University of Minnesota
ST. ANTHONY FALLS HYDRAULIC LABORATORY

Project Report No. 147

# A DESIGN ORIENTED CONTINUOUS SYNTHESIS MODEL

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# A DESIGN ORIENTED CONTINUOUS SYNTHESIS MODEL

## I. INTRODUCTION

Some of the techniques presently used in mathematical models might be more readily accepted in engineering practice if they were combined to some degree with standard engineering approaches currently in use. Past experience has shown that as practicing engineers use a given method they develop a substantial working knowledge of its applicability and limitations. Often it is difficult to introduce new methods because of a lack of understanding of and trust in the concepts on which the new methods are based.

In the field of hydrology the "unit hydrograph" method of transforming an impulse of rain or snowmelt into a time distribution of runoff is widely used in the designing of hydraulic structures. While there are some features of the method that are subject to question, designers are usually sufficiently familiar with the procedure and its limitations to apply it as the primary hydrologic tool in designing large structures.

Applications of the unit hydrograph procedure to a design problem usually involves the analysis of past storms and the resulting flood to arrive at a unit hydrograph. Usually a discrete storm is selected as opposed to complex storms consisting of numerous rain impulses. This would provide a unit hydrograph, but perhaps not an adequate evaluation of the soil moisture condition at the start of or during the storm or of its effect on the volume of storm or direct runoff. Thus it may be desirable to analyze moisture inputs and runoff from the basin or watershed under study for a selected period in advance of the storm of interest and so provide a quantitative measure of the soil moisture condition at the start of and during the storm. An antecedent precipitation index would be one possible measure of this variable. Obviously, the index or other method of analyzing the soil moisture condition should increase (or decrease) with precipitation or snowmelt and move in the opposite direction for dry periods.

## II. OBJECTIVE

As stated in the proposal:

> The objective of the study is to develop methods which will encourage the practicing engineer to make practical use of some current advances in hydrology. One improvement which can be made is the introduction of a loss function that operates on a continuous basis over both wet and dry periods to characterize a basin rather than one which is fitted to a short, discontinuous period concerning one specific event. With a better understanding of the loss function of a basin, fewer uncertainties will exist in selecting loss rates for the design event. This will in turn permit the engineer to better specify the factor of safety, which is sometimes dictated by an accumulation of uncertainties over many steps in the design process.

In discussions with the sponsor it was agreed that the best way to implement this proposed objective would be to convert a portion of the unit hydrograph program HEC-1 to a continuous synthesis basis. Of particular interest would be the retention of the well-established unit hydrograph procedure and the optimization features associated with this program with (1) a moisture accounting loss rate analysis that would operate from event to event during a given year and (2) addition of a baseflow component more closely related to basin moisture conditions and groundwater regimes. It was anticipated that these changes in HEC-1 would require revision of the data storage techniques included in the program.

## III. HEC-1CS - CONTINUOUS SYNTHESIS MODEL

The computer program HEC-1 - Flood Hydrograph Package contains a main program and ten subroutines which can be used in various combinations to perform five major types of flood hydrograph analysis. These are*

"1. Optimization of routing parameters;

"2. Optimization of unit graph and loss rate parameters;

"3. Generalized precipitation, runoff, routing and combining operations to simulate the hydrologic response of a watershed and its stream network;

"4. Stream system computations for specified precipitation depth-area storm relationships for the entire watershed or region;

"5. Specialized precipitation streamflow network simulation relative to multiple floods for multiple plans of basin development and the economic analysis of flood damages."

Some of the design features available in the original version are either not required or not compatible with a continuous computation scheme. The following options were eliminated from the continuous form of HEC-1 (hereafter designated HEC-1CS)for the above reasons and to reduce the model size so it would be operable on smaller computers:

1. Hydrograph balance
2. Comprehensive stream system design flood computation
3. Economic analysis
4. Multiple plan analysis
5. Routing optimization

HEC-1CS retains the following capabilities:

1. Hydrograph generation
2. Hydrograph routing

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*Hydrologic Engineering Center, HEC-1, Flood Hydrograph Package, Report No. 723-010, HEC, U.S. Army Corps of Engineers, January 1973.

3. Hydrograph combining

4. Unit hydrograph and loss rate optimization

The program coding was altered to reflect the above changes and the program was then executed successfully on several test problems. These changes reduced the core storage requirements for both program code and data storage. However, before all the above changes were made, consideration was given to the handling of potentially large amounts of data for the continuous synthesis of streamflow hydrographs. As precipitation data, and possibly air temperature and other parameters, would be required for a number of stations for a period of as much as a year, it would be impractical to hold all these data in core storage.

In addition to station input data, it is necessary to compute and save basin values for parameters. During optimization runs these basin values are referred to many times. For runs in which several hydrographs are determined and later combined and routed, the intermediate results must be saved for subsequent operations. Again it would be undesirable to assign a large amount of core storage to the saving of these intermediate results.

Alternate possibilities exist. The data could be so structured that computations for a given basin would proceed for a certain time period, such as a month, during which time all necessary data would be held in core storage. Then as the next period was processed, the new month's input data would replace the previous month's and the hydrograph for the month would be saved on file. A month is used here as an illustration; in practice the period would be a fixed number of ordinates of the hydrograph and the time covered would depend on the time increment.

To achieve these purposes, random access mass storage was used. Under the random access system, which requires disk storage or another mass storage device, an index is maintained which enables any block of information written on the disk to be read off directly without the necessity of reading through any intervening information.

This system overcomes the disadvantages of sequential data files. No time is wasted in reading through data to locate the record desired. It is not necessary for the user to rewind or otherwise consider his present position in a data file relative to the position of the next desired block of data. Instead he need only request a certain data record, which he may identify by an index number or a name, and that record will be read from the random access file and deposited at any specified location in core. In order to use this approach it is, of course, necessary to keep an index of the data records that have been written.

While in theory the use of random access files appears very desirable, the practicality depends on the availability of random access devices to users of HEC-1CS. The CDC 6600 has available random access disk storage which is accessible through the FORTRAN library routines READMS and WRITMS. These routines have been used quite extensively at the University of Minnesota with very good results.

FORTRAN callable random access should also be available at most other types of installations that have mass storage devices. It is anticipated that all random access storage would be handled through one subroutine. This one subroutine would vary from installation to installation depending on the specific routines (i.e., READMS, WRITMS, SETSCT, SAVSET, etc.) available for implementing random I/O operations. This would also make it possible to simulate the random I/O with a conventional sequential tape unit where mass storage was not available (although at greatly reduced efficiency).

A test program was executed on the GE 400 computer system through the St. Paul District office to evaluate the GE 400's random access disk capability. The test confirmed the availability and operation of random access disk storage on the GE 400 system. Extensive changes were made in HEC-1 so that the HEC-1CS program would have the capability of computing for long, continuous periods of time. The basic structure of the program was left unaltered. The hydrograph is first broken into a series of segments, each KQ coordinates in length. The given operation is then performed on each segment of the hydrograph. Each segment is stored on the random access disk file. At present the program will successfully read in a hydrograph of any length and correctly perform the segmenting operation, saving the results for future use.

Consideration has been given to methods of simulating the hydrograph baseflow, but time limitations prevented completion of this feature of the program. The desired routine should produce a good estimate of base flow during periods between storm events. It should produce reasonable volumes of runoff which, when combined with direct storm runoff, will provide correct annual volumes.

One approach that appears to have some promise would require three parameters. Two of these could be taken directly from published data and the third could easily be derived from published data. The first parameter is normal annual runoff (NRO), which is readily available from USGS stream gaging data. It is easily generalized for ungaged areas by plotting on maps. The second parameter is normal monthly precipitation (NMP). This is readily available from National Weather Service data and can be generalized for ungaged watersheds. The third parameter is the percentage of normal annual runoff that is derived from base flow; this can also be generalized.

Given the above parameters, it is possible to determine a normal monthly baseflow (NMBF). The simulated baseflow can then be taken as

$$\text{Baseflow} = \text{NMBF}\left(1.0 + \frac{(\text{Actual Monthly Precip}) - \text{NMP}}{\text{NMP}}\right)$$

Such a function will produce reasonable amounts of long term baseflow discharge and of annual baseflow. It is possible that a non-linear relationship such as the following would provide a better simulation:

$$\text{BF} = \text{NMBF}\left(1.0 + \frac{\text{AMP} - \text{NMP}}{\text{NMP}}\right)^{E}$$

In the relationships shown, the baseflow becomes a function of the normal monthly baseflow and the departure of the actual monthly precipitation from the normal monthly precipitation. In wetter-than-normal months the resulting baseflow would be higher than normal, and vice versa.

Monthly values were used here for illustrative purposes only. In practice, periods of other than one month may be desirable, depending on the size, soil types, and other basin characteristics.

A frequency analysis of daily streamflow was made for several Minnesota streams. Of interest was the relative volume of annual runoff occurring between flood events--or, in other words, as base flow. The results showed that 90 per cent of the annual volume occurred for large stream discharges that occurred only 25 per cent of the time. The average discharge was exceeded only 22 per cent of the time. Thus the low flow or base flow discharges contributed a relatively minor amount to the annual runoff for these streams. On this basis a relatively simple baseflow procedure of the type described above should suffice for many applications of HEC-1CS.

## IV. CURRENT STATUS OF HEC-1CS

Currently the HEC-1CS program will correctly perform hydrograph generation, routing, and combining of any desired length hydrograph. The hydrograph can be generated only from basin average precipitation as input from Ø1 and Ø2 cards. The unit hydrograph can be determined from the parameters TC and R and a synthetic or actual time-area curve or can be input directly by the user. Snowmelt computations can be performed by either the degree-day or the energy budget method.

Hydrograph routing can be performed using the Muskingum and Straddle-Stagger (including Tatum) methods. However, changes in reservoir routing techniques were not completed. Routing can be performed perfectly for a single segment hydrograph, but for multiple segment hydrographs the first term of each subsequent segment is slightly different from the correct value.

An elementary recovery technique has been included in the exponential loss rate analysis. The accumulated loss in a basin is now allowed to decrease between storm events. In this way the accumulated loss actually becomes an indication of basin soil moisture levels. The recovery is controlled by either or both of the variables RECOV and REC. RECOV is a constant rate of recovery, expressed in inches per day, that is subtracted from the current value of accumulated loss for each computation period. REC is a factor, less than one, that is multiplied by the current value of accumulated loss for each computation period. Thus RECOV provides a uniform recovery rate and REC provides an exponential recovery rate.

Items remaining to be accomplished in order to make HEC-1CS fully operational include (1) the addition of a base flow routine of the type described in the preceding section and (2) testing and possibly modifying to make the optimization routine operational on a continuous basis.

The development of HEC-1CS has involved extensive modification of HEC-1 as well as extensive testing and evaluation of the various changes. It is felt that the progress achieved during this year constitutes satisfactory completion of the contract even though some work remains to make the program fully operational.

A listing of the current HEC-1CS program and test runs of many features are included as appendices A and B to this report. A source deck in the form of cards is also being provided along with the report.

# APPENDIX B

## Test Run of HEC-1CS for 150 Time Periods

526810

TEST DECK

TEST OF RUNOFF COMPUTATION,HYDROGRAPH COMBINING AND ROUTING

JOB SPECIFICATION

| NQ | NHR | NMIN | IDAY | IHR | IMIN | METRC | IPLT | IPRT | NSTAN |
|---|---|---|---|---|---|---|---|---|---|
| 100 | 24 | -0 | -0 | -0 | -0 | -0 | 2 | 1 | -0 |

JOPER
3

TEST RUN OF HEC-1CS
for 150 Time Periods

******************************

SEGMENT 1 OF 2 SEGMENTS

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********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF COMPUTATION OF STATION 10

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT |
|---|---|---|---|---|---|
| 10 | -0 | -0 | -0 | -0 | -0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| -0 | -0 | 1280.00 | -0 | -0 | -0 | -0 | -0 | -0 | -0 |

PRECIP DATA

| NP | STORM | DAJ | DAK |
|---|---|---|---|
| 100 | -0 | -0 | -0 |

```
RECORD ENTERED BY RANDSK     WRITE    4    1    1    1    1  100          R          R          R        3    0
RECORD ENTERED BY RANDSK     WRITE    4    1    2    1    1   50          0          0          R       11    0
```

PRECIP PATTERN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| .02 | .11 | .22 | .11 | .88 | .45 | 0 | .11 | .13 | .14 |
| .04 | 0 | 0 | 0 | 0 | .02 | .01 | .04 | .03 | .09 |
| .06 | .04 | .27 | .64 | .35 | .13 | 0 | 0 | 0 | 0 |
| 0 | .07 | .02 | .19 | .09 | .14 | .09 | 1.51 | .39 | 0 |
| 0 | 0 | .06 | 1.01 | .35 | .07 | .01 | 0 | 0 | .42 |
| .39 | .18 | .13 | .50 | .40 | .09 | 0 | .06 | .21 | .04 |
| .03 | .02 | .22 | .22 | .04 | .42 | .22 | .13 | .03 | 0 |
| 0 | 0 | .09 | .06 | 0 | 0 | 0 | 0 | 0 | 0 |
| .12 | .62 | .49 | .02 | .01 | .13 | .42 | .15 | 0 | 0 |
| 0 | .03 | 0 | 0 | .16 | .52 | .31 | .01 | 0 | .03 |

LOSS DATA

| STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP | REC | RECOV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .30 | .20 | 2.00 | .70 | -0 | -0 | -0 | -0 | -0 | -0 | 1.00 | .10 |

| LOSS RATE INITIAL VALUE | 2.00 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 |
|---|---|---|---|---|---|---|---|---|---|---|

UNIT HYDROGRAPH DATA
NCLRK= -0 TC= 70.00 R= 80.00

RECESSION DATA

HEC/CS

STRTQ= 100.0 QRCSN= 200.0 RTIOR= 2.50

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I | I | I | I | I | I | I | I | I | I | .02 | 1.92 | .26 | 0 | .02 |
| 2 | I | I | I | I | I | I | I | I | I | I | .11 | 1.93 | .26 | .00 | .11 |
| 3 | I | I | I | I | I | I | I | I | I | I | .22 | 2.05 | .26 | .00 | .22 |
| 4 | I | I | I | I | I | I | I | I | I | I | .11 | 2.06 | .26 | .00 | .11 |
| 5 | I | I | I | I | I | I | I | I | I | I | .62 | 2.58 | .26 | .26 | .88 |
| 6 | I | I | I | I | I | I | I | I | I | I | .37 | 2.85 | .25 | .08 | .45 |
| 7 | I | I | I | I | I | I | I | I | I | I | 0 | 2.75 | .25 | 0 | 0 |
| 8 | I | I | I | I | I | I | I | I | I | I | .11 | 2.76 | .25 | .00 | .11 |
| 9 | I | I | I | I | I | I | I | I | I | I | .13 | 2.79 | .25 | 0 | .13 |
| 10 | I | I | I | I | I | I | I | I | I | I | .14 | 2.83 | .25 | 0 | .14 |
| 11 | I | I | I | I | I | I | I | I | I | I | .04 | 2.77 | .25 | 0 | .04 |
| 12 | I | I | I | I | I | I | I | I | I | I | 0 | 2.67 | .25 | 0 | 0 |
| 13 | I | I | I | I | I | I | I | I | I | I | 0 | 2.57 | .25 | 0 | 0 |
| 14 | I | I | I | I | I | I | I | I | I | I | 0 | 2.47 | .25 | 0 | 0 |
| 15 | I | I | I | I | I | I | I | I | I | I | 0 | 2.37 | .25 | 0 | 0 |
| 16 | I | I | I | I | I | I | I | I | I | I | .02 | 2.29 | .25 | 0 | .02 |
| 17 | I | I | I | I | I | I | I | I | I | I | .01 | 2.20 | .26 | 0 | .01 |
| 18 | I | I | I | I | I | I | I | I | I | I | .04 | 2.14 | .26 | 0 | .04 |
| 19 | I | I | I | I | I | I | I | I | I | I | .03 | 2.07 | .26 | 0 | .03 |
| 20 | I | I | I | I | I | I | I | I | I | I | .09 | 2.06 | .26 | .00 | .09 |
| 21 | I | I | I | I | I | I | I | I | I | I | .06 | 2.02 | .26 | 0 | .06 |
| 22 | I | I | I | I | I | I | I | I | I | I | .04 | 1.96 | .26 | 0 | .04 |
| 23 | I | I | I | I | I | I | I | I | I | I | .27 | 2.13 | .26 | 0 | .27 |
| 24 | I | I | I | I | I | I | I | I | I | I | .49 | 2.52 | .26 | .15 | .64 |
| 25 | I | I | I | I | I | I | I | I | I | I | .31 | 2.73 | .25 | .04 | .35 |
| 26 | I | I | I | I | I | I | I | I | I | I | .13 | 2.76 | .25 | 0 | .13 |
| 27 | I | I | I | I | I | I | I | I | I | I | 0 | 2.66 | .25 | 0 | 0 |
| 28 | I | I | I | I | I | I | I | I | I | I | 0 | 2.56 | .25 | 0 | 0 |
| 29 | I | I | I | I | I | I | I | I | I | I | 0 | 2.46 | .25 | 0 | 0 |
| 30 | I | I | I | I | I | I | I | I | I | I | 0 | 2.36 | .25 | 0 | 0 |
| 31 | I | I | I | I | I | I | I | I | I | I | 0 | 2.26 | .25 | 0 | 0 |
| 32 | I | I | I | I | I | I | I | I | I | I | .07 | 2.23 | .26 | 0 | .07 |
| 33 | I | I | I | I | I | I | I | I | I | I | .02 | 2.15 | .26 | 0 | .02 |
| 34 | I | I | I | I | I | I | I | I | I | I | .19 | 2.24 | .26 | .00 | .19 |
| 35 | I | I | I | I | I | I | I | I | I | I | .09 | 2.23 | .26 | .00 | .09 |
| 36 | I | I | I | I | I | I | I | I | I | I | .14 | 2.27 | .26 | 0 | .14 |
| 37 | I | I | I | I | I | I | I | I | I | I | .09 | 2.26 | .26 | .00 | .09 |
| 38 | I | I | I | I | I | I | I | I | I | I | .89 | 3.05 | .26 | .62 | 1.51 |
| 39 | I | I | I | I | I | I | I | I | I | I | .33 | 3.28 | .24 | .06 | .39 |
| 40 | I | I | I | I | I | I | I | I | I | I | 0 | 3.18 | .24 | 0 | 0 |
| 41 | I | I | I | I | I | I | I | I | I | I | 0 | 3.08 | .24 | 0 | 0 |
| 42 | I | I | I | I | I | I | I | I | I | I | 0 | 2.98 | .24 | 0 | 0 |
| 43 | I | I | I | I | I | I | I | I | I | I | .06 | 2.94 | .24 | 0 | .06 |
| 44 | I | I | I | I | I | I | I | I | I | I | .64 | 3.48 | .24 | .37 | 1.01 |
| 45 | I | I | I | I | I | I | I | I | I | I | .29 | 3.67 | .24 | .06 | .35 |
| 46 | I | I | I | I | I | I | I | I | I | I | .07 | 3.64 | .23 | 0 | .07 |
| 47 | I | I | I | I | I | I | I | I | I | I | .01 | 3.55 | .23 | 0 | .01 |
| 48 | I | I | I | I | I | I | I | I | I | I | 0 | 3.45 | .23 | 0 | 0 |
| 49 | I | I | I | I | I | I | I | I | I | I | 0 | 3.35 | .23 | 0 | 0 |
| 50 | I | I | I | I | I | I | I | I | I | I | .34 | 3.59 | .24 | .08 | .42 |
| 51 | I | I | I | I | I | I | I | I | I | I | .31 | 3.80 | .23 | .08 | .39 |
| 52 | I | I | I | I | I | I | I | I | I | I | .18 | 3.88 | .23 | .00 | .18 |
| 53 | I | I | I | I | I | I | I | I | I | I | .13 | 3.91 | .23 | 0 | .13 |
| 54 | I | I | I | I | I | I | I | I | I | I | .37 | 4.18 | .23 | .13 | .50 |
| 55 | I | I | I | I | I | I | I | I | I | I | .31 | 4.38 | .22 | .09 | .40 |
| 56 | I | I | I | I | I | I | I | I | I | I | .09 | 4.37 | .22 | .00 | .09 |
| 57 | I | I | I | I | I | I | I | I | I | I | 0 | 4.27 | .22 | 0 | 0 |
| 58 | I | I | I | I | I | I | I | I | I | I | .06 | 4.23 | .22 | 0 | .06 |
| 59 | I | I | I | I | I | I | I | I | I | I | .19 | 4.33 | .22 | .02 | .21 |
| 60 | I | I | I | I | I | I | I | I | I | I | .04 | 4.27 | .22 | 0 | .04 |
| 61 | I | I | I | I | I | I | I | I | I | I | .03 | 4.20 | .22 | 0 | .03 |
| 62 | I | I | I | I | I | I | I | I | I | I | .02 | 4.12 | .22 | 0 | .02 |
| 63 | I | I | I | I | I | I | I | I | I | I | .20 | 4.22 | .23 | .02 | .22 |
| 64 | I | I | I | I | I | I | I | I | I | I | .20 | 4.32 | .22 | .02 | .22 |
| 65 | I | I | I | I | I | I | I | I | I | I | .04 | 4.26 | .22 | 0 | .04 |

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| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 66 | I | I | I | I | I | I | I | I | I | I | .32 | 4.48 | .22 | .10 | .42 |
| 67 | I | I | I | I | I | I | I | I | I | I | .20 | 4.58 | .22 | .02 | .22 |
| 68 | I | I | I | I | I | I | I | I | I | I | .13 | 4.61 | .22 | 0 | .13 |
| 69 | I | I | I | I | I | I | I | I | I | I | .03 | 4.54 | .22 | 0 | .03 |
| 70 | I | I | I | I | I | I | I | I | I | I | 0 | 4.44 | .22 | 0 | 0 |
| 71 | I | I | I | I | I | I | I | I | I | I | 0 | 4.34 | .22 | 0 | 0 |
| 72 | I | I | I | I | I | I | I | I | I | I | 0 | 4.24 | .22 | 0 | 0 |
| 73 | I | I | I | I | I | I | I | I | I | I | .09 | 4.23 | .22 | .00 | .09 |
| 74 | I | I | I | I | I | I | I | I | I | I | .06 | 4.19 | .22 | 0 | .06 |
| 75 | I | I | I | I | I | I | I | I | I | I | 0 | 4.09 | .22 | 0 | 0 |
| 76 | I | I | I | I | I | I | I | I | I | I | 0 | 3.99 | .22 | 0 | 0 |
| 77 | I | I | I | I | I | I | I | I | I | I | 0 | 3.89 | .22 | 0 | 0 |
| 78 | I | I | I | I | I | I | I | I | I | I | 0 | 3.79 | .22 | 0 | 0 |
| 79 | I | I | I | I | I | I | I | I | I | I | 0 | 3.69 | .22 | 0 | 0 |
| 80 | I | I | I | I | I | I | I | I | I | I | 0 | 3.59 | .22 | 0 | 0 |
| 81 | I | I | I | I | I | I | I | I | I | I | .12 | 3.61 | .23 | 0 | .12 |
| 82 | I | I | I | I | I | I | I | I | I | I | .43 | 3.94 | .23 | .19 | .62 |
| 83 | I | I | I | I | I | I | I | I | I | I | .36 | 4.20 | .23 | .13 | .49 |
| 84 | I | I | I | I | I | I | I | I | I | I | .02 | 4.12 | .22 | 0 | .02 |
| 85 | I | I | I | I | I | I | I | I | I | I | .01 | 4.03 | .23 | 0 | .01 |
| 86 | I | I | I | I | I | I | I | I | I | I | .13 | 4.06 | .23 | 0 | .13 |
| 87 | I | I | I | I | I | I | I | I | I | I | .32 | 4.28 | .23 | .10 | .42 |
| 88 | I | I | I | I | I | I | I | I | I | I | .15 | 4.33 | .22 | 0 | .15 |
| 89 | I | I | I | I | I | I | I | I | I | I | 0 | 4.23 | .22 | 0 | 0 |
| 90 | I | I | I | I | I | I | I | I | I | I | 0 | 4.13 | .22 | 0 | 0 |
| 91 | I | I | I | I | I | I | I | I | I | I | 0 | 4.03 | .22 | 0 | 0 |
| 92 | I | I | I | I | I | I | I | I | I | I | .03 | 3.96 | .23 | 0 | .03 |
| 93 | I | I | I | I | I | I | I | I | I | I | 0 | 3.86 | .23 | 0 | 0 |
| 94 | I | I | I | I | I | I | I | I | I | I | 0 | 3.76 | .23 | 0 | 0 |
| 95 | I | I | I | I | I | I | I | I | I | I | .16 | 3.82 | .23 | 0 | .16 |
| 96 | I | I | I | I | I | I | I | I | I | I | .38 | 4.10 | .23 | .14 | .52 |
| 97 | I | I | I | I | I | I | I | I | I | I | .26 | 4.25 | .23 | .05 | .31 |
| 98 | I | I | I | I | I | I | I | I | I | I | .01 | 4.16 | .22 | 0 | .01 |
| 99 | I | I | I | I | I | I | I | I | I | I | 0 | 4.06 | .22 | 0 | 0 |
| 100 | I | I | I | I | I | I | I | I | I | I | .03 | 3.99 | .23 | 0 | .03 |

1 2 100 9.62E+04 4.28E+03 0 1.00E-02 I I

UNIT HYDROGRAPH 20 END-OF-PERIOD ORDINATES, LAG= 62.53 HOURS, CP= .48 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1274. | 4311. | 6399. | 5848. | 4322. | 3195. | 2361. | 1745. | 1290. | 953. |
| 705. | 521. | 385. | 285. | 210. | 155. | 115. | 85. | 63. | 46. |

END-OF-PERIOD FLOW

| TIME | RAIN | EXCS | COMP Q |
|---|---|---|---|
| 1 | .02 | 0 | 91. |
| 2 | .11 | .00 | 83. |
| 3 | .22 | .00 | 76. |
| 4 | .11 | .00 | 69. |
| 5 | .88 | .26 | 398. |
| 6 | .45 | .08 | 1290. |
| 7 | 0 | 0 | 2070. |
| 8 | .11 | .00 | 2083. |
| 9 | .13 | 0 | 1635. |
| 10 | .14 | 0 | 1216. |
| 11 | .04 | 0 | 906. |
| 12 | 0 | 0 | 676. |
| 13 | 0 | 0 | 505. |
| 14 | 0 | 0 | 379. |
| 15 | 0 | 0 | 285. |
| 16 | .02 | 0 | 215. |
| 17 | .01 | 0 | 196. |
| 18 | .04 | 0 | 179. |
| 19 | .03 | 0 | 163. |
| 20 | .09 | .00 | 149. |
| 21 | .06 | 0 | 136. |
| 22 | .04 | 0 | 124. |

