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Expected Annual Flood Damage Computation

User's Manual

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13. ABSTRACT *(Maximum 200 words)*
The EAD program and user's manual were developed to assist in economic evaluation of flood plain management plans. Particular attention was given to current (as of 1989) federal policy on evaluation of national economic development benefits of flood plain management plans. Only inundation reduction benefits are calculated by this program. This program is based on the principle that flood damage to an individual structure, group of structures, or flood plain reach can be estimated by determining the dollar value of flood damage for different magnitudes of flooding and by estimating the percent chance of exceedance of each flood magnitude.

The program was originally released in June 1977, revised in August 1979, May 1983, February 1984, and March 1989. The April 1994 release was the final release with no major enhancements presently planned. However, HEC plans to create a successor FDA Package for the future.

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EAD
Expected Annual Flood Damage Computation
Software Distribution and Availability Statement

The EAD executable code and documentation are public domain software that was developed by the Hydrologic Engineering Center for the U.S. Army Corps of Engineers. The software was developed at the expense of the United States Federal Government, and is therefore in the public domain. HEC cannot provide technical support for this software to non-Corps users. See our software vendor list (www.hec.usace.army.mil) to locate organizations that provide the program, documentation, and support services for a fee. However, we will respond to all documented instances of program errors. Documented errors are bugs in the software due to programming mistakes not model problems due to user-entered data.

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Introduction

Origin of Program

This program (EAD) was written in The Hydrologic Engineering Center (HEC) by Harold E. Kubik with guidance from Darryl W. Davis and William K. Johnson. The program was originally issued in June 1977, revised in August 1979, May 1983, February 1987, and March 1989. The development of this program was sponsored by the Corps research and development program.

Program Capabilities

This program was developed to assist in economic evaluation of flood plain management plans[1]. Particular attention was given to current federal policy on evaluation of national economic development benefits of flood plain management plans. Of the three types of benefits discussed in policy guidance--inundation reduction, intensification and location--only inundation reduction benefits are computed by this program.

Damage may be computed in three different modes:

(1) the damage associated with a specific flood event, for example, the estimated damage should the standard project flood occur

(2) the expected annual damage associated with a specific year or several selected years, for example, expected annual flood damage for year 1985, 1990, and 2000 hydrologic, hydraulic, and economic conditions

(3) the equivalent annual flood damage associated with a particular discount rate and period of analysis, for example, equivalent annual damage discounted and amortized at 7 percent for a period of analysis of 50 years.

The computation of damage for specific flood events or of expected annual flood damage is made for each flood plain management plan based on the hydrologic, hydraulic and economic data for a damage reach. Several damage categories such as urban, agricultural, industrial, and residential may be analyzed at the same time and are totaled for each plan and reach. Expected annual damage may also be computed for conditions existing during some previous year (historic conditions). Equivalent annual flood damage is computed when the discount rate and period of analysis are specified.

The current dimension limits for various parameters in the program constrain input to the values listed in Table 1.

Table 1: Input Parameter Limits

Parameter	Limit
Flood Plain Management Plans	13
Number of Reaches	Unlimited
Damage Categories	18
Exceedance Frequency Values, and Corresponding Flow or Stages	18
Stages and Corresponding Flow Values for Rating Curve	18
Stages or Flows, and Corresponding Damage Values	18
Input Data Years	9
Number of Input Data Years that Represent Historic Conditions	3

[1] See "Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies, March 10, 1983.

Hardware and Software Requirements

The program was originally written in FORTRAN IV, developed on the CDC 7600 computer, required about 17,000 words of memory, and did not require any special library functions. The current version of the program is written in FORTRAN 77, is developed on a MS-DOS Compaq compatible microcomputer, requires about 350,000 words of memory, and utilizes library functions from the HECLIB and HECDSS libraries. Table 2 lists disk assignments made by the program.

Table 2: File Assignments

FORTRAN File Number	Keyword	Keyword Abbrev.	Description
5	INPUT	I	The standard input device from which EAD input data is read. On the personal computer (PC), the default assignment is to the user's keyboard.
6	OUTPUT	O	The standard output device to which EAD output is written. On the PC, the default assignment is to the user's monitor.
7	PUNCH	P	Currently deactivated. In previous versions, this was the local disk file name used when damage data was written to a punch file for use with HEC-5. On the PC, the default assignment is to the file "SCRATCH.001".
8	FILE8	F	The local disk file name used by the EAD program as a formatted scratch file for storing user input prior to decoding. On the PC, the default assignment is to the file "SCRATCH.008".
9	FILE9	FILE9	The local disk file name used by the EAD program as a formatted scratch file on which reach summary information is stored. On the PC, the default assignment is to the file "SCRATCH.009".
29	TRACE	T	The local disk file name used for writing trace output. It is activated by the TL and TS records. On the PC, the default assignment is to the file "SCRATCH.002".
71	DSSFILE	D	The local disk file name used for a HECDSS data file when retrieving and / or storing frequency, rating, and aggregated elevation-damage data. On the PC, the default assignment is to the file "SCRATCH.031".

Future Program Development

The EAD program is considered to be a mature program with no major enhancements presently planned. However, HEC plans to create a successor FDA Package for the workstation environment. This Package would use some of the methodology and computer software code currently in use by the EAD program.

Most future plans discussed in the 1977 documentation have been accomplished through development of the Structure Inventory for Damage Analysis (SID) program and linkage with the HEC data storage system (DSS) (see Exhibit 5).

The program was substantially modified in February 1987 when it was converted to FORTRAN 77. In addition to FORTRAN 77 modifications, it was modified to:

- Read all of the same types of data from a HECDSS data file as it could read from a direct record input data file.
- Compute affluence. This is typically calculated only for residential contents where the value of the contents increases as a percentage of structure value over the analysis period.
- Modification of the use of the ZR record so that it may be used in a manner consistent with other HEC programs.
- Write computed results to a HECDSS data file. These include the frequency-damage matrix, plan-expected annual damage matrix, category-expected annual damage matrix, and reach-expected annual damage matrix.

The final component of the HEC flood damage package is a program that more directly accommodates agricultural flood damage. The separate program AGDAM has been written to accomplish this and contains routines which compute expected annual damage. Thus, there is no linkage (and no need for a linkage) to the EAD program.

Any user who has suggestions for increased capability of EAD is encouraged to contact HEC. An increasingly capable set of utilities (plots, special tabulation, etc.) is available through use of the HECDSS as that system expands in capability.

Program Description

Basic Principles

This program is based on the principle that flood damage to an individual structure, group of structures, or flood plain reach can be estimated by determining the dollar value of flood damage for different magnitudes of flooding and by estimating the percent chance of exceedance of each flood magnitude. The damage caused by a single flood event of known magnitude is estimated directly from a damage function. When is it desired to compute the damage which can be expected in any year, then the damage corresponding to each magnitude of flooding is weighted by the percent chance of each being exceeded (damage caused by rare events is thus weighted less). The sum of the weighted damage represents the expected annual flood damage.

If the damage and frequency matrices remain unchanged each year, then the expected annual value represents the average damage which can be expected to result from many years of flood experience. However, in practice, either one or more matrices are likely to change over time; therefore, the expected annual value will also change. This results in a variation over time of the expected annual value. To compare alternative plans or to compare damage with costs, an equivalent annual value is computed. This equivalent value represents a uniform distribution (the same each year) of annual values and is computed by discounting and amortizing each year's expected annual damage value over a period of analysis. The discounting and amortization takes into account the time value of money associated with damage values.

The basic terms used to define the flood magnitude, frequency and damage vary among Corps Districts. For the EAD program, the water surface descriptors are **stage** and **depth**. Stage is used herein as a term to represent both the situation in which a local datum is used for each location in the study area and also for the more general case of a common datum for the entire study area. In the latter case, "elevation" would often be used by others as an appropriate term but herein "stage" is used. The frequency (be it of stage, flow or damage) is referred to as exceedance frequency (a preferred terminology) or simply frequency. Damage is always referred to in the singular. Other descriptors such as event, equivalent annual or expected annual may be used along with the term damage.

There are several different combinations in which the stage, flow, damage and frequency data can be expressed to develop the damage-frequency matrix. The simplest way is to relate stage or flow to damage and stage or flow to frequency. The common parameter, stage or flow, can be used to relate damage to frequency. If the damage and frequency data are not directly related to a common parameter then another matrix must be used. This is commonly a stage-flow matrix (or rating curve). Thus, if damage is expressed as a function of stage and frequency as a function of flow, or vice versa, damage can be related to frequency with the stage-flow function.

Because stage, flow, frequency and damage matrices vary along a river, it is common practice to divide a river into reaches and let a set of these matrices represent the stage, flow, frequency and damage data for a reach. An index location is selected within the reach and a single stage or flow-frequency matrix and stage-flow matrix are applied at that location and considered representative of these variables for the entire reach. In the case of damage, several vectors are usually used in one matrix, each representative of a particular damage category.

The principal reason for computing flood damage is to determine the effectiveness of different flood plain management plans in reducing damage. This reduction is commonly referred to as an inundation reduction benefit and is measured as the difference in equivalent annual flood damage with and without a plan. Different management plans alter the stage, flow, frequency, and/or damage functions in different ways (see Exhibit 1 for a detailed discussion). With a different function the damage is different, usually lower, than without the plan. Thus, for any plan which causes a change which can be quantified, damage with the plan can be computed. Without a plan, damage is still likely to change. Increases in damageable property in existing structures, residual damage to new structures, increases in stage from greater, or more rapid runoff all can cause a change in future damage.

Reach Selection

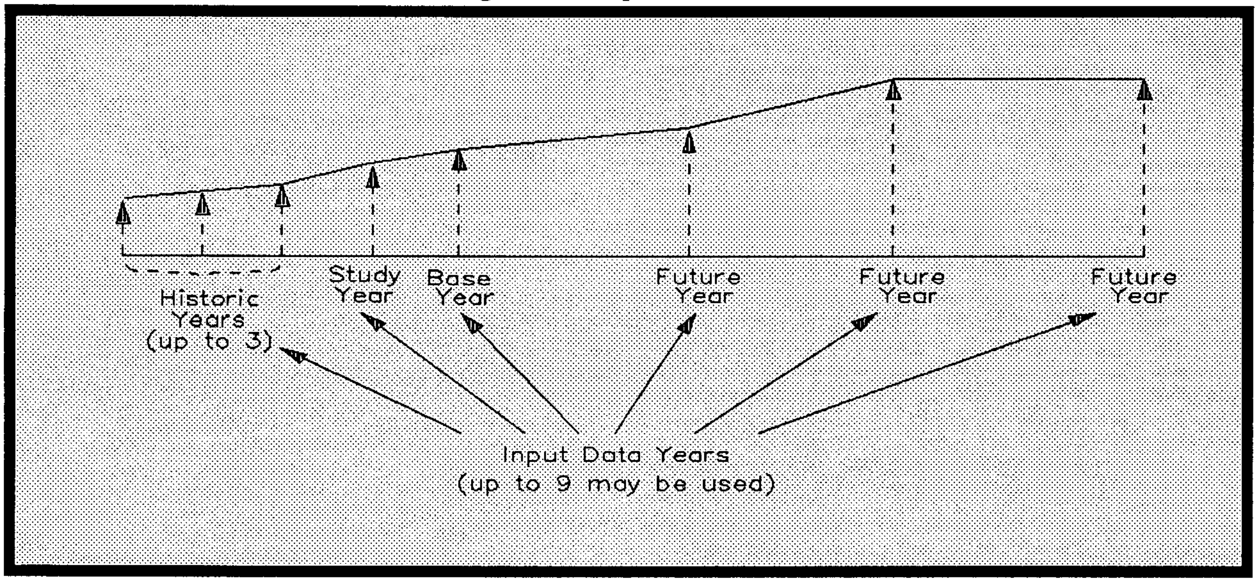
Frequency, flow, stage and damage data are used for each reach; thus, these data must be representative of the actual frequency of flood events, flow regime, and flood damage for that reach. Reach lengths should be selected to allow segregation of output as required for specific study needs. For example, for plan formulation, output may be needed in sufficient detail that changes in stream and development characteristics are identified. Generally, hydraulic and hydrologic factors govern the selection of the index location. However, other factors such as local zoning laws may govern the selection. Frequency data input for one reach will be used for subsequent reaches until another data set is input (FR records). This does not hold for stage, flow or damage data (QF, SF, SQ, QS, SD, QD or DG records). These data must be input for each reach.

Flood Plain Management Plans

The expected annual flood damage with any structural or nonstructural flood plain management plan can be computed provided the effect of such a plan can be expressed in terms of the stage, flow, frequency or damage data used by the program. Such plans can include nonstructural measures as well as reservoirs, channels and levees. A discussion of the effect of various measures on the stage, flow, frequency and damage functions is presented in Exhibit 1.

Up to 13 flood plain management plans can be evaluated. Each plan's name and number are input (PN record) as are the corresponding stage, flow and damage data on the appropriate reach records for each reach and input data year. If, within a reach, several plans have the same stage-flow or damage matrix, the matrix need only be entered for the first plan and it will be used for all subsequent plans until a matrix is entered for another plan. Also, one plan may be made equivalent to another within a reach (RV record).

Figure 1: Input Data Years



Input Data Years

Stage, flow, or damage matrices can be entered, and expected annual damage computed for conditions representative of a past historic year, a study year, a base year, and a future year --- up to a total of nine different years. These points in time for which stage, flow, damage and frequency data are provided are termed input data years and are shown in Figure 1. Expected annual damage computed from these data is assumed to occur at the end of the respective year.

The purpose of defining data for several different years is to accommodate changes in hydrologic, hydraulic and economic data which occur over time. For example, it may be desired to compute expected annual damage for historic years with non-urban land use and past channel conditions, or for future years with urban land use and modified channel conditions. The years selected are identified on the DY record. For each reach only those input data years desired need be selected from those identified on the DY record. For each reach, the frequency vector applies to all input data years (FR record). When the data are available for an input data year, they should be entered. If the data is the same for all input years, one set of data can be entered which will then be used for all other input data years for that reach and plan.

Within a reach, stage, flow, frequency, or damage matrices may be modified for an input data year and plan by use of the RV record. The purpose of this feature is to allow the user to easily specify data for one input data year by modifying another input data year. For example, flow data may be entered for 1980 and these data multiplied by a factor 1.2 to compute flow data for input data year 2000. The arithmetic operations by which a vector of data may be modified are:

- Addition of a constant value
- Subtraction of a constant value
- Multiplication by a constant value
- A zero damage level can be specified by defining a stage, or frequency value below which there is no damage.

Stage Versus Flow Matrix

The stage-flow matrix (or sometimes called "rating curve") relates the stage or water surface elevation of a river at a specific location to the flow of the river at that location. When the flood plain is divided into reaches, one stage-flow matrix is taken as representative for that reach. In such a case, a matrix of stage and corresponding flow data are entered (SQ and QS records). Up to 18 pairs of data may be used. One set of data is provided for each reach, each input data year, and each plan, unless it is desired to use the same data set for all input data years or all plans. When the stage-flow matrix changes by year, only the flow data need be changed (QS record). Also, flow data for any input data year or plan can be modified or used to compute a stage-flow matrix for another input data year or plan (RV record). A constant value may be added or subtracted from each value in the stage or flow vector (SQ or QS record), or each value may be multiplied by a constant.

Damage Matrix

Damage data may be related to either frequency, river stage (elevation) or flow. For each river reach a frequency-, stage- or flow-damage matrix is required for the input years being used for that reach unless it is desired to use the same data set for all input data years. The same is true for each plan. The input matrices for each reach are assumed to represent the damage potential of that reach whether they are entered as aggregate functions (representing groups of structures) or as individual structure functions.

Each plan may have up to 18 damage categories. The categories specified (CN record) are for all reaches, input data years, and plans, but damage data need be entered only for those categories pertinent to each reach (DG record).

Stage data are entered using an SD record, flow data using a QD record, and damage data with a DG record. For a given reach, either SD or QD records may be used, but not both. Up to 18 values may be entered using each type record. The same data set will be used for all input data years if only one set is provided.

A stage-damage or flow-damage matrix for an input data year, plan, or category may be modified or used to compute a similar relationship for another input data year or plan (RV record). A constant value may be added, subtracted or multiplied to produce a new damage vector. In addition, a value may be specified below which there is no damage.

Frequency Matrix

A flow-frequency matrix for a reach of river represents the percent chance that a certain magnitude of the river flow will be exceeded. Quite often a single matrix is considered representative of many reaches or an entire flood plain. In the program, frequency data are entered using an FR record and corresponding stage or flow data using either the SF or the QF records. When frequency-damage matrix is used, the damage vectors are entered using the DG record. The frequency vector on the FR record need only be entered for the first reach, each subsequent reach will use the same vector until another FR record is encountered. In general, the analyst should pick exceedance frequency values for the FR record at the beginning of the study and never change them during the course of the study. For a given reach, either SF or QF records may be used, but not both. The stage or flow vector may be provided for each desired input data year.

Data on the SF (stage), QF (flow) or FR (frequency) records may be modified or used to compute a stage or flow-frequency matrix for another input data year or plan by using the RV record. A constant value may be added or subtracted, the vector multiplied by a constant, or a value of stage, flow, or frequency specified beyond which no damage is computed.

Specific Event Flood Damage

Sometimes it is desired to compute the damage which is estimated to occur if a specific flood event should occur such as a historic event or SPF event. This may be done using either the SID or the EAD program. When using the EAD program, the input stage or flow damage data will normally contain values based upon specific historic events. However, it is often desirable to compute damage for events other than those used to derive the input matrix. For this computation, stage or flow data are entered using the SD or QD records respectively and damage data using the DG record. The input damage data is associated with a specific input data year, plan, and damage category. The number of flood events for which it is desired to compute estimated damage is entered on the FR record. The actual stage or flow for each event is specified on the SF record if it is stage or QF record if it is flow. The stage-flow matrix must be provided if flow-frequency and stage-damage functions are the input matrices. Thus, for each input data year and plan, the estimated flood damage for a specific flood event (specified by stage or flow) can be computed. A maximum of 18 events may be specified.

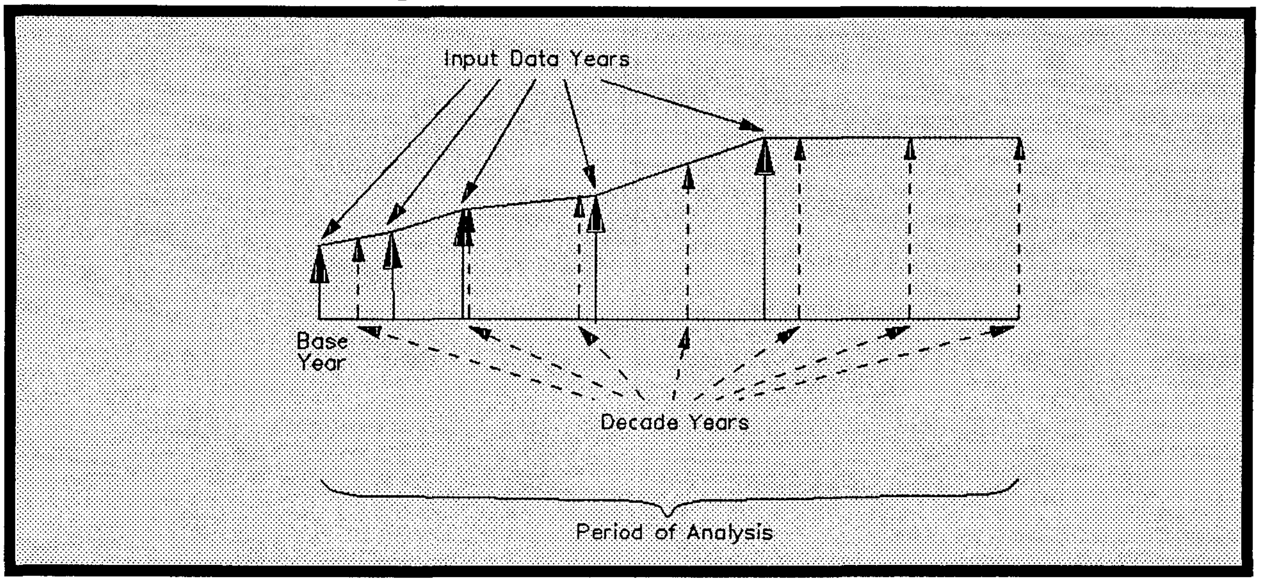
Expected Annual Flood Damage

Expected annual damage is the frequency weighted sum of damage for the full range of possible damaging flood events and can be viewed as what might be expected to occur in the present or any future year. It represents the annual damage for a particular set of hydrologic, hydraulic, and damage conditions. Expected annual damage is computed for each input data year, the study year, the base year and each decade year by first computing a damage-frequency matrix from stage, flow, frequency and damage data for each reach, plan and damage category. Each damage value is then weighted according to its percent chance of exceedance. An explanation of this integration routine is presented in Exhibit 2.

Within the period of analysis, expected annual damage is computed for each year. This is done by first computing expected annual damage for the base year, each decade year (every 10 years from the beginning of operation), and for each input data year. Stage, flow, and damage data for each input data year are used to compute similar data for the base and decade years. Between any pair of input data years, the stage, flow, and damage matrices for the base or decade years are computed by linear interpolation. Outside any pair of input data years or for a single input data year, the stage, flow, and damage matrices are assumed to be the same as for the last or single input data year. As an example, if the last two input data years were 2005 and 2015 and the last year of the analysis were 2020, the stage, flow, and damage matrices for decade year 2010 would be obtained by linear interpolation of stage, flow, and damage matrices. Data for 2020 would be the same as for input data year 2015.

Once the stage, flow or damage matrices have been computed for the base and decade years by interpolation then expected annual damage is computed for the base, decade, and

Figure 2: Generation of the EAD Matrix



input data years. For the remaining years expected annual damage is computed by linear interpolation using expected annual damage previously computed for the base, decade, and input data years. Figure 2 conceptually illustrates this process.

Affluence Factor

An increase or decrease in the value of the contents in residential structures during a period of analysis can be taken into account in the computation of expected annual damage by one of two methods:

- Use of the RV record to modify the input damage matrix by multiplying the damage vector by some factor.
- Use of the RC record to define the annual rate increase in the damage vector and maximum value expressed as a percentage.

Use of the RV Record

In the first method, the change in the value of the contents is computed by invoking the RV record to specify the affluence factor as a ratio (1.04 indicates a 4 percent affluence factor), the damage category (residential contents), and the input data years to which it applies. This factor can be applied to each plan with a damage category for residential contents. It is required that the maximum level for the value of contents (expressed as a percentage of the value of structure) be determined by the analyst. The program does not automatically determine to which year it applies. The effect of affluence is displayed in the equivalent annual damage for the residential contents category and the total damage for each year. The EAD program has computed affluence using this method for a number of years. It is a fairly simplistic computation and requires the user to monitor the calculations for correctness.

Use of the RC Record

The second method was implemented with the February 1987 version of the program. For this method, the change in the value of the contents is computed by invoking RC records to define the economic year, the rate of affluence, and the maximum value of the contents as a function of the structure value.

Federal regulations permit projecting changes in the value of certain damage during the period of analysis. The most common projections are for increased value of household contents. Such an increase or a decrease may be computed automatically by specifying on RC records the appropriate annual rates of change for any previously defined damage category. The program then computes the appropriate increase or decrease for specified stage-damage or discharge-damage matrices. Nine annual rates of change can be specified, beginning with the economic base year and ending with the final year of the study, (IBASYR+IPOA-1). They must correspond with the input data years specified on the DY record.

Figure 3 illustrates the manner in which the specified rates are used to update the stage-damage or discharge-damage matrix for each year of the computations. The damage matrix for the economic base year is entered by the user to the EAD program on "DG" records. If only one rate of change is used, the modified damage values for any year, T, are computed by multiplying all damage vectors for the appropriate stage-damage or discharge-damage matrix for the economic base year by the parameter "FACTOR" shown in Figure 3.

If more than one rate of change is specified, the following steps are performed:

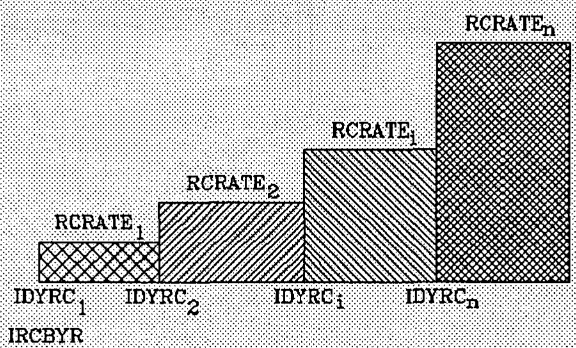
(1) Determine the rate for each year.

(2) Compute the "future value" factor for each year.

(3) Multiply the damage function by the "future value" factor at each analysis year.

The user may impose a lower or upper bound on the damage functions computed automatically by the program. For example, to conform to current Corps of Engineers regulations, the projected value of household goods for a structure may not exceed an upper bound of 75 percent of the structure value. This limitation is imposed by setting DGRCMX (RC.6) equal to the percent of structure value of this upper bound. The maximum damage value of each stage-damage or discharge-damage function (which is subsequently computed by scaling the base-year function) is compared to this bound. If the bound is exceeded, the computed factor is reduced, so the maximum value of the computed function equals the specified bound.

Figure 3: Rate of Affluence

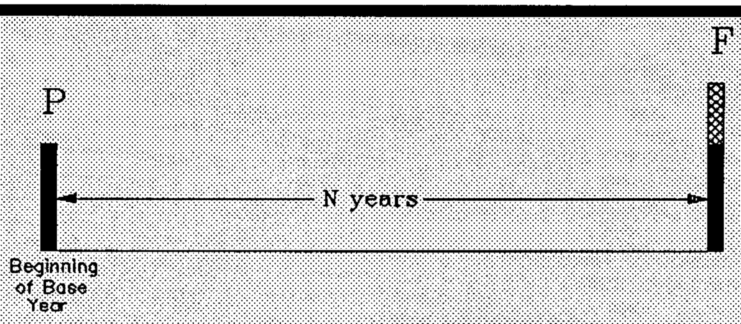


$$\text{FACTOR} = \left(1 + \frac{\text{RCRATE}(1)}{100}\right)^{(T-\text{IECONYR}+1)}$$

where:

RCRATE(1)	Projected rate of change, in percent, after and including the economic base year.
IECONYR	Economic base year of computation.
T	Current year of computation

Figure 4: Discounting Formula



$$P = F * \frac{1}{(1 + i)^N} \qquad \text{(Single payment present-worth factor)}$$

where:

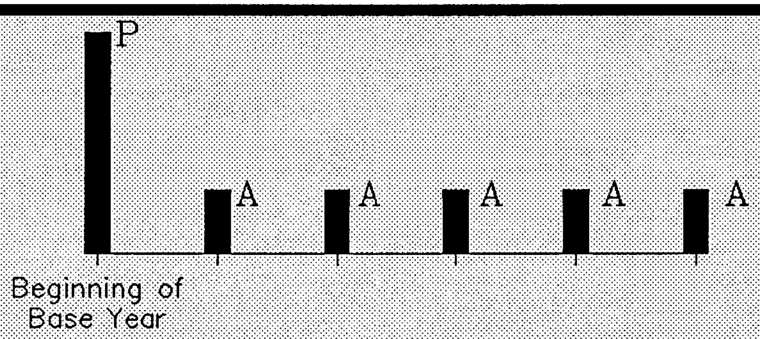
P	Present amount (at beginning of base year) of some future amount.
F	Future amount.
N	Number of years the future amount is from present.
i	Discount rate.

Equivalent Annual Flood Damage

Up to three discount rates may be used to compute equivalent annual flood damage (J2 record). Prior to discounting, expected annual flood damage is computed for each year of the period of analysis. Each year's expected annual damage, which is assumed to occur at the end of the year, is discounted back to the beginning of the base year, then amortized over the period of analysis. The discounting formula used is shown in Figure 4.

The present amount of all future amounts over the period of analysis is amortized using the formula shown in Figure 5.

Figure 5: Amortization Formula



$$A = P * \frac{i(1 + i)^N}{(1 + i)^N - 1} \qquad \text{(Capital Recovery Factor)}$$

where:

A	Equivalent annual amount.
P	Present amount (at beginning of base year).
i	Discount rate.
N	Number of years over which the present amount "P" is amortized.

Inundation Reduction Benefits

The inundation reduction benefits of a flood plain management plan are the flood damage prevented by the plan. This applies to those activities which are expected to use the flood plain even without the plan. The damage prevented by a plan would be the difference between equivalent annual damage without a plan and with a plan. It is assumed equivalent annual damage computed for the period of analysis represents damage to activities which would occupy the flood plain without a plan. To compute this difference it is necessary to enter stage, flow, frequency and damage data for both with and without plan conditions.

Input Preparation

General Description

This section describes the type of data which is entered on each record and which records are used for the type of analysis desired. The actual format of the input data is described in detail in Exhibit 6, Input Description.

The program has been designed to be flexible in the types of data that can be used for analysis and in the detail of output desired. Therefore, particular attention was given to methods of entering the data. Many of the records are optional records and need not be provided unless that particular data are needed to be entered, a particular type of analysis is desired, or selected portions of the output are to be suppressed.

The EAD program has the capability (at the user's option) of automatically retrieving input data from files that were created by other computer programs. Rating data (as developed by the HEC-2 program "Water Surface Profiles"), frequency data (as developed by HEC-1 "Flood Hydrograph Package"), and damage data (as developed by SID "Structure Inventory For Damage Analysis" and DAMCAL "Damage Reach Stage - Damage Calculation") can be placed in a special random access file (termed the HEC data storage system file) and automatically retrieved by EAD for analysis in a largely transparent (to the user) manner. Exhibit 5 describes these concepts in more detail. Training Document 21 entitled "Flood Damage Analysis Package" describes and demonstrates these linkages in detail.

Program Input Hierarchy

Table 3 shows a hierarchy of major data types used in the program. Its purpose is to display the data types and their place within the hierarchy of the program.

Table 3: Program Input Hierarchy

<u>Title Records</u>	
<u>Job Records</u>	
• Job Title	
• Plan Names	
• Damage Category Names	These data apply to every reach, input data year, plan and damage category.
• Input Data Years	
• Discount Rates, Study Year, Base Year, Period of Analysis	
<u>Reach Records</u>	
• Reach Names	These data apply to all data within a reach.
• Frequency Data	These data apply to a particular plan and, if appropriate, input data year within a reach.
• Input data year	
• Plan order number	
• Flow or stage (frequency) data	
• Stage (flow) data	
• Flow (stage) data	
• category number	These data apply to a particular plan, damage category and, if appropriate, input data year within a reach.
• stage or flow (damage) data	
• damage data	
<u>End of Data Records</u>	

Title Records

TT: Title Record

The title records are used to identify the unique features of a particular job to provide documentation for the analyst when the output is encountered at some later time. Useful items to note on these records are the run date, data bases, items modified from the last job, different operation mode or design feature for one or more flood plain management plans. etc. Sometimes it is convenient to adopt a sequential numbering system for each job run during a particular study. As many TT records may be provided as desired. Although these records are usually input at the beginning of the job, they may be inserted before reach or plan data to annotate the features of the input data. The first three title records are stored for labeling the summary output.

Job Records

These records define parameters and analysis procedures which will apply throughout the job. Note that two records, CN and PN, are required records and must be entered for each job.

J1: First Job Record

This optional record need only be provided when a period analysis is desired (equivalent expected annual damage). A positive value for variable IPOA activates the economic routines which compute equivalent annual damage by applying the input discount rates (J2 record) to compute present worth and to amortize the results over a period of analysis. Unless any of the input data are varied by time (input data years), the expected annual damage will be the same for each year and equal to the equivalent annual damage. The study year (ISTDYR) references the year that represents existing conditions. If any of the input parameters are referenced to a year before and after the study year, the particular parameter values will be found by interpolation. The base year (IBASYR) identifies the first year that the plan is expected to be operational. As the hydrologic, hydraulic and economic conditions are assumed to represent end-of-year values, the expected annual damage computed for the base year is discounted one year to the beginning of the period of analysis. IDOLYR conveys the month and year to which the economic data are referenced and is only used for information purposes on the output. NHIS defines the number of input data years that represent historic years (prior to the study year). The expected annual damage for these years will be output with the period of analysis results, but do not impact on the equivalent annual damage computations.

J2: Second Job Record	This optional record is used to enter the discount rates for a period analysis with one or more flood plain management plans. This record must be entered if IPOA on the J1 record is positive. The first discount rate is treated as the primary rate and is included in the detailed output. The results for the other optional, or trial, discount rates are only included in the job summary output.
CN: Damage Category Names	The damage category names for the job are noted on this record(s). Abbreviations will probably be necessary as only eight characters are allowed for each name. If more than nine different categories are used, a second record is required. If retrieving elevation-damage matrices from a HECDSS data file, the damage category names must **match exactly** the category names used when they were stored. For example, if the damage matrices were stored by SID, the category names must match those entered on the DC records in the SID input data file.
CI: Damage Category Price Index	This record is used to index price levels from some period (for which data has been prepared) to the price level desired for the computer run to be performed. This record permits input of price level variations by damage category.
PN: Flood Plain Management Plan Names	The flood plain management names are entered successively, one record for each plan name. The assigned plan numbers need not be sequential but must be a number from 1 through 99.
DY: Input Data Years	The years associated with any of the input data must be listed on this record. If all of the data are referenced to a common year, it is not necessary to provide the record. The first NHIS (field 5 of the J1 record) values must correspond to the historic years being analyzed.
ZW: HECDSS Storage of Results	This record provides the pathname parts required by EAD in order to store computed results in a HECDSS data file. Once a ZW record is entered, the storage of results cannot be terminated. The pathname part C defines the type of computed matrix which is stored in the HECDSS data file. When storing frequency-damage data, the option ".E" may be used to store all of the computed ordinates in the frequency-damage matrix.

Reach Data Records

This data must be supplied for each damage reach.

PP: Printout and Punch Options

This record is used to modify the normal printout and punch (deactivated) options. Although this record is listed with the reach data, it may be input at any time to activate or deactivate desired options for a selected portion of the run.

RN: Reach Name

This record is used to identify the reach. A very abbreviated (6 characters) identifier for the reach should appear on the other reach records to identify the record in case one or more records are withdrawn, either intentionally or accidentally, from the rest of the data.

RV: Revision of Data

This record provides for the creation of input data by modifying the last record of that type for the reach. For instance, if the flows associated with the flow-frequency matrix are expected to increase 10 percent from 1996 to 2000 and 15 percent from 2000 to 2030, this record could be used to create the QF records for the input data years of 2000 and 2030 after the QF record for 1996 has been entered. Also, the RV record may follow an EP record to create data for a new plan. For example, if a levee project is part of the plan for the reach, the damage data can be truncated below the design stage of the levee.

FR: Frequency Vector

This record is usually used to enter the necessary exceedance frequency vector. The data are entered in descending order and are expressed in percent e.g., a value of 10 is entered for the .10 exceedance probability event and 2.0 for the .02 exceedance probability event. It is important that the first value be at or below the zero damage point and the last value to be an infrequent event; usually 0.1 (.001 exceedance probability event) is adequate. For proper curve definition, anywhere from 10 to 18 points should be provided.

The frequency vector corresponds to one of the following:

- Directly to damage vectors (DG record)
- Stage vector (SF record) and then stage-damage matrix (SD and DG records)
- Flow vector (QF record) then:
  - Either flow-damage matrix
  - Or stage-flow matrix (SQ and QS records), and stage-damage matrix (SD and DG records).

The analyst may compute damage only for several input events, based on either stage or flow, by preceding the number of values (NFRQ) with a minus sign. The expected annual damage routines are then bypassed.

QF: Flow Vector for Flow-Frequency Matrix

When expected annual damage is to be computed and the available data is flow-frequency matrices, this record is used to enter the flow vector which will correspond to the frequency vector on the FR record. Several sets of QF records may be entered, each referenced to a different input data year. If no input data year is found, the same flow vector is used for each subsequent plan until another QF record is encountered. If NFRQ on the FR record is negative, then the values on this record represent flows for which damage is computed.

SF: Stage Vector For Stage-Frequency Matrix

This record is used instead of a QF record when the known matrix is a stage-frequency function. This record may be used in the same manner as the QF record (see above description of use).

SQ-QS: Stage-Flow Matrix

These records must be entered when the rating curve is necessary to the analysis. For example, if the known matrices are a flow-frequency and stage-damage, then the rating curve must be entered in order to link the frequencies with the damage data. Several sets of QS records may be entered if the stage-flow matrix is expected to change with time (input data years). Also, the stage-flow matrix may change with different flood plain management plans.

