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STORMWATER MANAGEMENT MODEL USER'S MANUAL VERSION III
Addendum I EXTRAN

by

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FOREWORD

The U.S. Environmental Protection Agency was created because of increasing public and government concern about the dangers of pollution to the health and welfare of the American people. Noxious air, foul water, and spoiled land are tragic testimonies to the deterioration of our natural environment. The complexity of that environment and the interplay of its components require a concentrated and integrated attack on the problem.

Research and development is that necessary first step in problem solution; it involves defining the problem measuring its impact, and searching for solutions. The Municipal Environmental Research Laboratory develops new and improved technology and systems to prevent, treat, and manage wastewater and solid and hazardous waste pollutant discharges from municipal and community sources, to preserve and treat public drinking water supplies, and to minimize the adverse economic, social, health, and aesthetic effects of pollution. This publication is one of the products of that research and provides a most vital communications link between the researcher and the user community.

Mathematical models are an important tool for use in analysis of quantity and quality problems resulting from urban storm water runoff and combined sewer overflows. This report is an updated user's manual and documentation for one of the first of such models, the EPA Storm Water Management Model (SWMM). Detailed instructions on the use of the model are given and its use is illustrated with case studies.

Francis T. Mayo, Director
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PREFACE

This document is the user's guide and program documentation for the computer model EXTRAN. EXTRAN is a dynamic flow routing model that routes inflow hydrographs through an open channel and/or closed conduit system, computing the time history of flows and heads throughout the system. While the computer program was developed primarily for use in urban drainage systems -- including combined systems and separate systems -- it can also be used for stream channels if the cross-section can be adequately represented as a trapezoidal channel.

EXTRAN is intended for application in systems where the assumption of steady flow, for purposes of computing backwater profiles, cannot be made. The program solves the full dynamic equation for gradually varied flow (Navier-Stokes equation) using an explicit solution technique to step forward in time. As a result, the solution time-step is governed by the wave celerity in the shorter channels or conduits in the system. Time-steps of 5-seconds to 60-seconds are typically used, which means that computer time is a significant consideration in the use of the model.

The conceptual representation of the drainage system is based on the "link-node" concept which does not constrain the drainage system to a dendritic form. This permits a high degree of flexibility in type of problems that can be examined with EXTRAN. These include parallel pipes, looped systems, lateral diversions such as weirs, orifices, pumps, and partial surcharge within the system.

Because of the versatility of the EXTRAN model, there is a tendency for some users to apply the model to the entire drainage system being analyzed even though flow routing through most of the system could be performed with a simpler model such as RUNOFF or TRANSPORT*. The result is a very large system simulated at relatively small time-steps which produces great quantities of data that are difficult to digest. Where simpler models are applicable (no backwater, surcharges, or bifurcations) substantial savings in data preparation and computer solution time can be realized using the simpler routing model.

EXTRAN has limitations which, if not appreciated, can result in improperly specified systems and the erroneous computation of heads and flows. The significant limitations are these:

- Headloss at manholes, expansions, contractions, bends, etc. are not explicitly accounted for. These losses

*That is, the RUNOFF and TRANSPORT Modules from the EPA SWMM computer program.

must be reflected in the value of the Manning n specified for the channels or conduits where the loss occurs.

- Changes in hydraulic head due to rapid expansions or contractions are neglected. At expansions, the headloss will tend to equalize the heads; but at contractions, the headloss could aggravate the problem.
- At a manhole where the invert of connecting pipes are different (e.g., a drop manhole), computational errors will occur during surcharge periods if the invert of the highest pipe lies above the crown of the lowest pipe. The severity of the error increases as the separation increases.
- Computational instabilities can occur at junctions with weirs if: 1) the junction is surcharged, and 2) the weir becomes submerged to the extent that the downstream head equals or exceeds the upstream head.
- EXTRAN is not capable of simulating water quality. Any quality information input on tape to EXTRAN is ignored by the program.

Methods for dealing with these problems are discussed in Chapter 4.

Finally, a word of caution. EXTRAN is a tool, like a calculator, that can assist engineers in the examination of the hydraulic response of a drainage system to inflow hydrographs. While the model is based on scientific truth, approximations in time and space are made in order to solve these problems. While we have tried to anticipate most prototype configurations, these approximations may not be appropriate in some system configurations or unusual hydraulic situations. Therefore, persons using the computer program must be experienced hydraulicians. The computational results should never be taken for granted, but rather the computer output should be scanned for each simulation to look for suspicious results. The checking procedure should be analogous to that which would be followed in checking a backwater profile that a junior engineer had performed by hand computation. Remember that the major difference between the engineer and the computer is that the computer can't think!

For the May 1982 Second Printing, minor typographical errors have been corrected on the following pages: iii, 8, 19, 93, 94, 95, 99, 100, 102, 103, 106, 110, 115, 116, 121, 122, 153, 160, 162, 164. Where easily done, some changes in the program code that make the program agree with that contained on the May 1982 Version III.1 of SWMM are shown on pages: 169, 183, 184, 188, 189, 190, 201, 208, 215. (Only those on pages 189, 201 and 208 are error corrections.)

For the July 1983 Sixth Printing, minor typographical errors have been corrected on the following pages: v, 13, 19, 99, 100, 105, 110, 113, 114.

ABSTRACT

This report contains the documentation and user's manual for the Extended Transport (EXTRAN) Block of the Storm Water Management Model (SWMM). EXTRAN is a dynamic flow routing model used to compute backwater profiles in open channel and/or closed conduit systems experiencing unsteady flow. It represents the drainage system as links and nodes, allowing parallel or looped pipe networks; weirs, orifices, and pumps; and system surcharges to be simulated. EXTRAN is used most efficiently if it is only applied to those parts of the drainage system which cannot be simulated accurately by simpler, less costly models.

The EXTRAN manual is designed to give the user complete information in executing of the model both as a block of the SWMM package and as an independent model. Formulation of the input data is discussed in detail and demonstrated by seven example problems. Typical computer output is also discussed. Problem areas which the user may confront are described, as well as the theory on which the EXTRAN model rests. The manual concludes with a comprehensive discussion of the EXTRAN code.

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CHAPTER 1

BLOCK DESCRIPTION

BACKGROUND

EXTRAN is a hydraulic flow routing model for open channel and/or closed conduit systems. The EXTRAN Block receives hydrograph input at specific nodal locations by tape transfer from the RUNOFF Block and/or by input. The model performs dynamic routing of stormwater flows through the major storm drainage system to the points of outfall to the receiving water system. The program will simulate branched or looped networks, backwater due to tidal or nontidal conditions, free-surface flow, pressure flow or surcharge, flow reversals, flow transfer by weirs, orifices and pumping facilities, and storage at on or off-line facilities. Types of channels that can be simulated include circular, rectangular, horseshoe, egge, baskethandle pipes, plus trapezoidal channels. Simulation output takes the form of water surface elevations and discharge at selected system locations.

EXTRAN was developed for the City of San Francisco in 1973^(1,2). At that time it was called the San Francisco Model and (more properly) the WRE Transport Model. In 1974, EPA acquired this model and incorporated it into the SWMM package, calling it the Extended Transport Model - EXTRAN - to distinguish it from the TRANSPORT Module developed by the University of Florida as part of the original SWMM package. Since that time, the model has been refined, particularly in the way the flow routing is performed under surcharge conditions. Also, much experience has been gained in the use and misuse of the model.

This document is the User's Manual and Program Documentation of the most recent version of EXTRAN as extended and refined by Camp Dresser & McKee Inc. (CDM)¹. The documentation section (Chapter 5) has been expanded to include more discussions of program limitations and the input data descriptions have been revised to provide more guidance in the preparation of data for the model.

The remainder of this chapter discusses program operating requirements and characteristics of EXTRAN, and how it interfaces with other SWMM blocks. Chapter 2 contains instructions for data preparation. Narrative discussions of the input data requirements contain tips for developing a well defined system. Chapter 3 consists of several example problems that demonstrate how to set up EXTRAN for each of the storage/diversion options in the model.

¹Water Resources Engineers was wholly integrated into Camp Dresser & McKee, Inc. in 1980.

Chapter 4 discusses typical problems that can occur with the use of the model and what action should be taken to correct them. A discussion of error messages contained in the program is also presented. Chapter 5 describes the conceptual, mathematical, and functional representation of EXTRAN; the program structure and listing is contained in Chapter 6.

PROGRAM OPERATING REQUIREMENTS

EXTRAN was originally programed for the Univac 1108 in FORTRAN V. This version of the FORTRAN compiler is essentially compatible with the IBM FORTRAN LEVEL G compiler and the extended compiler used on CDC 6600 series equipment. The model was subsequently installed on IBM, CDC, DEC 20, and several other computers. The latest refinements to the model have been performed on the DEC 20 computer.

EXTRAN is presently sized to simulate drainage systems of up to 187 channels, 187 junctions, 20 storage elements, 60 orifices, 60 weirs, 20 pumps, and 25 outfalls. The core storage and peripheral equipment to operate this program are:

- High speed core: 130,000₈ words
45,000₁₀ words
- Peripheral storage: 2 drum, disk or tape files
- One card reader or input file device
- One line printer

Execution times for EXTRAN are roughly proportional to the number of system conduits and the number of time-steps in the simulation period. A summary of CDM's prior experience in running the EXTRAN on both CDC 6600 and Univac 1108 systems is presented graphically in Figure 1. Using the Univac 1108 operating data in Figure 1 as an example, it is estimated that the total computation time for a network of 100 pipes, using a 10-second time-step over a 1-hour simulation period, would be approximately 300 system-seconds. Run time for the example problems in Chapter 3 (9 pipes, 8 hour simulation, 20 second time-step) was about 44 seconds on the DEC 20 computer. Note that the curves presented in Figure 1 become highly nonlinear for $t < 10$ seconds because of the increased frequency of internal tape transfers and output processing.

INTERFACING WITH OTHER SWMM BLOCKS

The EXTRAN Program can easily be interfaced with other SWMM Blocks, even though EXTRAN is designed to stand by itself. Figure 2 shows a schematic overview of the EXTRAN Block and its relation to SWMM system control and input data cards. The EXTRAN Block receives hydrograph input at specific nodal locations either by tape transfer from a preceding block, usually RUNOFF, or by card input, described in Chapter 2. The output tape, which contains hydrographs at all system outfall points, can be generated if desired. This output tape can then be used as input to any subsequent SWMM Block, typically RECEIV. The EXTRAN Program itself is called as a subroutine by the Executive Block. The EXTRAN Block, in turn, reads the input data it requires to perform its flow routing function.

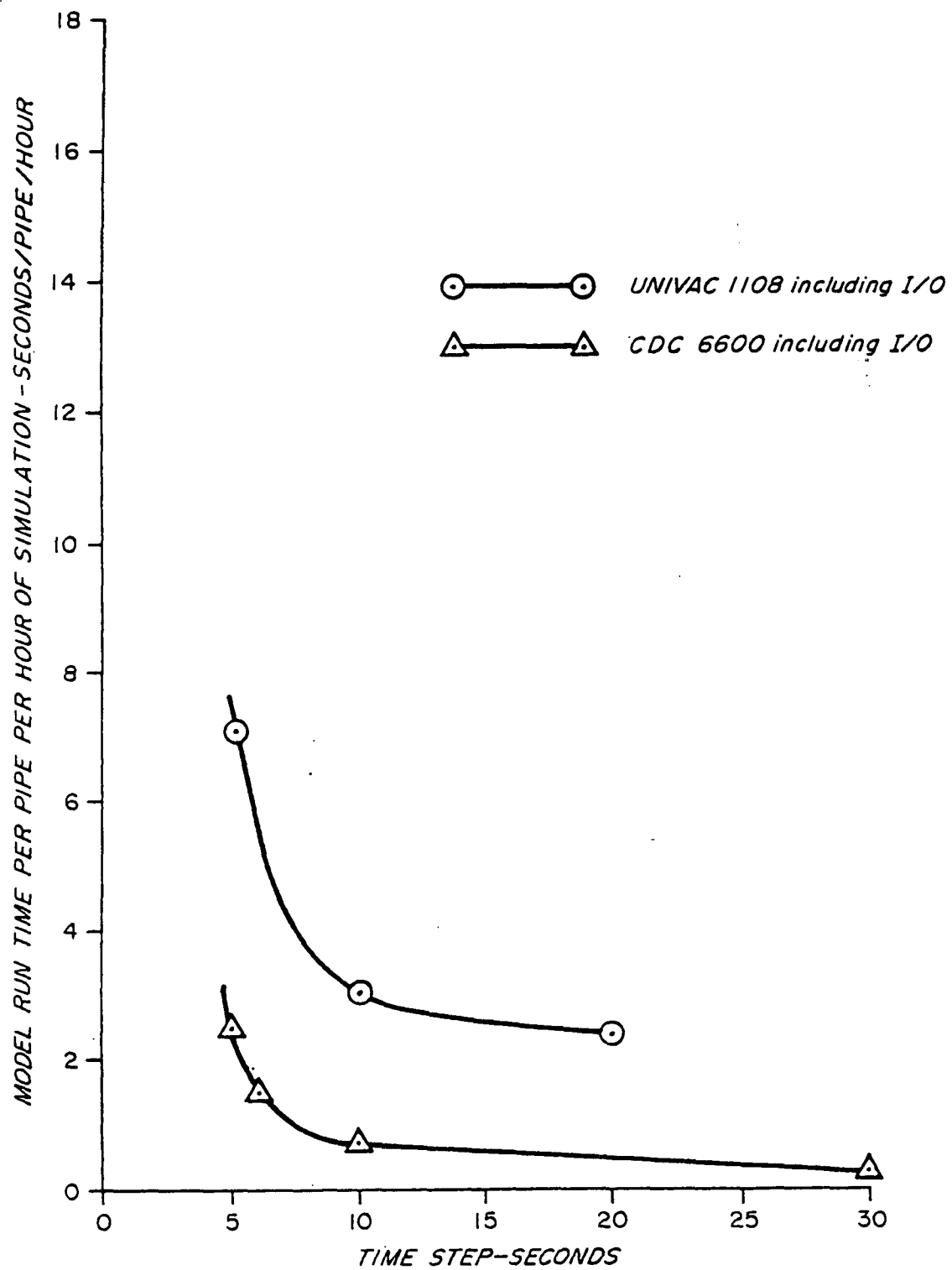


Figure 1. Summary of EXTRAN run times on CDC and UNIVAC systems.

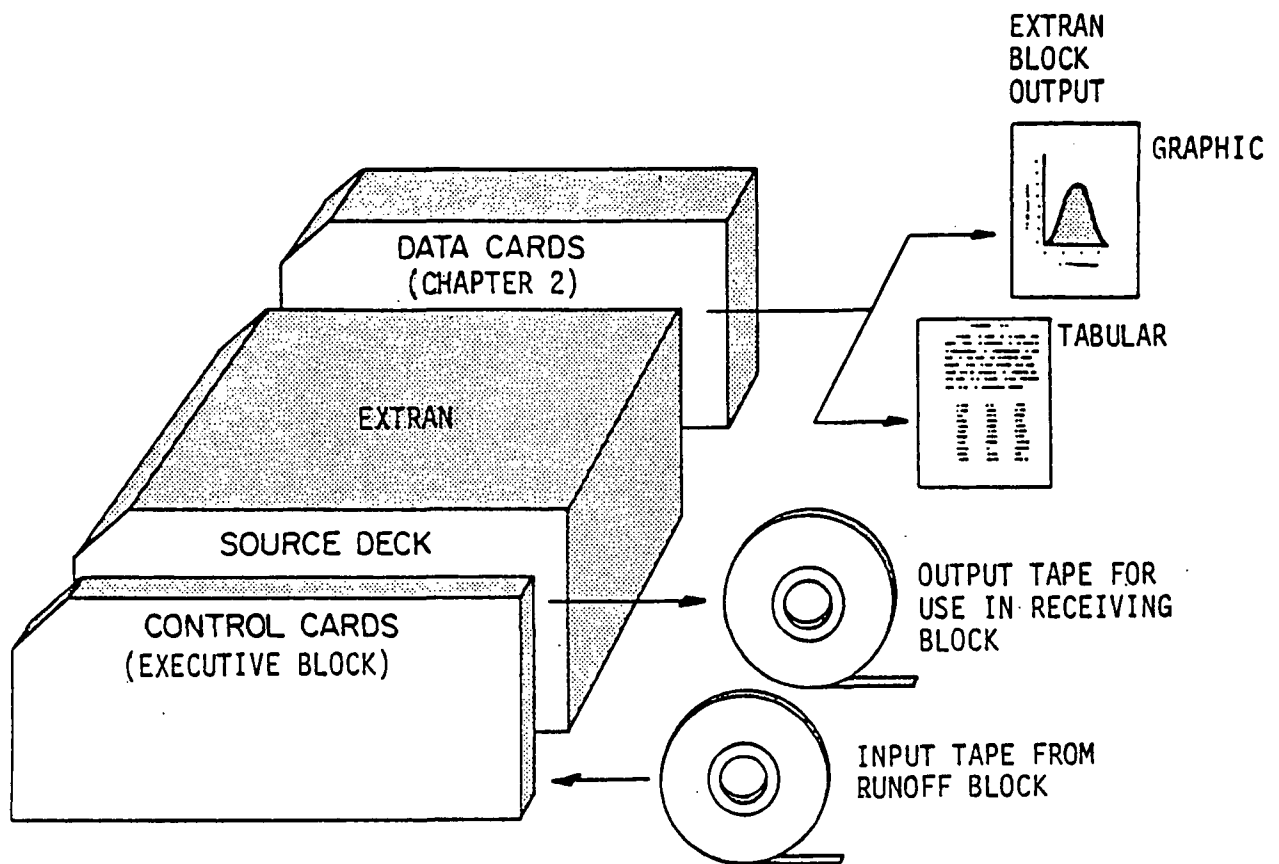


Figure 2. Typical schematic of EXTRAN block setup deck.

The version of EXTRAN shown in Appendix Table A-3 is set up to run outside the SWMM Executive Block. Chapter 6 explains the revisions to the code needed to convert the present main program of EXTRAN to Subroutine EXTRAN of the Executive Block. Although SWMM is designed to run successive blocks consecutively without user intervention, it is strongly recommended that this option not be used with EXTRAN. Simulation results should be examined before they are used as input to EXTRAN; EXTRAN results should be reviewed, in turn, for reasonableness before they are input to subsequent blocks. To bypass the inter-block review process is to invite undetected errors in the analysis results and/or to require expensive reruns of blocks that used erroneous output data from a preceeding block.

If EXTRAN is the only block called from the Executive Block, input data for the Executive Block would be structured as follows:

CARD GROUP 1 I/O tape/disk assignments

JIN = output tape/file number from, typically, the
RUNOFF Block if RUNOFF hydrographs are to be
used in simulation

= 0 if input hydrographs are from cards only (See
Card Group 20 and 21 in EXTRAN Block input data
description)

JOUT = output tape/file number that will be used to
input outfall hydrographs from EXTRAN into a
subsequent block such as RECEIV

= 0 if the outfall hydrographs are not required by
a subsequent block

Note that there is no EXTRAN Quality Block. If pollutographs
are to be routed through the drainage system, it is suggested
that RUNOFF or TRANSPORT be used for this purpose.

CARD GROUP 2 - Scratch tape/disk assignment

Enter a blank card

CARD GROUP 3 - Block Control Card

Enter EXTRAN only

In this case, Card Group 1 of the EXTRAN input data set shown in Chapter 2, Table 1, is not needed and should be omitted. If, on the other hand, EXTRAN is run independently of the Executive Block using the code shown in Appendix Table A-3, the input data set should be formed exactly as shown in Table 1, omitting the above Executive Block input data.

CHAPTER 2

INSTRUCTIONS FOR DATA PREPARATION

INTRODUCTION

When a drainage system is to be analyzed with EXTRAN, the first step in the study is generally to define the sewer system and the watershed (sewer-shed) that it drains. This information is usually available from the agency responsible for operation and maintenance of the system. Care should be taken in this step to insure that "as built" drawings of the system are used. Where information is suspect, a field investigation is in order.

Once the sewer system and watershed has been defined, the watershed is subdivided into subareas in accordance with the guidelines presented in the RUNOFF Block documentation. Figure 3 shows the South Boston combined sewer system and its watershed subdivided into subbasins. Figure 4 is a schematic representation of the South Boston combined sewer system. Note that "TRANSPORT" refers to EXTRAN in this case. The figure shows all pipes and channels to be simulated in the study, the location and type of all diversion structures and all system outlets and overflow points. It may be of interest to note here that the 6000-series channels at the Columbus Park Headworks represent the four-channel grit chambers in the headworks that determine the stage-discharge relationship at Junction 60101 in the system.

Note that conduits are distinguished on Figure 4 between those that will be simulated in RUNOFF and those to be simulated in EXTRAN. As a general rule, the upstream portions of the drainage system should be represented in RUNOFF as much as possible because the data preparation is more simple and the flow routing takes less computer time. The dividing point for the two systems is the point where backwater effects, surcharge, and/or diversion facilities affect the flow and head computation. Pipes and channels downstream of this point should be included in EXTRAN.

Junction Points should be identified at each:

- Upstream terminal point in the system,
- Outfall and discharge point,
- Pump station, storage point, orifice and weir diversion,
- Junction where inflow hydrographs will be input (either by card input or from RUNOFF),
- Pipe junction,
- Point where pipe size/shape changes significantly,
- Point where pipe slope changes significantly, and
- Point where pipe inverts are significantly different.

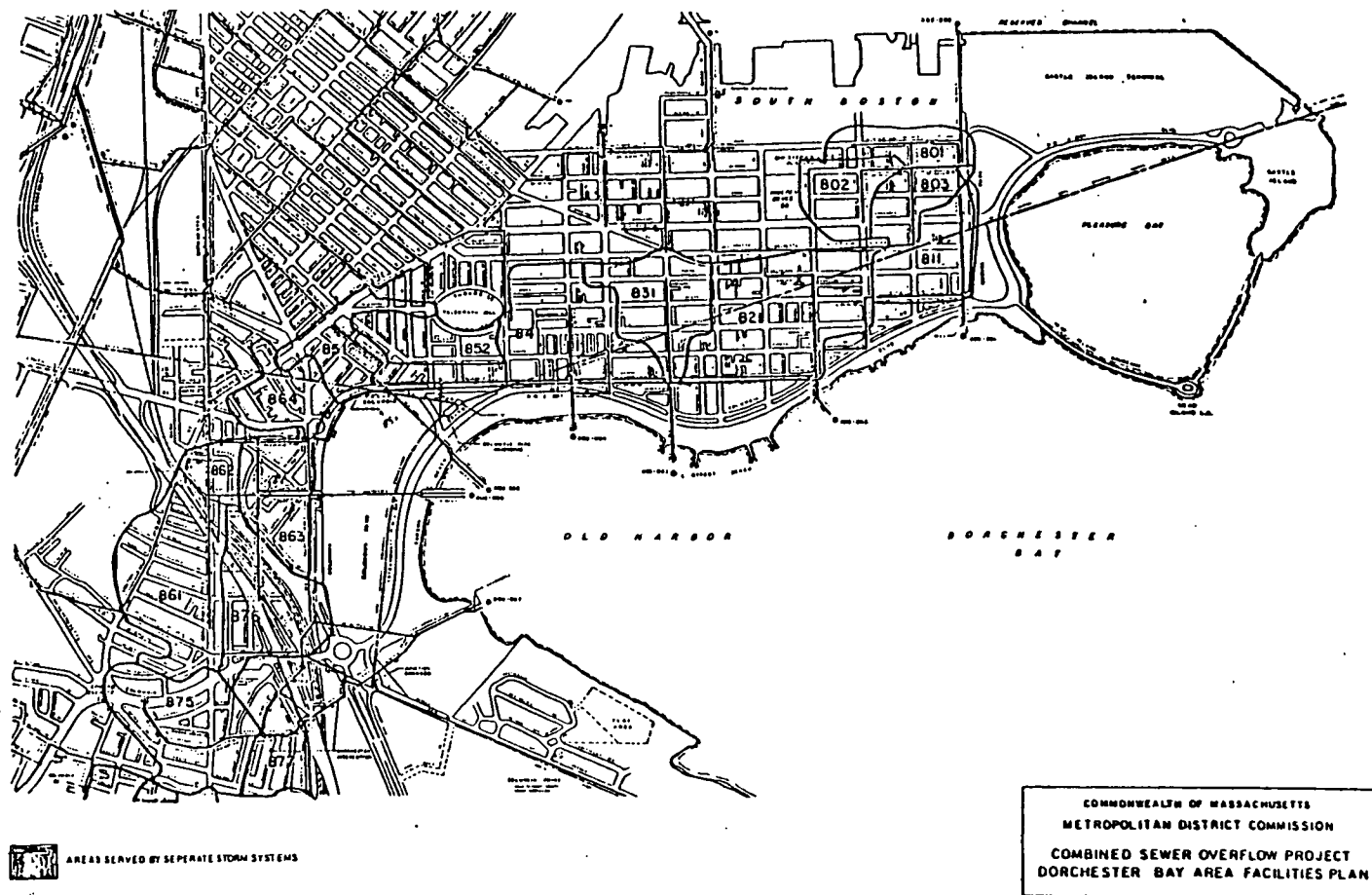


Figure 3. Runoff Subbasins Tributary to South Boston Interceptor.

Following the preliminary identification of junction points, a check should be made to eliminate extremely long or short distances between junctions. As a rule of thumb, the longest conduit should not exceed four or five times the length of the shortest conduit. If this occurs, short conduits can be increased in length by use of equivalent pipes and long conduits can be shortened by adding intermediate junction points.

Keep in mind when setting conduits lengths (placing junctions) that the time-step is generally controlled by the wave celerity in the system. To estimate the time-step, first compute:

$$\Delta t_c = \frac{L}{\sqrt{gD}} \quad (1)$$

where:

Δt_c = time for a surface wave to travel from one end of a conduit to the other in seconds,
 L = conduit length in feet,
 g = 32.2 ft/sec,
 D = channel depth or pipe diameter in feet.

The time-step can usually exceed Δt_c by a factor of 1.5 to 2.0 for a few widely separated conduits. For most problems, conduit lengths can be of such length that a 15 to 30 second time-step can be used. Occasionally, a 5 to 10 second time-step is required. A time-step of 60 to 90 seconds should not be exceeded even in large open channel systems where the celerity criteria is not violated with a larger time-step.

If an extremely short pipe is included in the system, as indicated by a small Δt_c , an equivalent longer pipe can be developed using the following steps. First, set the Manning equation for the pipe and its proposed equivalent equal:

$$\frac{1.49}{n_p} A_p R_p^{2/3} S_p^{1/2} = \frac{1.49}{n_e} A_e R_e^{2/3} S_e^{1/2} \quad (2)$$

where:

p = actual pipe,
 e = equivalent pipe,
 n = Manning's roughness coefficient,
 A = cross-sectional area,
 R = hydraulic radius, and
 S = slope of the hydraulic grade line.

If we assume that the equivalent pipe will have the same cross-sectional area and hydraulic radius as the pipe it replaces, we can say:

$$S_p^{1/2}/n_p = S_e^{1/2}/n_e \quad (3)$$

Now, since

$$S = h_L/L \quad (4)$$

where:

h_L = the total head loss over the conduit length, and
 L = conduit length,

and since the head losses are to be equal in both pipes, equation (2) can be simplified to:

$$n_e = n_p L_p^{1/2} / L_e^{1/2} \quad (5)$$

where L_e is the desired equivalent pipe length, either no smaller than four to five times smaller than the longest pipe in the system, or large enough to give a t_c within the range indicated above. The user, through experience, will be able to determine the pipe length changes required to achieve stability and an acceptable time-step for the simulation.

At this point, the system schematic should be in pretty good shape for developing model input data. The remaining sections of this chapter describe, step-by-step, how to develop the input data file for EXTRAN.

INPUT DATA DESCRIPTION

Specifications for input data preparation are contained in Table 1. The table defines input format column location and variable description and name. Table A-1 in the Appendix is a set of input data forms which can be used to facilitate encoding the data for EXTRAN. Perusal of Table 1 reveals that the input data is divided into 22 card groups. Card Groups 1-7 are control cards that identify the simulation, set the time-step and start time, and identify junctions for card input hydrograph, and junction and conduits for printing and plotting of heads and flows. The identification of conduits and junctions is done in Card Groups 8 and 9, respectively. Card Groups 10-13 identify storage and diversion junctions, while Groups 14-18 identify system outfalls and backwater conditions at the outfalls. Initial conditions for heads and flows are defined in Card Groups 19-20. Card Groups 21 and 22 define card input hydrographs. Further descriptions of the data to be entered in each card group are given below.

Card Group 1: Tape Numbers

Card Group 1 is a single card which specifies the identifying numbers of tapes used for input and output hydrograph storage, if used. A zero should be entered if a particular tape is not used. Card Group 1 should be included only if EXTRAN is to be run on its own, i.e., outside the SWMM Executive Block.