526813

| | | | |
|---|---|---|---|
| 23 | .27 | 0 | 113. |
| 24 | .64 | .15 | 218. |
| 25 | .35 | .04 | 701. |
| 26 | .13 | 0 | 1118. |
| 27 | 0 | 0 | 1112. |
| 28 | 0 | 0 | 864. |
| 29 | 0 | 0 | 640. |
| 30 | 0 | 0 | 474. |
| 31 | 0 | 0 | 352. |
| 32 | .07 | 0 | 261. |
| 33 | .02 | 0 | 238. |
| 34 | .19 | .00 | 217. |
| 35 | .09 | .00 | 198. |
| 36 | .14 | 0 | 181. |
| 37 | .09 | .00 | 165. |
| 38 | 1.51 | .62 | 837. |
| 39 | .39 | .06 | 2797. |
| 40 | 0 | 0 | 4283. |
| 41 | 0 | 0 | 4068. |
| 42 | 0 | 0 | 3079. |
| 43 | .06 | 0 | 2276. |
| 44 | 1.01 | .37 | 2150. |
| 45 | .35 | .06 | 2909. |
| 46 | .07 | 0 | 3532. |
| 47 | .01 | 0 | 3207. |
| 48 | 0 | 0 | 2434. |
| 49 | 0 | 0 | 1799. |
| 50 | .42 | .08 | 1437. |
| 51 | .39 | .08 | 1441. |
| 52 | .18 | .00 | 1591. |
| 53 | .13 | 0 | 1514. |
| 54 | .50 | .13 | 1375. |
| 55 | .40 | .09 | 1589. |
| 56 | .09 | .00 | 1921. |
| 57 | 0 | 0 | 1870. |
| 58 | .06 | 0 | 1465. |
| 59 | .21 | .02 | 1100. |
| 60 | .04 | 0 | 865. |
| 61 | .03 | 0 | 689. |
| 62 | .02 | 0 | 526. |
| 63 | .22 | .02 | 411. |
| 64 | .22 | .02 | 373. |
| 65 | .04 | 0 | 392. |
| 66 | .42 | .10 | 502. |
| 67 | .22 | .02 | 772. |
| 68 | .13 | 0 | 981. |
| 69 | .03 | 0 | 913. |
| 70 | 0 | 0 | 697. |
| 71 | 0 | 0 | 513. |
| 72 | 0 | 0 | 379. |
| 73 | .09 | .00 | 280. |
| 74 | .06 | 0 | 202. |
| 75 | 0 | 0 | 185. |
| 76 | 0 | 0 | 169. |
| 77 | 0 | 0 | 154. |
| 78 | 0 | 0 | 140. |
| 79 | 0 | 0 | 128. |
| 80 | 0 | 0 | 117. |
| 81 | .12 | 0 | 107. |
| 82 | .62 | .19 | 255. |
| 83 | .49 | .13 | 981. |
| 84 | .02 | 0 | 1762. |
| 85 | .01 | 0 | 1930. |
| 86 | .13 | 0 | 1569. |
| 87 | .42 | .10 | 1286. |
| 88 | .15 | 0 | 1287. |

526814

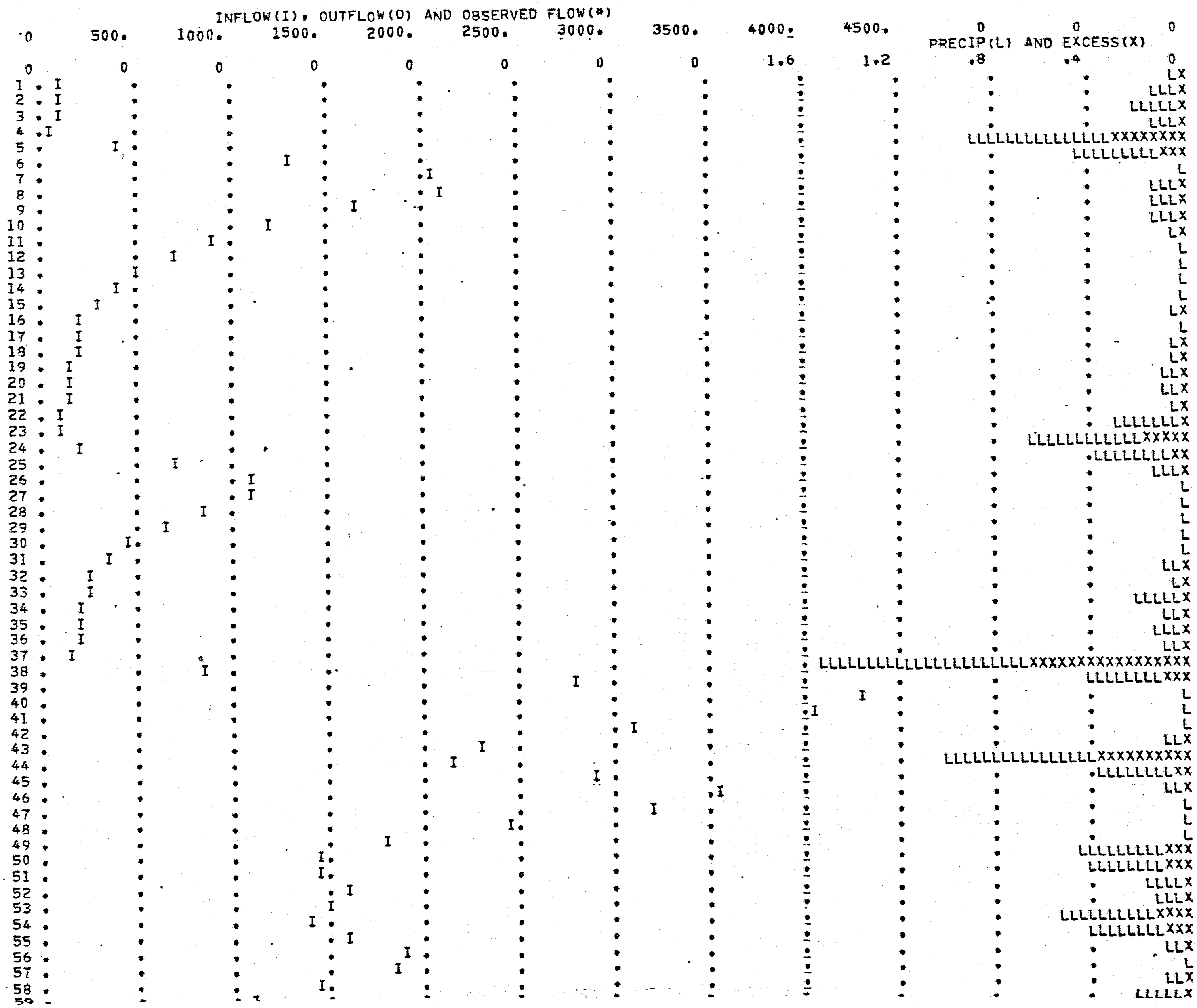
| | | | |
|---|---|---|---|
| 90 | 0 | 0 | 1052. |
| 91 | 0 | 0 | 778. |
| 92 | .03 | 0 | 575. |
| 93 | 0 | 0 | 425. |
| 94 | 0 | 0 | 314. |
| 95 | .16 | 0 | 232. |
| 96 | .52 | .14 | 353. |
| 97 | .31 | .05 | 805. |
| 98 | .01 | 0 | 1226. |
| 99 | 0 | 0 | 1232. |
| 100 | .03 | 0 | 969. |
| SUM | 1481.00 | 281.00 | 96248. |

*OVF*

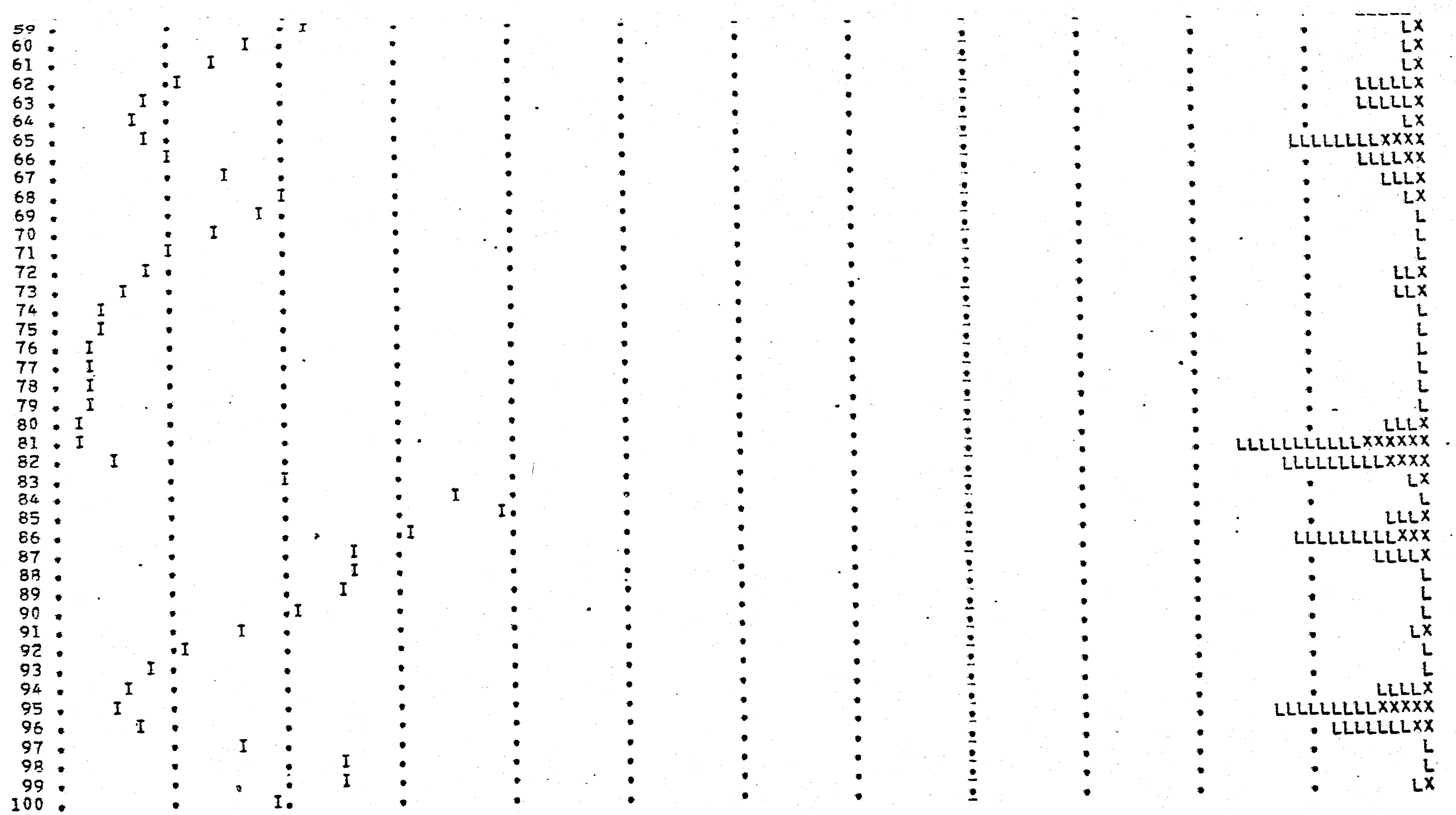
526815

*OVF*

STATION 10



526816




20 -0 0 73

*OVF*
*OVN*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RECORD ENTERED BY RANDSK | WRITE | 4 | 1 | 1 | 10 | 1 | 20 | R | R | R | 16 | 0 |
| RECORD ENTERED BY RANDSK | WRITE | 4 | 1 | 1 | 3 | 1 | 100 | R | R | R | 19 | 0 |

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SEGMENT 2 OF 2 SEGMENTS

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********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF COMPUTATION OF STATION 10

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT |
|---|---|---|---|---|---|
| 10 | -0 | -0 | -0 | -0 | -0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| -0 | -0 | 1280.00 | -0 | -0 | -0 | -0 | -0 | -0 | -0 |

PRECIP DATA

| NP | STORM | DAJ | DAK |
|---|---|---|---|
| 50 | -0 | -0 | -0 |

PRECIP PATTERN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | .03 | .25 | 0 | 0 | 0 | 0 | 0 | .01 |
| .01 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 |
| .04 | 0 | 0 | 0 | 0 | .02 | .01 | .04 | .03 | .09 |
| .39 | .18 | .13 | .50 | .40 | .09 | 0 | .06 | .21 | .04 |
| 0 | .07 | .02 | -0 | -0 | -0 | -0 | -0 | -0 | 0 |

LOSS DATA

| STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP | REC | RECOV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| .30 | .20 | 2.00 | .70 | -0 | -0 | 0 | -0 | -0 | -0 | 1.00 | .10 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| LOSS RATE INITIAL VALUE | 2.00 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 |

UNIT HYDROGRAPH DATA

NCLRK= -0 TC= 70.00 R= 80.00

RECESSION DATA

STRTQ= 100.0 QRCSN= 200.0 RTIOR= 2.50

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I | I | I | I | I | I | I | I | I | I | 0 | 3.89 | .23 | 0 | 0 |
| 2 | I | I | I | I | I | I | I | I | I | I | 0 | 3.79 | .23 | 0 | 0 |
| 3 | I | I | I | I | I | I | I | I | I | I | .03 | 3.72 | .23 | 0 | .03 |
| 4 | I | I | I | I | I | I | I | I | I | I | .23 | 3.85 | .23 | .02 | .25 |
| 5 | I | I | I | I | I | I | I | I | I | I | 0 | 3.75 | .23 | 0 | 0 |
| 6 | I | I | I | I | I | I | I | I | I | I | 0 | 3.65 | .23 | 0 | 0 |
| 7 | I | I | I | I | I | I | I | I | I | I | 0 | 3.55 | .23 | 0 | 0 |
| 8 | I | I | I | I | I | I | I | I | I | I | 0 | 3.45 | .23 | 0 | 0 |
| 9 | I | I | I | I | I | I | I | I | I | I | 0 | 3.35 | .23 | 0 | 0 |
| 10 | I | I | I | I | I | I | I | I | I | I | .01 | 3.26 | .24 | 0 | .01 |
| 11 | I | I | I | I | I | I | I | I | I | I | .01 | 3.17 | .24 | 0 | .01 |
| 12 | I | I | I | I | I | I | I | I | I | I | 0 | 3.07 | .24 | 0 | -0 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14 | I | I | I | I | I | I | I | I | I | I | 0 | 2.87 | .24 | 0 | -0 |
| 15 | I | I | I | I | I | I | I | I | I | I | 0 | 2.77 | .24 | 0 | -0 |
| 16 | I | I | I | I | I | I | I | I | I | I | 0 | 2.67 | .24 | 0 | -0 |
| 17 | I | I | I | I | I | I | I | I | I | I | 0 | 2.57 | .24 | 0 | -0 |
| 18 | I | I | I | I | I | I | I | I | I | I | 0 | 2.47 | .24 | 0 | -0 |
| 19 | I | I | I | I | I | I | I | I | I | I | 0 | 2.37 | .24 | 0 | -0 |
| 20 | I | I | I | I | I | I | I | I | I | I | 0 | 2.27 | .24 | 0 | -0 |
| 21 | I | I | I | I | I | I | I | I | I | I | .04 | 2.21 | .26 | 0 | .04 |
| 22 | I | I | I | I | I | I | I | I | I | I | 0 | 2.11 | .26 | 0 | 0 |
| 23 | I | I | I | I | I | I | I | I | I | I | 0 | 2.01 | .26 | 0 | 0 |
| 24 | I | I | I | I | I | I | I | I | I | I | 0 | 1.91 | .26 | 0 | 0 |
| 25 | I | I | I | I | I | I | I | I | I | I | 0 | 1.81 | .26 | 0 | 0 |
| 26 | I | I | I | I | I | I | I | I | I | I | .02 | 1.73 | .26 | 0 | .02 |
| 27 | I | I | I | I | I | I | I | I | I | I | .01 | 1.64 | .27 | 0 | .01 |
| 28 | I | I | I | I | I | I | I | I | I | I | .04 | 1.58 | .27 | 0 | .04 |
| 29 | I | I | I | I | I | I | I | I | I | I | .03 | 1.51 | .27 | 0 | .03 |
| 30 | I | I | I | I | I | I | I | I | I | I | .09 | 1.50 | .27 | .00 | .09 |
| 31 | I | I | I | I | I | I | I | I | I | I | .36 | 1.77 | .27 | .03 | .39 |
| 32 | I | I | I | I | I | I | I | I | I | I | .18 | 1.85 | .27 | .00 | .18 |
| 33 | I | I | I | I | I | I | I | I | I | I | .13 | 1.88 | .26 | 0 | .13 |
| 34 | I | I | I | I | I | I | I | I | I | I | .42 | 2.20 | .26 | .08 | .50 |
| 35 | I | I | I | I | I | I | I | I | I | I | .35 | 2.45 | .26 | .05 | .40 |
| 36 | I | I | I | I | I | I | I | I | I | I | .09 | 2.44 | .25 | .00 | .09 |
| 37 | I | I | I | I | I | I | I | I | I | I | 0 | 2.34 | .25 | 0 | 0 |
| 38 | I | I | I | I | I | I | I | I | I | I | .06 | 2.30 | .26 | 0 | .06 |
| 39 | I | I | I | I | I | I | I | I | I | I | .21 | 2.41 | .26 | 0 | .21 |
| 40 | I | I | I | I | I | I | I | I | I | I | .04 | 2.35 | .25 | 0 | .04 |
| 41 | I | I | I | I | I | I | I | I | I | I | 0 | 2.25 | .25 | 0 | 0 |
| 42 | I | I | I | I | I | I | I | I | I | I | .07 | 2.22 | .26 | 0 | .07 |
| 43 | I | I | I | I | I | I | I | I | I | I | .02 | 2.14 | .26 | 0 | .02 |
| 44 | I | I | I | I | I | I | I | I | I | I | 0 | 2.04 | .26 | 0 | -0 |
| 45 | I | I | I | I | I | I | I | I | I | I | 0 | 1.94 | .26 | 0 | -0 |
| 46 | I | I | I | I | I | I | I | I | I | I | 0 | 1.84 | .26 | 0 | -0 |
| 47 | I | I | I | I | I | I | I | I | I | I | 0 | 1.74 | .26 | 0 | -0 |
| 48 | I | I | I | I | I | I | I | I | I | I | 0 | 1.64 | .26 | 0 | -0 |
| 49 | I | I | I | I | I | I | I | I | I | I | 0 | 1.54 | .26 | 0 | -0 |
| 50 | I | I | I | I | I | I | I | I | I | I | 0 | 1.44 | .26 | 0 | -0 |

2 2 50 1.07E+05 4.28E+03 0 1.00E-02 I I

UNIT HYDROGRAPH 20 END-OF-PERIOD ORDINATES, LAG= 62.53 HOURS, CP= .48 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1274. | 4311. | 6399. | 5848. | 4322. | 3195. | 2361. | 1745. | 1290. | 953. |
| 705. | 521. | 385. | 285. | 210. | 155. | 115. | 85. | 63. | 46. |

END-OF-PERIOD FLOW

| TIME | RAIN | EXCS | COMP Q |
|---|---|---|---|
| 1 | 0 | 0 | 716. |
| 2 | 0 | 0 | 523. |
| 3 | .03 | 0 | 382. |
| 4 | .25 | .02 | 311. |
| 5 | 0 | 0 | 304. |
| 6 | 0 | 0 | 296. |
| 7 | 0 | 0 | 240. |
| 8 | 0 | 0 | 219. |
| 9 | 0 | 0 | 200. |
| 10 | .01 | 0 | 182. |
| 11 | .01 | 0 | 166. |
| 12 | -0 | 0 | 152. |
| 13 | -0 | 0 | 139. |
| 14 | -0 | 0 | 126. |
| 15 | -0 | 0 | 115. |
| 16 | -0 | 0 | 105. |
| 17 | -0 | 0 | 96. |
| 18 | -0 | 0 | 88. |
| 19 | -0 | 0 | 80. |
| 20 | -0 | 0 | 73. |

*OVN*

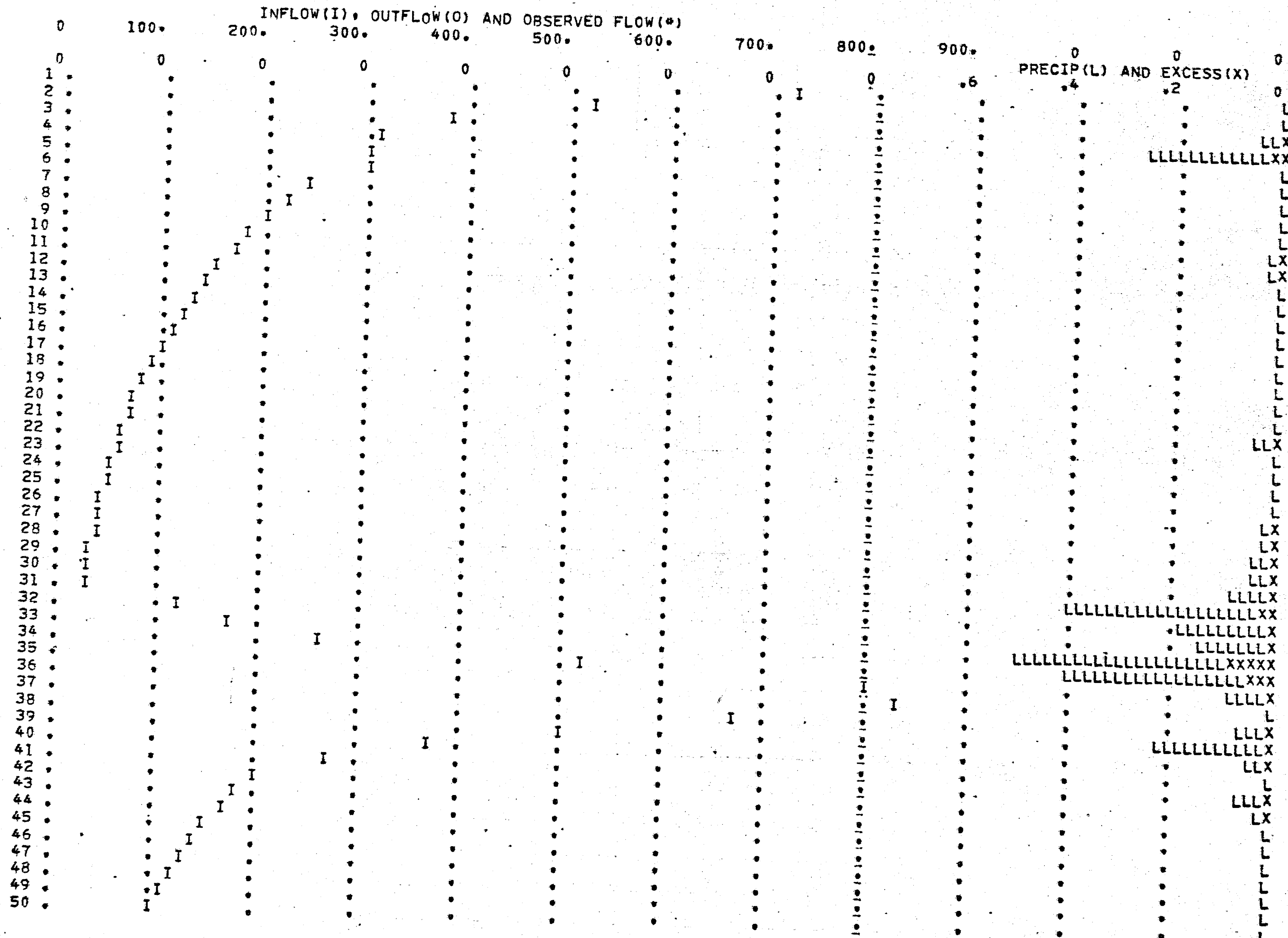
526819

| | | | |
|---|---|---|---|
| 20 | -0 | 0 | 73. |
| 21 | .04 | 0 | 67. |
| 22 | 0 | 0 | 61. |
| 23 | 0 | 0 | 55. |
| 24 | 0 | 0 | 51. |
| 25 | 0 | 0 | 46. |
| 26 | .02 | 0 | 42. |
| 27 | .01 | 0 | 38. |
| 28 | .04 | 0 | 35. |
| 29 | .03 | 0 | 32. |
| 30 | .09 | .00 | 29. |
| 31 | .39 | .03 | 35. |
| 32 | .18 | .00 | 117. |
| 33 | .13 | 0 | 174. |
| 34 | .50 | .08 | 260. |
| 35 | .40 | .05 | 520. |
| 36 | .09 | .00 | 801. |
| 37 | 0 | 0 | 835. |
| 38 | .06 | 0 | 671. |
| 39 | .21 | 0 | 496. |
| 40 | .04 | 0 | 366. |
| 41 | 0 | 0 | 271. |
| 42 | .07 | 0 | 200. |
| 43 | .02 | 0 | 183. |
| 44 | -0 | 0 | 167. |
| 45 | -0 | 0 | 152. |
| 46 | -0 | 0 | 139. |
| 47 | -0 | 0 | 127. |
| 48 | -0 | 0 | 116. |
| 49 | -0 | 0 | 105. |
| 50 | -0 | 0 | 96. |
| SUM | 17.43 | 2.99 | 107048. |

*OVF*

526820

STATION 10



526821

```
*OVN*
                                                  21      .04       0       67.
*OVN*
RECORD ENTERED BY RANDSK    WRITE     4     1 '  2     3     1    50              R              R              R              23    0


    ******************************

    SEGMENT   1  OF   2  SEGMENTS

    ******************************


          **********        **********        **********        **********        **********

                                  SUB-AREA RUNOFF COMPUTATION

                      RUNOFF COMPUTATION OF STATION 20

                               ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT
                                  20      -0      -0      -0      -0      -0

                                          HYDROGRAPH DATA
                 IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
                    -0      -1 1280.00      -0      -0      -0      -0      -0      -0      -0
RECORD ENTERED BY RANDSK    WRITE     4     1    1     1     2   100              R              R              R              26    0
RECORD ENTERED BY RANDSK    WRITE     4     1    2     1     2    50              0              0              R              28    0

                                           PRECIP DATA
                                    NP   STORM     DAJ     DAK
                                  -100      -0      -0      -0

                                            LOSS DATA
          STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP     REC   RECOV
             -0      -0      -0      -0      -0      -0     .75     .01      -0      -0    1.00      -0


    LOSS RATE INITIAL VALUE        -0      -0      -0      -0      -0      -0      -0      -0      -0      -0

                                  GIVEN UNIT GRAPH, NUHGQ=  79
                 0        5.       10.      180.      349.     1959.     3569.     5395.     7221.     7374.
             7526.     7066.     6606.     6171.     5736.     5358.     4980.     4652.     4323.     4038.
             3753.     3506.     3258.     3043.     2829.     2642.     2456.     2294.     2132.     1992.
             1851.     1729.     1607.     1501.     1359.     1303.     1211.     1131.     1051.      982.
              913.      853.      792.      740.      688.      643.      597.      558.      518.      484.
              450.      421.      391.      365.      339.      316.      294.      275.      255.      255.
              255.      239.      222.      207.      192.      180.      167.      156.      145.      136.
              126.      118.      109.      102.       95.       88.       82.       76.       71.

                                           RECESSION DATA
                              STRTQ=  100.0     QRCSN=  200.0     RTIOR= 2.00
  1     I     I     I     I     I     I     I     I     I     I   .02    .02   .26     0   .02
  2     I     I     I     I     I     I     I     I     I     I   .11    .13   .26   .00   .11
  3     I     I     I     I     I     I     I     I     I     I   .22    .35   .26   .00   .22
  4     I     I     I     I     I     I     I     I     I     I   .11    .46   .26   .00   .11
  5     I     I     I     I     I     I     I     I     I     I   .45    .91   .26   .43   .88
  6     I     I     I     I     I     I     I     I     I     I   .24   1.15   .26   .21   .45
  7     I     I     I     I     I     I     I     I     I     I     0   1.15   .26     0     0
  8     I     I     I     I     I     I     I     I     I     I   .11   1.26   .26   .00   .11
  9     I     I     I     I     I     I     I     I     I     I   .13   1.39   .26     0   .13
 10     I     I     I     I     I     I     I     I     I     I   .14   1.53   .26     0   .14
```