SD: Stage Vector in Stage-Damage Matrix

This record is used when the available input is in the form of stage (elevation) damage functions. The damage vector on the DG record will correspond to the stage vector entered on this record. If vectors for several damage categories are entered, a set of SD-DG records is required for each category. The SD record does not need to be repeated for a particular plan if all damage categories are referenced to the same vector of SD values.

QD: Flow-Damage Data

This record is used instead of an SD record when the available data are in the form of flow-damage functions. If data for several damage categories are entered, a set of QD-DG records is required for each category. The QD record does not need to be repeated for a particular plan if all damage categories are referenced to the same set of flows.

DG: Damage Data

This record is used to enter the damage values which may be associated with frequencies (FR record), stages (SD record) or flows (QD record). The input damage data relate to a particular damage category and sets of SD-DG or QD-DG records are required for each damage category. The damage data may also be referenced to specific input data years and plans.

The damage data may be in dollars, thousands of dollars or millions of dollars, but each reach must be coded in the same units or the final summary has no meaning. It is recommended that the title records (TT) note the units of the damage values.

RC: Residential Content Affluence Adjustment

This record is used to define the projected annual rate of change in the value of damageable property. It is normally used only for the contents in residential structures and only if a change in value can be forecast and substantiated.

DZ: DSS Damage Category Aggregation

This record is used to aggregate up to 50 damage categories that might exist in a DSS file down to a maximum of 18 categories, since EAD can only accommodate 18 categories. In the EAD input data file, it must appear before the ZR records.

ZR: HECDSS Pathname Retrieval

This record provides the pathname data required to retrieve data from the HECDSS data file for processing by EAD. One record is required for each desired input data matrix. It is entered in the same location and in the same conceptual manner as if the functions were entered directly. For example, a frequency-flow matrix is entered directly using one set of FR records and one set of QF records. If the matrix is stored in the HECDSS data file instead, one ZR record is entered and the EAD program retrieves a two vector matrix containing frequency and flow values.

End of Data Records

To terminate input data for a plan, subreach, reach, or to terminate one "job", **only one** of the following records is **required**.

EP: End-of-Plan

This record signifies the end of data input for a particular plan and indicates that data for another plan will follow. The input data are processed after each EP record. Either damage data or expected annual damage and, if a period analysis, equivalent annual damage is computed before reading more input data. The input data for the next plan need only be for those relations that change. For instance, one QF record(s) and an EP record may be the only input necessary for the next plan.

ES: End-of-Subreach

This record signifies the end of data input for a segment of a large reach. For example, it could be used to separate the expected annual damage for the left bank from the right bank or to separate identified commercial categories. The hydrologic and hydraulic relationships for a set of subreaches within a reach are assumed to be referenced to the same index location.

ER: End-of-Reach

This record signifies the end of input data for the last plan of the particular reach. The next data read will be for a new damage reach.

EJ: End-of-Job

This record signifies the last plan for the last reach and, after processing the data for the plan, will cause the final summary tables to be output. This record terminates the EAD run unless input for a new job immediately follows the EJ record.

Output Display

Initial Job Data

The initial output defines the program version, echoes the user's input data, and displays the global job control parameters. (Note: The output following this description is annotated by a sequence of numbers which are referenced in the text.) Every record is output in a format that enables the detection of errors.

Program Title, version date, and Input Listing (1)

The first item printed in the EAD output is the program title, the number of the program, and the version date, followed by a listing of the input data, if requested.

Title (2).

The title records are output whenever encountered (2).

Job Records (3 and 4).

If job records, J1 and J2, are required for the analysis, they are output as found (3). For this example as input on the J1 record, the period of analysis is for 50 years, no study year was indicated, the base year is 1980, the economic data are indexed to January 1974, and there are no historic events. On the J2 record, the discount rate of 7 percent is input (4).

Damage Category (5).

The damage category names are output as found on the CN record (5). For the example, there is only one damage category for residential structures.

Flood Plain Management Plans (6).

Each plan name is output sequentially (6). There is only one plan for this example.

Input Data Years (7).

Input data years, if placed on the optional DY record, are output (7). Two input data years, 1980 and 2009, are being used for the example.

Reach Input Data

The reach input data will be output unless suppressed by adding 1 to the print suppression code for JDGPR on the PP record.

Reach Name (8).

The reach name (8) and the input data for one plan are input, then the appropriate computations are made and the results printed before the data for the next plan are read. For this reach, flow-frequency, stage-flow and stage-damage relations are input. The records were read and output in the sequence described below.

Exceedance Frequency (9).

The exceedance frequencies, in percent, as entered on the FR record (9).

Flows for Frequency (10 & 11).

The flows (QF record) corresponding to the exceedance frequencies for input data years 1980 (10) and 2009 (11).

Stages for Rating Curve (12).

The stages for the rating curve, SQ record (12).

Flows for Rating Curve (13).

The flows (QS record) corresponding to stages for the rating curve (13).

Stages for Damage Data (14).

The stages for damage data, SD record (14).

Damage for Damage Data (15).

The damage data (DG record) corresponding to the stages (15); if stage-damage data were input for other damage categories, that data would follow.

End of Data Record (16).

The type of record ending the input data is shown following the last damage category read for each plan (16), in this case an EJ record.

Damage Results

The EAD program displays a matrix of frequency-flow-stage (elevation)-damage for each plan, reach, and job. The table includes the calculated expected annual damage value for each category.

Frequency-Damage (17)

The damage by category is shown for each input frequency value, or stage or flow value if only event damage data are to be computed (17). If frequency-stage is entered, the flow column is filled with values of "-1". If frequency-damage is entered, both the flow and the stage columns are filled with "-1". Following the total column is a column of accumulated expected annual damage values that are accumulated from zero frequency for each input frequency value. If computing equivalent expected annual damage, these data are output for the study year, base year, five decade years and, if unique, the end of period year and the input data years. The analyst may suppress this table by adding 2 to the print suppression code for JDGPR on the PP record.

Expected Annual Damage (18)

Expected annual damage values are output, if computed, along with the damage data (18). These values may be suppressed by adding 4 to the print suppression code for JDGPR on the PP record.

Period of Analysis (19)

A summary table (19) of the results is output showing key output data and the expected annual damage values for the study year, base year, decade years and end-of-period year. Also equivalent annual damage has been computed by discounting each year back to the beginning of the base year and then amortizing over the period of analysis. Note that the economic results are end-of-year values; therefore, the input data should also represent end-of-year conditions.

Output Summaries (20 & 21)

Several summaries are printed on completion of processing. A summary of reach names (20) is printed, followed by a set of summaries. Each damage category is summarized by damage reach followed by a grand summary by reach wherein the damage categories are added. This is followed by another grand summary that is by damage categories wherein reaches have been added (21). The summaries may be suppressed by specifying the appropriate print suppression code for JDGPR on the PP record.

End-Message (22)

The END OF RUN message (22) indicates that the run has terminated without any fatal execution errors found by the computer. The program itself may have identified data sequence errors or missing data elements which are printed prior to this message. The lack of error messages **does not** mean that there are no errors in the ouput caused by incorrect input. Therefore a careful check of all output for correctness is required.

```
++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible       +
+ Version Date     December 1, 1988        +
++++++++++++++++++++++++++++++++++++++++++++


** LIST OF RECORDS READ BY READIN **
RECORD
 ORDER          1         2         3         4         5         6         7         8
NUMBER 12345678901234567890123456789012345678901234567890123456789012345678901234567890

     1 TT   COMPUTER ANALYSIS OF EXAMPLE COMPUTATION (EXHIBIT 3)
     2 TT   PERIOD ANALYSIS WITH TWO INPUT DATA YEARS
     3 TT   DAMAGE VALUES IN $1,000
     4 TT   MARCH 1989
     5 J1    50             1980  1 1974
     6 J2    7.
     7 CN     1 RES/STR
     8 PN     1 WITHOUT CONDITION
     9 DY     2    1980    2009
    10 RN   TYPICAL REACH NUMBER 1
    11 FR RCH 1       9      20      10       5       3       2       1      .5      .2
    12 FR    .1
    13 QF RCH 11980 1      5700    8100   11000   13800   16200   21000   27000   36000
    14 QF 44000
    15 QF RCH 12009 1      6900    9600   12800   15400   18000   22800   28500   38000
    16 QF 46200
    17 SQ RCH 1      11       8      12      16      20      24      26      28      30
    18 SQ    32      34      36
    19 QS RCH 1            3000    7100   11000   15000   19000   21500   25200   30500
    20 QS 36000   41500   48000
    21 SD RCH 1      17      11      14      16      17    17.5    18.0    18.5    19.0
    22 SD  20.0    22.0    24.0    25.5    26.0    31.0    33.0    34.0    35.0
    23 DG RCH 1     1 1       0      10      30      60      90     180     400     830
    24 DG  1220    1700    2160    2370    2470    3400    3840    4230    5000
    25 EJ     1

READIN --    25 RECORDS WRITTEN TO LOGICAL FILE  8
```

<u>Program</u>

(1) Program title, number and the version date.

```
+++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible       +
+ Version Date     December 1, 1988        +
+++++++++++++++++++++++++++++++++++++++++++


TT   COMPUTER ANALYSIS OF EXAMPLE COMPUTATION (EXHIBIT 3)
TT   PERIOD ANALYSIS WITH TWO INPUT DATA YEARS
TT   DAMAGE VALUES IN $1,000
TT   MARCH 1989

**JOB RECORD**
      IPOA  ISTDYR  IBASYR   IDMTH  IDOLYR    NHIS   NDMTH  NDOLYR
J1      50       0    1980       1    1974       0       0       0


   RATE(1) RATE(2) RATE(3)    CPLI
J2  7.0000   .0000   .0000  1.0000


**DAMAGE CATEGORY NAMES**
CN   1   RES/STR


**FLOOD PLAIN MANAGEMENT PLAN NAMES**
PN   1   WITHOUT CONDITION


**INPUT DATA YEARS**
     NDYRS   IDYRS
DY       2    1980    2009

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

<u>*Title Records*</u>

(2) TT records identify the particular job and units of damage, etc.

<u>*Job Records*</u>

(3) First job record specifies a period of analysis of 50 years, a base year of 1980, and the economic data are indexed to January 1974.

(4) Discount rate is 7 percent and no trial rates will be used.

(5) One damage category for residential structures.

(6) Only one flood plain management plan for this example.

(7) Two input data years of 1980 and 2009.

```
REACH    1, REACH NAME -
RN   TYPICAL REACH NUMBER 1

++++ INPUT DATA ++++



**FREQUENCIES**
FR RCH 1        9   20.00   10.00    5.00    3.00    2.00    1.00     .50     .20
     .10


**FLOOD PEAKS**
QF RCH 11980 1      5700.   8100.  11000.  13800.  16200.  21000.  27000.  36000.
  44000.


QF RCH 12009 1      6900.   9600.  12800.  15400.  18000.  22800.  28500.  38000.
  46200.

**STAGES FOR RATING CURVE**
SQ RCH 1       11    8.00   12.00   16.00   20.00   24.00   26.00   28.00   30.00
   32.00   34.00   36.00

**FLOWS FOR RATING CURVE**
QS RCH 11980 0      3000.   7100.  11000.  15000.  19000.  21500.  25200.  30500.
  36000.  41500.  48000.



**STAGES FOR DAMAGE DATA**
SD RCH 1       17   11.00   14.00   16.00   17.00   17.50   18.00   18.50   19.00
   20.00   22.00   24.00   25.50   26.00   31.00   33.00   34.00   35.00

**FLOOD DAMAGE DATA**
DG RCH 11980 1 1      .00   10.00   30.00   60.00   90.00  180.00  400.00  830.00
 1220.00 1700.00 2160.00 2370.00 2470.00 3400.00 3840.00 4230.00 5000.00



**END OF INPUT DATA FOR PLAN  1 **
EJ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

<u>Input Data</u>

(8) *Reach identification. Following input data are for plan 1 of reach 1. The input data may be suppressed with a value of 1 for JDGPR on the PP record.*

(9) *Exceedance frequencies in percent.*

(10) *Flows for year 1980 and plan 1 which correspond exceedance frequencies.*

(11) *Flows for year 2009 and plan 1.*

(12) *Stages for stage-flow matrix.*

(13) *Flows correspond to stages (SQ record). As no year or plan is indicated, the same matrix will be used for all years and each plan.*

(14) *Stages for stage-damage matrix.*

(15) *Damage corresponding to stage (SD record) for plan 1 and damage category 1. As no year is specified, the same matrix is used for all years.*

(16) *End of input data. EJ indicates end of data for a plan, a reach, and the job. Always enter the plan number in field 1 of the ES, ER, EP, and EJ records.*

```
++DAMAGE DATA FOR PLAN 1 AND YEAR 1980 --  WITHOUT CONDITION

     FREQ      FLOW      STAGE   RES/STR     TOTAL   ACC EAD
  1 20.00     5700.      10.63       .00       .00     66.47
  2 10.00     8100.      13.03      6.75      6.75     66.24
  3  5.00    11000.      16.00     30.00     30.00     65.52
  4  3.00    13800.      18.80    658.00    658.00     62.77
  5  2.00    16200.      21.20   1508.00   1508.00     51.37
  6  1.00    21000.      25.60   2390.00   2390.00     31.87
  7   .50    27000.      28.68   2968.34   2968.34     18.51
  8   .20    36000.      32.00   3620.00   3620.00      8.83
  9   .10    44000.      34.77   4822.31   4822.31      4.82

EXP ANNUAL DAMAGE,   YEAR 1980     66.47     66.47

++DAMAGE DATA FOR PLAN 1 AND YEAR 1989 --  WITHOUT CONDITION

     FREQ      FLOW      STAGE   RES/STR     TOTAL   ACC EAD
  1 20.00     6072.      11.00       .00       .00     72.60
  2 10.00     8566.      13.50      8.34      8.34     72.25
  3  5.00    11559.      16.56     46.76     46.76     71.29
  4  3.00    14297.      19.30    945.66    945.66     66.10
  5  2.00    16759.      21.76   1642.07   1642.07     53.07
  6  1.00    21559.      26.03   2475.89   2475.89     32.48
  7   .50    27466.      28.85   3001.01   3001.01     18.88
  8   .20    36621.      32.23   3669.66   3669.66      9.08
  9   .10    44683.      34.98   4984.06   4984.06      4.98

EXP ANNUAL DAMAGE,   YEAR 1989     72.60     72.60

++DAMAGE DATA FOR PLAN 1 AND YEAR 1999 --  WITHOUT CONDITION

     FREQ      FLOW      STAGE   RES/STR     TOTAL   ACC EAD
  1 20.00     6486.      11.40      1.34      1.34     80.15
  2 10.00     9083.      14.03     10.34     10.34     79.65
  3  5.00    12179.      17.18     70.76     70.76     78.29
  4  3.00    14848.      19.85   1160.83   1160.83     69.29
  5  2.00    17379.      22.38   1787.24   1787.24     54.69
  6  1.00    22179.      26.37   2538.30   2538.30     33.00
  7   .50    27983.      29.05   3037.32   3037.32     19.13
  8   .20    37310.      32.48   3724.83   3724.83      9.21
  9   .10    45441.      35.21   5000.00   5000.00      5.00

EXP ANNUAL DAMAGE,   YEAR 1999     80.15     80.15
```

Output Data

(17) Damage data for each input frequency value, damage category, and a particular year of the analysis period (in this case the base year). This output may be suppressed with a value of 2 for JDGPR on the PP record.

(18) Expected annual damage data for each damage category and particular year. This output may be suppressed with a value of 4 for JDGPR on the PP record.

Damage data for the first decade year (1989). Output continues through 5 decades, end of period year, and any unique input data years.

++DAMAGE DATA FOR PLAN 1 AND YEAR 2009 -- WITHOUT CONDITION

	FREQ	FLOW	STAGE	RES/STR	TOTAL	ACC EAD
1	20.00	6900.	11.80	2.68	2.68	88.93
2	10.00	9600.	14.56	15.64	15.64	88.24
3	5.00	12800.	17.80	144.00	144.00	86.20
4	3.00	15400.	20.40	1316.00	1316.00	72.16
5	2.00	18000.	23.00	1930.00	1930.00	56.18
6	1.00	22800.	26.70	2600.70	2600.70	33.49
7	.50	28500.	29.25	3073.62	3073.62	19.37
8	.20	38000.	32.73	3780.00	3780.00	9.32
9	.10	46200.	35.45	5000.00	5000.00	5.00

EXP ANNUAL DAMAGE, YEAR 2009 88.93 88.93

++DAMAGE DATA FOR PLAN 1 AND YEAR 2019 -- WITHOUT CONDITION

	FREQ	FLOW	STAGE	RES/STR	TOTAL	ACC EAD
1	20.00	6900.	11.80	2.68	2.68	88.93
2	10.00	9600.	14.56	15.64	15.64	88.24
3	5.00	12800.	17.80	144.00	144.00	86.20
4	3.00	15400.	20.40	1316.00	1316.00	72.16
5	2.00	18000.	23.00	1930.00	1930.00	56.18
6	1.00	22800.	26.70	2600.70	2600.70	33.49
7	.50	28500.	29.25	3073.62	3073.62	19.37
8	.20	38000.	32.73	3780.00	3780.00	9.32
9	.10	46200.	35.45	5000.00	5000.00	5.00

EXP ANNUAL DAMAGE, YEAR 2019 88.93 88.93

++DAMAGE DATA FOR PLAN 1 AND YEAR 2029 -- WITHOUT CONDITION

	FREQ	FLOW	STAGE	RES/STR	TOTAL	ACC EAD
1	20.00	6900.	11.80	2.68	2.68	88.93
2	10.00	9600.	14.56	15.64	15.64	88.24
3	5.00	12800.	17.80	144.00	144.00	86.20
4	3.00	15400.	20.40	1316.00	1316.00	72.16
5	2.00	18000.	23.00	1930.00	1930.00	56.18
6	1.00	22800.	26.70	2600.70	2600.70	33.49
7	.50	28500.	29.25	3073.62	3073.62	19.37
8	.20	38000.	32.73	3780.00	3780.00	9.32
9	.10	46200.	35.45	5000.00	5000.00	5.00

EXP ANNUAL DAMAGE, YEAR 2029 88.93 88.93

```
   COMPUTER ANALYSIS OF EXAMPLE COMPUTATION (EXHIBIT 3)
   PERIOD ANALYSIS WITH TWO INPUT DATA YEARS
   DAMAGE VALUES IN $1,000

** EXPECTED ANNUAL FLOOD DAMAGE **

**       FOR REACH  1 =   TYPICAL REACH NUMBER 1


**       WITH PLAN  1 = WITHOUT CONDITION


** INPUT DATA YEARS   =  1980  2009

** PERIOD OF ANALYSIS =   50 YEARS

** DISCOUNT RATE      =  7.0000 PERCENT

** DAMAGE BASE        =  JAN 1974 DOLLARS


   ----------------------------------------------------------------------------------------------------

                  STUDY      BASE    ................. DECADE YEARS ................    END OF  EQUIVALENT
     DAMAGE        YEAR      YEAR        10        20        30        40        50    PERIOD     ANNUAL
   CATEGORIES         0      1980      1989      1999      2009      2019      2029      2029     DAMAGE
   ----------------------------------------------------------------------------------------------------
    1 RES/STR       .00     66.47     72.60     80.15     88.93     88.93     88.93     88.93      75.03
   ----------------------------------------------------------------------------------------------------
        TOTAL       .00     66.47     72.60     80.15     88.93     88.93     88.93     88.93      75.03

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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   COMPUTER ANALYSIS OF EXAMPLE COMPUTATION (EXHIBIT 3)
   PERIOD ANALYSIS WITH TWO INPUT DATA YEARS
   DAMAGE VALUES IN $1,000


** SUMMARY OF REACH NAMES  **

 NO     ID     . . NAME . . .
--------------------------------------------------------------------------------
  1  RCH 1       TYPICAL REACH NUMBER 1


--------------------------------------------------------------------------------
```

<u>*Period of Analysis Results*</u>

(19) Summary of damage results for the management plan for the reach. Equivalent annual damage has been computed. This output may be suppressed with a value of 8 for JDGPR on the PP record.

<u>*Output Summaries*</u>

(20) Summary of reach names, provides a catalogue of all reach names with data processed.

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

   COMPUTER ANALYSIS OF EXAMPLE COMPUTATION (EXHIBIT 3)
   PERIOD ANALYSIS WITH TWO INPUT DATA YEARS
   DAMAGE VALUES IN $1,000


** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS   =  1980  2009

PERIOD OF ANALYSIS =   50 YEARS

** DISCOUNT RATE      =  7.0000 PERCENT

** DAMAGE BASE        =   JAN 1974 DOLLARS

** FLOOD PLAIN MANAGEMENT PLANS
         1 -  WITHOUT CONDITION


GRAND SUMMARY - ALL DAMAGE CATEGORIES
--------------------

            EQUIVALENT ANNUAL DAMAGE

  DAMAGE      BASE
 CATEGORY   CONDITION
            (PLAN  1)
--------------------

   RES/STR     75.03
--------------------

     TOTAL     75.03

--------------------


READIN --  NO RECORDS READ FROM USER INPUT


++++++++++++++++
END OF RUN
EAD PROGRAM STOP
++++++++++++++++
```

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Johnson, William K. and Davis, Darryl W. 1984. "The Hydrologic Engineering Center Experience in Nonstructural Planning," Technical Paper-96. Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, CA.

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Exhibit 1

Effects of Flood Plain Management Measures on Stage, Damage, Flow, and Frequency Functions

Exhibit 1

Effects of Flood Plain Management Measures
on Stage, Damage, Flow, and Frequency Functions

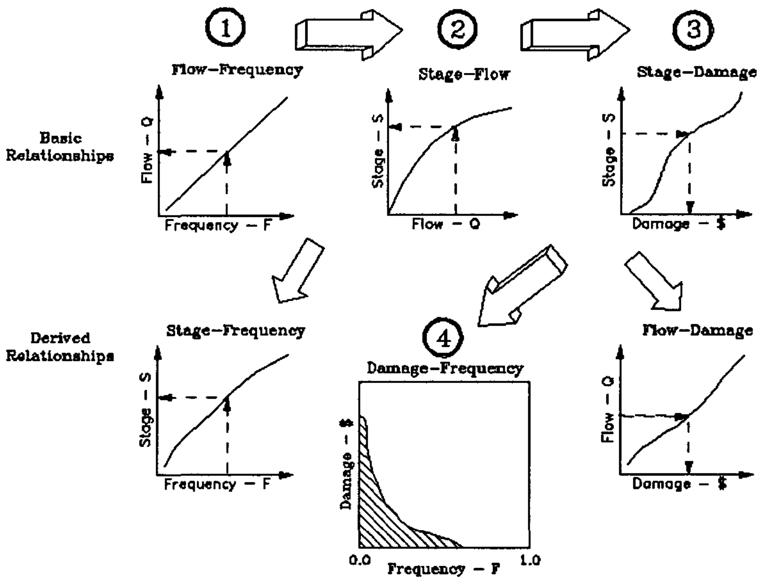
Introduction

Flood plain management measures protect damageable property, both existing and future, in one of two ways. Either they reduce flooding or they reduce the damage susceptibility of the property. The tabulation below includes several typical measures of each type that will be discussed and illustrated in this section.

Measures designed to manage water, either locally or throughout a system, can alter various hydrologic, hydraulic, and economic matrices which exist at specific locations. Measures designed to manage damage susceptibility alter only economic matrices. The basic matrices that can display the hydrologic, hydraulic, and economic characteristics of flood plain management measures are the stage-damage relationship, stage-flow relationship and the flow-frequency relationship. All others, such as flow-damage, stage-frequency and damage-frequency can be obtained from these basic three by combinations with a common parameter. It is important to understand what the basic matrices are, and how they are altered by the various measures, both beneficially (on purpose) and adversely. On the following pages each relationship and the effect of each measure are described and illustrated. The effect of several flood plain management measures are shown in terms of the impact on three basic evaluation matrices plus the derived stage-frequency relationship because of its common reference in planning reports.

Flood Plain Management Measures	
Water Management	**Damage Susceptibility Management**
Reservoirs Levee or Floodwall Channel Modification Diversion Flood Forecasting	Flood Proofing Relocation Flood Warning and Preparedness Land Use Control

Figure 6: Basic and Derived Functions



The **basic** and **derived** evaluation functions are shown above. Concepts important to their construction are described herein.

1. Flow-Frequency Matrix: This defines the relationship between exceedance frequency and flow at a location. It is the basic function describing the probability nature of stream flow and is commonly determined from either statistical analysis of gaged flow data or watershed model calculations.

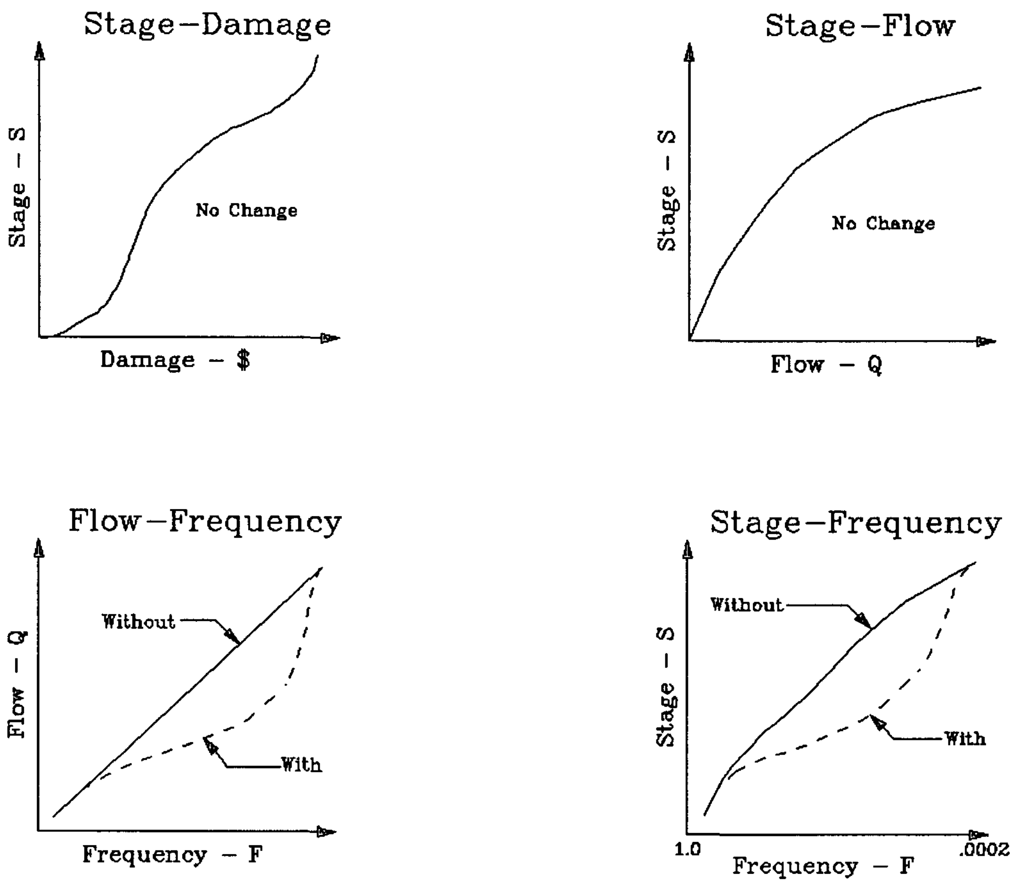
2. Stage-Flow Matrix: This defines the relationship between flow rate and stage at a location. It is the basic function describing the hydraulic nature of the stream. It is frequently referred to as a "rating curve" and is normally derived from water surface profile computations.

3. Stage-Damage Matrix: This defines is the relationship between the river's water surface elevation and damage which would occur some distance upstream and downstream from the specified location. It is a basic function which usually represents an aggregate of the damage which could occur to many structures. It is usually developed from field damage surveys.

4. Damage-Frequency Matrix: This matrix is derived by combining the basic matrices (1,2,and 3) using the common parameters of stage and flow. For example, the damage for a specific exceedance frequency is determined by interpolating the corresponding flow rate from the flow-frequency matrix, the stage corresponding to this flow rate from the stage-flow matrix, and finally the corresponding damage from the stage-damage matrix. Any changes which occur in the basic relationships because of watershed development or the implementation of one or more flood plain management measures will change the damage-frequency matrix and therefore the expected annual damage that is computed as the integral of that function (area underneath).

Other Functional Matrices: Two intermediate matrices are derived in the process of developing the Damage-Frequency matrix. The stage-frequency matrix is developed by combining the stage-flow with the flow-frequency matrix using flow as the common parameter. The flow-damage matrix is developed by combining the stage-damage with the stage-flow matrix using stage as the common parameter (or vector).

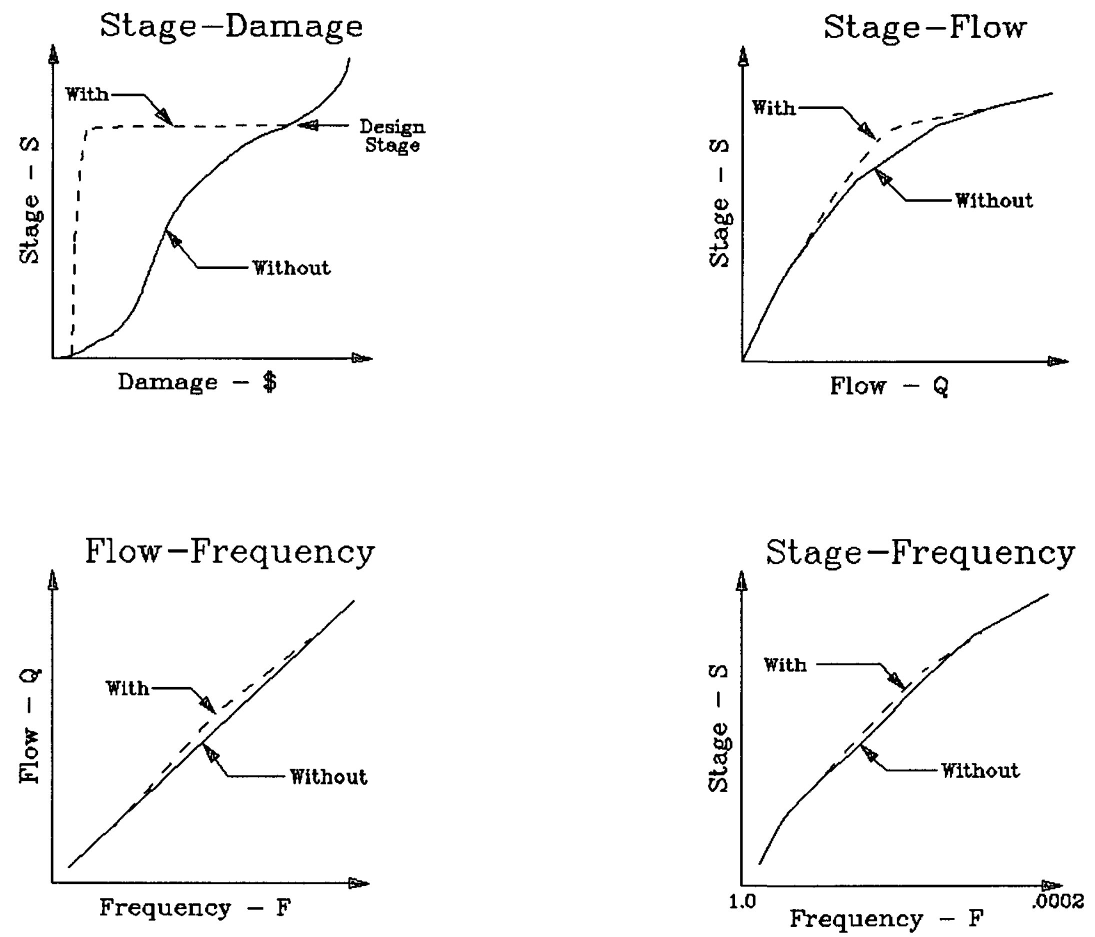
Figure 7: Effect of Flood Control Reservoir



The purpose of a flood control reservoir is to store flood water during storm periods and release them during periods of lower flow. Because the streamflow is altered by the reservoir, the flood frequency at all locations downstream are altered, generally by lowering the flow for a given frequency of event. The magnitude of the flow reduction may be small or large depending upon the size of the reservoir, the magnitude of the event, and the location of the reservoir in relation to the downstream point. No other functional matrices are directly affected by a reservoir. The sketch displays the impact of a reservoir immediately downstream on without project functional matrices.

Systems of reservoirs can exhibit more complex affects because of the influence of complex operation rules and varying priorities in release patterns. Reservoirs can result in long term changes in downstream conveyance (by scour or deposition) which changes the stage-flow matrix and by inducing development onto the flood plain which could affect the stage-damage matrix.

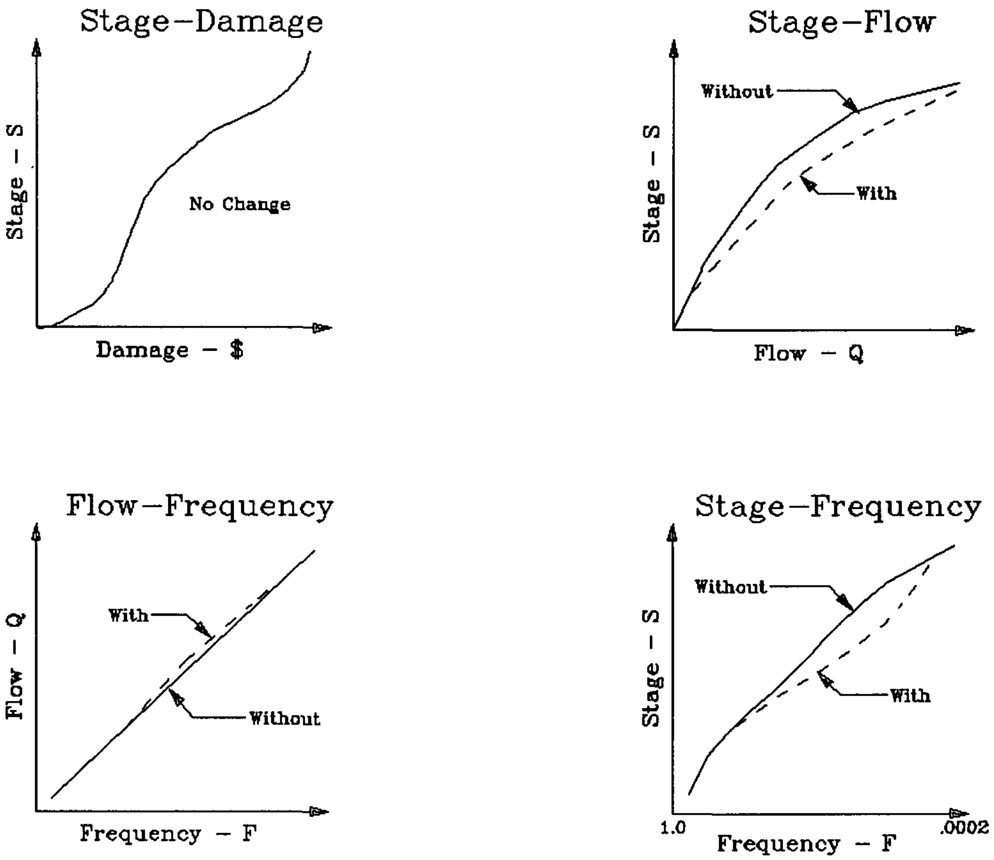
Figure 8: Effect of Levee and Floodwall



Levees and floodwalls are designed to prevent flooding to adjacent protected areas. They provide a direct mans of flood protection in that they can be located where needed and can act to confine flood waters to the channel up to the design flow. The direct planned for effect is therefore a truncation of the stage-damage matrix below the design flow rate. The river stage can be raised for a given flow rate if the flow conveyance area is significantly reduced by the measure. The stage-flow matrix can therefore be incidentally affected.

Higher flow rates for a specific event can be induced downstream if a significant amount of flood plain storage is eliminated because the stage is lowered by the measure. The flow-frequency matrix can be affected similarly to the affect of a levee and floodwall. The sketch displays the impact of the measure on the functional relationship in the downstream reaches of the project area.

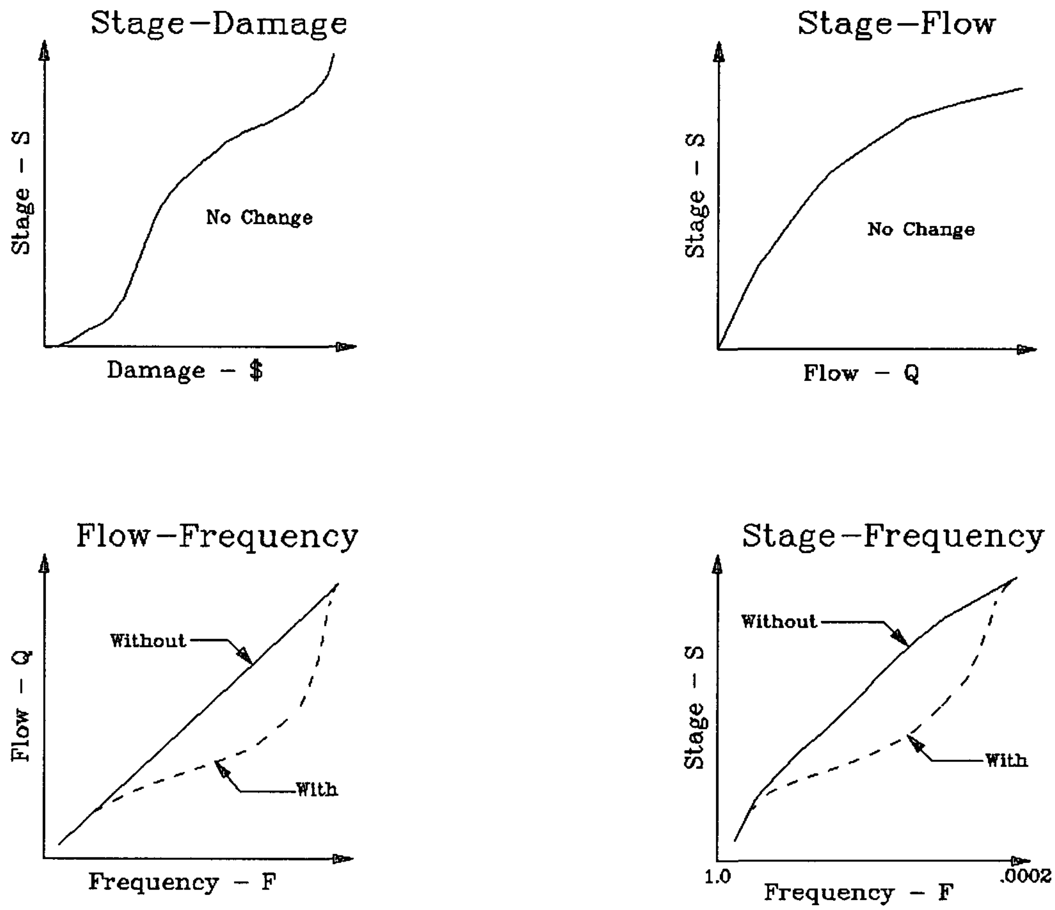
Figure 9: Effect of Channel Modification



Channel modifications are designed to increase the stream conveyance capacity by enlarging the channel flow area, by decreasing surface roughness by clearing and lining, and by shortening and straightening the flow path. All these actions generally lower the stage and increase the velocity for a specific flood event. The direct planned for affect is therefore a lowering of the stage-flow matrix

Higher flow rates for a specific event can be induced downstream if a significant amount of flood plain storage is eliminated because the stage is lowered by the measure. The flow-frequency matrix can be affected similarly to the affect of a levee and floodwall. The sketch displays the mpact of the measure on the functional matrix in the downstream reaches of the project area.

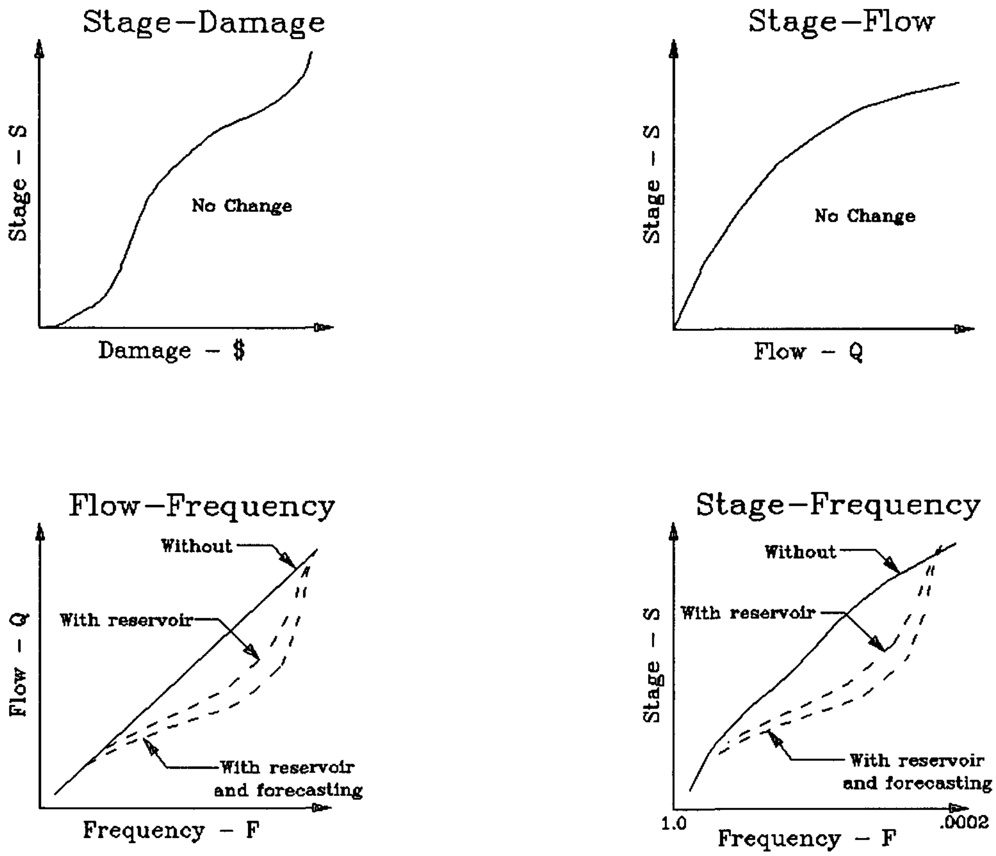
Figure 10: Effect of Diversion



A diversion removes flow from the river during high stages and passes it safely away from damage areas. this has the immediate effect of reducing the amount of flow at all locations below the diversion. The direct planned for effect is the lowering of the flow-frequency matrix.

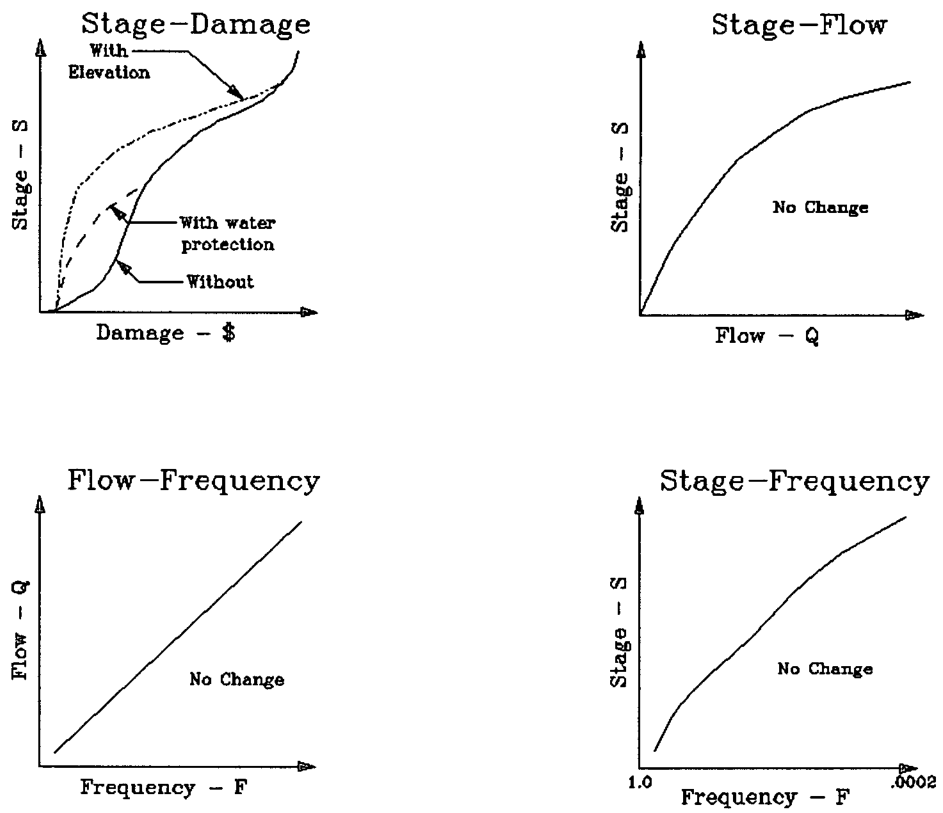
No other functions are directly or indirectly affected. Long term stream regime changes induced by the change in flow and sediment content could affect downstream conveyance capacity thus affecting the stage-flow matrix at some point in the future.

Figure 11: Effect of Flood Forecasting



Flood runoff forecasting allows flood control measures, such as reservoirs and diversions, to be operated so that flows are better controlled at critical damage centers resulting in lower flows than without forecasting. The planned effect is therefore an additional lowering of the flow-frequency matrix. No other functions are directly affected. Estimates of expected storm flows are provided by real-time flood forecasting systems using rainfall and stream measurements and hydrologic simulation models. Reservoirs are then operated using the forecast data to improve use of storage.

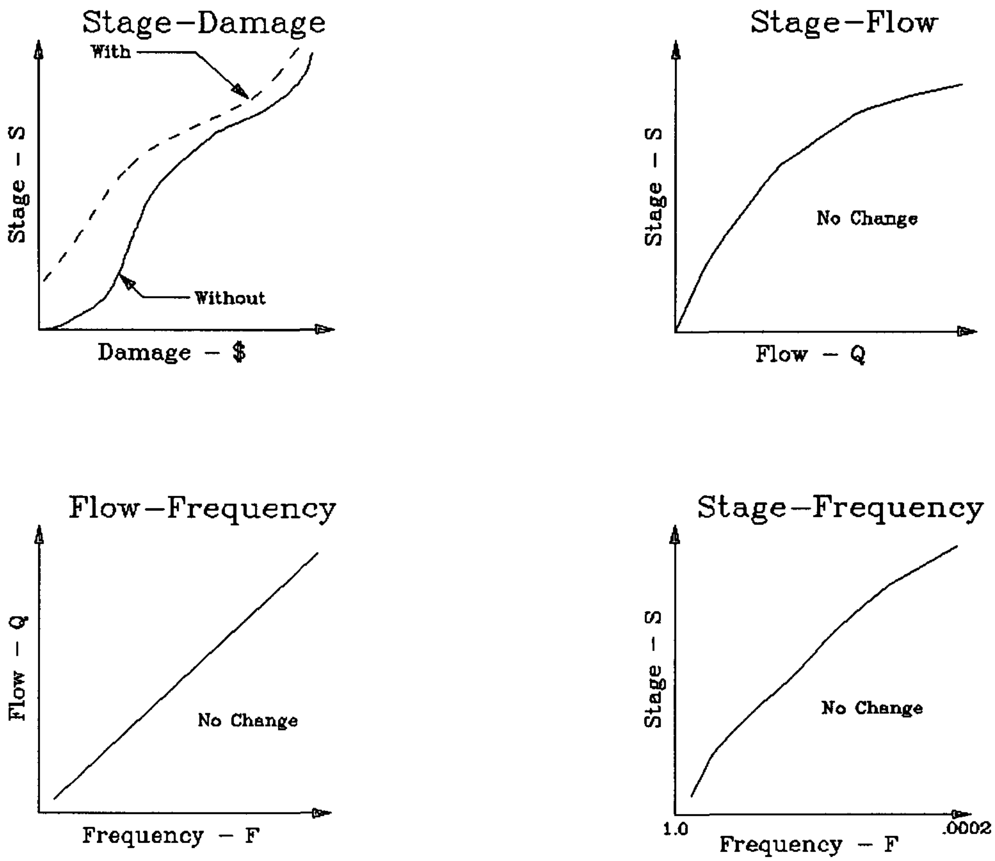
Figure 12: Effect of Flood Proofing Individual Structures



This group of measures can take may forms and is designed to protect individual structures and contents from flood waters. The appropriate measure used depends on the type, location and susceptibility to damage of the specific structure and contents. when protection is provided and a single structure or group of structures are "flood proofed" the relationship between stage and damage is modified.

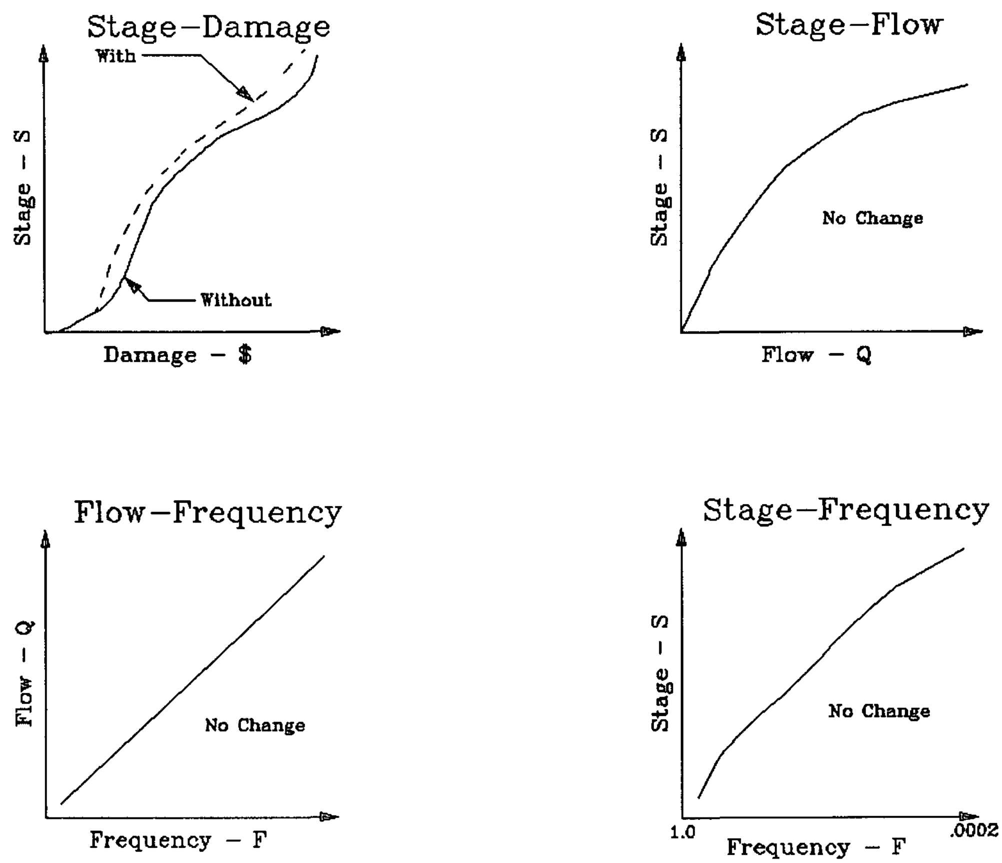
Structures may be raised or protected in place. The hydrologic system will generally remain unchanged so that no other functional relationships are directly affected. The sketch displays the impact of flood proofing all structures within a flood hazard area a uniform amount, say 3 feet, by raising some and by placing barriers around others.

Figure 13: Effect of Structure Relocation



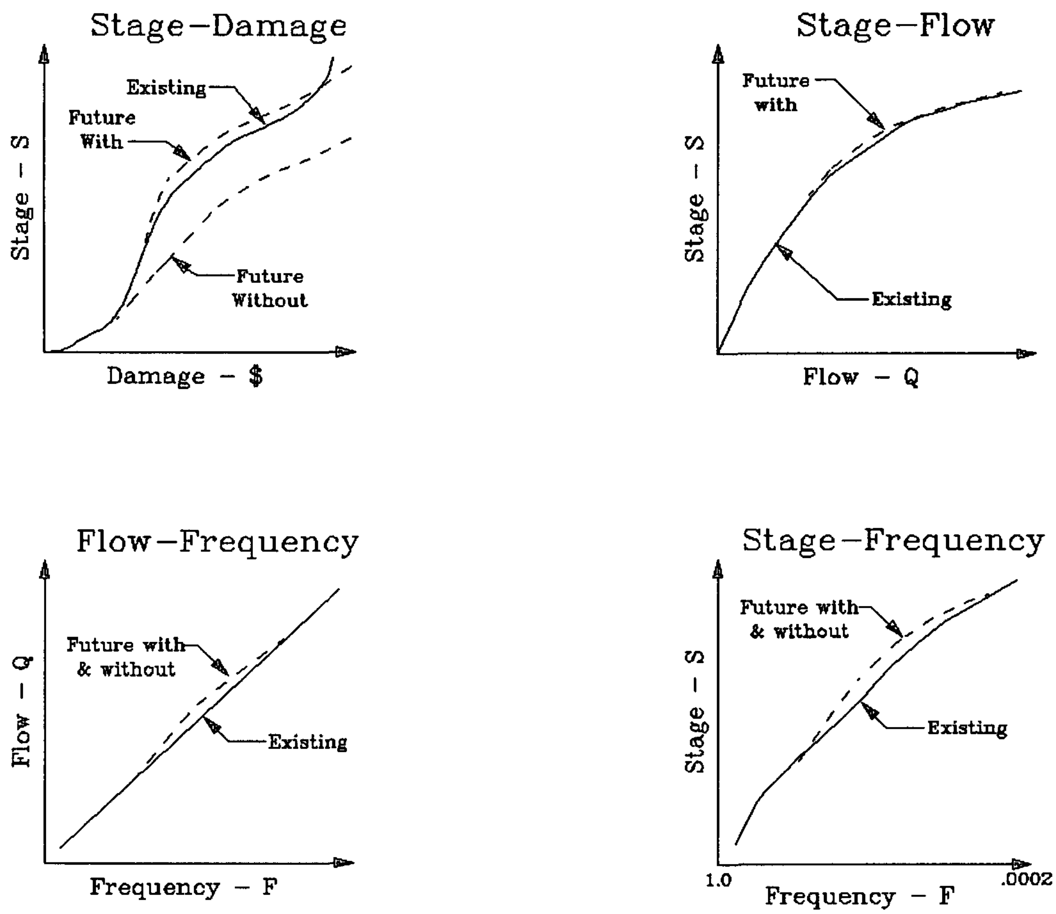
This measure is completely effective in preventing flood damage to a structure or contents by removing them from areas susceptible to floods. The stage-damage matrix is thus changed depending upon the amount of property removed and the location to which it is moved. The sketch displays the impact of removing all structures below a specific flood hazard elevation.

Figure 14: Effect of Flood Warning



Advance warning can allow temporary measures to be implemented to protect or remove damageable property. For example, the temporary relocation of movable property or the raising or sandbagging of property which must remain. Flood warning and preparedness is a combination of flood proofing and relocation, and while it is not as dependable as the permanent measures it can help to reduce potential damage. The stage-damage matrix, as described in the sections on flood proofing and evacuation, is the only one affected. The sketch displays the impact of significant advance warning (say greater than 12 hours notice).

Figure 15: Effect of Future Land Use Control
(Fill Placement to Elevate New Development)



Land use controls such as local restrictive zoning and similar actions that may be induced by the sanctions of the national flood insurance program apply almost exclusively to future development. They are designed to influence future decisions so that the long term affect is to cause the stage-damage function that would have existed in the future in the absence of the measures to be lowered, that is, to prevent future development but not significantly influence existing development. Provisions such as prevention of improvements or refurnishing after floods could lead to reduction of existing development by attrition. In this instance, the future stage-damage function would be lowered even further by gradual removal of damageable property. the sketch displays the impact of land use controls implemented immediately on the damage potential at some point in the future.

Summary

Table 4 below summarizes the effects of the measures discussed. The relationship effect represents the immediate (in time) change at the site of the measure. Exceptions are noted in the footnotes.

Table 4: Effect of Flood Plain Management Measures

	Impacted Relationship[1]				
Measure	Stage-flow	Stage-Damage	Flow-Damage	Flow-Frequency	Damage-Frequency
Reservoir[2]	NC	NC	NC	M	M
Levee or floodwall[2]	M	M	M	M[3]	M
Channel Modification[2]	M	NC	M	M[3]	M
Diversion[2]	NC	NC	NC	M	M
Flood Forecasting	NC	NC	NC	M	M
Flood Proofing	NC	M	M	NC	M
Relocation	NC	M	M	NC	M
Flood Warning	NC	M	M	NC	M
Land Use Control[4]	NC	M	M	M	M

1 The following codes apply to the table above:

NC = No Change in parametric relationship
M = Modification to parametric relationship

2 Long-term effects resulting from a change in stream regime induced by these measures could affect the basic stage-flow relationship and thus other derived relationships at some future date.

3 Elimination of significant amounts of flood plain storage can result in downstream effects on flow-frequency relationship.

4 The impact indicated is that which would occur to a future condition in the absence of the measure.

Exhibit 2

Damage-Frequency Integration Procedure

Exhibit 2

Damage-Frequency Integration Procedure

Introduction

An accurate computation of expected annual damage requires good input data and a good integration method. The user is responsible for preparing good input data. Because linear interpolation is used to define most of the relations, the input data points must be selected to adequately represent each relation by a series of straight lines. Past experience has shown that integration by the usual summation of rectangular areas can result in significant errors because of the nonlinearity of the damage-frequency function. An integration procedure has been developed for expected annual damage which will yield accurate results and is computationally efficient.

Exceedance Frequency Matrix

To obtain expected annual damage, a damage-frequency matrix is necessary. Therefore, depending on input, several levels of interpolation may be necessary to obtain the necessary matrix. If the input matrix is already damage-frequency, the interpolation routines are bypassed and the process goes directly to the integration step. As the interpolation process keys on the input exceedance frequency values, additional exceedance frequency points are internally inserted between the input values to better define the nonlinear relation as well as to more accurately define the beginning of damage. Nine exceedance frequency values are added that are 1/10 of the interval between each pair of input exceedance frequency values. Therefore, if the first two input values are 90.0 and 80.0, the nine values added between this interval would be 89, 88, 87....etc.

If flows (or stages) corresponding to exceedance frequencies are provided for several input data years, then the flow (or stage) corresponding to the frequency is found by linear interpolation between input data years for the year that expected annual damage is being computed.

The frequency-flow or frequency-stage matrix is highly nonlinear. To more nearly linearize the matrix for interpolation, the frequency scale is transformed to either normal standard deviates when annual series frequencies are entered or to logarithms when partial duration series frequencies are entered. A logarithmic transformation is made to flows, but no transform is made to stages. The transformed values are fit by a cubic polynomial procedure, and either flow or stage values, depending on input, are found for each inserted frequency value.

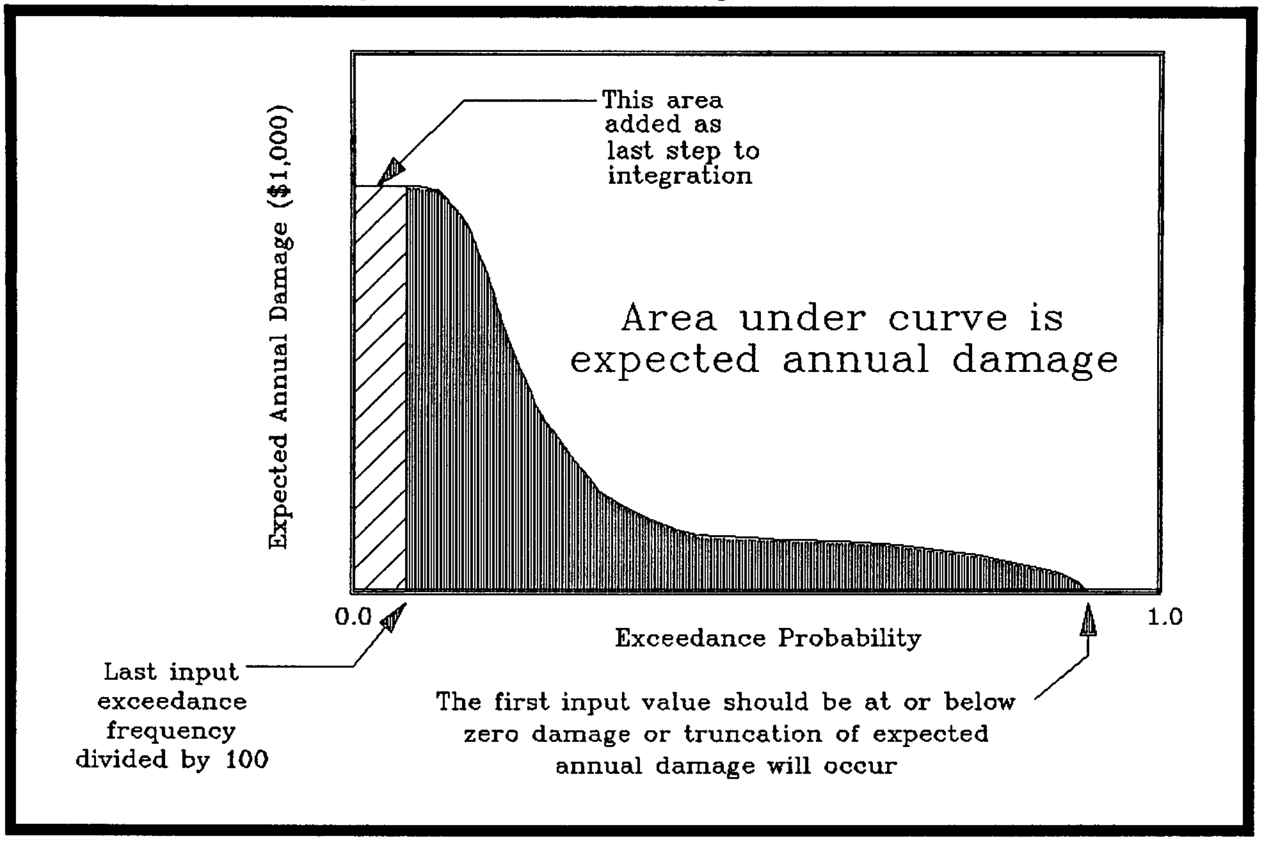
Computation of Damage

A damage value must be computed for each input and inserted exceedance frequency value. The exact steps that are taken depend upon the input data. The usual input matrices of flow-exceedance frequency, stage-flow and stage-damage are used to illustrate the process.

After the flows are interpolated for each exceedance frequency as described above, the stage for each of the flows must be found from the stage-flow matrix (rating curve). The appropriate stage-flow matrix for the year in which expected annual damage is being computed is found by linear interpolation if the rating curve was expected to change with time. Completion of this step provides a stage-frequency matrix.

Next, the damage values corresponding to the interpolated stages from the previous step are computed for each damage category. If the damage values change with time, the appropriate stage-damage matrix is computed first for the year in which expected annual damage is computed. Completion of this step provides a damage-frequency matrix for each damage category.

Figure 16: Illustration of Integration Procedure



Integration

The remaining task is to integrate the damage-frequency matrix to obtain the expected annual damage. The matrix is well defined at this point because of the insertion of the additional exceedance frequency points. This matrix can be quite nonlinear in nature so it is also fit by the cubic polynomial procedure mentioned earlier.

The exceedance frequency values are converted to exceedance probability values by dividing by 100. Then the area between each pair of points is found by the three-point Gaussian quadrature method. This method computes three points between a pair of points for the X variable (exceedance probability in this case) and then finds the corresponding Y value (damage) by the cubic-polynomial fit. These three Y values are given mathematically derived weights, summed, and multiplied by the X interval. Repeating this process for each successive pair of exceedance probability points and summing the results yields the expected annual damage between the limits of the input exceedance frequency values.

The analyst must select a beginning frequency value that is below the nondamaging stage because there is no extrapolation to zero damage. At the other end of the curve, the analyst must select a fairly rare event (such as an exceedance frequency of 0.1% or 1,000 year return period) in order to calculate a more accurate integration. A rectangular area is added to the area determined defined from the analyst's input exceedance frequencies. It is equal to the product of the last exceedance probability times the damage associated with that value (see Figure 16). Table 5 shows the computer solution to the data in Exhibit 3, Example Computation.

Table 5: Computer Integration Steps

(Partial Example)[1]

Data for 1980 Conditions

Input Exceedance Frequency (Events per 100 years)	Added Exceedance Frequency (Events per 100 years)	Input Flow (cfs)	Interpolated Flow (cfs)	Interpolated Stages (feet)	Interpolated Damage Value ($)	Incremental Expected Annual Damage ($)
.20		36000	-------	32.00	3620.00	
						.364
	.19		36556	32.20	3664.44	
						.369
	.18		37147	32.42	3711.78	
						.374
	.17		37780	32.65	3762.38	
						.379
	.16		38485	32.89	3816.67	
						.386
	.15		39190	33.16	3902.37	
						.396
	.14		39982	33.45	4014.71	
						.407
	.13		40845	33.76	4137.06	
						.421
	.12		41791	34.09	4298.83	
						.442
	.11		42835	34.41	4546.38	
						.468
.10		44000	-------	34.77	4822.31	
			Total for All Increments			4.006

[1]The frequency interval .2 to .1 shown is for the example output described earlier in the "Output Display" section. Other intervals are processed in the same manner.

Exhibit 3

Example Computation

Exhibit 3

Example Computation

Introduction

This example illustrates EAD's computational methods, to compute single event damage, expected annual damage and equivalent annual damage. It is assumed that damage, flow, stage and frequency data have been collected by field survey or other means, and that these data have been put into the traditional stage or flow-damage, stage-flow and stage or flow-frequency matrix form. Stage-damage, stage-flow and flow-frequency matrices are selected for this example and are shown on Figures 17, 18, and 19. In addition to these, the computer program can handle other combinations such as frequency-damage; or stage-damage and stage-frequency; or flow-damage and flow-frequency; or flow-damage, stage-flow and stage-frequency. The computational procedures are essentially the same for all combinations.

Damage-Frequency Matrix

When Figures 17, 18, and 19 are combined, the damage-frequency function shown in Figure 18 is obtained. There are several ways to do this by hand. One might select elevations on the stage-damage matrix (Figure 17), use these same elevations to find corresponding flows on Figure 18, use the flows to find corresponding frequencies on Figure 19, and thus relate damage to frequency. Or, one might reverse the procedure and begin with selected frequencies and find corresponding damage. What is of critical importance to achieve an acceptable level of accuracy in constructing the damage-frequency matrix is that **each** matrix used in the derivation be defined with carefully selected points, such as significant slope breaks, such that a linear interpolation between points is a reasonable representation of the actual function.

In hand computations this is sometimes difficult to do unless a large number of points are selected. For example, while sufficient elevation points may be selected to define a stage-damage matrix, these same elevations may not accurately define the stage-flow function. Since hand computations use one set of discrete points the only alternative is to go back to the stage-damage matrix and take additional points. In the computer program **each** matrix used in the derivation of the damage-frequency matrix can be defined with up to 18 points and each set of points can be different. For example, the stage-damage matrix can be defined with up to 18 points and the stage-flow with up to 18 entirely different points, and the same for the flow-frequency matrix. This allows **each** function to be defined independently and accurately and lets the program do the linear interpolation. Additional points are developed internally within the program and these are discussed below.

In this example, nine frequency points were initially selected to define the damage-frequency matrix and illustrate the computational procedure. These data are shown in Table 6. Corresponding stages were obtained from Figure 18 and damage from Figure 17. Each damage value represents the estimated damage for a flood of a particular exceedance frequency. The damage-frequency data in Table 6 are plotted in Figure 20. The interpolated values were obtained from program results.

In the computer program the sequence of computations is the same as that described above except that nine intermediate points are used between each pair of input frequency values. For example, if the frequency input data values were those shown in Table 6, the computer would interpolate between .1 and .2 and compute nine intermediate points, .11, .12, etc. Each of these points would also be used to compute damage values. A cubic polynomial fit routine uses the input and intermediate data to compute additional points prior to integration. The use of intermediate points allows for a more accurate determination of the damage-frequency matrices. This point is illustrated in Figure 20 which shows both the input data and the intermediate points computed by the program.

Figure 17: Stage-Damage Function

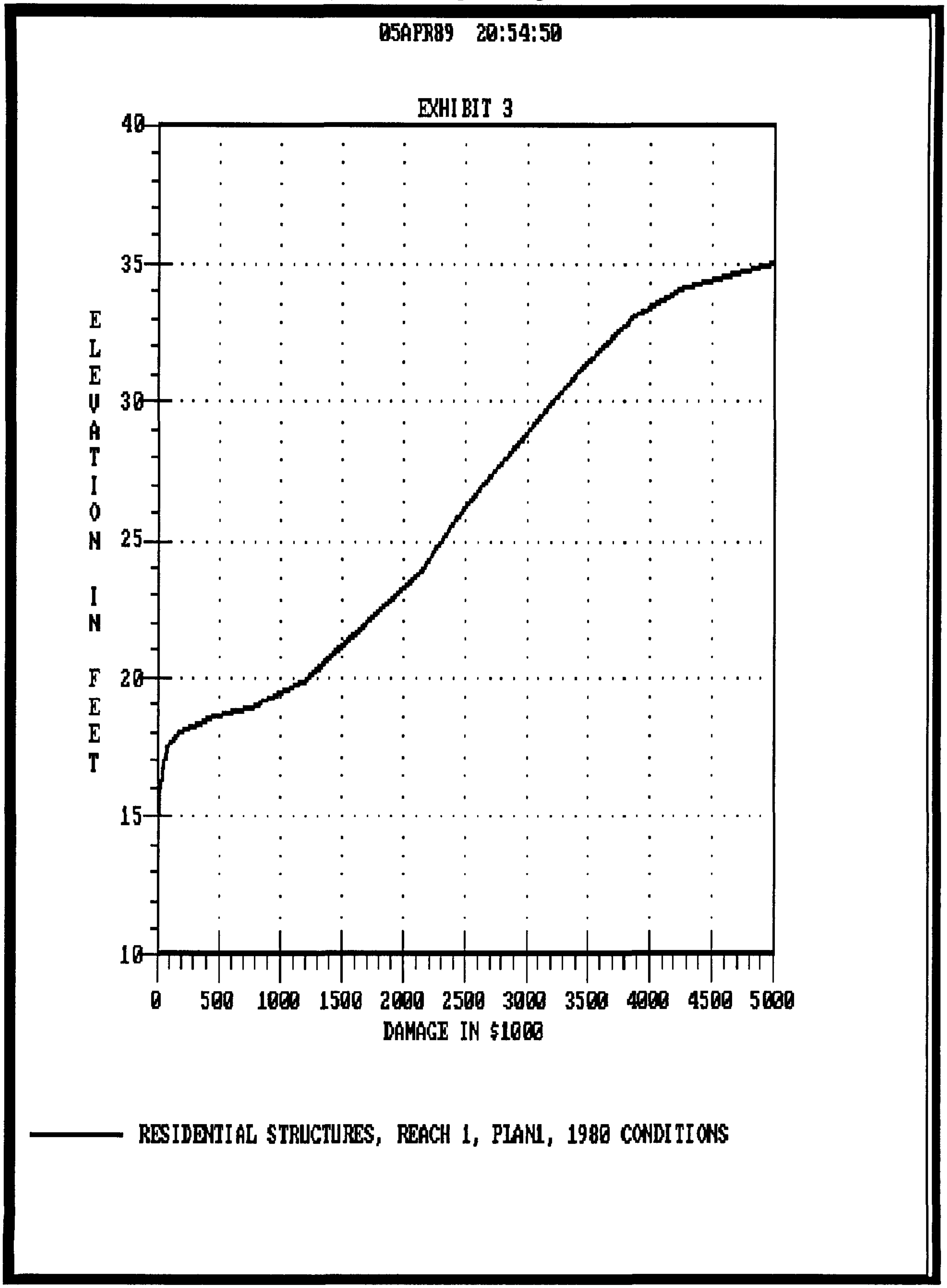


Figure 18: Stage-Flow Function

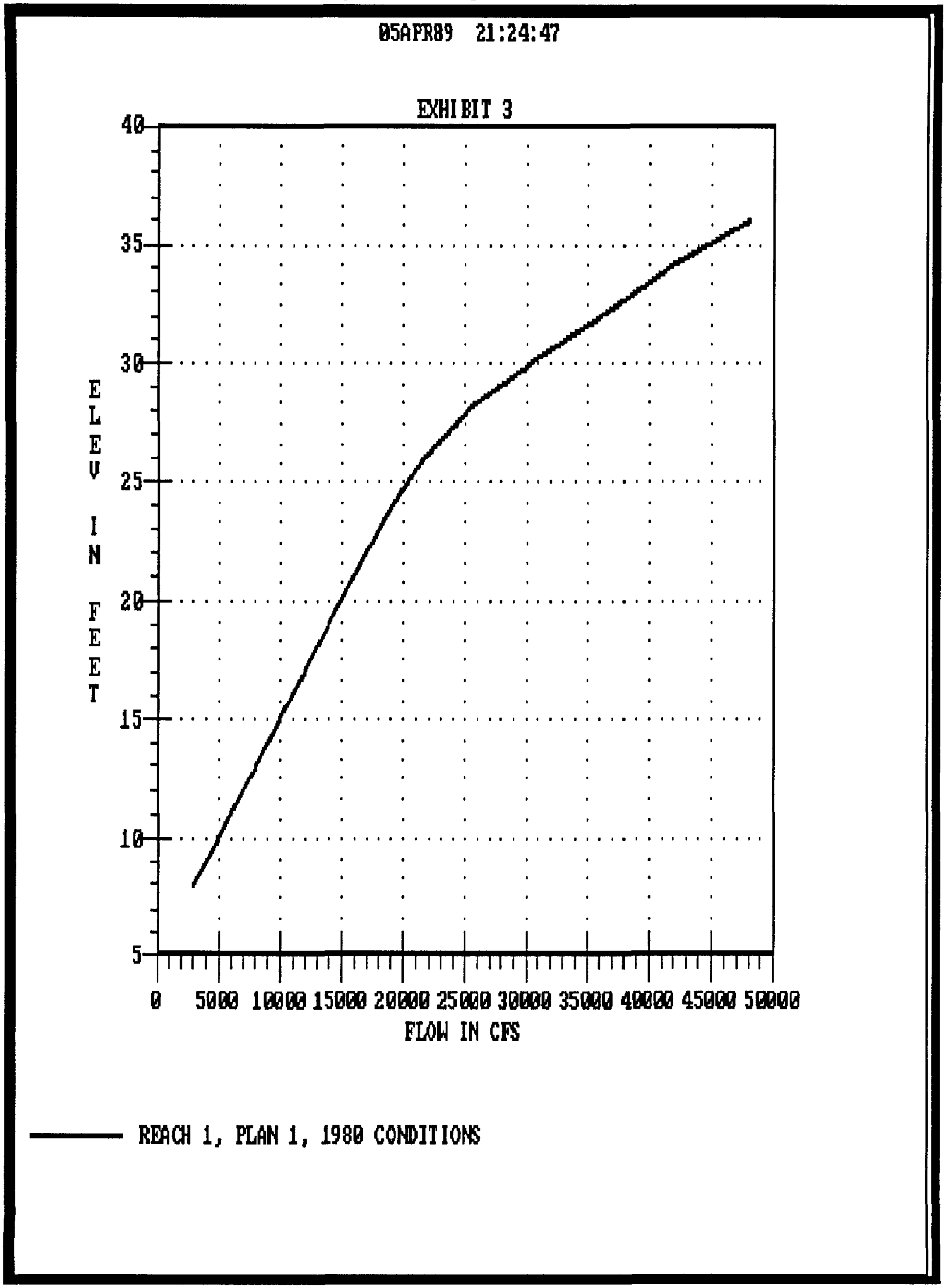


Figure 19: Flow-Frequency Function

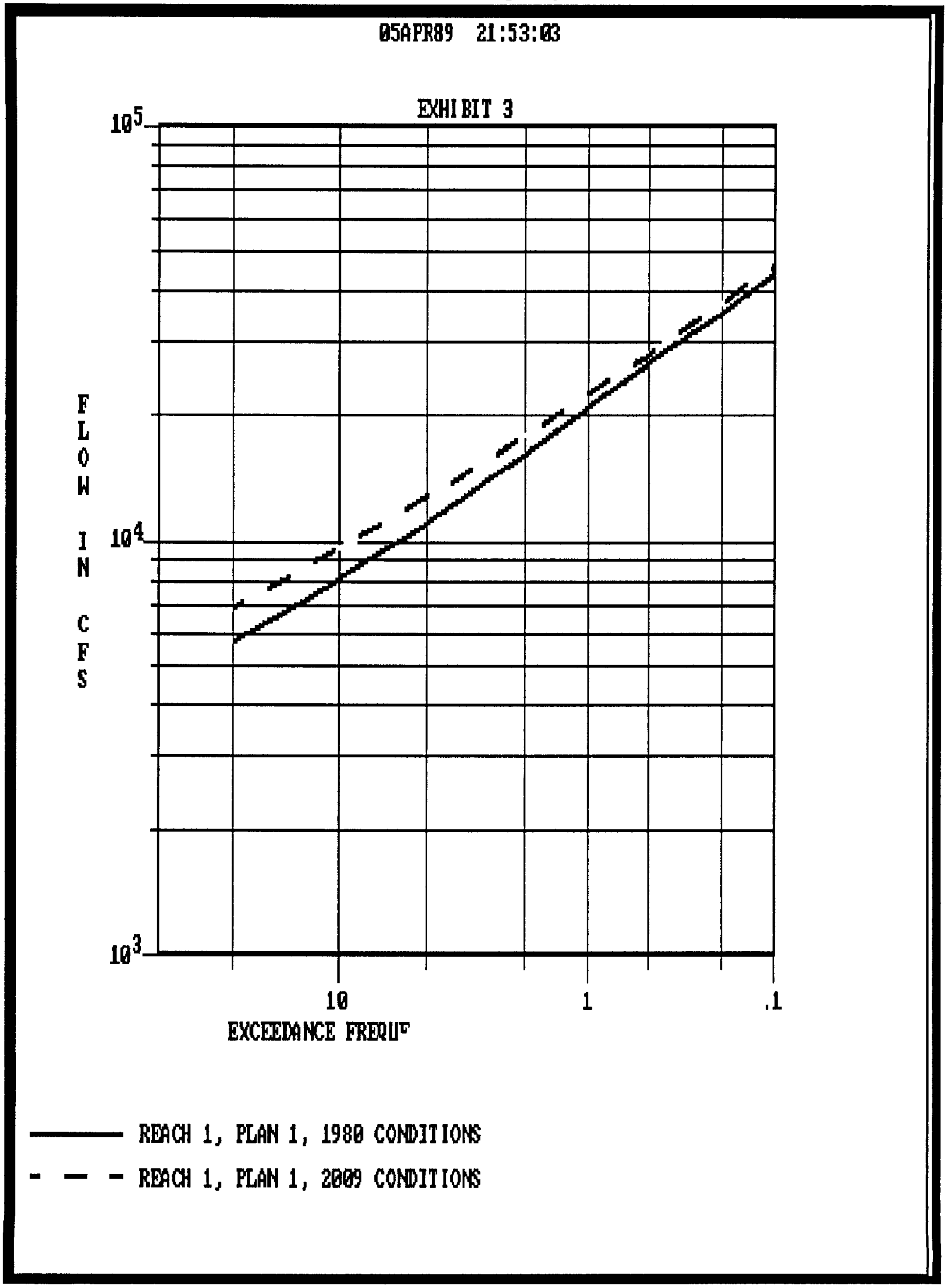


Figure 20: Damage-Frequency Function

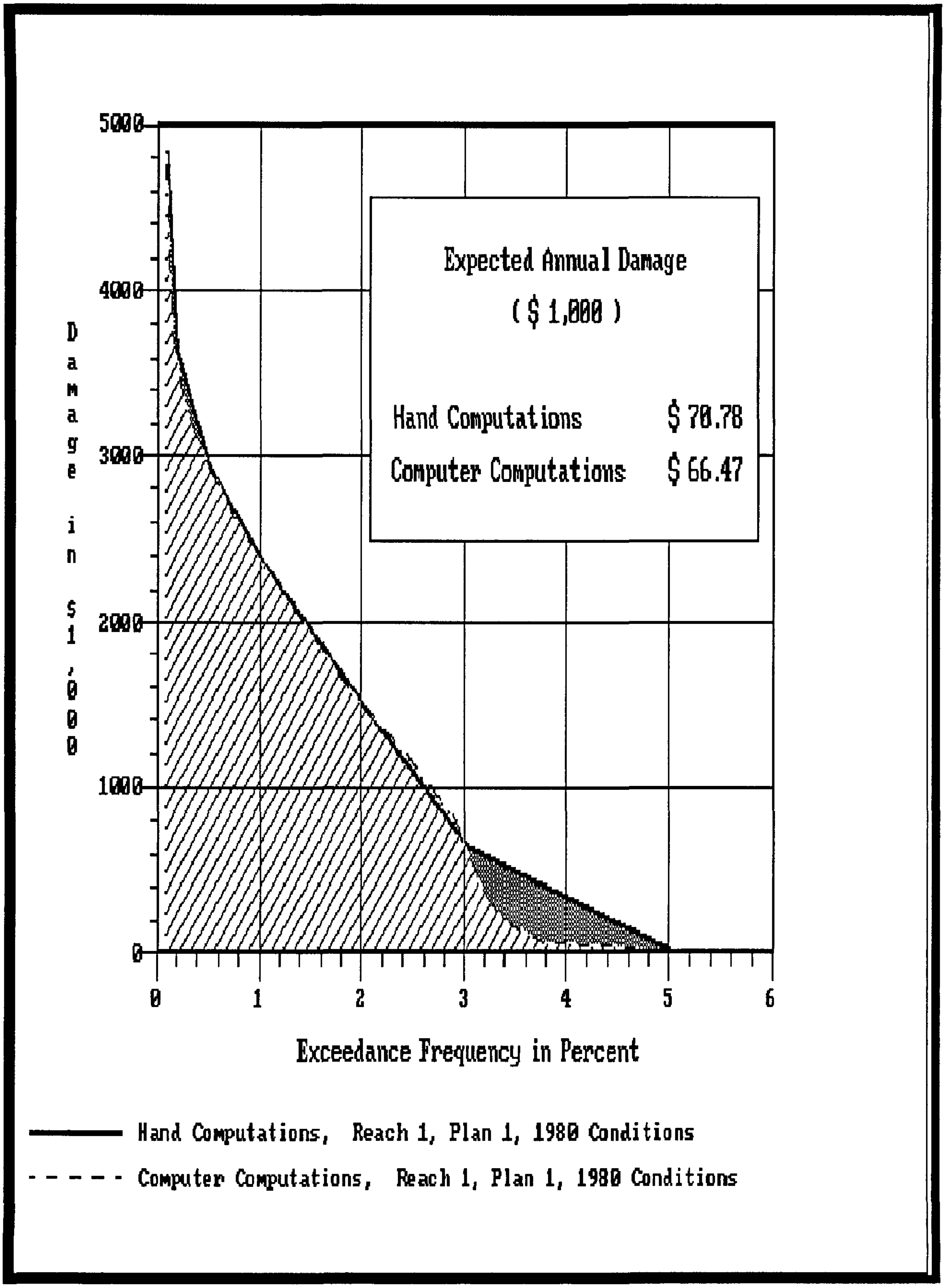


Table 6: Development of Damage-Frequency Matrix

Exceedance Frequency (in events per 100 years)	Flow (cfs)	Stage (feet)	Damage ($1,000)
.1	44000	34.77	4822.31
.2	36000	32.00	3620.00
.5	27000	28.68	2968.34
1.0	21000	25.60	2390.00
2.0	16200	21.20	1508.00
3.0	13800	18.80	658.00
5.0	11000	16.00	30.00
10.0	8100	13.03	6.75
20.0	5700	10.63	0.00

Single Event Flood Damage

Using Figure 20, flood damage can be estimated for any flood event of known frequency simply by picking the damage off the curve at known frequency values. For example, the 1% chance event (1.0 exceedance frequency in events per 100 years) would cause an estimated $2.39 million damage with 1980 conditions. The 2% chance event (2.0 exceedance frequency) would cause an estimated $1.5 million damage. The computer program can compute damage for any single event using stage or flow as its input values instead of frequency.

Expected Annual Flood Damage

Expected annual damage is the average damage which can be expected to result from many years of flow experiences with conditions remaining unchanged. It is computed by weighting each damage value in Figure 20 according to its probability of exceedance. Graphically this amounts to finding the area beneath the damage-frequency curve over the entire range of damaging events. It needs to be emphasized that the correct computation of expected damage includes the full range of probabilities from initial threshold to zero. Any truncation, that is, not going to zero or to the threshold will result in an error which can be significant depending upon the shape of the function. The hand integration or weighting of the damage values is commonly performed by planimeter or rectangular area computation. The latter approach is illustrated in Table 7.

Equivalent Annual Flood Damage

The expected annual damage computed from Figure 20 is for 1980 conditions. That is, the damage, stage, flow and frequency data are characteristic of the flood plain and flood hazard in 1980. If these conditions were to remain the same in the future, then the expected annual damage value would be the damage which could be expected to occur during any one year. However, it is common for conditions to change--damageable property in the flood plain may increase or decrease, urbanization upstream may cause increased runoff, or the channel itself may change. For these and other reasons it is necessary when analyzing flood damage over a period of time to compute expected annual damage for each year conditions change. The method of computation is the same as that described above and only the damage, stage, flow or frequency data change. Rather than compute expected annual damage for each year, it is common practice to select several future years and interpolate or extrapolate.

Table 7: Computation of Expected Annual Damage (1980 Conditions)

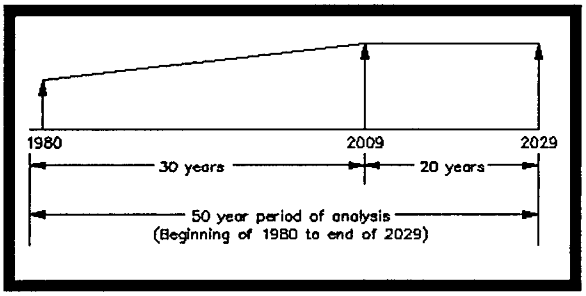
Frequency (Exceedance Frequency in Events per 100 Years)	Frequency Interval (Events per Year)	Damage	Average Damage for Frequency Interval ($1,000)	Weighted Damage
.0		4822.30[1]		
	.001		4822.31	4.82
.1		4822.31		
	.001		4221.16	4.22
.2		3620.00		
	.003		3294.17	9.88
.5		2968.34		
	.005		2679.17	13.40
1.0		2390.00		
	.010		1949.00	19.49
2.0		1508.00		
	.010		1083.00	10.83
3.0		658.00		
	.020		344.00	6.88
5.0		30.00		
	.050		18.38	.92
10.0		6.75		
	.100		3.38	.34
20.0		0.00		
			Total	70.78

[1] It is common practice to assume damage at 0.0 frequency is the same as the last known damage value. This is acceptable if the last known value is a rare event such as the 0.1% chance exceedance frequency (1,000 year return period).

To illustrate the methodology used in the computer program, assume that it is desired to compute equivalent annual damage for Reach 1, Plan 1 and damage category residential structures for a 50-year period of analysis and 7 percent discount rate. Assume 1980 is the base year (first year of project operation) and that conditions change for future years but only year 2009 will be used to compute expected annual damage for these future years. Figure 21 illustrates this problem. Each year's damage is assumed to occur at the end of that year.

Because it is the economic, hydrologic, or hydraulic conditions which may change in the future and not directly the expected annual damage, the computer program interpolates stage, flow, and damage data from input years to compute similar matrices for decade years.

Figure 21: Period of Analysis



This is illustrated in Table 8. For this example, only flow-frequency data are assumed to change in future years (future urbanization upstream). If stage or damage data were to change, the same procedure would be used. The 2009 matrix is shown in Figure 19.

Table 8: Computation of a Flow-Frequency Matrix for Decade Years

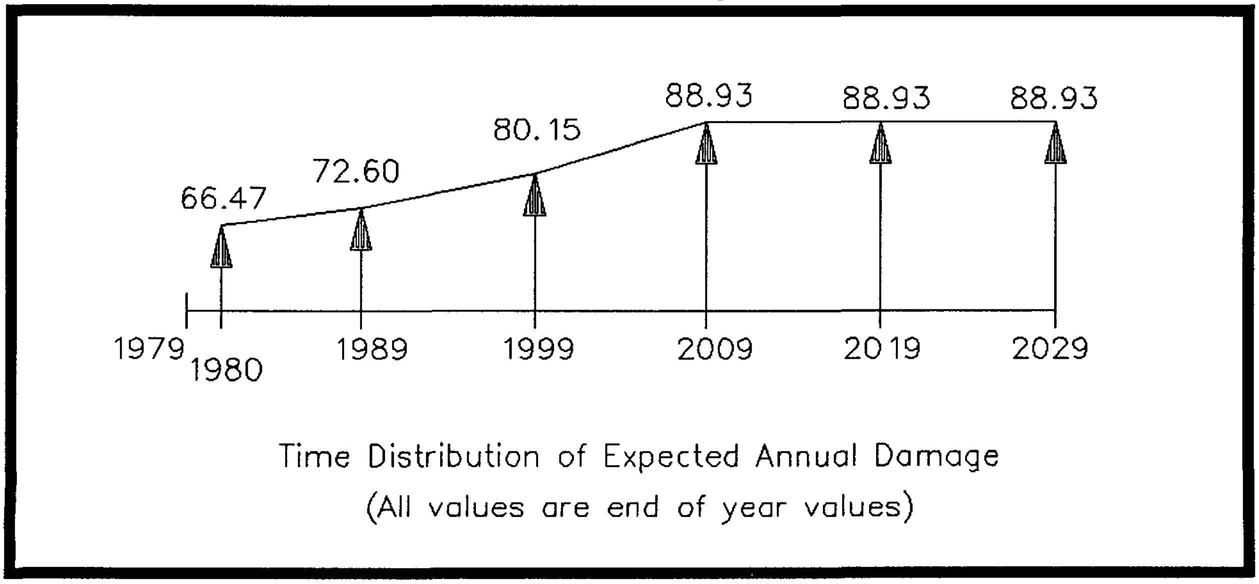
Exceedance Frequency in Events per 100 Years	Flow in CFS					
	1980 Interval[1]	1989 (9 yr)	1999 (10 yr)	2009 (10 yr)	2019 (10 yr)	2029 (10 yr)
.1	44,000	44,683	45,441	46,200	46,200	46,200
.2	36,000	36,621	37,310	38,000	38,000	38,000
.5	27,000	27,466	27,983	28,500	28,500	28,500
1.0	21,000	21,559	22,179	22,800	22,800	22,800
2.0	16,200	16,759	17,379	18,000	18,000	18,000
3.0	13,800	14,297	14,848	15,400	15,400	15,400
5.0	11,000	11,559	12,179	12,800	12,800	12,800
10.0	8,100	8,566	9,083	9,600	9,600	9,600
20.0	5,700	6,072	6,486	6,900	6,900	6,900

[1] Each year's flow is assumed to apply at the end of the year to be consistent with annual damage computation notation.

Flow-frequency data are known for 1980 and 2009. Similar data are computed for decade years 1989, 1999, 2019 and 2029. Values between 1980 and 2009 are obtained by linear interpolation. Beyond 2009 the same values are used as for 2009. These computations are shown in Table 8.

Next, expected annual damage is computed for each decade year. The method used is exactly the same as that already described in the previous section for 1980. Figure 22 illustrates the results (the values shown are program results). In situations where the input data years are not decade years (for example, if year 2005 was entered instead of 2009), both input data years and decade years would be included in Figure 22.

Figure 22: Time Distribution of Expected Annual Damage



Expected annual damage for years between decade years (1981, 1982, etc.) is computed by linear interpolation. This is illustrated in Figure 23.

At this point, expected annual damage has been computed for each year throughout the period of analysis. The remaining step is to discount all of these values back to time zero (the beginning of 1980 which is the same as the end of 1979) and amortize the present value over the period of analysis. The computer program discounts each individual year and amortizes the sum. Sample calculations are shown in Table 9.

Figure 23: EAD Interpolation

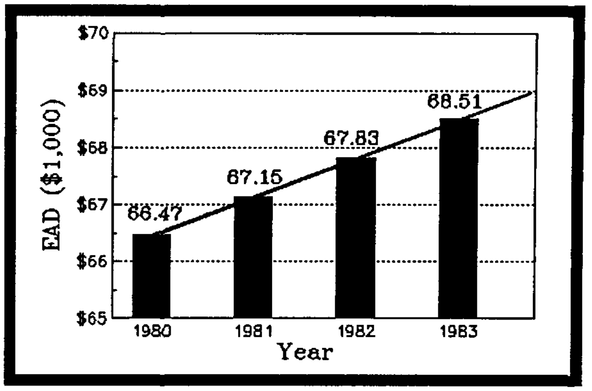
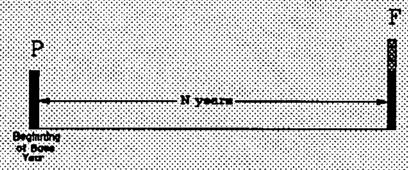


Table 9: Example Discounting and Amortization

For Discounting

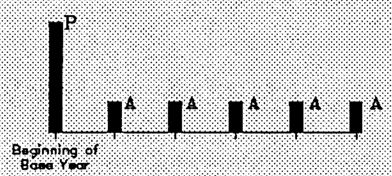
$$\text{Single Payment Present Worth Factor (Discounting)} = P/F = \frac{1}{(1 + i)^N}$$



Year	N	P/F	F	P
1980	1	.93458	66.47	62.12
1981	2	.87344	67.15	58.65
1982	3	.81630	67.83	55.37
1983	4	.76290	68.51	52.27
.....	...	.....	.....	.....
.....	...	.....	.....	.....
.....	...	.....	.....	.....
2029	50	.03395	88.93	3.02
Total present value of expected annual damage				1035.47

For Amortization

$$\text{Capital Recovery Factor} = A / P = \frac{i\ (1 + i)^N}{(1 + i)^N - 1}$$



$$A / P = \frac{.07\ (1 + .07)^{50}}{(1 + .07)^{50} - 1} = 0.07246$$

A = Equivalent Annual Damage

A = (1035.47) (0.07246) = 75.03

Exhibit 4

Test Examples of Input and Output

Test Examples of Input and Output

The input and output for four test problems are provided to illustrate the use of various records and to assist the user in verifying the correct execution of the program on different computer systems. Input and output showing every combination of possible input data and desired analysis options would be voluminous. These four examples should guide the user in input preparation for the usual applications. A brief description of each test example is provided, which is followed by a listing of the input records and output for the three examples.

Test Example 1 Computation of Damage for Events

Features of this example:

- One reach.
- Three damage categories of urban, rural and crops.
- Three flood plain management plans:
  - natural conditions
  - three existing reservoirs
  - addition of a proposed reservoir.
- Computation of event damage for four peak flood events (1944, 1948, 1951, and a hypothetical event labelled 9999).

Description of This Example:

The analysis of event damage can be accomplished two different ways. One way is to assign each peak flow an input data year and input sequentially on QF records, as was done for the test output. Another way would be to enter all four events on one QF record. The disadvantage of this method is that the events are not labelled by year on the output. Note the minus one (-1) in the second field of the FR record as this value indicates the computation of event damage values only.

EXHIBIT 4