Card Group 2: Run Identification

Card Group 2 consists of 2 cards, each having 80 columns or less, which typically describe the system and the particular storm being simulated.

Card Group 3: Run Control

Card Group 3 is a single card defining the number of integration steps in the simulation period, the length of each time-step, output control data, the number of hydrograph input points to be supplied by cards (in addition to, or rather than, tape input generated by the Runoff Block), and control parameters for iterations on computations for surcharged areas.

The time-step, DELT, is most critical to the cost and stability of the EXTRAN model run and must be selected carefully. The time-step should be selected according to the guideline described in the Introduction to this chapter (see Equation 1). The computer program will check each conduit for violation of the surface wave criteria and will print the message:

**** WARNING **** (C*DELT/LEN) IN CONDUIT IS rrr AT FULL DEPTH

where rrr is the ratio

$$rrr = \frac{\Delta t \sqrt{gD}}{L} \quad (6)$$

where

Δt = the time-step
g = gravity
D = conduit height or pipe diameter
L = conduit length

As already noted, if rrr is greater than 1.5 or 2.0 for any conduit, or if several conduits have rrr over 1.5, the time-step should be reduced. rrr should never exceed 1.0 in a terminal conduit (i.e., an upstream terminal conduit or outfall).

Another constraint to be observed carefully is the length of the total simulation period defined as the product of NTCYC and DELT. This period must not extend in time beyond the simulation period of any preceding block. Otherwise, an improper attempt to read beyond the end-of-file of the input hydrograph tape is made and execution of EXTRAN stops.

The printing interval, INTER, also must be specified carefully to insure proper output of heads, velocities, and flows. The present output capacity of EXTRAN provides for 100 values each of nodal water depth, elevation, conduit flow, and velocity to be printed as detailed output for any given simulation run. When this number is exceeded, the printing arrays are filled with extraneous results taken from other core storage locations which bear no resemblance to the desired output. As an example, if NTCYC = 1600 and we start printing in cycle 1 (NSTART=1), then INTER must = 16 or more to maintain correct printing control. Alternatively, if NSTART = 801 then INTER can be 8. Also, the output looks better if NSTART and INTER are selected so that the first (and subsequent) output(s) occurs at an even minute(s) or half minute(s).

The variables ITMAX and SURTOL control the accuracy of the solution in surcharged areas. In reality, the inflow to a surcharged area should equal the outflow from it. Therefore, the flows and heads in surcharged areas are

recalculated until either the difference in inflows and outflows is less than a tolerance, defined as SURTOL times the average flow in the surcharged area, or the number of iterations exceeds ITMAX. It has been found that good starting values for ITMAX and SURTOL are 30 and 0.05, respectively. The user should be careful to check the intermediate printout, which indicates whether the iteration is converging. Also, if there is more than one surcharged section of the drainage system, special rules apply. More details on checking convergence of the surcharge iterations are found in Tips For Troubleshooting (Chapter 4).

Card Groups 4 and 5: Detailed Printing for Junctions and Conduits

Card Group 4 contains the list of individual junctions (up to 20) for which water depth and water surface elevations are to be printed continuously throughout the course of the simulation period. Card Group 5 contains the list of individual conduits (up to 20) for which flows and velocities are to be printed.

Card Groups 6 and 7: Detailed Plotting for Junctions and Conduits

Card Groups 6 and 7 contain, respectively, the lists of junctions and conduits for which time histories and water surface elevation and flows are to be plotted.

Card Group 8: Conduit Data

Card Group 8 contains data input specification for conduits including shape, size, length, hydraulic roughness, connecting junctions, and invert distances referenced from the junction invert. The input data instructions, as presented in Table 1, are self-explanatory with the exception of junction/conduit invert elevations.

Basic definitions of conduit invert distances $ZP(N,1)$ and $ZP(N,2)$ are illustrated in Figure 5. The junction invert elevation is specified in Card Group 9. The distance ZP is height of the invert of connecting conduits above the junction floor. Note, however, that the lowest pipe connected to the junction (pipe N in Figure 5) must have a ZP of zero. If it does not, the junction will behave like a mass sink in the system. Water will flow into the junction but none will flow out.

Card Group 9: Junction Data

The explanation of ground and invert elevations is also shown in Figure 5. One junction card is required for every junction in the network including: regular junctions, storage and diversion junctions, pump junctions, and out-fall junctions. It is emphasized again that the junction invert elevation is defined as the invert elevation of the lowest pipe connected to the junction. The program execution will terminate with an error message:

```
**** ERROR **** ALL CONDUITS CONNECTING TO JUNCTION ____  
LIE ABOVE THE JUNCTION INVERT
```

unless there is at least one pipe having a zero ZP at the junction.

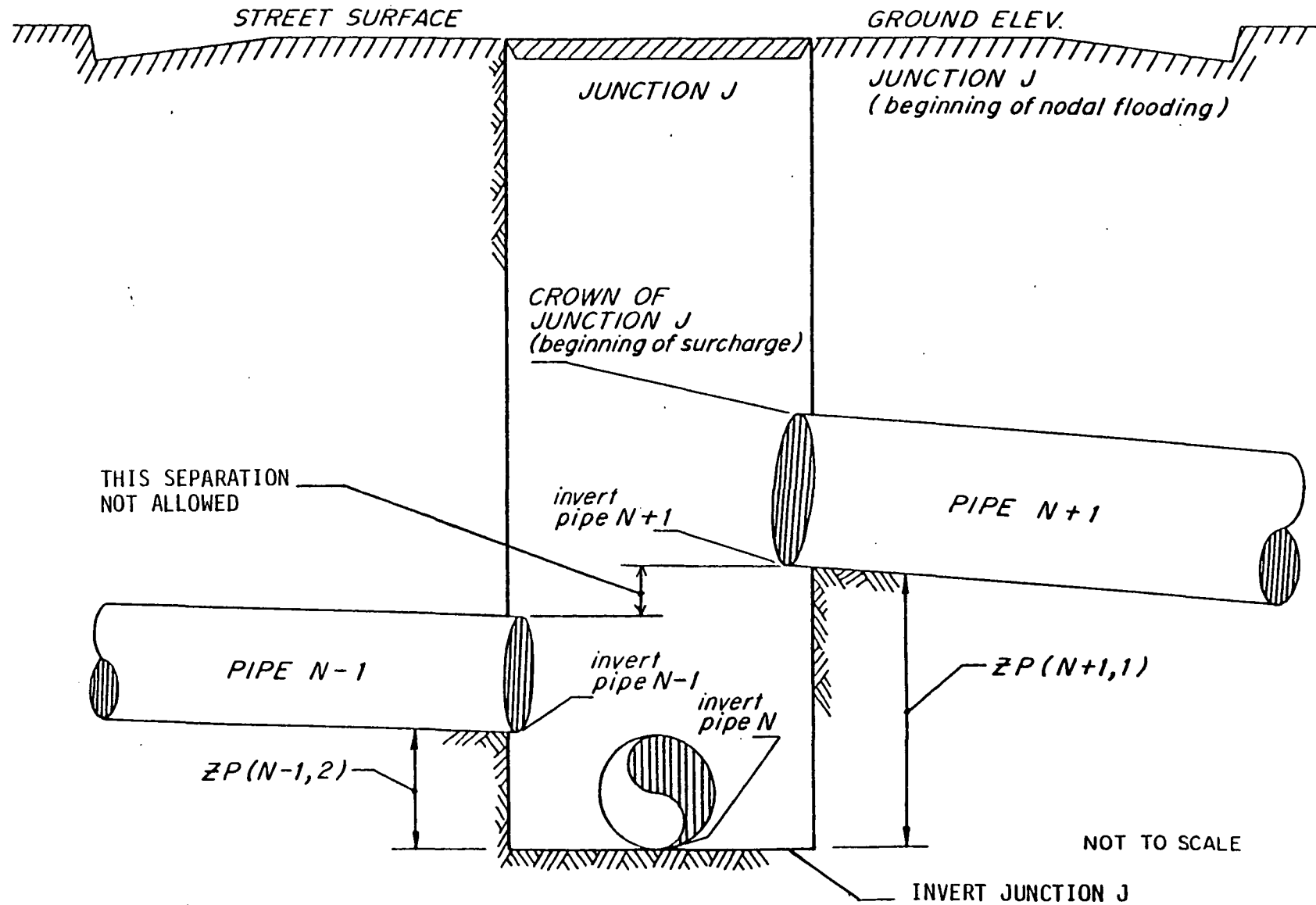


Figure 5. Definition of elevation terms for three-pipe junction.

The surcharge level or junction crown elevation is defined as the crown elevation of the highest connecting pipe and is computed automatically by EXTRAN. Note that the junction must not surcharge except when the water surface elevation exceeds the crown of the highest pipe connected to the junction. Pipe N+1 in Figure 5 is too high. This junction would go into surcharge during the period when the water surface is between the crown of pipe N-1 and the invert of pipe N+1. If a junction is specified as shown in Figure 5 and the water surface rises above the crown of pipe N-1, the program will print an error message:

**** ERROR **** SURFACE AREA AT JUNCTION ____ IS ZERO,
CHECK FOR HIGH PIPE

and will then stop. To correct this situation, a new junction should be specified that connects to pipe N+1. A "dummy conduit" is specified which connects the old junction with pipes N-1 and N to the new junction which connects to pipe N+1. The pipe diameter should be that of N+1 and the length selected to meet the stability criteria given by Equation 6. The Manning n for the "dummy pipe" is computed to reflect the energy loss that occurs during surcharge as water moves up through the manhole and into pipe N+1.

The "ground elevation", GRELEV(J), is the elevation at which the assumption of pressure flow is no longer valid. Normally, this will be the street or ground elevation; however, if the manholes are bolted down, the GRELEV(J) should be set sufficiently high so that the simulated water surface elevation does not exceed it. When the hydraulic head must exceed GRELEV(J) to maintain continuity at the junction, the program allows the excess junction inflow to "overflow onto the ground" and become lost from the system for the remainder of the simulation period.

QINST(J) is the net constant flow entering (positive) or leaving (negative) the junction.

Card Group 10: Storage Junctions

Conceptually, storage junctions are tanks of constant surface area, over their depth. A storage "tank" may be placed at any junction in the system, either in-line or off-line. The elevation of the top of the tank is specified in the storage junction data and must be at least as high as the highest pipe crown at the junction. If this condition is violated, the system will go into simulated surcharge before the highest pipe is flowing full.

Card Group 11: Orifice Cards

EXTRAN simulates orifices as equivalent pipes (see Chapter 5). Data entry is straightforward. For sump orifices, the program automatically sets the invert of the orifice one diameter below the junction invert so that the orifice is flowing full before there is any discharge (overflow) to conduits downstream of the junction containing the orifice.

Card Group 12: Weir Cards

The definition sketch for weirs is illustrated in Figure 6. The following types of weirs can be simulated:

- Internal diversions (from one junction to another via a transverse or sideflow weir.
- Outfall weirs which discharge to the receiving waters. These weirs may be transverse or sideflow types, and may be equipped with flap gates that prevent backflow.

Transverse weir and sideflow weirs are distinguished in EXTRAN by the value of the exponent to which the head on the weir is taken. For transverse weirs, head is taken to the 3/2 power (i.e., $Q_w \sim H^{3/2}$) while for sideflow weirs the exponent is 5/3 (i.e., $Q_w \sim H^{5/3}$).

When the water depth at the weir junction exceeds YTOP (see Figure 6) the weir functions as an orifice ($Q_w \sim H^{1/2}$). The discharge coefficient for the orifice flow condition is computed internally in EXTRAN (see Chapter 5).

Stability problems can be encountered at weir junctions if the junction surcharges during the simulation. If this happens or is suspected of happening, the weir may be represented as an equivalent pipe. To do this, equate the pipe and weir discharge equations, e.g.:

$$\frac{1.49}{n} AR^{2/3} S^{1/2} = C_w WH^{3/2} \quad (7)$$

where:

- n = Manning n for the pipe,
- A = cross-sectional area,
- R = hydraulic radius,
- S = hydraulic grade line for the pipe,
- H = head across the weir,
- C_w = weir discharge coefficient,
- W = weir length.

In this equation, $S = H/L$ where L is the pipe length, and $A = WH$. If R is set at the value of the hydraulic radius where the head is half way between YCREST and YTOP, and L is set in accordance with Equation 6, then n can be computed as:

$$n = \frac{R^{2/3}}{C_w L^{1/2}} \quad (8)$$

for the equivalent pipe.

Card Group 13: Pump Cards

Pumps may be of two types:

1. An off-line pump station with a wet well; the rate of pumping depends upon the volume (level) of water in the wet well.

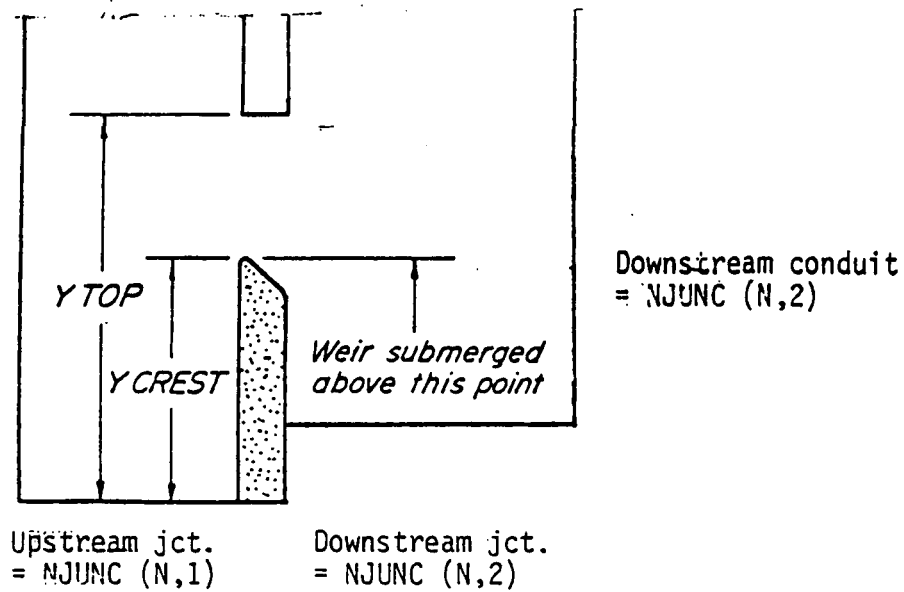


Figure 6. Definition sketch of weir input data.

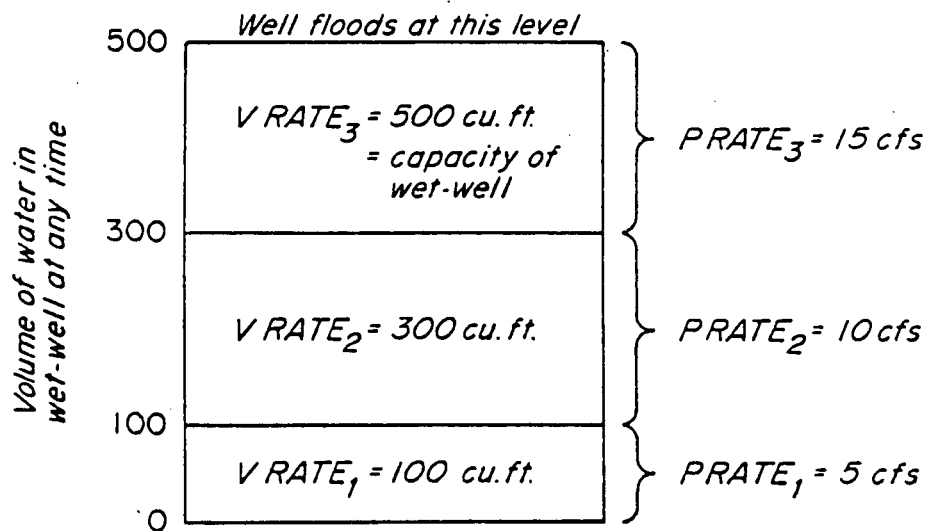


Figure 7. Definition sketch of pump input data.

2. An on-line lift station that pumps according to the level of the water surface at the junction being pumped.

The definition sketch in Figure 7 defines the input variable for Type 1 pump.

For a Type 2 pump station, the following operating rule is used:

$$\begin{array}{ll}
 Y \leq \text{VRATE}(I,1) & Q_p = \text{Junction inflow or PRATE}(I,1), \\
 & \text{whichever is less} \\
 \text{VRATE}(I,1) < Y \leq \text{VRATE}(I,2) & Q_p = \text{PRATE}(I,2) \\
 \text{VRATE}(I,2) < Y & Q_p = \text{PRATE}(I,3)
 \end{array}$$

Note that for a Type 2 pump station VRATE is the water depth at the pump junction, while for a Type 1 station it is the volume of water in the wet well.

Note also that only one conduit may be connected to a Type 1 pump station junction.

Card Group 14: Free Outfall Pipes

Three types of outfalls can be simulated in EXTRAN:

1. A weir outfall with or without a flap (tide) gate (Card Group 12),
2. A conduit outfall without a flap gate (Card Group 14), or
3. A conduit outfall with a flap (tide) gate (Card Group 15).

Under Card Group 14, enter the outfall junction number for outfall conduits without flap gates.

Card Group 15: Outfall Pipes With Flap Gates

Enter the outfall junction number for conduits with flap gates.

Card Groups 16, 17, and 18: Tidal Backwater Control Cards

Card Groups 16, 17, and 18 describe the single tidal backwater condition which is applied at all outfalls in the drainage system. The tidal index, NTIDE, is specified according to whether there is: (1) no water surface at any outfall; (2) a water surface at constant elevation; (3) a tide whose period and amplitude are described by user supplied tide coefficients; or (4) a tide which will be computed by EXTRAN using Equation 37 which is based on a specified number of stage-time points describing a single tidal cycle.

Card Groups 19 and 20: Initial Flows, Velocities, and Heads

Frequently, it is desired to initialize the drainage network with starting values of flow, velocity, and water surface elevation which represent either the dry weather or antecedent flow conditions just prior to the storm to be simulated. Card Groups 19 and 20 are designed for the purpose of supplying these initial conditions throughout the drainage system at the beginning of the simulation. Card Group 19 contains discharge for each conduit in the same order as it is specified in Card Group 9. Note that initial

discharge must be specified for all real conduits plus all internal links. (There is one internal link for each orifice, weir, pump, and outfall in the system. In a complex network, the total number of real plus internal conduits is best determined from the conduit connectivity summary in a trial run with EXTRAN.) As an example, in a system of 25 real conduits, 28 junctions, 2 orifices, 3 weirs, and 1 free outfall, we have a total of 31 links. The specification of initial discharges in Card Group 19 requires a total of 8 cards with 4 conduits on each. For the case where all flows and heads are zero at the start of the simulation, enter 99999. in columns 6 thru 10 of Card Group 19.

Similarly, initial depths of flow (not elevations) are keypunched according to the instruction in Card Group 20. Again the initial heads are supplied for all real and internal junctions. The latter are specified automatically by the EXTRAN program for each weir in the system. Thus in the example above, we would have a total of 31 junctions and the initial dry-weather heads would be punched on four cards in the order the junctions appear in Card Group 10.

Card Groups 21 and 22: Hydrograph Input Cards

EXTRAN provides for input of up to 20 inflow hydrographs by cards in cases where it is desirable to run EXTRAN alone without prior use of the Runoff Block or to add additional input hydrographs, either at the same or different nodes, to those computed by the Runoff Block. The specification of individual junctions receiving hydrograph input by cards is given in Card Group 21. Note that multiple hydrographs coming into a given junction can be indicated by repeating the junction number in Group 21 for each inflow hydrograph. The order of hydrograph time discharge points in Card Group 22 now must correspond exactly with the order specified by Card Group 21. The time, TE0, of each discharge point is given in decimal clock hours; i.e., 10:45 a.m. is punched as 10.75. Hydrograph time input points can be specified at any convenient time as long as a point is included for each junction specified in Card Group 21. The hydrographs are then formed by interpolating between consecutive time input points for each time step.

TABLE 1. EXTRAN DATA REQUIREMENTS

Card Group	Format	Card Columns	Description	Variable Name
TAPE UNIT NUMBERS				
NOTE: ONLY INCLUDE CARD GROUP 1 IF EXTRAN IS RUN STANDING ALONE. SKIP IF EXTRAN IS CALLED FROM THE EXECUTIVE BLOCK OF SWMM.				
1	2I5	1-5	Hydrograph input tape from Runoff Block	N21
		6-10	Outfall hydrograph tape for input to RECEIVE Block	N22
RUN TITLE				
2	20A4	1-60	Description of computer run (2 cards.) Will be printed on output (2 lines).	ALPHA
RUN CONTROL PARAMETERS				
3	I5,2F5.0, 8I5,F5.0	1-5	Number of integration steps or time cycles desired	NTCYC
		6-10	Length of integration step, seconds	DELT
		11-15	Start time of simulation, decimal hours	TZERO
		16-20	Number of junctions for detailed printing of head output (20 nodes max.)	NHPRT
		21-25	Number of conduits for detailed printing of discharge output (20 pipes max.)	NQPRT
		26-30	Number of junctions to be plotted (20 max.)	NPLT
		31-35	Number of conduit flows to be plotted (20 max.)	LPLT
		36-40	First time-step to begin print cycle	NSTART

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
3 (Continued)		41-45	Interval between print cycles (max. number of cycles printed is <u>NTCYC - NSTART</u> INTER	INTER
		46-50	Number of input junctions, if card input hydrographs are used (65 max.)	NJSW
		51-55	Maximum number of iterations to adjust head and flow of surcharged junctions	ITMAX
		56-60	Segment of flow in surcharged areas to be used as the tolerance for ending surcharge iterations	SURTOL
PRINTED HEADS				
4	8I10	1-10	First junction number for detailed printing	JPRT(1)
		11-20	Second junction number, up to number of nodes defined by NHPRT	JPRT(2)
PRINTED FLOWS				
5	8I10	1-10	First conduit number for detailed printing	CPRT(1)
		11-20	Second conduit number up to number of nodes defined by NQPRT	CPRT(2)
PLOTTED HEADS				
NOTE: IF NPLT = 0, SKIP THIS CARD GROUP				
6	8I10	1-10	First junction number for plotting	JPLT(1)
		11-20	Second junction number, up to number of nodes defined by NPLT	JPLT(2)
PLOTTED FLOWS				
NOTE: IF LPLT = 0, SKIP THIS CARD GROUP				
7	8I10	1-10	First conduit number for plotting	KPLT(1)

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
7 (Continued)		11-20	Second conduit number for plotting, up to number of nodes defined by LPLT (This option is for conduit flow rate)	KPLT(2)
CONDUIT CARDS(1 CARD/CONDUIT, 187 MAX.)				
8	415, 9F5.0	1-5	Conduit number (none greater than 90000)	NCOND(N)
		6-10	Junction number at upstream end of conduit	NJUNC(N,1)
		11-15	Junction number at downstream end of conduit	NJUNC(N,2)
		16-20	Type of conduit shape 1 = circular 2 = rectangular 3 = horseshoe 4 = egg 5 = baskethandle 6 = trapezoid	NKCLASS(N)
		21-25	Cross sectional area of conduit, sq. ft. (necessary only for types 3, 4, and 5)	AFULL(N)
		26-30	Vertical depth of conduit, ft.	DEEP(N)
		31-35	Maximum width of conduit, ft. Bottom width for trapezoid, ft.	WIDE(N)
		36-40	Length of conduit, ft.	LEN(N)
		41-45	Distance of conduit invert above junction invert at NJUNC(N,1)	ZP(N,1)
		46-50	Distance of conduit invert above junction invert at NJUNC(N,2)	ZP(N,2)
		51-55	Mannings coefficient (includes entrance and exit losses)	ROUGH(N)
		56-60	Slope of one side of trapezoid, (horizontal/vertical; 0=vertical)	STHETA(N)

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
8 (Continued)		61-65	Slope on other side of trapezoid, (horizontal/vertical; 0=vertical)	SPHI(N)
(Last card must have 99999 in columns 1 to 5)				
JUNCTION CARDS (1 CARD/JUNCTION, 187 MAX.)				
9	I5, 3F5.0	1-5	Junction number (none greater than 90000)	JUN(J)
		6-10	Ground elevation, ft.	GRELEV(J)
		11-15	Invert elevation, ft.	Z(J)
		16-20	Net constant flow into junction, cfs (may be a negative number)	QINST(J)
(Last card must have a 99999 in columns 1 to 5)				
STORAGE JUNCTIONS (1 CARD/JUNCTION, 20 MAX.)				
NOTE: JUNCTION MUST BE IDENTIFIED IN JUNCTION DATA				
10	I5, 2F5.0	1-5	Junction containing storage facility	JSTORE(I)
		6-10	Junction crown elevation (must be higher than crown of highest pipe connected to storage facility)	ZCROWN(J)
		11-15	Storage volume per foot of depth (surface area), cu. ft/ft.	ASTORE(I)
(Last card must have a 99999 in columns 1 to 5)				
ORIFICE CARDS (1 CARD/ORIFICE, 60 MAX.)				
11	3I5, 3F5.0	1-5	Junction containing orifice	NJUNC(N,1)
		6-10	Junction to which orifice discharges	NJUNC(N,2)
		11-15	Type of orifice 1 = side outlet 2 = bottom outlet	NKCLASS(N)

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
11 (Continued)		16-20	Orifice area in sq. ft.	AORIF(I)
		21-25	Orifice discharge coefficient	CORIF(I)
		26-30	Distance of orifice invert above junction floor (define only for side outlet orifices)	ZP(I)
		(Last card must have 99999 in columns 1 to 5)		
WEIR CARDS (1 CARD/WEIR, 60 MAX.)				
12	3I5, 4F5.0	1-5	Junction at which weir is located	NJUNC(N,1)
		6-10	Junction to which weir discharges NOTE: To designate outfall weir, set NJUNC(N,2) equal to zero	NJUNC(N,2)
		11-15	Type of weir 1 = transverse 2 = transverse with tide gates 3 = side flow 4 = side flow with tide gates	KWEIR(I)
		16-20	Height of weir crest above invert, ft.	YCREST(I)
		21-25	Height to top of weir opening above invert (surcharge level) ft.	YTOP(I)
		26-30	Weir length, ft.	WLEN(I)
		31-35	Coefficient of discharge for weir	COEF(I)
		(Last card must have 99999 in columns 1 to 5)		
PUMP CARDS (1 CARD/PUMP, 20 MAX.)				
NOTE: ONLY ONE PIPE CAN BE CONNECTED TO A PUMP NODE				
13	3I5, 7F5.0	1-5	Junction being pumped	NJUNC(N,1)
		6-10	Pump discharge goes to this junction	NJUNC(N,2)

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
13 (Continued)		11-15	Type of pump 1 = off-line pump with wet well 2 = on-line lift pump	IPTYP(I)
		16-20	Initial wet well volume, cu. ft. (enter 0 for type 2 pump)	VWELL(I)
		21-25	Lower pumping rate, cfs.	PRATE(I,1)
		26-30	Mid-pumping rate, cfs.	PRATE(I,2)
		31-35	High pumping rate, cfs.	PRATE(I,3)
		36-40	Wet well volume (or junction depth) for mid rate pumps to start, cu. ft. (or ft.)	VRATE(I,1)
		41-45	Wet well volume (or junction depth) for high rate pumps to start, cu. ft. (or ft.)	VRATE(I,2)
		46-50	Total wet well capacity, cu. ft. (enter 0 for type 2 pump)	VRATE(I,3)
(Last card must have 99999 in columns 1 to 5)				
OUTFALL PIPES W/O TIDE GATES (1 CARD OUTFALL, 25 MAX.)				
NOTE: ONLY ONE CONNECTING CONDUIT IS PERMITTED TO A FREE OUTFALL NODE				
14	I5	1-5	Junction for free outfall	JFREE(I)
(Last card must have 99999 in columns 1 to 5)				
OUTFALL PIPES WITH TIDE GATES (1 CARD OUTFALL, 25 MAX.)				
NOTE: ONLY ONE CONNECTING CONDUIT IS PERMITTED TO OUTFALL NODE				
15	I5	1-5	Junction at which gate is located	JGATE(1)
(Last card must have 99999 in columns 1 to 5)				

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
1 CARD FOR TIDAL CONTROL				
16	I5, 8F5.0	1-5	Tide index: 1 = no water surface at outfalls 2 = outfall control water surface at constant elevation, A1 3 = tide coefficients provided 4 = program will compute tide coefficients	NTIDE
		6-10	First tide coefficient	A1
		NOTE: COLUMNS 11-45 NOT REQUIRED UNLESS NTIDE = 3		
		11-15	Second tide coefficient	A2
		16-20	Third tide coefficient	A3
		21-25	Fourth tide coefficient	A4
		26-30	Fifth tide coefficient	A5
		31-35	Sixth tide coefficient	A6
		36-40	Seventh tide coefficient	A7
		41-45	Tidal period in hours	W
REQUIRED IF NTIDE = 4				
17	3I5	1-5	If one, there are four information points, program will develop the coefficients	K0
		6-10	Number of information points (4 if K0 above equals 1)	NI
		11-15	If one, will print information on tide coefficient development	NCHTID

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
REQUIRED IF NTIDE = 4				
18	8F10.0	1-10	Time, first information points	TT(1)
		11-20	Tidal stage, at time above	YY(1)
		21-30	Time, second information points	TT(2)
		31-40	Tidal stage, at time above, up to number of points as defined by <u>NI</u>	YY(2)
INITIAL FLOWS				
19	8F10.0	1-10	Initial flows (cfs)	Q(1)
		11-20	Initial velocities (fps)	V(1)
		21-30	NOTE: IF ALL INITIAL FLOWS, VELOCITIES AND HEADS ARE ZERO, PUNCH	Q(2)
		31-40	99999. IN COLS. 1-10 OF FIRST CARD FOR Q(1). NO OTHER CARDS REQUIRED	V(2)
		41-50		
(4 conduits per card, up to NTL conduits. Includes internal links.)				
INITIAL DEPTHS				
20	8F10.0	1-10	Initial junction depth (ft.)	Y(1)
		11-20	NOTE: SKIP IF A 99999. HAS BEEN PUNCHED FOR Q(1) ABOVE.	Y(2)
(8 junctions per card up to NJ junctions. Includes internal junctions.)				
Y(NJ)				

TABLE 1. EXTRAN DATA REQUIREMENTS
(Continued)

Card Group	Format	Card Columns	Description	Variable Name
CARD HYDROGRAPHS				
IF NJSW = 0, SKIP CARD GROUPS 21 and 22				
21	I6I5	1-5	First input node for card hydrograph	JSW(1)
		6-10	Second input node for card hydrograph	JSW(2)
		.		.
		.		.
REQUIRED IF NJSW $\geq$ 1				
22	8F10.0	1-10	Clock time, in decimal hours	TEO
		11-20	Flow rate, cfs., first input node, JSW(1)	QCARD(1,1)
		21-30	Flow rate, cfs., second input node, JSW(2), up to <u>NJSW</u> nodes	QCARD(2,1)
		.		.
.		.		
.		(If more than one card is needed for each time, the next QCARD(N,1) should begin in Columns 1-10 of each subsequent card, 8 QCARD(N,1) per card up to QCARD(NJSW,1). Repeat with the same number of cards for each TEO with the final TEO greater than the end time of the run.)	.	