526822

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | I | I | I | I | I | I | I | I | I | I | 0 | 1.57 | .26 | 0 | 0 |
| 13 | I | I | I | I | I | I | I | I | I | I | 0 | 1.57 | .26 | 0 | 0 |
| 14 | I | I | I | I | I | I | I | I | I | I | 0 | 1.57 | .26 | 0 | 0 |
| 15 | I | I | I | I | I | I | I | I | I | I | 0 | 1.57 | .26 | 0 | 0 |
| 16 | I | I | I | I | I | I | I | I | I | I | .02 | 1.59 | .26 | 0 | .02 |
| 17 | I | I | I | I | I | I | I | I | I | I | .01 | 1.60 | .26 | 0 | .01 |
| 18 | I | I | I | I | I | I | I | I | I | I | .04 | 1.64 | .26 | 0 | .04 |
| 19 | I | I | I | I | I | I | I | I | I | I | .03 | 1.67 | .26 | 0 | .03 |
| 20 | I | I | I | I | I | I | I | I | I | I | .09 | 1.76 | .26 | .00 | .09 |
| 21 | I | I | I | I | I | I | I | I | I | I | .06 | 1.82 | .26 | 0 | .06 |
| 22 | I | I | I | I | I | I | I | I | I | I | .04 | 1.86 | .26 | 0 | .04 |
| 23 | I | I | I | I | I | I | I | I | I | I | .24 | 2.10 | .26 | .03 | .27 |
| 24 | I | I | I | I | I | I | I | I | I | I | .24 | 2.34 | .26 | .40 | .64 |
| 25 | I | I | I | I | I | I | I | I | I | I | .24 | 2.58 | .26 | .11 | .35 |
| 26 | I | I | I | I | I | I | I | I | I | I | .13 | 2.71 | .26 | 0 | .13 |
| 27 | I | I | I | I | I | I | I | I | I | I | 0 | 2.71 | .26 | 0 | 0 |
| 28 | I | I | I | I | I | I | I | I | I | I | 0 | 2.71 | .26 | 0 | 0 |
| 29 | I | I | I | I | I | I | I | I | I | I | 0 | 2.71 | .26 | 0 | 0 |
| 30 | I | I | I | I | I | I | I | I | I | I | 0 | 2.71 | .26 | 0 | 0 |
| 31 | I | I | I | I | I | I | I | I | I | I | 0 | 2.71 | .26 | 0 | 0 |
| 32 | I | I | I | I | I | I | I | I | I | I | .07 | 2.78 | .26 | 0 | .07 |
| 33 | I | I | I | I | I | I | I | I | I | I | .02 | 2.80 | .26 | 0 | .02 |
| 34 | I | I | I | I | I | I | I | I | I | I | .19 | 2.99 | .26 | .00 | .19 |
| 35 | I | I | I | I | I | I | I | I | I | I | .09 | 3.08 | .26 | .00 | .09 |
| 36 | I | I | I | I | I | I | I | I | I | I | .14 | 3.22 | .26 | 0 | .14 |
| 37 | I | I | I | I | I | I | I | I | I | I | .09 | 3.31 | .26 | .00 | .09 |
| 38 | I | I | I | I | I | I | I | I | I | I | .24 | 3.55 | .26 | 1.27 | 1.51 |
| 39 | I | I | I | I | I | I | I | I | I | I | .24 | 3.79 | .26 | .15 | .39 |
| 40 | I | I | I | I | I | I | I | I | I | I | 0 | 3.79 | .26 | 0 | 0 |
| 41 | I | I | I | I | I | I | I | I | I | I | 0 | 3.79 | .26 | 0 | 0 |
| 42 | I | I | I | I | I | I | I | I | I | I | 0 | 3.79 | .26 | 0 | 0 |
| 43 | I | I | I | I | I | I | I | I | I | I | .06 | 3.85 | .26 | 0 | .06 |
| 44 | I | I | I | I | I | I | I | I | I | I | .24 | 4.09 | .26 | .77 | 1.01 |
| 45 | I | I | I | I | I | I | I | I | I | I | .24 | 4.33 | .26 | .11 | .35 |
| 46 | I | I | I | I | I | I | I | I | I | I | .07 | 4.40 | .26 | 0 | .07 |
| 47 | I | I | I | I | I | I | I | I | I | I | .01 | 4.41 | .26 | 0 | .01 |
| 48 | I | I | I | I | I | I | I | I | I | I | 0 | 4.41 | .26 | 0 | 0 |
| 49 | I | I | I | I | I | I | I | I | I | I | 0 | 4.41 | .26 | 0 | 0 |
| 50 | I | I | I | I | I | I | I | I | I | I | .24 | 4.65 | .26 | .18 | .42 |
| 51 | I | I | I | I | I | I | I | I | I | I | .24 | 4.89 | .26 | .15 | .39 |
| 52 | I | I | I | I | I | I | I | I | I | I | .18 | 5.07 | .26 | .00 | .18 |
| 53 | I | I | I | I | I | I | I | I | I | I | .13 | 5.20 | .26 | 0 | .13 |
| 54 | I | I | I | I | I | I | I | I | I | I | .24 | 5.44 | .26 | .26 | .50 |
| 55 | I | I | I | I | I | I | I | I | I | I | .24 | 5.68 | .26 | .16 | .40 |
| 56 | I | I | I | I | I | I | I | I | I | I | .09 | 5.77 | .26 | .00 | .09 |
| 57 | I | I | I | I | I | I | I | I | I | I | 0 | 5.77 | .26 | 0 | 0 |
| 58 | I | I | I | I | I | I | I | I | I | I | .06 | 5.83 | .26 | 0 | .06 |
| 59 | I | I | I | I | I | I | I | I | I | I | .21 | 6.04 | .26 | 0 | .21 |
| 60 | I | I | I | I | I | I | I | I | I | I | .04 | 6.08 | .26 | 0 | .04 |
| 61 | I | I | I | I | I | I | I | I | I | I | .03 | 6.11 | .26 | 0 | .03 |
| 62 | I | I | I | I | I | I | I | I | I | I | .02 | 6.13 | .26 | 0 | .02 |
| 63 | I | I | I | I | I | I | I | I | I | I | .22 | 6.35 | .26 | .00 | .22 |
| 64 | I | I | I | I | I | I | I | I | I | I | .22 | 6.57 | .26 | .00 | .22 |
| 65 | I | I | I | I | I | I | I | I | I | I | .04 | 6.61 | .26 | 0 | .04 |
| 66 | I | I | I | I | I | I | I | I | I | I | .24 | 6.85 | .26 | .18 | .42 |
| 67 | I | I | I | I | I | I | I | I | I | I | .22 | 7.07 | .26 | .00 | .22 |
| 68 | I | I | I | I | I | I | I | I | I | I | .13 | 7.20 | .26 | 0 | .13 |
| 69 | I | I | I | I | I | I | I | I | I | I | .03 | 7.23 | .26 | 0 | .03 |
| 70 | I | I | I | I | I | I | I | I | I | I | 0 | 7.23 | .26 | 0 | 0 |
| 71 | I | I | I | I | I | I | I | I | I | I | 0 | 7.23 | .26 | 0 | 0 |
| 72 | I | I | I | I | I | I | I | I | I | I | 0 | 7.23 | .26 | 0 | 0 |
| 73 | I | I | I | I | I | I | I | I | I | I | .09 | 7.32 | .26 | .00 | .09 |
| 74 | I | I | I | I | I | I | I | I | I | I | .06 | 7.38 | .26 | 0 | .06 |
| 75 | I | I | I | I | I | I | I | I | I | I | 0 | 7.38 | .26 | 0 | 0 |
| 76 | I | I | I | I | I | I | I | I | I | I | 0 | 7.38 | .26 | 0 | 0 |
| 77 | I | I | I | I | I | I | I | I | I | I | 0 | 7.38 | .26 | 0 | 0 |

*DVN*

526823 26819

| | | | |
|---|---|---|---|
| 21 | .04 | 0 | 67. |
| 22 | 0 | 0 | 61. |
| 23 | 0 | 0 | 55. |
| 24 | 0 | 0 | 51. |
| 25 | 0 | 0 | 46. |
| 26 | .02 | 0 | 42. |
| 27 | .01 | 0 | 38. |

| | | | | | |
|---|---|---|---|---|---|
| 78 | 0 | 7.38 | .26 | 0 | 0 |
| 79 | 0 | 7.38 | .26 | 0 | 0 |
| 80 | 0 | 7.38 | .26 | 0 | 0 |
| 81 | .12 | 7.50 | .26 | 0 | .12 |
| 82 | .24 | 7.74 | .26 | .38 | .62 |
| 83 | .24 | 7.98 | .26 | .25 | .49 |
| 84 | .02 | 8.00 | .26 | 0 | .02 |
| 85 | .01 | 8.01 | .26 | 0 | .01 |
| 86 | .13 | 8.14 | .26 | 0 | .13 |
| 87 | .24 | 8.38 | .26 | .18 | .42 |
| 88 | .15 | 8.53 | .26 | 0 | .15 |
| 89 | 0 | 8.53 | .26 | 0 | 0 |
| 90 | 0 | 8.53 | .26 | 0 | 0 |
| 91 | 0 | 8.53 | .26 | 0 | 0 |
| 92 | .03 | 8.56 | .26 | 0 | .03 |
| 93 | 0 | 8.56 | .26 | 0 | 0 |
| 94 | 0 | 8.56 | .26 | 0 | 0 |
| 95 | .16 | 8.72 | .26 | 0 | .16 |
| 96 | .24 | 8.96 | .26 | .28 | .52 |
| 97 | .24 | 9.20 | .26 | .07 | .31 |
| 98 | .01 | 9.21 | .26 | 0 | .01 |
| 99 | 0 | 9.21 | .26 | 0 | 0 |
| 100 | .03 | 9.24 | .26 | 0 | .03 |

1 2 100 6.49E+05 1.59E+04 0 1.00E-02

UNIT HYDROGRAPH 79 END-OF-PERIOD ORDINATES, LAG= 62.53 HOURS, CP= .48 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 5. | 10. | 180. | 349. | 1959. | 3569. | 5395. | 7221. | 7374. |
| 7526. | 7066. | 6606. | 6171. | 5736. | 5358. | 4980. | 4652. | 4323. | 4038. |
| 3753. | 3506. | 3258. | 3043. | 2829. | 2642. | 2456. | 2294. | 2132. | 1992. |
| 1851. | 1729. | 1607. | 1501. | 1359. | 1303. | 1211. | 1131. | 1051. | 982. |
| 913. | 853. | 792. | 740. | 688. | 643. | 597. | 558. | 518. | 484. |
| 450. | 421. | 391. | 365. | 339. | 316. | 294. | 275. | 255. | 255. |
| 255. | 239. | 222. | 207. | 192. | 180. | 167. | 156. | 145. | 136. |
| 126. | 118. | 109. | 102. | 95. | 88. | 82. | 76. | 71. | |

END-OF-PERIOD FLOW

| TIME | RAIN | EXCS | COMP Q |
|---|---|---|---|
| 1 | .02 | 0 | 93. |
| 2 | .11 | .00 | 87. |
| 3 | .22 | .00 | 81. |
| 4 | .11 | .00 | 76. |
| 5 | .88 | .43 | 71. |
| 6 | .45 | .21 | 68. |
| 7 | 0 | 0 | 67. |
| 8 | .11 | .00 | 137. |
| 9 | .13 | 0 | 241. |
| 10 | .14 | 0 | 964. |
| 11 | .04 | 0 | 1989. |
| 12 | 0 | 0 | 3108. |
| 13 | 0 | 0 | 4272. |
| 14 | 0 | 0 | 4718. |
| 15 | 0 | 0 | 4813. |
| 16 | .02 | 0 | 4645. |
| 17 | .01 | 0 | 4349. |
| 18 | .04 | 0 | 4064. |
| 19 | .03 | 0 | 3784. |
| 20 | .09 | .00 | 3529. |
| 21 | .06 | 0 | 3285. |
| 22 | .04 | 0 | 3064. |
| 23 | .27 | .03 | 2852. |
| 24 | .64 | .40 | 2660. |
| 25 | .35 | .11 | 2478. |
| 26 | .13 | 0 | 2319. |

526824

| | | | |
|---|---|---|---|
| 30 | 0 | 0 | 3545. |
| 31 | 0 | 0 | 4388. |
| 32 | .07 | 0 | 5214. |
| 33 | .02 | 0 | 5376. |
| 34 | .19 | .00 | 5345. |
| 35 | .09 | .00 | 5074. |
| 36 | .14 | 0 | 4744. |
| 37 | .09 | .00 | 4427. |
| 38 | 1.51 | 1.27 | 4123. |
| 39 | .39 | .15 | 3835. |
| 40 | 0 | 0 | 3585. |
| 41 | 0 | 0 | 3567. |
| 42 | 0 | 0 | 3577. |
| 43 | .06 | 0 | 5437. |
| 44 | 1.01 | .77 | 7524. |
| 45 | .35 | .11 | 9906. |
| 46 | .07 | 0 | 12330. |
| 47 | .01 | 0 | 12771. |
| 48 | 0 | 0 | 12986. |
| 49 | 0 | 0 | 13545. |
| 50 | .42 | .18 | 14178. |
| 51 | .39 | .15 | 15022. |
| 52 | .18 | .00 | 15899. |
| 53 | .13 | 0 | 15600. |
| 54 | .50 | .26 | 15154. |
| 55 | .40 | .16 | 14570. |
| 56 | .09 | .00 | 14147. |
| 57 | 0 | 0 | 13886. |
| 58 | .06 | 0 | 13684. |
| 59 | .21 | 0 | 13679. |
| 60 | .04 | 0 | 13660. |
| 61 | .03 | 0 | 13669. |
| 62 | .02 | 0 | 13635. |
| 63 | .22 | .00 | 13243. |
| 64 | .22 | .00 | 12607. |
| 65 | .04 | 0 | 11890. |
| 66 | .42 | .18 | 11084. |
| 67 | .22 | .00 | 10348. |
| 68 | .13 | 0 | 9631. |
| 69 | .03 | 0 | 9015. |
| 70 | 0 | 0 | 8423. |
| 71 | 0 | 0 | 8151. |
| 72 | 0 | 0 | 7854. |
| 73 | .09 | .00 | 7736. |
| 74 | .06 | 0 | 7600. |
| 75 | 0 | 0 | 7205. |
| 76 | 0 | 0 | 6824. |
| 77 | 0 | 0 | 6374. |
| 78 | 0 | 0 | 5910. |
| 79 | 0 | 0 | 5537. |
| 80 | 0 | 0 | 5154. |
| 81 | .12 | 0 | 4809. |
| 82 | .62 | .38 | 4475. |
| 83 | .49 | .25 | 4186. |
| 84 | .02 | 0 | 3871. |
| 85 | .01 | 0 | 3668. |
| 86 | .13 | 0 | 3528. |
| 87 | .42 | .18 | 3958. |
| 88 | .15 | 0 | 4746. |
| 89 | 0 | 0 | 5654. |
| 90 | 0 | 0 | 6651. |
| 91 | 0 | 0 | 7027. |
| 92 | .03 | 0 | 7248. |
| 93 | 0 | 0 | 7254. |
| 94 | 0 | 0 | 7151. |
| 95 | .16 | 0 | 7073. |

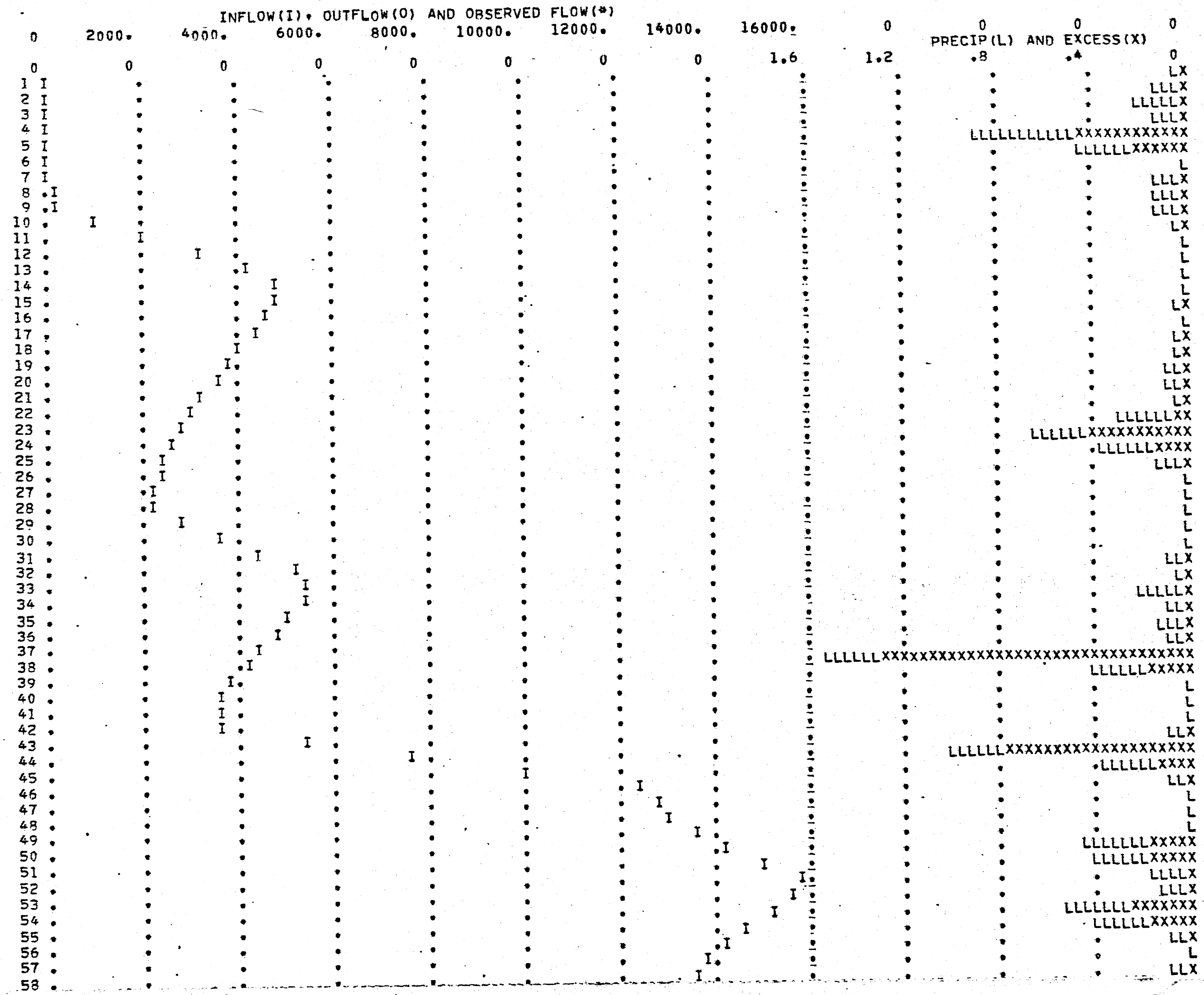
78 I I I I I I I I I I 0 7.38 .26 0 0

| | | | |
|---|---|---|---|
| 94 | 0 | 0 | 7151. |
| 95 | .16 | 0 | 7073. |
| 96 | .52 | .28 | 6701. |
| 97 | .31 | .07 | 6388. |
| 98 | .01 | 0 | 5986. |
| 99 | 0 | 0 | 5636. |
| 100 | .03 | 0 | 5307. |
| SUM | 1481.00 | 557.00 | 649049. |

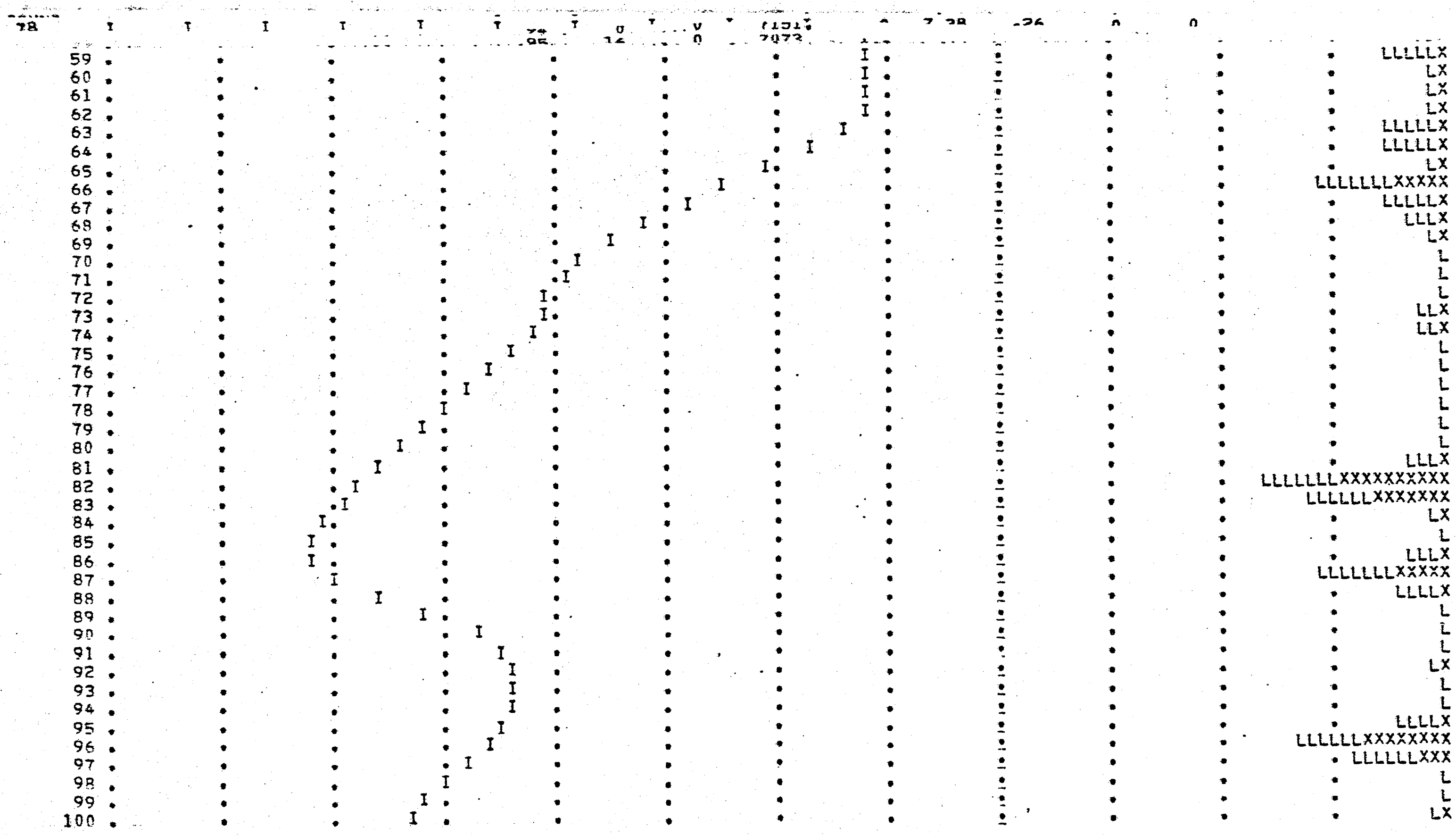
*OVF*

526826

STATION 20



526827



```
*OVN*
RECORD ENTERED BY RANDSK     WRITE     4    1    1   10    2   20                R             R             R             29   0
RECORD ENTERED BY RANDSK     WRITE     4    1    1    3    2  100                R             R             R             30   0
```

526828

*****************************

SEGMENT 2 OF 2 SEGMENTS

*****************************

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

RUNOFF COMPUTATION OF STATION 20

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT |
|---|---|---|---|---|---|
| 20 | -0 | -0 | -0 | -0 | -0 |

HYDROGRAPH DATA

| IHYDG | IUHG | TAREA | SNAP | TRSDA | TRSPC | RATIO | ISNOW | ISAME | LOCAL |
|---|---|---|---|---|---|---|---|---|---|
| -0 | -1 | 1280.00 | -0 | -0 | -0 | -0 | -0 | -0 | -0 |

PRECIP DATA

| NP | STORM | DAJ | DAK |
|---|---|---|---|
| 50 | -0 | -0 | -0 |

PRECIP PATTERN

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | .03 | .25 | 0 | 0 | 0 | 0 | 0 | .01 |
| .01 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 | -0 |
| .04 | 0 | 0 | 0 | 0 | .02 | .01 | .04 | .03 | .09 |
| .39 | .18 | .13 | .50 | .40 | .09 | 0 | .06 | .21 | .04 |
| 0 | .07 | .02 | -0 | -0 | -0 | -0 | -0 | -0 | 0 |

LOSS DATA

| STRKR | DLTKR | RTIOL | ERAIN | STRKS | RTIOK | STRTL | CNSTL | ALSMX | RTIMP | REC | RECOV |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -0 | -0 | -0 | -0 | -0 | -0 | 0 | .01 | -0 | -0 | 1.00 | 0 |

LOSS RATE INITIAL VALUE -0 -0 -0 -0 -0 -0 -0 -0 -0 -0

GIVEN UNIT GRAPH, NUHGQ= 79

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 5. | 10. | 180. | 349. | 1959. | 3569. | 5395. | 7221. | 7374. |
| 7526. | 7066. | 6606. | 6171. | 5736. | 5358. | 4980. | 4652. | 4323. | 4038. |
| 3753. | 3506. | 3258. | 3043. | 2829. | 2642. | 2456. | 2294. | 2132. | 1992. |
| 1851. | 1729. | 1607. | 1501. | 1359. | 1303. | 1211. | 1131. | 1051. | 982. |
| 913. | 853. | 792. | 740. | 688. | 643. | 597. | 558. | 518. | 484. |
| 450. | 421. | 391. | 365. | 339. | 316. | 294. | 275. | 255. | 255. |
| 255. | 239. | 222. | 207. | 192. | 180. | 167. | 156. | 145. | 136. |
| 126. | 118. | 109. | 102. | 95. | 88. | 82. | 76. | 71. | |

RECESSION DATA

STRTQ= 100.0 QRCSN= 200.0 RTIOR= 2.00

```
1    I    I    I    I    I    I    I    I    I    I
2    I    I    I    I    I    I    I    I    I    I      0   9.24   .26     0     0
3    I    I    I    I    I    I    I    I    I    I      0   9.24   .26     0     0
4    I    I    I    I    I    I    I    I    I    I    .03   9.27   .26     0   .03
5    I    I    I    I    I    I    I    I    I    I    .24   9.51   .26   .01   .25
6    I    I    I    I    I    I    I    I    I    I      0   9.51   .26     0     0
                              L    I    I    I    I      0   9.51   .26     0     0
                              22  .04   0  124.
```