```
+++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580      IBM-PC Compatible       +
+ Version Date      December 1, 1988        +
+++++++++++++++++++++++++++++++++++++++++++++


** LIST OF RECORDS READ BY READIN **
RECORD
 ORDER          1         2         3         4         5         6         7         8
NUMBER 12345678901234567890123456789012345678901234567890123456789012345678901234567890

     1 TT  TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
     2 TT  DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
     3 TT  JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)
     4 TT  DAMAGE VALUES IN THOUSAND DOLLARS
     5 TT  MARCH 1989
     6 CN      3   URBAN   RURAL   CROPS
     7 PN      1 NATURAL CONDITIONS
     8 PN      2 WITH THREE EXISTING RESERVOIRS
     9 PN      3 EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR
    10 DY      4     1944     1948     1951     9999
    11 RN  R-47  SMALL CR TO BIG CR, PODUNK CENTER
    12 FR  R-47       -1
    13 QF  R-471944 1     72300
    14 QF  R-471948 1     83000
    15 QF  R-471951 1    436000
    16 QF  R-479999 1    460000
    17 SQ  R-47       15       23.       26.       27.       28.       29.       30.       31.       32.
    18 SQ   33.      34.       35.       36.       38.       40.       42.
    19 QS  R-47              12000     15000     16100     18000     19500     21500     24000     27500
    20 QS 33500    45000     60500     83000    147000    260000    470000
    21 SD  R-47       16       23.       29.      30.5       32.      32.9      34.5      35.7       37.
    22 SD  37.5      38.      38.5       39.      39.6      40.5      41.5       42.
    23 DG  R-47        1        0.        2.       25.       55.      100.      200.      300.      440.
    24 DG  510.     600.      750.      830.      900.      980.     1050.     1090.
    25 SD  R-47       11       23.       27.      28.3       30.      31.4       34.       37.       39.
    26 SD  40.5     41.5       42.
    27 DG  R-47        2        0.       20.       40.       80.      130.      240.      380.      500.
    28 DG  600.     680.      720.
    29 SD  R-47       13       23.       24.       25.       26.       28.       29.       30.       32.
    30 SD   34.      36.       38.       40.       42.
    31 DG  R-47        3        0.      200.      340.      450.      590.      750.      930.     1140.
    32 DG 1250.    1310.     1360.     1380.     1410.
    33 EP      1
    34 QF  R-471944 2     65000
    35 QF  R-471948 2     80000
    36 QF  R-471951 2    279000
```

```
37 QF  R-479999 2     391000
38 EP      2
39 QF  R-471944 3      26000
40 QF  R-471948 3      29000
41 QF  R-471951 3     229000
42 QF  R-479999 3      95000
43 EJ      3

READIN --    43 RECORDS WRITTEN TO LOGICAL FILE  8
```

EXHIBIT 4

```
+++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible       +
+ Version Date     December 1, 1988        +
+++++++++++++++++++++++++++++++++++++++++++++


TT  TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
TT  DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
TT  JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)
TT  DAMAGE VALUES IN THOUSAND DOLLARS
TT  MARCH 1989

**DAMAGE CATEGORY NAMES**
CN   3     URBAN   RURAL   CROPS

**FLOOD PLAIN MANAGEMENT PLAN NAMES**
PN   1   NATURAL CONDITIONS
PN   2   WITH THREE EXISTING RESERVOIRS
PN   3   EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

**INPUT DATA YEARS**
     NDYRS   IDYRS
DY       4    1944    1948    1951    9999

+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

```
REACH   1, REACH NAME -
RN  R-47  SMALL CR TO BIG CR, PODUNK CENTER

++++ INPUT DATA ++++

**FREQUENCIES**
FR  R-47       1   -1.00

**FLOOD PEAKS**
QF  R-471944 1    72300.
QF  R-471948 1    83000.
QF  R-471951 1   436000.
QF  R-479999 1   460000.

**STAGES FOR RATING CURVE**
SQ  R-47      15   23.00   26.00   27.00   28.00   29.00   30.00   31.00   32.00
   33.00   34.00   35.00   36.00   38.00   40.00   42.00

**FLOWS FOR RATING CURVE**
QS  R-471944 0    12000.  15000.  16100.  18000.  19500.  21500.  24000.  27500.
  33500.  45000.  60500.  83000. 147000. 260000. 470000.

**STAGES FOR DAMAGE DATA**
SD  R-47      16   23.00   29.00   30.50   32.00   32.90   34.50   35.70   37.00
   37.50   38.00   38.50   39.00   39.60   40.50   41.50   42.00

**FLOOD DAMAGE DATA**
DG  R-471944 0 1     .00    2.00   25.00   55.00  100.00  200.00  300.00  440.00
  510.00  600.00  750.00  830.00  900.00  980.00 1050.00 1090.00

**STAGES FOR DAMAGE DATA**
SD  R-47      11   23.00   27.00   28.30   30.00   31.40   34.00   37.00   39.00
   40.50   41.50   42.00

**FLOOD DAMAGE DATA**
DG  R-471944 0 2     .00   20.00   40.00   80.00  130.00  240.00  380.00  500.00
  600.00  680.00  720.00

**STAGES FOR DAMAGE DATA**
SD  R-47      13   23.00   24.00   25.00   26.00   28.00   29.00   30.00   32.00
   34.00   36.00   38.00   40.00   42.00

**FLOOD DAMAGE DATA**
DG  R-471944 0 3     .00  200.00  340.00  450.00  590.00  750.00  930.00 1140.00
 1250.00 1310.00 1360.00 1380.00 1410.00

**END OF INPUT DATA FOR PLAN  1 **
EP+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

++DAMAGE DATA FOR PLAN 1 AND YEAR 1944 -- NATURAL CONDITIONS

	FREQ	FLOW	STAGE	URBAN	RURAL	CROPS	TOTAL
1	-1.00	72300.	35.52	285.37	311.14	1295.73	1892.24

++DAMAGE DATA FOR PLAN 1 AND YEAR 1948 -- NATURAL CONDITIONS

	FREQ	FLOW	STAGE	URBAN	RURAL	CROPS	TOTAL
1	-1.00	83000.	36.00	332.31	333.33	1310.00	1975.64

++DAMAGE DATA FOR PLAN 1 AND YEAR 1951 -- NATURAL CONDITIONS

	FREQ	FLOW	STAGE	URBAN	RURAL	CROPS	TOTAL
1	-1.00	436000.	41.68	1064.10	694.10	1405.14	3163.33

++DAMAGE DATA FOR PLAN 1 AND YEAR 9999 -- NATURAL CONDITIONS

	FREQ	FLOW	STAGE	URBAN	RURAL	CROPS	TOTAL
1	-1.00	460000.	41.90	1082.38	712.38	1408.57	3203.33

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RN  R-47  SMALL CR TO BIG CR, PODUNK CENTER

++++ INPUT DATA ++++

**FLOOD PEAKS**
QF  R-471944 2    65000.
QF  R-471948 2    80000.
QF  R-471951 2   279000.
QF  R-479999 2   391000.

**END OF INPUT DATA FOR PLAN  2 **
EP++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 2 AND YEAR 1944 --  WITH THREE EXISTING RESERVOIRS

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00    65000.      35.20    258.33    296.00   1286.00   1840.33

++DAMAGE DATA FOR PLAN 2 AND YEAR 1948 --  WITH THREE EXISTING RESERVOIRS

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00    80000.      35.87    317.95    327.11   1306.00   1951.06

++DAMAGE DATA FOR PLAN 2 AND YEAR 1951 --  WITH THREE EXISTING RESERVOIRS

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00   279000.      40.18    951.64    578.73   1382.71   2913.08

++DAMAGE DATA FOR PLAN 2 AND YEAR 9999 --  WITH THREE EXISTING RESERVOIRS

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00   391000.      41.25   1032.33    659.81   1398.71   3090.86
```

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RN  R-47  SMALL CR TO BIG CR, PODUNK CENTER

++++ INPUT DATA ++++

**FLOOD PEAKS**
QF  R-471944 3    26000.
QF  R-471948 3    29000.
QF  R-471951 3   229000.
QF  R-479999 3    95000.

**END OF INPUT DATA FOR PLAN  3 **
EJ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 3 AND YEAR 1944 --  EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00    26000.      31.57     46.43    137.25   1095.00   1278.68

++DAMAGE DATA FOR PLAN 3 AND YEAR 1948 --  EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00    29000.      32.25     67.50    165.96   1153.75   1387.21

++DAMAGE DATA FOR PLAN 3 AND YEAR 1951 --  EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00   229000.      39.45    882.66    530.09   1374.51   2787.26

++DAMAGE DATA FOR PLAN 3 AND YEAR 9999 --  EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

       FREQ      FLOW      STAGE     URBAN     RURAL     CROPS     TOTAL
   1  -1.00    95000.      36.38    372.69    350.83   1319.38   2042.90
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
 DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
 JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)


** SUMMARY OF REACH NAMES  **

 NO    ID    . . NAME . . .
--------------------------------------------------------------------------------
  1  R-47      R-47  SMALL CR TO BIG CR, PODUNK CENTER

--------------------------------------------------------------------------------

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 TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
 DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
 JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)


** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS   =  1944  1948  1951  9999

** FLOOD PLAIN MANAGEMENT PLANS
         1 -  NATURAL CONDITIONS
         2 -  WITH THREE EXISTING RESERVOIRS
         3 -  EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

GRAND SUMMARY - ALL DAMAGE CATEGORIES
  FOR INPUT DATA YEAR 1944
---------------------------------------------------------
             . . . . . . . DAMAGE BY EVENT
 DAMAGE       BASE     .... PLAN  2....  .... PLAN  3....
 CATEGORY   CONDITION  DAMAGE   DAMAGE   DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN   REDUCED  W/PLAN   REDUCED
---------------------------------------------------------
     URBAN    285.37   258.33    27.04     46.43   238.94
     RURAL    311.14   296.00    15.14    137.25   173.89
     CROPS   1295.73  1286.00     9.73   1095.00   200.73
---------------------------------------------------------

     TOTAL   1892.24  1840.33    51.91   1278.68   613.56

---------------------------------------------------------
```

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* *

TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)

** SUMMARY OF REACH NAMES **

NO	ID	. . NAME . . .
1	R-47	R-47 SMALL CR TO BIG CR, PODUNK CENTER

* *
* *

TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)

** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS = 1944 1948 1951 9999

** FLOOD PLAIN MANAGEMENT PLANS
1 - NATURAL CONDITIONS
2 - WITH THREE EXISTING RESERVOIRS
3 - EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

GRAND SUMMARY - ALL DAMAGE CATEGORIES
FOR INPUT DATA YEAR 1948

	. . . . DAMAGE BY EVENT				
DAMAGE	BASE	.... PLAN 2....		.... PLAN 3....	
CATEGORY	CONDITION	DAMAGE	DAMAGE	DAMAGE	DAMAGE
	(PLAN 1)	W/PLAN	REDUCED	W/PLAN	REDUCED
URBAN	332.31	317.95	14.36	67.50	264.81
RURAL	333.33	327.11	6.22	165.96	167.37
CROPS	1310.00	1306.00	4.00	1153.75	156.25
TOTAL	1975.64	1951.06	24.58	1387.21	588.43

```
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 TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
 DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
 JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)


** SUMMARY OF REACH NAMES  **

 NO     ID    . . NAME . . .
--------------------------------------------------------------------------------
  1   R-47      R-47  SMALL CR TO BIG CR, PODUNK CENTER

--------------------------------------------------------------------------------
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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 TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
 DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
 JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)


** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS   =  1944  1948  1951  9999

** FLOOD PLAIN MANAGEMENT PLANS
         1 -  NATURAL CONDITIONS
         2 -  WITH THREE EXISTING RESERVOIRS
         3 -  EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

GRAND SUMMARY - ALL DAMAGE CATEGORIES
  FOR INPUT DATA YEAR 1951
---------------------------------------------------------
            . . . . . . . DAMAGE BY EVENT
  DAMAGE      BASE     .... PLAN  2....  .... PLAN  3....
 CATEGORY   CONDITION  DAMAGE   DAMAGE   DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN   REDUCED  W/PLAN   REDUCED
---------------------------------------------------------
     URBAN   1064.09   951.64   112.45   882.66   181.44
     RURAL    694.10   578.73   115.36   530.09   164.01
     CROPS   1405.14  1382.71    22.43  1374.51    30.63
---------------------------------------------------------

     TOTAL   3163.33  2913.08   250.25  2787.26   376.08

---------------------------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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 TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
 DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
 JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)


** SUMMARY OF REACH NAMES  **

 NO    ID    . . NAME . . .
--------------------------------------------------------------------------------
  1  R-47      R-47  SMALL CR TO BIG CR, PODUNK CENTER

--------------------------------------------------------------------------------
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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 TEST NO. 1 -- COMPUTATION OF DAMAGE ONLY
 DAMAGE EXPECTED FROM REPEAT OF APRIL 1944, JULY 1948, AND
 JULY 1951 EVENTS AND ONE HYPOTHETICAL EVENT (9999)


** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS   =  1944  1948  1951  9999

** FLOOD PLAIN MANAGEMENT PLANS
         1 -  NATURAL CONDITIONS
         2 -  WITH THREE EXISTING RESERVOIRS
         3 -  EXISTING PROJECTS PLUS NEW PROPOSED RESERVOIR

GRAND SUMMARY - ALL DAMAGE CATEGORIES
  FOR INPUT DATA YEAR 9999
---------------------------------------------------------
             . . . . . . . DAMAGE BY EVENT
  DAMAGE     BASE    .... PLAN  2....  .... PLAN  3....
 CATEGORY  CONDITION  DAMAGE   DAMAGE   DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED  W/PLAN  REDUCED
---------------------------------------------------------
     URBAN   1082.38  1032.33    50.05   372.69   709.69
     RURAL    712.38   659.81    52.57   350.83   361.55
     CROPS   1408.57  1398.71     9.86  1319.38    89.20
---------------------------------------------------------