CHAPTER 3

EXAMPLE PROBLEMS

INTRODUCTION

Seven test runs of EXTRAN have been made and are included in this report. They will demonstrate how to set up the input data sets for each of the flow diversions included in the model. The complete or partial results of these runs have also been included as an example of typical output and an aid in interpreting EXTRAN results.

EXAMPLE 1: BASIC PIPE SYSTEM

Figure 8 shows a typical system of conduits and channels conveying stormwater flow. In this system, which is used in all the example problems below, conduits are designated with four-digit numbers while junctions have been given five-digit numbers. There are three inflow hydrographs, which are read from cards, and one free outfall. Table 2 is the input data set for Example 1.

The complete output for Example 1 is found in Table 3. The first section is an echo of the input data and a listing of conduits created internally by EXTRAN to represent outfalls and diversion caused by weirs, orifices, and pumps.

The next section of the output is the intermediate printout. This lists system inflows as they are read by EXTRAN and gives the depth at each junction and flow in each conduit in the system at a user-input time interval. A junction in surcharge is indicated by printing an asterisk beside its depth. Also, if surcharge iterations are occurring at the time of the intermediate printout, EXTRAN prints the flow differential over all surcharged junctions and the number of iterations required. An asterisk beside a conduit flow indicates that the flow is the normal flow for the conduit. The intermediate print out ends with the printing of a continuity balance of the water passing through the system during the simulation. Printed outflows from junctions not designated as outfalls in the input data set are junctions which have flooded.

The final section of the output gives the time history of depths and flows for those junctions and conduits input by the user, as well as a summary for all junctions and conduits in the system. The output ends with the user-requested plots of junction heads and conduit flows.

EXAMPLE 2: TIDE GATE

Figure 9 shows the system simulated in Example 2, which is the basic pipe system with a tide gate at the outfall and a constant receiving water depth of 94.4 feet. Two changes to the input data set, shown in Table 4, are required for this situation. These, shown in Table 4, are:

1. Placing the outfall junction number (10208) in Card Group 14; and
2. Changing NTIDE in Card Group 15 to 2 and inputting $A1 = 94.4$.

The summary statistics for this run are in Table 5.

EXAMPLE 3: SUMP ORIFICE DIVERSION

Example 3 uses a two foot diameter sump orifice to divert flow to junction 15009 in order to relieve the flooding upstream of junction 82309. A free outfall is also used in this example. Table 6 indicates that the sump orifice is inserted simply by changing Card Group 10 as shown. A summary of the results from this example is found in Table 7.

EXAMPLE 4: WEIR DIVERSION

A weir can also be used as a diversion structure to relieve the flooding upstream of junction 82309, as shown in Figure 11. Card Group 11 has been revised as shown in Table 8 in order to input the specifications for this weir. Summary results are shown in Table 9.

EXAMPLE 5: STORAGE FACILITY WITH SIDE OUTLET ORIFICE

Inclusion of a storage facility requires several changes to the basic pipe system. Figure 12 shows that a new junction, 82308, has been inserted to receive the outflow from the orifice in the storage facility. Table 10 shows that this requires a new junction in Card Group 8, the invert of which is set to that of conduit 1602. This change, however, also requires that the invert of junction 82309 be raised to that of conduit 8060. Table 2 shows that, for the basic pipe system, conduit 8060 is 2.2 feet ($ZP(N,2)$) above the invert of junction 82309. Thus, the invert of 82308 is set at 112.3 feet (the original elevation of 82309), the invert of 82309 is 114.5 feet, and $ZP(N,2)$ for 8060 is 0.0. Card Group 9 is revised to show the size of the storage facility, and Card Group 10 is changed to show the specifications of the two foot diameter size orifice. Table 11 gives the results of this example.

EXAMPLE 6: OFF-LINE PUMP STATION

Inclusion of an off-line pump station requires the addition of a junction to represent the wet-well and a conduit to divert the flow to it, as Figure 13 demonstrates. Examination of Card Groups 7 and 8 in Table 12 shows the specifications for junction 82310 and conduit 8061. The length and Manning's n of conduit 8061 shown here, though, have been altered for stability purposes to those of an equivalent pipe to the actual 8061, which is 20 feet long with an n of .015. Chapter 2 gives the details of the equivalent pipe transformation. Also, Card Group 12 now includes a card giving the pump specifications. Results from this example are found in Table 13.

EXAMPLE 7: IN-LINE PUMP STATION

The pump in Example 6 can be moved to junction 82309 to simulate an inline pump station. Figure 14 shows that this requires no alteration to the basic pipe system of Example 1. The only change to the input data set, shown in Table 14, is the pump card in Group 12. It should be noted, though, that the VWELL variables are now water elevations at junction 82309 rather than the volume of a wet-well. Results are found in Table 15.

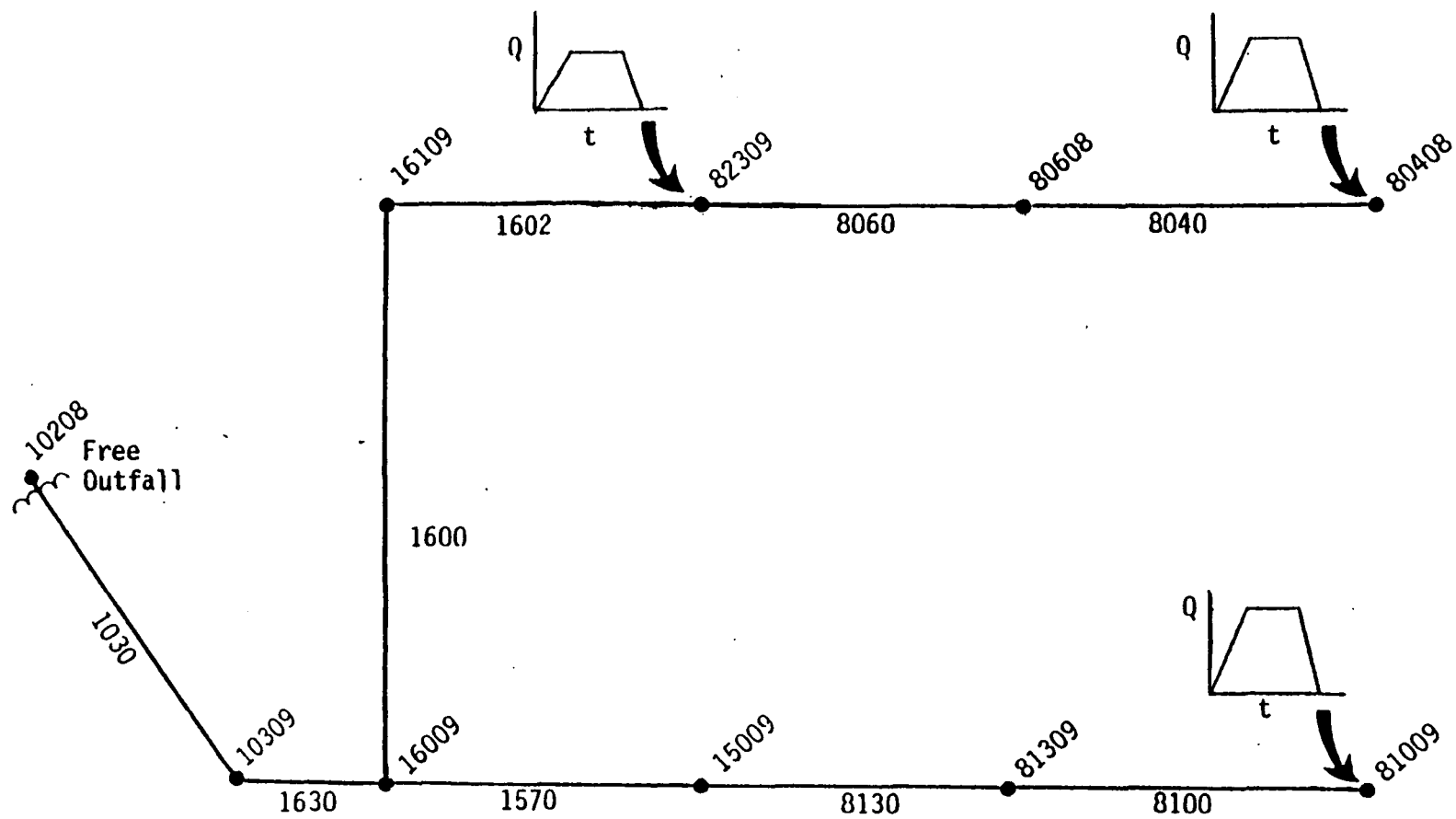


Figure 8. Basic system with free outfall.

TABLE 2
INPUT DATA SET FOR EXAMPLE 1

```

0      0
EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8
1440  20.   .0   6   6   6   6   45   45   3   30  0.05
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
80408040880608.   1      4.00      1800.      .015
80608060882309   1      4.00      2075.      2.2   .015
81008100981309   1      4.50      5100.      .015
81308130915009   1      4.50      3500.      .015
10301030910208   6      9.0       4500.      .016   3.   3
15701500916009   1      5.5       5000.      .0154
16001600916109   1      6.0       500.      .015
16301600910309   6      9.0       300.      .015   3.   3
16028230916109   1      5.       5000.      .034
99999
80408138.0124.6  0.0
80608135.0118.3  0.0
81009137.0128.2  0.0
81309130.0117.5  0.0
82309155.0112.3  0.0
10208100.0 89.9  0.0
10309111.0101.6  0.0
15009125.0111.3  0.0
16009120.0102.0  0.0
16109125.0102.8  0.0
99999
99999
99999
99999
99999
10208
99999
99999
1
99999
823098040881009
0.0      0.0      0.0      0.0
0.25     40.0     45.0     50.0
3.0      40.0     45.0     50.0
3.25     0.0      0.0      0.0
12.0     0.0      0.0      0.0

```

TABLE 3
OUTPUT FROM EXAMPLE 1

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

INTEGRATION CYCLES 1440

LENGTH OF INTEGRATION STEP IS 20. SECONDS

PRINTING STARTS IN CYCLE 45 AND PRINTS AT INTERVALS OF 45 CYCLES

INITIAL TIME 0.00 HOURS

PRINTED OUTPUT AT THE FOLLOWING 6 JUNCTIONS

80608 16009 16109 15009 82309 80408

AND FOR THE FOLLOWING 6 CONDUITS

1030 1630 1600 1602 1570 8130

WATER SURFACE ELEVATIONS WILL BE PLOTTED FOR THE FOLLOWING 6 JUNCTIONS

80608 16009 16109 15009 82309 80408

FLOW RATE WILL BE PLOTTED FOR THE FOLLOWING 6 CONDUITS

1030 1630 1600 1602 1570 8130

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

**** EXTENDED TRANSPORT PROGRAM ****

**** ANALYSIS MODULE ****

**** WATER RESOURCES DIVISION ****
**** CAMP DRESSER & MCKEE INC. ****
**** ANNANDALE, VIRGINIA ****

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

	CONDUIT NUMBER	LENGTH (FT)	CLASS	AREA (SQ FT)	MANNING COEF.	MAX WIDTH (FT)	DEPTH (FT)	JUNCTIONS AT ENDS	INVERT HEIGHT ABOVE JUNCTIONS	TRAPEZOID SIDE SLOPE
1	8040	1800.	1	12.57	0.015	4.00	4.00	80408 80608		
2	8060	2073.	1	12.57	0.015	4.00	4.00	80608 82309	0.00 2.20	
3	8100	5100.	1	15.90	0.015	4.50	4.50	81009 81309		
4	8130	3500.	1	15.90	0.015	4.50	4.50	81309 15009		
5	1030	4500.	6	243.00	0.016	0.01	9.00	10309 10208		3.00 3.00
6	1570	5000.	1	23.76	0.015	5.50	5.50	15009 16009		
7	1600	500.	1	28.27	0.015	6.00	6.00	16009 16109		
8	1630	300.	6	243.00	0.015	0.01	9.00	16009 10309		3.00 3.00
9	1602	5000.	1	19.63	0.034	5.00	5.00	82309 16109		

**** WARNING **** (C*DEL7/LEN) IN CONDUIT 1630 IS 1.1 AT FULL DEPTH.

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

	JUNCTION NUMBER	GROUND ELEV.	CROWN ELEV.	INVERT ELEV.	QINST (CFS)	CONNECTING CONDUITS	
1	80408	138.00	128.60	124.60	0.00	8040	
2	80608	135.00	122.30	118.30	0.00	8040	8060
3	81009	137.00	132.70	128.20	0.00	8100	
4	81309	130.00	122.00	117.50	0.00	8100	8130
5	82309	155.00	118.50	112.30	0.00	8060	1602
6	10208	100.00	98.90	89.90	0.00	1030	
7	10309	111.00	110.60	101.60	0.00	1030	1630
8	15009	125.00	117.00	111.50	0.00	8130	1570
9	16009	120.00	111.00	102.00	0.00	1570	1600 1630
10	16109	125.00	108.80	102.80	0.00	1600	1602

----- FREE OUTFALL DATA -----

FREE OUTFLOW AT JUNCTIONS 10208

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

***** EXTENDED TRANSPORT PROGRAM *****

***** ANALYSIS MODULE *****

***** WATER RESOURCES DIVISION *****
***** CAMP DRESSER & MCKEE INC. *****
***** ANNANDALE, VIRGINIA *****

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

----- INTERNAL CONNECTIVITY INFORMATION -----

CONDUIT	JUNCTION	JUNCTION
90010	10208	0

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

----- SUMMARY OF INITIAL HEADS, FLOWS AND VELOCITIES -----

INITIAL HEADS, FLOWS AND VELOCITIES ARE ZERO

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

***** SYSTEM INFLOWS (CARDS) AT 0.00 HOURS FOR 3 JUNCTIONS

82309/ 0.00 80408/ 0.00 81009/ 0.00

***** SYSTEM INFLOWS (CARDS) AT 0.25 HOURS (JUNCTION / INFLOW,CFS)

82309/ 40.00 80408/ 45.00 81009/ 50.00

***** SYSTEM INFLOWS (CARDS) AT 3.00 HOURS (JUNCTION / INFLOW,CFS)

82309/ 40.00 80408/ 45.00 81009/ 50.00

CYCLE 45 TIME 0 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/ 2.60 80608/ 1.70 81009/ 2.27 81309/ 0.33 82309/ 2.23 10208/ 0.00 10309/ 0.00 15009/ 0.00
16009/ 0.00 16109/ 0.17

CONDUITS / FLOWS

8040/ 42.76 8060/ 15.52 8100/ 15.81 8130/ 0.25 1030/ 0.00 1570/ 0.00 1600/ 0.09 1630/ 0.00
1602/ 6.33 90010/ 0.00

CYCLE 90 TIME 0 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/ 2.26 80608/ 3.82 81009/ 3.32 81309/ 2.12 82309/ 9.578 10208/ 0.00 10309/ 0.08 15009/ 0.37

16009/ 0.33 16109/ 2.05

CONDUITS / FLOWS

8040/ 45.018 8060/ 8.34 8100/ 54.64 8130/ 13.33 1030/ 0.00 1570/ 1.088 1600/ 20.74 1630/ 0.51
1602/ 47.72 90010/ 0.00

CYCLE 133 TIME 0 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.758 80608/ 16.708 81009/ 2.72 81309/ 3.48 82309/ 21.658 10208/ 0.34 10309/ 2.16 15009/ 1.47
16009/ 2.68 16109/ 2.88

CONDUITS / FLOWS

8040/ 45.00 8060/ 28.02 8100/ 52.988 8130/ 44.19 1030/ 21.08 1570/ 18.938 1600/ 69.12 1630/ 88.59
1602/ 68.02 90010/ 21.08

CYCLE 180 TIME 1 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.758 80608/ 16.708 81009/ 2.63 81309/ 3.48 82309/ 21.658 10208/ 0.44 10309/ 3.41 15009/ 2.27
16009/ 3.10 16109/ 2.87

CONDUITS / FLOWS

8040/ 45.00 8060/ 27.98 8100/ 50.248 8130/ 54.64 1030/ 68.44 1570/ 43.738 1600/ 66.70 1630/ 98.88
1602/ 67.98 90010/ 68.44

CYCLE 225 TIME 1 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.758 80608/ 16.708 81009/ 2.62 81309/ 3.25 82309/ 21.548 10208/ 0.49 10309/ 3.90 15009/ 2.50
16009/ 3.55 16109/ 3.13

CONDUITS / FLOWS

8040/ 45.00 8060/ 29.32 8100/ 50.02 8130/ 53.80 1030/ 97.16 1570/ 52.17 1600/ 67.35 1630/ 113.23
1602/ 69.33 90010/ 97.16

CYCLE 270 TIME 1 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.75 80608/ 16.70 81009/ 2.62 81309/ 3.11 82309/ 21.48 10208/ 0.52 10309/ 4.11 15009/ 2.50
16009/ 3.76 16109/ 3.30

CONDUITS / FLOWS

8040/ 45.00 8060/ 30.14 8100/ 50.00 8130/ 51.72 1030/ 112.26 1570/ 52.40 1600/ 69.26 1630/ 119.11
1602/ 70.14 90010/ 112.26

CYCLE 315 TIME 1 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.75 80608/ 16.70 81009/ 2.62 81309/ 3.06 82309/ 21.46 10208/ 0.53 10309/ 4.19 15009/ 2.47
16009/ 3.84 16109/ 3.37

CONDUITS / FLOWS

8040/ 45.00 8060/ 30.46 8100/ 50.00 8130/ 50.54 1030/ 118.23 1570/ 51.23 1600/ 70.16 1630/ 120.54
1602/ 70.46 90010/ 118.23

CYCLE 360 TIME 2 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.75 80608/ 16.70 81009/ 2.62 81309/ 3.05 82309/ 21.45 10208/ 0.53 10309/ 4.22 15009/ 2.45
16009/ 3.86 16109/ 3.39

CONDUITS / FLOWS

8040/ 45.00 8060/ 30.56 8100/ 50.00x 8130/ 50.09 1030/ 120.08 1570/ 50.43x 1600/ 70.48 1630/ 120.69
 1602/ 70.56 90010/ 120.08

 CYCLE 405 TIME 2 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.75x 80608/ 16.70x 81009/ 2.62 81309/ 3.05 82309/ 21.45x 10208/ 0.53 10309/ 4.22 15009/ 2.44
 16009/ 3.87 16109/ 3.39

CONDUITS / FLOWS

8040/ 45.00 8060/ 30.58 8100/ 50.00x 8130/ 49.97 1030/ 120.51 1570/ 50.09x 1600/ 70.57 1630/ 120.62
 1602/ 70.58 90010/ 120.51

 CYCLE 450 TIME 2 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.75x 80608/ 16.70x 81009/ 2.62 81309/ 3.05 82309/ 21.45x 10208/ 0.53 10309/ 4.22 15009/ 2.44
 16009/ 3.87 16109/ 3.39

CONDUITS / FLOWS

8040/ 45.00 8060/ 30.59 8100/ 50.00x 8130/ 49.97 1030/ 120.57 1570/ 49.99x 1600/ 70.59 1630/ 120.58
 1602/ 70.59 90010/ 120.57

 CYCLE 495 TIME 2 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.75x 80608/ 16.70x 81009/ 2.62 81309/ 3.05 82309/ 21.45x 10208/ 0.53 10309/ 4.22 15009/ 2.44
 16009/ 3.87 16109/ 3.39

CONDUITS / FLOWS

8040/ 45.00 8060/ 30.59 8100/ 50.00x 8130/ 49.98 1030/ 120.57 1570/ 49.98x 1600/ 70.59 1630/ 120.57

1602/ 70.59 90010/ 120.57

***** SYSTEM INFLOWS (CARDS) AT 3.25 HOURS (JUNCTION / INFLOW,CFS)

82309/ 0.00 80408/ 0.00 81009/ 0.00

CYCLE 540 TIME 3 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/ 12.758 80608/ 16.708 81009/ 2.62 81309/ 3.05 82309/ 21.458 10208/ 0.53 10309/ 4.22 15009/ 2.44
16009/ 3.87 16109/ 3.39

CONDUITS / FLOWS

8040/ 45.00 8060/ 30.59 8100/ 50.008 8130/ 49.99 1030/ 120.57 1570/ 49.998 1600/ 70.59 1630/ 120.58
1602/ 70.59 90010/ 120.57

***** SYSTEM INFLOWS (CARDS) AT 12.00 HOURS (JUNCTION / INFLOW,CFS)

82309/ 0.00 80408/ 0.00 81009/ 0.00

CYCLE 585 TIME 3 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.89 80608/ 2.59 81009/ 1.56 81309/ 2.61 82309/ 5.89 10208/ 0.52 10309/ 4.11 15009/ 2.36
16009/ 3.75 16109/ 3.12

CONDUITS / FLOWS

8040/ 8.388 8060/ 41.038 8100/ 20.518 8130/ 41.93 1030/ 111.64 1570/ 47.458 1600/ 48.45 1630/ 99.70

1602/ 47.22 90010/ 111.64

CYCLE 630 TIME 3 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.21 80608/ 0.83 81009/ 0.71 81309/ 1.61 82309/ 3.80 10208/ 0.49 10309/ 3.87 15009/ 1.93
16009/ 3.50 16109/ 2.85

CONDUITS / FLOWS

8040/ 0.438 8060/ 5.118 8100/ 4.328 8130/ 19.608 1030/ 95.20 1570/ 32.788 1600/ 40.76 1630/ 79.89
1602/ 35.03 90010/ 95.20

CYCLE 675 TIME 3 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.10 80608/ 0.44 81009/ 0.43 81309/ 1.06 82309/ 2.32 10208/ 0.45 10309/ 3.49 15009/ 1.42
16009/ 3.12 16109/ 2.41

CONDUITS / FLOWS

8040/ 0.118 8060/ 0.88 8100/ 1.558 8130/ 8.628 1030/ 72.33 1570/ 18.178 1600/ 27.00 1630/ 53.68
1602/ 19.298 90010/ 72.33

CYCLE 720 TIME 4 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.06 80608/ 0.33 81009/ 0.30 81309/ 0.75 82309/ 1.44 10208/ 0.41 10309/ 3.05 15009/ 1.07
16009/ 2.67 16109/ 1.93

CONDUITS / FLOWS

8040/ 0.058 8060/ 0.45 8100/ 0.728 8130/ 4.338 1030/ 50.49 1570/ 10.218 1600/ 14.68 1630/ 33.37
1602/ 7.908 90010/ 50.49

CYCLE 765 TIME 4 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.04 80608/ 0.25 81009/ 0.22 81309/ 0.57 82309/ 1.01 10208/ 0.38 10309/ 2.64 15009/ 0.83
16009/ 2.26 16109/ 1.51

CONDUITS / FLOWS

8040/ 0.028 8060/ 0.24 8100/ 0.388 8130/ 2.428 1030/ 34.73 1570/ 6.108 1600/ 9.14 1630/ 22.09
1602/ 3.908 90010/ 34.73

CYCLE 810 TIME 4 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.03 80608/ 0.21 81009/ 0.17 81309/ 0.45 82309/ 0.76 10208/ 0.36 10309/ 2.30 15009/ 0.66
16009/ 1.92 16109/ 1.17

CONDUITS / FLOWS

8040/ 0.018 8060/ 0.14 8100/ 0.228 8130/ 1.478 1030/ 24.37 1570/ 3.848 1600/ 6.09 1630/ 15.25
1602/ 2.198 90010/ 24.37

CYCLE 853 TIME 4 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.02 80608/ 0.18 81009/ 0.14 81309/ 0.36 82309/ 0.60 10208/ 0.27 10309/ 2.02 15009/ 0.55
16009/ 1.65 16109/ 0.89

CONDUITS / FLOWS

8040/ 0.018 8060/ 0.10 8100/ 0.168 8130/ 0.948 1030/ 16.76 1570/ 2.588 1600/ 4.12 1630/ 10.60
1602/ 1.338 90010/ 16.76

CYCLE 900 TIME 5 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.01 80608/ 0.16 81009/ 0.12 81309/ 0.30 82309/ 0.49 10208/ 0.19 10309/ 1.81 15009/ 0.46
16009/ 1.44 16109/ 0.68

CONDUITS / FLOWS

8040/ 0.01% 8060/ 0.07 8100/ 0.11% 8130/ 0.66% 1030/ 11.9% 1570/ 1.77% 1600/ 2.85 1630/ 7.57
1602/ 0.87% 90010/ 11.9%

CYCLE 945 TIME 5 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.01 80608/ 0.14 81009/ 0.10 81309/ 0.26 82309/ 0.41 10208/ 0.14 10309/ 1.63 15009/ 0.39
16009/ 1.26 16109/ 0.51

CONDUITS / FLOWS

8040/ 0.00% 8060/ 0.06 8100/ 0.09% 8130/ 0.47% 1030/ 8.87 1570/ 1.29% 1600/ 2.02 1630/ 5.61
1602/ 0.59% 90010/ 8.87

CYCLE 990 TIME 5 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.01 80608/ 0.12 81009/ 0.08 81309/ 0.22 82309/ 0.33 10208/ 0.11 10309/ 1.48 15009/ 0.34
16009/ 1.11 16109/ 0.38

CONDUITS / FLOWS

8040/ 0.00% 8060/ 0.05 8100/ 0.07% 8130/ 0.34% 1030/ 6.73 1570/ 0.97% 1600/ 1.22% 1630/ 4.12
1602/ 0.43% 90010/ 6.73

CYCLE 1035 TIME 5 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/	0.01	80408/	0.11	81009/	0.07	81309/	0.20	82309/	0.30	10208/	0.08	10309/	1.33	15009/	0.30
16009/	0.98	16109/	0.30												

CONDUITS / FLOWS

8040/	0.008	8060/	0.04	8100/	0.058	8130/	0.268	1030/	5.16	1570/	0.738	1600/	0.768	1630/	3.08
1602/	0.328	90010/	5.16												

CYCLE 1080 TIME 6 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/	0.01	80608/	0.10	81009/	0.06	81309/	0.18	82309/	0.26	10208/	0.06	10309/	1.24	15009/	0.26
16009/	0.87	16109/	0.26												

CONDUITS / FLOWS

8040/	0.008	8060/	0.03	8100/	0.048	8130/	0.208	1030/	4.01	1570/	0.568	1600/	0.518	1630/	2.37
1602/	0.23	90010/	4.01												

CYCLE 1125 TIME 6 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/	0.00	80608/	0.09	81009/	0.05	81309/	0.16	82309/	0.23	10208/	0.05	10309/	1.14	15009/	0.24
16009/	0.77	16109/	0.22												

CONDUITS / FLOWS

8040/	0.008	8060/	0.03	8100/	0.038	8130/	0.178	1030/	3.17	1570/	0.448	1600/	0.388	1630/	1.86
1602/	0.17	90010/	3.17												

CYCLE 1170 TIME 6 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/	0.00	80608/	0.08	81009/	0.05	81309/	0.14	82309/	0.21	10208/	0.04	10309/	1.05	15009/	0.21
16009/	0.68	16109/	0.19												

CONDUITS / FLOWS

8040/	0.008	8060/	0.03	8100/	0.038	8130/	0.158	1030/	2.54	1570/	0.358	1600/	0.308	1630/	1.50
1602/	0.13	90010/	2.54												

CYCLE 1215 TIME 6 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/	0.00	80608/	0.08	81009/	0.04	81309/	0.13	82309/	0.19	10208/	0.03	10309/	0.98	15009/	0.20
16009/	0.61	16109/	0.17												

CONDUITS / FLOWS

8040/	0.008	8060/	0.02	8100/	0.028	8130/	0.138	1030/	2.07	1570/	0.318	1600/	0.248	1630/	1.74
1602/	0.11	90010/	2.07												

CYCLE 1260 TIME 7 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/	0.00	80608/	0.07	81009/	0.04	81309/	0.12	82309/	0.18	10208/	0.03	10309/	0.91	15009/	0.18
16009/	0.55	16109/	0.15												

CONDUITS / FLOWS

8040/	0.008	8060/	0.02	8100/	0.028	8130/	0.118	1030/	1.72	1570/	0.278	1600/	0.208	1630/	1.03
1602/	0.09	90010/	1.72												

CYCLE 1305 TIME 7 HRS - 15.00 MIN

JUNCTIONS / DEPTHS

80408/	0.00	80608/	0.07	81009/	0.03	81309/	0.11	82309/	0.17	10208/	0.02	10309/	0.85	15009/	0.17
--------	------	--------	------	--------	------	--------	------	--------	------	--------	------	--------	------	--------	------

16009/ 0.50 16109/ 0.13

CONDUITS / FLOWS

8040/ 0.008 8060/ 0.02 8100/ 0.028 8130/ 0.098 1030/ 1.44 1570/ 0.238 1600/ 0.178 1630/ 0.87
1602/ 0.08 90010/ 1.44

CYCLE 1350 TIME 7 HRS - 30.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.00 80608/ 0.06 81009/ 0.03 81309/ 0.10 82309/ 0.16 10208/ 0.02 10309/ 0.80 15009/ 0.15
16009/ 0.45 16109/ 0.12

CONDUITS / FLOWS

8040/ 0.008 8060/ 0.02 8100/ 0.018 8130/ 0.088 1030/ 1.21 1570/ 0.208 1600/ 0.148 1630/ 0.74
1602/ 0.07 90010/ 1.21

CYCLE 1395 TIME 7 HRS - 45.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.00 80608/ 0.06 81009/ 0.03 81309/ 0.09 82309/ 0.15 10208/ 0.02 10309/ 0.76 15009/ 0.14
16009/ 0.41 16109/ 0.11

CONDUITS / FLOWS

8040/ 0.008 8060/ 0.01 8100/ 0.018 8130/ 0.078 1030/ 1.03 1570/ 0.188 1600/ 0.128 1630/ 0.618
1602/ 0.06 90010/ 1.03

CYCLE 1440 TIME 8 HRS - 0.00 MIN

JUNCTIONS / DEPTHS

80408/ 0.00 80608/ 0.05 81009/ 0.02 81309/ 0.09 82309/ 0.14 10208/ 0.01 10309/ 0.71 15009/ 0.13
16009/ 0.38 16109/ 0.10

CONDUITS / FLOWS

8048/	0.008	8060/	0.01	8100/	0.018	8130/	0.078	1030/	0.88	1570/	0.168	1600/	0.118	1630/	0.498
1602/	0.06	90010/	0.88												

----- CONTINUITY BALANCE AT END OF RUN -----

TOTAL SYSTEM INFLOW VOLUME = 1458000. CU FT

JUNCTION OUTFLOWS AND
STREET FLOODING

JUNCTION OUTFLOW, FT3

80408	585.
80608	136037.
10208	1328008.