526829

```
 7  I  I  I  I  I  I  I  I  I  I     0   9.51  .26    0     0
 8  I  I  I  I  I  I  I  I  I  I     0   9.51  .26    0     0
 9  I  I  I  I  I  I  I  I  I  I     0   9.51  .26    0     0
10  I  I  I  I  I  I  I  I  I  I   .01   9.52  .26    0   .01
11  I  I  I  I  I  I  I  I  I  I   .01   9.53  .26    0   .01
12  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
13  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
14  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
15  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
16  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
17  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
18  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
19  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
20  I  I  I  I  I  I  I  I  I  I     0   9.53  .26    0    -0
21  I  I  I  I  I  I  I  I  I  I   .04   9.57  .26    0   .04
22  I  I  I  I  I  I  I  I  I  I     0   9.57  .26    0     0
23  I  I  I  I  I  I  I  I  I  I     0   9.57  .26    0     0
24  I  I  I  I  I  I  I  I  I  I     0   9.57  .26    0     0
25  I  I  I  I  I  I  I  I  I  I     0   9.57  .26    0     0
26  I  I  I  I  I  I  I  I  I  I   .02   9.59  .26    0   .02
27  I  I  I  I  I  I  I  I  I  I   .01   9.60  .26    0   .01
28  I  I  I  I  I  I  I  I  I  I   .04   9.64  .26    0   .04
29  I  I  I  I  I  I  I  I  I  I   .03   9.67  .26    0   .03
30  I  I  I  I  I  I  I  I  I  I   .09   9.76  .26  .00   .09
31  I  I  I  I  I  I  I  I  I  I   .24  10.00  .26  .15   .39
32  I  I  I  I  I  I  I  I  I  I   .18  10.18  .26  .00   .18
33  I  I  I  I  I  I  I  I  I  I   .13  10.31  .26    0   .13
34  I  I  I  I  I  I  I  I  I  I   .24  10.55  .26  .26   .50
35  I  I  I  I  I  I  I  I  I  I   .24  10.79  .26  .16   .40
36  I  I  I  I  I  I  I  I  I  I   .09  10.88  .26  .00   .09
37  I  I  I  I  I  I  I  I  I  I     0  10.88  .26    0     0
38  I  I  I  I  I  I  I  I  I  I   .06  10.94  .26    0   .06
39  I  I  I  I  I  I  I  I  I  I   .21  11.15  .26    0   .21
40  I  I  I  I  I  I  I  I  I  I   .04  11.19  .26    0   .04
41  I  I  I  I  I  I  I  I  I  I     0  11.19  .26    0     0
42  I  I  I  I  I  I  I  I  I  I   .07  11.26  .26    0   .07
43  I  I  I  I  I  I  I  I  I  I   .02  11.28  .26    0   .02
44  I  I  I  I  I  I  I  I  I  I     0  11.28  .26    0    -0
45  I  I  I  I  I  I  I  I  I  I     0  11.28  .26    0    -0
46  I  I  I  I  I  I  I  I  I  I     0  11.28  .26    0    -0
47  I  I  I  I  I  I  I  I  I  I     0  11.28  .26    0    -0
48  I  I  I  I  I  I  I  I  I  I     0  11.28  .26    0    -0
49  I  I  I  I  I  I  I  I  I  I     0  11.28  .26    0    -0
50  I  I  I  I  I  I  I  I  I  I     0  11.28  .26    0    -0
  2  2  50  8.04E+05  1.59E+04   0  1.00E-02   I   I
```

UNIT HYDROGRAPH 79 END-OF-PERIOD ORDINATES, LAG= 62.53 HOURS, CP= .48 VOL= 1.00

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 5. | 10. | 180. | 349. | 1959. | 3569. | 5395. | 7221. | 7374. |
| 7526. | 7066. | 6606. | 6171. | 5736. | 5358. | 4980. | 4652. | 4323. | 4038. |
| 3753. | 3506. | 3258. | 3043. | 2829. | 2642. | 2456. | 2294. | 2132. | 1992. |
| 1851. | 1729. | 1607. | 1501. | 1359. | 1303. | 1211. | 1131. | 1051. | 982. |
| 913. | 853. | 792. | 740. | 688. | 643. | 597. | 558. | 518. | 484. |
| 450. | 421. | 391. | 365. | 339. | 316. | 294. | 275. | 255. | 255. |
| 255. | 239. | 222. | 207. | 192. | 180. | 167. | 156. | 145. | 136. |
| 126. | 118. | 109. | 102. | 95. | 88. | 82. | 76. | 71. | |

END-OF-PERIOD FLOW

| TIME | RAIN | EXCS | COMP Q |
|---|---|---|---|
| 1 | 0 | 0 | 5421. |
| 2 | 0 | 0 | 5650. |
| 3 | .03 | 0 | 5954. |
| 4 | .25 | .01 | 6314. |
| 5 | 0 | 0 | 6220. |
| 6 | 0 | 0 | 6025. |

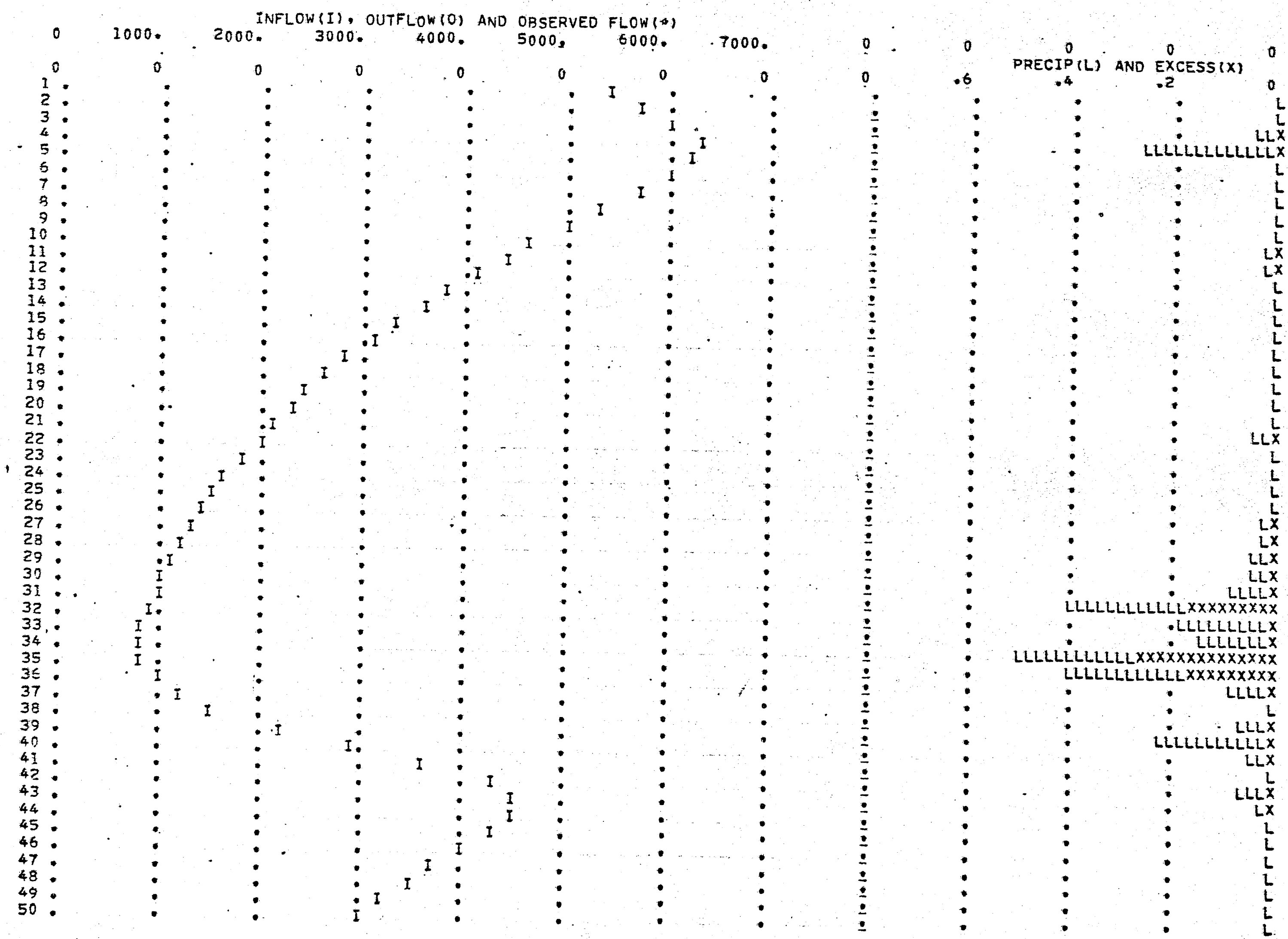
526830

| | | | |
|---|---|---|---|
| 8 | 0 | 0 | 5300. |
| 9 | 0 | 0 | 4964. |
| 10 | .01 | 0 | 4645. |
| 11 | .01 | 0 | 4355. |
| 12 | -0 | 0 | 4077. |
| 13 | -0 | 0 | 3812. |
| 14 | -0 | 0 | 3562. |
| 15 | -0 | 0 | 3325. |
| 16 | -0 | 0 | 3082. |
| 17 | -0 | 0 | 2794. |
| 18 | -0 | 0 | 2599. |
| 19 | -0 | 0 | 2423. |
| 20 | -0 | 0 | 2256. |
| 21 | .04 | 0 | 2097. |
| 22 | 0 | 0 | 1959. |
| 23 | 0 | 0 | 1776. |
| 24 | 0 | 0 | 1646. |
| 25 | 0 | 0 | 1537. |
| 26 | .02 | 0 | 1435. |
| 27 | .01 | 0 | 1338. |
| 28 | .04 | 0 | 1246. |
| 29 | .03 | 0 | 1149. |
| 30 | .09 | .00 | 1050. |
| 31 | .39 | .15 | 985. |
| 32 | .18 | .00 | 921. |
| 33 | .13 | 0 | 842. |
| 34 | .50 | .26 | 799. |
| 35 | .40 | .16 | 774. |
| 36 | .09 | .00 | 968. |
| 37 | 0 | 0 | 1209. |
| 38 | .06 | 0 | 1510. |
| 39 | .21 | 0 | 2191. |
| 40 | .04 | 0 | 2852. |
| 41 | 0 | 0 | 3580. |
| 42 | .07 | 0 | 4256. |
| 43 | .02 | 0 | 4493. |
| 44 | -0 | 0 | 4462. |
| 45 | -0 | 0 | 4262. |
| 46 | -0 | 0 | 3990. |
| 47 | -0 | 0 | 3728. |
| 48 | -0 | 0 | 3474. |
| 49 | -0 | 0 | 3236. |
| 50 | -0 | 0 | 3016. |
| SUM | 17.43 | 6.15 | 804285. |

22 .04 0 124.

*OVF*

STATION 20




526831

526832

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*OVN*
RECORD ENTERED BY RANDSK    WRITE    4   1   2   3   2   50          R          R          R          32   0
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SEGMENT 1 OF 2 SEGMENTS

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********** ********** ********** ********** **********

COMBINE HYDROGRAPHS

COMBINE TWO HYDROGRAPHS AT STATION 30

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT |
|---|---|---|---|---|---|
| 30 | 2 | -0 | -0 | -0 | -0 |

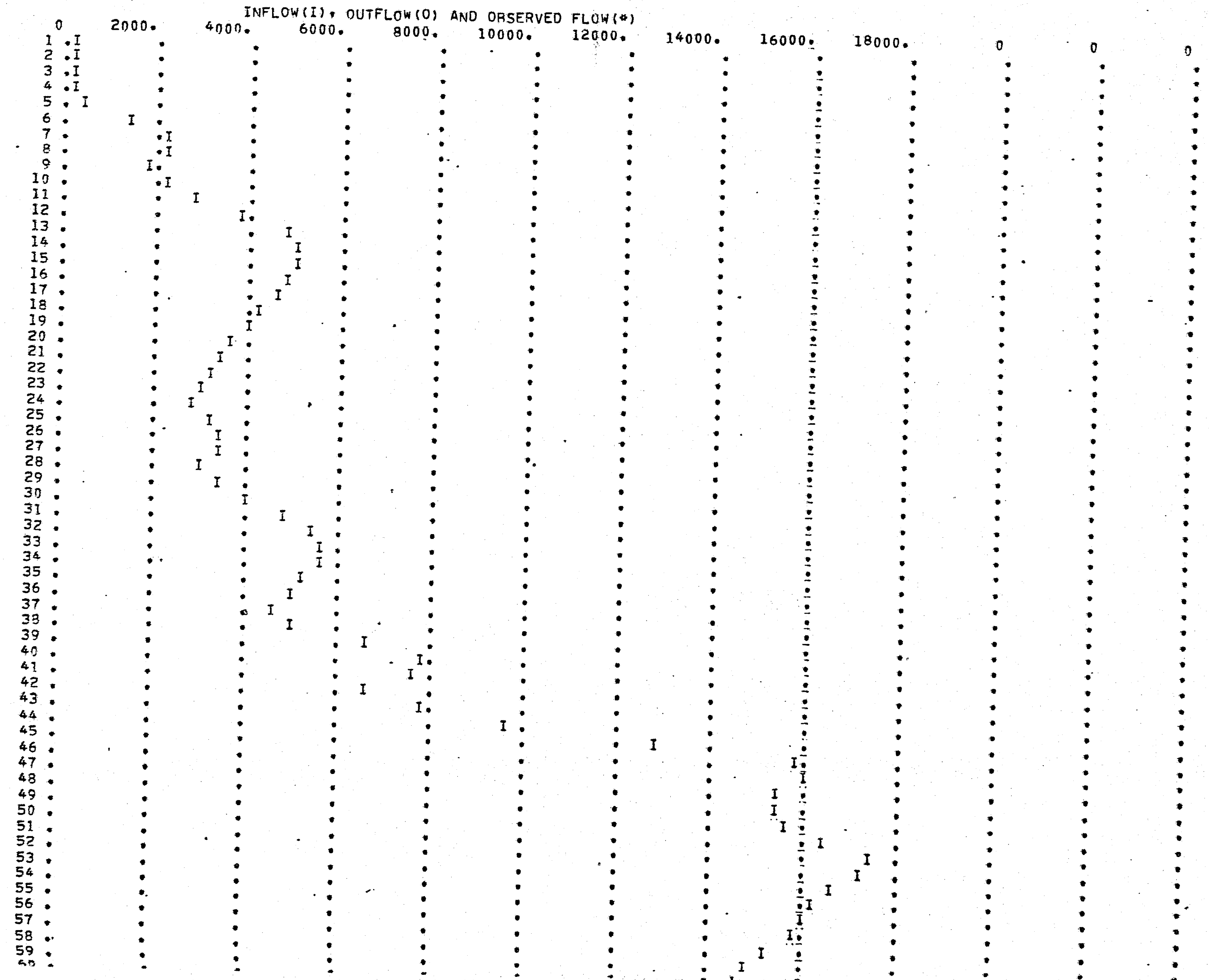
SUM OF 2 HYDROGRAPHS AT 30

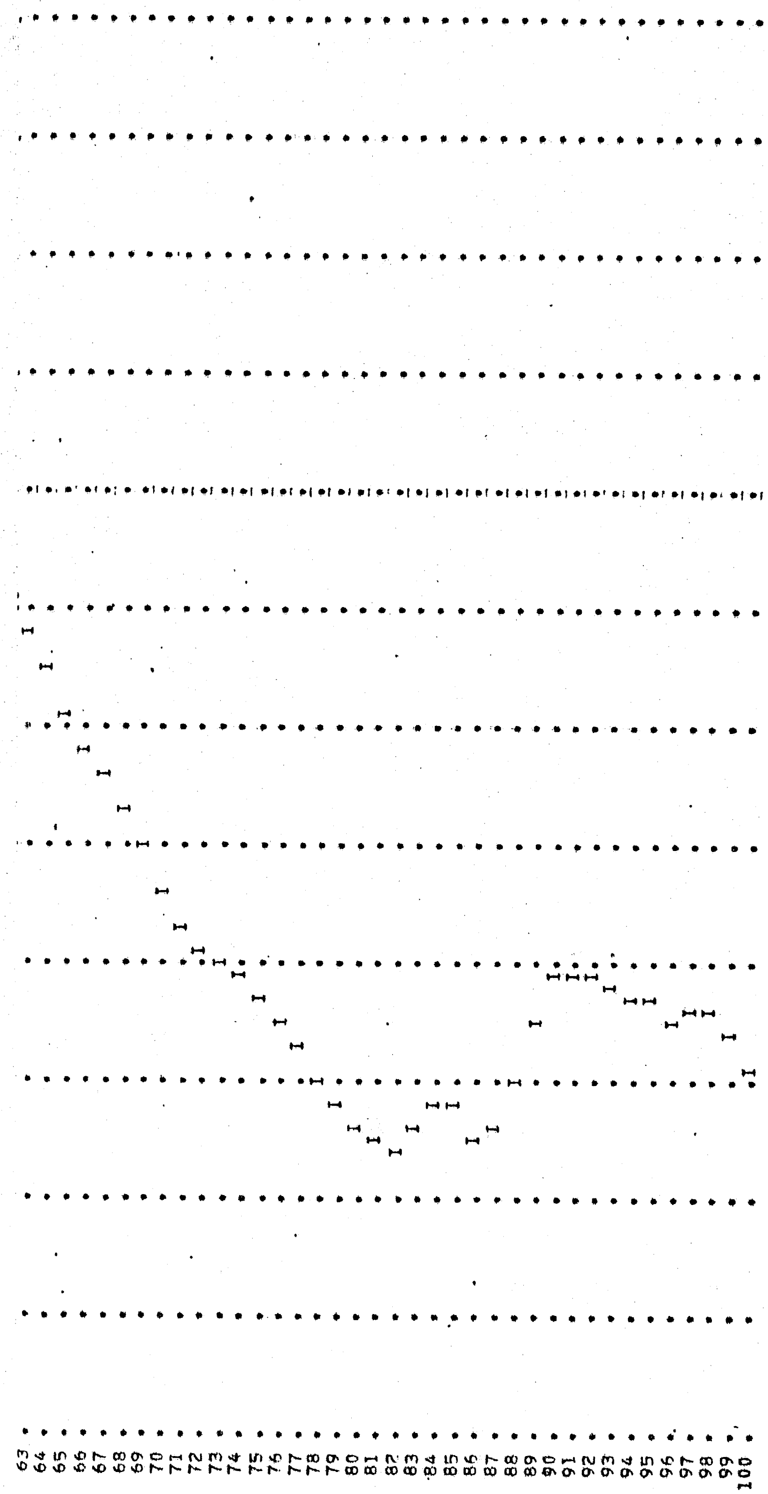
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 185. | 170. | 157. | 145. | 469. | 1358. | 2137. | 2220. | 1876. | 2180. |
| 2895. | 3784. | 4777. | 5097. | 5098. | 4860. | 4545. | 4243. | 3947. | 3678. |
| 3421. | 3188. | 2965. | 2877. | 3179. | 3437. | 3345. | 3086. | 3435. | 4019. |
| 4739. | 5475. | 5614. | 5563. | 5272. | 4924. | 4592. | 4960. | 6632. | 7868. |
| 7635. | 6656. | 7713. | 9674. | 12815. | 15862. | 15978. | 15420. | 15344. | 15615. |
| 16463. | 17490. | 17114. | 16530. | 16159. | 16068. | 15756. | 15149. | 14779. | 14525. |
| 14357. | 14161. | 13654. | 12980. | 12282. | 11587. | 11120. | 10613. | 9929. | 9120. |
| 8664. | 8233. | 8016. | 7803. | 7390. | 6993. | 6528. | 6050. | 5665. | 5271. |
| 4916. | 4730. | 5166. | 5633. | 5598. | 5096. | 5244. | 6033. | 6926. | 7703. |
| 7804. | 7822. | 7678. | 7465. | 7305. | 7054. | 7194. | 7212. | 6868. | 6276. |

*OVF*

526833

STATION 30




63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

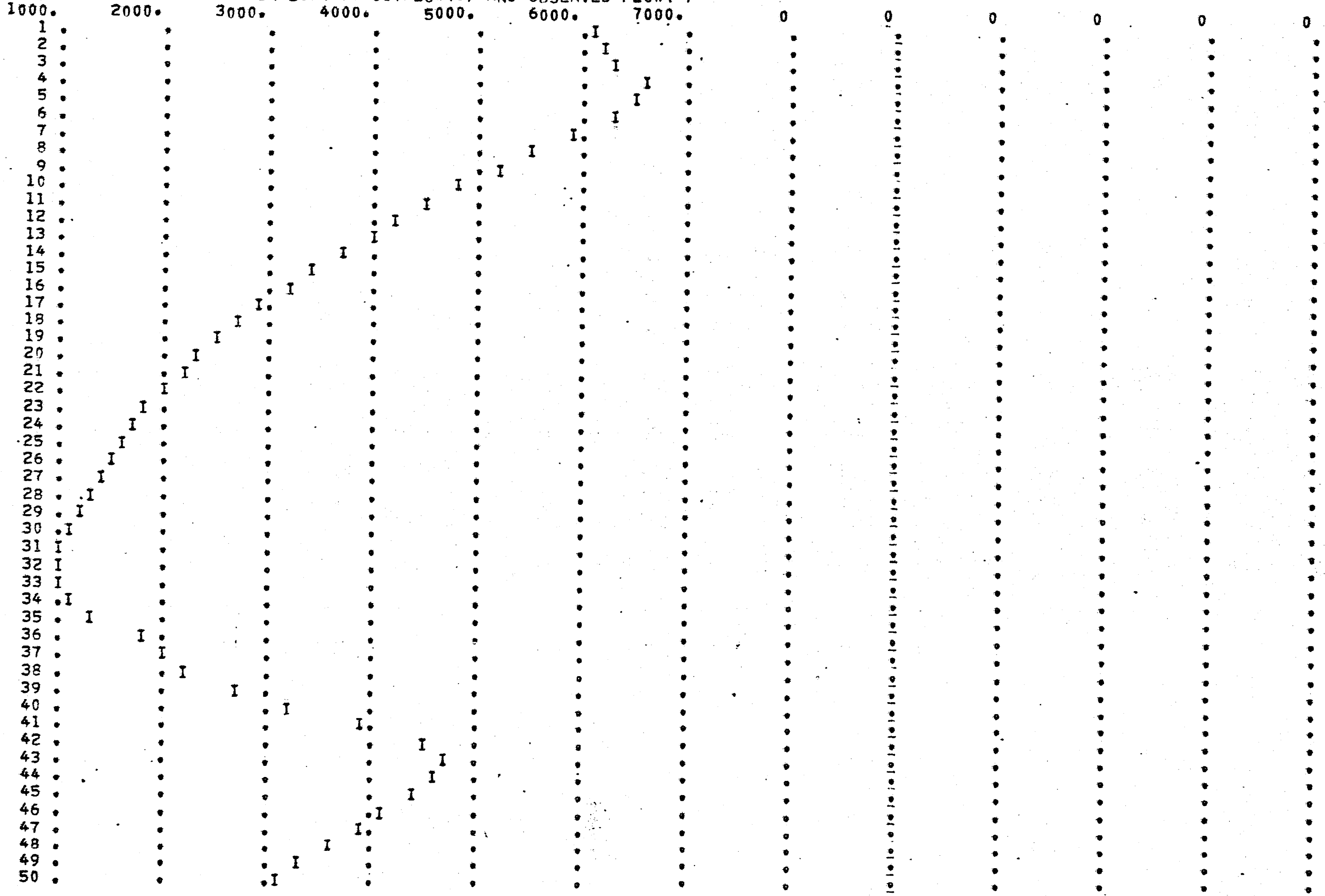
526834

*OVF*

526836

STATION 30

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)



526837

*DVF*
*DVN*
RECORD ENTERED BY RANDSK WRITE 4 1 2 3 3 50 R R R 36 0

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SEGMENT 1 OF 2 SEGMENTS
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********** ********** ********** ********** **********

HYDROGRAPH ROUTING

STRADDLE-STAGGER ROUTING OF THE HYDROGRAPH FROM STATION 30 TO 40

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT |
|---|---|---|---|---|---|
| 40 | 1 | -0 | -0 | -0 | -0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME |
|---|---|---|---|---|
| -0 | -0 | -0 | -0 | -0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA |
|---|---|---|---|---|---|---|
| 3 | 5 | 2 | -0 | -0 | -0 | -0 |

ROUTED FLOWS AT 40
SUM= 731841.

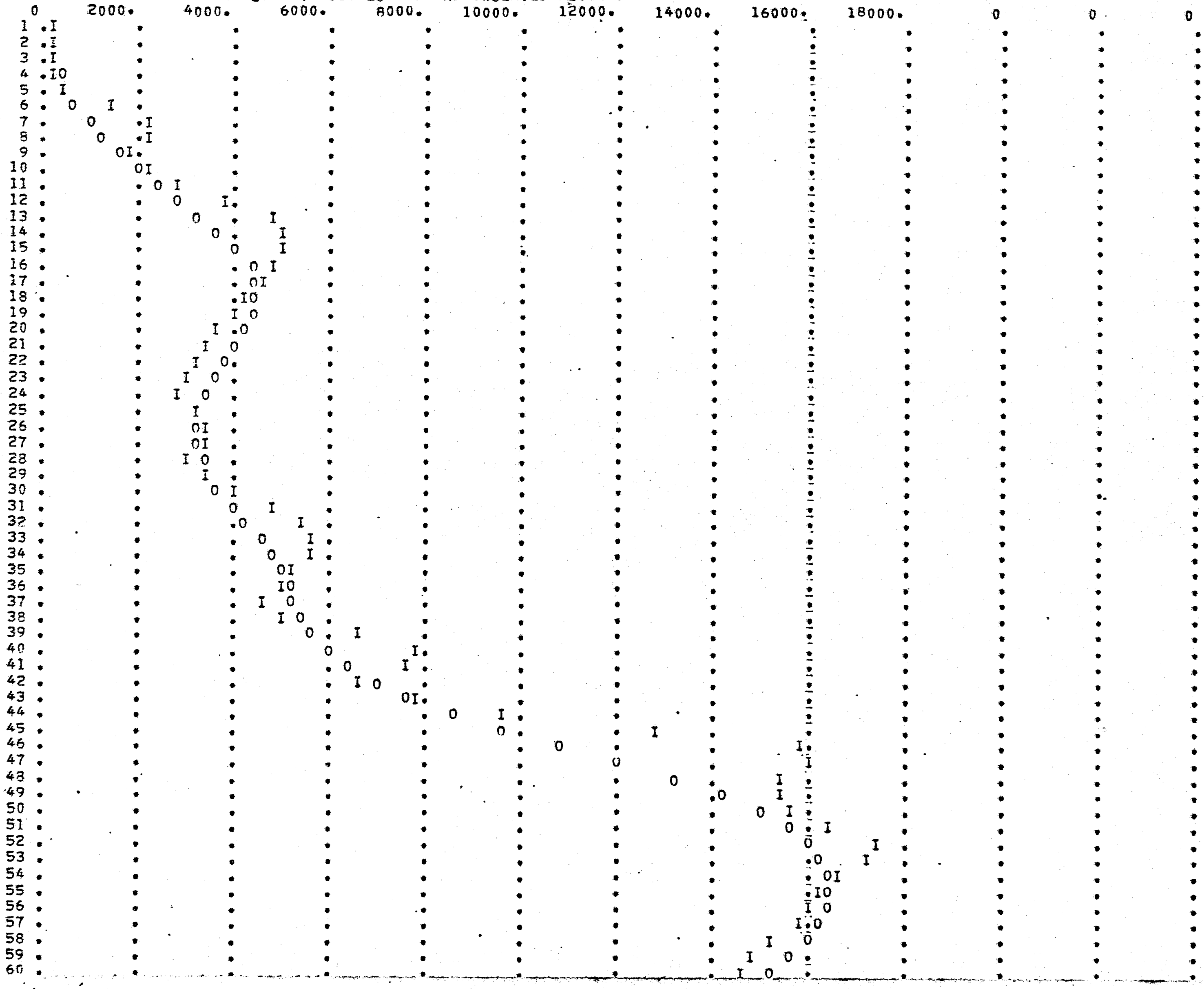
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 183. | 195. | 234. | 316. | 457. | 665. | 935. | 1247. | 1589. | 1958. |
| 2354. | 2776. | 3219. | 3656. | 4039. | 4325. | 4481. | 4499. | 4397. | 4211. |
| 3982. | 3751. | 3545. | 3382. | 3275. | 3226. | 3235. | 3305. | 3443. | 3650. |
| 3919. | 4229. | 4542. | 4812. | 5018. | 5168. | 5291. | 5434. | 5651. | 5966. |
| 6386. | 6935. | 7649. | 8539. | 9610. | 10828. | 12085. | 13263. | 14273. | 15059. |
| 15619. | 16006. | 16258. | 16392. | 16422. | 16347. | 16166. | 15906. | 15598. | 15267. |
| 14926. | 14575. | 14203. | 13793. | 13336. | 12829. | 12280. | 11701. | 11108. | 10519. |
| 9952. | 9419. | 8927. | 8479. | 8067. | 7676. | 7294. | 6909. | 6525. | 6160. |
| 5836. | 5575. | 5395. | 5302. | 5290. | 5353. | 5494. | 5710. | 5994. | 6329. |
| 6681. | 7003. | 7251. | 7402. | 7455. | 7423. | 7333. | 7207. | 7060. | 6902. |