     TOTAL   3203.33  3090.86   112.48  2042.90  1160.43

---------------------------------------------------------
```

Test Example 2 Period of Record Analysis

Features of this example:

- Two reaches.
- Three damage categories of agriculture, services and urban.
- Four flood plain management plans:
  - Natural conditions.
  - One existing reservoir.
  - The addition of a proposed reservoir.
  - The substitution of a proposed levee in place of the proposed reservoir.
- The frequency curve at Reach 3 is expected to change with increasing upstream urbanization.
- The flood damage data at Reach 13 is expected to increase with development in the flood plain.
- Computation of expected annual damage and equivalent annual damage for a period of analysis.

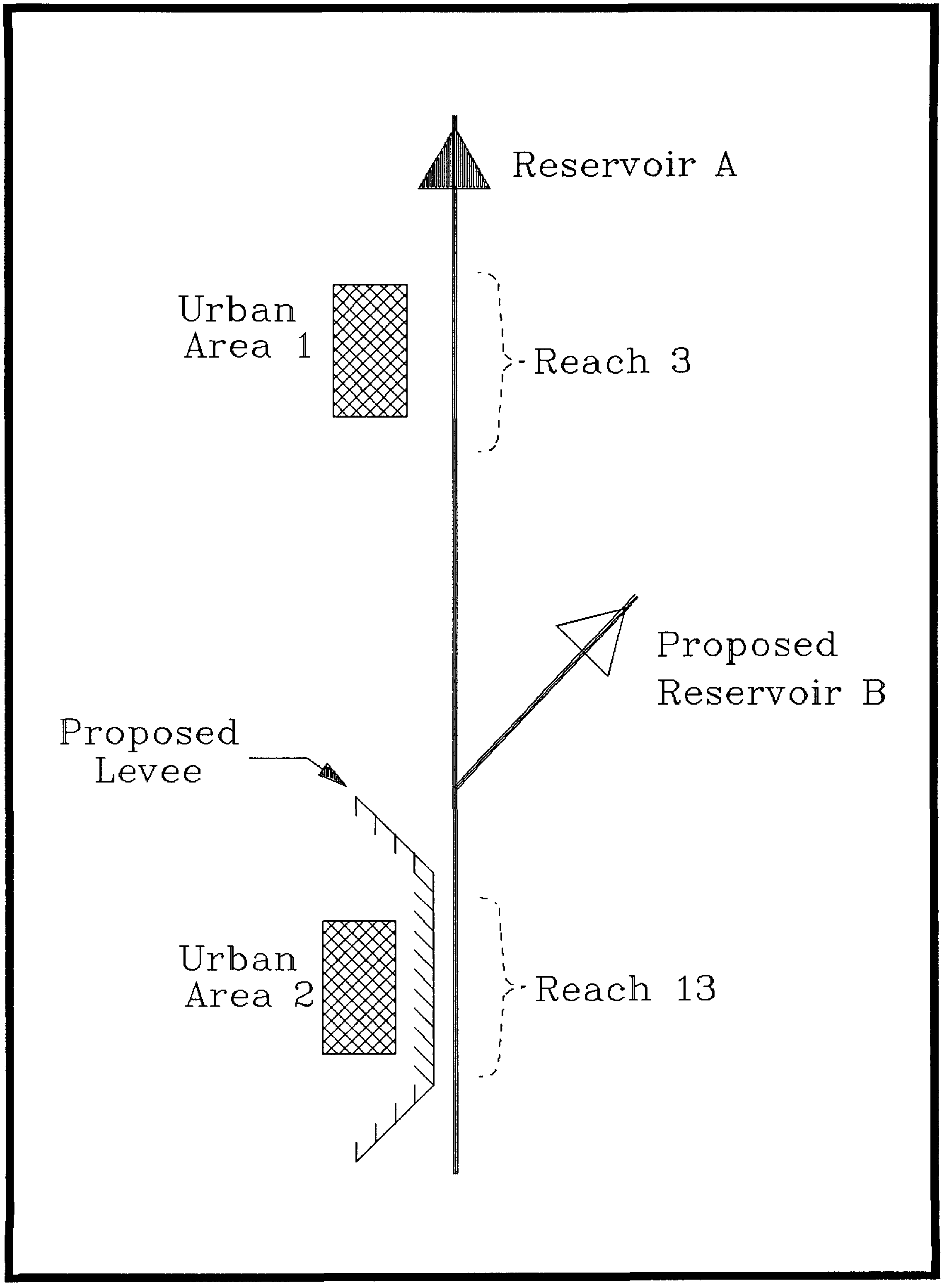
Description of This Example:

The period of analysis of 100 years and the expected project completion date of 1981 are required on the J1 record and the interest rate of 6-3/8 percent is required on the J2 record. The frequency curves (QF records) are entered for three input data years of 1976, 1990 and 2020 for Reach 3. The damage data for Reach 13 are entered for the same years on DG records.

The printout suppression option (PP record) was changed after the first plan of Reach 3 to suppress the damage computed for each flow (Code of 2) and the expected annual damage for the base year and each decade year (Code of 4). The input code for JDGPR on the PP record is then the sum of 2 and 4 which is 6.

Note that flood plain management plans 3 and 4 do not affect Reach 3 and Reach 13 is far enough downstream that the increasing frequency curve at Reach 3 is assumed to have no effect. The basin schematic is shown in Figure 24.

Figure 24: Test Example 2 Schematic



```
+++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible       +
+ Version Date     December 1, 1988        +
+++++++++++++++++++++++++++++++++++++++++++++

** LIST OF RECORDS READ BY READIN **
RECORD
 ORDER         1         2         3         4         5         6         7         8
NUMBER 12345678901234567890123456789012345678901234567890123456789012345678901234567890

     1 TT  TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
     2 TT  BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
     3 TT  DAMAGE VALUES IN $1000
     4 TT  MARCH 1989
     5 J1   100     1976     1981  6 1974
     6 J2 6.375
     7 CN     3   AGRIC SERVICE   URBAN
     8 PN     1 WITHOUT PROJECTS
     9 PN     2 REGULATED BY EXISTING RESERVOIR A
    10 PN     3 REGULATED BY RES A AND PROPOSED RESERVOIR B
    11 PN     4 REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2
    12 DY     3     1976     1990     2020
    13 RN DAMAGE REACH 3 BELOW RES A - URBAN AREA 1
    14 FR              16       99.       90.       80.       70.       60.       50.       40.       30.
    15 FR   20.       10.        5.        2.        1.        .5        .2        .1
    16 QF      31976 1        5600      6100      6700      7500      8400      9700     11300     14000
    17 QF 18000     26500     37000     54000     70000     90000    121000    152000
    18 QF      31990 1        6440      7020      7700      8630      9660     11200     13000     16000
    19 QF 22000     30000     41500     60000     77000     97000    130000    160000
    20 QF      32020 1        7000      7600      8400      9400     10500     12100     14000     17500
    21 QF 22500     32000     44000     63000     81000    101000    136000    165000
    22 SQ     3        14       12.       14.       16.       18.       20.       22.       24.       25.
    23 SQ   26.       27.       28.       29.      29.5       30.
    24 QS     3                 4900      6000      7300      8900     10700     13300     17000     20000
    25 QS 25000     37000     58000     96000    135000    200000
    26 SD     3         9      16.0      22.3      23.0      24.0      25.0      26.0      27.2      28.5
    27 SD  30.0
    28 DG     3       1 1        0.        58       100       350       700      1200      2000      3000
    29 DG  4500
    30 SD     3        13      16.0      18.5      19.7      21.0      22.1      22.4      23.4      24.0
    31 SD  25.0      26.1      26.7      28.5      30.0
    32 DG     3       1 2        0.        2.        5.        14        25        35        50        75
    33 DG   125       200       250       425       600
    34 SD     3        11       19.       22.       24.       26.      26.5       27.      27.5       28.
    35 SD  28.5       29.       30.
    36 DG     3       1 3        0.       90.      270.      530.      650.      900.     1450.     2430.
    37 DG 3500.     3850.     4450.
    38 EP     1
```

```
39 PP                    6
40 QF     31976 2     4700     5200     5750     6400     7200     8300     9700    11700
41 QF 15000   22000   30000    46000    62000    82000   115000   145000
42 QF     31990 2     5200     5700     6300     7000     7900     9100    10700    13000
43 QF 16600   24000   34000    51500    68000    88000   121000   150000
44 QF     32020 2     5600     6200     6900     7700     8600    10000    11600    14000
45 QF 18000   27000   38000    56000    74000    94000   127000   155000
46 ER     2
47 RN DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2
48 QF     13       1    8400     9100    10000    11300    13000    15000    17600    21700
49 QF 28500   44000   65000   106000   150000   208000   310000   410000
50 SQ     13      17     6.5      7.0      7.4      8.5      9.6     10.8     11.6     13.0
51 SQ  14.0    16.0    17.0     18.0     19.0     20.0     21.0     22.0     23.0
52 QS     13            8700     9200    10000    11300    13000    15000    17000    25000
53 QS 34000   67000   92000   123000   160000   210000   263000   330000   415000
54 SD     13      10      9.     13.5     15.0     16.0     16.7     17.1     17.4     19.9
55 SD   22.     23.
56 DG     13     1 1      0.       2.     10.0      21.      35.      50.      76.     271.
57 DG    440     520
58 SD     13      11      9.     13.4     14.5     15.1     15.8     16.5     17.5     18.5
59 SD   19.9    22.0    23.0
60 DG     13     1 2      0.        5       13       28       50       87      150      250
61 DG    427     700     850
62 SD     13      14     11.      12.      13.      14.      15.     15.5      16.      17.
63 SD   17.5     18.     20.      21.      22.      23.
64 DG     131976 1 3      0.      30.     150.     250.     400.     600.     930.    1850.
65 DG 2250.   2470.   3420.    3970.    4680.    5900.
66 DG     131990 1 3      0.      35.     165.     270.     450.     700.    1030.    2040.
67 DG 2500.   2730.   3870.    4400.    5200.    6500.
68 DG     132020 1 3      0.      40.     180.     300.     500.     770.    1150.    2300.
69 DG 2750.   3000.   4200.    4800.    5700.    7200.
70 EP     1
71 QF     13       2    8400     9100     9900    11000    12500    14200    16800    20500
72 QF 26000   38500   59000   100000   145000   204000   308000   410000
73 EP     2
74 QF     13       3    7900     8600     9200    10000    10900    12000    14000    16800
75 QF 22000   34000   51000    85000   126000   183000   296000   410000
76 EP     3
77 QF     13       4    8400     9100     9900    11000    12500    14200    16800    20500
78 QF 26000   38500   59000   100000   145000   204000   308000   410000
79 SD     13       6    18.6    18.61      20.      21.      22.      23.
80 DG     131976 4 3      0.    2760.    3420.    3970.    4680.    5900.
81 DG     131990 4 3      0.     3050     3780     4400     5200     6500
82 DG     132020 4 3      0.    3360.    4200.    4800.    5700.    7200.
83 EJ     4

READIN --    83 RECORDS WRITTEN TO LOGICAL FILE  8
```

```
++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible      +
+ Version Date     December 1, 1988       +
++++++++++++++++++++++++++++++++++++++++++++


TT  TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
TT  BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
TT  DAMAGE VALUES IN $1000
TT  MARCH 1989

**JOB RECORD**
      IPOA  ISTDYR  IBASYR   IDMTH  IDOLYR    NHIS   NDMTH  NDOLYR
J1     100    1976    1981       6    1974       0       0       0

   RATE(1) RATE(2) RATE(3)    CPLI
J2  6.3750   .0000   .0000  1.0000

**DAMAGE CATEGORY NAMES**
CN   3     AGRIC SERVICE   URBAN

**FLOOD PLAIN MANAGEMENT PLAN NAMES**
PN   1   WITHOUT PROJECTS
PN   2   REGULATED BY EXISTING RESERVOIR A
PN   3   REGULATED BY RES A AND PROPOSED RESERVOIR B
PN   4   REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2

**INPUT DATA YEARS**
     NDYRS   IDYRS
DY       3    1976    1990    2020

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

EXHIBIT 4

```
REACH   1, REACH NAME -
RN DAMAGE REACH 3 BELOW RES A - URBAN AREA 1

++++ INPUT DATA ++++

**FREQUENCIES**
FR           16   99.00   90.00   80.00   70.00   60.00   50.00   40.00   30.00
   20.00   10.00    5.00    2.00    1.00     .50     .20     .10

**FLOOD PEAKS**
QF      31976 1     5600.   6100.   6700.   7500.   8400.   9700.  11300.  14000.
  18000.  26500.  37000.  54000.  70000.  90000. 121000. 152000.
QF      31990 1     6440.   7020.   7700.   8630.   9660.  11200.  13000.  16000.
  22000.  30000.  41500.  60000.  77000.  97000. 130000. 160000.
QF      32020 1     7000.   7600.   8400.   9400.  10500.  12100.  14000.  17500.
  22500.  32000.  44000.  63000.  81000. 101000. 136000. 165000.

**STAGES FOR RATING CURVE**
SQ      3      14   12.00   14.00   16.00   18.00   20.00   22.00   24.00   25.00
   26.00   27.00   28.00   29.00   29.50   30.00

**FLOWS FOR RATING CURVE**
QS      31976 0     4900.   6000.   7300.   8900.  10700.  13300.  17000.  20000.
  25000.  37000.  58000.  96000. 135000. 200000.

**STAGES FOR DAMAGE DATA**
SD      3       9   16.00   22.30   23.00   24.00   25.00   26.00   27.20   28.50
   30.00

**FLOOD DAMAGE DATA**
DG      31976 1 1     .00   58.00  100.00  350.00  700.00 1200.00 2000.00 3000.00
 4500.00

**STAGES FOR DAMAGE DATA**
SD      3      13   16.00   18.50   19.70   21.00   22.10   22.40   23.40   24.00
   25.00   26.10   26.70   28.50   30.00

**FLOOD DAMAGE DATA**
DG      31976 1 2     .00    2.00    5.00   14.00   25.00   35.00   50.00   75.00
  125.00  200.00  250.00  425.00  600.00

**STAGES FOR DAMAGE DATA**
SD      3      11   19.00   22.00   24.00   26.00   26.50   27.00   27.50   28.00
   28.50   29.00   30.00

**FLOOD DAMAGE DATA**
DG      31976 1 3     .00   90.00  270.00  530.00  650.00  900.00 1450.00 2430.00
 3500.00 3850.00 4450.00
```

**END OF INPUT DATA FOR PLAN 1 **

EP++

++DAMAGE DATA FOR PLAN 1 AND YEAR 1976 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	5600.	13.27	.00	.00	.00	.00	579.81
2	90.00	6100.	14.15	.00	.00	.00	.00	579.81
3	80.00	6700.	15.08	.00	.00	.00	.00	579.81
4	70.00	7500.	16.25	2.30	.20	.00	2.50	579.78
5	60.00	8400.	17.37	12.66	1.10	.00	13.76	578.99
6	50.00	9700.	18.89	26.60	2.97	.00	29.57	576.86
7	40.00	11300.	20.46	41.07	10.27	43.85	95.19	570.79
8	30.00	14000.	22.38	62.70	34.28	124.05	221.04	556.45
9	20.00	18000.	24.33	466.67	91.67	313.33	871.67	508.61
10	10.00	26500.	26.13	1283.33	202.08	560.00	2045.42	365.56
11	5.00	37000.	27.00	1866.66	279.17	900.00	3045.83	243.40
12	2.00	54000.	27.81	2468.86	357.87	2056.67	4883.40	132.20
13	1.00	70000.	28.32	2858.30	407.09	3105.79	6371.18	76.15
14	.50	90000.	28.84	3342.11	464.91	3739.47	7546.49	41.42
15	.20	121000.	29.32	3820.51	520.73	4042.31	8383.55	17.56
16	.10	152000.	29.63	4130.77	556.92	4228.46	8916.15	8.92

EXP ANNUAL DAMAGE, YEAR 1976 317.53 52.35 209.93 579.81

++DAMAGE DATA FOR PLAN 1 AND YEAR 1981 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	5900.	13.82	.00	.00	.00	.00	640.10
2	90.00	6429.	14.66	.00	.00	.00	.00	640.10
3	80.00	7057.	15.63	.00	.00	.00	.00	640.10
4	70.00	7904.	16.75	6.95	.60	.00	7.55	639.85
5	60.00	8850.	17.94	17.84	1.55	.00	19.39	638.52
6	50.00	10236.	19.48	32.08	4.46	14.52	51.06	635.59
7	40.00	11907.	20.93	45.37	13.51	57.86	116.74	627.15
8	30.00	14714.	22.76	85.87	40.47	158.80	285.14	609.47
9	20.00	19429.	24.81	633.33	115.48	375.24	1124.05	543.68
10	10.00	27750.	26.23	1352.78	210.76	585.00	2148.54	381.06
11	5.00	38607.	27.08	1917.69	286.61	984.18	3188.48	252.45
12	2.00	56143.	27.91	2547.36	367.79	2256.67	5171.81	135.41
13	1.00	72500.	28.38	2908.91	413.49	3246.58	6568.98	77.23
14	.50	92500.	28.91	3407.89	472.59	3785.53	7666.01	41.75
15	.20	124214.	29.36	3861.72	525.53	4067.03	8454.29	17.65
16	.10	154857.	29.65	4152.75	559.49	4241.65	8953.88	8.95

EXP ANNUAL DAMAGE, YEAR 1981 351.78 57.68 230.64 640.10

++DAMAGE DATA FOR PLAN 1 AND YEAR 1990 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	6440.	14.68	.00	.00	.00	.00	748.88
2	90.00	7020.	15.57	.00	.00	.00	.00	748.88
3	80.00	7700.	16.50	4.60	.40	.00	5.00	748.75
4	70.00	8630.	17.66	15.31	1.33	.00	16.64	747.69
5	60.00	9660.	18.84	26.19	2.86	.00	29.05	745.43
6	50.00	11200.	20.38	40.37	9.74	41.54	91.64	739.60
7	40.00	13000.	21.77	53.11	21.69	83.08	157.88	727.35
8	30.00	16000.	23.46	214.87	52.48	221.35	488.70	700.75
9	20.00	22000.	25.40	900.00	152.27	452.00	1504.27	601.66
10	10.00	30000.	26.42	1477.78	226.39	630.00	2334.17	409.01
11	5.00	41500.	27.21	2010.99	300.00	1135.72	3446.70	268.59
12	2.00	60000.	28.05	2655.87	381.51	2542.63	5580.01	140.51
13	1.00	77000.	28.50	3000.00	425.00	3500.00	6925.00	78.93
14	.50	97000.	29.01	3512.82	484.83	3857.69	7855.34	42.26
15	.20	130000.	29.44	3935.90	534.19	4111.54	8581.63	17.81
16	.10	160000.	29.69	4192.31	564.10	4265.39	9021.80	9.02
EXP ANNUAL DAMAGE,		YEAR 1990		413.18	67.28	268.42	748.88	

++DAMAGE DATA FOR PLAN 1 AND YEAR 2000 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	6627.	14.96	.00	.00	.00	.00	774.93
2	90.00	7213.	15.87	.00	.00	.00	.00	774.93
3	80.00	7933.	16.79	7.29	.63	.00	7.92	774.60
4	70.00	8887.	17.98	18.26	1.59	.00	19.85	773.24
5	60.00	9940.	19.16	29.05	3.64	4.67	37.36	770.63
6	50.00	11500.	20.62	42.49	11.34	48.46	102.29	763.58
7	40.00	13333.	22.02	55.40	24.18	91.62	171.21	750.18
8	30.00	16500.	23.73	282.43	63.74	245.68	591.85	718.57
9	20.00	22167.	25.43	916.67	154.55	456.33	1527.54	613.26
10	10.00	30667.	26.47	1514.82	231.02	643.33	2389.17	417.18
11	5.00	42333.	27.25	2041.51	303.86	1179.36	3524.73	273.02
12	2.00	61000.	28.08	2676.11	384.06	2598.95	5659.12	141.86
13	1.00	78333.	28.54	3035.09	429.09	3524.56	6988.74	79.40
14	.50	98333.	29.03	3529.91	486.82	3867.95	7884.69	42.42
15	.20	132000.	29.46	3961.54	537.18	4126.92	8625.64	17.86
16	.10	161667.	29.71	4205.13	565.60	4273.08	9043.80	9.04
EXP ANNUAL DAMAGE,		YEAR 2000		426.77	69.54	278.62	774.93	

++DAMAGE DATA FOR PLAN 1 AND YEAR 2010 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	6813.	15.25	.00	.00	.00	.00	801.86
2	90.00	7407.	16.13	1.23	.11	.00	1.33	801.85
3	80.00	8167.	17.08	9.97	.87	.00	10.84	801.26
4	70.00	9143.	18.27	20.90	1.82	.00	22.72	799.59
5	60.00	10220.	19.47	31.92	4.42	14.00	50.33	796.44
6	50.00	11800.	20.85	44.62	12.93	55.38	112.93	788.20
7	40.00	13667.	22.20	57.06	28.27	107.84	193.17	773.56
8	30.00	17000.	24.00	350.00	75.00	270.00	695.00	736.08
9	20.00	22333.	25.47	933.33	156.82	460.67	1550.82	624.73
10	10.00	31333.	26.53	1551.85	235.65	663.89	2451.39	425.34
11	5.00	43167.	27.29	2072.04	307.72	1223.02	3602.77	277.41
12	2.00	62000.	28.11	2696.36	386.62	2655.26	5738.24	143.20
13	1.00	79667.	28.57	3070.18	433.19	3549.12	7052.48	79.86
14	.50	99667.	29.05	3547.01	488.82	3878.21	7914.03	42.58
15	.20	134000.	29.49	3987.18	540.17	4142.31	8669.66	17.91
16	.10	163333.	29.72	4217.95	567.09	4280.77	9065.81	9.07

EXP ANNUAL DAMAGE, YEAR 2010 440.82 71.87 289.17 801.86

++DAMAGE DATA FOR PLAN 1 AND YEAR 2020 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	7000.	15.54	.00	.00	.00	.00	829.53
2	90.00	7600.	16.38	3.45	.30	.00	3.75	829.43
3	80.00	8400.	17.37	12.66	1.10	.00	13.76	828.58
4	70.00	9400.	18.56	23.53	2.14	.00	25.67	826.61
5	60.00	10500.	19.78	34.78	5.54	23.33	63.65	822.67
6	50.00	12100.	21.08	46.74	14.77	62.31	123.82	813.31
7	40.00	14000.	22.38	62.70	34.28	124.05	221.04	797.23
8	30.00	17500.	24.17	408.33	83.33	291.67	783.33	753.25
9	20.00	22500.	25.50	950.00	159.09	465.00	1574.09	636.06
10	10.00	32000.	26.58	1588.89	240.28	691.67	2520.83	433.43
11	5.00	44000.	27.33	2102.56	311.57	1266.67	3680.81	281.76
12	2.00	63000.	28.13	2716.60	389.18	2711.58	5817.36	144.50
13	1.00	81000.	28.61	3105.26	437.28	3573.68	7116.23	80.31
14	.50	101000.	29.06	3564.10	490.81	3888.46	7943.38	42.73
15	.20	136000.	29.51	4007.69	542.56	4154.62	8704.87	17.96
16	.10	165000.	29.73	4230.77	568.59	4288.46	9087.82	9.09

EXP ANNUAL DAMAGE, YEAR 2020 455.29 74.26 299.98 829.53

++DAMAGE DATA FOR PLAN 1 AND YEAR 2030 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	7000.	15.54	.00	.00	.00	.00	829.53
2	90.00	7600.	16.38	3.45	.30	.00	3.75	829.43
3	80.00	8400.	17.37	12.66	1.10	.00	13.76	828.58
4	70.00	9400.	18.56	23.53	2.14	.00	25.67	826.61
5	60.00	10500.	19.78	34.78	5.54	23.33	63.65	822.67
6	50.00	12100.	21.08	46.74	14.77	62.31	123.82	813.31
7	40.00	14000.	22.38	62.70	34.28	124.05	221.04	797.23
8	30.00	17500.	24.17	408.33	83.33	291.67	783.33	753.25
9	20.00	22500.	25.50	950.00	159.09	465.00	1574.09	636.06
10	10.00	32000.	26.58	1588.89	240.28	691.67	2520.83	433.43
11	5.00	44000.	27.33	2102.56	311.57	1266.67	3680.81	281.76
12	2.00	63000.	28.13	2716.60	389.18	2711.58	5817.36	144.50
13	1.00	81000.	28.61	3105.26	437.28	3573.68	7116.23	80.31
14	.50	101000.	29.06	3564.10	490.81	3888.46	7943.38	42.73
15	.20	136000.	29.51	4007.69	542.56	4154.62	8704.87	17.96
16	.10	165000.	29.73	4230.77	568.59	4288.46	9087.82	9.09

EXP ANNUAL DAMAGE, YEAR 2030 455.29 74.26 299.98 829.53

++DAMAGE DATA FOR PLAN 1 AND YEAR 2080 -- WITHOUT PROJECTS

	FREQ	FLOW	STAGE	AGRIC	SERVICE	URBAN	TOTAL	ACC EAD
1	99.00	7000.	15.54	.00	.00	.00	.00	829.53
2	90.00	7600.	16.38	3.45	.30	.00	3.75	829.43
3	80.00	8400.	17.37	12.66	1.10	.00	13.76	828.58
4	70.00	9400.	18.56	23.53	2.14	.00	25.67	826.61
5	60.00	10500.	19.78	34.78	5.54	23.33	63.65	822.67
6	50.00	12100.	21.08	46.74	14.77	62.31	123.82	813.31
7	40.00	14000.	22.38	62.70	34.28	124.05	221.04	797.23
8	30.00	17500.	24.17	408.33	83.33	291.67	783.33	753.25
9	20.00	22500.	25.50	950.00	159.09	465.00	1574.09	636.06
10	10.00	32000.	26.58	1588.89	240.28	691.67	2520.83	433.43
11	5.00	44000.	27.33	2102.56	311.57	1266.67	3680.81	281.76
12	2.00	63000.	28.13	2716.60	389.18	2711.58	5817.36	144.50
13	1.00	81000.	28.61	3105.26	437.28	3573.68	7116.23	80.31
14	.50	101000.	29.06	3564.10	490.81	3888.46	7943.38	42.73
15	.20	136000.	29.51	4007.69	542.56	4154.62	8704.87	17.96
16	.10	165000.	29.73	4230.77	568.59	4288.46	9087.82	9.09

EXP ANNUAL DAMAGE, YEAR 2080 455.29 74.26 299.98 829.53

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TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
DAMAGE VALUES IN $1000

** EXPECTED ANNUAL FLOOD DAMAGE **

** FOR REACH 1 = DAMAGE REACH 3 BELOW RES A - URBAN AREA 1

** WITH PLAN 1 = WITHOUT PROJECTS

** INPUT DATA YEARS = 1976 1990 2020

** PERIOD OF ANALYSIS = 100 YEARS

** DISCOUNT RATE = 6.3750 PERCENT

** DAMAGE BASE = JUNE 1974 DOLLARS

DAMAGE CATEGORIES	STUDY YEAR 1976	BASE YEAR 1981	DECADE YEARS 10 1990	20 2000	30 2010	40 2020	50 2030	END OF PERIOD 2080	EQUIVALENT ANNUAL DAMAGE
1 AGRIC	317.53	351.78	413.18	426.77	440.82	455.29	455.29	455.29	407.86
2 SERVICE	52.35	57.68	67.28	69.54	71.87	74.26	74.26	74.26	66.55
3 URBAN	209.93	230.64	268.42	278.62	289.17	299.98	299.98	299.98	266.55
TOTAL	579.81	640.10	748.88	774.93	801.86	829.53	829.53	829.53	740.96

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REACH   1, REACH NAME -
RN DAMAGE REACH 3 BELOW RES A - URBAN AREA 1

++++ INPUT DATA ++++

**OUTPUT OPTIONS**
                     JDGPR   JDGPU  JTRACE
PP                       6       0       0

**FLOOD PEAKS**
QF     31976 2    4700.   5200.   5750.   6400.   7200.   8300.   9700.  11700.
  15000.  22000.  30000.  46000.  62000.  82000. 115000. 145000.
QF     31990 2    5200.   5700.   6300.   7000.   7900.   9100.  10700.  13000.
  16600.  24000.  34000.  51500.  68000.  88000. 121000. 150000.
QF     32020 2    5600.   6200.   6900.   7700.   8600.  10000.  11600.  14000.
  18000.  27000.  38000.  56000.  74000.  94000. 127000. 155000.

**END OF INPUT DATA FOR PLAN  2 **
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TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
DAMAGE VALUES IN $1000

** EXPECTED ANNUAL FLOOD DAMAGE **

** FOR REACH 1 = DAMAGE REACH 3 BELOW RES A - URBAN AREA 1

** WITH PLAN 2 = REGULATED BY EXISTING RESERVOIR A

** INPUT DATA YEARS = 1976 1990 2020

** PERIOD OF ANALYSIS = 100 YEARS

** DISCOUNT RATE = 6.3750 PERCENT

** DAMAGE BASE = JUNE 1974 DOLLARS

DAMAGE CATEGORIES	STUDY YEAR 1976	BASE YEAR 1981	.... DECADE YEARS 10 1990	20 2000	30 2010	40 2020	50 2030	END OF PERIOD 2080	EQUIVALENT ANNUAL DAMAGE
1 AGRIC	227.08	243.28	273.65	290.78	307.75	324.65	324.65	324.65	278.70
2 SERVICE	37.97	40.62	45.54	48.20	50.83	53.47	53.47	53.47	46.27
3 URBAN	150.87	162.26	183.92	195.03	206.48	218.17	218.17	218.17	186.87
TOTAL	415.92	446.17	503.11	534.01	565.06	596.28	596.28	596.28	511.84

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REACH   2, REACH NAME -
RN DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

++++ INPUT DATA ++++

**FLOOD PEAKS**
QF    131976 1     8400.   9100.  10000.  11300.  13000.  15000.  17600.  21700.
  28500.  44000.  65000. 106000. 150000. 208000. 310000. 410000.

**STAGES FOR RATING CURVE**
SQ    13      17    6.50    7.00    7.40    8.50    9.60   10.80   11.60   13.00
   14.00   16.00   17.00   18.00   19.00   20.00   21.00   22.00   23.00

**FLOWS FOR RATING CURVE**
QS    131976 0     8700.   9200.  10000.  11300.  13000.  15000.  17000.  25000.
  34000.  67000.  92000. 123000. 160000. 210000. 263000. 330000. 415000.

**STAGES FOR DAMAGE DATA**
SD    13      10    9.00   13.50   15.00   16.00   16.70   17.10   17.40   19.90
   22.00   23.00

**FLOOD DAMAGE DATA**
DG    131976 1 1     .00    2.00   10.00   21.00   35.00   50.00   76.00  271.00
  440.00  520.00

**STAGES FOR DAMAGE DATA**
SD    13      11    9.00   13.40   14.50   15.10   15.80   16.50   17.50   18.50
   19.90   22.00   23.00

**FLOOD DAMAGE DATA**
DG    131976 1 2     .00    5.00   13.00   28.00   50.00   87.00  150.00  250.00
  427.00  700.00  850.00

**STAGES FOR DAMAGE DATA**
SD    13      14   11.00   12.00   13.00   14.00   15.00   15.50   16.00   17.00
   17.50   18.00   20.00   21.00   22.00   23.00

**FLOOD DAMAGE DATA**
DG    131976 1 3     .00   30.00  150.00  250.00  400.00  600.00  930.00 1850.00
 2250.00 2470.00 3420.00 3970.00 4680.00 5900.00
DG    131990 1 3     .00   35.00  165.00  270.00  450.00  700.00 1030.00 2040.00
 2500.00 2730.00 3870.00 4400.00 5200.00 6500.00
DG    132020 1 3     .00   40.00  180.00  300.00  500.00  770.00 1150.00 2300.00
 2750.00 3000.00 4200.00 4800.00 5700.00 7200.00

**END OF INPUT DATA FOR PLAN  1 **
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TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
DAMAGE VALUES IN $1000

** EXPECTED ANNUAL FLOOD DAMAGE **

** FOR REACH 2 = DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

** WITH PLAN 1 = WITHOUT PROJECTS

** INPUT DATA YEARS = 1976 1990 2020

** PERIOD OF ANALYSIS = 100 YEARS

** DISCOUNT RATE = 6.3750 PERCENT

** DAMAGE BASE = JUNE 1974 DOLLARS

DAMAGE CATEGORIES	STUDY YEAR 1976	BASE YEAR 1981	DECADE YEARS 10 1990	20 2000	30 2010	40 2020	50 2030	END OF PERIOD 2080	EQUIVALENT ANNUAL DAMAGE
1 AGRIC	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93	6.93
2 SERVICE	13.32	13.32	13.32	13.32	13.32	13.32	13.32	13.32	13.32
3 URBAN	174.05	180.98	193.45	200.29	207.12	213.96	213.96	213.96	195.40
TOTAL	194.31	201.24	213.71	220.54	227.38	234.22	234.22	234.22	215.66

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EXHIBIT 4

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REACH   2, REACH NAME -
RN DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

++++ INPUT DATA ++++

**FLOOD PEAKS**
QF    131976 2     8400.   9100.   9900.  11000.  12500.  14200.  16800.  20500.
  26000.  38500.  59000. 100000. 145000. 204000. 308000. 410000.

**END OF INPUT DATA FOR PLAN  2 **
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TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
DAMAGE VALUES IN $1000

** EXPECTED ANNUAL FLOOD DAMAGE **

**   FOR REACH 2 = DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

**   WITH PLAN 2 = REGULATED BY EXISTING RESERVOIR A

** INPUT DATA YEARS   = 1976 1990 2020

** PERIOD OF ANALYSIS =   100 YEARS

** DISCOUNT RATE   =   6.3750 PERCENT

** DAMAGE BASE   = JUNE 1974 DOLLARS

DAMAGE CATEGORIES	STUDY YEAR 1976	BASE YEAR 1981	DECADE YEARS 10 1990	20 2000	30 2010	40 2020	50 2030	END OF PERIOD 2080	EQUIVALENT ANNUAL DAMAGE
1 AGRIC	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21
2 SERVICE	11.82	11.82	11.82	11.82	11.82	11.82	11.82	11.82	11.82
3 URBAN	152.53	158.57	169.45	175.41	181.38	187.34	187.34	187.34	171.15
TOTAL	170.56	176.60	187.48	193.44	199.40	205.37	205.37	205.37	189.18

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REACH   2, REACH NAME -
RN DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

++++ INPUT DATA ++++

**FLOOD PEAKS**
QF    131976 3     7900.   8600.   9200.  10000.  10900.  12000.  14000.  16800.
  22000.  34000.  51000.  85000. 126000. 183000. 296000. 410000.

**END OF INPUT DATA FOR PLAN  3 **
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  TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
  BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
  DAMAGE VALUES IN $1000


** EXPECTED ANNUAL FLOOD DAMAGE **

**       FOR REACH  2 =  DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

**       WITH PLAN  3 =  REGULATED BY RES A AND PROPOSED RESERVOIR B

** INPUT DATA YEARS   =  1976  1990  2020

** PERIOD OF ANALYSIS =   100 YEARS

** DISCOUNT RATE      =   6.3750 PERCENT

** DAMAGE BASE        =  JUNE 1974 DOLLARS
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DAMAGE CATEGORIES	STUDY YEAR 1976	BASE YEAR 1981	.... DECADE YEARS 10 1990	20 2000	30 2010	40 2020	50 2030	END OF PERIOD 2080	EQUIVALENT ANNUAL DAMAGE
1 AGRIC	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
2 SERVICE	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25	9.25
3 URBAN	117.48	122.14	130.54	135.15	139.75	144.36	144.36	144.36	131.85
TOTAL	131.59	136.25	144.65	149.26	153.86	158.47	158.47	158.47	145.97

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REACH   2, REACH NAME -
RN DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

++++ INPUT DATA ++++

**FLOOD PEAKS**
QF    131976 4     8400.   9100.   9900.  11000.  12500.  14200.  16800.  20500.
  26000.  38500.  59000. 100000. 145000. 204000. 308000. 410000.