TOTAL	1464631. CU FT
-------	----------------

VOLUME LEFT IN SYSTEM = 7902. CU FT

ERROR IN CONTINUITY, PERCENT = -1.00

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSTS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 9

***** TIME HISTORY OF H. G. L. *****
(VALUES IN FEET)

TIME HR. MIN	JUNCTION80608		JUNCTION16009		JUNCTION16109		JUNCTION15009		JUNCTION82309		JUNCTION80408	
	GRND 135.00 ELEV	DEPTH	GRND 120.00 ELEV	DEPTH	GRND 125.00 ELEV	DEPTH	GRND 125.00 ELEV	DEPTH	GRND 135.00 ELEV	DEPTH	GRND 138.00 ELEV	DEPTH
0.15	120.00	1.70	102.00	0.00	102.97	0.17	111.50	0.00	114.53	2.23	127.20	2.60
0.30	122.12	3.82	102.53	0.53	104.85	2.05	111.87	0.37	121.87	6.20	126.86	2.26
0.45	135.00	4.00	104.68	2.68	105.68	2.88	112.97	1.47	133.75	6.20	137.33	4.00
1. 0	135.00	4.00	105.10	3.10	105.67	2.87	113.77	2.27	133.95	6.20	137.33	4.00
1.15	135.00	4.00	105.55	3.55	105.93	3.13	114.00	2.50	133.84	6.20	137.33	4.00
1.30	135.00	4.00	105.76	3.76	106.10	3.30	114.00	2.50	133.78	6.20	137.33	4.00
1.45	135.00	4.00	105.84	3.84	106.17	3.37	113.97	2.47	133.76	6.20	137.33	4.00
2. 0	135.00	4.00	105.86	3.86	106.19	3.39	113.95	2.45	133.75	6.20	137.33	4.00
2.15	135.00	4.00	105.87	3.87	106.19	3.39	113.94	2.44	133.75	6.20	137.33	4.00
2.30	135.00	4.00	105.87	3.87	106.19	3.39	113.94	2.44	133.75	6.20	137.33	4.00
2.45	135.00	4.00	105.87	3.87	106.19	3.39	113.94	2.44	133.75	6.20	137.33	4.00
3. 0	135.00	4.00	105.87	3.87	106.19	3.39	113.94	2.44	133.75	6.20	137.33	4.00
3.15	120.89	2.59	105.75	3.75	105.92	3.12	113.36	2.36	118.19	5.89	125.49	0.89
3.30	119.13	0.83	105.50	3.50	105.65	2.85	113.43	1.93	116.10	3.80	124.81	0.21
3.45	118.74	0.44	105.12	3.12	105.21	2.41	112.92	1.42	114.62	2.32	124.70	0.10
4. 0	118.63	0.33	104.67	2.67	104.73	1.93	112.57	1.07	113.74	1.44	124.66	0.06
4.15	118.53	0.25	104.26	2.26	104.31	1.51	112.33	0.83	113.31	1.01	124.64	0.04
4.30	118.51	0.21	103.92	1.92	103.97	1.17	112.16	0.66	113.06	0.76	124.63	0.03
4.45	118.48	0.18	103.65	1.65	103.69	0.89	112.05	0.55	112.90	0.60	124.62	0.02
5. 0	118.46	0.16	103.44	1.44	103.48	0.68	111.96	0.46	112.79	0.49	124.61	0.01
5.15	118.44	0.14	103.26	1.26	103.31	0.51	111.89	0.39	112.71	0.41	124.61	0.01
5.30	118.42	0.12	103.11	1.11	103.18	0.38	111.84	0.34	112.65	0.35	124.61	0.01
5.45	118.41	0.11	102.98	0.98	103.10	0.30	111.80	0.30	112.60	0.30	124.61	0.01
6. 0	118.40	0.10	102.87	0.87	103.06	0.26	111.76	0.26	112.56	0.26	124.61	0.01
6.15	118.39	0.09	102.77	0.77	103.02	0.22	111.74	0.24	112.53	0.23	124.60	0.00
6.30	118.38	0.08	102.68	0.68	102.99	0.19	111.71	0.21	112.51	0.21	124.60	0.00
6.45	118.38	0.08	102.61	0.61	102.97	0.17	111.70	0.20	112.49	0.19	124.60	0.00
7. 0	118.37	0.07	102.55	0.55	102.95	0.15	111.68	0.18	112.48	0.18	124.60	0.00
7.15	118.37	0.07	102.50	0.50	102.93	0.13	111.67	0.17	112.47	0.17	124.60	0.00
7.30	118.36	0.06	102.45	0.45	102.92	0.12	111.65	0.15	112.46	0.16	124.60	0.00
7.45	118.36	0.06	102.41	0.41	102.91	0.11	111.64	0.14	112.45	0.15	124.60	0.00
8. 0	118.35	0.05	102.38	0.38	102.90	0.10	111.63	0.13	112.44	0.14	124.60	0.00

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

***** SUMMARY STATISTICS FOR JUNCTIONS *****

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURENCE HR. MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
80408	138.00	128.60	13.40	0 32	9.40	0.00	153.0
80608	135.00	122.30	16.70	0 30	12.70	0.00	159.3
81009	137.00	132.70	3.36	0 27	0.00	5.44	0.0
81309	130.00	122.00	3.56	0 31	0.00	8.94	0.0
82309	155.00	118.50	21.68	0 33	15.48	21.02	165.3
10208	100.00	98.90	0.53	3 1	0.00	9.57	0.0
10309	111.00	110.60	4.22	3 1	0.00	5.18	0.0
15009	125.00	117.00	2.51	1 22	0.00	10.99	0.0
16009	120.00	111.00	3.87	3 0	0.00	14.13	0.0
16109	125.00	108.80	3.39	3 0	0.00	18.81	0.0

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

***** TIME HISTORY OF FLOW AND VELOCITY *****
Q(CFS), VEL(FPS)

TIME HR . MIN	CONDUIT 1030		CONDUIT 1630		CONDUIT 1600		CONDUIT 1602		CONDUIT 1570		CONDUIT 8130	
	FLOW	VEL	FLOW	VEL	FLOW	VEL	FLOW	VEL	FLOW	VEL	FLOW	VEL
0.15	0.00	0.2	0.00	0.2	0.09	0.6	6.33	1.6	0.00	0.3	0.25	1.0
0.30	0.00	0.3	0.51	1.3	20.74	4.3	47.72	2.9	1.08	1.1	13.33	3.5
0.45	21.08	3.5	88.59	5.0	69.12	5.4	68.02	3.9	18.93	2.2	44.19	5.0
1. 0	68.44	4.7	98.88	3.1	66.70	4.8	67.98	3.9	43.73	3.8	34.64	5.1
1.15	97.16	5.2	113.23	2.7	67.35	4.2	69.33	3.9	52.17	3.9	53.80	5.0
1.30	112.26	5.4	119.11	2.6	69.26	4.0	70.14	3.9	52.40	3.8	51.72	5.0
1.45	118.23	5.4	120.54	2.5	70.16	4.0	70.46	3.9	51.23	3.6	50.54	4.9
2. 0	120.08	5.4	120.69	2.5	70.48	3.9	70.56	3.9	50.43	3.6	50.09	4.9
2.15	120.51	5.5	120.62	2.5	70.57	3.9	70.58	3.9	50.09	3.6	49.97	4.9
2.30	120.57	5.5	120.58	2.5	70.59	3.9	70.59	3.9	49.99	3.6	49.97	4.9
2.45	120.57	5.5	120.57	2.4	70.59	3.9	70.59	3.9	49.98	3.6	49.98	4.9
3. 0	120.57	5.5	120.58	2.4	70.59	3.9	70.59	3.9	49.99	3.6	49.99	4.9
3.15	111.64	5.3	99.70	2.1	48.45	2.9	47.22	2.7	47.45	3.5	41.73	4.7
3.30	95.20	5.1	79.89	2.0	40.76	2.7	35.03	2.5	32.78	2.8	19.60	3.4
3.45	72.33	4.8	53.68	1.6	27.00	2.1	19.29	2.1	18.17	2.0	8.62	2.4
4. 0	50.49	4.4	33.37	1.4	14.68	1.5	7.90	1.4	10.21	1.4	4.33	1.9
4.15	34.73	4.0	22.09	1.2	9.14	1.2	3.90	1.0	6.10	1.1	2.42	1.5
4.30	24.37	3.6	15.25	1.1	6.09	1.0	2.19	0.8	3.84	0.9	1.47	1.3
4.45	16.76	3.3	10.60	1.0	4.12	0.9	1.33	0.7	2.58	0.7	0.94	1.1
5. 0	11.96	3.0	7.57	1.0	2.85	0.8	0.87	0.7	1.77	0.6	0.66	1.0
5.15	8.87	2.8	5.61	0.9	2.02	0.8	0.59	0.7	1.29	0.6	0.47	0.9
5.30	6.73	2.6	4.12	0.8	1.22	0.6	0.43	0.7	0.97	0.5	0.34	0.8
5.45	5.16	2.4	3.08	0.7	0.76	0.4	0.32	0.6	0.73	0.5	0.26	0.7
6. 0	4.01	2.2	2.37	0.7	0.51	0.4	0.23	0.6	0.56	0.4	0.20	0.7
6.15	3.17	2.1	1.86	0.7	0.38	0.3	0.17	0.5	0.44	0.4	0.17	0.7
6.30	2.54	2.0	1.50	0.7	0.30	0.3	0.13	0.5	0.35	0.4	0.15	0.7
6.45	2.07	1.9	1.24	0.6	0.24	0.3	0.11	0.5	0.31	0.4	0.13	0.6
7. 0	1.72	1.8	1.03	0.6	0.20	0.3	0.09	0.4	0.27	0.4	0.11	0.6
7.15	1.44	1.7	0.87	0.6	0.17	0.3	0.08	0.4	0.23	0.4	0.09	0.6
7.30	1.21	1.6	0.74	0.6	0.14	0.3	0.07	0.4	0.20	0.4	0.08	0.6
7.45	1.03	1.6	0.61	0.6	0.12	0.3	0.06	0.4	0.18	0.4	0.07	0.5
8. 0	0.88	1.5	0.49	0.5	0.11	0.3	0.06	0.4	0.16	0.4	0.07	0.5

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ARLANDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

***** SUMMARY STATISTICS FOR CONDUITS *****

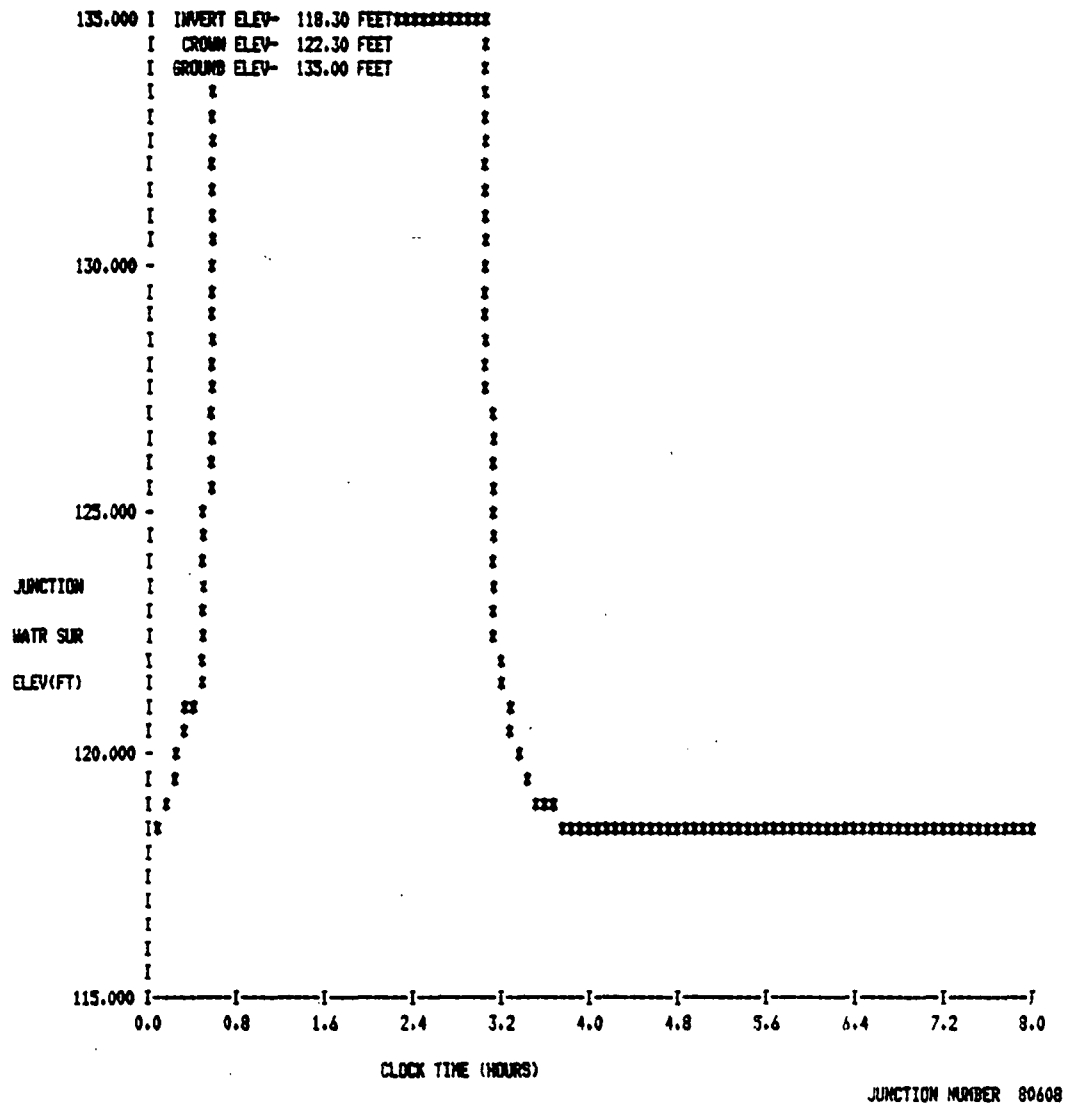
CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURENCE HR. MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURENCE HR. MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS UPSTREAM (FT) DOWNSTREAM (FT)
8040	73.6	5.9	48.0	50.8	0 19	6.4	0 18	0.7	13.40 16.70
8060	53.3	4.2	48.0	47.3	0 23	5.0	0 24	0.9	16.70 19.48
8100	78.1	4.9	54.0	61.0	0 37	5.5	0 34	0.8	3.36 3.36
8130	70.6	4.4	54.0	54.9	1 4	5.1	0 57	0.8	3.56 2.51
1030	3028.3	12.5	108.0	120.6	3 1	5.5	3 2	0.0	4.22 0.53
1570	123.6	5.2	66.0	52.7	1 22	3.9	1 10	0.4	2.51 3.87
1600	146.8	5.2	72.0	73.7	0 40	6.1	0 38	0.5	3.39 3.87
1630	2313.2	9.5	108.0	120.7	1 57	5.0	0 44	0.1	3.87 4.22
1602	43.4	2.2	60.0	70.6	2 60	4.0	0 28	1.6	21.68 3.39

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

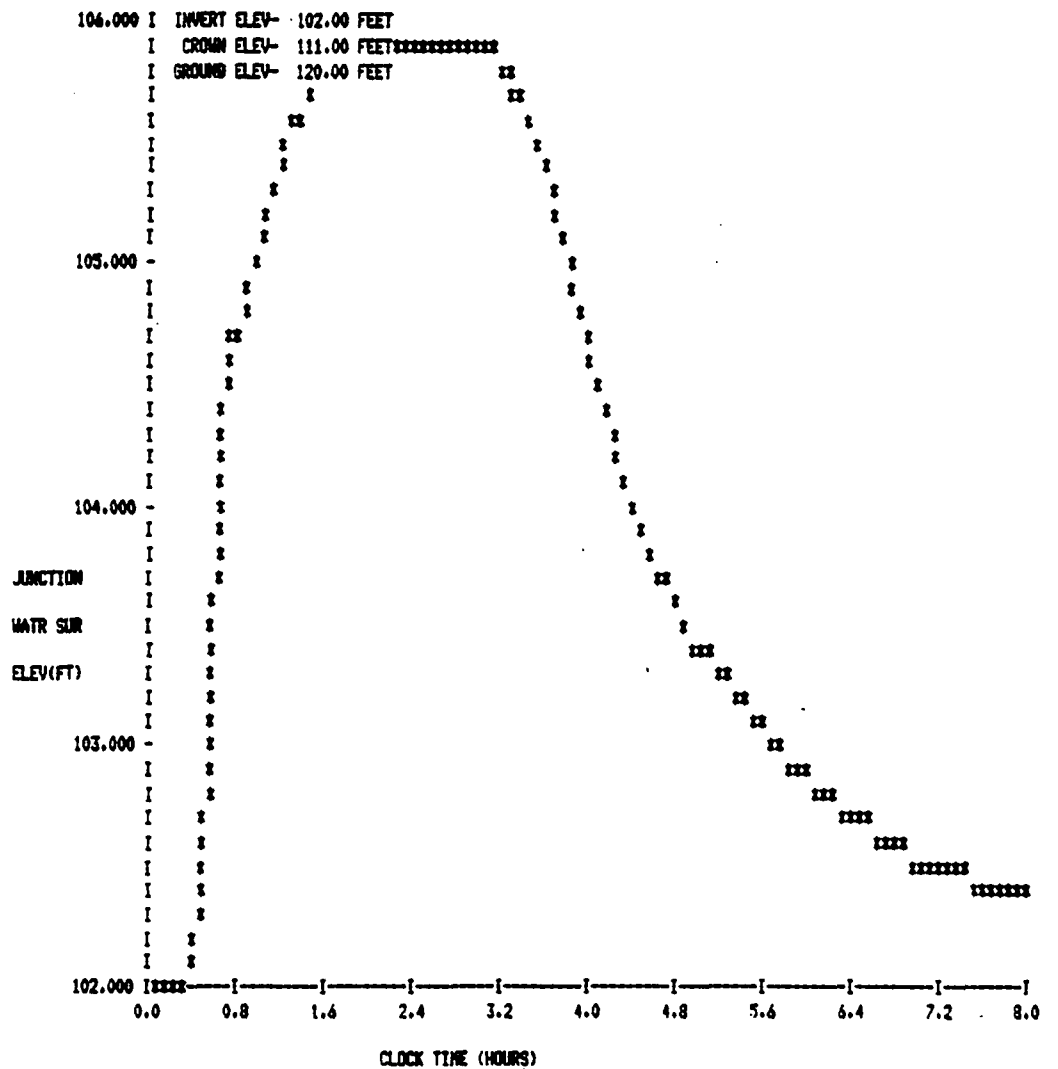


ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

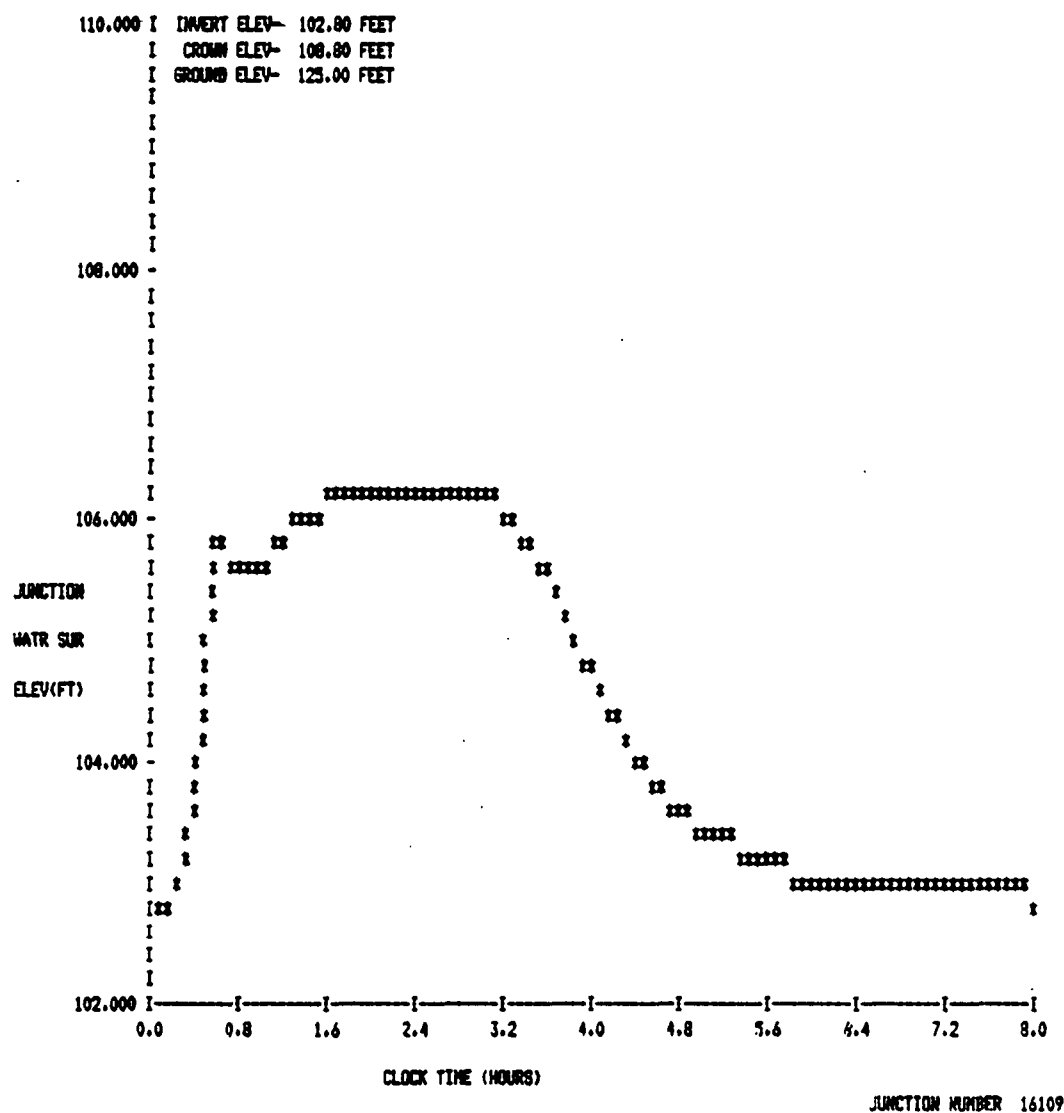
XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8