*OVF*

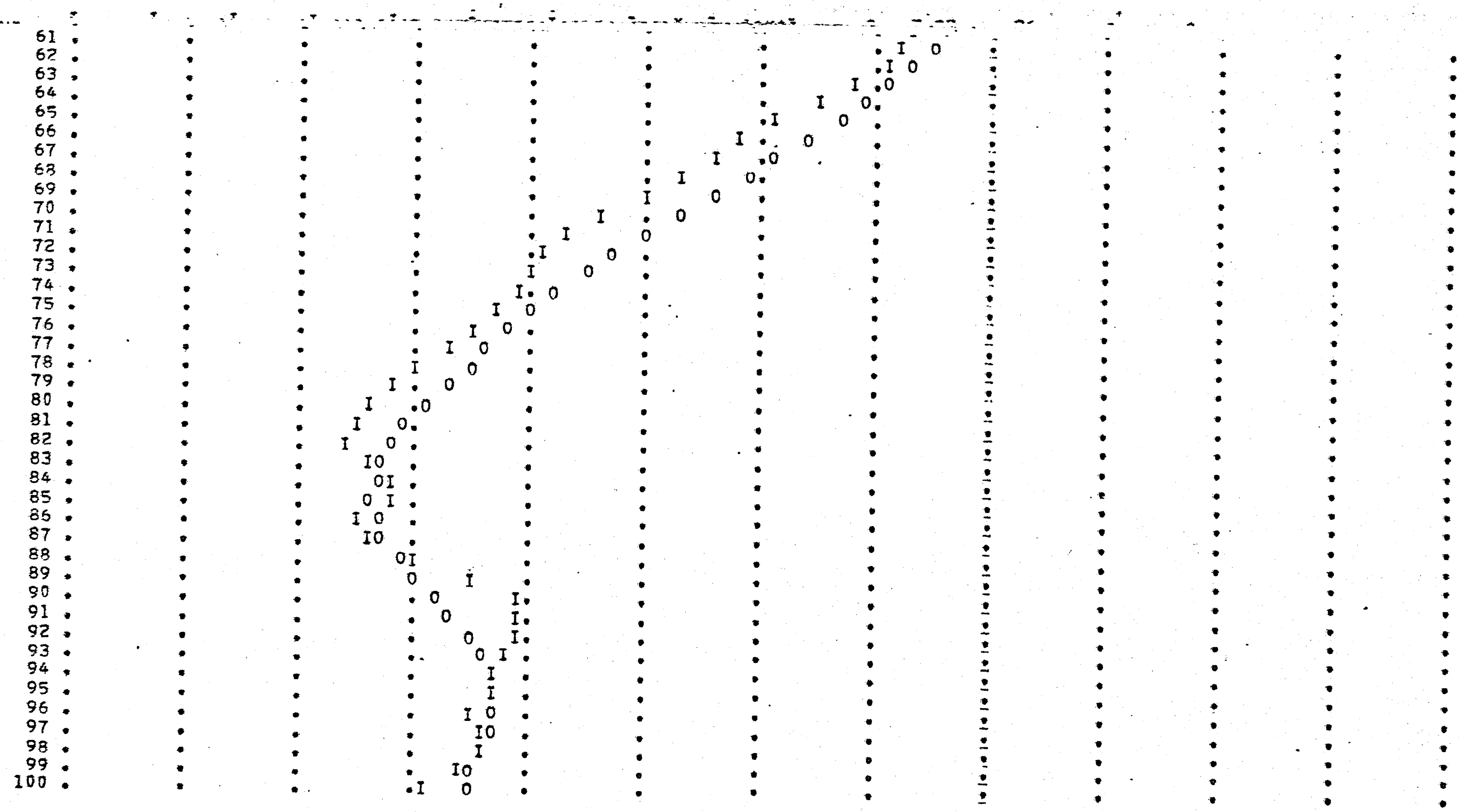
526838

STATION 40

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)



526839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*OVN*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RECORD ENTERED BY RANDSK | WRITE | 4 | 1 | 1 | 10 | 4 | 20 | R | R | R | 37 | 0 |
| RECORD ENTERED BY RANDSK | WRITE | 4 | 1 | 1 | 3 | 4 | 100 | R | R | R | 38 | 0 |

526840

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SEGMENT 2 OF 2 SEGMENTS

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********** ********** ********** ********** **********

HYDROGRAPH ROUTING

STRADDLE-STAGGER ROUTING OF THE HYDROGRAPH FROM STATION 30 TO 40

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT |
|---|---|---|---|---|---|
| 40 | 1 | -0 | -0 | -0 | -0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME |
|---|---|---|---|---|
| -0 | -0 | -0 | -0 | -0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA |
|---|---|---|---|---|---|---|
| 3 | 5 | 2 | -0 | -0 | -0 | -0 |

ROUTED FLOWS AT 40

SUM= 172766.

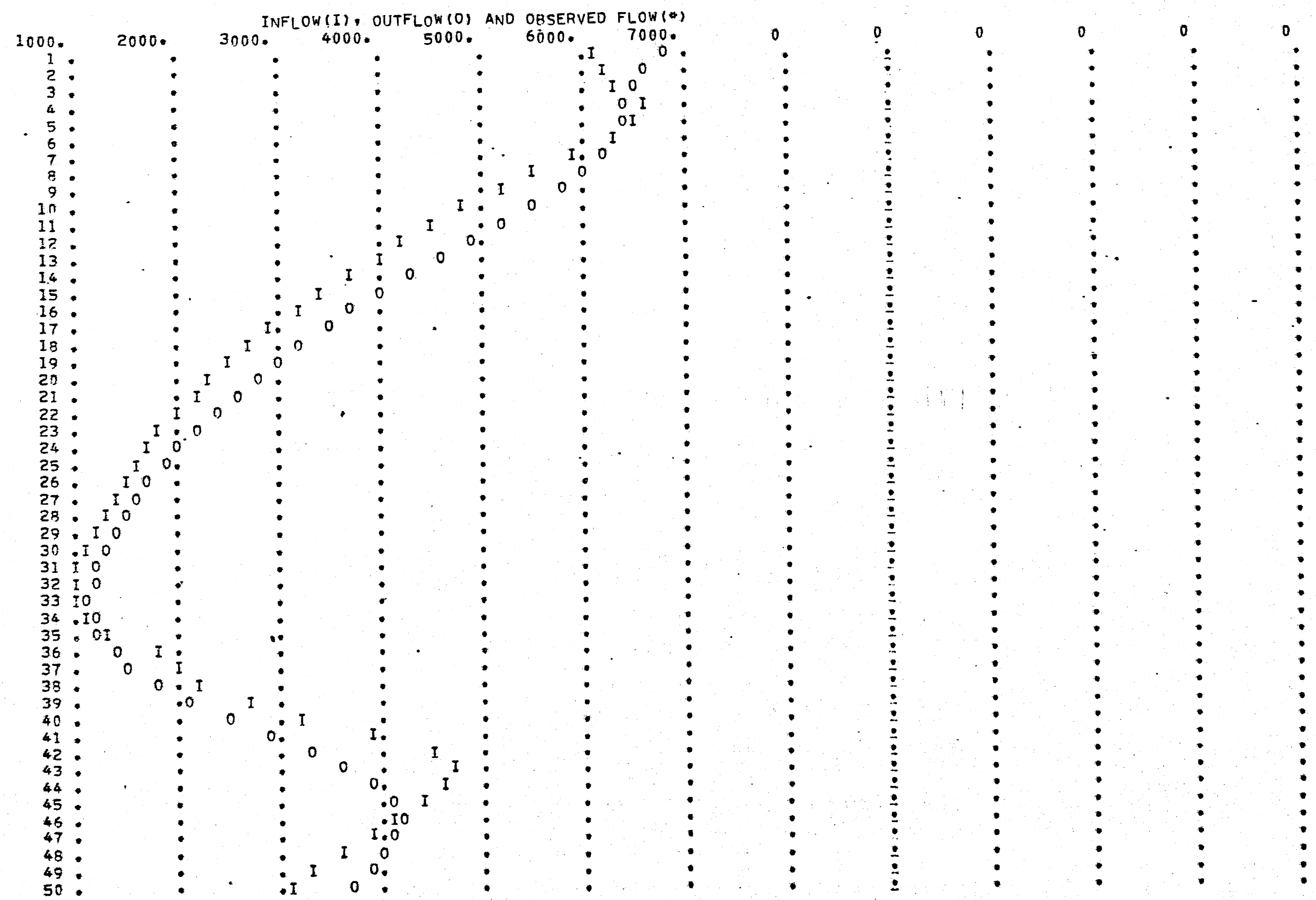
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6750. | 6614. | 6502. | 6419. | 6351. | 6274. | 6162. | 5997. | 5775. | 5503. |
| 5200. | 4886. | 4574. | 4274. | 3988. | 3715. | 3455. | 3207. | 2974. | 2755. |
| 2552. | 2365. | 2191. | 2030. | 1881. | 1744. | 1617. | 1501. | 1396. | 1302. |
| 1224. | 1169. | 1146. | 1163. | 1232. | 1361. | 1550. | 1800. | 2110. | 2469. |
| 2858. | 3250. | 3611. | 3902. | 4094. | 4173. | 4143. | 4027. | 3858. | 3672. |

21 .06 0 136.

*OVF*

526841

STATION 40



*OVN*

RECORD ENTERED BY RANDSK WRITE 4 1 2 3 4 50 R R R 40 0

526842

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SEGMENT 1 OF 2 SEGMENTS

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********** ********** ********** ********** **********

HYDROGRAPH ROUTING

MUSKINGUM ROUTING OF HYDROGRAPH FROM STATION 40 TO 50

| ISTAQ | ICOMP | IECON | ITAPE | JPLT | JPRT |
|---|---|---|---|---|---|
| 50 | 1 | -0 | -0 | -0 | -0 |

ROUTING DATA

| QLOSS | CLOSS | AVG | IRES | ISAME |
|---|---|---|---|---|
| -0 | -0 | -0 | -0 | -0 |

| NSTPS | NSTDL | LAG | AMSKK | X | TSK | STORA |
|---|---|---|---|---|---|---|
| 3 | -0 | 4 | 4.500 | .200 | -0 | -0 |

ROUTED FLOWS AT 50

SUM= .700001.

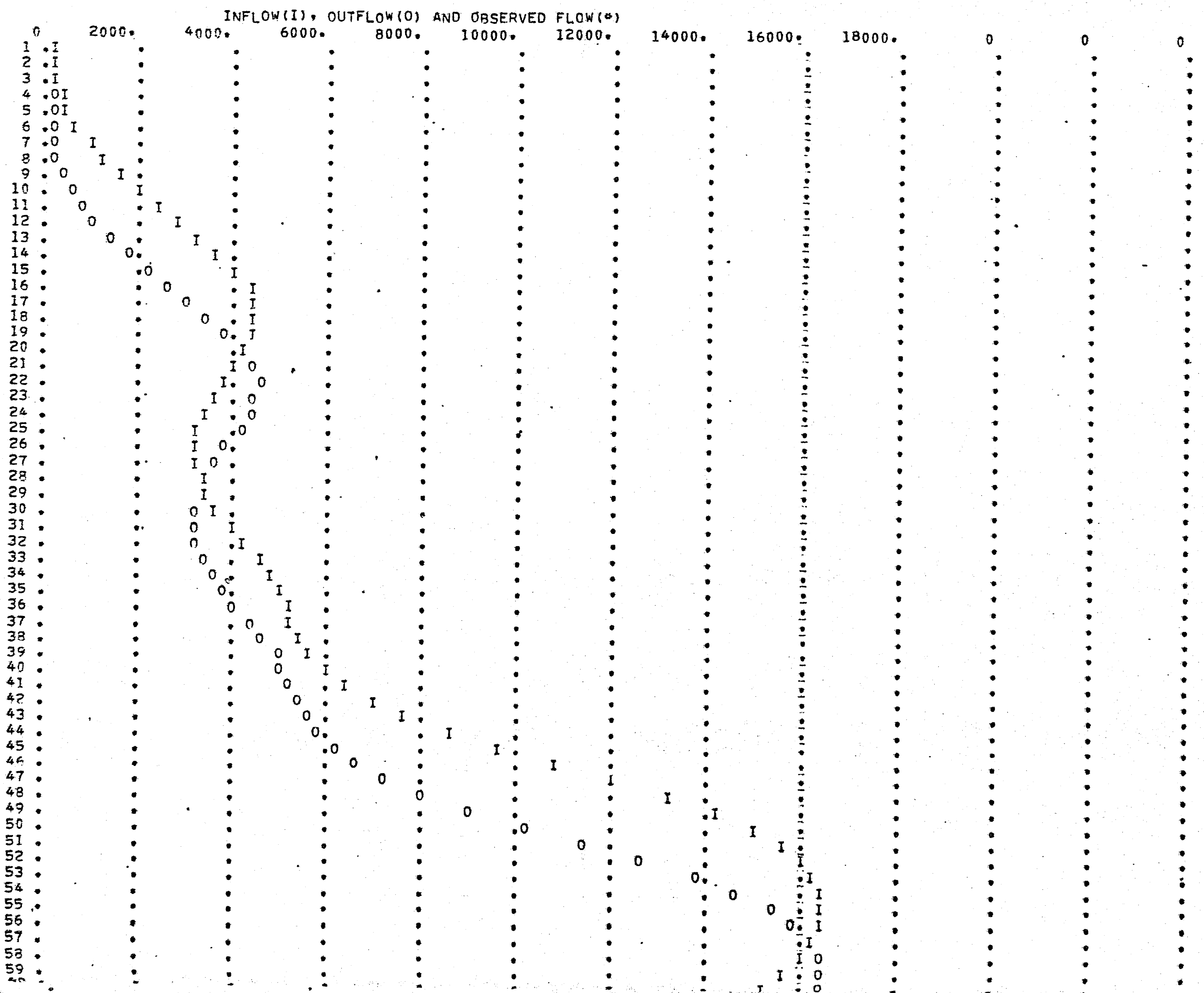
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 183. | 183. | 183. | 183. | 183. | 187. | 209. | 266. | 372. | 542. |
| 777. | 1067. | 1394. | 1748. | 2129. | 2536. | 2968. | 3411. | 3829. | 4173. |
| 4405. | 4502. | 4465. | 4323. | 4115. | 3881. | 3658. | 3470. | 3330. | 3248. |
| 3225. | 3260. | 3359. | 3527. | 3762. | 4051. | 4366. | 4664. | 4908. | 5089. |
| 5224. | 5352. | 5522. | 5779. | 6140. | 6614. | 7232. | 8022. | 8991. | 10129. |
| 11374. | 12609. | 13721. | 14638. | 15325. | 15804. | 16128. | 16328. | 16415. | 16399. |
| 16278. | 16060. | 15775. | 15456. | 15119. | 14773. | 14414. | 14027. | 13598. | 13119. |
| 12593. | 12029. | 11443. | 10850. | 10269. | 9715. | 9200. | 8727. | 8296. | 7894. |
| 7508. | 7126. | 6741. | 6364. | 6015. | 5716. | 5489. | 5346. | 5289. | 5311. |
| 5407. | 5581. | 5828. | 6136. | 6482. | 6825. | 7118. | 7326. | 7434. | 7449. |

22 .04 0 124.

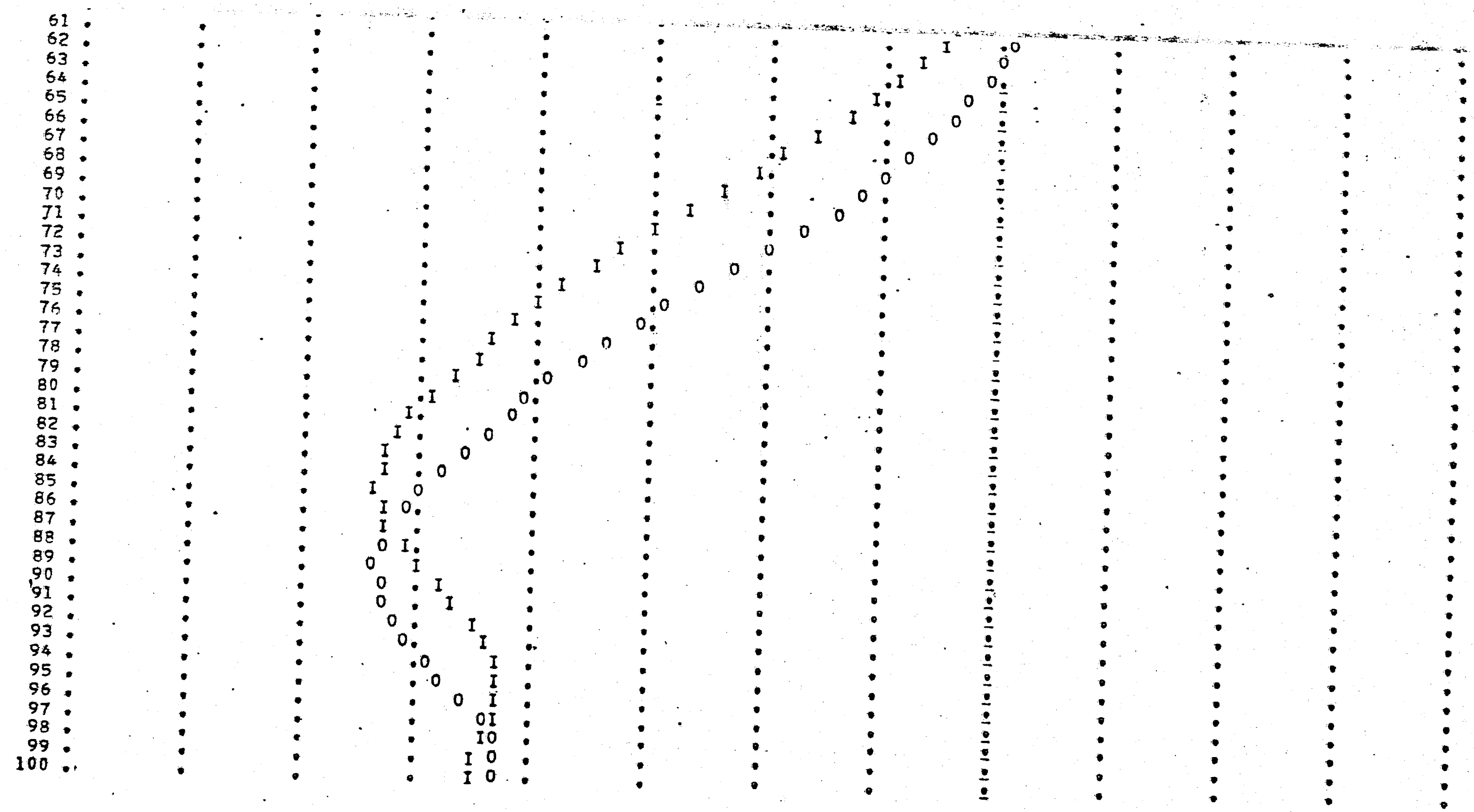
*OVF*

526843

STATION 50



526844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*OVF*
*OVF*
*OVN*
RECORD ENTERED BY RANDSK    WRITE    4    1    1   10    5   20         R         R         R         41    0
RECORD ENTERED BY RANDSK    WRITE    4    1    1    3    5  100         R         R         R         42    0
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SEGMENT   2  OF   2  SEGMENTS

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**********          **********          **********          **********          **********

                              HYDROGRAPH ROUTING

                 MUSKINGUM ROUTING OF HYDROGRAPH FROM STATION 40 TO 50

                     ISTAQ    ICOMP    IECON    ITAPE    JPLT     JPRT
                        50        1       -0       -0       -0       -0
                                    ROUTING DATA
                         QLOSS    CLOSS      AVG     IRES    ISAME
                            -0       -0       -0       -0       -0

                 NSTPS    NSTDL     LAG   AMSKK        X      TSK    STORA
                     3       -0       4   4.500     .200       -0       -0