**STAGES FOR DAMAGE DATA**
SD    13       6   18.60   18.61   20.00   21.00   22.00   23.00

**FLOOD DAMAGE DATA**
DG    131976 4 3     .00 2760.00 3420.00 3970.00 4680.00 5900.00
DG    131990 4 3     .00 3050.00 3780.00 4400.00 5200.00 6500.00
DG    132020 4 3     .00 3360.00 4200.00 4800.00 5700.00 7200.00

**END OF INPUT DATA FOR PLAN  4 **
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  TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
  BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
  DAMAGE VALUES IN $1000

** EXPECTED ANNUAL FLOOD DAMAGE **

**      FOR REACH  2 =  DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

**      WITH PLAN  4 =  REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2

** INPUT DATA YEARS   =  1976  1990  2020

** PERIOD OF ANALYSIS =   100 YEARS

** DISCOUNT RATE      =   6.3750 PERCENT

** DAMAGE BASE        =  JUNE 1974 DOLLARS
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DAMAGE CATEGORIES	STUDY YEAR 1976	BASE YEAR 1981	.... DECADE YEARS 10 1990	20 2000	30 2010	40 2020	50 2030	END OF PERIOD 2080	EQUIVALENT ANNUAL DAMAGE
1 AGRIC	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21	6.21
2 SERVICE	11.82	11.82	11.82	11.82	11.82	11.82	11.82	11.82	11.82
3 URBAN	36.65	38.04	40.53	41.93	43.32	44.72	44.72	44.72	40.94
TOTAL	54.68	56.07	58.56	59.96	61.35	62.75	62.75	62.75	58.97

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  TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
  BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
  DAMAGE VALUES IN $1000

** SUMMARY OF REACH NAMES  **

 NO     ID    . . NAME . . .
-----------------------------------------------------------------------------
  1      3     DAMAGE REACH 3 BELOW RES A - URBAN AREA 1
  2     13     DAMAGE REACH 13, BELOW RES A AND B - URBAN AREA 2

-----------------------------------------------------------------------------
```

* *

TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
DAMAGE VALUES IN $1000

** EQUIVALENT ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS = 1976 1990 2020

** PERIOD OF ANALYSIS = 100 YEARS

** DISCOUNT RATE = 6.3750 PERCENT

** DAMAGE BASE = JUNE 1974 DOLLARS

** FLOOD PLAIN MANAGEMENT PLANS
1 - WITHOUT PROJECTS
2 - REGULATED BY EXISTING RESERVOIR A
3 - REGULATED BY RES A AND PROPOSED RESERVOIR B
4 - REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2

SUMMARY FOR DAMAGE CATEGORY 1 - AGRIC

REACH NO	REACH ID	BASE CONDITION (PLAN 1)	EQUIVALENT ANNUAL DAMAGE PLAN 2 DAMAGE W/PLAN	PLAN 2 DAMAGE REDUCED	PLAN 3 DAMAGE W/PLAN	PLAN 3 DAMAGE REDUCED	PLAN 4 DAMAGE W/PLAN	PLAN 4 DAMAGE REDUCED
1	3	407.86	278.70	129.16	278.70	129.16	278.70	129.16
2	13	6.93	6.21	.73	4.86	2.08	6.21	.73
	AGRIC	414.79	284.91	129.88	283.56	131.23	284.91	129.88

* *

TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
DAMAGE VALUES IN $1000

** EQUIVALENT ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS = 1976 1990 2020

** PERIOD OF ANALYSIS = 100 YEARS

** DISCOUNT RATE = 6.3750 PERCENT

** DAMAGE BASE = JUNE 1974 DOLLARS

** FLOOD PLAIN MANAGEMENT PLANS
1 - WITHOUT PROJECTS
2 - REGULATED BY EXISTING RESERVOIR A
3 - REGULATED BY RES A AND PROPOSED RESERVOIR B
4 - REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2

SUMMARY FOR DAMAGE CATEGORY 2 - SERVICE

REACH NO	REACH ID	. . . . EQUIVALENT ANNUAL DAMAGE BASE CONDITION (PLAN 1)	.... PLAN 2.... DAMAGE W/PLAN	DAMAGE REDUCED	.... PLAN 3.... DAMAGE W/PLAN	DAMAGE REDUCED	.... PLAN 4.... DAMAGE W/PLAN	DAMAGE REDUCED
1	3	66.55	46.27	20.28	46.27	20.28	46.27	20.28
2	13	13.32	11.82	1.50	9.25	4.07	11.82	1.50
SERVICE		79.87	58.09	21.78	55.53	24.35	58.09	21.78

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
  BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
  DAMAGE VALUES IN $1000

** EQUIVALENT ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1976  1990  2020

** PERIOD OF ANALYSIS =  100 YEARS

** DISCOUNT RATE      =  6.3750 PERCENT

** DAMAGE BASE        =  JUNE 1974 DOLLARS

** FLOOD PLAIN MANAGEMENT PLANS
        1 -  WITHOUT PROJECTS
        2 -  REGULATED BY EXISTING RESERVOIR A
        3 -  REGULATED BY RES A AND PROPOSED RESERVOIR B
        4 -  REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2

SUMMARY FOR DAMAGE CATEGORY  3 -    URBAN
---------------------------------------------------------------------------
            . . . . . . . . . . EQUIVALENT ANNUAL DAMAGE
   REACH      BASE     .... PLAN  2....   .... PLAN  3....   .... PLAN  4....
 NO    ID   CONDITION  DAMAGE   DAMAGE    DAMAGE   DAMAGE    DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED    W/PLAN  REDUCED    W/PLAN  REDUCED
---------------------------------------------------------------------------
  1     3    266.55    186.87    79.68    186.87    79.68    186.87    79.68
  2    13    195.40    171.15    24.25    131.85    63.55     40.94   154.46
---------------------------------------------------------------------------

     URBAN   461.95    358.02   103.93    318.73   143.22    227.82   234.13

---------------------------------------------------------------------------
```

* *

TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
DAMAGE VALUES IN $1000

** EQUIVALENT ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS = 1976 1990 2020

** PERIOD OF ANALYSIS = 100 YEARS

** DISCOUNT RATE = 6.3750 PERCENT

** DAMAGE BASE = JUNE 1974 DOLLARS

** FLOOD PLAIN MANAGEMENT PLANS
1 - WITHOUT PROJECTS
2 - REGULATED BY EXISTING RESERVOIR A
3 - REGULATED BY RES A AND PROPOSED RESERVOIR B
4 - REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2

GRAND SUMMARY - ALL DAMAGE CATEGORIES

		. . . . EQUIVALENT ANNUAL DAMAGE						
REACH		BASE	.... PLAN 2....		.... PLAN 3....		.... PLAN 4....	
NO	ID	CONDITION (PLAN 1)	DAMAGE W/PLAN	DAMAGE REDUCED	DAMAGE W/PLAN	DAMAGE REDUCED	DAMAGE W/PLAN	DAMAGE REDUCED
1	3	740.96	511.84	229.11	511.84	229.11	511.84	229.11
2	13	215.66	189.18	26.48	145.97	69.69	58.97	156.69
TOTAL		956.61	701.02	255.59	657.81	298.80	570.82	385.80

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

 TEST NO. 2 -- PERIOD OF RECORD ANALYSIS WITH PRINTOUT SUPPRESSION
 BASIN DEVELOPMENT FOR 1976, 1990, AND 2020
 DAMAGE VALUES IN $1000


** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS   =  1976  1990  2020

PERIOD OF ANALYSIS =  100 YEARS

** DISCOUNT RATE      =  6.3750 PERCENT

** DAMAGE BASE        =  JUNE 1974 DOLLARS

** FLOOD PLAIN MANAGEMENT PLANS
         1 -  WITHOUT PROJECTS
         2 -  REGULATED BY EXISTING RESERVOIR A
         3 -  REGULATED BY RES A AND PROPOSED RESERVOIR B
         4 -  REGULATED BY RES A AND PROPOSED LEVEE AT URBAN AREA 2

GRAND SUMMARY - ALL DAMAGE CATEGORIES
---------------------------------------------------------------------------
             . . . . . . . . . EQUIVALENT ANNUAL DAMAGE
  DAMAGE      BASE     .... PLAN  2....  .... PLAN  3....  .... PLAN  4....
 CATEGORY   CONDITION  DAMAGE   DAMAGE   DAMAGE   DAMAGE   DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN   REDUCED  W/PLAN   REDUCED  W/PLAN   REDUCED
---------------------------------------------------------------------------
     AGRIC    414.79   284.91   129.88   283.56   131.23   284.91   129.88
   SERVICE     79.87    58.09    21.78    55.53    24.35    58.09    21.78
     URBAN    461.95   358.02   103.93   318.73   143.22   227.82   234.13
---------------------------------------------------------------------------

     TOTAL    956.61   701.02   255.59   657.81   298.80   570.82   385.80

---------------------------------------------------------------------------


READIN --  NO RECORDS READ FROM USER INPUT


++++++++++++++++
END OF RUN
EAD PROGRAM STOP
++++++++++++++++
```

Test Example 3 Retrieval of Damage Data from HECDSS

Features of this example:

- two reaches.
- Seven damage categories (contents for residential and commercial are separated from the main categories).
- Two alternative plans.
- Stage-frequency same for both plans, stage-damage matrices change (nonstructural plan).
- Stage-damage matrix retrieved automatically from HECDSS data file. This matrix was created by HEC program Structure Inventory for Damage Analysis (SID). See the SID manual for the creation of this stage-damage matrix.

Description of This Example:

This test example demonstrates the automatic data retrieval capability of the EAD program, by illustrating retrieval of stage-damage matrices from a DSS file. The capability is not limited to stage-damage matrices but also includes flow-frequency and stage-flow matrices. Retrieval procedures are similar. The capability presently exists only on Corps of Engineers supported mini-computer facilities and on MS-DOS, Compaq compatible microcomputers. The DSS system that makes this capability practical is currently distributed to the public on for MS-DOS microcomputers.

The stage-damage data were developed by the HEC program "Structure Inventory for Damage Analysis" (SID). The example herein is similar to Exhibit E-5 in the SID Users Manual. Specific codes and pathnames must be specified for the SID run, when performed, so that data are available in the DSS for retrieval by EAD. Exhibit 5 in this manual and E-5 in the SID User Manual provide further documentation. A publication is planned for fiscal year 1984 that describes the integrated family of flood damage programs and will provide specific instructions for making use of the DSS linkage capability.

The test problem retrieves two sets of stage damage functions for two reaches. The key elements (other than a normal run for EAD) are the specification of the pathnames on the ZR records and noting on the appropriate DG records that data will come from a file.

```
+++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580      IBM-PC Compatible      +
+ Version Date      December 1, 1988       +
+++++++++++++++++++++++++++++++++++++++++++++


** LIST OF RECORDS READ BY READIN **
RECORD
 ORDER          1         2         3         4         5         6         7         8
NUMBER 12345678901234567890123456789012345678901234567890123456789012345678901234567890

     1 TT  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
     2 TT  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
     3 TT  INSERTED INTO THE EAD INPUT FILE.
     4 TT  DAMAGE VALUES IN THOUSAND DOLLARS
     5 TT  MARCH 1989
     6 CN     7MOBL HOMAPARTMTSS.F.RES.  RESCONCOMMERCL  COMCON   OTHER
     7 PN     1  PLAN 1
     8 PN     2  PLAN 2
     9 DY     1    1982
    10 RNDAMAGE REACH 1
    11 FR             7      50      20      10       5       2       1     0.2
    12 SF   DR11981       485.3   490.2   492.3   493.5   494.5   495.5   496.3
    13 ZR A=SID TEST   B=DR1   C=DG   E=1982   F=PLAN1
    14 EP     1
    15 ZR A=SID TEST   B=DR1   C=DG   E=1982   F=PLAN2
    16 ER     2
    17 RNDAMAGE REACH 2
    18 SFDR2   1982       495.3   498.8   500.6   502.6   503.6   507.7   508.1
    19 ZR A=SID TEST   B=DR2   C=DG   E=1982   F=PLAN1
    20 EP     1
    21 ZR A=SID TEST   B=DR2   C=DG   E=1982   F=PLAN2
    22 EJ     2


READIN --    22 RECORDS WRITTEN TO LOGICAL FILE  8
```

```
++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible       +
+ Version Date     December 1, 1988        +
++++++++++++++++++++++++++++++++++++++++++++


TT  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
TT  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
TT  INSERTED INTO THE EAD INPUT FILE.
TT  DAMAGE VALUES IN THOUSAND DOLLARS
TT  MARCH 1989

**DAMAGE CATEGORY NAMES**
CN   7  MOBL HOMAPARTMTSS.F.RES.  RESCONCOMMERCL  COMCON   OTHER

**FLOOD PLAIN MANAGEMENT PLAN NAMES**
PN   1    PLAN 1
PN   2    PLAN 2

**INPUT DATA YEARS**
     NDYRS   IDYRS
DY       1    1982

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++


REACH   1, REACH NAME -
RNDAMAGE REACH 1

++++ INPUT DATA ++++

**FREQUENCIES**
FR             7   50.00   20.00   10.00    5.00    2.00    1.00     .20

**** CAUTION -- INPUT DATA YEAR OF 1981 NOT ON DY RECORD.
SET TO NEAREST YEAR OF 1982

**FLOOD STAGES**
SF   DR11982 0    485.30  490.20  492.30  493.50  494.50  495.50  496.30
   -----DSS---ZOPEN; Existing File Opened - Unit:  71  File: TESTDATA.DSS

** HECDSS DATA FILE OPENED: TESTDATA.DSS

** STAGES FOR DAMAGE DATA READ FROM HECDSS FILE **
SD   DR1       18  485.00  486.00  487.00  488.00  489.00  490.00  491.00  492.00
  493.00  494.00  495.00  496.00  497.00  498.00  499.00  500.00  501.00  502.00
```

```
** FLOOD DAMAGE DATA READ FROM HECDSS FILE **

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  1   (MOBL HOM)
DG   DR11982 0 1      0.      0.      0.      0.      0.      0.      0.     10.
     62.    116.    240.    396.    474.    515.    532.    541.    546.    546.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  2   (APARTMTS)
DG   DR11982 0 2      0.      0.     35.     94.    174.    296.    443.    593.
    760.    891.   1021.   1248.   1395.   1546.   1715.   1840.   1955.   2024.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  3   (S.F.RES.)
DG   DR11982 0 3      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  4   (  RESCON)
DG   DR11982 0 4      0.      0.     19.     43.     75.    126.    191.    235.
    277.    343.    458.    690.    822.    965.   1089.   1168.   1229.   1276.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  5   (COMMERCL)
DG   DR11982 0 5      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  6   (  COMCON)
DG   DR11982 0 6      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  7   (   OTHER)
DG   DR11982 0 7      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

**END OF INPUT DATA FOR PLAN  1 **
EP++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 1 --   PLAN 1
```

	FREQ	FLOW	STAGE	MOBL HOM	APARTMTS	S.F.RES.	RESCON	COMMERCL	COMCON	OTHER	TOTAL	ACC EAD
1	50.00	-1.	485.30	.00	.00	.00	.00	.00	.00	.00	.00	244.87
2	20.00	-1.	490.20	.00	325.50	.00	139.41	.00	.00	.00	464.92	201.61
3	10.00	-1.	492.30	25.44	642.75	.00	247.53	.00	.00	.00	915.72	133.82
4	5.00	-1.	493.50	89.30	825.63	.00	310.15	.00	.00	.00	1225.08	80.46
5	2.00	-1.	494.50	177.95	956.30	.00	400.65	.00	.00	.00	1534.90	40.12
6	1.00	-1.	495.50	317.85	1134.83	.00	574.15	.00	.00	.00	2026.83	22.75
7	.20	-1.	496.30	419.52	1292.26	.00	729.45	.00	.00	.00	2441.23	4.88
EXP ANNUAL DAMAGE				13.03	163.48	.00	68.36	.00	.00	.00	244.87	

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   1, REACH NAME -
RNDAMAGE REACH 1

++++ INPUT DATA ++++

WARNING, TOO MANY POINTS IN DAMAGE RELATIONSHIP STORED IN HECDSS FILE
LIMITED TO:  18 POINTS
RELATIONSHIP TRUNCATED

** STAGES FOR DAMAGE DATA READ FROM HECDSS FILE **
SD   DR1       21  485.00  486.00  487.00  488.00  489.00  490.00  491.00  492.00
  492.30  493.00  493.50  494.00  494.50  495.00  496.00  497.00  498.00  499.00
  500.00  501.00  502.00

** FLOOD DAMAGE DATA READ FROM HECDSS FILE **

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  1   (MOBL HOM)
DG   DR11982 0 1       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      8.     16.     68.    120.    267.    342.    379.    396.
    405.    410.    410.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  2   (APARTMTS)
DG   DR11982 0 2       0.      0.      0.      0.      0.    296.    443.    593.
    638.    760.    835.    891.    948.   1021.   1248.   1395.   1546.   1715.
   1840.   1955.   2024.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  3   (S.F.RES.)
DG   DR11982 0 3       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  4   (  RESCON)
DG   DR11982 0 4       0.      0.      0.      0.      0.    126.    191.    234.
    243.    265.    287.    318.    358.    424.    651.    780.    922.   1045.
   1123.   1184.   1231.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  5   (COMMERCL)
DG   DR11982 0 5       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  6   (  COMCON)
DG   DR11982 0 6       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  7   (   OTHER)
DG   DR11982 0 7       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.

**END OF INPUT DATA FOR PLAN  2 **
```

ER+++

++DAMAGE DATA FOR PLAN 2 -- PLAN 2

	FREQ	FLOW	STAGE	MOBL HOM	APARTMTS	S.F.RES.	RESCON	COMMERCL	COMCON	OTHER	TOTAL	ACC EAD
1	50.00	-1.	485.30	.00	.00	.00	.00	.00	.00	.00	.00	207.34
2	20.00	-1.	490.20	.00	325.50	.00	139.41	.00	.00	.00	464.92	190.81
3	10.00	-1.	492.30	.00	637.50	.00	243.00	.00	.00	.00	880.50	123.58
4	5.00	-1.	493.50	8.00	835.00	.00	287.25	.00	.00	.00	1130.25	73.54
5	2.00	-1.	494.50	68.00	947.50	.00	357.75	.00	.00	.00	1373.25	36.87
6	1.00	-1.	495.50	193.50	1134.83	.00	537.55	.00	.00	.00	1865.88	21.09
7	.20	-1.	496.30	289.35	1292.26	.00	689.84	.00	.00	.00	2271.45	4.54
EXP ANNUAL DAMAGE				4.49	145.05	.00	57.79	.00	.00	.00	207.34	

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   2, REACH NAME -
RNDAMAGE REACH 2

++++ INPUT DATA ++++

**FLOOD STAGES**
SFDR2   1982 0    495.30  498.80  500.60  502.60  503.60  507.70  508.10

** STAGES FOR DAMAGE DATA READ FROM HECDSS FILE **
SD   DR2       18  498.00  499.00  500.00  501.00  502.00  503.00  504.00  505.00
  506.00  507.00  508.00  509.00  510.00  511.00  512.00  513.00  514.00  515.00

** FLOOD DAMAGE DATA READ FROM HECDSS FILE **

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  1   (MOBL HOM)
DG   DR21982 0 1      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  2   (APARTMTS)
DG   DR21982 0 2      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  3   (S.F.RES.)
DG   DR21982 0 3      0.      0.      0.      0.    115.    148.    215.    316.
    382.    448.    534.    596.    636.    671.    706.    723.    745.    764.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  4   (  RESCON)
DG   DR21982 0 4      0.      0.      0.      0.     57.     74.    126.    203.
    243.    298.    385.    434.    472.    513.    551.    575.    599.    632.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  5   (COMMERCL)
DG   DR21982 0 5      0.      0.      0.      0.      0.    302.    958.   1424.
   1777.   2041.   2192.   2293.   2356.   2381.   2394.   2394.   2394.   2394.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  6   (  COMCON)
DG   DR21982 0 6      0.      0.      0.      0.      0.    144.    456.    678.
    846.    972.   1044.   1092.   1122.   1134.   1140.   1140.   1140.   1140.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  7   (   OTHER)
DG   DR21982 0 7      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.

**END OF INPUT DATA FOR PLAN  1 **
EP++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
```

++DAMAGE DATA FOR PLAN 1 --   PLAN 1

	FREQ	FLOW	STAGE	MOBL HOM	APARTMTS	S.F.RES.	RESCON	COMMERCL	COMCON	OTHER	TOTAL	ACC EAD
1	50.00	-1.	495.30	.00	.00	.00	.00	.00	.00	.00	.00	97.84
2	20.00	-1.	498.80	.00	.00	.00	.00	.00	.00	.00	.00	97.84
3	10.00	-1.	500.60	.00	.00	.00	.00	.00	.00	.00	.00	97.84
4	5.00	-1.	502.60	.00	.00	135.01	67.34	181.44	86.40	.00	470.19	91.22
5	2.00	-1.	503.60	.00	.00	188.31	105.41	695.52	331.20	.00	1320.45	68.92
6	1.00	-1.	507.70	.00	.00	508.31	358.89	2147.04	1022.40	.00	4036.65	41.27
7	.20	-1.	508.10	.00	.00	540.26	389.99	2202.48	1048.80	.00	4181.53	8.36
EXP ANNUAL DAMAGE				.00	.00	16.32	9.85	48.55	23.12	.00	97.84	

```
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

REACH   2, REACH NAME -
RNDAMAGE REACH 2

++++ INPUT DATA ++++

WARNING, TOO MANY POINTS IN DAMAGE RELATIONSHIP STORED IN HECDSS FILE
LIMITED TO:  18 POINTS
RELATIONSHIP TRUNCATED

** STAGES FOR DAMAGE DATA READ FROM HECDSS FILE **
SD   DR2       21  498.00  499.00  500.00  500.60  501.00  502.00  502.60  503.00
  503.60  504.00  505.00  506.00  507.00  508.00  509.00  510.00  511.00  512.00
  513.00  514.00  515.00

** FLOOD DAMAGE DATA READ FROM HECDSS FILE **

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  1   (MOBL HOM)
DG   DR21982 0 1       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  2   (APARTMTS)
DG   DR21982 0 2       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  3   (S.F.RES.)
DG   DR21982 0 3       0.      0.      0.      0.      0.      0.      0.      0.
      0.    195.    306.    376.    444.    527.    594.    632.    668.    706.
    723.    745.    764.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  4   (  RESCON)
DG   DR21982 0 4       0.      0.      0.      0.      0.      0.      0.      0.
      0.    107.    196.    237.    290.    379.    430.    469.    509.    551.
    575.    599.    632.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  5   (COMMERCL)
DG   DR21982 0 5       0.      0.      0.      0.      0.      0.      3.     14.
     35.    958.   1424.   1777.   2041.   2192.   2293.   2356.   2381.   2394.
   2394.   2394.   2394.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  6   (  COMCON)
DG   DR21982 0 6       0.      0.      0.      0.      0.      0.      0.      0.
      0.    456.    678.    846.    972.   1044.   1092.   1122.   1134.   1140.
   1140.   1140.   1140.

DATA BELOW WILL BE AGGREGATED TO DAMAGE CATEGORY  7   (   OTHER)
DG   DR21982 0 7       0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.      0.      0.      0.      0.      0.      0.      0.
      0.      0.      0.

**END OF INPUT DATA FOR PLAN  2 **
```

EJ+++

++DAMAGE DATA FOR PLAN 2 -- PLAN 2

	FREQ	FLOW	STAGE	MOBL HOM	APARTMTS	S.F.RES.	RESCON	COMMERCL	COMCON	OTHER	TOTAL	ACC EAD
1	50.00	-1.	495.30	.00	.00	.00	.00	.00	.00	.00	.00	67.62
2	20.00	-1.	498.80	.00	.00	.00	.00	.00	.00	.00	.00	67.62
3	10.00	-1.	500.60	.00	.00	.00	.00	.00	.00	.00	.00	67.62
4	5.00	-1.	502.60	.00	.00	.00	.00	2.88	.00	.00	2.88	67.60
5	2.00	-1.	503.60	.00	.00	.00	.00	35.04	.00	.00	35.04	67.14
6	1.00	-1.	507.70	.00	.00	502.45	352.49	2147.04	1022.40	.00	4024.38	41.15
7	.20	-1.	508.10	.00	.00	533.99	384.19	2202.48	1048.80	.00	4169.47	8.34
EXP ANNUAL DAMAGE				.00	.00	8.29	5.69	36.51	17.13	.00	67.62	

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** SUMMARY OF REACH NAMES  **

 NO     ID    . . NAME . . .
--------------------------------------------------------------------------------
  1    DR1    DAMAGE REACH 1
  2    DR2    DAMAGE REACH 2

--------------------------------------------------------------------------------

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

SUMMARY FOR DAMAGE CATEGORY  1 - MOBL HOM
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE     .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1     13.03     4.49     8.53
  2    DR2       .00      .00      .00
---------------------------------------

  MOBL HOM     13.03     4.49     8.53

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

SUMMARY FOR DAMAGE CATEGORY  2 - APARTMTS
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE     .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1    163.48   145.05    18.43
  2    DR2       .00      .00      .00
---------------------------------------

  APARTMTS    163.48   145.05    18.43

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

SUMMARY FOR DAMAGE CATEGORY  3 - S.F.RES.
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE    .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1        .00      .00      .00
  2    DR2      16.32     8.29     8.04
---------------------------------------

  S.F.RES.      16.32     8.29     8.04

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

SUMMARY FOR DAMAGE CATEGORY  4 -   RESCON
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE    .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1     68.36    57.79    10.57
  2    DR2      9.85     5.69     4.15
---------------------------------------

    RESCON     78.21    63.49    14.72

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

SUMMARY FOR DAMAGE CATEGORY  5 - COMMERCL
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE    .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1       .00       .00      .00
  2    DR2     48.55     36.51    12.05
---------------------------------------

  COMMERCL     48.55     36.51    12.05

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

SUMMARY FOR DAMAGE CATEGORY  6 -   COMCON
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE    .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1       .00       .00       .00
  2    DR2     23.12     17.13      5.99
---------------------------------------

    COMCON     23.12     17.13      5.99

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

SUMMARY FOR DAMAGE CATEGORY  7 -    OTHER
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE    .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1       .00      .00      .00
  2    DR2       .00      .00      .00
---------------------------------------

     OTHER       .00      .00      .00

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** EXPECTED ANNUAL DAMAGE SUMMARY BY REACH **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

GRAND SUMMARY - ALL DAMAGE CATEGORIES
  FOR INPUT DATA YEAR 1982
---------------------------------------
            .EXPECTED ANNUAL DAMAGE
   REACH      BASE     .... PLAN  2....
 NO    ID   CONDITION  DAMAGE   DAMAGE
            (PLAN  1)  W/PLAN  REDUCED
---------------------------------------
  1    DR1    244.87   207.34    37.53
  2    DR2     97.84    67.62    30.22
---------------------------------------

     TOTAL    342.71   274.96    67.75

---------------------------------------
```

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
 * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

  TEST NO. 3 -- RETRIEVAL OF DATA FROM THE HEC DATA STORAGE SYSTEM
  SID DAMAGE DATA FOR TWO PLANS ARE AUTOMATICALLY RETRIEVED AND
  INSERTED INTO THE EAD INPUT FILE.


** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS   =  1982

** FLOOD PLAIN MANAGEMENT PLANS
         1 -   PLAN 1
         2 -   PLAN 2

GRAND SUMMARY - ALL DAMAGE CATEGORIES
  FOR INPUT DATA YEAR 1982
```

DAMAGE CATEGORY	.EXPECTED ANNUAL DAMAGE BASE CONDITION (PLAN 1)	.... PLAN 2.... DAMAGE W/PLAN	DAMAGE REDUCED
MOBL HOM	13.03	4.49	8.53
APARTMTS	163.48	145.05	18.43
S.F.RES.	16.32	8.29	8.04
RESCON	78.21	63.49	14.72
COMMERCL	48.55	36.51	12.05
COMCON	23.12	17.13	5.99
OTHER	.00	.00	.00
TOTAL	342.71	274.96	67.75

Test Example 4 Computation of Affluence Using RC Records

Features of this example:

- One reach.
- Four damage categories: Residential Structure, Residential Content, Commercial, and Public.
- One flood plain management plan: Natural conditions.
- The Residential Content Damage Category is increasing in value during the projects serviceable life according to the following rates:

Year	Rate (annual percent)
1984	1.35
1990	1.50
2000	2.50
2015	2.70
2034	2.80

- The period of analysis is 50 years.
- The study year is 1983, the base year is 1985, and the economic base year (the year in which the stage-damage matrices apply) is 1983.
- The value of the residential contents at the beginning of the economic base year (1983) is 30% of the structure value.
- During the period of analysis, the residential contents cannot exceed 60% of the value of the structure.

Description of This Example:

The period of analysis of 50 years and the start of the period of analysis of 1985 are required on the **J1** record.

The discount rate of 5% is required on the **J2** record. The discount rate is used both for discounting (single payment present worth factor) as well as the amortization (capital recovery factor equation).

The four damage category names must be entered on the **CN** record.

The one plan must be entered on the **PN** record.

The appropriate data years must be entered on the **DY** record. In this case, the analyst must enter 1983 (the study and economic base year), 1984 (the first year of the affluence rate of 1.35%), 1985 (the period of analysis base year), 1990, 2000, 2015, and 2034 (the years in which the affluence rate changes). The EAD program uses the rate of change in the residential content value for all years subsequent to and including the corresponding year. For example, the rate of 2.5% and the year 2000 is used as the annual rate from 2000 through 2014.

The **FR**, **SF**, **SD**, and **DG** records are entered in the usual manner. The stage-damage matrix is entered for the year 1983. If there is projected development, then the analyst must enter additional DG records representing and increase in damage due to the construction of additional structures in the flood plain.

One **RC** record is entered for each affluence growth rate. In this case, there are five different rates for the growth in content value. The content value for the economic year (30% in 1983) and the maximum allowable content value (60%) are entered on the first RC record. The same values may be entered on any of the RC records --- The EAD program uses the last one entered.

In any given year, all structures in the residential content category are valued at the same percentage of the value of the structure. For example, in 1983, all residential structures have contents which are valued at 30% of the structure value; a $100,000 house contains contents worth $30,000 and a $200,000 house contains contents worth $60,000. By looking at the EAD output, the analyst can determine that in the year 1990, all residential structures contain contents which are 33% of the structure value. This is computed by taking the content value in the economic base year (30%) and multiplying it by the "adjusted factor" of 1.10004. If development is occurring, new structures do **not** contain contents that are 30% of the structure value but rather contain contents that are valued at the percentage computed using the affluence growth rate (33% for 1990).

In the affluence table output, the column entitled "UNADJUSTED FACTOR" is the computed affluence factor based on user input growth rates. To determine the content value as a function of the structure value in any given year, this factor is multiplied by the content value (in percent) which is observed in the economic base year (30% in 1973). For example, in the year 2000, contents are 38.7% of the structure value (multiply 30% by 1.28922). The maximum allowable factor is 2.0 (the maximum content value is 60% of the structure value; the content value is 30% of the structure value in the base economic year of 1973; divide 60% by 30%). The column entitled "ADJUSTED FACTOR" contains the actual factor used in computing the content value and it reflects the maximum limit of 60%.

```
+++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible       +
+ Version Date     December 1, 1988        +
+++++++++++++++++++++++++++++++++++++++++++


** LIST OF RECORDS READ BY READIN **
RECORD
 ORDER          1         2         3         4         5         6         7         8
NUMBER 12345678901234567890123456789012345678901234567890123456789012345678901234567890

     1 TT       TEST NO. 4 -- AFFLUENCE CALCULATION FOR RESIDENTIAL CONTENTS
     2 TT       FIVE RATES OF GROWTH IN AFFLUENCE (1984, 1990, 2000, 2015, 2034)
     3 TT       ECONOMIC BASE YEAR IS 1983
     4 TT       PERIOD OF ANALYSIS BASE YEAR IS 1985
     5 TT       DAMAGE IN $1,000
     6 TT       MARCH 1989
     7 J1     50    1983    1985
     8 J2      5
     9 CN      4RESIDNTLRES-CONTCOMM    PUBLIC
    10 PN      1BASE CONDITION
    11 DY       7    1983    1984    1985    1990    2000    2015    2034
    12 RN   REACH 1
    13 FR   RCH1       3      90      50       1
    14 SF   RCH11983 1       835     855     880
    15 SD   RCH1       3     850     860     880
    16 DG   RCH11983 1 1       0     333    1667
    17 DG   RCH11983 1 2       0     100     500
    18 DG   RCH11983 1 3       0     200    1200
    19 DG   RCH11983 1 4       0      50     175
    20 RC       RES-CONT    1984    1.35      30      60              1983
    21 RC       RES-CONT    1990     1.5
    22 RC       RES-CONT    2000     2.5
    23 RC       RES-CONT    2015     2.7
    24 RC       RES-CONT    2034     2.8
    25 EJ      1

READIN --    25 RECORDS WRITTEN TO LOGICAL FILE  8
```

```
++++++++++++++++++++++++++++++++++++++++++++
+ Expected Annual Flood Damage Computation +
+ 761-X6-L7580     IBM-PC Compatible       +
+ Version Date     December 1, 1988        +
++++++++++++++++++++++++++++++++++++++++++++



TT      TEST NO. 4 -- AFFLUENCE CALCULATION FOR RESIDENTIAL CONTENTS
TT      FIVE RATES OF GROWTH IN AFFLUENCE (1984, 1990, 2000, 2015, 2034)
TT      ECONOMIC BASE YEAR IS 1983
TT      PERIOD OF ANALYSIS BASE YEAR IS 1985
TT      DAMAGE IN $1,000
TT      MARCH 1989

**JOB RECORD**
      IPOA  ISTDYR  IBASYR   IDMTH  IDOLYR    NHIS   NDMTH  NDOLYR
J1      50    1983    1985       0       0       0       0       0

   RATE(1) RATE(2) RATE(3)    CPLI
J2  5.0000   .0000   .0000  1.0000

**DAMAGE CATEGORY NAMES**
CN   4  RESIDNTLRES-CONTCOMM    PUBLIC

**FLOOD PLAIN MANAGEMENT PLAN NAMES**
PN   1  BASE CONDITION

**INPUT DATA YEARS**
     NDYRS   IDYRS
DY       7    1983    1984    1985    1990    2000    2015    2034

++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++


REACH   1, REACH NAME -
RN  REACH 1

++++ INPUT DATA ++++

**FREQUENCIES**
FR  RCH1       3   90.00   50.00    1.00

**FLOOD STAGES**
SF  RCH11983 1    835.00  855.00  880.00

**STAGES FOR DAMAGE DATA**
SD  RCH1       3  850.00  860.00  880.00
```

```
**FLOOD DAMAGE DATA**
DG  RCH11983 1 1     .00  333.00 1667.00

**FLOOD DAMAGE DATA**
DG  RCH11983 1 2     .00  100.00  500.00

**FLOOD DAMAGE DATA**
DG  RCH11983 1 3     .00  200.00 1200.00

**FLOOD DAMAGE DATA**
DG  RCH11983 1 4     .00   50.00  175.00

**AFFLUENCE DATA**
             CNMRC   IDYRC  RCRATE  RCRTIO  DGRCMX  DGRCMN  IRCBYR
RC        RES-CONT    1984    1.35   30.00   60.00     .00    1983
             CNMRC   IDYRC  RCRATE  RCRTIO  DGRCMX  DGRCMN  IRCBYR
RC        RES-CONT    1990    1.50   30.00   60.00     .00    1983
             CNMRC   IDYRC  RCRATE  RCRTIO  DGRCMX  DGRCMN  IRCBYR
RC        RES-CONT    2000    2.50   30.00   60.00     .00    1983
             CNMRC   IDYRC  RCRATE  RCRTIO  DGRCMX  DGRCMN  IRCBYR
RC        RES-CONT    2015    2.70   30.00   60.00     .00    1983
             CNMRC   IDYRC  RCRATE  RCRTIO  DGRCMX  DGRCMN  IRCBYR
RC        RES-CONT    2034    2.80   30.00   60.00     .00    1983


AFFLUENCE FACTORS FOR DAMAGE CATEGORY  2   (RES-CONT).
--------------------------------------------------------------------------------

ECONOMIC YEAR OF DAMAGE DATA...................    1983
COMPUTATIONAL YEAR.............................    2034
RATIO OF CONTENTS TO STRUC ECON YR (%).........   30.00
MAX RATIO OF CONTENTS TO STRUC COMP YR (%).....   60.00
MIN RATIO OF CONTENTS TO STRUC COMP YR (%).....     .00

USER DEFINED RATES - 5 YEARS
 YEAR  RATE (%)   MAX RATIO (%)   MIN RATIO (%)
------------------------------------------------
 1984    1.350          60.000            .000
 1990    1.500          60.000            .000
 2000    2.500          60.000            .000
 2015    2.700          60.000            .000
 2034    2.800          60.000            .000