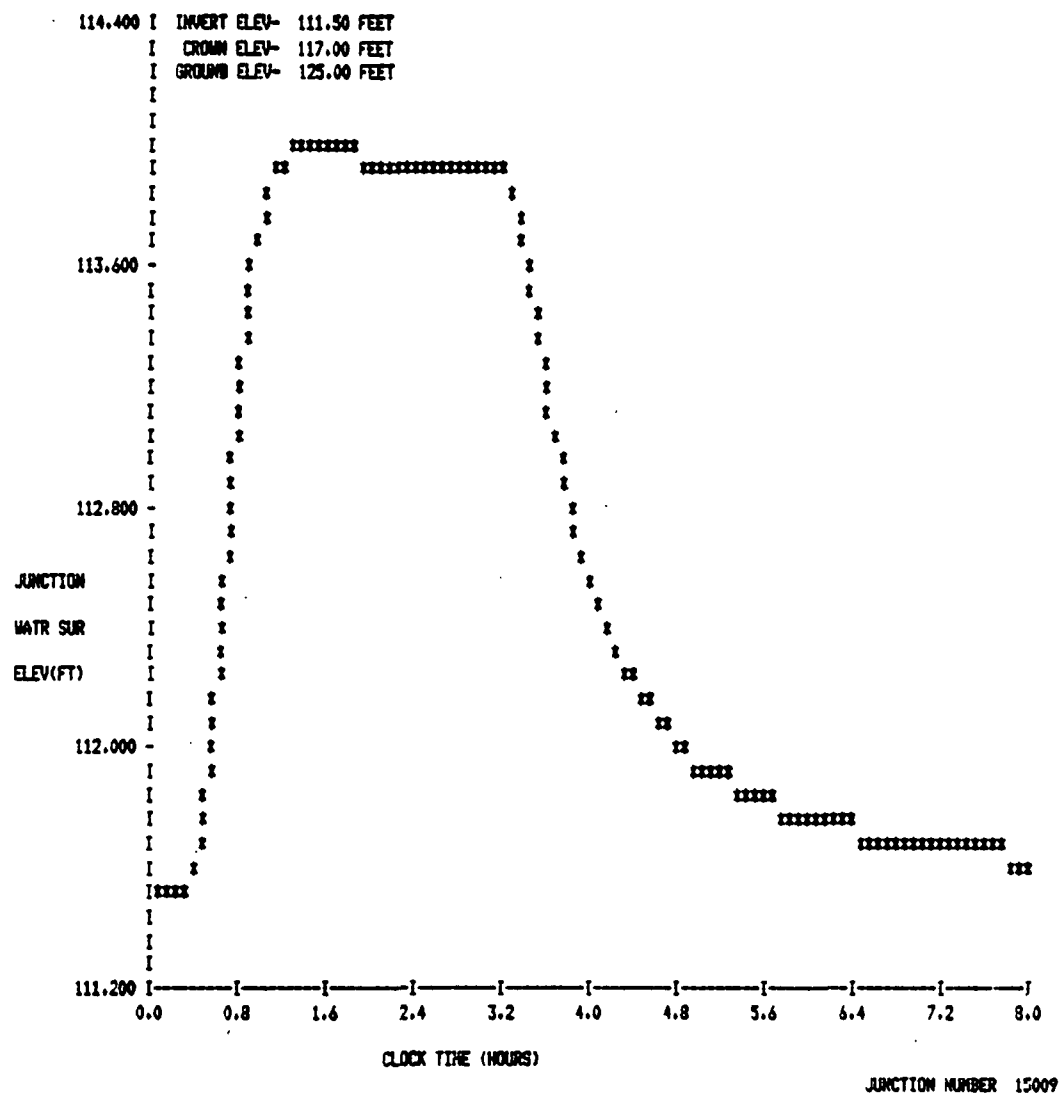
WATER RESOURCES DIVISION
CAMP DRESSER & MCKEE INC.
ARLINGTON, VIRGINIA

WATER RESOURCES DIVISION
CAMP DRESSER & MCKEE INC.
ARMANDALE, VIRGINIA



WATER RESOURCES DIVISION
CAMP DRESSER & MCKEE INC.
ARLINGTON, VIRGINIA

WATER RESOURCES DIVISION
CAMP DRESSER & MCKEE INC.
ARMANDALE, VIRGINIA

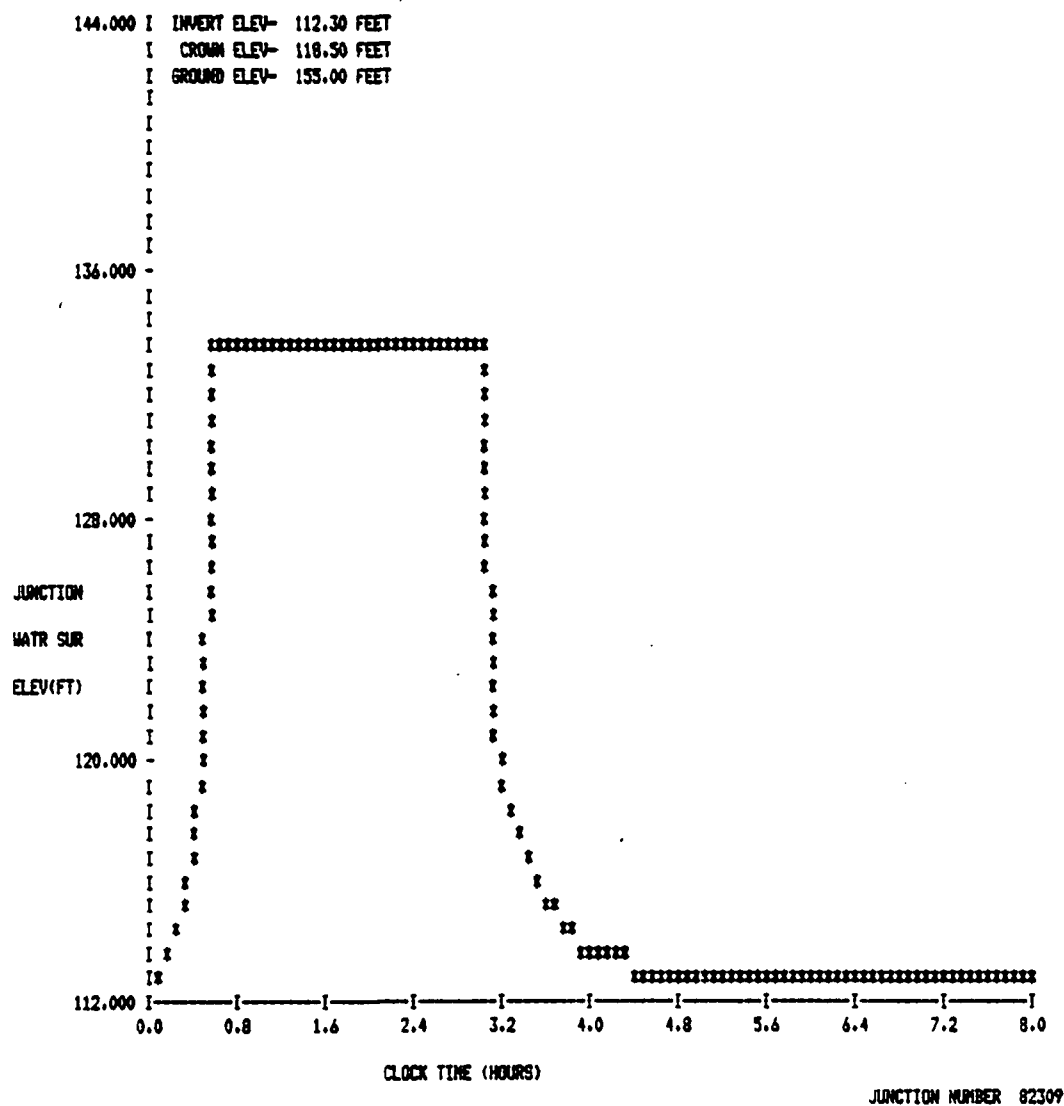


ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8



XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ARNOLD, VIRGINIA

140.000	I	INVERT ELEV-	124.60	FEET
	I	CROWN ELEV-	128.60	FEET
	I	GROUND ELEV-	138.00	FEET

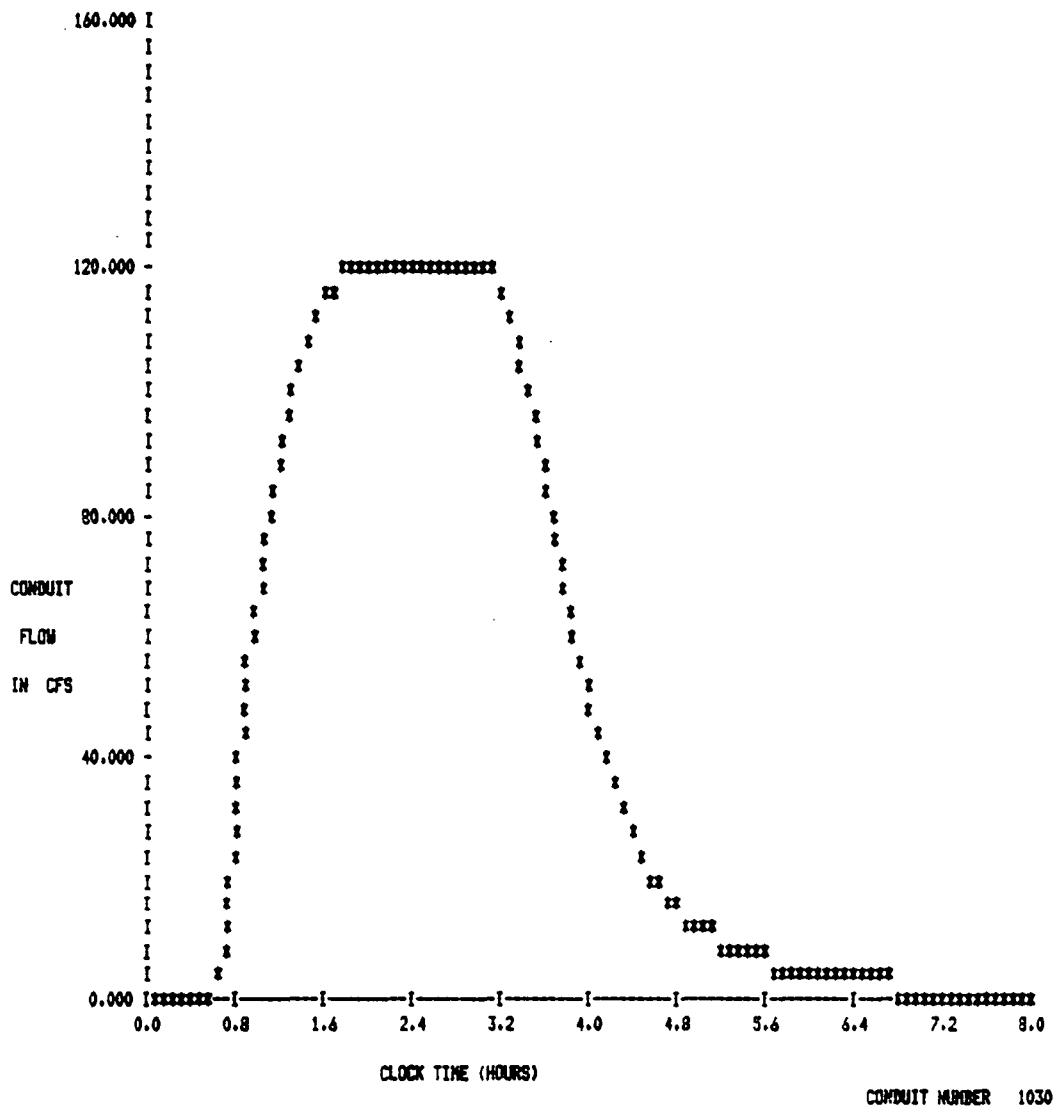


ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

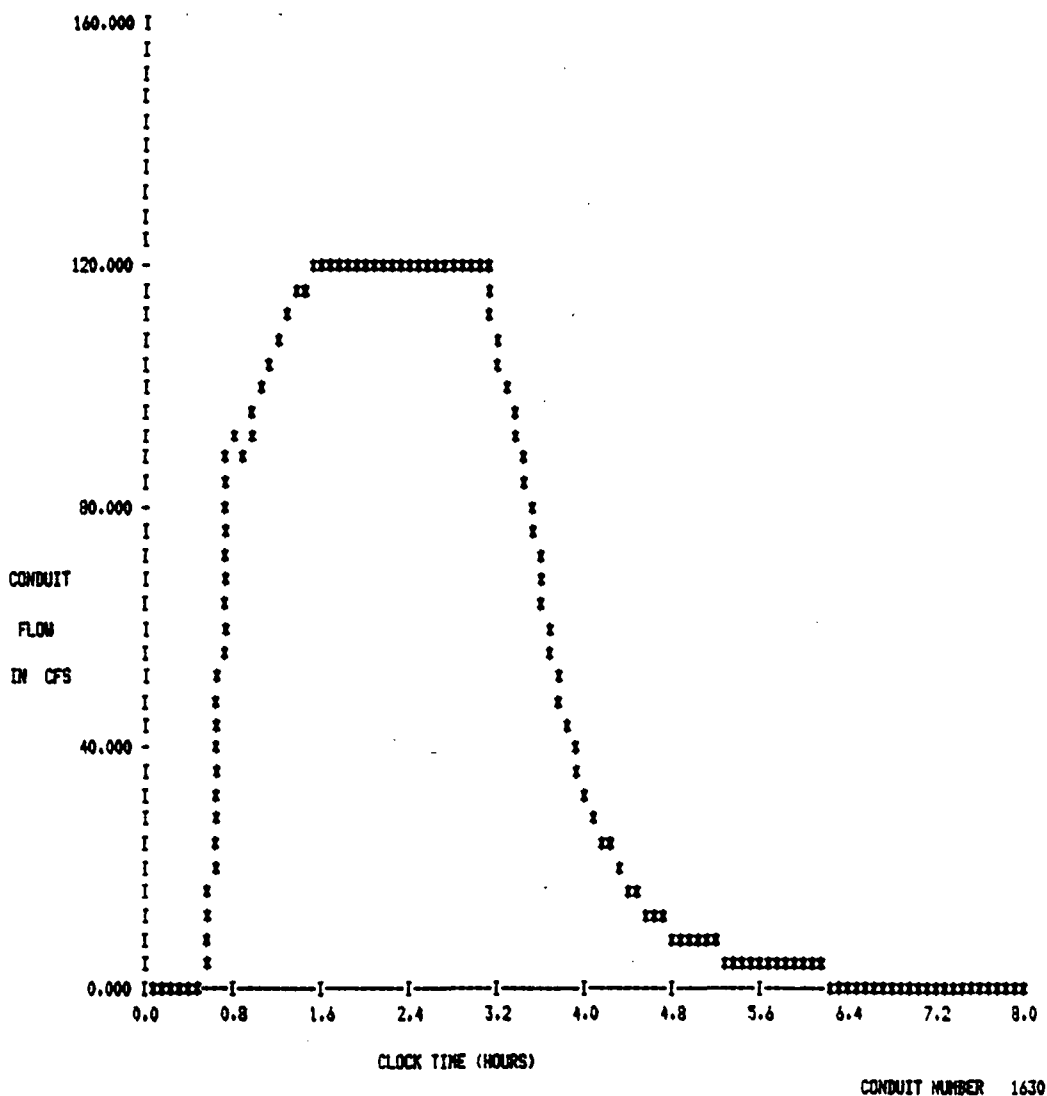


ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & HCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

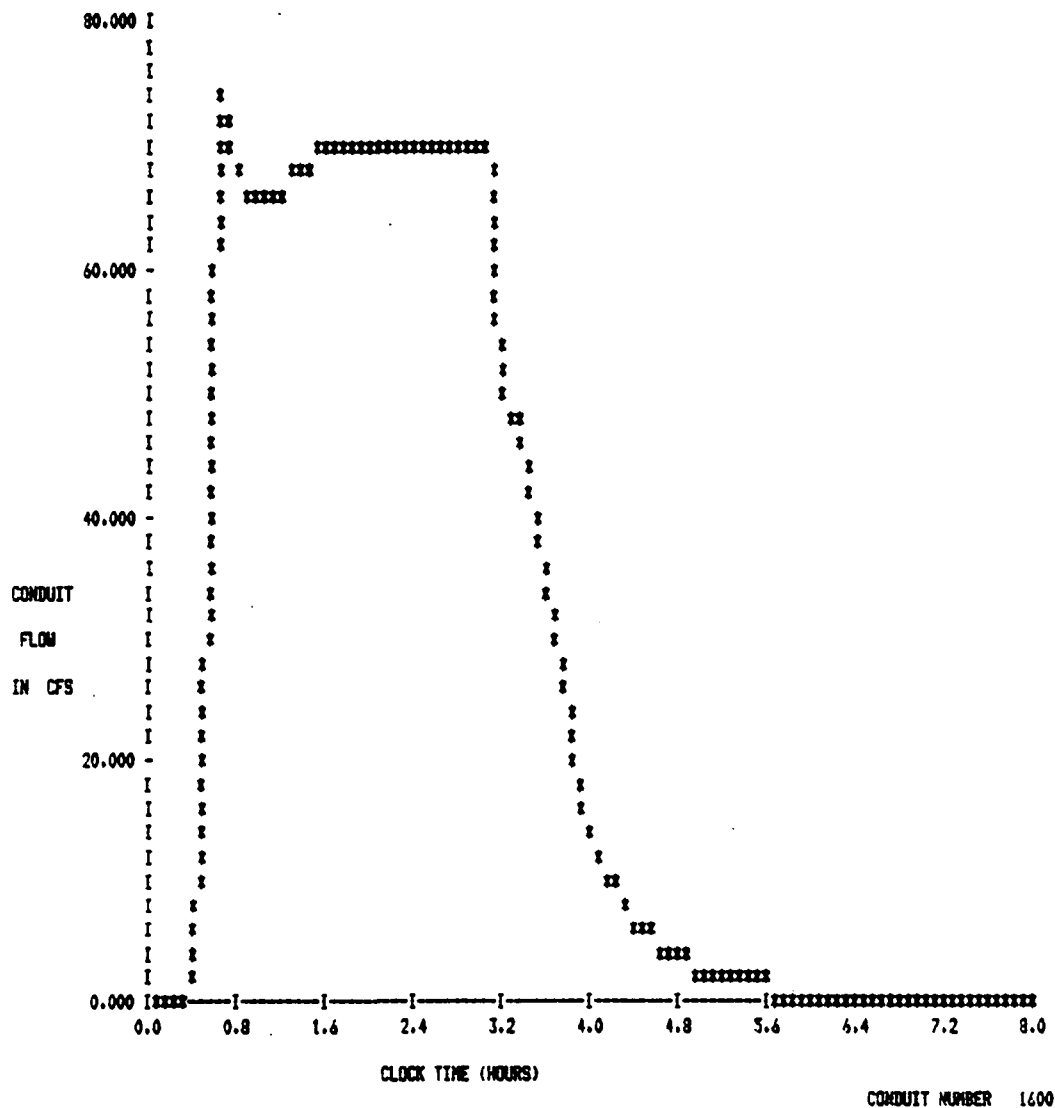


ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

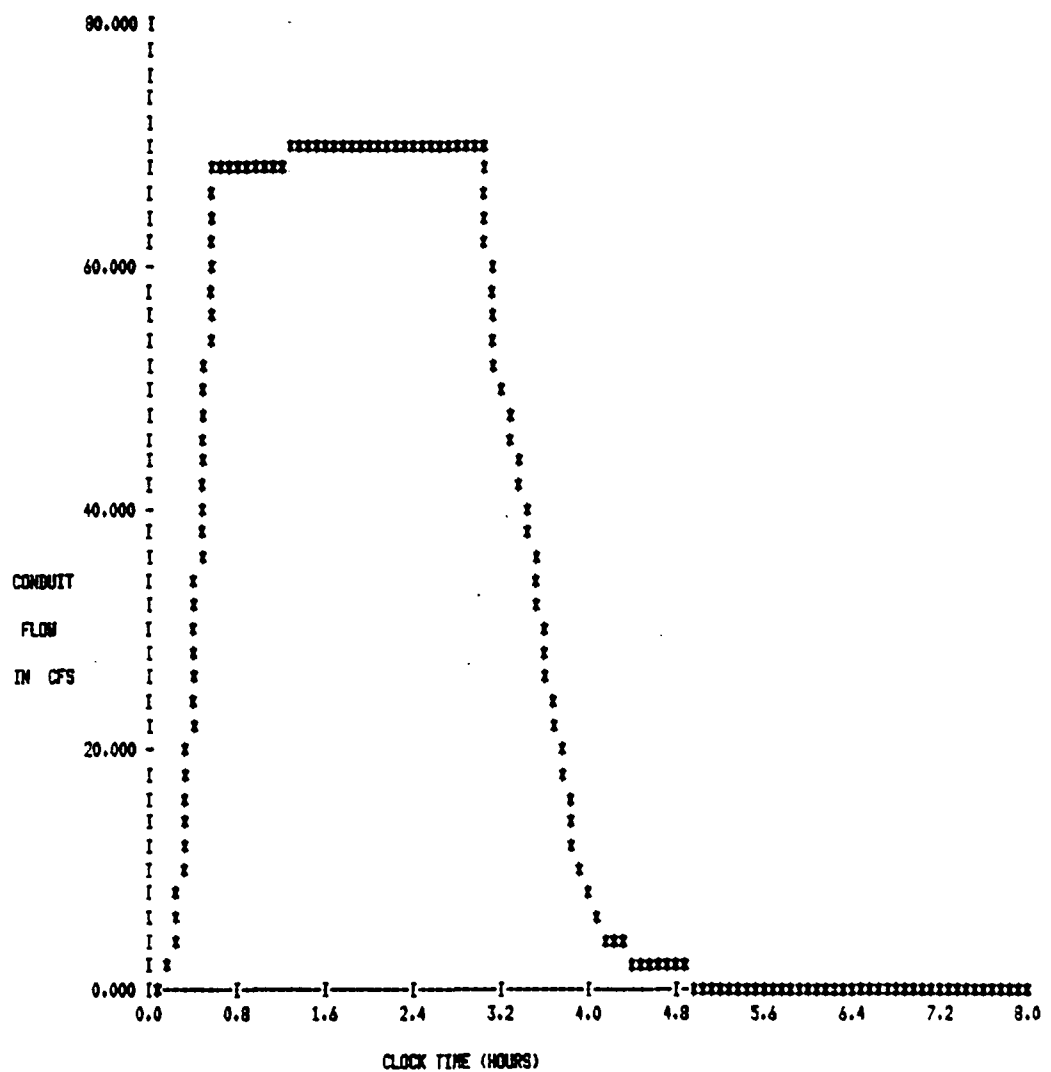


ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

EXTENDED TRANSPORT PROGRAM
ANALYSIS MODULE

WATER RESOURCES DIVISION
CAMP DRESSER & MCKEE INC.
ARNDTDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8



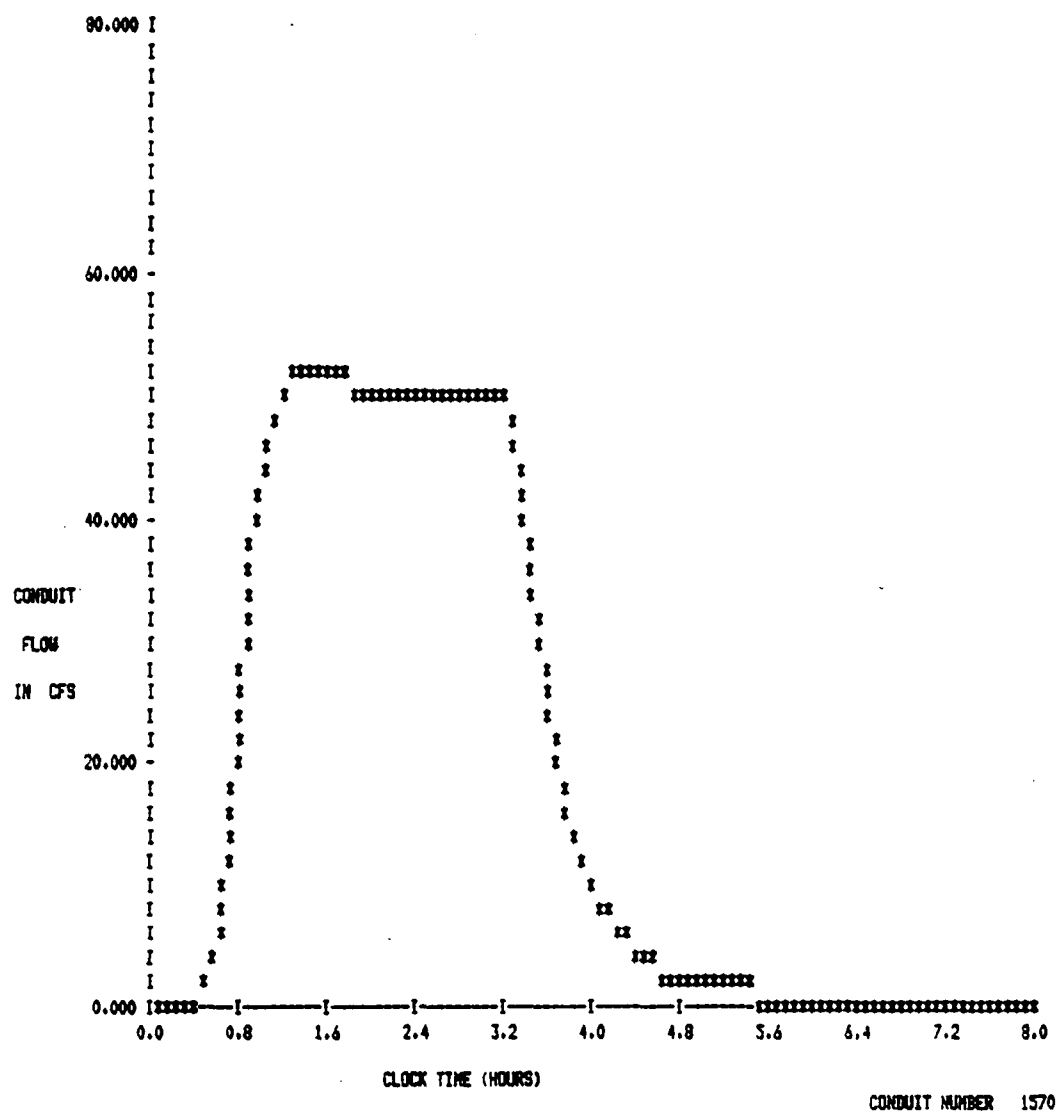
CONDUIT NUMBER 1602

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8

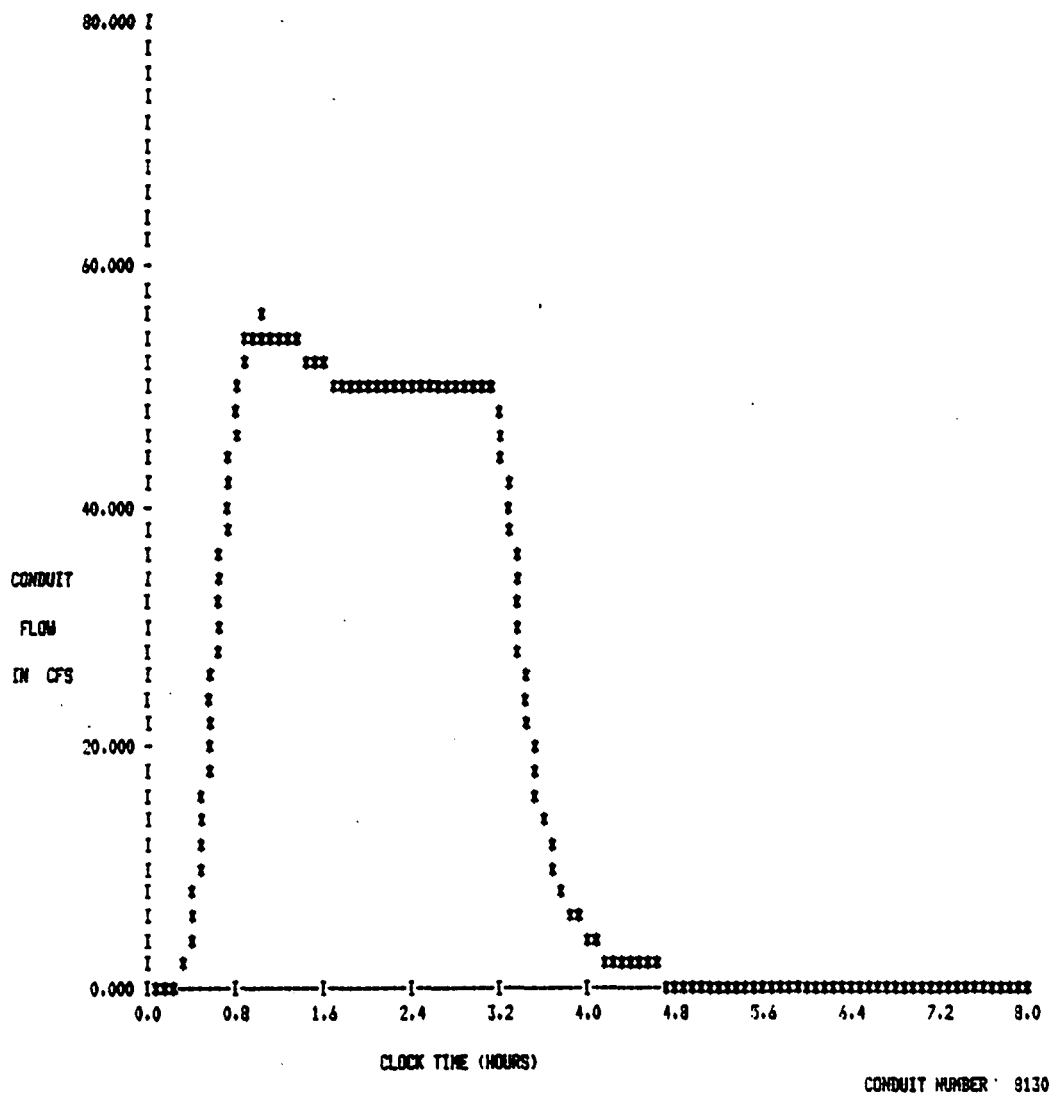


ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 1
BASIC PIPE SYSTEM FROM FIGURE 8



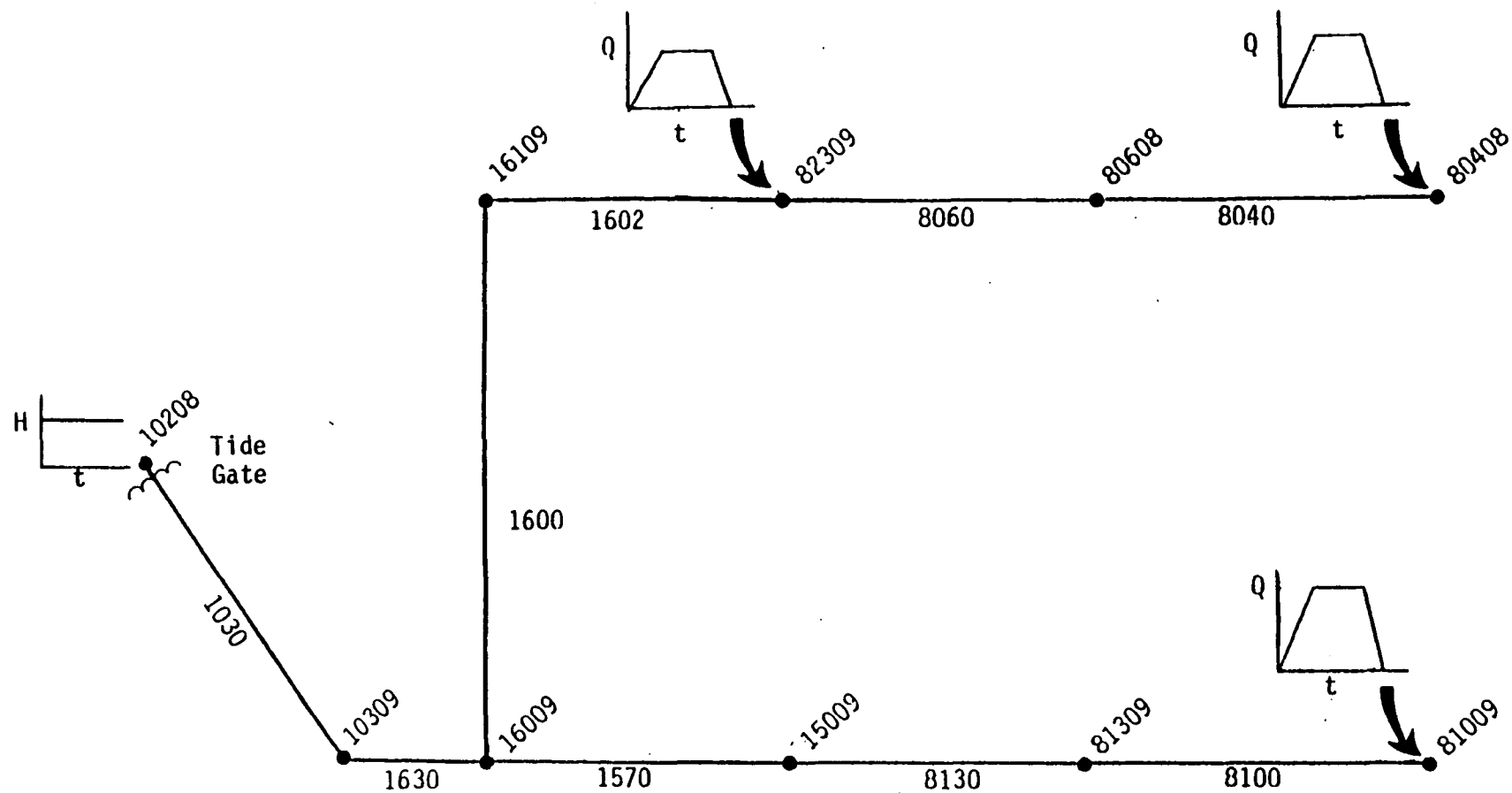


Figure 9. Basic system with tide gate.

