous month is one of the independent variables so as to preserve the serial correlation. The program is dimensioned for a maximum of 10 stations, but more stations can be intercorrelated by multipass operations. Input is limited to 100 years of monthly flows. Station numbers should be 3 digits or less (can be 4 digits by changing input format) and generated values cannot exceed 999,999 units.

HEC-1 Flood Hydrograph Package (723-X6-L2010)

All ordinary flood hydrograph computations associated with a single recorded or hypothetical storm can be accomplished with this package. Routines include rainfall-snowfall-snowpack-snowmelt determinations, computations of basin precipitation, unit hydrographs, and of hydrographs, routing by reservoir, storage-lag, multiple-storage, straddle stagger, Tatum and Muskingum methods, and complete stream system hydrograph combining and routing. Best-fit unit hydrograph, loss-rate, snowmelt, base freezing temperatures and routing coefficients can be derived automatically. Automatic plot routines are also provided. Unit hydrograph derivation is done by the instantaneous unit hydrograph method and Snyder coefficients are obtained. Snowmelt determinations are made by either the degree-day method or the energy budget method. Loss rates are computed using either an initial and uniform loss rate or by a variable loss rate function. Derivation of unit hydrograph and loss rate coefficients or routing coefficients is accomplished by means of an optimization subroutine utilizing the Univariate Method. The program is dimensioned for a variable number of locations, depending upon the number of alternative development plans or stream system computations and the maximum number of hydrographs retained in memory at any one time. Maximum number of flow values is 150 and maximum number of hydrographs is 270.

Water Surface Profiles (HEC-2) (723-X6-L202A)

The program computes water surface profiles for steady, gradually varied flow in rivers of any cross section. Flow may be subcritical or supercritical. Various routines are available for modifying input cross section data, for example, for locating encroachments or inserting a trapezoidal excavation on cross sections. The water surface profile through structures such as bridges, culverts and weirs can be modeled. Variable channel roughness and variable reach length between adjacent cross sections can be accommodated. Printer plots can be made to the river cross sections and computed profiles. Input may be in either English or Metric units. The method used is the step method which is generally like method 1, U.S. Army Corps of Engineers, Engineering Manual EM 1110-2-1409, 7 December 1959 - Backwater Curves in River Channels. Friction losses can be calculated from a choice of four different equations. Bridge losses are based on energy and momentum principles, and weir and orifice formulas. Critical depth is based on minimum energy.

Gradually Varied Unsteady Flow Profiles (723-G2-L7450)

This program simulates one-dimensional, unsteady, free surface flows. It calculates water surface elevations, discharges, velocities, and flow direction as functions of time at each cross section. Discharge hydrographs, stage hydrographs, or rating curves may be used for boundary conditions. Local (tributary) inflow can be accommodated. Solution of the one-dimensional equations of continuity and momentum (the St. Venant equations) is accomplished by numerical integration using an explicit, centered difference computation scheme.

Spillway Rating and Flood Routing (723-G1-L7100)

The main purpose of this program is to compute a spillway rating curve for a concrete ogee spillway with vertical walls for an assumed design head, then make a flood routing of the spillway design flood to determine the maximum water surface. The rating can also be for a broad-crested weir and can also include the discharge from a conduit or sluice. The routing can be for a gated or uncontrolled spillway. Rating curves for spillway based on WES Hydraulic Design Criteria. Rating curves for conduits based on $Q = CA\ 2gH/K$. Reservoir routing for uncontrolled spillway by modified puls. Reservoir routing for gated spillway by emergency release diagram discussed in EM 1110-2-3600. The program uses FORTRAN II.

Spillway Rating-Partial Tainter Gate Openings (723-G1-L2120)

This program was developed to compute the discharge for ogee-type weirs with partial tainter gate openings. Precise ratings can be obtained in a convenient table form for use in reservoir regulation sections or a limited volume of output can be obtained that is useful during the planning and design stages of a project. Partial gate opening ratings can be determined for any planned or existing ogee-spillway having radial-type gates. In general, the computational procedure shown on WES Hydraulic Design Charts 311-1 to 311-5 is followed with the primary difference being in the determination of G_o (effective gate opening).

Spillway Gate Regulation Curve (723-G1-L2360)

This program will compute the gate regulation schedule curves for a reservoir utilizing the area capacity curves, the induced surcharge envelope curve, and a constant T_s which represents the slope of the recession leg of an inflow hydrograph. These curves are used to operate a gated spillway while the reservoir pool is rising under emergency conditions when communications have failed and in determining dam height for design purposes. The method of computation is based on EM 1110-2-3600, "Reservoir Regulation". FORTRAN II.

Reservoir Area-Capacity Tables by Conic Method (723-G1-L233A)

This program will compute reservoir area-capacity tables for an elevation increment of 1.0, .1 or .01 foot. The conic procedure employed is considered more suitable than the frequently used "average end area method" for determining reservoir capacities. Written in FORTRAN II.

Reservoir Yield (723-G2-L2400)

This program will perform a simulated operation study for a single reservoir with controls at the reservoir and one downstream control point. Operation is for water supply, power, water quality and water rights, taking account of flood control and other storage restrictions at the reservoir, quantity and quality of inflow to the reservoir, evaporation, quantity and quality of local inflows downstream and channel and outlet capacities, as well as project requirements. Operation interval can vary, but usually a monthly interval would be used. Translatory and channel storage effects are ignored. Water quality routing assumes thorough mixing of the inflow and reservoir quantities and pure-water evaporation before releases are made. Power is computed as a function of average head, efficiency, outflow and hydraulic losses. Written in FORTRAN II.

HEC-3 Reservoir System Analysis (723-X6-L2030)

Program will perform a multipurpose, multireservoir routing of a reservoir system. All requirements are supplied from reservoirs so as to maintain a specified balance of storage in all reservoirs, insofar as possible. Power is computed as a function of average head for each period, efficiency, outflow and hydraulic losses. In the case of conservation functions, a monthly computation interval is usually used, and economic benefits are computed based on a fixed relationship between the hydrologic quantity for a specified calendar month and location, and associated economic benefit for that month. In the case of flood control studies, the computation interval can be any length, time translations are accomplished by translating all input flows by the time required to travel to a common location, and damages are computed as a function of peak flow only. Program will accept system power demands that override individual power plant requirements, but does not provide for channel routings or percolation losses. It can assign economic values to all outputs and summarize and allocate these in various ways.

Simulation of Flood Control and Conservation Systems (HEC-5C) (723-X6-L2500)

The program is designed to simulate the sequential operation of a reservoir-channel system of any configuration. The program can be used to evaluate existing and proposed systems using defined flow sequences. Operating time intervals can be varied throughout a discharge sequence to best define the essence of the modeled operation. Expected annual damages, system costs, and net benefits for flood damage reduction can also be determined. This program represents a major expansion of the capabilities of the HEC-5 program for flood control operation. The input for HEC-5 is generally compatible with the requirements for this program. Discharge hydrographs are provided to the modeled locations in the system. Hydrographs are routed through channels by any of five hydrologic routing techniques. Reservoir releases are made to evacuate flood control storage as rapidly as possible without causing flooding, to provide for two levels of minimum flow requirements, and to provide defined hydropower requirements. Diverions can also be simulated within the system. The program is dimensioned for 15 control points, 10 reservoirs, 9 power plants, 11 diverions and 50 time periods. (Any number of time periods can be used with the program.) The dimensions can be varied for larger or smaller computer systems.