YEAR     RATE  UNADJUSTED    ADJUSTED     MAXIMUM     MINIMUM
          (%)     FACTOR       FACTOR      FACTOR      FACTOR
-------------------------------------------------------------
```

1983	1.350	1.01350	1.01350	2.00000	.00000
1984	1.350	1.02718	1.02718	2.00000	.00000
1985	1.350	1.04105	1.04105	2.00000	.00000
1986	1.350	1.05510	1.05510	2.00000	.00000
1987	1.350	1.06935	1.06935	2.00000	.00000
1988	1.350	1.08378	1.08378	2.00000	.00000
1989	1.350	1.09841	1.09841	2.00000	.00000
1990	1.500	1.11489	1.11489	2.00000	.00000
1991	1.500	1.13161	1.13161	2.00000	.00000
1992	1.500	1.14859	1.14859	2.00000	.00000
1993	1.500	1.16582	1.16582	2.00000	.00000
1994	1.500	1.18330	1.18330	2.00000	.00000
1995	1.500	1.20105	1.20105	2.00000	.00000
1996	1.500	1.21907	1.21907	2.00000	.00000
1997	1.500	1.23736	1.23736	2.00000	.00000
1998	1.500	1.25592	1.25592	2.00000	.00000
1999	1.500	1.27475	1.27475	2.00000	.00000
2000	2.500	1.30662	1.30662	2.00000	.00000
2001	2.500	1.33929	1.33929	2.00000	.00000
2002	2.500	1.37277	1.37277	2.00000	.00000
2003	2.500	1.40709	1.40709	2.00000	.00000
2004	2.500	1.44227	1.44227	2.00000	.00000
2005	2.500	1.47832	1.47832	2.00000	.00000
2006	2.500	1.51528	1.51528	2.00000	.00000
2007	2.500	1.55316	1.55316	2.00000	.00000
2008	2.500	1.59199	1.59199	2.00000	.00000
2009	2.500	1.63179	1.63179	2.00000	.00000
2010	2.500	1.67259	1.67259	2.00000	.00000
2011	2.500	1.71440	1.71440	2.00000	.00000
2012	2.500	1.75726	1.75726	2.00000	.00000
2013	2.500	1.80120	1.80120	2.00000	.00000
2014	2.500	1.84622	1.84622	2.00000	.00000
2015	2.700	1.89607	1.89607	2.00000	.00000
2016	2.700	1.94727	1.94727	2.00000	.00000
2017	2.700	1.99984	1.99984	2.00000	.00000
2018	2.700	2.05384	2.00000	2.00000	.00000
2019	2.700	2.10929	2.00000	2.00000	.00000
2020	2.700	2.16624	2.00000	2.00000	.00000
2021	2.700	2.22473	2.00000	2.00000	.00000
2022	2.700	2.28480	2.00000	2.00000	.00000
2023	2.700	2.34649	2.00000	2.00000	.00000
2024	2.700	2.40984	2.00000	2.00000	.00000
2025	2.700	2.47491	2.00000	2.00000	.00000
2026	2.700	2.54173	2.00000	2.00000	.00000
2027	2.700	2.61036	2.00000	2.00000	.00000
2028	2.700	2.68084	2.00000	2.00000	.00000
2029	2.700	2.75322	2.00000	2.00000	.00000
2030	2.700	2.82756	2.00000	2.00000	.00000
2031	2.700	2.90390	2.00000	2.00000	.00000

```
2032   2.700    2.98231     2.00000     2.00000      .00000
2033   2.700    3.06283     2.00000     2.00000      .00000
2034   2.800    3.14859     2.00000     2.00000      .00000

**END OF INPUT DATA FOR PLAN  1 **
EJ+++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

++DAMAGE DATA FOR PLAN 1 AND YEAR 1983 -- BASE CONDITION

       FREQ       FLOW     STAGE  RESIDNTL  RES-CONT  COMM      PUBLIC       TOTAL   ACC EAD
   1  90.00        -1.    835.00       .00       .00       .00       .00       .00    698.64
   2  50.00        -1.    855.00    166.50     50.67    100.00     25.00    342.17    673.28
   3   1.00        -1.    880.00   1667.00    506.75   1200.00    175.00   3548.75     35.49

EXP ANNUAL DAMAGE,   YEAR 1983    332.48    101.11    224.54     40.51    698.64

++DAMAGE DATA FOR PLAN 1 AND YEAR 1985 -- BASE CONDITION

       FREQ       FLOW     STAGE  RESIDNTL  RES-CONT  COMM      PUBLIC       TOTAL   ACC EAD
   1  90.00        -1.    835.00       .00       .00       .00       .00       .00    701.39
   2  50.00        -1.    855.00    166.50     52.05    100.00     25.00    343.55    675.93
   3   1.00        -1.    880.00   1667.00    520.52   1200.00    175.00   3562.52     35.63

EXP ANNUAL DAMAGE,   YEAR 1985    332.48    103.86    224.54     40.51    701.39

++DAMAGE DATA FOR PLAN 1 AND YEAR 1994 -- BASE CONDITION

       FREQ       FLOW     STAGE  RESIDNTL  RES-CONT  COMM      PUBLIC       TOTAL   ACC EAD
   1  90.00        -1.    835.00       .00       .00       .00       .00       .00    715.58
   2  50.00        -1.    855.00    166.50     59.17    100.00     25.00    350.67    689.59
   3   1.00        -1.    880.00   1667.00    591.65   1200.00    175.00   3633.65     36.34

EXP ANNUAL DAMAGE,   YEAR 1994    332.48    118.06    224.54     40.51    715.58

++DAMAGE DATA FOR PLAN 1 AND YEAR 2004 -- BASE CONDITION

       FREQ       FLOW     STAGE  RESIDNTL  RES-CONT  COMM      PUBLIC       TOTAL   ACC EAD
   1  90.00        -1.    835.00       .00       .00       .00       .00       .00    741.41
   2  50.00        -1.    855.00    166.50     72.11    100.00     25.00    363.61    714.47
   3   1.00        -1.    880.00   1667.00    721.13   1200.00    175.00   3763.13     37.63

EXP ANNUAL DAMAGE,   YEAR 2004    332.48    143.89    224.54     40.51    741.41
```

```
++DAMAGE DATA FOR PLAN 1 AND YEAR 2014 -- BASE CONDITION

      FREQ       FLOW      STAGE  RESIDNTL  RES-CONT  COMM       PUBLIC      TOTAL   ACC EAD
  1  90.00        -1.     835.00       .00       .00       .00       .00       .00    781.72
  2  50.00        -1.     855.00    166.50     92.31    100.00     25.00    383.81    753.27
  3   1.00        -1.     880.00   1667.00    923.11   1200.00    175.00   3965.11     39.65

EXP ANNUAL DAMAGE,   YEAR 2014     332.48    184.19    224.54     40.51    781.72

++DAMAGE DATA FOR PLAN 1 AND YEAR 2024 -- BASE CONDITION

      FREQ       FLOW      STAGE  RESIDNTL  RES-CONT  COMM       PUBLIC      TOTAL   ACC EAD
  1  90.00        -1.     835.00       .00       .00       .00       .00       .00    797.06
  2  50.00        -1.     855.00    166.50    100.00    100.00     25.00    391.50    768.05
  3   1.00        -1.     880.00   1667.00   1000.00   1200.00    175.00   4042.00     40.42

EXP ANNUAL DAMAGE,   YEAR 2024     332.48    199.53    224.54     40.51    797.06

++DAMAGE DATA FOR PLAN 1 AND YEAR 2034 -- BASE CONDITION

      FREQ       FLOW      STAGE  RESIDNTL  RES-CONT  COMM       PUBLIC      TOTAL   ACC EAD
  1  90.00        -1.     835.00       .00       .00       .00       .00       .00    797.06
  2  50.00        -1.     855.00    166.50    100.00    100.00     25.00    391.50    768.05
  3   1.00        -1.     880.00   1667.00   1000.00   1200.00    175.00   4042.00     40.42

EXP ANNUAL DAMAGE,   YEAR 2034     332.48    199.53    224.54     40.51    797.06

++DAMAGE DATA FOR PLAN 1 AND YEAR 1984 -- BASE CONDITION

      FREQ       FLOW      STAGE  RESIDNTL  RES-CONT  COMM       PUBLIC      TOTAL   ACC EAD
  1  90.00        -1.     835.00       .00       .00       .00       .00       .00    700.00
  2  50.00        -1.     855.00    166.50     51.36    100.00     25.00    342.86    674.59
  3   1.00        -1.     880.00   1667.00    513.59   1200.00    175.00   3555.59     35.56

EXP ANNUAL DAMAGE,   YEAR 1984     332.48    102.48    224.54     40.51    700.00

++DAMAGE DATA FOR PLAN 1 AND YEAR 1990 -- BASE CONDITION

      FREQ       FLOW      STAGE  RESIDNTL  RES-CONT  COMM       PUBLIC      TOTAL   ACC EAD
  1  90.00        -1.     835.00       .00       .00       .00       .00       .00    708.75
  2  50.00        -1.     855.00    166.50     55.74    100.00     25.00    347.24    683.02
  3   1.00        -1.     880.00   1667.00    557.45   1200.00    175.00   3599.45     35.99

EXP ANNUAL DAMAGE,   YEAR 1990     332.48    111.23    224.54     40.51    708.75
```

++DAMAGE DATA FOR PLAN 1 AND YEAR 2000 -- BASE CONDITION

	FREQ	FLOW	STAGE	RESIDNTL	RES-CONT	COMM	PUBLIC	TOTAL	ACC EAD
1	90.00	-1.	835.00	.00	.00	.00	.00	.00	727.88
2	50.00	-1.	855.00	166.50	65.33	100.00	25.00	356.83	701.44
3	1.00	-1.	880.00	1667.00	653.31	1200.00	175.00	3695.31	36.95
EXP ANNUAL DAMAGE,			YEAR 2000	332.48	130.36	224.54	40.51	727.88	

++DAMAGE DATA FOR PLAN 1 AND YEAR 2015 -- BASE CONDITION

	FREQ	FLOW	STAGE	RESIDNTL	RES-CONT	COMM	PUBLIC	TOTAL	ACC EAD
1	90.00	-1.	835.00	.00	.00	.00	.00	.00	786.69
2	50.00	-1.	855.00	166.50	94.80	100.00	25.00	386.30	758.06
3	1.00	-1.	880.00	1667.00	948.04	1200.00	175.00	3990.04	39.90
EXP ANNUAL DAMAGE,			YEAR 2015	332.48	189.17	224.54	40.51	786.69	

* *
* *

TEST NO. 4 -- AFFLUENCE CALCULATION FOR RESIDENTIAL CONTENTS
FIVE RATES OF GROWTH IN AFFLUENCE (1984, 1990, 2000, 2015, 2034)
ECONOMIC BASE YEAR IS 1983

** EXPECTED ANNUAL FLOOD DAMAGE **

** FOR REACH 1 = REACH 1

** WITH PLAN 1 = BASE CONDITION

** INPUT DATA YEARS = 1983 1984 1985 1990 2000 2015 2034

** PERIOD OF ANALYSIS = 50 YEARS

** DISCOUNT RATE = 5.0000 PERCENT

DAMAGE CATEGORIES	STUDY YEAR 1983	BASE YEAR 1985	.... DECADE YEARS 10 1994	20 2004	30 2014	40 2024	50 2034	END OF PERIOD 2034	EQUIVALENT ANNUAL DAMAGE
1RESIDNTL	332.48	332.48	332.48	332.48	332.48	332.48	332.48	332.48	332.47
2RES-CONT	101.11	103.86	118.06	143.89	184.19	199.53	199.53	199.53	137.50
3COMM	224.54	224.54	224.54	224.54	224.54	224.54	224.54	224.54	224.54
4PUBLIC	40.51	40.51	40.51	40.51	40.51	40.51	40.51	40.51	40.51
TOTAL	698.64	701.39	715.58	741.41	781.72	797.06	797.06	797.06	735.02

* *
* *

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
     TEST NO. 4 -- AFFLUENCE CALCULATION FOR RESIDENTIAL CONTENTS
     FIVE RATES OF GROWTH IN AFFLUENCE (1984, 1990, 2000, 2015, 2034)
     ECONOMIC BASE YEAR IS 1983


** SUMMARY OF REACH NAMES  **

 NO    ID    . . NAME . . .
--------------------------------------------------------------------------------
  1  RCH1      REACH 1

--------------------------------------------------------------------------------
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
     TEST NO. 4 -- AFFLUENCE CALCULATION FOR RESIDENTIAL CONTENTS
     FIVE RATES OF GROWTH IN AFFLUENCE (1984, 1990, 2000, 2015, 2034)
     ECONOMIC BASE YEAR IS 1983

** GRAND SUMMARY BY CATEGORY **

** INPUT DATA YEARS   =  1983  1984  1985  1990  2000  2015  2034

PERIOD OF ANALYSIS =   50 YEARS

** DISCOUNT RATE      =  5.0000 PERCENT

** FLOOD PLAIN MANAGEMENT PLANS
         1 - BASE CONDITION

GRAND SUMMARY - ALL DAMAGE CATEGORIES
---------------------
            EQUIVALENT ANNUAL DAMAGE
  DAMAGE      BASE
 CATEGORY   CONDITION
            (PLAN  1)
---------------------
  RESIDNTL    332.47
  RES-CONT    137.50
  COMM        224.54
  PUBLIC       40.51
---------------------

     TOTAL    735.02

---------------------
READIN --  NO RECORDS READ FROM USER INPUT
```

EXHIBIT 4

Exhibit 5

Use of HECDSS With the EAD Program

Exhibit 5

Use of HECDSS With the EAD Program

Overview of HECDSS

The DSS is a direct (or random) access file which enables the automatic interface of analysis programs via exchange of information (input-output) through use of a computer storage device (magnetic disk). The output storage and retrieval of data utilizes a unique classification scheme, termed "pathname", of each data set. Application of DSS is designed to minimize the effort of the user in transferring data from one analysis stage (e.g., hydrology) to damage computations. It also provides for some utility/file management of the basic evaluation data.

Figure 25 shows the concept of using the DSS in performing flood damage assessments. Analyses for flood runoff (HEC-1), yielding frequency curves, rating functions (HEC-2), and elevation-damage functions (SID) are specified for automatic output to the DSS. These data are subsequently automatically accessed by the EAD program to perform evaluations of expected annual damage and benefits. The entire process may be performed in stages by the various disciplines (normal situation for project studies), or performed as linked programs for a single program execution.

The DSS system makes use of a "pathname" to establish the hierarchy of the random access file. The pathname consists of a unique hierarchical labeling scheme for each data set. Information stored in the DSS by an analysis program using a specific pathname may be accessed by a different program using the same pathname. Figure 26 depicts this concept for elevation-damage data. In this schematic, six levels of the pathname are required to uniquely define the elevation-damage functions for each damage reach. They are:

- Project name (James River), pathname part A.
- Location name (Damage Reach 10) pathname part B.
- Parameters (elevation-damage function) pathname part C.
- BLANK (field omitted) pathname part D.
- Data Year pathname part E.
- Alternative name (Floodproof Plan B) pathname part F.

For this example, the pathname may be written as:

/Project name/location/variable//year/alternative name/

/JAMES RIVER/DR10/ELEVATION-DAMAGE//1985/FLOODP ROOF PLAN/

The HECDSS enables the pathname to include up to six levels of identifiers. The EAD, DAMCAL, SID, HEC-1, and HEC-2 uses only the 5 levels shown between the slash marks.

Different locations and/or assessments of other alternative plans would subsequently have different pathnames. Retrieval of the elevation-damage functions for input into EAD from the DSS would require the use of the exact same pathnames as that of the data sets desired. Other data sets stored in DSS have variations to the pathname so each set is uniquely labeled and retrievable. To the extent possible, interface of the analysis programs with DSS (using the pathname concepts) have been made transparent to the user. Prior to the initiation of production executions of the programs, the user must know the elements of the pathname for the data stored in the DSS. Therefore, this requires an initial understanding of the procedures and an agreement on cataloging of alternative plan names, station names, etc., by the study participants prior to the initiation of production oriented evaluations. While this might seem somewhat burdensome at first, it is a good study management practice for any type of evaluation.

Figure 25: Damage Analysis With HECDSS

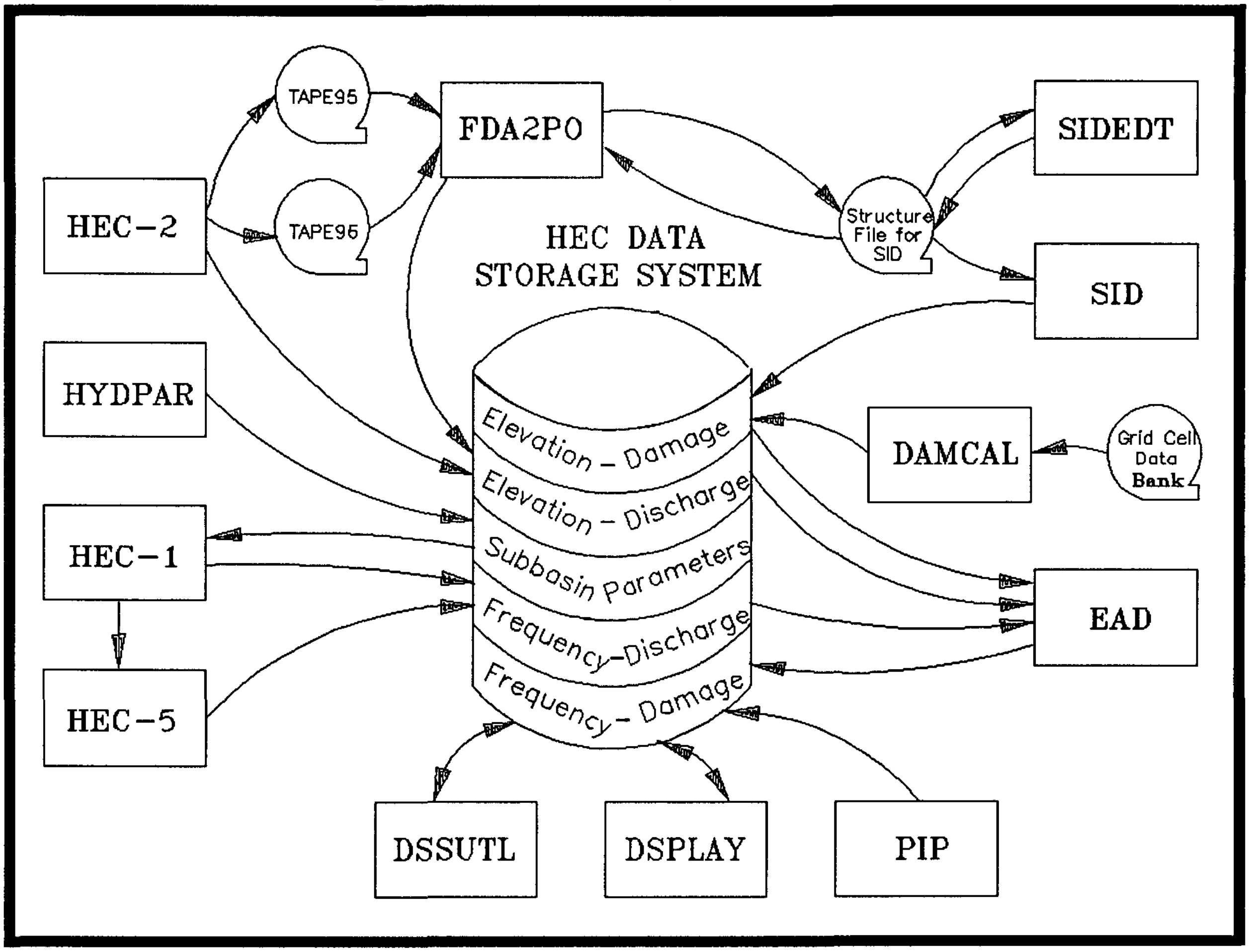
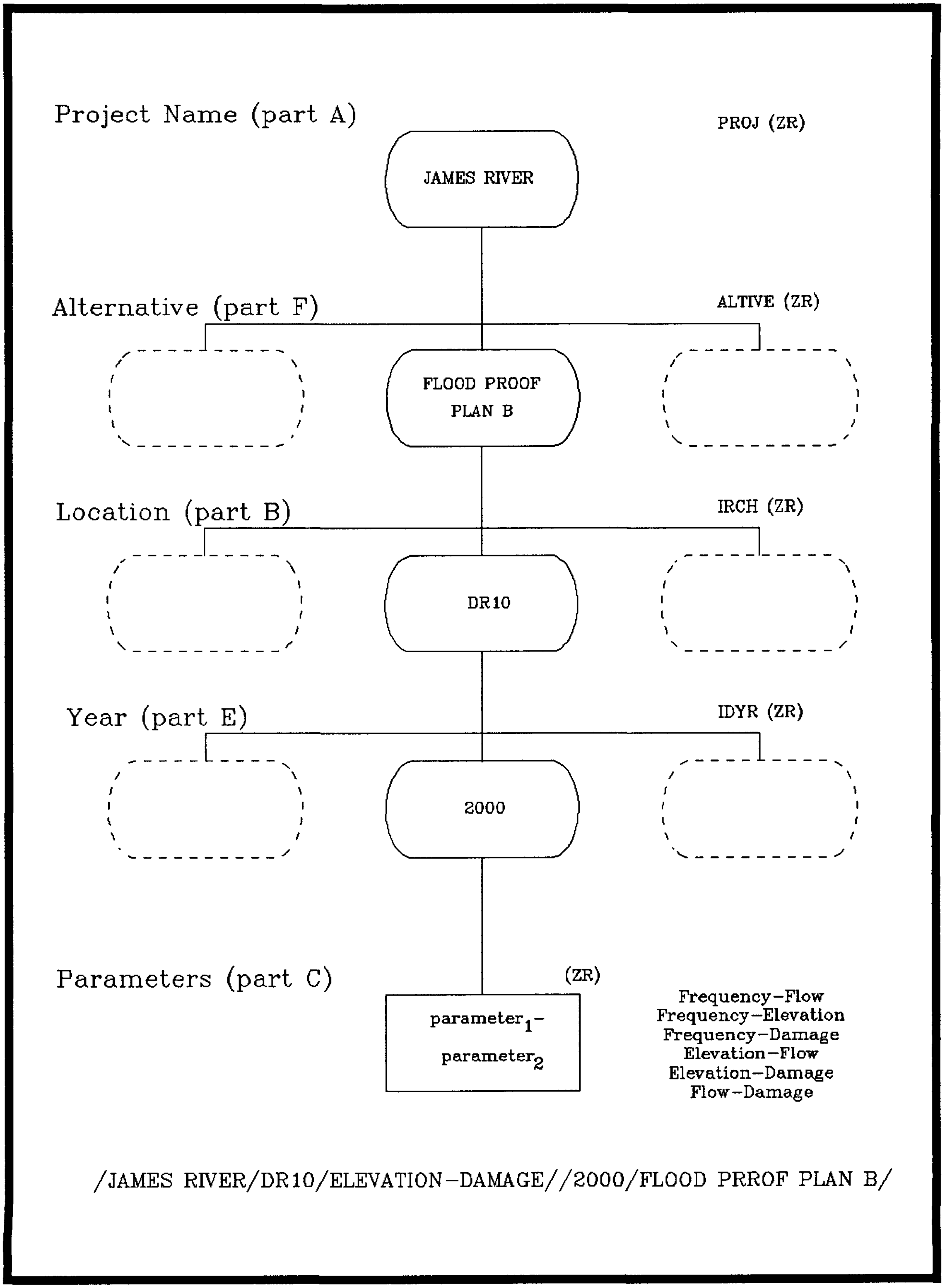


Figure 26: Pathname Structure for Damage Computation Data



The following paragraphs outline user considerations relevant to using the DSS.

- The station names, pathname location component, (control points, damage reaches, subbasins, etc.) should have been chosen carefully, and if possible, be recognizable locations. The location names used by the programs may be any combination of alphanumeric values except for slashes which are reserved for program usage. The names must be exact for storing and retrieval of the same data set. Leading and trailing blanks are ignored but blanks within the name are considered part of that name.

- Flexibility has been incorporated into the programs to enable the location name of the data set to be modified and stored in the DSS as a different location name.

- On some computer systems, (where multiple access is allowed) to avoid two programs updating the same DSS file simultaneously and potentially having an unrevised data set, any execution of a program using the DSS should include job control language to lock out others until the execution is completed.

- When a program executes and writes data to the DSS with the exact pathname as a previous execution, the existing data is overwritten.

The DSS has utility programs available for manipulating information and pathnames stored (HECDSS-DSSUTL). The programs enable editing of information, changing pathnames, purging unwanted data sets and insertion of other data sets. Graphic output is also available for DSS data (HECDSS-DSPLAY). The interested user is encouraged to contact HEC for up-to-date information and documentation on the DSS and companion utility programs. It should be emphasized, however, that users wishing to use the DSS with EAD (or HEC-1, HEC-2 or SID) need not be familiar and proficient with all the intricacies of the general purpose system. Study of the examples in SID, herein and minimal DSS familiarity should suffice for the average user. Other related documentation includes a microcomputer installation guide and a Training Document on the FDA Package.

Retrieving Matrices From HECDSS File

The EAD Program can read input data from two sources:

- An ASCII (or "human readable") data file.

- A special unformatted (binary) direct access data file called an HECDSS data file.

The EAD Program can read some input records only from the ASCII data file. This includes such records as the job, damage category, plan number, and end-of-job records (TT, J1, J2, CN, PN, RN, EJ, etc.). However, the matrix data can be read either from the ASCII data file or from the special direct access data file. This includes such matrices as the stage-damage, stage-flow, and flow-frequency. The general purpose random access file, termed HEC Data Storage System (HECDSS), provides for an automatic linkage of:

- Elevation-damage matrices (from Structure Inventory for Damage Analysis - SID and Damage Reach Stage-Damage Calculation - DAMCAL).

- Elevation-flow matrices (from Water Surface Profiles - HEC-2)

- Flow-frequency matrices (from Flood Hydrograph Package - HEC-1) to the EAD program for damage analysis.

The use of the HECDSS file as a source of input matrices to EAD requires the use of ZR records (which specify the pathname parts) and the addition of the DZ record to aggregate categories, (when more than 18 damage categories are stored in its DSS file). Pathname parts are entered in the HEC standard free-format style; each pathname part is preceded by the part identifier (A, B, C, D, E, or F) and an equal sign. Pathname parts that remain the same need not be repeated. Part C of the pathname may be defined in one of two ways by entering:

- The actual pathname part.

- A special code recognized by the EAD program. This code is keyed to the record I.D. which is used in directly entering the matrix (e.g. "QF" for frequency-flow matrices).

An example user entry to retrieve a frequency-flow matrix may look like one of the following:

ZR A=SILVER CREEK B=RCH 1 C=QF F=BASELINE

ZR A=SILVER CREEK B=RCH 1 C=FREQ-FLOW F=BASE

Table 10 lists and the Section entitled "EAD Input Description" lists and describes each of these special codes. The desired matrix is stored in the EAD program's buffer (memory) right at the time the ZR record is encountered. Effectively, the ZR record replaces the actual matrix which would otherwise be entered at that location. For the example above, the frequency-flow matrix is entered on FR and QF records. The same matrix is retrieved from the HECDSS data file by replacing the FR and QF records by a ZR record like the ones above. Table 11 displays a simple schematic of an EAD input data file which uses ZR records to retrieve the three basic matrices: frequency-flow, elevation-flow, and elevation-damage.

Table 10: Part C Codes For ZR Record

Code	Matrix
QS	Elevation-Flow
QF	Frequency-Flow
SF	Frequency-Elevation
SD (or DG)	Elevation-Damage
QD	Flow-Damage
DF	Frequency-Damage

Some records (QF, QS, and DG) contain other information such as the year, plan, and damage category index number. When retrieving from the HECDSS data file, these parameters are defined from other locations as follows:

- **Year** is defined by pathname part E on the ZR record.

- **Plan** is defined by the first field of the EP, ES, ER, or EJ records.

- **Damage Category** index number is defined by matching the 8 character category name stored in the "header" of the damage matrix record of the HECDSS data file with the category names entered on the CN record(s) of the EAD input data file.

Table 11: Schematic ZR Record Input

```
TT   SCHEMATIC OF ZR RECORD USE
J1   ...
CN      2  RESNTL COMERCL
PN      1  BASE CONDITION
RN  REACH 1
FR RCH 1       5     90.     50.     20.     10.      1.
ZR A=SILVER CREEK B=RCH 1 C=QF F=BASELINE
ZR A=SILVER CREEK B=RCH 1 C=QS F=BASELINE
ZR A=SILVER CREEK B=RCH 1 C=SD F=BASELINE
EJ      1
```

If the programs HEC-1, HEC-2, and SID are not used, these matrices may be entered directly to the HECDSS data file by conventional means using DSS utility programs such as PIP and DSSPD. In the simplest form of EAD input, a frequency-damage matrix is entered. In this case, the EAD program needs only to integrate the matrix to calculate expected annual damage. Even in this case, the user is encouraged to enter the matrix into the HECDSS data file using the PIP program, and then retrieve it using ZR records in the EAD input file for several reasons including:

- The user may plot the matrix using the HECDSS utility program HECDSS-DSPLAY.
- The user may compute (by interpolation) damage at frequencies other than those used to define the matrix.
- The input matrix may be compared graphically with the computed matrix which is used for the integration.

The HECDSS means of transferring / managing data is particularly applicable for flood damage analysis involving large numbers of structures, damage categories, damage reaches and alternative plans. PLEASE NOTE: The DSS system capability is presently operational on only Corps supported computer systems and MS-DOS Compaq compatible microcomputers.

Storing Matrices In the HECDSS File

Computed results are written to a HECDSS data file by entering "ZW" records with a coded pathname part C. Parts B and E are automatically determined by the program and should not be entered by the user. In some cases, the EAD program also determines part F. The matrices written to the HECDSS data file are somewhat paired data convention, but not entirely. For example, the frequency-damage matrix contains not only damage data but also frequency-elevation and frequency-flow data. The category-expected annual damage function contains damage category names that are character in nature. The current standard data conventions of the HECDSS system do not automatically facilitate display of these types of data. Thus, the use of DSSUTL and DSPLAY to tabulate or plot the matrices is awkward and confusing but they can be utilized. Currently, EAD can store four different types of tabular output in a HECDSS data file. Those matrices and their associated pathname part C codes are shown in Table 12.

Table 12: Matrices Stored In HECDSS File

Part C Code	Matrix Description

FREQ-DAMAGE	Frequency-Damage including:
	• Frequency-Flow
	  • Frequency-stage
	  • Frequency-damage for each category
	  • Total Frequency-damage for all categories
	  • Accumulated expected annual damage.
	
	This output coincides exactly with the frequency-damage table the EAD writes to the output file for each plan and each reach.

REACH-EAD	The expected annual damage for each plan by reach.
CATEGORY-EAD	The expected annual damage for each plan by category.
PLAN-EAD	The expected annual damage for each plan.

Each output matrix is conceptually shown in the following pages.

Type of Matrices

There are basically two types of data that may be stored in a HECDSS data file:

- Expected annual damage versus either reach or category or plan.

- Damage versus exceedance frequency.

The content of each of these functions are described below. The example pathname strings contain upper and lower case characters. The lower case letters are pathname parts that either the EAD program determines or that the user defines. The parts in upper case letters are fixed for a particular type of function. When the discussion includes the terminology "curve", it refers to the concept of curve as used in the HECDSS - DSPLAY and DSSUTL programs and the paired function convention data.

Expected Annual Damage or Equivalent Annual Damage

Expected annual damage appears in the output of three matrices for each reach, damage category, and plan as indicated by their associated pathname part C as follows:

- REACH-EAD
- CATEGORY-EAD
- PLAN-EAD

The following sections describe these three matrices in detail.

REACH-EAD

For each damage category, one HECDSS record is written for each damage category and each discount rate and one record is written containing the total damage in all categories for each plan, reach, and discount rate.

Number of curves	NPLAN+1
Number of vectors	NPLAN+2
Number of ordinates (rows)	NREACH+1

Each vector contains the following information:

Vector	Curve	Description
1	na	First four characters of reach name.
2	1	Last two characters of reach name.
3	2	Plan 1 (or base condition) expected annual damage.
3 thru NPLAN+2	2 thru NPLAN+1	Expected annual damage for each plan.

Each ordinate is the expected annual damage associated with one reach. The ordinate "NREACH+1" is the total expected annual damage for a given plan. The user should define pathname parts A and C on the ZW record and may define part F. An example user entry is:

ZW A=SILVER CREEK C=REACH-EAD

For each execution of the EAD program, one record is written to the HECDSS data file for each damage category and each discount rate. The format of these records is shown in Table 13.

Table 13: Schematic of REACH-EAD Matrix

```
Each Category  /basin/category/REACH-EAD//discount rate/qualifier/
Example:       /SILVER CREEK/RESIDNTL/REACH-EAD/6.375%///

               Reach     Base    Plan 2  Plan 3  Plan 4

               DR 1      ......  ......  ......  ......
               DR 2      ......  ......  ......  ......
               ...
               RESIDNTL  ......  ......  ......  ......    (total EAD for each plan for RESIDNTL)

Each Job       /basin/ALL CATEGORIES/REACH-EAD//discount rate/qualifier/
Example:       /SILVER CREEK/ALL CATEGORIES/REACH-EAD//6.375%//

          Reach     Base    Plan 2  Plan 3  Plan 4

          DR 1      ......  ......  ......  ......
          DR 2      ......  ......  ......  ......
          ...
          TOTAL     ......  ......  ......  ......    (total EAD for each plan for all categories)
```

CATEGORY-EAD

For each EAD job, one record is written which contains the expected annual damage for each plan versus damage category. Each record contains the following:

Number of curves	NPLAN+1
Number of vectors	NPLAN+2
Number of ordinates (rows)	NCAT+1

Each vector contains the following information:

Vector	Curve	Description
1	na	First four characters of damage category name.
2	1	Last four characters of damage category name.
3	2	Plan 1 (or base condition) expected annual damage.
3 thru NPLAN+2	2 thru NPLAN+1	Expected annual damage for each plan.

Each ordinate is the expected annual damage associated with one damage category. The ordinate "NCAT+1" is the total expected annual damage for a given plan. The user should define pathname parts A and C on the ZW record and may define part F. An example user entry is:

```
ZW A=SILVER CREEK C=CATEGORY-EAD F=PLANS 1,32-45
```

The CATEGORY-EAD function is stored in a modified paired function convention format. Each vector (curve) is the expected annual damage for a given plan. Each ordinate (row) is the expected annual damage for a given damage category and the last ordinate of each curve is the total damage for a given category. Table 14 illustrates the format of these records.

Table 14: Schematic of CATEGORY-EAD Matrix

Each Job /basin/ALL REACHES/CATEGORY-EAD//discount rate/qualifier/

Example: /SILVER CREEK/ALL REACHES/CATEGORY-EAD//6.375%/PLANS 1,32-45/

category	Base	Plan 32	Plan 33	Plan 34	....
RESIDNTL	......	......	......	......	......
COMMERCL	......	......	......	......	......
......	......	......	......	......	......
TOTAL	......	......	......	......	......

PLAN-EAD

For each EAD job, one record is written which contains the expected annual damage for each plan. The PLAN-EAD matrix is stored in true paired data convention format. This record contains the following:

Number of curves	1
Number of vectors	2
Number of ordinates (rows)	NPLAN

Each vector contains the following information:

Vector	Curve	Description
1	na	Plan number as entered in the first field of the PN record.
2	1	For each plan, the total expected annual damage for all reaches and damage categories.

The user should define pathname part A on the ZW record and may define parts B and F. An example user entry is:

ZW A=SILVER CREEK C=PLAN-EAD

Table 15 illustrates the format of these records.

Table 15: Schematic of PLAN-EAD Matrix

```
Each Job     /basin/location/PLAN-EAD//discount rate/qualifier/
Example:     /SILVER CREEK//PLAN-EAD//6.375%//

             Plan     EAD

              1       ......
              2       ......
              3       ......
              4       ......
              5       ......
              6       ......
```

Damage-Frequency Matrix

The Damage-Frequency Matrix appears in the output of one matrix for each reach, damage category, and plan as indicated by their associated pathname part C: FREQ-DAMAGE. The following section describes this matrix in detail.