TABLE 4
INPUT DATA SET FOR EXAMPLE 2

```

      0      0
EXTRAN USER'S MANUAL EXAMPLE PROBLEM 2
BASIC PIPE SYSTEM WITH TIDE GATE FROM FIGURE 9
1440  20.   .0   6   6   6   6   45  45   3   30  0.05
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
80408040880608      1      4.00      1800.      .015
80608060882309      1      4.00      2075.      2.2 .015
81008100981309      1      4.50      5100.      .015
81308130915009      1      4.50      3500.      .015
10301030910208      6      9.0      4500.      .016 3. 3
15701500916009      1      5.5      5000.      .0154
16001600916109      1      6.0      500.      .015
16301600910309      6      9.0      300.      .015 3. 3
16028230916109      1      5.      5000.      .034
99999
80408138.0124.6 0.0
80608135.0118.3 0.0
81009137.0128.2 0.0
81309130.0117.3 0.0
82309155.0112.3 0.0
10208100.0 89.9 0.0
10309111.0101.6 0.0
15009123.0111.5 0.0
16009120.0102.0 0.0
16109125.0102.8 0.0
99999
99999
99999
99999
99999
99999
99999
10208
99999
      2 94.4
99999
823098040881009
0.0      0.0      0.0      0.0
0.25      40.0      45.0      50.0
3.0      40.0      45.0      50.0
3.25      0.0      0.0      0.0
12.0      0.0      0.0      0.0

```

TABLE 5
OUTPUT FROM EXAMPLE 2

ENVIRONMENTAL PROTECTION AGENCY	****	EXTENDED TRANSPORT PROGRAM	****	WATER RESOURCES DIVISION
WASHINGTON, D.C.	****		****	CAMP DRESSER & MCKEE INC.
	****	ANALYSIS MODULE	****	ARNDTDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 2
BASIC PIPE SYSTEM WITH TIDE GATE FROM FIGURE 9

***** SUMMARY STATISTICS FOR JUNCTIONS *****

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURENCE HR. MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
80408	138.00	128.60	13.40	0 32	9.40	0.00	153.3
80608	135.00	122.30	12.70	0 30	12.70	0.00	159.7
81009	137.00	132.70	3.36	0 27	0.00	5.44	0.0
81309	130.00	122.00	3.56	0 51	0.00	8.94	0.0
82309	153.00	118.50	21.48	0 33	15.48	21.02	166.3
10208	100.00	98.90	4.50	0 10	0.00	5.60	0.0
10309	111.00	110.60	2.48	1 35	0.00	6.72	0.0
15009	125.00	117.00	2.51	1 22	0.00	10.99	0.0
16009	120.00	111.00	3.09	0 48	0.00	14.91	0.0
16109	125.00	108.80	3.07	0 37	0.00	19.13	0.0

TABLE 5
OUTPUT FROM EXAMPLE 2
(Continued)

ENVIRONMENTAL PROTECTION AGENCY	XXXX	EXTENDED TRANSPORT PROGRAM	XXXX	WATER RESOURCES DIVISION
WASHINGTON, D.C.	XXXX		XXXX	CAMP DRESSER & MCKEE INC.
	XXXX	ANALYSIS MODULE	XXXX	ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 2
BASIC PIPE SYSTEM WITH TIDE GATE FROM FIGURE 9

***** SUMMARY STATISTICS FOR CONDUITS *****

CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURENCE HR. MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURENCE HR. MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS UPSTREAM (FT) DOWNSTREAM (FT)
8040	73.6	5.9	48.0	50.8	0 19	6.4	0 18	0.7	13.40 16.70
8060	53.3	4.2	48.0	47.5	0 25	5.0	0 24	0.9	16.70 19.48
8100	78.1	4.9	54.0	61.0	0 37	5.5	0 34	0.8	3.36 3.36
8130	70.6	4.4	54.0	54.9	1 4	5.1	0 57	0.8	3.56 2.51
1030	3028.3	12.5	108.0	120.4	1 35	3.0	1 35	0.0	2.68 4.59
1570	123.6	5.2	66.0	52.7	1 22	4.5	1 23	0.4	2.51 3.09
1600	146.8	5.2	72.0	74.6	0 40	6.1	0 38	0.5	3.07 3.09
1630	2313.2	9.5	108.0	120.8	1 25	5.5	0 31	0.1	3.09 2.68
1602	43.4	2.2	60.0	69.0	0 37	4.0	0 28	1.6	21.68 3.07

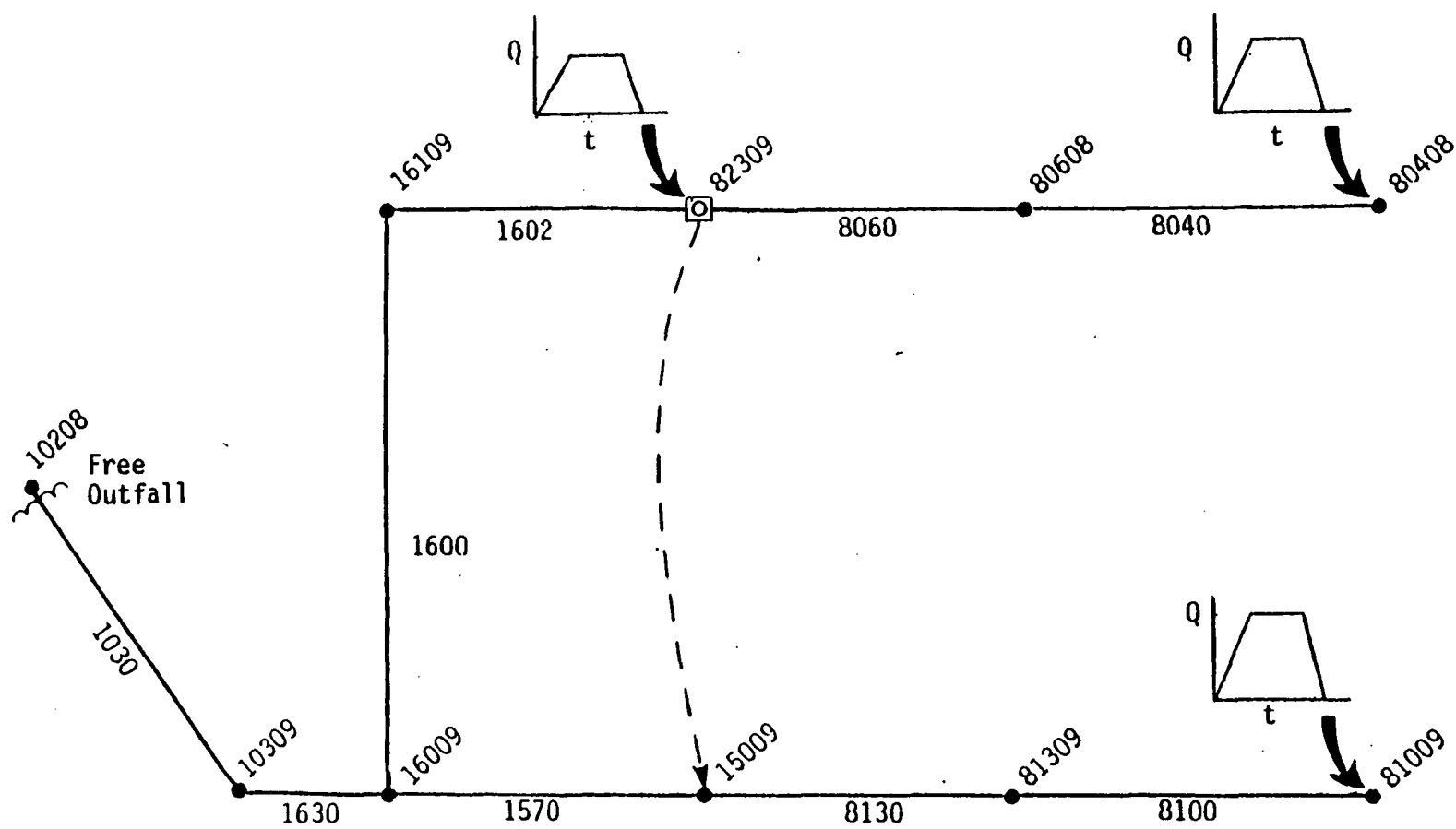


Figure 10. Sump orifice at Junction 82309..

TABLE 6
INPUT DATA SET FOR EXAMPLE 3

```

0      0
EXTRAN USER'S MANUAL EXAMPLE PROBLEM 3
BASIC PIPE SYSTEM WITH SUMP ORIFICE AT JUNCTION 82309 FROM FIG. 10
1440  20.   .0   6   6   6   6   45  45   3   30  0.05
      80608   16009   16109   15009   82309   80408
      1030    1630    1600    1602    1570    8130
      80608   16009   16109   15009   82309   80408
      1030    1630    1600    1602    1570    8130
80408040880608   1   4.00   1800.   .015
80608060882309   1   4.00   2075.   2.2   .015
81008100981309   1   4.50   5100.   .015
81308130915009   1   4.50   3500.   .015
10301030910208   6   9.0    4500.   .016   3.   3
15701500916009   1   5.5    5000.   .0154
16001600916109   1   6.0    500.   .015
16301600910309   6   9.0    300.   .015   3.   3
16028230916109   1   5.     5000.   .034
99999
80408138.0124.6  0.0
80608135.0118.3  0.0
81009137.0128.2  0.0
81309130.0117.5  0.0
82309155.0112.3  0.0
10208100.0 89.9  0.0
10309111.0101.6  0.0
15009125.0111.5  0.0
16009120.0102.0  0.0
16109125.0102.8  0.0
99999
99999
8230915009      2  3.14   .85
99999
99999
99999
10208
99999
99999
1
99999
823098040881009
0.0      0.0      0.0      0.0
0.25     40.0     45.0     50.0
3.0      40.0     45.0     50.0
3.25     0.0      0.0      0.0
12.0     0.0      0.0      0.0

```

TABLE 7
OUTPUT FROM EXAMPLE 3

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSTS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 3

BASIC PIPE SYSTEM WITH SUMP ORIFICE AT JUNCTION 82309 FROM FIG. 10

***** SUMMARY STATISTICS FOR JUNCTIONS *****

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURRENCE HR. MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
90408	138.00	128.60	2.61	0 16	0.00	10.79	0.0
90608	135.00	122.30	3.21	0 32	0.00	13.49	0.0
91009	137.00	132.70	3.48	0 29	0.00	5.32	0.0
81309	130.00	122.00	2.86	0 58	0.00	9.64	0.0
82309	153.00	118.50	6.16	0 59	0.00	36.54	0.0
10208	100.00	98.90	0.56	2 40	0.00	9.54	0.0
10309	111.00	110.60	4.40	2 41	0.00	5.00	0.0
15009	125.00	117.00	3.60	1 2	0.00	9.90	0.0
16009	120.00	111.00	4.05	2 41	0.00	13.95	0.0
16109	125.00	108.80	3.37	2 40	0.00	18.83	0.0

TABLE 7
OUTPUT FROM EXAMPLE 3
(Continued)

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

***** EXTENDED TRANSPORT PROGRAM *****

***** ANALYSIS MODULE *****

***** WATER RESOURCES DIVISION *****
***** CAMP DRESSER & MCKEE INC. *****
***** ARDMANDALE, VIRGINIA *****

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 3

BASIC PIPE SYSTEM WITH SUMP ORIFICE AT JUNCTION 82309 FROM FIG. 10

***** SUMMARY STATISTICS FOR CONDUITS *****

CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURENCE HR. MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURENCE HR. MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS UPSTREAM DOWNSTREAM (FT) (FT)
8040	73.6	5.9	48.0	50.8	0 19	6.4	0 18	0.7	2.61 3.21
8060	53.3	4.2	48.0	49.5	0 40	5.1	0 34	0.9	3.21 3.96
8100	78.1	4.9	54.0	57.2	0 41	5.5	0 37	0.7	3.48 2.86
8130	70.6	4.4	54.0	51.6	0 58	4.3	0 52	0.7	2.86 3.60
1030	3028.3	12.5	108.0	135.0	2 40	5.6	2 40	0.0	4.40 0.56
1570	123.6	5.2	66.0	93.3	1 7	5.7	1 3	0.8	3.60 4.05
1600	146.8	5.2	72.0	47.6	2 31	3.3	0 50	0.3	3.37 4.05
1630	2313.2	9.5	108.0	135.1	2 13	4.8	0 44	0.1	4.05 4.40
1602	43.4	2.2	60.0	47.7	1 31	2.8	0 55	1.1	6.16 3.37

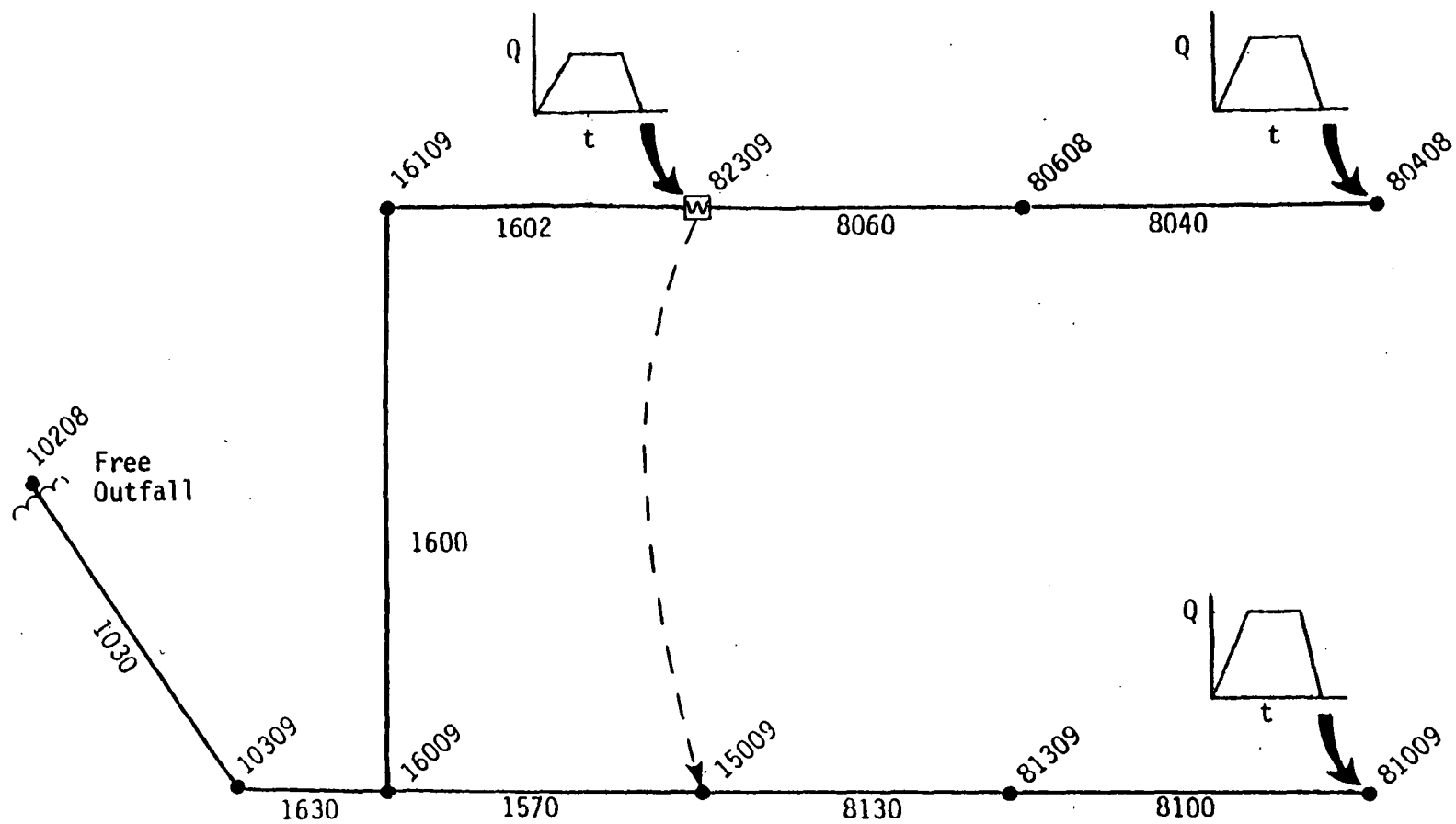


Figure 11. Weir at Junction 82309.

TABLE 8
INPUT DATA SET FOR EXAMPLE 4

```

      0      0
EXTRAN USER'S MANUAL EXAMPLE PROBLEM 4
BASIC PIPE SYSTEM WITH A WEIR AT JUNCTION 82309 FROM FIGURE 11
1440 20.    .0    6    6    6    6    45    45    3    30 0.05
      80608    16009    16109    15009    82309    80408
      1030      1630      1600      1602      1570      8130
      80608    16009    16109    15009    82309    80408
      1030      1630      1600      1602      1570      8130
80408040880608    1      4.00      1800.      .015
80608060882309    1      4.00      2075.      2.2    .015
81008100981309    1      4.50      5100.      .015
81308130915009    1      4.50      3500.      .015
10301030910208    6      9.0      4300.      .016    3.    3
15701500916009    1      5.5      5000.      .0154
16001600916109    1      6.0      500.      .015
16301600910309    6      9.0      300.      .015    3.    3
16028230916109    1      5.      5000.      .034
99999
80408138.0124.6 0.0
80608135.0118.3 0.0
81009137.0128.2 0.0
81309130.0117.5 0.0
82309155.0112.3 0.0
10208100.0 89.9 0.0
10309111.0101.6 0.0
15009125.0111.3 0.0
16009120.0102.0 0.0
16109125.0102.8 0.0
99999
99999
99999
8230915009    1    3.0    6.0    3.0    .80
99999
99999
10208
99999
99999
      1
99999
823098040881009
0.0      0.0      0.0      0.0
0.25      40.0      45.0      50.0
3.0      40.0      45.0      50.0
3.25      0.0      0.0      0.0
12.0      0.0      0.0      0.0

```

TABLE 9
OUTPUT FROM EXAMPLE 4

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 4
BASIC PIPE SYSTEM WITH A WEIR AT JUNCTION 82309 FROM FIGURE 11

***** SUMMARY STATISTICS FOR JUNCTIONS *****

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURENCE HR. MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
80408	138.00	128.60	10.12	0 37	6.12	3.28	144.3
80608	135.00	122.30	13.32	0 38	9.32	3.38	153.3
81009	137.00	132.70	3.36	0 28	0.00	5.44	0.0
81309	130.00	122.00	3.14	0 47	0.00	9.36	0.0
82309	155.00	118.50	16.46	0 38	10.26	26.24	160.7
10208	100.00	98.90	0.56	3 1	0.00	9.54	0.0
10309	111.00	110.60	4.40	3 1	0.00	5.00	0.0
15009	125.00	117.00	3.13	1 11	0.00	10.37	0.0
16009	120.00	111.00	4.05	3 0	0.00	13.95	0.0
16109	125.00	108.80	3.46	3 0	0.00	18.74	0.0

TABLE 9
OUTPUT FROM EXAMPLE 4
(Continued)

ENVIRONMENTAL PROTECTION AGENCY WASHINGTON, D.C.	***** EXTENDED TRANSPORT PROGRAM ***** ***** ANALYSIS MODULE *****	***** WATER RESOURCES DIVISION CAMP DRESSER & MCXEE INC. ARLINGTON, VIRGINIA *****
---	---	--

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 4
BASIC PIPE SYSTEM WITH A WEIR AT JUNCTION 82309 FROM FIGURE 11

***** SUMMARY STATISTICS FOR CONDUITS *****

CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURENCE HR. MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURENCE HR. MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS	
									UPSTREAM (FT)	DOWNSTREAM (FT)
8040	73.6	5.9	48.0	50.8	0 19	6.4	0 18	0.7	10.12	13.32
8060	53.3	4.2	48.0	47.4	0 25	5.0	0 24	0.9	13.32	14.26
8100	78.1	4.9	54.0	59.5	0 38	5.5	0 34	0.8	3.36	3.14
8130	70.6	4.4	54.0	53.7	0 56	5.0	0 48	0.8	3.14	3.13
1030	3028.3	12.5	108.0	135.0	3 1	5.6	3 1	0.0	4.40	0.56
1570	123.6	5.2	66.0	76.3	1 11	5.2	0 55	0.6	3.13	4.05
1600	146.8	5.2	72.0	62.3	0 41	5.6	0 38	0.4	3.46	4.05
1630	2313.2	9.5	108.0	133.0	3 0	5.2	0 45	0.1	4.05	4.40
1602	43.4	2.2	60.0	61.2	3 0	3.6	0 29	1.4	16.46	3.46

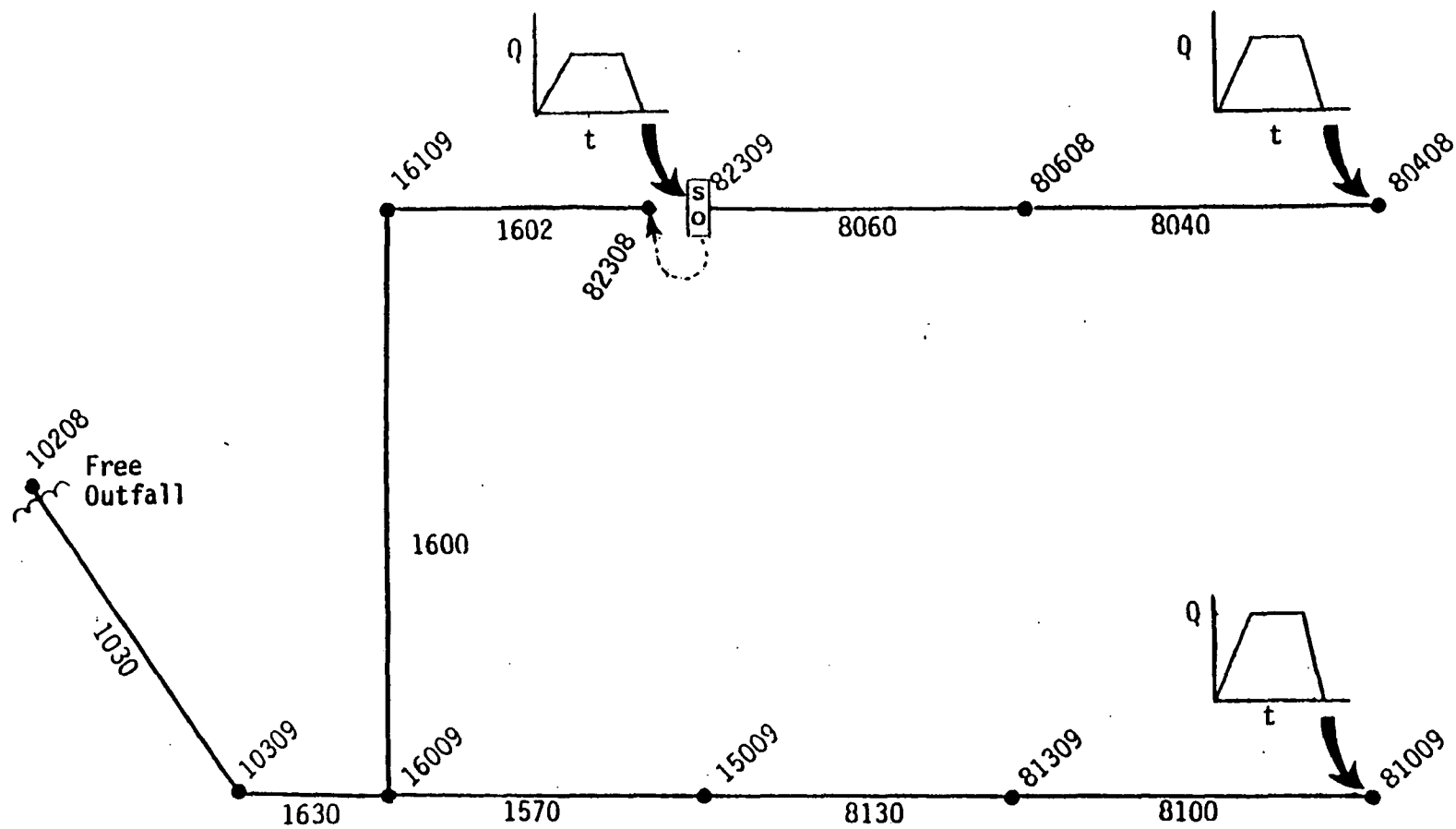


Figure 12. Storage facility and side outlet orifice at Junction 82309.