                               ROUTED FLOWS AT    50
                                    SUM=   187387.
```

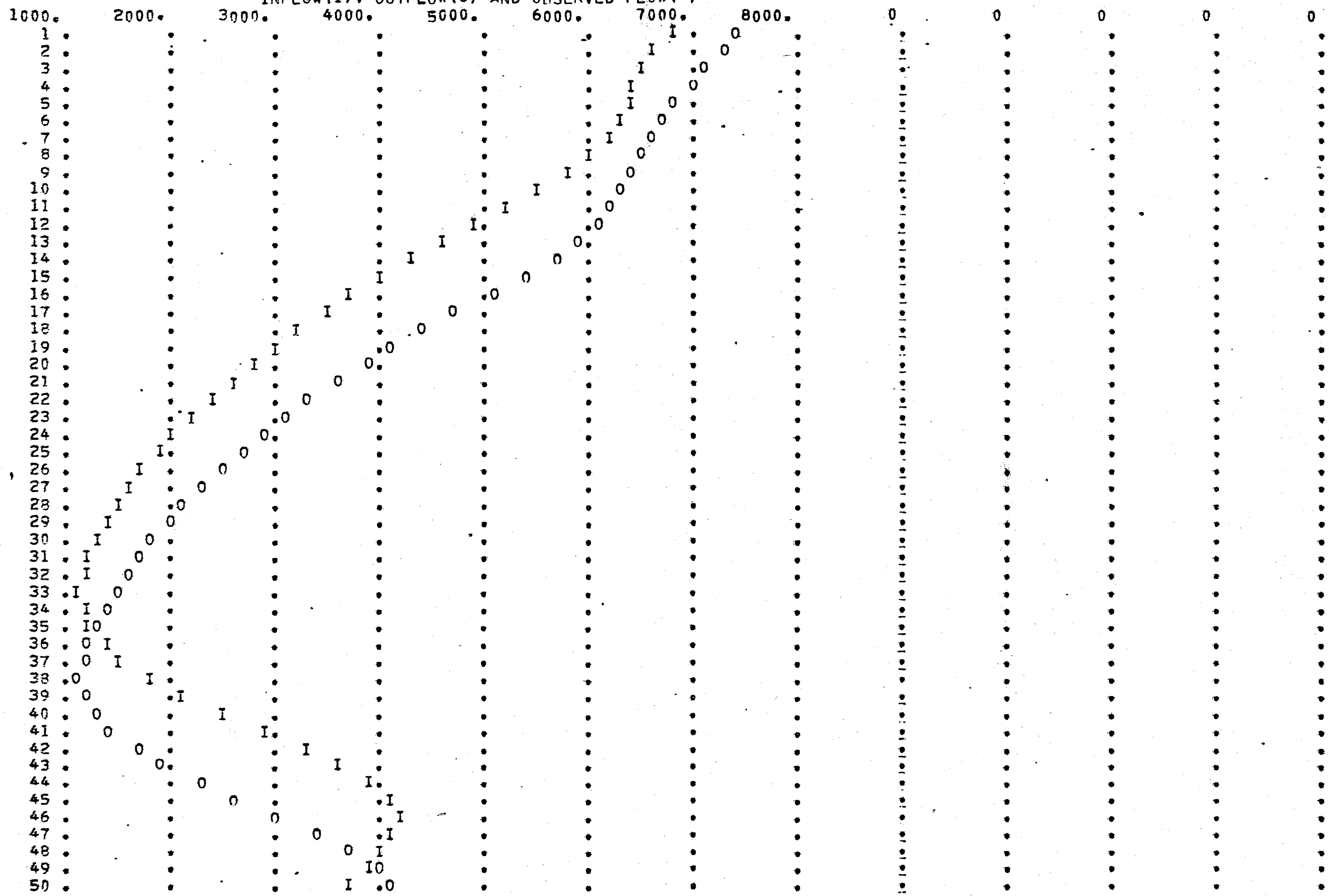
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7389. | 7281. | 7145. | 6992. | 6835. | 6689. | 6563. | 6463. | 6387. | 6318. |
| 6228. | 6095. | 5905. | 5660. | 5373. | 5063. | 4749. | 4442. | 4148. | 3867. |
| 3600. | 3345. | 3104. | 2877. | 2665. | 2469. | 2288. | 2120. | 1964. | 1820. |
| 1688. | 1565. | 1454. | 1354. | 1266. | 1198. | 1156. | 1150. | 1189. | 1283. |
| 1438. | 1654. | 1930. | 2263. | 2637. | 3029. | 3411. | 3745. | 3995. | 4139. |

*OVF*

526846

STATION 50

INFLOW(I), OUTFLOW(O) AND OBSERVED FLOW(*)



526847

*OVN*
RECORD ENTERED BY RANDSK WRITE 4 1 2 3 5 50 R R R 44 0

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SEGMENT 1 OF 2 SEGMENTS

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RECORD ENTERED BY RANDSK WRITE 4 1 1 4 6 100 R R R 45 0
RECORD ENTERED BY RANDSK WRITE 4 1 2 4 6 50 R R R 49 0

****************************** COMPARISON OF COMPUTED AND OBSERVED FLOWS AT STATION 50 ******************************

| INTERVAL | COMPUTED | OBSERVED | RESIDUAL |
|---|---|---|---|
| 1 | 183. | 2. | -181. |
| 2 | 183. | 4. | -179. |
| 3 | 183. | 9. | -174. |
| 4 | 183. | 80. | -103. |
| 5 | 183. | 300. | 117. |
| 6 | 187. | 650. | 463. |
| 7 | 209. | 1000. | 791. |
| 8 | 266. | 3900. | 3634. |
| 9 | 372. | 6600. | 6228. |
| 10 | 542. | 5940. | 5398. |
| 11 | 777. | 5270. | 4493. |
| 12 | 1067. | 4260. | 3193. |
| 13 | 1394. | 3210. | 1816. |
| 14 | 1748. | 2520. | 772. |
| 15 | 2129. | 2120. | -9. |
| 16 | 2536. | 1820. | -716. |
| 17 | 2968. | 1540. | -1428. |
| 18 | 3411. | 1260. | -2151. |
| 19 | 3829. | 992. | -2837. |
| 20 | 4173. | 810. | -3363. |
| 21 | 4405. | 850. | -3555. |
| 22 | 4502. | 900. | -3602. |
| 23 | 4465. | 1000. | -3465. |
| 24 | 4323. | 1100. | -3223. |
| 25 | 4115. | 1200. | -2915. |
| 26 | 3881. | 1300. | -2581. |
| 27 | 3658. | 1400. | -2258. |
| 28 | 3470. | 1500. | -1970. |
| 29 | 3330. | 1600. | -1730. |
| 30 | 3248. | 1700. | -1548. |
| 31 | 3225. | 1800. | -1425. |
| 32 | 3260. | 1900. | -1360. |
| 33 | 3359. | 2000. | -1359. |
| 34 | 3527. | 2500. | -1027. |
| 35 | 3762. | 2800. | -962. |
| 36 | 4051. | 3100. | -951. |
| 37 | 4366. | 3500. | -866. |
| 38 | 4664. | 4000. | -664. |
| 39 | 4908. | 4500. | -408. |
| 40 | 5089. | 5000. | -89. |
| 41 | 5224. | 6000. | 776. |
| 42 | 5352. | 7000. | 1648. |
| 43 | 5522. | 8000. | 2478. |
| 44 | 5779. | 10000. | 4221. |
| 45 | 6140. | 12000. | 5860. |

526848

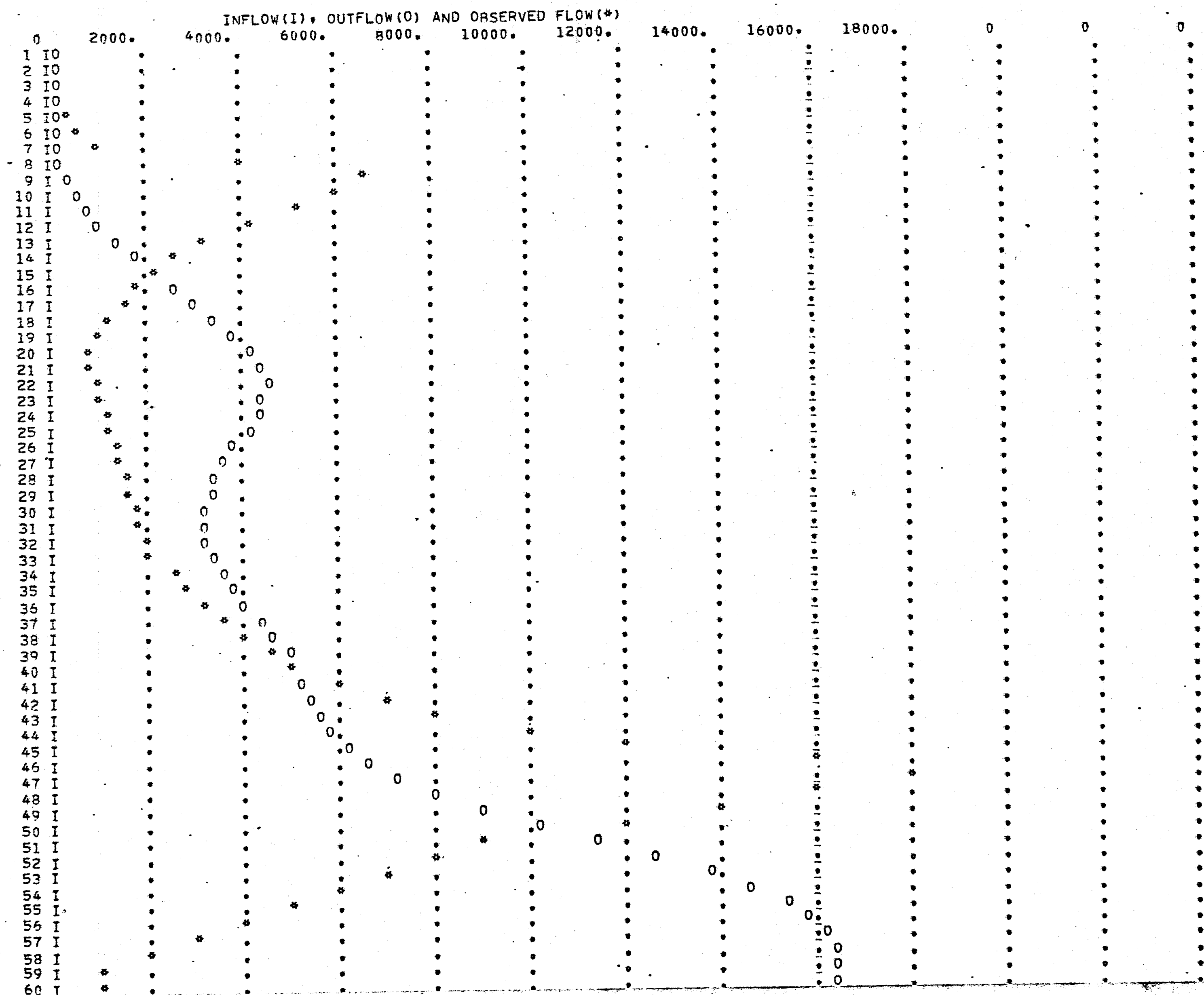
| | | | |
|---|---|---|---|
| 46 | 6614. | 16000. | 9386. |
| 47 | 7232. | 18000. | 10768. |
| 48 | 8022. | 16000. | 7978. |
| 49 | 8991. | 14000. | 5009. |
| 50 | 10129. | 12000. | 1871. |
| 51 | 11374. | 9000. | -2374. |
| 52 | 12609. | 8000. | -4609. |
| 53 | 13721. | 7000. | -6721. |
| 54 | 14638. | 6000. | -8638. |
| 55 | 15325. | 5000. | -10325. |
| 56 | 15804. | 4000. | -11804. |
| 57 | 16128. | 3000. | -13128. |
| 58 | 16328. | 2000. | -14328. |
| 59 | 16415. | 1000. | -15415. |
| 60 | 16399. | 900. | -15499. |
| 61 | 16278. | 800. | -15478. |
| 62 | 16060. | 700. | -15360. |
| 63 | 15775. | 600. | -15175. |
| 64 | 15456. | 500. | -14956. |
| 65 | 15119. | 400. | -14719. |
| 66 | 14773. | 300. | -14473. |
| 67 | 14414. | 200. | -14214. |
| 68 | 14027. | 250. | -13777. |
| 69 | 13598. | 300. | -13298. |
| 70 | 13119. | 350. | -12769. |
| 71 | 12593. | 316. | -12277. |
| 72 | 12029. | 268. | -11761. |
| 73 | 11443. | 268. | -11175. |
| 74 | 10850. | 213. | -10637. |
| 75 | 10269. | 194. | -10075. |
| 76 | 9715. | 175. | -9540. |
| 77 | 9200. | 157. | -9043. |
| 78 | 8727. | 140. | -8587. |
| 79 | 8296. | 125. | -8171. |
| 80 | 7894. | 115. | -7779. |
| 81 | 7508. | 120. | -7388. |
| 82 | 7126. | 170. | -6956. |
| 83 | 6741. | 250. | -6491. |
| 84 | 6364. | 400. | -5964. |
| 85 | 6015. | 600. | -5415. |
| 86 | 5716. | 900. | -4816. |
| 87 | 5489. | 1100. | -4389. |
| 88 | 5346. | 1300. | -4046. |
| 89 | 5289. | 1600. | -3689. |
| 90 | 5311. | 2000. | -3311. |
| 91 | 5407. | 2500. | -2907. |
| 92 | 5581. | 2800. | -2781. |
| 93 | 5828. | 2900. | -2928. |
| 94 | 6136. | 3200. | -2936. |
| 95 | 6482. | 3600. | -2882. |
| 96 | 6825. | 4000. | -2825. |
| 97 | 7118. | 4400. | -2718. |
| 98 | 7326. | 6000. | -1326. |
| 99 | 7434. | 7000. | -434. |
| 100 | 7449. | 8000. | 551. |
| SUM | 700001. | 310048. | -389953. |

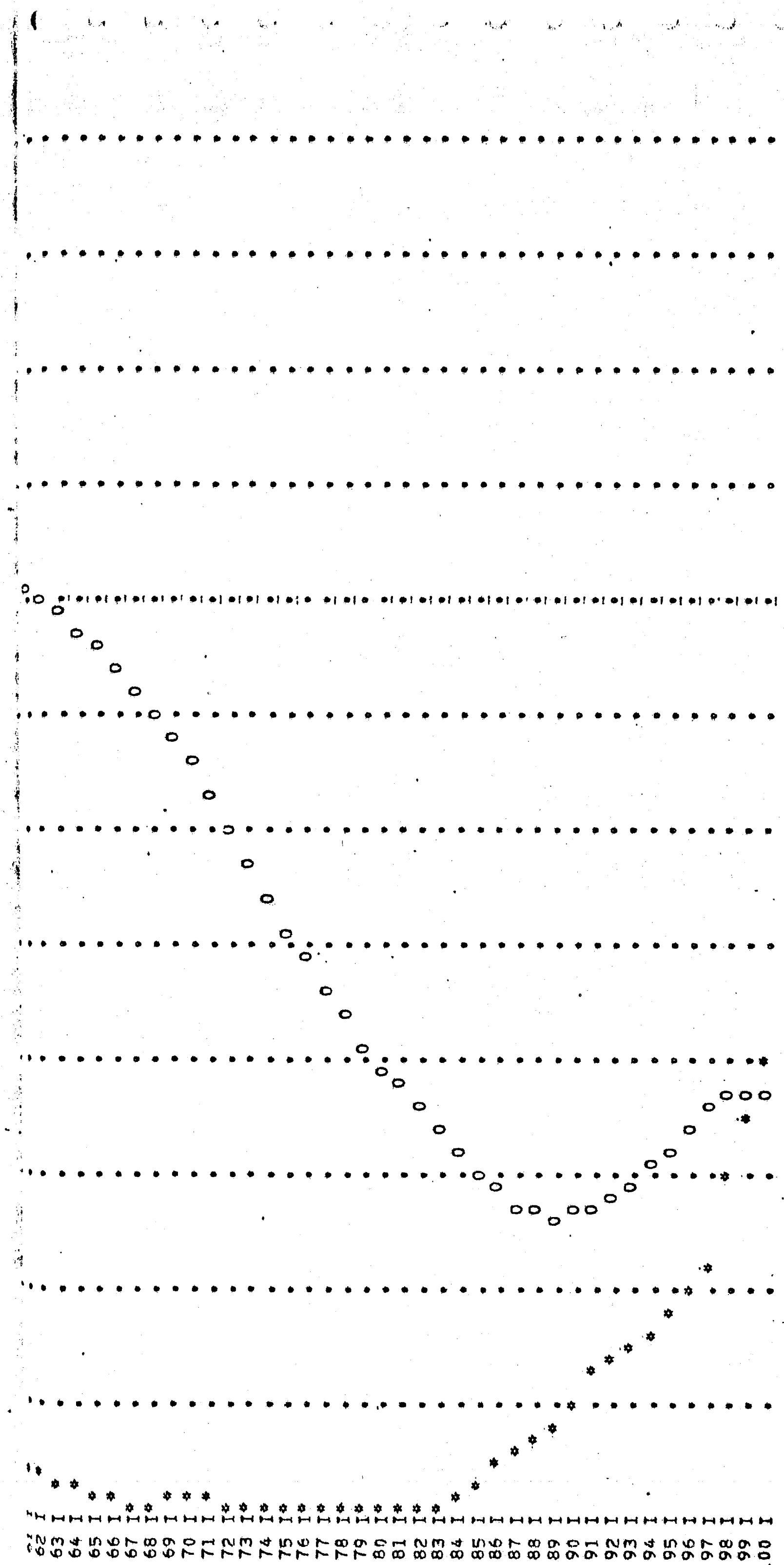
| | | | |
|---|---|---|---|
| 21 | .06 | 0 | 136. |
| 22 | .04 | 0 | 124. |

*OVF*

526849

STATION 50





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526850

*OVN*

526851

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SEGMENT 2 OF 2 SEGMENTS

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******************************** COMPARISON OF COMPUTED AND OBSERVED FLOWS AT STATION 50 ********************************

| INTERVAL | COMPUTED | OBSERVED | RESIDUAL |
|---|---|---|---|
| 1 | 7389. | 7000. | -389. |
| 2 | 7281. | 6000. | -1281. |
| 3 | 7145. | 5000. | -2145. |
| 4 | 6992. | 4000. | -2992. |
| 5 | 6835. | 3000. | -3835. |
| 6 | 6689. | 2000. | -4689. |
| 7 | 6563. | 1000. | -5563. |
| 8 | 6463. | 900. | -5563. |
| 9 | 6387. | 800. | -5587. |
| 10 | 6318. | 700. | -5618. |
| 11 | 6228. | 600. | -5628. |
| 12 | 6095. | 500. | -5595. |
| 13 | 5905. | 400. | -5505. |
| 14 | 5660. | 300. | -5360. |
| 15 | 5373. | 400. | -4973. |
| 16 | 5063. | 500. | -4563. |
| 17 | 4749. | 600. | -4149. |
| 18 | 4442. | 700. | -3742. |
| 19 | 4148. | 750. | -3398. |
| 20 | 3867. | 800. | -3067. |
| 21 | 3600. | 900. | -2700. |
| 22 | 3345. | 1000. | -2345. |
| 23 | 3104. | 1200. | -1904. |
| 24 | 2877. | 1300. | -1577. |
| 25 | 2665. | 1400. | -1265. |
| 26 | 2469. | 1500. | -969. |
| 27 | 2288. | 1800. | -488. |
| 28 | 2120. | 2100. | -20. |
| 29 | 1964. | 2600. | 636. |
| 30 | 1820. | 2900. | 1080. |
| 31 | 1688. | 2600. | 912. |
| 32 | 1565. | 2200. | 635. |
| 33 | 1454. | 1900. | 446. |
| 34 | 1354. | 1500. | 146. |
| 35 | 1266. | 1200. | -66. |
| 36 | 1198. | 900. | -298. |
| 37 | 1156. | 700. | -456. |
| 38 | 1150. | 500. | -650. |
| 39 | 1189. | 300. | -889. |
| 40 | 1283. | 200. | -1083. |
| 41 | 1438. | 250. | -1188. |
| 42 | 1654. | 300. | -1354. |
| 43 | 1930. | 350. | -1580. |
| 44 | 2263. | 400. | -1863. |
| 45 | 2637. | 450. | -2187. |
| 46 | 3029. | 500. | -2529. |
| 47 | 3411. | 550. | -2861. |
| 48 | 3745. | 600. | -3145. |

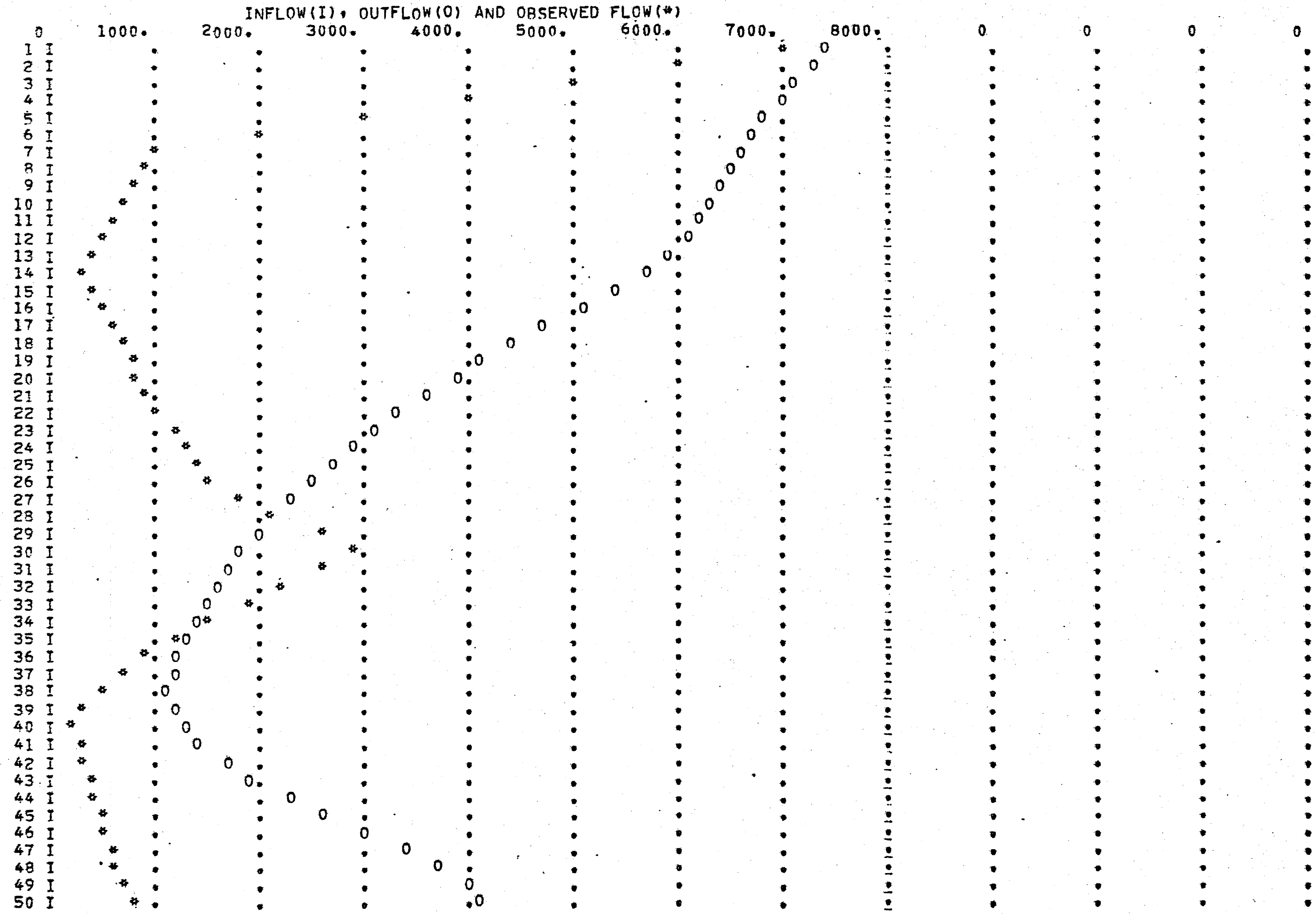
| | | | |
|---|---|---|---|
| 49 | 3995. | 700. | -3295. |
| 50 | 4139. | 750. | -3389. |
| SUM | 187387. | 69500. | -117887. |

526852

*OVF*

526853

STATION 50



# APPENDIX C

## Changes to HEC-1 Data Deck for Use in HEC-1CS

CHANGES TO HEC1 DATA DECK FOR USE IN HEC1CS. - SEE PAGES 5,7,8,9 10,14,15,16,17,19,22,24,26,30,36,37,38,39,40, OF HEC1 USERS MANUAL ADDENDUM OF JAN, 1973

## INPUT DATA DESCRIPTION

"X" MEANS DATA CARD OMITTED.

An overview of the general data requirements for the major functions of the program is shown in figure 1. The alphabetic and numeric card codes describing the input data cards are discussed in detail in this addendum The type of information contained on the data cards is summarized below:

| | |
|---|---|
| A | Job title |
| B | Job specifications |
| C | Observed hydrograph to be reconstituted |
| D | Routing optimization criteria and observed inflow hydrograph |
| E, F | Unit graph and loss rate optimization criteria |
| G, H | Station precipitation data for all subbasins of the watershed |
| I | Precipitation depth-drainage area data |
| J | Multiflood, multiplan data |
| K | Computation specification for model building |
| L | Hydrograph balancing criteria |
| M-X | Subarea runoff computation data including precipitation, losses, and unit graph information |
| Y | Individual reach routing criteria |
| Z | Economic and flood frequency data |

In modeling a watershed (nonoptimization jobs) the K cards, followed by the appropriate runoff or routing cards, will be repeated as many times as necessary in order to compute the runoff, routing and combining of hydrographs in a logical progression through the basin. Reference is made to figure 1, section 2a in the text, for an explanation of the program logic and when the various data are read by the program. Examples of usage of the K card to model a stream network are given in tests 5, 6 and 7 of "TEST PROBLEMS" of the text.

Each input card is described in detail below. Variable locations on each card are shown by field number. Each card is divided into ten fields of eight columns each except field 1. Variables occurring in field 1 may only occupy card columns 2-8 because card column 1 is reserved for the card identification alphabetic or numeric character. The card idenfification character, column 1, will be referred to as field zero.

Figure 1. Overview of General Data Requirements

| Type of Job (JØPER) | Routing Optimization (1) | Loss Rate and Unit Graph Optimization (2) | Generalized Storm Network Computation (3) | Stream System Computation (4) | Multiflood, multiplan Economic Computation (5) |
|---|---|---|---|---|---|
| Required Data Cards<br><br>*indicates cards supplied as necessary for the particular type of operation to be performed. e.g., only one of the methods for inputing precipitation can be used on a subarea runoff computation so that indicating cards Ø* through Q2* means that only one of the Ø, P, or Q sets of cards will actually be required. | 3A cards<br>2B cards<br>C, C1<br>D, D1, D2 | 3A cards<br>2B cards<br>C, C1<br><br>E, E1*<br>F<br>{ [G*H*, H1* and Q*, Q1*, Q2*]<br>or<br>[ Ø*, Ø1* ] }<br>If snowmelt is to be considered, also include R, R1, R2 and S*, S1*, S2* | 3A cards<br>2B cards<br>G*, H*, H1*<br>K, K1*<br>[M* through X* as necessary for subarea runoff]<br>K, K1*<br>[Y*, Y1*, Y2*, Y3* as necessary for routing]<br>[K, K1 for combining]<br>K, K1*<br>[L* for balancing]<br>K, K1*<br>[N* for comparison of previously computed and observed hydrographs]<br>K for summary and end of current series of computations | 3A cards<br>2B cards<br>I, I1<br>K, K1*<br>etc. as for JØPER=3 for runoff, routing, combining, etc. operations | 3A cards<br>2B cards<br>J, J1<br>K, K1*<br>etc. as for JOPER=3 for runoff, routing, combining, etc.<br>Z, Z1, Z2, Z3, Z4 following K card computations when economic analysis is desired, e.g.,<br>K, K1*<br>Y for no routing in Plan 1<br>Y, Y1, Y2, Y3 for reservoir routing in Plan 2<br>Z, Z1, Z2, Z3, Z4 for economic analysis of effects of reservoir at the current stream station<br>K, K1* etc. for following operations |

Numeric characters in field zero refer to sets of data to follow the preceding alphabetic character card. Cards will be referenced as "D" cards, meaning the card with a "D" in card column 1, or "D1," "D2," etc., cards referring to cards with 1, 2, etc., in card column 1, and following the D card as part of the D card series. Fields on the numeric cards will be referenced as "D2-5," meaning the fifth field on the D2 card.

The different values a variable may assume and the conditions for each are described for each variable. Some variables simply indicate whether a program option is to be used or not by using the numbers -1, 0, 1, etc. Other variables contain numbers which express the magnitude of the variable. For these, a + sign is shown in the description under "value" and the numerical value of the variable is entered as input. Where the variable value is to be zero, the variable may be left blank because a blank field is read as zero. A value of "AN" refers to alphanumeric characters.

In the following input data description, reference is made to "jobs" and "runs" on the computer. A job is defined as a set of input data cards starting with the A cards and ending with the last appropriate card (K card with ICOMP = 99 for nonoptimization jobs) in the series of hydrologic operations being performed. Upon completion of a job the program will immediately look for another job to process. Any number of jobs may be stacked in succession. Upon completion of the last job, another set of A cards and a set of blank B cards should follow in order to terminate the program. A run is defined as the entire sequence of control, program and data cards which are submitted to the computer for processing. A run may consist of one or more jobs.

a. A Cards

Three title cards for output title. These cards are required for each job.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | A | Card identification. |
| 1-10 | | AN | Job title information, preferably centered in fields 2-80, inclusive, on each card. |

b. B Cards

Two cards specifying basic data and program options relative to the entire job.

B Cards (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | B | Card identification. |
| 1 | NQ | + | Number of hydrograph ordinates to be computed. Indicates number of items to be read on several of the following cards (150 max). |
| 2 | NHR | + | Number of whole hours in tabulation interval. |
| 3 | NMIN | + | Number of minutes in tabulation interval in addition to NHR above. |
| 4 | IDAY | + | Day number at beginning of first tabulation interval. If this field is left blank, the program assumes the beginning of the first interval to be time "0". If fields 5 and 6 (IHR and IMIN) are also blank, the program will number the tabulation intervals sequentially starting with 1, without reference to day, hour or minute. |
| 5 | IHR | + | Hour number at beginning of first tabulation interval. |
| 6 | IMIN | + | Minute number at beginning of first tabulation interval. |
| 7 | METRC | 0 | English units will be used (cfs, in, ac-ft, °F). |
| | | 1 | Metric units will be used ($m^3$/sec, mm, 100 cu meters, °C). |
| 8 | IPLT | 1 | No graphs to be printed for entire job unless overridden by JPLT, K-5, for subarea (reach) computation. |
| | | 2 | Plot every computed hydrograph for entire job unless overridden by JPLT, K-5. |

B cards (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 9 | IPRT | 1 | Print all output including diagnostics for optimization jobs. |
| | | 2 | Same as above without diagnostics. |
| | | 3 | Same as above without stream system and multiplan hydrographs. |
| | | 4 | Print basic input data and intermediate and master summaries. |
| | | 5 | Print job specification and master summary only. |
| 10 | NSTAN | + | Total number (integer) of nonrecording regional precipitation stations to be used for entire job. If recording stations are to be used in computing basin average precipitation, they must be included in this count and also on the G and H cards for both recording and non-recording stations (50 max). |
| | | 0 | No precipitation station data (nonrecording or recording) to be used for this job. Precipitation, if necessary will be inputed as basin average values on the O or P cards. |

B1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | JOPER | X 1 | Job identification code for routing optimization. |
| | | 2 | Code for loss rate and unit graph optimization. |
| | | 3 | Code for generalized stream network computation. |
| | | X 4 | Code for depth-area stream system computation. |
| | | X 5 | Code for multiplan-ratio and economic analysis. |
| 2 | NWT | 0 | No weighting of observed hydrograph is to be given on C1 cards. NWT used only for optimization jobs (JOPER = 1 or 2). |

B Cards (cont)

B1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| | | + | Number of pairs of weighting factors (IQ, RQ) to be supplied on C1 card (NWT $\leq$ 5). |

c. C Cards

Two sets of cards specifying observed hydrograph flows (C card) and temporary weightings (C1 cards) for optimization jobs, i.e., JOPER (B1-1) is 1 or 2. The C1 cards are provided to assist the optimization process by temporarily weighting (increasing or decreasing) critical flows to force a better fit of the reconstituted to the observed hydrograph. The weighting is for particular portions of the hydrograph as indicated by the sequence number (position from 1 to NQ on the C1 cards) of the flow to be adjusted.

C Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | C | Card identification. |
| 1 | QO(1) | + | Observed flow in cfs ($m^3/s$) at the end of the first period. |
| 2 | QO(2) | + | Etc., NQ (B-1) values. |

C1 Card

Include only if NWT (B1-2) is greater than zero.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification |
| 1 | IQ(1) | + | Sequence number (integer) of C card flow value selected to be adjusted. |
| 2 | RQ(1) | + | Ratio by which selected flow, IQ(1), (field 1, above) is temporarily multiplied to aid in reconstitution. |
| 3 | IQ(2) | + | Sequence number for next flow to be adjusted. |
| 4 | RQ(2) | + | Corresponding ratio for IQ(2), field 3, above. |

Etc., for NWT (B1-2) pairs.

X d. D Cards

Three sets of cards specifying routing optimization criteria (D card), pattern hydrograph for local inflow (D1 card) and inflow hydrograph (D2 cards). These cards used only when JOPER (B1-1) is 1.

X D Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | D | Card identification. |
| 1 | ISTAQ | + | Stream station location identification number (integer). |
| 2 | NSTPS | + | Number (integer ≥ 1) of routing steps to be used for routing by Tatum method (equal to Tatum steps), Muskingum method (equal to number of reaches), or modified Puls method. |
| | | -1 | If number of steps for above methods is to be derived by the program. |
| | | 1 | If routing by straddle-stagger method. |
| 3 | NSTDL | + | Number (integer) of ordinates to be averaged in the straddle-stagger routing. |
| | | -1 | If straddle is to be derived by the program. |
| | | 2 | If routing by the Tatum method with or without derivation. |
| 4 | LAG | + | Number (integer) of intervals hydrograph is to be lagged. |
| | | -1 | If LAG is to be derived by the program. |
| 5 | AMSKK | + | Muskingum K coefficient in hours. |
| | | -1 | If K is to be derived by the program. |
| 6 | X | + | Muskingum X coefficient, between 0 and 0.5. |
| | | -1 | If X is to be derived by the program. |
| 7 | TSK | + | Time-of-storage coefficient in hours. |
| | | -1 | If TSK is to be derived by the program. |

D
D1
D2
E

X D Cards (cont)

D Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 8 | QLOSS | + | Constant channel loss in entire routing in cfs ($m^3$/sec). This value is subtracted from every ordinate of the inflow hydrograph. |
| 9 | CLOSS | + | Ratio of reminaing flow (after QLOSS) which is lost for entire routing. Each inflow hydrograph ordinate (after QLOSS is subtracted) is multiplied by (1 - CLOSS). |
| 10 | AVG | 1 | Inflows to be routed are average for period. |
| | | 0 | Inflows to be routed are end-of-period values. |

X D1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | TMPR(1) | + | Pattern hydrograph for local inflow which will be adjusted for volume in routing coefficient derivation. |
| 2 | TMPR(2) | + | Etc., NQ (B-1) values. |

X D2 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 2 | Card identification. |
| 1 | Q(1) | + | Inflow hydrograph to routing reach. |
| 2 | Q(2) | + | Etc., NQ (B-1) values. |

e. E Cards

Specification of hydrograph criteria and starting flow and recession characteristics. Required only if JOPER (B1-1) is 2.

E Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | E | Card identification. |
| 1 | ISTAQ | + | Stream station location identification number (integer). |

E Cards (cont)

E Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 2 | ISNOW | 0 | No snow computations are to be made. |
| | | 1 | Snowmelt computations are to be made by the degree-day method (R, R1 and R2 cards required). |
| | | 2 | Snowmelt computations are to be made by the energy-budget method (R, R1, R2 and S, S1, S2 cards required). |
| 3 | TAREA | + | Drainage area in square miles (sq. km.) |
| 4 | SNAP | + | Normal annual precipitation for the drainage area (E-3) above. Will be overridden by computed normal annual for snowmelt zone. |
| | | 0 | Weighting by basin normal annual precipitation will not be performed. |
| 5 | STRTQ | + | Flow at start of storm in cfs ($m^3/s$) will be receded in same manner as QRCSN (E-6) below. |
| 6 | QRCSN | + | Flow in cfs ($m^3/s$) below which base flow recession occurs in accordance with the recession constant RTIOR (E-7). QRCSN is that flow where the straight line (in semilog paper) recession deviates from the falling limb of the hydrograph. |
| | | − | When negative, it is the ratio by which the peak discharge is multiplied to compute QRCSN. |
| 7 | RTIOR | + | Ratio of recession flow, QRCSN (E-6) to that flow occurring 10 tabulation intervals later. Must be $\geq$ 1. |
| 8 | NTA | 0 | Program-supplied Clark time-area curve is to be used to compute unit graph. |
| | | + | Number (integer) of Clark time-area ordinates to be read on E1 cards for use in computing a unit graph (100 max). |
| 9 | ALSMX | | Maximum possible loss rate in inches per hour. |
| 10 | RTIMP | | Ratio of basin that is impervious. |

E1
F

E2 ① REC ② RECOV ③ DRNFZ (See R-5)

E3 Initial Values CUML ① → ⑩

{REC : Recession Function (less than 1)
{RECOV : Recovery Function.

CUML(J) = CUML(J) + REC − RECOV

E Cards (cont)

E1 Card

Time-area ordinates supplied only if NTA (E-8) is greater than zero.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | QCLK(1) | + | Area (in any units) that contributes at time zero (usually area of reservoir, if any) at concentration point. |