FREQUENCY-DAMAGE

The EAD program writes one record to the HECDSS data file for each damage reach, each plan, and each data year. Each record contains not only frequency-damage but frequency-flow and frequency-stage as well. Specifically, each record contains the following:

Number of curves	NCAT+4
Number of vectors	NCAT+5
Number of ordinates (rows)	NFRQ

Each vector contains the following information:

Vector	Curve	Description
1	na	Exceedance frequency values entered on the FR records.
2	1	Flow corresponding to frequency.
3	2	Elevation (stage) corresponding to frequency.
4 thru NCAT+3	3 thru NCAT+2	Damage corresponding to frequency for each damage category.
NCAT+4	NCAT+3	Total damage for all categories corresponding to frequency.
NCAT+5	NCAT+4	Accumulated expected annual damage corresponding to frequency.

The user should define pathname parts A and C and may define additions to part F. The EAD program defines part F using the plan number in the format "PLAN i" where "i" is the plan number (1-99) entered in the first field of the PN record. An example user entry is:

ZW A=SILVER CREEK C=FREQ-DAMAGE

There are two options for storing this data:

- The user may store only the computed data points which correspond to the frequencies entered on the FR records.
- The user may store all of the computed data points which are used in the computation of expected annual damage. These include the nine frequency points which are inserted by the EAD program between each of the user specified exceedance frequencies.

Table 16 illustrates the format of these records.

Table 16: Schematic of FREQUENCY-DAMAGE Matrix

Each reach, plan, and year:
/basin/reach/FREQ-DAMAGE//year/plan-qualifier/

Example:
/SILVER CREEK/DR 1/FREQ-DAMAGE//1985/PLAN 32-PLANS 1,32-45/

frequency	flow	stage	cat. $_1$	cat. $_2$	cat. $_i$	cat. $_n$	total	acc ead
......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......
......	......	......	......	......	......	......	......	......

Exhibit 6

EAD Input Description

Exhibit 6

EAD Input Description

Record Summary

Record	Description	Page
	Input Description	150
TT (required)	Title Records (character job information)	151
J1 (optional)	Period of analyses, base year, and study year	152
J2 (optional)	Discount rates and price level	153
CN (required)	Damage category names	154
CI (optional)	Damage category price level index	155
PN (required)	Plan names	156
ZW (optional)	HECDSS write record for storing computed results	157
DY (optional)	Data years associated with input data	158
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RV (optional)	Revision of data by functional modification	163
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QS (optional)	Flow corresponding to stage values	168
SD (optional)	Stage coordinate values (for damage)	169
QD (optional)	Flow coordinate values (for damage)	169
DG (required)	Damage values corresponding to stage or flow	170
RC (optional)	Affluence rates for content categories	171
DZ (optional)	Damage category aggregation (for use with DSS)	173
ZR (optional)	HECDSS read record for retrieving stored data	174
EP, ES, ER, EJ (required)	End of data for plan, reach or job	175

Input Description

This exhibit contains a detailed description of the data input requirements for each variable on each input record. A summary of the input records is shown in Exhibit 7. Many of the records described can be omitted if the options to which they apply are not required.

The location of the variables on each input record is shown by field number. The records are normally divided into ten fields of eight columns each except for field 1. Variables in field 1 may only occupy record columns 3-8 since columns 1-2, field 0, are reserved for the required record identification characters. Some variables are used to indicate a particular program option and the variables are integer values which must be right justified (entered on the far right side of the field) without a decimal point. Other variables are assigned numbers to express the magnitude of that variable. A "+" sign is shown under "value" and the numerical value is entered as input. Where the value of the variable is to be zero, the variable may be left blank, since the blank field is read as zero and any number without a sign is considered positive.

Unless noted otherwise, variable names beginning with the letters I, J, K, L, M or N represent integer variables and a decimal point must not appear in the field. All others are floating point variables and may either have a decimal point or be right justified.

The location of variables on records is often referred to by an abbreviated designation, for example, J1.5 means the fifth field of the J1 record.

Several jobs may be processed at the same time by stacking the respective data sets.

The first output from a job execution is an echo listing of the input data (records). The listing may be suppressed by inserting a "*NOLIST" (or "*N") record beginning in column 1. Listing of the input may be reactivated at any time with a "*LIST" (or "*L") record. Comment records that are only listed in this echo print may be inserted at any location in the input data deck as a "* comment" record. The asterisk (*) is in column 1, a blank in column 2 and comments in columns 3 through 80.

Title Records

TT Record - Title Record

Field	Variable	Value	Description
0	ICD	TT	Record Identification.
1-10	---	Alpha	Alphanumeric information to identify the job. As many TT records as desired may be used for descriptive information. The TT records will be printed at the top of first output page. The first three title records are saved and printed at the beginning of each summary table. TT records may be entered at any location in the EAD input data stream.

Job Records

The default values under each variable name on an optional record will be used if the record is not provided. However, if the record is supplied, the parameters will **not** be set to the default value. A field left blank is treated the same as entering a value of zero.

J1 Record - First Job Record (Optional Record)

This record and the J2 record are required if period analysis computations are desired. The record is not required if damage is computed for a single event or if expected annual damage is to be computed without discounting.

Field	Variable	Value	Description
0	ICD	J1	Record Identification.
1	IPOA (0)	+	The length of the period of analysis in years. This variable activates economic analysis routines which compute equivalent annual damage by applying the specified discount rates (J2 record).
2	ISTDYR (0)	+	The study year, i.e., the year that represents existing conditions.
3	IBASYR (0)	+	The base year, i.e., the first year in which the plan is expected to become operational.
4	IDOLYR (0)	+	The month and year of the dollars upon which the damage data on the DG records were estimated. The order number of the month (if desired) is entered in columns 26-27 and the year in columns 29-32. Used for documenting output. NDOLYR (J1.6), if specified, will control output value.
5	NHIS (0)	+	The number of input data years (DY record) that represents historic hydrologic, hydraulic and/or economic conditions. The results of these years are output with the period of analysis results, but do not affect the computation of equivalent annual damage. Dimensioned for three.
6	NDOLYR (0)	+	Month and year of the damage data after the values on the DG records have been multiplied by the price level index CPLI (J2.4) or CI record). The order number of the month (if desired) is entered in columns 42-43 and the year in columns 45-48. Used for documenting output.

J2 Record - Second Job Record (Optional Record)

Provide this record if a period of analysis is indicated (IPOA [J1.1]).

Field	Variable	Value	Description
0	ICD	J2	Record identification.
1	RATE(1)	+	The discount rate to be used for present worth and amortization computations. Express as a percentage.
2	RATE(2) (0.0)		A trial discount rate, e.g., the current Federal discount rate, to evaluate the effect on inundation reduction benefits. Express as a percentage. The results are only presented in the summary.
		0	No trial discount rate analysis desired.
		+	A trial discount rate, expressed as a percentage.
3	RATE(3)		A second trial discount rate. If desired, see above for description.
4	CPLI (1.0)	+	Price Level Index to be applied to all damage categories. All damage data on DG records will be multiplied by this factor. NDOLYR (J1.6) must be provided. If the price level index varies by damage category, a CI record must be used.

CN Record - Damage Category Names (Required Record)

The CN record(s) are required. They contain the damage category names. When transferring elevation-damage matrices from the SID program to the EAD program, the category names are **extremely important!** The names entered on the DC records in the SID input must agree exactly with the names entered on the CN records in the EAD input. If a match cannot be found, the EAD program prints an error message and continues processing.

Field	Variable	Value	Description
0	ICD	CN	Record identification.
1	NCAT	+	The number of different damage categories (or types), e.g., urban, rural, utilities, etc. Dimensioned for 18.
2	NMCAT	Alpha	Alphanumeric identification for first damage category. Damage data (DG record) must be identified by the order entered here.
3-10	NMCAT	Alpha	Repeat as required by NCAT (CN.1). If a second record is required, begin the tenth name in field 2.

CI Record - Damage Category Price Level Index (Optional Record)

This record may be used to apply different price level index values for each damage category. The indexes are entered in the same fields corresponding to the category names on the CN record. The date of this index must be provided (NDOLYR, J1.6).

Field	Variable	Value	Description
0	ICD	CI	Record identification.
1	---	--	Not used.
2	CPLI (1.0)	+	Price level index for damage category 1.
3-10	CPLI (1.0)	+	Repeat as required by NCAT (CN.1). If a second record is required, begin the index for the tenth damage category in field 2 of the second record.

PN Record - Flood Plain Management Plan Names (Required Record)

One PN record is required for each plan,
maximum of 13 plans.

Field	Variable	Value	Description
0	ICD	PN	Record identification.
1	IPLNN	+	The assigned number of the flood plain management plan name which follows on record. The number need not be consecutive but may not exceed 99.
2-10	NMPLN	Alpha	Alphanumeric title for flood plain management plan (columns 9-80).

ZW Record - Write Results To a HECDSS Data File (Optional Record)

Computed results are written to a HECDSS data file by entering "ZW" records with a coded pathname part C. The user must enter the pathname parts in a free-format fashion; each part is preceded by the part I.D. (A through F) and an equal sign. Parts B and E are automatically determined by the program and should not be entered by the user. In some cases, the EAD program also determines part F. The functions written to the HECDSS data file are somewhat paired data convention, but not entirely. For example, the frequency-damage function contains not only damage data but also frequency-elevation and frequency-flow data.

The category-expected annual damage function contains damage category names that are character in nature. The current standard data conventions of the HECDSS system do not automatically facilitate display of these types of data. Thus, the use of DSSUTL and DSPLAY to tabulate or plot the functions is awkward and confusing but it can be accomplished. See Exhibit 5 for a more complete description of the ZW record. Currently, EAD can store four different types of tabular output in a HECDSS data file. Those functions and their associated pathname part C codes are:

Code	Function
FREQ-DAMAGE	Frequency-damage including frequency-flow, frequency-stage, frequency-damage for each category, frequency-damage for all categories, and accumulated expected annual damage. This output coincides exactly with the frequency-damage table the EAD writes to the output file for each plan and each reach. The user must define parts A and C, and may define additional information for part F. The EAD program assigns the name "PLAN i" to pathname part F, where "i" is the plan number entered on the PN record; It assigns the reach I.D. to part B; It assigns the year to part E.
REACH-EAD	The expected annual damage for each plan by reach. The user must define parts A and C, and may define part F. The EAD program assigns the damage category name to part B; It assigns the discount rate to part E. For each job, it stores one record with the name "ALL CATEGORIES" assigned to part B --- this record contains the damage for all categories in a reach versus EAD matrix.
CATEGORY-EAD	The expected annual damage for each plan by category for all reaches. The user must define parts A and C, and may define part F. The EAD program assigns the discount rate to part E; It assigns the name "ALL REACHES" to part B to indicate that the matrix represents damage in all reaches.
PLAN-EAD	The expected annual damage for each plan. The user must define parts A and C, and may define part F. The EAD program assigns the discount rate to part E.

An example entry which instructs the EAD program to store the frequency-damage matrices in a HECDSS data file is:

ZW A=SILVER CREEK C=FREQ-DAMAGE

DY Record - Input Data Years (Optional Record)

This record is not necessary if all of the input data are referenced to one common year. It is required for all period of analysis calculations.

Field	Variable	Value	Description
0	ICD	DY	Record identification.
1	NDYRS (0)	+	Number of input data years for which various hydrologic, hydraulic and/or damage information will be specified. Dimensioned for 9.
2	IDYRS	+	The year associated with a particular data set. The first NHIS (J1.5) values must be the years corresponding to historic information. The others may represent changes in the hydrologic, hydraulic and/or damage conditions.
3-10	IDYRS	+	Repeat as required by NDYRS (DY.1).

PP Record - Printout and Punch Options (Optional Record)

This record may be inserted at any time along with reach input data to activate or deactivate desired printout and/or punch options. The specified options remain in effect until another PP record is encountered.

Field	Variable	Value	Description
0	ICD	PP	Record identification.
1	---	--	Reserved for future use.
2	---	--	Reserved for future use.
3	JDGPR (0)	+	The sum of the following printout suppression options that are desired for expected annual damage routines. For example, a value of 15 will suppress all output for each reach and only the final job summary will be output. Some of the test data in Exhibit 4 illustrates the use of this option.
		0	No output will be suppressed.
		1	Suppress printout of input data for each damage reach.
		2	Suppress printout of computed damage for each flow or stage (usually associated with an exceedance frequency).
		4	Suppress printout of expected annual damage (EAD) as computed. Results of EAD will only appear in the summary tabulation.
		8	Suppress printout of expected annual damage by decades and equivalent annual flood damage for each plan of each reach.
		16	Suppress summary by reach for each category.
		32	Suppress grand summary by reach for total damage.
		64	Suppress all summary output.

PP Record - Printout and Punch Options (Optional Record), (Continued)

Field	Variable	Value	Description
4	JDGPU (0)		Option to write selected output to logical file (LFN) 7. On some computer systems, file 7 defaults to the record punch. On others, it must be so assigned.
		0	No output written to LFN 7.
		1	Output written in HEC-5 record image format to LFN 7. Output consists of: • RN record to identify output. • HEC-5 DA record containing expected annual damage values for base condition. Only first 9 damage categories are output. • HEC-5 DF record containing exceedance probabilities in descending order. • HEC-5 DQ record containing discharge corresponding to the probabilities on DF record. • HEC-5 DC records containing the damage values corresponding to the probabilities on DF record. Up to 9 sets, one set for each category, will be output.

PP Record - Printout and Punch Options (Optional Record)

Field	Variable	Value	Description
5	JTRACE	+	THIS DIAGNOSTIC TRACE OUTPUT OPTION IS PRIMARILY FOR USE BY HEC PROGRAM ANALYSTS. USERS ARE CAUTIONED AGAINST USING THE OPTION. CONSULTATION WITH HEC WOULD BE DESIRABLE IF THE USER DESIRES TO ACTIVATE THE OPTION. The sum of the following trace output options that are desired for the damage and expected annual damage routines. Caution should be used in selecting this option because it will generate a great amount of output. The option should be activated just before and deactivated just after the particular reach or plan with questionable results the user wishes to examine.
		0	No trace output.
		1	Trace output from subroutine DAMAGE of the expanded frequency vector and corresponding interpolated flow, stage, and damage values.
		2	Trace output from subroutine DAMAGE of the expanded frequency vector and the interpolated flows, if QF record used, or stages if SF record used. Useful if execution terminates with an error condition before the results can be printed with JTRACE = 1.
		4	Trace output from subroutine DAMAGE of interpolated values after considering the rating curve. Useful if execution terminates with an error condition before the results can be printed with JTRACE = 1.
		8	Trace output from subroutine DAMAGE of any interpolations involving the input data years.
		16	Trace output from subroutine DAMAGE of the interpolated probability at which truncation of damage begins (see RV record).
		32	Trace output from subroutine EAV of the interpolation from each expanded segment of the frequency damage relation.
		64	Trace output from subroutine AREA of the points selected for the 3-point gaussian quadrature solution.
		128	Trace output from subroutine FRQFIT and CURFIT of the cubic polynomial interpolation to derive the expanded frequency matrix.

RN Record - Reach Name (Required Record)

Field	Variable	Value	Description
0	ICD	RN	Record identification.
1-10	NMRCH	Alpha	Alphanumeric title for the reach. May include a reach number, index location or any other identifying information. Columns 3-80 may be used. This reach identification will be output before the input data, in the reach summary tables and in the final job summary.

RV Record - Revision of Data (Optional Record)

This record is used to modify a particular set of conditions (records) for a given input data year and plan to represent the conditions for a different input data year or plan. For example, this record could be used to specify a 1980 flow-frequency curve if that curve differs in a consistent manner from the 1976 curve, or this record could be used to decrease the flow-frequency curve by some ratio for a plan that includes an additional reservoir. A floodway, a uniform shift in the stage-flow relation, an additive or ratio change in damages, and a truncation of damages (as by a levee) may be represented. This record **may not** be used to modify input relation **before** they have been processed, e.g. the RV record is only operable for PLAN 2 and subsequent plans. This record **must follow** the relations to be modified; consequently this record may appear at several locations in the input stream.

Field	Variable	Value	Description
0	ICD	RV	Record identification.
1	ICRD	Alpha	The record ID in columns 7 and 8 for the data that are to be revised for a new input data year or plan. The ID may be FR, QF, SF, SQ, QS, SD, QD, DG or blank. A blank is valid only when IFUNC (RV.6) is 5.
2	IPDYR	+	The input data year of the data that are to be modified, if so subscripted.
3	IPLNN	+	The assigned plan number for the new (modified) data. See PN record description.
4	INDYR	+	The input data year for the new (modified) data, if so subscripted. Must correspond to a year on the DY record.
5	ICAT	+	The damage category order number, if so subscripted, of the old and new data.
6	IFUNC		The particular operation that will be done on the old data by the variable CONST (RV.7).
		1	Add the quantity CONST (RV.7) to each value in the vector.
		2	Multiply each value in the vector by the quantity CONST (RV.7).

RV Record - Revision of Data (Optional Record), (Continued)

Field	Variable	Value	Description
		3	The quantity (CONST) (RV.7) represents the value at (and below) which no damage occurs (truncation). CONST may be frequency if ICRD (RV.1) is a FR record (see caution below); stage if a SD record; or flow of a QD record. CAUTION - the frequency matrix must not change by input data years when truncation is based on frequency. If ICAT (RV.5) is blank, the truncation will be applied to all categories and each RV record must be separated by an EP record. The truncation levels can be automatically applied at successive sub-reaches (see description of ES record of this Exhibit) by specifying a value of 4.
		4	The specified truncation level for a given plan (see above) will automatically be applied to the last plan read in at each successive sub-reach (see description of ES record of this Exhibit) until an ER record is encountered. If more than one truncation level is to be specified, consecutive RV records, each with a different plan number (RV.3) must be provided without EP records before the ES record of the first sub-reach.
		5	All input relations for this plan, IPLNN (RV.3), at this reach are identical to a previous plan. Enter the previous plan order number as CONST (RV.7). This equivalencing is for the summary and is not necessary if the summary is suppressed (IDGRP, PP.3, equals 64) or the plan is equivalent to the immediately preceding plan. This RV record will be the only record between an EP and another EP, ES, ER or EJ record.
7	CONST	+	The value which will be used in the operations specified by IFUNC (RV.6).

FR Record - Frequency Data (Required at least for the first reach)

This record, by use of the sign of NFRQ (FR.2), controls whether damage only or expected annual damage will be computed. This record is required for only the first reach if the selected frequency values remain fixed for all reaches and plans; otherwise, provide only when the frequency values are changed. If an aggregated frequency versus damage relation is desired (NFRQ, FR.2), the exceedance frequency values must remain constant for the complete run. This record becomes optional when reading frequency-flow data from the HEC data storage system (DSS). If an FR record is included, the frequency flow data read from the DSS file will be interpolated and extrapolated to provide flows for the exceedance frequencies provided on the FR record.

Field	Variable	Value	Description
0	ICD	FR	Record identification.
1	IRCH	Alpha	A brief reach identification (or station number) to identify the data. May be left blank if desired.
2	NFRQ	+	The number of exceedance frequency values that are to be input for computation of expected annual damage. Dimensioned for 18.
		-	The number of flow (QF) or stage (SF) values, preceded by a minus sign, to be entered for computation of damage only for a specific flood event. The remainder of this record may be left blank or may contain the frequency values if an aggregated frequency versus damage is desired in the summary. Maximum of 18.
3	FREQ	+	Exceedance frequency values (in percent). Values must be in descending order (99., 90., . . . 10. for the 10-year event, 1.0 for the 100-year event, etc.).
4-10	FREQ	+	Repeat as required by NFRQ. If there are more than 8 values, the 9th value must begin in the first field of the next record.

QF Record - Flow (Frequency) Data or SF Record - Stage (Frequency) Data (Optional Records).

Only one type of frequency relation can be provided for a given reach. Do not provide this record if damage-frequency relations are to be entered. The flow or stage data for a particular input data year and/or plan may be computed by modifying (by a RV record) the preceding QF or SF record.

Field	Variable	Value	Description
0	ICD	QF or SF	Record identification.
1	IRCH	Alpha	A brief reach identification (or station number) to identify the data. May be left blank if desired, unless reading the frequency curve from a DSS file.
2			A coded number containing the input data year and the plan number in columns 9-14. May be left blank if the same flow-frequency data are applied to all input data years and plans for the reach.
	IDYFR	0	If columns 9-12 are blank or zero, the same flow-frequency data applies to all input data years.
		+	The data year is coded in columns 9-12.
	IPLNN	0	If zero or blank, the same flow-frequency data applies to all plans for the reach.
		+	The assigned plan number (see PN records) is coded in columns 13 and 14.
	---	---	Columns 15 and 16 will be blank.
3	PFRQ	-1	This must be a QF record and flow-frequency data will be retrieved from a file by use of the HEC data storage system (DSS). See Exhibit 5. The remainder of the record will be blank. Note that the program will retrieve and process only the first 18 flow-frequency values from the DSS.
		+	Frequency parameters values, either peak flows (QF record) or peak stages (SF record). Must correspond to exceedance frequency values (FR record) if expected annual damage is to be computed. Each successive value must be larger than the previous value.
4-10	PFRQ	+	Repeat as required by NFRQ. If more than 8 values, the 9th value must begin in the first field of the next record.

SQ Record - Stage (Flow) Data (Optional Record)

It is necessary to provide stage, and corresponding flow, data when flow-frequency and stage-damage data are entered.

Field	Variable	Value	Description
0	ICD	SQ	Record identification.
1	IRCH	Alpha	A brief reach identification (or station number) to identify the data. May be left blank, if desired.
2	NSTG	+	The number of stage (and corresponding flow) values that are to be entered, dimensioned for 18.
3	STGQ	+	Stage values corresponding to flow values on the QS record. Values must be in ascending order.
4-10	STGQ	+	Repeat as required by NSTG. If more than 8 values, the 9th value must begin in the first field of the next record.

QS Record - Flow (Stage) Data (Optional Record)

The flow data for a particular data year and/or plan may be computed by modifying (by a RV record) the preceding QS record.

Field	Variable	Value	Description
0	ICD	QS	Record identification.
1	IRCH	Alpha	A brief reach identification (or station number) to identify the data. May be left blank, if desired, unless reading the rating curve from a DSS file.
2			A coded number containing the input data year and the plan number in columns 9-14. May be left blank if the same stage-flow data applies to all input data years and plans for the reach.
	IDYQS	0	If columns 9-12 are blank or zero, the same stage-discharge data will be applied to all input data years.
		+	The data year is coded in columns 9-12.
	IPLNN	0	If zero or blank, the same stage-flow data applies to all plans for the reach.
		+	The assigned plan number (see PN records) is coded in columns 13 and 14.
	---	---	Columns 15 and 16 will be blank.
3	QSTG	-1	Stage flow data will be retrieved from a file by use of the HEC data storage system (DSS) (See Exhibit 5). The SQ record is omitted and the remainder of this record is left blank. Note that the program will retrieve and process only the first 18 flow-frequency values from the DSS.
		+	Discharge values corresponding to the stages on the SQ record. Each successive value must be larger than the previous value.
4-10	QSTG	+	Repeat as required by NSTG. If more than 8 values, the 9th value must begin in the first field of the next record.

SD Record - Stage (Damage) Data or QD Record - Flow (Damage) Data (Optional Records).

Only one type of damage matrix, either stage-damage or flow-damage can be provided for a given reach. Do not provide this record if frequency-damage matrices are entered. Provide a set of SD, or QD, and DG records for each damage category to be computed for the reach. If successive SD, or QD, records for different damage categories are identical, only the first SD, or QD, record need be provided.

Field	Variable	Value	Description
0	ICD	SD or QD	Record identification.
1	IRCH	Alpha	A brief reach identification (or station number) to identify the data. May be left blank, if desired.
2	NDMG	+	The number of stage (and corresponding damage) values that are to be entered. Dimensioned 18.
3	PDMG	+	Damage parameter values either stages (SD record) or flows (QD record) corresponding to damage on the DG record. Values must be in ascending order and each successive value must be larger than the previous value.
4-10	PDMG	+	Repeat as required by NDMG. If more than 8 values, the 9th value must begin in the first field of the next record.

DG Record - Damage Data (Required for each reach)

The damage may correspond to the exceedance frequencies (FR record) if only the frequency-damage matrix is provided, to stages (SD record) if the stage-damage matrix is provided, or to peak flows (QD record) if the flow-damage matrix is provided. The damage vector for a particular input data year, plan, and damage category may be computed by modifying (RV record) the preceding DG record for the same damage category. Damage is set to zero for those damage categories not found for the reach or subreach.

Field	Variable	Value	Description
0	ICD	DG	Record identification.
1	IRCH	Alpha	A brief reach identification (or station number) to identify the data. This ID is used for the summary.
2			A coded number containing the input data year, plan number, and damage category number in columns 9-16. Columns 9-14 may be blank if the same damage vector applies to all input data years and plans for the reach.
	IDYDG	0	If columns 9-12 are blank or zero, the same stage or flow damage vector will be applied to all input data years.
		+	The data year is coded in columns 9-12.
	IPLNN	0	If zero or blank, the same damage vector applies to all plans for the reach.
		+	The assigned number (see PN records) is coded in columns 13 and 14.
	ICAT	+	The damage category order number (as read on CN record) is coded in columns 15 and 16.
3	DAMG	+	Damage values corresponding to exceedance frequencies (FR record) if there are no SD or QD records, stages if SD records are provided, or flows if QD records are provided.
4-10	DAMG	+	Repeat as required by NDMG. If more than 8 values, the 9th value must begin in the first field of the next record. Dimensioned for 18 values.

RC Record - Calculation of Affluence (Optional Record)

The computation of affluence requires that RC records be entered in the EAD input data stream. Values on this record define the projected annual rate of change in value of damageable property. The record is included for one or more damage categories at desired input data years for which projected changes in damage are computed; a maximum of NCAT (CN.1) times NDYRS (DY.1) records may be included. The rates apply to the specified category for this reach only, beginning with the economic base year. The economic base year is defined by the following hierarchy:

IRCBYR (RC.8)	If IRCBYR is non-blank or non-zero.
NDOLYR (J1.6)	If IRCBYR is blank (or zero) and NDOLYR is non-blank or non-zero.
IDOLYR (J1.4)	If IRCBYR and NDOLYR are blank (or zero) and IDOLYR is non-blank or non-zero.
ISTDYR (J1.2)	If IRCBYR, NDOLYR and IDOLYR are blank (or zero) and ISTDYR is non-blank or non-zero.
IBASYR (J1.3)	If IRCBYR, NDOLYR, IDOLYR, and ISTDYR are all either blank or zero.

The Expected Annual Damage program uses the beginning of the economic base year for computational purposes --- not the end or some intermediate month. In other words, the months associated with IDOLYR and NDOLYR are ignored.

Field	Variable	Value	Description
0	ICD	RC	Record identification.
1	---	---	Not used.
2	CNMRC	Char.	Character identification of the damage category to which the rates of change apply. The damage category must be identified previously on the CN record. (Typically the rate is applied to household contents only).
3	IDYRC	+	The year in which the rate of change of damage values (RCRATE, field RC.4) applies (e.g. 1973).
4	RCRATE	-,0,+	Projected annual rate of change of damage values, in percent, for the year "IDYRC". If RCRATE is negative, the damage values decrease annually. If RCRATE is zero, the values neither decrease or increase, but remain the same. If RCRATE is positive, the values increase annually.
5	RCRTIO	+	The ratio (in percent) of content value to structure value at the beginning of the economic base year. This ratio is used with either DGRCMX or DGRCMN to determine the boundary value for the change in damage.

RC Record - Calculation of Affluence (continued)

Field	Variable	Value	Description
6	DGRCMX	+	The maximum percent damage after value increase (expressed as a percent of the structural value). Federal regulations as of March 1986 limit the value of contents to 75 percent of structural value.
7	DGRCMN	-	The minimum percent damage after value decrease (expressed as a percent of the structural value).
8	IRCBYR	+	The economic base year for affluence computations. This is the year which corresponds to the damage values entered as elevation-damage or flow-damage functions. If this year is left blank, the EAD program uses the hierarchy described above to determine the base economic data year. There can be only one valid data year for each damage category - the last one entered will be used in computations.

DZ Record - Damage Category Aggregation (Optional Record, only used with damage data from DSS file).

This record provides for the aggregation of damage categories that are retrieved from a DSS file. If the DSS file contains more than 18 categories, the (maximum allowed by EAD) aggregation is required or only the first 18 categories are retrieved. The DZ record contains the number of categories to retrieve from the DSS file and the names of the categories (corresponding to those on the CN record) into which each damage category should be aggregated. The DZ record(s) are required only once and must precede the ZR record which retrieves the damage matrix.

Field	Variable	Value	Description
0	ICD	DZ	Record identification.
1	MCAT	+	Number of damage categories to be aggregated from the DSS file. Leave field 1 blank on additional DZ records, should they be required.
2	NAGG	Alpha	Damage category name (corresponding to name on CN record) into which the first damage category from the DSS file is aggregated.
3	NAGG	Alpha	Damage category name (corresponding to name on CN record) into which the second damage category from the DSS file will be aggregated.
4-10	NAGG	Alpha	Repeat as required by MCAT (DZ.1). If more than 9 values, the 10th value must begin in the second field of the second DZ record and likewise the 19th value would begin in the second field of the third DZ record.

ZR Record - DSS Read Record (Optional Record).

This record is required when data are to be retrieved from a file by use of HEC's data storage system (DSS). The ZR record provides essential parts of the pathname needed for retrieval. One ZR record is required for each type of matrix to be retrieved. These matrices include frequency-damage, frequency-stage, frequency-flow, stage-discharge, stage-damage, and flow-damage. Pathname parts A, B, C, D, E, and F may be entered on this record. Part C may be entered as either the full pathname part or as a special code as described below. The pathname parts are entered in free-format, each part is preceded by part I.D. followed by an equal sign (A=..... B=..... C=...., etc.). If a pathname part does not change between reaches or plans, the analyst need not reenter that part. If a part is specified and is later blank, the analyst must enter the part I.D., followed by an equal sign, followed by at least one blank character. The damage vectors for each damage category may be retrieved separately; however, the stage (or flow or frequency) vector associated with the damage vector **must** be identical for each damage vector. See Exhibit 5 for a discussion on the use of the DSS system.

Field	Variable	Value	Description
A=	CPA	Alpha	HECDSS Pathname part A. This should be the river basin or study name.
B=	CPB	Alpha	HECDSS Pathname part B. This should be the damage reach I.D., cross-section number, or control point identifier.
C=	CPC	Alpha	HECDSS Pathname part C. This is the two parameters for which the matrix applies. This part is entered as either the full pathname part or as the following codes:

Code	Matrix
QS	Elevation-Flow
QF	Frequency-Flow
SF	Frequency-Elevation
SD (or DG)	Elevation-Damage
QD	Flow-Damage
DF	Frequency-Damage

Field	Variable	Value	Description
D=	CPC	Alpha	Miscellaneous use. Generally not used.
E=	CPD	Alpha	HECDSS pathname part E. The data year to which the matrix applies. May be left blank if the same matrix applies to all years. If the year is entered, it must be the four digit year (e.g. 1990).
F=	CPF	Alpha	HECDSS pathname part F. The flood damage reduction alternative name (BASE, FLOODPROOFING-2% LEVEL, etc.).

EP, ES, ER, EJ Records - End of Data (Required Record)

The two letter record code is used to convey the type of operation to perform next. **Only one** of these records is required to terminate a given subreach, reach, plan, or job; none of these records should be adjacent to each other. For example, an "EJ" record (not an "ER" record) should follow the data for the last plan of the last reach at the end of the last job. If retrieving data from an HECDSS data file, always enter the plan number in the first field of these records. In general, it is always good practice to enter the plan number in the first field.

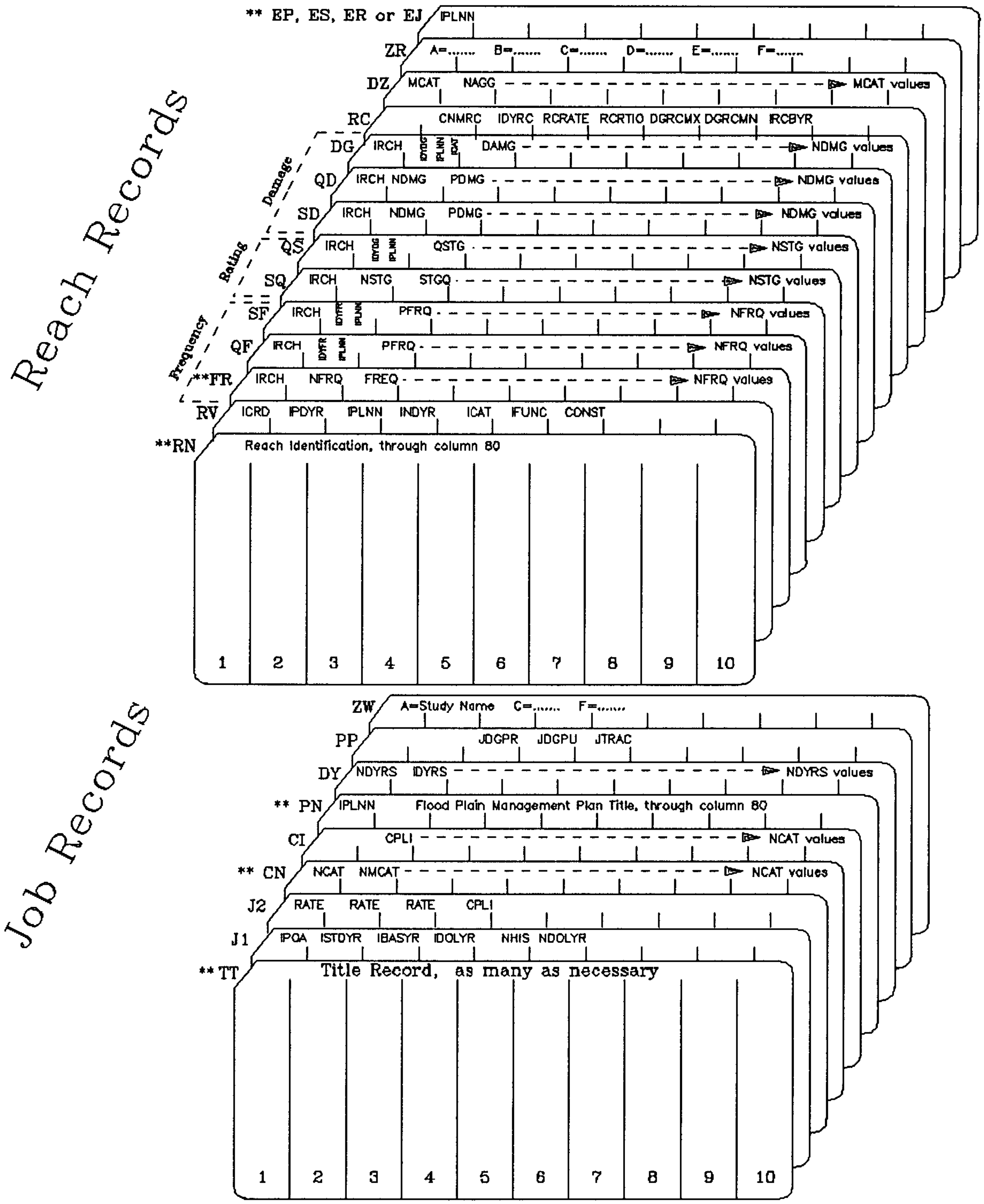
Field	Variable	Value	Description
0	ICD		Record identification.
		EP	End of data for one plan. The data read in will be processed and output before reading the data for the next plan or
		or ES	End of data for a sub-reach. This is an optional end-of-reach indicator to use where the same index station will be used for the next data set. It is then not necessary to provide frequency-discharge (or stage) or stage-discharge matrices, if they were not modified by one of the preceding plans, for the following sub-reach. If the hydraulic and hydrologic matrices **do** change between sub-reaches, an ER record should be used.
		or ER	End of data for the reach. After processing the data just read, summary totals are output for the reach. The next data to be read will be for a different reach.
		or EJ	End of job. After processing the data just read (ER record summaries), summary totals for all reaches will be output. This record terminates the EAD run unless input for a new job immediately follow the EJ record.
1	IPLNN	0	If zero or blank, the last assigned plan number (IPLNN) read from one of the reach records will be assigned to the preceding data set.
		+	The assigned plan number to be associated with the preceding set of data. This value will override any value of IPLNN read from a reach record.

EXHIBIT 6

Exhibit 7

Summary of EAD Records

EXHIBIT 7



Record Field Numbers

** Required Record; Others required depending upon desired analysis.
1 One PN record required for each Flood Plain Management Plan.
2 Either a QF or a SF record may be entered for a given reach, not both.
3 Either a SD or a QD record may be entered for a given reach, not both.