TABLE 10
INPUT DATA SET FOR EXAMPLE 5

```

      0      0
EXTRAN USER'S MANUAL EXAMPLE PROBLEM 5
STORAGE FACILITY AND SIDE OUTLET ORIFICE AT JUNC. 82309 (FIG. 12)
1440 20. .0 6 6 6 45 45 3 30 0.05
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
80408040880608      1      4.00      1800.      .015
80608060882309      1      4.00      2075.      .015
81008100981309      1      4.50      5100.      .015
81308130915009      1      4.50      3500.      .015
10301030910208      6      9.0      4500.      .016 3. 3
15701500916009      1      5.5      5000.      .0154
16001600916109      1      6.0      500.      .015
16301600910309      6      9.0      300.      .015 3. 3
16028230816109      1      5.      5000.      .034
99999
80408138.0124.6 0.0
80608135.0118.3 0.0
81009137.0128.2 0.0
81309130.0117.5 0.0
82309155.0114.5 0.0
82308155.0112.3 0.0
10208100.0 89.9 0.0
10309111.0101.6 0.0
15009125.0111.5 0.0
16009120.0102.0 0.0
16109125.0102.8 0.0
99999
82309      155.0      800.0
99999
8230982308      1 3.14 .85 0.0
99999
99999
99999
10208
99999
99999
      1
99999
823098040881009
0.0      0.0      0.0      0.0
0.25      40.0      45.0      50.0
3.0      40.0      45.0      50.0
3.25      0.0      0.0      0.0
12.0      0.0      0.0      0.0

```

TABLE 11
OUTPUT FROM EXAMPLE 5

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

***** EXTENDED TRANSPORT PROGRAM *****

***** ANALYSIS MODULE *****

***** WATER RESOURCES DIVISION *****
***** CAMP DRESSER & MCKEE INC. *****
***** ANNANDALE, VIRGINIA *****

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 5
STORAGE FACILITY AND SIDE OUTLET ORIFICE AT JUNC. 82309 (FIG. 12)

***** SUMMARY STATISTICS FOR JUNCTIONS *****

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURENCE HR. MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
80408	138.00	128.60	13.01	0 33	9.01	0.39	164.0
80608	135.00	122.30	16.70	0 33	12.70	0.00	172.3
81009	137.00	132.70	3.36	0 27	0.00	5.44	0.0
81309	130.00	122.00	3.53	0 51	0.00	8.97	0.0
82309	155.00	155.00	21.03	0 35	0.00	19.47	0.0
82308	155.00	117.30	16.01	0 35	11.01	26.69	165.0
10208	100.00	98.90	0.51	3 2	0.00	9.59	0.0
10309	111.00	110.60	4.08	3 2	0.00	5.32	0.0
15009	125.00	117.00	2.51	1 22	0.00	10.99	0.0
16009	120.00	111.00	3.73	3 1	0.00	14.27	0.0
16109	125.00	108.80	3.19	3 0	0.00	19.01	0.0

TABLE 11
OUTPUT FROM EXAMPLE 5
(Continued)

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

XXXX EXTENDED TRANSPORT PROGRAM
XXXX
XXXX ANALYSIS MODULE

XXXX WATER RESOURCES DIVISION
XXXX CAMP DRESSER & MCKEE INC.
XXXX ANNANDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 5
STORAGE FACILITY AND SIDE OUTLET ORIFICE AT JUNC. 82309 (FIG. 12)

***** SUMMARY STATISTICS FOR CONDUITS *****

CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURENCE HR. MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURENCE HR. MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS UPSTREAM DOWNSTREAM (FT) (FT)
8040	73.6	5.9	48.0	52.6	0 19	6.4	0 20	0.7	13.01 16.70
8060	53.3	4.2	48.0	47.2	0 27	3.8	0 28	0.9	16.70 21.03
9100	78.1	4.9	54.0	61.0	0 37	5.5	0 34	0.8	3.36 3.53
8130	70.6	4.4	54.0	54.6	1 4	5.1	0 57	0.8	3.53 2.51
1030	3028.3	12.5	108.0	109.9	3 2	5.3	3 3	0.0	1.08 0.51
1570	123.6	5.2	66.0	52.6	1 22	4.1	1 7	0.4	2.51 3.73
1600	146.8	5.2	72.0	65.2	0 43	5.9	0 41	0.4	3.19 3.73
1630	2313.2	9.5	108.0	109.9	3 1	5.0	0 48	0.0	3.73 4.08
1602	43.4	2.2	60.0	61.0	0 31	3.9	0 32	1.4	16.01 3.19

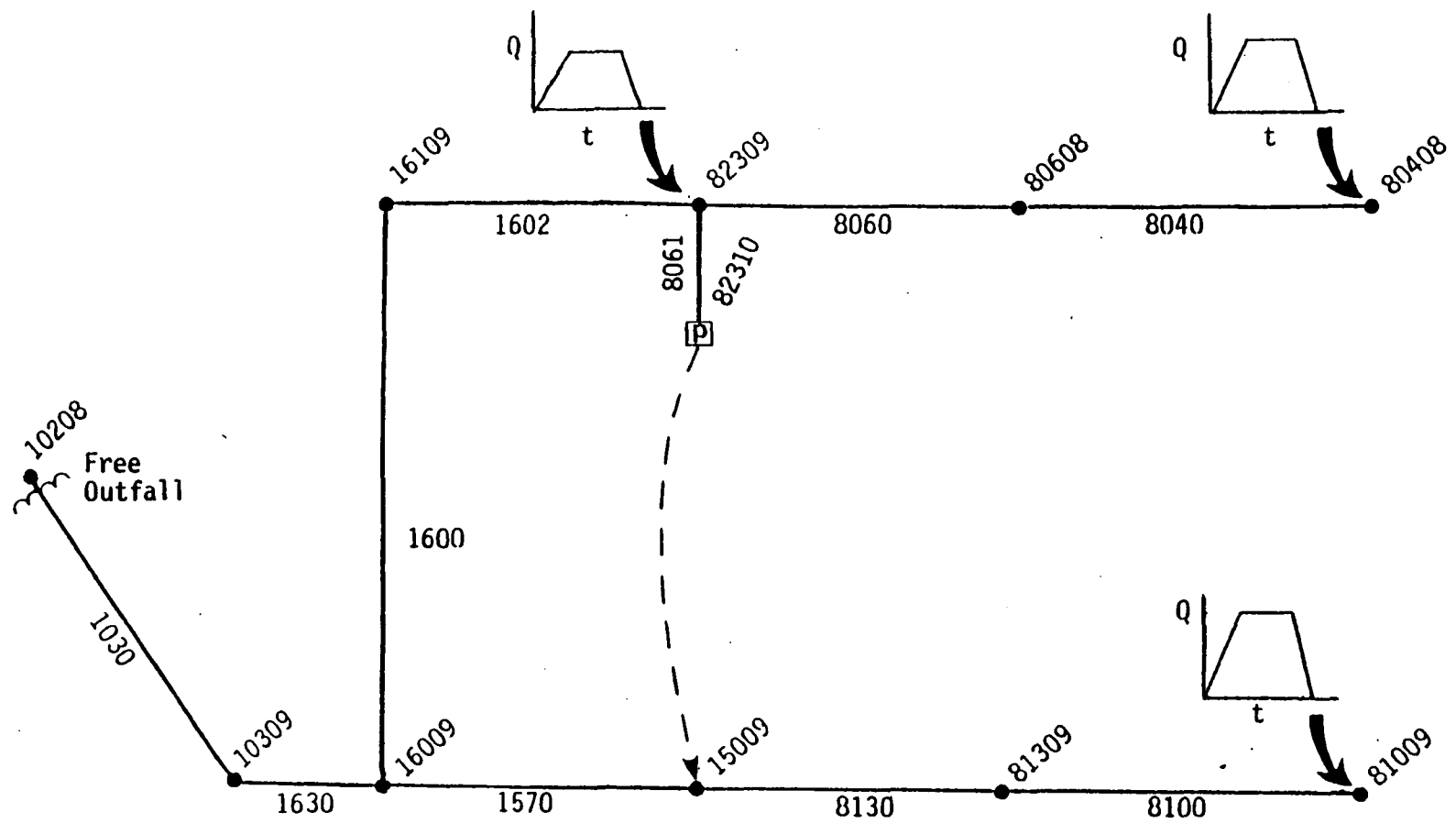


Figure 13. Off-line pump station (activated by wet well volume) at Junction 82310.

TABLE 12
INPUT DATA SET FOR EXAMPLE 6

```

0      0
EXTRAN USER'S MANUAL EXAMPLE PROBLEM 6
OFF LINE PUMP STATION AT JUNCTION 82310 FROM FIGURE 13
1440 20.  .0  6  6  6  6  45  45  3  30 0.05
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
80408040880608      1      4.00      1800.      .015
80608060882309      1      4.00      2075.      2.2 .015
81008100981309      1      4.50      5100.      .015
80618230982310      1      4.0      300.0      .004
81308130915009      1      4.50      3500.      .015
10301030910208      6      9.0      4500.      .016 3.  3
15701500916009      1      5.5      5000.      .0154
16001600916109      1      6.0      500.      .015
16301600910309      6      9.0      300.      .015 3.  3
16028230916109      1      5.      5000.      .034
99999
80408138.0124.6 0.0
82310155.0112.3 0.0
80608135.0118.3 0.0
81009137.0128.2 0.0
81309130.0117.5 0.0
82309155.0112.3 0.0
10208100.0 89.9 0.0
10309111.0101.6 0.0
15009125.0111.5 0.0
16009120.0102.0 0.0
16109125.0102.8 0.0
99999
99999
99999
99999
8231015009      1 60.0  5.0 10.0 20.0200.0600.01200.
99999
10208
99999
99999
1
99999
823098040881009
0.0      0.0      0.0      0.0
0.25      40.0      45.0      50.0
3.0      40.0      45.0      50.0
3.25      0.0      0.0      0.0
12.0      0.0      0.0      0.0

```

TABLE 13
OUTPUT FROM EXAMPLE 6

ENVIRONMENTAL PROTECTION AGENCY	XXXX	EXTENDED TRANSPORT PROGRAM	XXXX	WATER RESOURCES DIVISION
WASHINGTON, D.C.	XXXX		XXXX	CAMP DRESSER & MCKEE INC.
	XXXX	ANALYSIS MODULE	XXXX	ANNANDALE, VIRGINIA

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 6
OFF LINE PUMP STATION AT JUNCTION 82310 FROM FIGURE 13

***** SUMMARY STATISTICS FOR JUNCTIONS *****

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURENCE HR. MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
80408	138.00	128.60	13.19	0 44	9.19	0.21	137.7
82310	155.00	116.30	4.00	0 37	0.00	XXXXX	0.0
80608	135.00	122.30	16.70	0 45	12.70	0.00	145.7
81009	137.00	132.70	3.46	0 29	0.00	5.34	0.0
81309	130.00	122.00	2.87	0 57	0.00	9.63	0.0
82309	155.00	118.50	20.12	0 46	13.92	22.58	151.7
10208	100.00	98.90	0.56	3 1	0.00	9.54	0.0
10309	111.00	110.60	4.40	3 1	0.00	5.00	0.0
15009	125.00	117.00	2.98	1 19	0.00	10.52	0.0
16009	120.00	111.00	4.05	3 1	0.00	13.95	0.0
16109	125.00	108.80	3.49	3 0	0.00	18.71	0.0

TABLE 13
OUTPUT FROM EXAMPLE 6
(Continued)

ENVIRONMENTAL PROTECTION AGENCY WASHINGTON, D.C.	XXXX EXTENDED TRANSPORT PROGRAM XXXX XXXX ANALYSTS MODULE XXXX	XXXX WATER RESOURCES DIVISION XXXX XXXX CAMP DRESSER & MCKEE INC. XXXX XXXX ANNANDALE, VIRGINIA XXXX
---	--	---

EXTRAM USER'S MANUAL EXAMPLE PROBLEM 6
OFF LINE PUMP STATION AT JUNCTION 82310 FROM FIGURE 13

***** SUMMARY STATISTICS FOR CONDUITS *****

CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURENCE HR. MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURENCE HR. MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS UPSTREAM (FT)	DOWNSTREAM (FT)
8040	73.6	5.9	48.0	50.8	0 19	6.4	0 18	0.7	13.19	16.70
9060	53.3	4.2	48.0	50.4	0 33	5.1	0 30	0.9	16.70	17.92
8100	78.1	4.9	54.0	57.1	0 42	5.5	0 37	0.7	3.46	2.87
8061	0.0	0.0	48.0	115.8	3 9	9.5	3 9	0.0	20.12	XXXXX
8130	70.6	4.4	54.0	52.0	0 57	4.9	0 56	0.7	2.87	2.98
1030	3028.3	12.5	108.0	135.0	3 1	5.6	3 2	0.0	4.40	0.56
1570	123.6	5.2	66.0	70.5	1 19	5.0	0 42	0.6	2.98	4.05
1600	146.8	5.2	72.0	65.0	3 0	4.8	0 51	0.4	3.49	4.05
1630	2313.2	9.5	108.0	135.0	2 59	5.2	0 46	0.1	4.05	4.40
1602	43.4	2.2	60.0	65.7	1 5	3.7	0 47	1.5	20.12	3.49

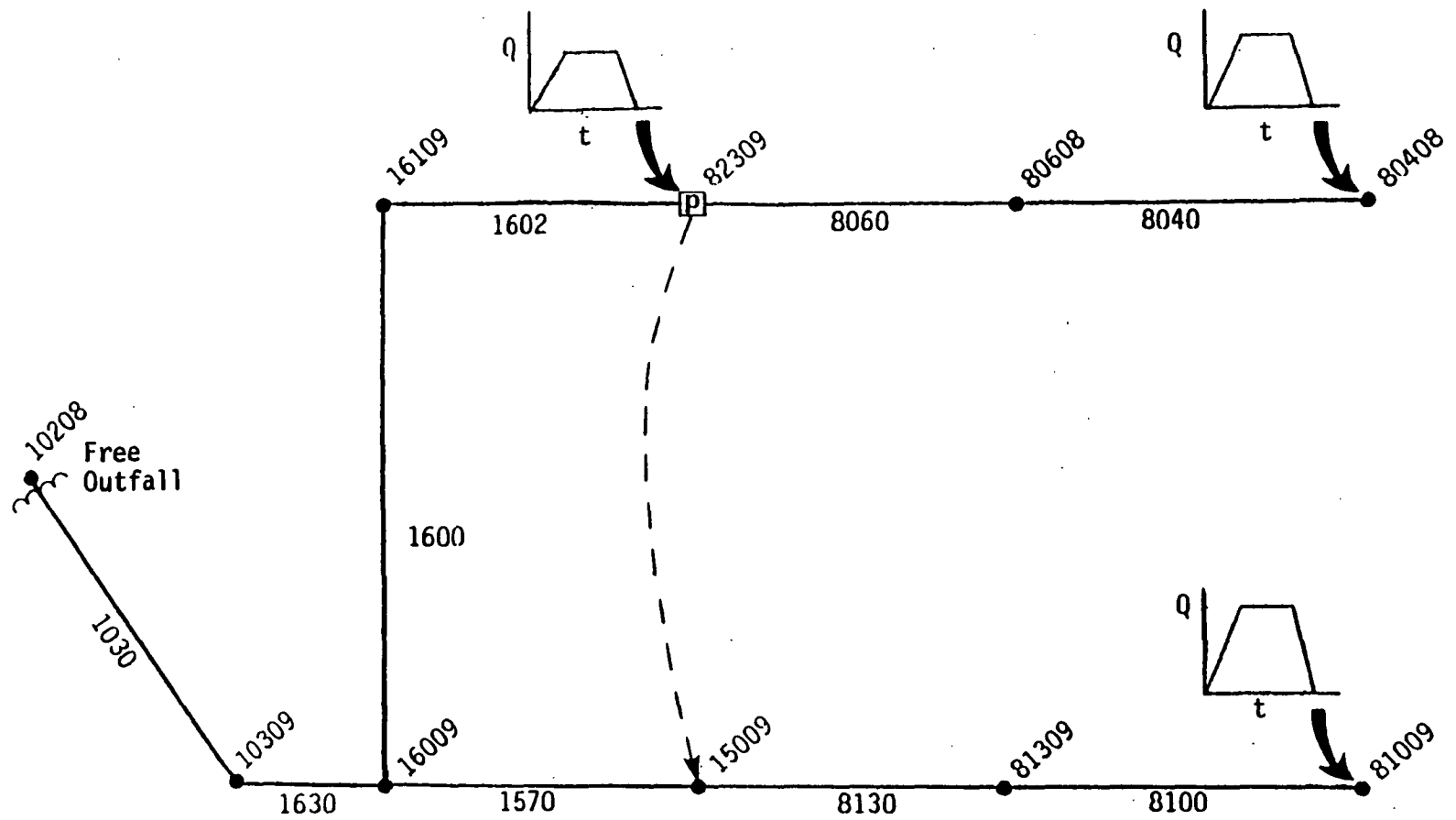


Figure 14. In-line pump (stage activated)
at Junction 82309.

TABLE 14
INPUT DATA SET FOR EXAMPLE 7

```

      0      0
EXTRAN USER'S MANUAL EXAMPLE PROBLEM 7
IN LINE PUMP STATION AT JUNCTION 82309 FROM FIGURE 14
1440 20.   .0   6   6   6   6   45  45   3   30 0.05
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
      80608      16009      16109      15009      82309      80408
      1030      1630      1600      1602      1570      8130
80408040880408      1      4.00      1800.      .015
80608060882309      1      4.00      2075.      2.2 .015
81008100981309      1      4.50      5100.      .015
81308130915009      1      4.50      3500.      .015
10301030910208      6      9.0      4500.      .016 3.   3
15701500916009      1      5.5      5000.      .0154
16001600916109      1      6.0      500.      .015
16301600910309      6      9.0      300.      .015 3.   3
16028230916109      1      5.      5000.      .034
99999
80408138.0124.6 0.0
80608135.0118.3 0.0
81009137.0128.2 0.0
81309130.0117.5 0.0
82309155.0112.3 0.0
10208100.0 89.9 0.0
10309111.0101.6 0.0
15009125.0111.5 0.0
16009120.0102.0 0.0
16109125.0102.8 0.0
99999
99999
99999
99999
8230915009      2  0.0  5.0 10.0 20.0  8.0 25.0  0.0
99999
10208
99999
99999
      1
99999
823098040881009
0.0      0.0      0.0      0.0
0.25     40.0     45.0     50.0
3.0      40.0     45.0     50.0
3.25     0.0      0.0      0.0
12.0     0.0      0.0      0.0

```

TABLE 15
OUTPUT FROM EXAMPLE 7

ENVIRONMENTAL PROTECTION AGENCY	**** EXTENDED TRANSPORT PROGRAM ****	**** WATER RESOURCES DIVISION
WASHINGTON, D.C.	****	**** CAMP DRESSER & MCKEE INC.
	**** ANALYSIS MODULE ****	**** ANNANDALE, VIRGINIA

EXTRA USER'S MANUAL EXAMPLE PROBLEM 7
IN LINE PUMP STATION AT JUNCTION 82309 FROM FIGURE 14

***** SUMMARY STATISTICS FOR JUNCTIONS *****

JUNCTION NUMBER	GROUND ELEVATION (FT)	UPPERMOST PIPE CROWN ELEVATION (FT)	MAXIMUM COMPUTED DEPTH (FT)	TIME OF OCCURRENCE HR. MIN.	FEET OF SURCHARGE AT MAX. DEPTH	FEET MAX. DEPTH IS BELOW GROUND ELEVATION	LENGTH OF SURCHARGE (MIN)
30408	138.00	128.60	13.40	0 35	9.40	0.00	148.7
80608	135.00	122.30	16.70	0 35	12.70	0.00	155.3
91009	137.00	132.70	3.13	0 28	0.00	5.37	0.0
81309	130.00	122.00	3.17	0 53	0.00	9.33	0.0
82309	155.00	118.50	20.93	0 36	14.73	21.77	162.0
10208	100.00	98.90	0.55	3 1	0.00	9.55	0.0
10309	111.00	110.60	4.34	3 1	0.00	5.06	0.0
15009	125.00	117.00	2.75	1 21	0.00	10.75	0.0
16009	120.00	111.00	3.99	3 0	0.00	14.01	0.0
16109	125.00	108.80	3.48	3 0	0.00	18.72	0.0

TABLE 15
OUTPUT FROM EXAMPLE 7
(Continued)

ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C.

***** EXTENDED TRANSPORT PROGRAM *****

***** ANALYSIS MODULE *****

***** WATER RESOURCES DIVISION *****
***** CAMP DRESSER & MCXFE INC. *****
***** ANNANDALE, VIRGINIA *****

EXTRAN USER'S MANUAL EXAMPLE PROBLEM 7
IN LINE PUMP STATION AT JUNCTION 82309 FROM FIGURE 14

***** SUMMARY STATISTICS FOR CONDUITS *****

CONDUIT NUMBER	DESIGN FLOW (CFS)	DESIGN VELOCITY (FPS)	CONDUIT VERTICAL DEPTH (IN)	MAXIMUM COMPUTED FLOW (CFS)	TIME OF OCCURRENCE HR. MIN.	MAXIMUM COMPUTED VELOCITY (FPS)	TIME OF OCCURRENCE HR. MIN.	RATIO OF MAX. TO DESIGN FLOW	MAXIMUM DEPTH ABOVE INVERT AT CONDUIT ENDS UPSTREAM (FT) DOWNSTREAM (FT)
8040	73.6	5.9	48.0	50.8	0 19	6.4	0 18	0.7	13.40 16.70
8060	53.3	4.2	48.0	48.5	0 27	5.1	0 25	0.9	16.70 18.73
8100	78.1	4.9	54.0	59.3	0 40	5.5	0 36	0.8	3.43 3.17
8130	70.6	4.4	54.0	53.4	1 3	5.0	0 54	0.8	3.17 2.75
1030	3028.3	12.5	108.0	129.8	3 1	5.6	3 1	0.0	4.34 0.55
1570	123.6	5.2	66.0	61.9	1 21	4.4	1 2	0.5	2.75 3.99
1600	146.8	5.2	72.0	69.8	3 0	5.8	0 38	0.5	3.48 3.99
1630	2313.2	9.5	108.0	129.8	3 0	5.2	0 45	0.1	3.99 4.34
1602	43.4	2.2	60.0	69.8	3 0	3.9	0 30	1.6	20.93 3.48

CHAPTER 4

TIPS FOR TROUBLE-SHOOTING

In the preceding three chapters of this user's manual, we have described in detail the individual data input elements for EXTRAN. We believe that careful study of the data input instructions, together with the example problems of the last section, will go a long way in answering the usual questions of "how to get started" in using a computerized stormwater model as intricate as this one.

Obviously, it is not possible to anticipate all problems in advance and therefore certain questions are bound to occur in the user's initial attempts at application. The purpose of this section is to offer a set of guidelines and recommendations for setting up EXTRAN which will help to reduce the number of problem areas and thereby alleviate frequently encountered start-up pains.

Most difficulties in using the EXTRAN MODEL arise from three sources: (1) improper selection of time step and incorrect specification of the total simulation period; (2) incorrect print and plot control variables; and (3) improper system connectivity in the model. These and other problems are discussed below:

- Numerical stability constraints in the EXTRAN Model require that DELT, the time-step, be no longer than the time it takes flow to travel the length of the shortest conduit in the transport system. A 10-second time-step is recommended for most wet-weather runs, while a 45-second step may be used satisfactorily for DWF conditions. The numerical stability criteria for the explicit finite-difference scheme used by the model are discussed in Chapter 2.
- Numerical instability in the EXTRAN Block is signaled by the occurrence of the following hydraulic indicators:
 - (1) Oscillations in flow and water surface elevation which are undampened in time are sure signs of numerical instability. Certain combinations of pipe and weir structures may cause temporary resonance, but this is normally short lived. The unstable pipe usually is short relative to other adjacent pipes and may be subject to backwater created by a downstream weir. The correction is a shorter time-step, a longer pipe length

or combination of both. Neither of these should be applied until a careful check of system connections on all sides of the unstable pipe has been made as suggested below.

- (2) A second indicator of numerical instability is a node which continued to "dry up" on each time-step despite a constant or increasing inflow from upstream sources. The cause usually is too large a time-step and excessive discharges in adjacent downstream pipe elements which pull the upstream water surface down. The problem is related to items (1) and (3) and may usually be corrected by a smaller time-step.
 - (3) Excessive velocities (over 20 fps) and discharges which appear to grow without limit at some point in the simulation run are manifestations of an unstable pipe element in the transport system. The cause usually can be traced to the first source above and the corrections are normally applied, as suggested in item (1) above.
 - (4) A large continuity error is a good indicator of either stability or other problems. A continuity check, which sums the volumes of inflow, outflow, and storage at the end of the simulation, is found at the end of the intermediary printout. If the continuity error exceeds + 10%, the user should check the intermediate printout for pipes with zero flow or oscillating flow. These could be caused by stability or an improperly connected system.
- Systems in surcharge require a special iteration loop, allowing the explicit solution scheme to account for the rapid changes in flows and heads during surcharge conditions. This iteration loop is controlled by two variables, ITMAX, the maximum number of iterations, and SURTOL, a fraction of the flow through the surcharged area. It is recommended that ITMAX and SURTOL be set initially at 30 and 0.05, respectively. The user can check the convergence of the iteration loop by examining the number of iterations actually required and the size of the net difference in the flows through the surcharged area, shown in the intermediate printout. These are significant since the iterations end when either SURTOL times the average flow through the surcharged area is less than the flow differential discussed above, or when the number of iterations exceeds ITMAX. If ITMAX is exceeded many times, leaving relatively large flow differentials, the user should increase ITMAX to improve the accuracy of the surcharge computation. If, on the other hand, the user finds that most or all of the iterations do converge, he may decrease ITMAX or increase SURTOL to decrease the runtime of the model and, consequently, the cost. The user should also keep an eye on the continuity error to insure that a large loss of water is not caused by the iterations.

- In some large systems, more than one area may be in surcharge at the same time. If this occurs and the flows in these areas differ appreciably, those areas with the smallest flows may not converge, while areas with large flows will. This is because both the tolerance and flow differential are computed as sums of all flows in surcharge. It is possible, therefore, to assume convergence has occurred even when relatively large flow errors still exist in surcharge areas with small flows. If the user suspects this situation exists, he can compute a flow differential for any particular surcharge area by adding the differences between inflow to and outflow from each node in that surcharge area. Such information can be found in the intermediary printout. Whenever the flow differential computed in this way is a significantly large fraction of the average flow in this area, inaccurate results may be expected. To correct this, SURTOL can be decreased until the flow differential for the area in question decreases to a small value over time. It should be noted, however, that large flow differentials for a short period of time are not unusual providing they decrease to near or below the established tolerance for most of the simulation.
- The simulation period is defined by the product NTCYC x DELT or the number of integration cycles times the length of each cycle. If this product exceeds the simulation period of the inflow hydrograph tape, an illegal end-of-file is encountered and execution stops. NTCYC must then be reduced to correspond with this simulation period.
- The length of all conduits in the transport system should be roughly constant and no less than 100 feet. This constraint may be difficult to meet in the vicinity of weirs and abrupt changes in pipe configurations which must be represented in the model. However, the length of the shortest conduit does directly determine the maximum time step and the number of pipe elements, both of which in turn control the cost of simulation as indicated in Chapter 2. The use of longer pipes should be facilitated through use of equivalent sections and slopes in cases where significant changes in pipe shape, cross sectional area and gradient must be represented in the model.
- In EXTRAN, printed output can be requested for a maximum of 20 nodes and conduits. In addition, the number of printed points for a given node or conduit is automatically set at 100 regardless of the length of simulation. This requires that the print frequency control variable INTER is defined strictly by the criterion:

$$\frac{\text{NTCYC} - \text{NSTART}}{\text{INTER}}$$

where all variables are as defined in Chapter 2. If, for example, NTCYC = 1600 and NSTART = 9, and we had selected

INTER = 10 then the ratio (NTCYC - NSTART) - INTER = 159. Because the 100-value printing arrays would then be filled with 159 values, an overflow situation would occur thereby producing output which is badly scrambled at best and unusable at worst. Therefore, it is worthwhile to look closely at INTER prior to any major EXTRAN run.

- Prior to a lengthy run of EXTRAN for a new system, a short test run of perhaps five integration cycles should be made to confirm that the link-node model is properly connected and correctly represents the prototype. This check should be made on the echo of the input data, which show the connecting links at each node. The geometric-hydraulic data for each pipe and junction should also be confirmed. Particular attention should be paid to the nodal location of weirs, orifices, and outfalls to ensure these conform to the prototype system. In addition, the total number of conduits and junctions, including internal links and nodes created, can be determined from the Internal Connectivity Table. This information is necessary for proper specification of initial heads and flows at time zero in the simulation.
- The introduction of a ZP invert elevation difference for all pipes connecting a single junction will cause the junction invert elevation to be incorrectly specified. This, in turn, will create errors in hydraulic computation later in the simulation. The junction invert must be at the same elevation as the invert of the lowest pipe either entering or leaving the junction or it is improperly defined. This problem is readily corrected by checking the punched conduit data cards to determine where a non-zero ZP should be set to zero.

CHAPTER 5

FORMULATION OF EXTRAN

GENERAL

A conceptual overview of EXTRAN is shown in Figure 15. As shown here, the specific function of EXTRAN is to route inlet hydrographs through the network of pipes, junctions, and flow diversion structures of the main sewer system to the treatment plant interceptors and receiving water outfalls. It has been noted in Chapter 2 that the boundary between the RUNOFF and EXTRAN Models is dependent on the objectives of the simulation. EXTRAN must be used whenever it is important to represent severe backwater conditions and special flow devices such as weirs, orifices, pumps, storage basins, and tide gates. Normally, these conditions occur in the lower reaches of the drainage system when pipe diameters exceed roughly 20 inches (50 cm). The Runoff Model, on the other hand, is well suited for the simulation of overland and small pipe flow in the upper regions of the system where the kinematic assumptions of uniform flow hold.