| 2 | QCLK(2) | + | Total area contributing runoff during first of NTA equal intervals of any length of time. |
| 3 | QCLK(3) | + | Total area contributing runoff during second such interval. |
| 4 | QCLK(4) | + | Etc., NTA (E-8) ordinates. |

f. F Cards

F Card

Unit hydrograph and loss rate optimization variables are specified on this card. Required only if JOPER (B1-1) is 2. A variable will be optimized if the value entered is negative. If the value entered for the variable is negative, but not -1, the value following the minus sign is the starting value for the optimization process. If the value is -1, the program will estimate a starting value. All variables with values ≥ 0 will remain at that given value and will not be optimized. Snowmelt variables will not be considered unless ISNOW (E-2) is positive.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | F | Card identification. |
| 1 | TC | + | TC is the time of concentration in hours for the Clark unit hydrograph. Neither TC nor R are to be optimized. The value of R, field F-2, must also be positive. Value of variable is fixed at the given value. TC must be greater than or equal to (NHR + NMIN), B-3 and B-4 |

F Cards (cont)

| F Card Field | Variable | Value | Description |
|---|---|---|---|
| | | -1 | TC and R will both be optimized and the value of R (field F-2) must also be -1. The program will supply the starting value for the optimization scheme. |
| | | -2 | Ratio R/(TC+R) is to be read in the next field (F-2) and held constant. TC and R will both be optimized but the specified ratio will not be changed. Field F-2 must be a positive ratio R/(TC+R). |
| | | -X | Where X is the desired starting value for TC in the optimization and the starting value of R, field F-2, must also be supplied as a negative number. Cannot be equal to -1 or -2. X must be greater than or equal to (NHR + NMIN), B-3 and B-4. |
| 2 | R | + | R is the Clark storage coefficient in hours. No optimization of TC or R unless TC (F-1) is equal to -2. If TC (F-1) is -2, this field (F-2) contains the constant value for the ratio R/(TC+R). R must be greater than or equal to one half of the time interval (NHR + NMIN). |
| | | -1 | TC and R will both be optimized and the value of TC must also be -1. The program will supply the starting value. |
| | | -Y | Where Y is the desired starting value for R in the optimization and the starting value of TC (F-1)must also be supplied as a negative number. Cannot be -1. R must be greater than or equal to 0.5 * (NHR + NMIN). |
| 3 | COEF | 0, + | Snowmelt coefficient, usually about 0.07 for the F degree-day method or 1.0 for energy-budget method. Variable will not be optimized. |
| | | -1 | Variable will be optimized, program will supply starting value for optimization. |
| | | -Z | Variable will be optimized, Z is the desired starting value for the optimization scheme. Cannot be equal to -1. |

F Cards (cont)

F Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 4 | STRKR | 0,+ or - | Starting value in in/hr (mm/hr) of loss coefficient on exponential recession curve for rain losses (snowfree ground). See field 3 for meaning of 0, + and - values. |
| 5 | STRKS | 0,+ or - | Starting value in in/hr (mm/hr) of loss coefficient on exponential recession curve for snowmelt losses. See field 3 for meaning of 0, + and - values. |
| 6 | RTIOK | 0,+ or - | Ratio of snowmelt loss coefficient on exponential recession curve to that corresponding to 10 inches (25.4 mm) more of accumulated loss. See field 3 for meaning of value. |
| 7 | ERAIN | 0,+ or - | Exponent of precipitation for rain loss function. See field 3 for meaning of value. |
| 8 | FRZTP | 0,+ or - | Index temperature in °F (°C) at bottom of zone for snowmelt, usually 32°F (0°C) See field 3 for meaning of value. |
| 9 | DLTKR | 0,+ or - | DLTKR is the amount in inches (mm) of initial accumulated rain loss during which the loss coefficient is increased. See field 3 for meaning of value. |
| 10 | RTIOL | 0,+ or - | Ratio of rain loss coefficient on exponential recessing curve to that corresponding to 10 inches (25.4 mm) more of accumulated loss. See field 3 for meaning of value. |

g. G Cards

Nonrecording station data to be included only if NSTAN (B-10) is greater than 0.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | G | Card identification. |

G Cards (continued)

| Field | Variable | Value | Description |
|---|---|---|---|
| 1 | ISTAN | + | Nonrecording precipitation station identification number (integer). If a recording station has the same station number, the value of PRCPN (G-2) will be automatically computed as the sum of the recording station precipitation. |
| 2 | PRCPN | + | Total storm precipitation in inches (mm) for above station. Overridden if recording station has same station number. |
| 3 | ANAPN | + | Normal annual precipitation for above station. Used to compute basin mean precipitation by weighted average of station normal precipitation. |
| | | 0 | Weighting by normal annual precipitation will not be performed. |

Repeat same format on another G card for a total of NSTAN cards.

h. H Cards

Recording precipitation station data which must be included if NSTAN (B-10) is positive.

H Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | H | Card identification. |
| 1 | NSTAR | + | Total number (integer) of regional recording precipitation stations to be used to distribute computed basin precipitation (11 max). |
| 2 | NP | + | Number of precipitation items to be read for each recording precipitation station to follow. Must be $\leq$ NQ (B-1). |

H Card (cont)

H1 Cards

The set of H1 cards which follow are repeated NSTAR times.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | ISTAR | + | Station identification number (integer). |

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | PRCPR(1) | + | Precipitation in inches (mm) in first interval. |
| | | -1 | If data is missing. The program will not count these data in computing averages or fractional distributions and will assign a value of zero to the precipitation for the interval. |
| 2 | PRCPR(2) | + | Etc., for NP values of PRCPR. |

X i. I Cards

Two cards for depth-area stream system computation included only if JOPER (B1-1) is equal to 4.

X I Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | I | Card identification. |
| 1 | NSTM | + | Number of system depth-area hypothetical floods to be computed simultaneously for interpolating at each concentration point in accordance with size of tributary area. |

15

I Card (cont)

I1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | TRDA(1) | + | Area in square miles (sq km). |
| 2 | STRM(1) | + | Average precipitation in inches (mm) relative to the area TRDA(1). |
| 3 | TRDA(2) | + | Etc., for a total of NSTM pairs for increasing area sizes. |
| 4 | STRM(2) | + | |

j. J Cards

Two cards for multiplan, multiratio economic analysis required only if JOPER (B1-1) is equal to 5.

J Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | J | Card identification. |
| 1 | NPLAN | + | Number of alternative development plans to be considered. NPLAN sets of hydrographs will be computed at each stream station. |
| 2 | NRTIO | + | Number of flood ratios to be read on J1 card (maximum of 9). Each plan (J-1) will have NRTIO ratios computed for every stream station. |
| 3 | LRTIO | 0 | Indicates ratios are to be taken of precipitation. |
| | | 1 | Indicates ratios are to be taken of runoff. |

J1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | RTIO(1) | + | Ratio by which all hydrograph or precipitation ordinates of each subarea are to be multiplied for all plans. |
| 2 | RTIO(2) | + | Etc., NRTIO (J-2) values in ascending order. |

k. K Card

Computation specification cards are required for nonoptimization jobs, JOPER (B1-1) equal to 3, 4 or 5. This is the key card for modeling a stream network. The type of computation indicated by variable ICOMP (K-1) determines which data are to follow the K card. Upon completion of the appropriate data cards following the K card, the program will expect to find another K card describing the next operation. Examples of the use of the K card are given in the text in the section entitled TEST PROBLEMS, tests 5, 6 and 7. Also, figure 1 of this addendum shows an overview of how the K card is used.

The data description of a stream network must always begin at the most upstream point in the network. In progressing downstream, all flows contributing to a combination point must be combined before continuing farther downstream. Refer to PROGRAM USAGE, paragraph 1b, Job Construction in the text for a detailed explanation of the model-building sequence.

K Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | K | Card identification. |
| 1 | ICOMP | 0 | Indicates subarea runoff computation. |
| | | 1 | Indicates routing computation. |
| | | 2-87 2 | Indicates ICOMP hydrographs are to be combined at this point. Only 2 hydrographs may be combined at one time. |
| | | X 88 | Indicates hydrograph balance. |
| | | 95 | Indicates observed flows are to be read for this station and compared and plotted with the flows which have been computed for same. N cards should follow the K1 card (if used) and then another K card after the N cards to specify the next type of computation. |
| | | 99 | Indicates end-of-job, no K1 card is read; program goes to summary printout and then a new job (A cards) if desired. If run is to be terminated after the summary printout, this card must be followed by five blank cards with an "A" in column 1 of the first card. |

K Card (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 2 | ISTAQ | + | Stream station location identification number (integer). |
| X3 | IECON | 0 | Indicates no economic computations are to be performed at this location. |
| | | 1 | Indicates that economic computations will be performed at this location and that appropriate "Z" cards must be included. The economic computations will be performed immediately after the operation specified in field 1, ICOMP, is accomplished. |
| 4 | ITAPE* | 0 | Current hydrograph is not to be obtained from or saved for another separate computer run. |
| | | 1 | Save hydrograph data computed at this station on tape for use in a future job. |
| | | 2 | Read in hydrograph data from tape for this station. The station number, ISTAQ field 2 of this card, must correspond to the station number on the tape when the hydrograph was originially saved in a previous job. |
| | | 3 | Read and write hydrograph data for this station from and on tape. |
| | | 7 | Punches current computed hydrograph on cards in a (16X, 8I8/(10I8)) format. |

*The program provides for off-line storage (magnetic tape, disk, etc.) of hydrographs and their pertinent data. (See text for explanation of tape usage.) This storage may be desirable for saving hydrographs for portions of a stream network for which the user is satisfied with the results. The saved hydrographs can then be retrieved in another job without recomputing all upstream hydrographs. The reading of hydrographs from tape can save much computer time for continually recomputing upstream portions of the stream network when working on downstream reaches.

K Card (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 5 | JPLT | 0 | Plot control for this computation is the same as specified on IPLT (B-8). |
| | | 1 | No graphs are to be plotted for this computation. |
| | | 2 | Plot computed hydrograph for this computation. |
| 6 | JPRT | 0 | Print control for this computation is the same as specified on IPRT (B-9). |
| | | 1 | Print all output for this computation. |
| | | 2 | Same as above without diagnostics. |
| | | 3 | Same as above without stream system and multiplan hydrographs. |
| | | 4 | Print basin input data only for this computation. |
| | | 5 | No printout for this computation. |
| 7 | INAME | 0 | Station or computation description card (K1) is not to be used for this computation. |
| | | 1 | Read station or computation description card (K1). |

K1 Card

Not used when ICOMP (K-1) is 99, or INAME is 0.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1-10 | NAME | AN | Station or computation description. |

X1. L Card

Hydrograph balance data card required only if preceding ICOMP (K-1) is equal to 88. The current hydrograph in memory will be adjusted so that it has the volume-duration characteristics specified below.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | L | Card identification. |
| 1 | NQB(1) | + | Number of ordinates to be included in the shortest duration. |
| 2 | SUMB(1) | + | Sum of flows in the shortest duration, NQB(1). |
| 3 | NQB(2) | + | Number of ordinates for next larger duration (including the prior duration). |
| 4 | SUMB(2) | + | Sum of flows corresponding to duration NQB(2). |
| 5 | NQB(3) | + | Etc., up to five durations. |
| 6 | SUMB(3) | + | |

m. M Card

Subarea runoff computation specification card which should follow the K cards if ICOMP (K-1) is zero. Not used for optimization jobs (JOPER, B1-1 equal to 1 or 2).

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | M | Card identification. |
| 1 | IHYDG | -1 | Input a given runoff hydrograph on N cards. After N Cards the next card will be another K Card. |
| | | 0 | Read precipitation data on O cards. |
| | | 1 | Read standard project or probable maximum storm data on P card. |
| | | 2 | Read precipitation station weightings on Q cards. |

M Card (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 2 | IUHG | -1 | Input unit hydrograph on U cards. |
| | | 0 | Read Clark unit hydrograph coefficients on V card. |
| | | 1 | Read Snyder unit hydrograph coefficients on W card. |
| 3 | TAREA | + | Drainage area in square miles (sq. km.). Will be overridden by R1 cards if ISNOW (M-8) is positive. |
| 4 | SNAP | + | Normal annual precipitation over TAREA (M-3) in inches (mm). Used only if IHYDG (M-1) is 2 and adjustment for known basin normal annual precipitation is desired. Will be overridden by R1 cards if ISNOW (M-8) is positive. |
| | | 0 | No adjustment based on normal annual precipitation. |
| 5 | TRSDA | + | Drainage area in square miles (sq. km.). for which storm is transposed. Transposition drainage area is used to compute the storm reduction coefficient (M-6) for standard project and probable maximum precipitation. To be supplied only when using PMS or SPFE on P card or for interpolation between DAJ and DAK on the O cards. TRSDA may be different from the actual subbasin area TAREA(M-3). |
| 6 | TRSPC | + | Storm transposition coefficient. For standard project or probable maximum floods, the program will derive a value in accordance with EC 1110-2-27 (19 February 1968, see references) if the value given here is zero and if IHYDG (M-1) is 1. If no value (zero) is entered here and IHYDG (M-1) is zero, the program will use a value of 1.0 indicating no transposition. |
| 7 | RATIO | + | Ratio by which ordinates of hydrograph just computed or read in is to be multiplied before further use. |
| | | 0 | Computed or read-in hydrograph is not to be changed by ratio. |

M Card (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 8 | ISNOW | 0 | No snow computation. |
| | | 1 | Snowmelt computations by degree-day method (R cards). |
| | | 2 | Snowmelt computations by energy-budget method (R and S cards). |
| 9 | ISAME | 0 | Runoff hydrograph computations will be different for each plan (J-1) of development. Only used if JOPER (B1-1) is 5. Supply a new set of T through X cards for each plan. |
| | | 1 | Runoff hydrograph computations are to be the same for all plans (J-1) of development. Only used if JOPER (B1-1) is 5. |
| 10 | LOCAL | 0 | Local flows are not to be derived at this station. |
| | | 1 | Local flows are to be derived at this station. Observed total flows must be supplied on N cards following this card. Local flows are then computed as the difference between the observed total flows and the current hydrograph at this location. Negative flows may result. The observed total hydrograph is used in the next stream network operation. |

n. N Card

Runoff hydrographs to be supplied if preceding IHYDG (M-1) is -1 if LOCAL (M-10) is positive or ICOMP (K-1) is 95.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | N | Card identification. |
| 1 | Q(1) | + | Flow in cfs ($m^3/s$) at the end of the first interval. |
| 2 | Q(2) | + | Etc., for each of NQ (B-1) intervals. |

o. O Cards

Basin average precipitation cards to be included if IHYDG (M-1) is zero; or if JOPER (B1-1) is 2 and NSTAN (B-10) is zero. The program provides for three different methods of inputing basin average precipitation as follows.

- Precipitation distribution, or
- Precipitation time pattern and total storm precipitation, or
- Precipitation (patterns or actual distributions) for two differently sized areas for which the precipitation is to be interpolated (based on the logarithm of areas) to determine the average precipitation (pattern or actual distribution) to be used for the subarea of interest. Reference is made to 3a in the section of the text entitled DESCRIPTION OF PROGRAM for further explanation.

The other methods for computing basin average precipitation, station data and hypothetical storm data, are discussed on the Q and P cards, respectively.

O Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 0 | Card identification. |
| 1 | NP | + | NP must be equal to NQ<br>Number of precipitation intervals to be read on following O1 cards ~~(150 max)~~. |
| | | -NP | Precipitation data to be used is the same as that read on the last set of O cards for previous station. |
| 2 | STORM | + | Total storm basin precipitation in inches (mm). If this value is given, the following O1 and/or O2 cards values for PRCPR will be used as a distribution pattern for the STORM amount. |
| | | 0 | No STORM data is to be used and the PRCPR data on the following O1, O2 cards are actual basin average precipitation. |
| 3 | DAJ | 0 | Precipitation on O1 cards is basin average for area, TAREA (M-3), or E-3. |
| | | + | Area in square miles (sq km) relative to the precipitation distribution on O1 cards. Field O-4 is also required. |

## 0 Cards (cont)

### 0 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 4 | DAK | + | Area in square miles (sq km) relative to the precipitation distribution on 02 cards Included only if DAJ (0-4) is positive. Cannot be zero if DAJ is positive because of the logarithmic interpolation. |

### 01 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | PRCPR(1,KR) | + | Precipitation during first interval in inches (mm) if STORM (0-2) is zero, proportion of STORM if STORM is positive. KR is the maximum space allocated in the program. This is the precipitation relative to area DAJ (0-3) if DAJ is positive. |
| 2 | PRCPR(2,KR) | + | Precipitation as above for second interval. |
| 3 | PRCPR(3,KR) | + | Etc., NP values, the last interval being PRCPR (NP,KR). |

### 02 Card

Required if DAJ (0-3) and DAK (0-4) are positive.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 2 | Card identification. |
| 1 | PRCPR(1, KR-1) | + | Precipitation during first interval as defined on the 01 cards except that this precipitation is relative to area DAK (0-4) |
| 2 | PRCPR(2, KR-1) | + | Precipitation as above for second interval. |
| 3 | PRCPR | + | Etc., NP values, the last interval being PRCPR(NP, KR-1). |

X p. P Cards

Standard project or probable maximum storm precipitation data supplied only if the preceding IHYDG (M-1) is 1. TRSPC (M-6) will be applied to these storms.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | P | Card identification. |
| 1 | SPFE | + | Standard project index precipitation from EM 1110-2-1411 (reference 11). |
| | | 0 | Standard project storm is not used. |
| 2 | PMS | + | Probable maximum index precipitation from HMS Report 33 (reference 12). |
| | | 0 | Probable maximum storm is not used. |
| 3-8 supplied if PMS is positive. | | | |
| 3 | R6 | + | Maximum 6-hour precipitation in percent of index PMS (P-2). |
| 4 | R12 | + | Maximum 12-hour percentage of PMS. |
| 5 | R24 | + | Maximum 24-hour percentage of PMS. |
| 6 | R48 | + | Maximum 48-hour percentage of PMS. |
| 7 | R72 | + | Maximum 72-hour percentage of PMS. |
| 8 | R96 | + | Maximum 96-hour percentage of PMS. |

q. Q Cards

Station weighting for precipitation data on G and H cards for use in current subarea runoff computation. The preceding IHYDR (M-1) must be 2 for nonoptimization jobs. For loss rate and unit graph optimization jobs, the Q cards will automatically be read if NSTAN (B-10) is positive. Two sets of data follow for nonrecording and recording stations, respectively.

Q Cards (cont)

Q Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | Q | Card identification. |
| 1 | NSTN | + | Number of nonrecording precipitation stations to be used for computing subarea basin precipitation (25 max). |
| 2 | NSTR | + | Number of recording precipitation stations to be used to distribute computed precipitation above. (9 max). |

Q1 Card

Non recording precipitation station weighting.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | ISTN(1) | + | Station identification number (integer). Must correspond to one of the ISTAN station numbers on the G cards. |
| 2 | WTN(1) | + | Relative weight in any units for ISTN(1). Basin average total precipitation is computed as Σ (WTN*PRCPN)/Σ WTN for all NSTN stations. |
| 3 | ISTN(2) | + | Etc., NSTN (Q-1) pairs. |
| 4 | WTN(2) | + | |

Q2 Card

Recording precipitation station weighting.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 2 | Card identification. |
| 1 | ISTR(1) | + | Station identification number (integer). Must correspond to one of the (ISTAR) station numbers on the H1 cards. |

Q Cards (cont)

Q2 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 2 | WTR(1) | + | Relative weight in any units. The recording precipitation distribution is computed as Σ (WTR*PRCPR)/Σ WTR for all NSTR stations and NP intervals. This precipitation distribution is used as the pattern to distribute the computed basin average total precipitation from the O1 card. |
| 3 | ISTR(2) | + | Etc., NSTR (Q-2) pairs. |
| 4 | WTR(2) | + | |

r. R Cards

Snow zone and melt criteria (R and S cards) included only if ISNOW (M-8 or E-2) is positive. S cards needed only if energy-budget method is to be used (ISNOW = 2).

R Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | R | Card identification. |
| 1 | NZONE | + | Number (integer) of 1000 ft. (300 m) elevation zones the subbasin is to be subdivided into for snowfall and melt computation (10 max). |
| 2 | TLAPS | + | Temperature lapse rate in °F per 1000-ft elevation zone (in °C per 300-m zone). |
| 3 | COEF | + | Snowmelt coefficient, usually about 0.07 for degree-day method and 1.0 for energy-budget method. If optimizing, this variable will be read from the F card and any value given here will be ignored. |
| 4 | FRZTP | + | Index temperature at which snow will melt in °F (°C). Precipitation will be assumed to fall as snow at temperature of (FRZTP+2) and below. The temperature increment of 2 degrees is the same for both English and metric units. If optimizing, this variable will be read from the F card and any value given here will be ignored. |
| 5 | DRNFZ | | Temperature increment to define precipitation as rain or snow. |

R Cards (cont)

R1 Card

Elevation zone data, one card for each zone. Required only if ISNOW (M-8 or E-2) is positive.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | AREA(1) | + | Drainage area in sq. mi. (sq km) in zone 1 (lowest zone). |
| 2 | SNO(1) | + | Average water equivalent in inches (mm) of snowpack at start of this job (first interval of NQ) in zone 1. |
| 3 | ANAP(1) | + | Normal annual precipitation in inches (mm) zone 1 corresponding to AREA (1). |

Etc., NZONE (R-1) cards as above.

R2 Card

Temperature data for all snowmelt computations.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 2 | Card identification. |
| 1 | TEMPR(1) | + | Air temperature for first interval in °F (°C) at bottom of lowest elevation zone. Will be adjusted to each zone by use of TLAPS (R-2). |
| 2 | TEMPR(2) | + | Air temperature as above for second interval. |
| 3 | TEMPR(3) | + | Etc., NQ (B-1) values. |

s. S Cards

Three sets of data required for energy-budget snowmelt computation (ISNOW, M-8, or E-2 must be 2).

S Cards (cont)

S Card

Dew point data.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | S | Card identification. |
| 1 | DEWPT(1) | + | Dew point during first interval in °F (°C) at bottom of lowest elevation zone. Will be adjusted to each zone by use of 0.2 TLAPS (R-2). |
| 2 | DEWPT(2) | + | Dew point as above for second interval. |
| 3 | DEWPT(3) | + | Etc., NQ (B-1) values. |

S1 Card

Wind data.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | WIND(1) | + | Wind speed in mi/hr (km/hr) at 50 ft (15 m) above surface, average for basin during first interval. |
| 2 | WIND(2) | + | Wind speed as above for second interval. |
| 3 | WIND(3) | + | Etc., NQ (B-1) values. |

S2 Card

Solar radiation data.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 2 | Card identification. |
| 1 | SOL(1) | + | Shortwave radiation in langleys during first interval. |
| 2 | SOL(2) | + | Shortwave radiation during second interval |
| 3 | SOL(3) | + | Etc., NQ (B-1) values. |

t. T Card

Precipitation loss rate data required for subarea runoff computations when ICOMP (K-1) is zero. Optimization jobs (JOPER = 2) do not require this card because the information is supplied on the F card. Not used if IHYDG (M-1) is -1.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | T | Card identification. |
| 1 | STRKR | + | Starting value in in/hr (mm/hr) of loss coefficient on exponential recession curve for rain losses (snowfree ground). |
| | | 0 | Constant loss rates, T-7 and T-8 will be used instead of loss rate function. |
| 2 | DLTKR | + | DLTKR is the amount in inches (mm) of initial accumulated rain loss during which the loss coefficient is increased. |
| | | 0 | Loss rate function not used. |
| 3 | RTIOL | + | Ratio of rain loss coefficient on exponential recession curve to that corresponding to 10 inches (25.4 mm) more of accumulated loss. |
| | | 0 | Loss rate function not used. |
| 4 | ERAIN | + | Exponent of precipitation for rain loss function. |
| | | 0 | Loss rate function not used. |
| 5 | STRKS | + | Starting value of loss coefficient on exponential recession curve for snowmelt losses. In addition, if CNSTL (T-8) is positive, STRKS is the constant snowmelt loss in in/hr (mm/hr). |
| | | 0 | Snowmelt not considered and/or loss rate function not used. |
| 6 | RTIOK | + | Ratio of snowmelt loss coefficient on exponential recession curve to that corresponding to 10 inches (25.4 mm) more of accumulated loss. |
| | | 0 | Snowmelt not considered and/or loss rate function not used. |

T1 ① REC ③ RECOV

T2 Initial Values CUML ① → ⑩

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T Card (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 7 | STRTL | + | Initial rainfall loss in inches (mm) for snowfree ground. Not to be used if loss rate function is desired. |
| 8 | CNSTL | + | Uniform rainfall loss in in/hr (mm/hr) on snowfree ground. Not to be used if loss rate function is desired. |
| 9 | ALSMX | + | Maximum allowable loss rate in in/hr (mm/hr). CNSTL (T-8) may be overridden if this value is not large enough. This variable is applicable to both constant loss and loss rate function computations. If ALSMX is not specified, the program assigns a very large value. |
| 10 | RTIMP | + | Proportion of drainage basin that is impervious must be $\leq$ 1. The program uses this variable to reduce the computed basin average loss rate. The loss rate is reduced by this fraction and the resulting value is used for the entire subarea. |

u. U Cards

Direct input of a given unit hydrograph. Included only if ICOMP (K-1) is equal to zero and IHYDG (M-1) is not equal to -1 and IUHG (M-2) is equal to -1. Unit hydrograph cards are not used for optimization jobs.

U Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | U | Card identification. |
| 1 | NUHGQ | + | Number (integer) of unit hydrograph ordinates to be read on U1 cards to follow (100 max). |

U Cards (cont)

U1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | QUNGR(1) | + | Unit hydrograph flow in cfs ($m^3/s$) at end of first interval. |
| 2 | QUNGR(2) | + | Same for second interval. |
| 3 | QUNGR(3) | + | Etc., NUHGO (U-1) values. |

v. V Cards

Clark unit graph coefficients when IUHG (M-2) is zero. This information is supplied on E and E1 cards for optimization jobs.

V Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | V | Card identification. |
| 1 | TC | + | Time of concentration in hours for Clark unit graph. |
| 2 | R | + | Storage coefficient in hours for Clark unit graph. |
| 3 | NTA | + | Number of time-area ordinates to be read on V1 cards for use in computing a unit hydrograph (100 max). |
| | | 0 | Synthetic time-area curve in the program is to be used. |

V1 Card

Time-area ordinates if NTA (V-3) is greater than zero.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |

V Cards (cont)

V1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 1 | QCLK(1) | + | Area, in any units, that contributes at time zero (usually area of reservoir, if any) at concentration point. |
| 2 | QCLK(2) | + | Total area contributing runoff during first of NTA (V-3) equal intervals of any length of time. |
| 3 | QCLK(3) | + | Total area contributing runoff during second such interval. |
| 4 | QCLK(4) | + | Etc., NTA ordinates. |

w. W Card

Snyder coefficients when IUHG (M-2) is 1. Not used for optimization jobs.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | W | Card identification. |
| 1 | TP | + | Snyder's lag in hours. |
| 2 | CP | + | Snyder's peaking coefficient, $C_p$, of desired unit hydrograph. |
| 3 | NTA | | Number of time-area ordinates to be read on W1 cards for use in computing a unit hydrograph (100 max). |
| | | 0 | Synthetic time-area curve in the program is to be used. |

W1 Card

Time-area ordinates if NTA (W-3) is greater than zero.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |

W Cards (cont)

W1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 1 | QCLK(1) | + | Area in any units that contributes at time zero (usually area of reservoir, if any) at concentration point. |
| 2 | QCLK(2) | + | Total area contributing runoff during first of NTA equal intervals of any length of time. |
| 3 | QCLK(3) | + | Total area contributing runoff during second such interval. |
| 4 | QCLK(4) | + | Etc., NTA ordinates. |

x. X Card

Hydrograph starting and recessing characteristics. Not used for optimization jobs.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | X | Card identification. |
| 1 | STRTQ | + | Flow at start of storm in cfs ($m^3/s$). Will be receded in same manner as QRCSN. |
| | | - | When negative, it is the cfs/sq mi ($m^3/s/$ sq km) which will be multiplied by the subbasin area, TAREA (M-3) to determine STRTQ. |
| 2 | QRCSN | + | Flow is cfs ($m^3/s$) below which base flow recession occurs in accordance with the logarithmic recession constant RTIOR. QRCSN is that flow where the straight line (on semi-log paper) recession deviates from the falling limb of the hydrograph. |
| | | - | When negative, it is the ratio (decimal) of peak discharge which is to be used to compute QRCSN. |

X Card (cont)

| Field | Variable | Value | Description |
|---|---|---|---|
| 3 | RTIOR | + | Ratio of recession flow, ORCSN, to that flow occurring 10 tabulation intervals later. Must be ≥ 1. |

y. Y Cards

Routing criteria to be supplied only if preceding ICOMP (K-1) is 1. Not used for optimization jobs.

Y Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | Y | Card identification. |
| 1 | QLOSS | + | Constant channel loss in entire routing in cfs ($m^3$/sec). This value is subtracted from every ordinate of the inflow hydrograph. |
| 2 | CLOSS | + | Ratio of remaining flow (after QLOSS) which is lost for entire routing. Each inflow hydrograph ordinate (after QLOSS is subtracted) is multiplied by (1- CLOSS). |
| 3 | AVG | 1 | Inflows to be routed are average for period. |
| | | 0 | Inflows to be routed are end-of-period values. |
| 4 | IRES | -1 | Flows are not to be routed. Used when NPLAN (J-1) exceeds 1 and a reservoir in one plan does not exist in another. |
| | | 0 | Indicates no reservoir routing. |
| | | 1 | Indicates reservoir routing by modified Puls method or working R and D routing and calls for use of storage-outflow relationship given on Y2 and Y3 cards. If working R and D routing method is to be used, the value of X (Y1-5) must be supplied. |

Y Cards (cont)

Y Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 5 | ISAME | 1 | All plans (J-1) have same routing criteria. Used only if JOPER (B1-1 ) is 5. |
| | | 0 | Routing criteria will be different for each plan (J-1) of development at this stream station. Only used if JOPER (B1-1) is 5. Supply a new set of Y1, Y2 and Y3 cards as necessary for routing through each plan. |

Y1 Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | NSTPS | + | Number (integer ≥ 1) of routing steps to be used for routing by Tatum method (equal to Tatum steps), Muskingum method (equal to number of reaches), modified Puls or working R and D method. |
| 2 | NSTDL | + | Number (integer) of ordinates to be averaged in the straddle-stagger routing. |
| | | 2 | To indicate routing by the Tatum method. |
| 3 | LAG | + | Number (integer) of computation intervals hydrograph is to be lagged. |
| 4 | AMSKK | + | Muskingum K coefficient in hours (reach travel time). |
| 5 | X | + | Muskingum X coefficient for Muskingum routing or working R and D routing. |
| 6 | TSK | + | Time-of-storage coefficient in hours. |
| 7 | STORA | + | Initial storage in acre-ft (thousand $m^3$) for modified Puls or working R and D routing. |
| | | -1 | Inflow equals outflow at start of routing and storage will be determined from storage-outflow relation for the initial outflow |

Y Cards (cont)

Y2 Card

Storage table for modified Puls and working R and D routing supplied only if IRES (Y-4) is 1. Storage is total for entire reach. The program will divide the storage values by NSTPS (Y1-1) if NSTPS is greater than zero.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 2 | Card identification. |
| 1 | STOR(1) | + | Storage in ac-ft (thousand $m^3$) corresponding to respective outflow OUTFL(1), card Y3. |
| 2 | STOR(2) | + | Storage for OUTFL(2). |
| 3 | STOR(3) | + | Etc., up to 10 values corresponding to Y3 outflows. |

Y3 Card

Outflow table for modified Puls and working R and D routing supplied only if IRES (Y-4) is 1.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 3 | Card identification. |
| 1 | OUTFL(1) | + | Outflow in cfs ($m^3/s$) corresponding to respective storage, STOR(1), on Y2 card. |
| 2 | OUTFL(2) | + | Outflow in cfs ($m^3/s$) corresponding to STOR(2). |
| 3 | OUTFL(3) | + | Etc., up to 10 values corresponding to storage on Y2 card. |

X z. Z Cards

Supply these cards only if IECON (K-3) is positive. This group of cards contains the peak flow frequencies, peak flows and monetary damages resulting from peak flows necessary to compute average annual damages for a particular stream station. Average annual benefits are computed as reduction in damages from base plan (plan 1) when compared to alternative plans of development. The range of peak flows should extend higher and lower than those expected to be generated in the computations. Several different types of damage may be specified at each station.

## Z Cards (cont)

### Z Card

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | Z | Card identification. |
| 1 | ISTA | + | Station identification number (integer) corresponding to stream station number ISTAQ (K-2) for which the economic analysis is desired. |
| 2 | NFLOD | + | Number of values of FREQ, PEAK, and DAMAG data on Z1, Z2, and Z4 cards (18 max). |
| 3 | NDMG | + | Number (integer) of different types of damages (e.g., residential, agricultural, industrial, etc.) to be evaluated for each plan at this station ( max. 10). |
| 4 | ISAME | 0 | Different discharge-damage relations are to be used for all plans at this location. Requires supplying new Z2, Z3, and Z4 cards for each plan. |
| | | 1 | The same damage-discharge relationship will apply to all plans. |

### Z1 Card

Frequency data.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 1 | Card identification. |
| 1 | FREQ(1) | + | Exceedence probability range (frequency in events per year) associated with each corresponding PEAK and DAMAG value. |
| 2 | FREQ(2) | + | Etc., NFLOD (Z-2) items. |

X Z Cards (cont)

X Z2 Card: Peak flow data.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 2 | Card identification. |
| 1 | PEAK(1) | + | Peak flow in cfs ($m^3/s$) corresponding to FREQ(1). |
| 2 | PEAK(2) | + | Peak flow corresponding to FREQ(2). |
| 3 | PEAK(3) | + | Etc., NFLOD items. |

X Z3 Card

Average annual damages for each type of damage. This information, if known, is used to adjust the computed average annual damages to account for integration errors. If these data are not known or this adjustment is not desired, then a blank card must be supplied.

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 3 | Card identification |
| 1 | AVGAN(1) | + | Average annual damages in thousands of dollars (or same units as DAMAG) for the first type of damage. |
| 2 | AVGAN(2) | + | Average annual damages for the second damage category. |
| 3 | AVGAN(3) | + | Etc. NDMG (Z-3) items. |

X Z4 Card

Flood damages (NDMG sets) of this data in the same sequence as listed on the Z3 card(s).

| Field | Variable | Value | Description |
|---|---|---|---|
| 0 | | 4 | Card identification. |
| 1 | DAMAG(1,1) | + | Damage in thousands of dollars (or same units as AVGAN) corresponding to PEAK(1) for damage category 1. |

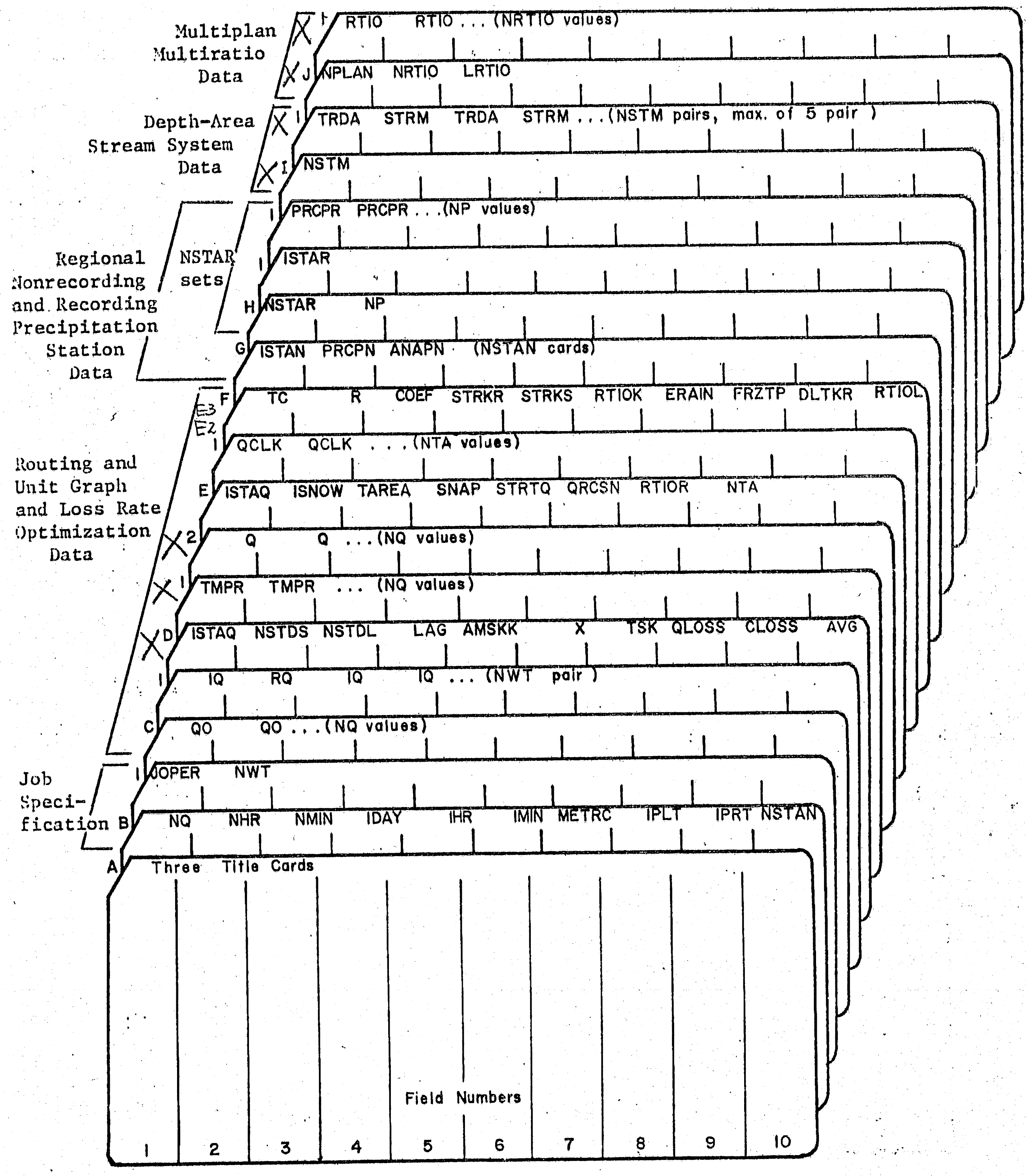
Z Cards (cont)

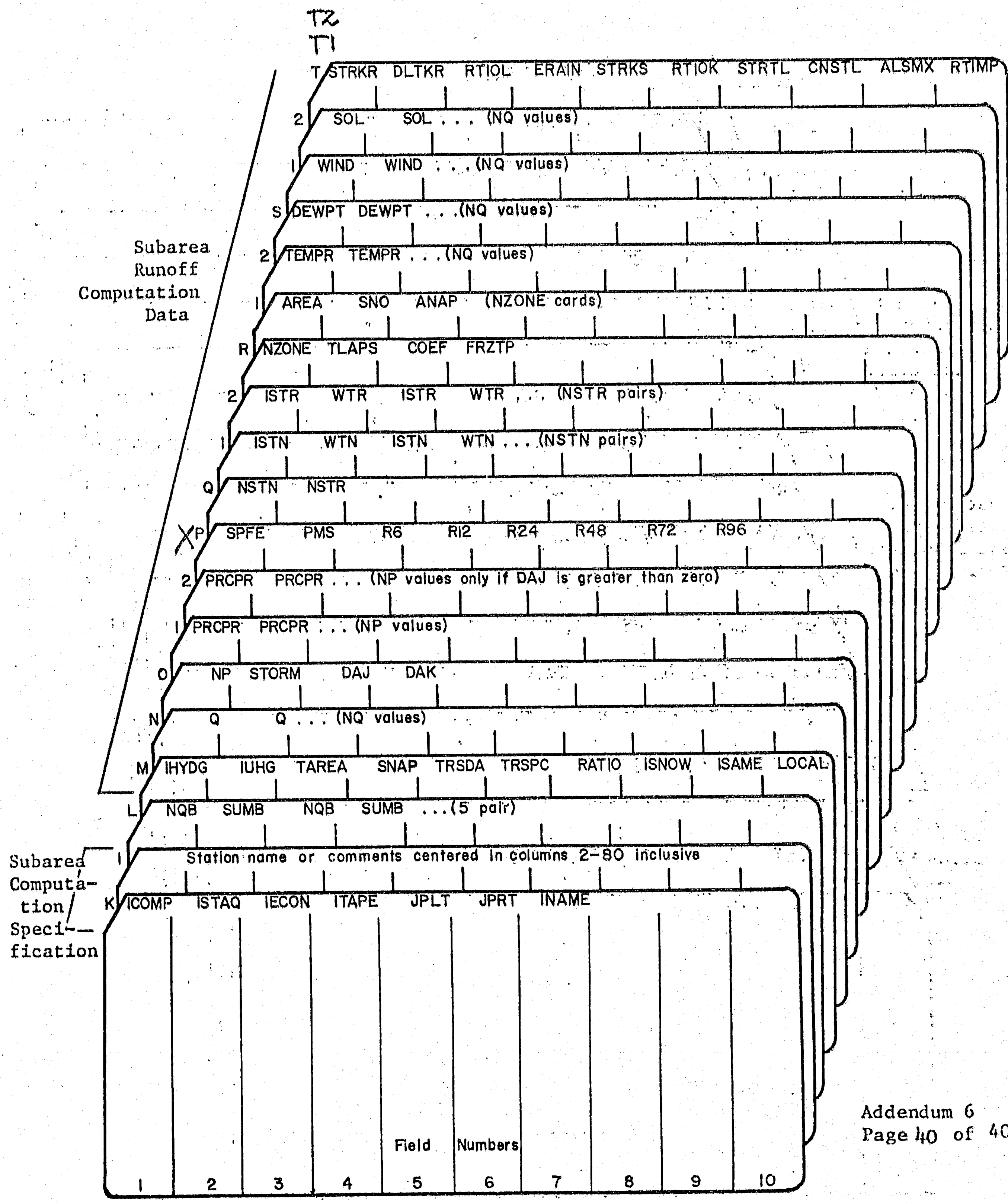
Z4 Card

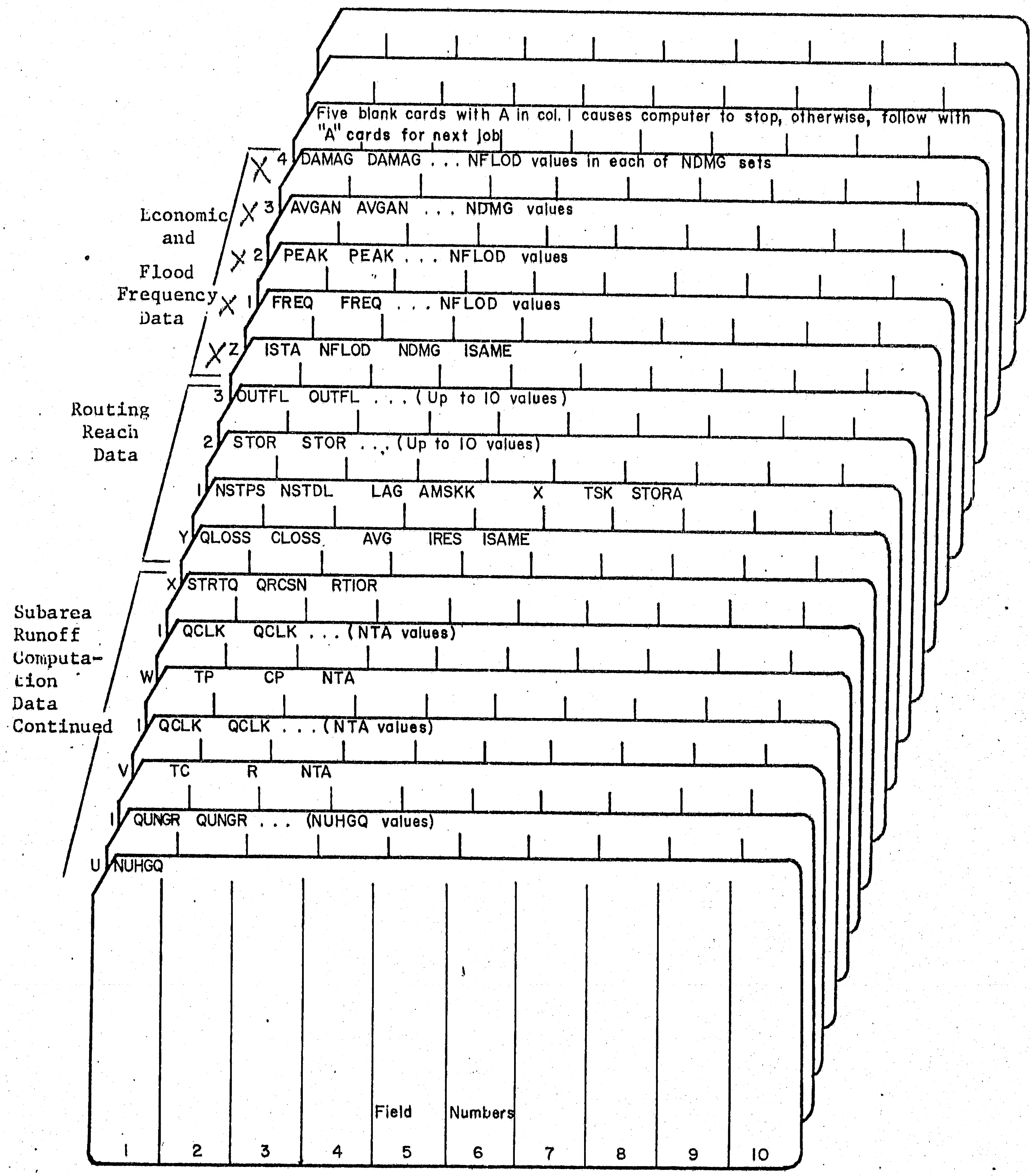
| Field | Variable | Value | Description |
|---|---|---|---|
| 2 | DAMAG(2,1) | + | Damage corresponding to PEAK(2) for damage category 1. |
| 3 | DAMAG(3,1) | + | Etc., NFLOD items and NDMG sets. |

If ISAME (Z-4) is zero, NPLAN sets (in total) of Z2, Z3, Z4 cards must be supplied.

In order to terminate the entire computer run, five blank "A" cards must follow the last data set. Otherwise, another job may be undertaken by starting with a new set of A cards, etc.


Multiplan Multiratio Data
I RTIO RTIO . . . (NRTIO values)
J NPLAN NRTIO LRTIO
Depth-Area Stream System Data
I TRDA STRM TRDA STRM . . . (NSTM pairs, max. of 5 pair)
I NSTM
Regional Nonrecording and Recording Precipitation Station Data
NSTAR sets
I PRCPR PRCPR . . . (NP values)
I ISTAR
H NSTAR NP
G ISTAN PRCPN ANAPN (NSTAN cards)
Routing and Unit Graph and Loss Rate Optimization Data
F TC R COEF STRKR STRKS RTIOK ERAIN FRZTP DLTKR RTIOL
E3
E2
I QCLK QCLK . . . (NTA values)
E ISTAQ ISNOW TAREA SNAP STRTQ QRCSN RTIOR NTA
2 Q Q . . . (NQ values)
I TMPR TMPR . . . (NQ values)
D ISTAQ NSTDS NSTDL LAG AMSKK X TSK QLOSS CLOSS AVG
I IQ RQ IQ IQ . . . (NWT pair)
C QO QO . . . (NQ values)
Job Specification
I JOPER NWT
B NQ NHR NMIN IDAY IHR IMIN METRC IPLT IPRT NSTAN
A Three Title Cards
Field Numbers
1 2 3 4 5 6 7 8 9 10


T2
T1
T STRKR DLTKR RTIOL ERAIN STRKS RTIOK STRTL CNSTL ALSMX RTIMP
2 SOL SOL . . . (NQ values)
1 WIND WIND . . . (NQ values)
S DEWPT DEWPT . . . (NQ values)
2 TEMPR TEMPR . . . (NQ values)
1 AREA SNO ANAP (NZONE cards)
R NZONE TLAPS COEF FRZTP
2 ISTR WTR ISTR WTR . . . (NSTR pairs)
1 ISTN WTN ISTN WTN . . . (NSTN pairs)
Q NSTN NSTR
P SPFE PMS R6 R12 R24 R48 R72 R96
2 PRCPR PRCPR . . . (NP values only if DAJ is greater than zero)
1 PRCPR PRCPR . . . (NP values)
O NP STORM DAJ DAK
N Q Q . . . (NQ values)
M IHYDG IUHG TAREA SNAP TRSDA TRSPC RATIO ISNOW ISAME LOCAL
L NQB SUMB NQB SUMB . . . (5 pair)
I Station name or comments centered in columns 2-80 inclusive
K ICOMP ISTAQ IECON ITAPE JPLT JPRT INAME
Subarea Runoff Computation Data
Subarea Computation Specification
Field Numbers
1 2 3 4 5 6 7 8 9 10


Five blank cards with A in col. 1 causes computer to stop, otherwise, follow with "A" cards for next job
X 4 DAMAG DAMAG . . . NFLOD values in each of NDMG sets
X 3 AVGAN AVGAN . . . NDMG values
X 2 PEAK PEAK . . . NFLOD values
X 1 FREQ FREQ . . . NFLOD values
X Z ISTA NFLOD NDMG ISAME
Economic and Flood Frequency Data
3 OUTFL OUTFL . . . (Up to 10 values)
2 STOR STOR . . . (Up to 10 values)
1 NSTPS NSTDL LAG AMSKK X TSK STORA
Y QLOSS CLOSS AVG IRES ISAME
Routing Reach Data
X STRTQ QRCSN RTIOR
1 QCLK QCLK . . . (NTA values)
W TP CP NTA
1 QCLK QCLK . . . (NTA values)
V TC R NTA
1 QUNGR QUNGR . . . (NUHGQ values)
U NUHGQ
Subarea Runoff Computation Data Continued
Field Numbers
1 2 3 4 5 6 7 8 9 10

# APPENDIX D

## Program Error Messages for HEC-1CS

## Table 1. Program Error Messages

The program will be terminated if any errors occur in job specifications or if dimensions are exceeded. The program will print the message "ERROR OCCURRED--CODE i, JOB TERMINATED" where "i" refers to one of the code numbers listed below.

| Error Code | Data Location | Description |
|---|---|---|
| 1 | Card B-11 | JOPER not in the range 1 through 5. |
| 2 | Card B-1 | NQ > 150 |
| 3 | Cards B-10 and/or F-1 and/or F-2 | NSTAN > 50, or NSTAR > 11, or NP > 150 |
| 4 | Cards B-1 or G-1 | (NQ*NSTM) >4800 |
| 5 | Card H | NDMG > 10 or NFLOD > 18 or (NPLAN*NRTIO*NQ) > 4800 |
| 6 | Card H | NRTIO > 9 or (NPLAN*NRTIO) > 45 |
| 7 | Card K | Total number of computation specifications (I cards) exceeded. Limited to a maximum of 500. |
| 8 | Card M-1 | NP > 150 |
| 9 | Card M | (NSTAR + 1) > 11 because the same array (PRCPR) is used for the precipitation on both card F and card M. |
| 10 | Card M | (NSTAR + 2) > 11 which may occur if DAJ and DAK are used. See code 9 for explanation of PRCPR array. |
| 11 | Card O | NSTN > 25 or NSTR > 9 |
| 12 | Card P-1 | NZONE > 10 |
| 13 | Card T-1 | NUHGO > 100 |
| 14 | Card Q-1,2 | NSTN.OR.NSTR.EQ.0 |
| Attempted read through end-of-file | Card K-2 | ISTAQ of current station is not equal to any ISTA of stations saved on tape. |
| | Any Card | Data not properly structured. |

101 Routing optimization option not available

102 Stream system option not available

103 Multiple plan option not available

104 HYDROGRAPH BALANCE OPTION NOT AVAILABLE

105 HYPOTHETICAL STORM OPTION NOT AVAILABLE

106 Incorrect continuation in subroutine read

107 PREC OPTION NOT IMPLEMENTED