As shown in Figure 15, EXTRAN simulates the following elements -- pipes, manholes (pipe junctions), weirs, orifices, pumps, storage basins, and outfall structures. These elements and their associated properties are summarized in Tables 16 and 17. Output from EXTRAN takes the form of 1) discharge hydrographs and velocities in selected conduits in printed and plotted form; and 2) flow depths and water surface elevations at selected junctions in printed and plotted form. This output is supplied by off-line storage (e.g., discs, tapes) to a subsequent block, e.g., the Receiving Water Block.

CONCEPTUAL REPRESENTATION OF THE TRANSPORT SYSTEM

EXTRAN uses a link-node description of the sewer system which facilitates the discrete representation of the physical prototype and the mathematical solution of the gradually-varied unsteady flow equations which form the mathematical basis of the model.

As shown in Figure 16, the conduit system is idealized as a series of links or pipes which are connected at nodes or junctions. Links and nodes have well defined properties which, taken together, permit representation of the entire pipe network. Moreover, the link-node concept is very useful in representing flow control devices. The specific properties of links and nodes have been summarized in Table 17.

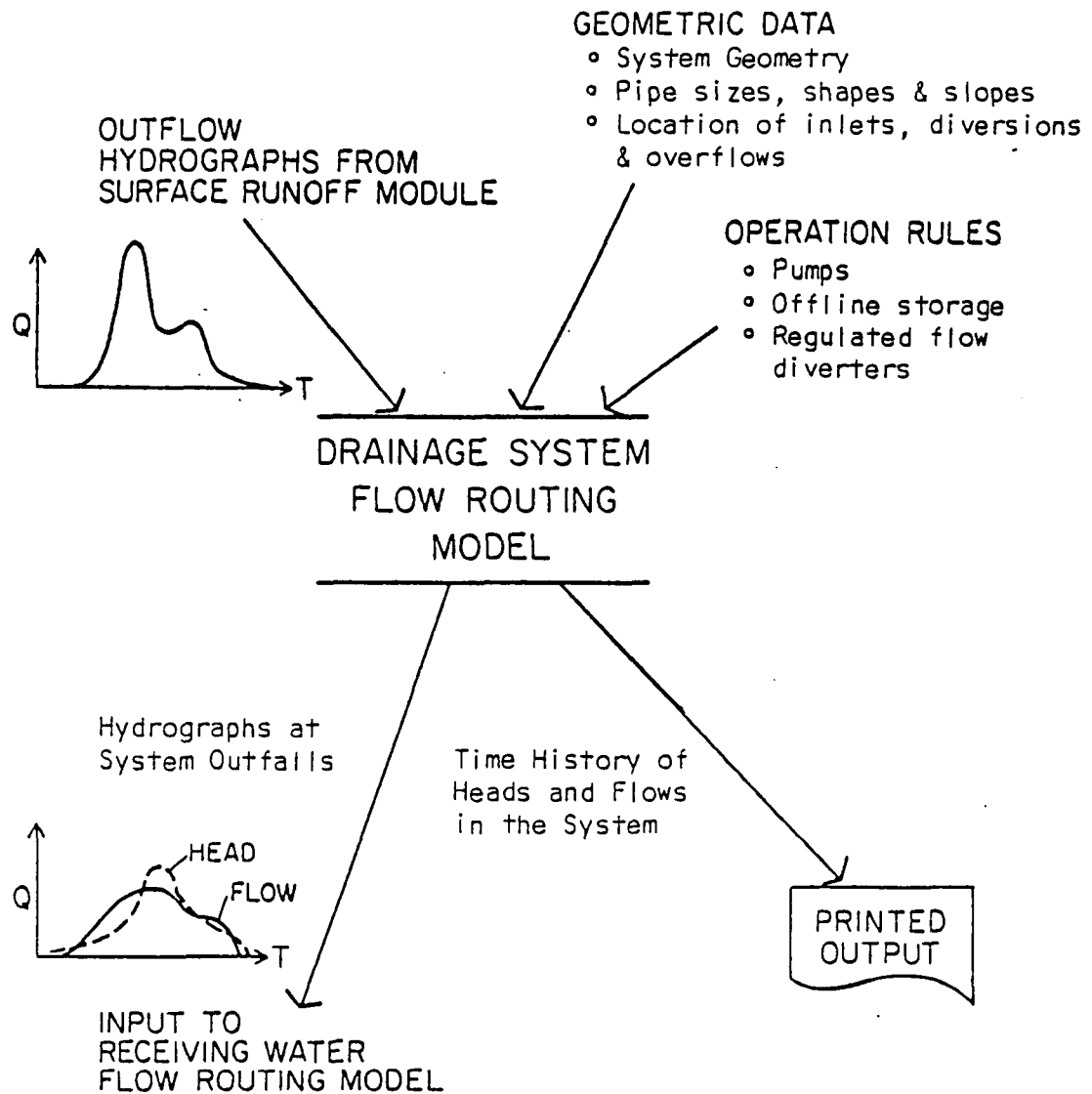


Figure 15. Schematic illustration of EXTRAN

TABLE 16
CLASSES OF ELEMENTS INCLUDED IN
THE TRANSPORT MODEL

Element Class	Types
Conduits or Links	Rectangular Circular Horseshoe Baskethandle Eggshape Trapezoid
Junctions or Nodes (Manholes)	-----
Diversion Structures	Orifices Transverse weirs Sideflow weirs
Pump Stations	On-line or off-line pump station
Storage Basins	On-line (enlarged pipes or tunnels)
Outfall Structures	Transverse weir with tide gate Transverse weir without tide gate Sideflow weir with tide gate Sideflow weir without tide gate Outfall with tide gate Free outfall without tide gate

TABLE 17
PROPERTIES OF NODES AND LINKS IN
THE TRANSPORT MODEL

Properties and Constraints	
NODES	
Constraint	ΣQ = change in storage
Properties computed at each time-step	Volume Surface area Head
Constant Properties	Invert, crown, and ground elevations
LINKS	
Constraint	$Q_{in} = Q_{out}$
Properties computed at each time-step	Cross-sectional area Hydraulic radius Surface width Discharge Velocity of flow
Constant Properties	Head loss coefficients Pipe shape, length, slope, roughness,

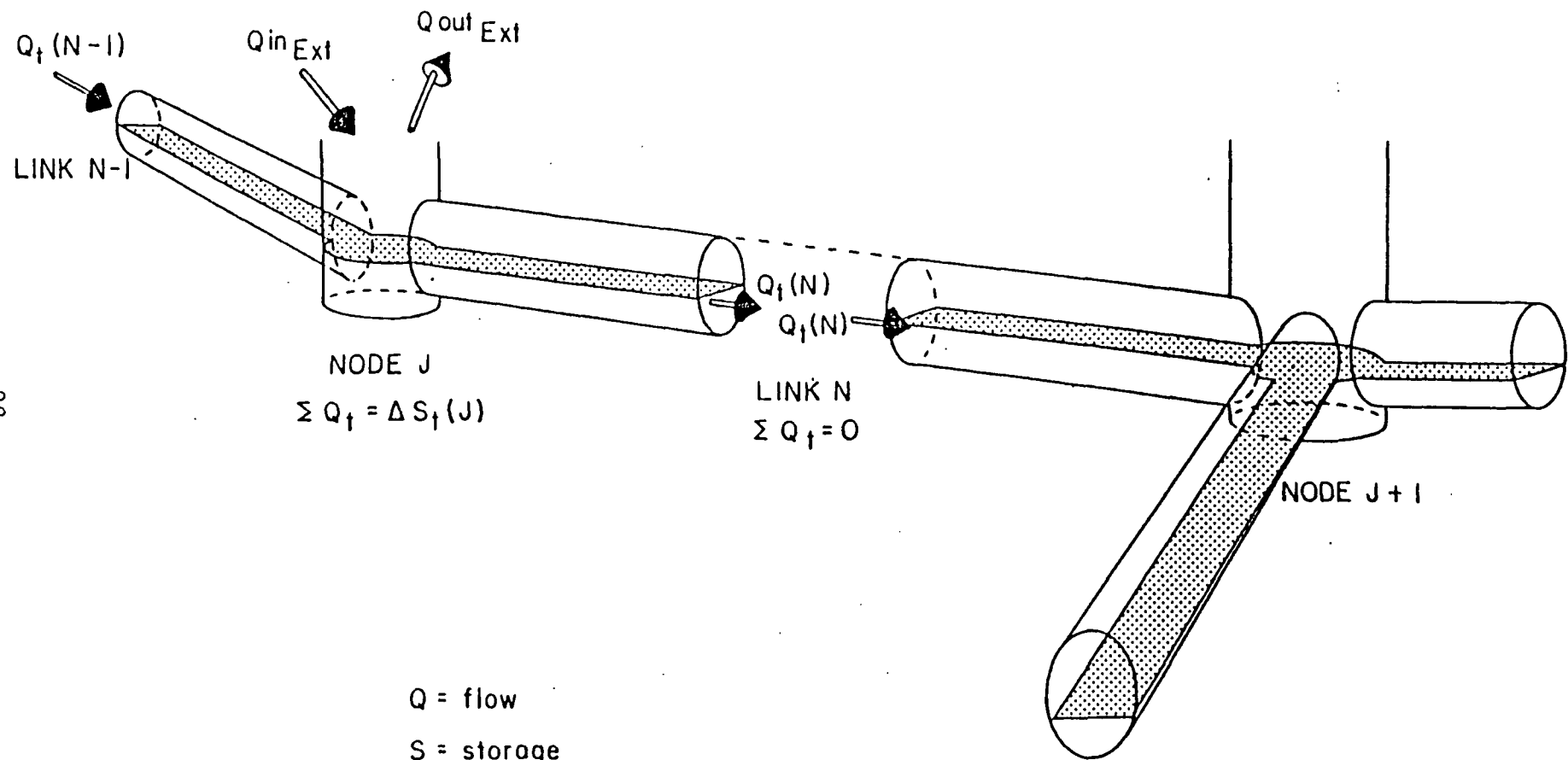


Figure 16. Conceptual representation of the EXTRAN model.

Links transmit flow from node to node. Properties associated with the links are roughness, length, cross-sectional area, hydraulic radius, and surface width. The last three properties are functions of the instantaneous depth of flow. The primary dependent variable in the links is the discharge, Q . It is assumed that Q is constant in the link, while velocity and the cross-sectional area of flow, or depth, are variable in the link. In the early development of EXTRAN, a constant velocity approach was used, but this was found later to produce highly unstable solutions.

Nodes are the storage elements of the system and correspond to manholes or pipe junctions in the physical system. The variables associated with a node are volume, head, and surface area. The primary dependent variable is the head, H , which is assumed to be changing in time but constant throughout any one node. Inflows, such as inlet hydrographs, and outflows, such as weir diversions, take place at the nodes of the idealized sewer system. The volume of the node at any time is equivalent to the water volume in the half-pipe lengths connected to any one node. The change in nodal volume during a given time step, Δt , forms the basis of head and discharge calculations as discussed below.

BASIC FLOW EQUATIONS

The basic differential equations for the sewer flow problem come from the gradually varied, unsteady flow equations for open channels, otherwise known as the Saint-Venant or shallow water equations. The equation for unsteady spatially varied discharge can be written:

$$\frac{\partial Q}{\partial t} = -gAS_f + 2V\frac{\partial A}{\partial t} + V^2\frac{\partial A}{\partial x} - gA\frac{\partial H}{\partial x} \quad (9)$$

where

- Q = discharge through the conduit
- V = velocity in the conduit
- A = cross-sectional area of the flow
- H = hydraulic head
- S_f = friction slope

The friction slope is defined by Manning's equation, i.e.

$$S_f = \frac{k}{gAR^{4/3}} Q|V| \quad (10)$$

where $k = g(n/1.49)^2$. Use of the absolute value sign on the velocity terms makes S_f a directional quantity and ensures that the frictional force always opposes the flow. Substituting in equation 9 and expressing the finite difference form gives:

$$Q_{t+\Delta t} = Q_t - \frac{k\Delta t}{R^{4/3}} |V_t| Q_{t+\Delta t} + 2V\frac{\Delta A}{\Delta t} \Delta t + V^2 \frac{A_2 - A_1}{L} \Delta t - gA \frac{H_2 - H_1}{L} \Delta t \quad (11)$$

Solving equation 11 for $Q_{t+\Delta t}$ gives the final finite difference form of the dynamic flow equation as:

$$Q_{t+\Delta t} = \frac{1}{1 + \frac{k \cdot \Delta t}{4/3} \frac{|V|}{\bar{R}}} \left[Q_t + 2\bar{V} \Delta A + \bar{V}^2 \frac{A_2 - A_1}{L} \Delta t - g\bar{A} \frac{H_2 - H_1}{L} \Delta t \right] \quad (12)$$

In equation 12, the values $\bar{V}$, $\bar{R}$, and $\bar{A}$ are weighted averages of the conduit end values at time t .

The basic unknowns in equation 12 are $Q_{t+\Delta t}$, H_2 and H_1 . The variables $\bar{V}$, $\bar{R}$, and $\bar{A}$ can all be related to Q and H . We, therefore, require another equation relating Q and H . This can be obtained by writing the continuity equation at a node.

$$\frac{\partial H}{\partial t}_t = \frac{\sum Q_t}{A_{s_t}} \quad (13)$$

or in finite difference form

$$H_{t+\Delta t} = H_t + \frac{\sum Q_t \Delta t}{A_{s_t}} \quad (14)$$

SOLUTION OF FLOW EQUATION BY MODIFIED EULER METHOD

Equations 12 and 14 can be solved sequentially to determine discharge in each link and head at each node over a time-step Δt . The numerical integration of equations 12 and 14 is accomplished by a modified Euler method. The results are accurate and, when certain constraints are followed, stable. Figure 17 shows how the process would work if only the discharge equation were involved. The first three operations determine the slope $\partial Q / \partial t$ at the "half-step" value of discharge. In other words, it is assumed that the slope at time $t + \Delta t/2$ is the mean slope during the interval. The method is extended easily to more than one equation, although graphic representation is then very difficult. The corresponding half-step and full-step calculations of head are shown below:

Half-step at node j: Time $t + \Delta t/2$

$$H_j(t + \frac{\Delta t}{2}) = H_j(t) + \frac{\Delta t}{2} \left[\frac{1}{2} \sum \left[Q(t) + Q(t + \frac{\Delta t}{2}) \right] + \sum Q(t + \frac{\Delta t}{2}) \right] / AS_j(t) \quad (15)$$

conduits
surface runoff

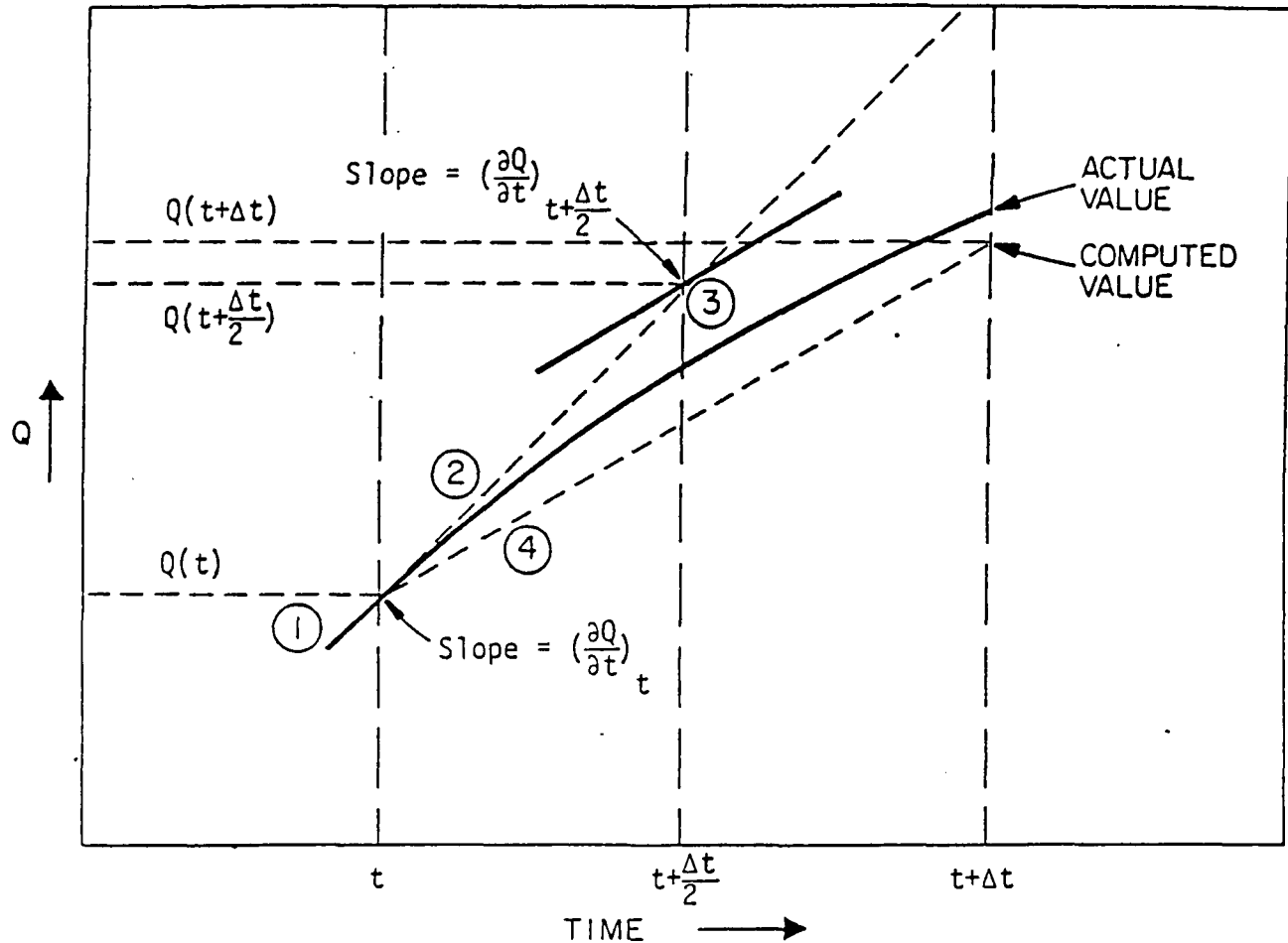
diversions
pumps
outfalls

Full-step at node j: Time $t + \Delta t$

$$H_j(t + \Delta t) = H_j(t) + \Delta t \left[\frac{1}{2} \sum \left[Q(t) + Q(t + \Delta t) \right] + \sum Q(t + \Delta t) \right] / AS_j(t) \quad (16)$$

conduits
surface runoff

diversions
pumps
outfalls



- ①. Compute $(\frac{\partial Q}{\partial t})_t$ from properties of system at time t
- ②. Project $Q(t + \frac{\Delta t}{2})$ as $Q(t + \frac{\Delta t}{2}) = Q(t) + (\frac{\partial Q}{\partial t})_t \frac{\Delta t}{2}$
- ③. a. Compute system properties at $t + \frac{\Delta t}{2}$
 b. Form $(\frac{\partial Q}{\partial t})_{t + \frac{\Delta t}{2}}$ from properties of system at time $t + \frac{\Delta t}{2}$
- ④. Project $Q(t + \Delta t)$ as $Q(t + \Delta t) = Q(t) + (\frac{\partial Q}{\partial t})_{t + \frac{\Delta t}{2}} \Delta t$

Figure 17. Modified Euler solution method for discharge based on half-step, full-step projection.

Note that the half-step computation of head uses the half-step computation of discharge in all connecting conduits. Similarly, the full-step computation requires the full-step discharge at time $t + \Delta t$ for all connecting pipes. In addition, the inflows to and diversions from each node by weirs, orifices, and pumps must be computed at each half and full-step. The total sequence of discharge computations in the links and head computations in the nodes can be summarized as:

1. Compute half-step discharge at $t + \Delta t/2$ in all links based on preceding full-step values of head at connecting junctions.
2. Compute half-step flow transfers by weirs, orifices, and pumps at time $t + \Delta t/2$ based on preceding full-step values of head at transfer junction.
3. Compute half-step head at all nodes at time $t + \Delta t/2$ based on average of preceding full-step and current half-step discharges in all connecting conduits, plus flow transfers at the current half-step.
4. Compute full-step discharge in all links at time $t + \Delta t$ based on half-step heads at all connecting nodes.
5. Compute full-step flow transfers between nodes at time $t + \Delta t$ based on current half-step heads at all weir, orifice, and pump nodes.
6. Compute full-step head at time $t + \Delta t$ for all nodes based on average of preceding full-step and current full-step discharges, plus flow transfers at the current full-step.

NUMERICAL STABILITY

The modified Euler method yields a completely explicit solution in which the motion equation is applied to discharge in each link and the continuity equation to head at each node entirely without implicit coupling. It is well known that explicit methods involve fairly simple arithmetic and require little storage space compared to implicit methods. However, they are generally less stable and often require very short time-steps. From a practical standpoint, experience with EXTRAN has indicated that the program is stable numerically when the following inequalities are met:

Conduits:

$$\Delta t \leq \frac{L}{\sqrt{gD}} \quad (17)$$

where L is the pipe length in feet, g is gravity (ft/sec²), D is the pipe depth, and Δt the time step in seconds.

Nodes:

$$\Delta t \leq \frac{C' A_s H_{\max}}{\Sigma Q} \quad (18)$$

where C' is a dimensionless constant determined by experience to be approximately 0.10, $H_{\max}$ is the maximum water-surface rise in time-step Δt , A_s is the corresponding surface area of the node, and ΣQ is the net inflow to the junction.

Examination of inequalities 17 and 18 reveals that the maximum allowable time, Δt , will be determined by the shortest, smallest pipe having high inflows. Based on past experience with EXTRAN, a time-step of 10 seconds is nearly always sufficiently small to produce outflow hydrographs and state-time traces which are free from spurious oscillation and also satisfy mass continuity under non-flooding conditions. In most applications, 15 to 30 second time-steps are adequate; occasionally time steps up to 60 seconds can be used.

Equivalent Pipes

An equivalent pipe is the computational substitution of an actual element of the drainage system by an imaginary conduit which is hydraulically identical to the element it replaces. Usually, an equivalent pipe is used when it is suspected that a numerical instability will be caused by the element of the drainage system being replaced in the computation. Short conduits and weirs are known at times to cause stability problems and thus occasionally need to be replaced by an equivalent pipe. (Orifices are automatically converted to equivalent pipes by the program; see the description below.)

The equivalent pipe substitution used by EXTRAN involves the following steps. First the flow equation for the element in question is set equal to the flow equation for an "equivalent pipe". This, in effect, says that the head losses in the element and its equivalent pipe are the same. The length of the equivalent pipe is computed using the numerical stability equation 17. Then, after making any additional assumptions which may be required about the equivalent pipe's dimensions, a Manning's n is computed based on the equal head loss requirement. In the case of orifices, this conversion occurs internally in EXTRAN, but in those cases where short pipes and weirs are found to cause instabilities, the user must make the necessary conversion and revise the input data set. Chapter 2 of this report outlines the steps needed to make these conversions.

SPECIAL PIPE FLOW CONSIDERATIONS

The solution technique discussed in the preceding paragraphs cannot be applied without modification to every conduit for the following reasons. First, the invert elevations of pipes which join at a node may be different since sewers are frequently built with invert discontinuities. Second, critical depth may occur in the conduit and thereby restrict the discharge. Third, normal depth may control. Finally, the pipe may be dry. In all of these cases, or combinations thereof, the flow must be computed by special techniques. Figure 18 shows each of the possibilities and describes the way in which surface area is assigned to the nodes. The options are:

1. Normal case. Flow computed from motion equation. Half of surface area assigned to each node.

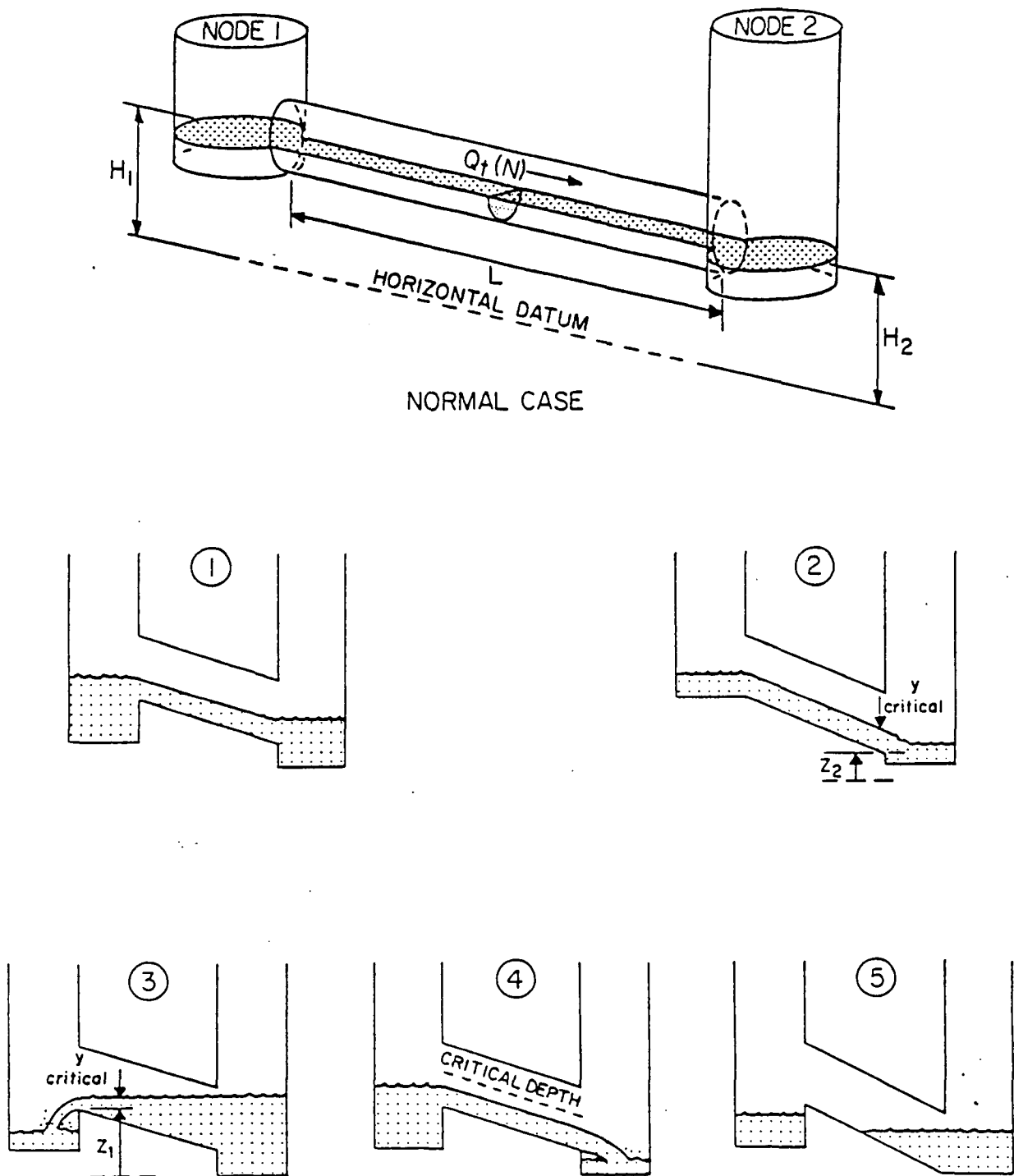


Figure 18. Special hydraulic cases in EXTRAN flow calculations.

2. Critical depth downstream. Use lesser of critical or normal depth downstream. Assign all surface area to upstream node.
3. Critical depth upstream. Use critical depth. Assign all surface area to downstream node.
4. Flow computed exceeds flow at critical depth.
Set flow to normal value. Assign surface area in usual manner as in (1).
5. Dry pipe. Set flow to zero. If any surface area exists, assign to downstream node.

Once these depth and surface area corrections are applied, the computations of head and discharge can proceed in the normal way for the current time-step. Note that any of these special situations may begin and end at various times and places during simulation. EXTRAN detects these automatically.

HEAD COMPUTATION DURING SURCHARGE AND FLOODING

Another hydraulic situation which requires special treatment is the occurrence of surcharge and flooding. Surcharge occurs when all pipes entering a node are full or when the water surface at the node lies between the crown of the highest entering pipe and the ground surface.

Flooding is a special case of surcharge which takes place when the hydraulic grade line breaks the ground surface and water is lost from the sewer node to the overlying surface system. While it would be possible to track the water lost to flooding by surface routing, this is not done in the present version of EXTRAN.

During surcharge, the head calculation in equations 15 and 16 is no longer possible because the surface area of the surcharged node is zero. Thus, the continuity equation for node j at time t is

$$\Sigma Q(t) = 0 \quad (19)$$

where $\Sigma Q(t)$ is all inflows to and outflows from the node from surface runoff, conduits, diversion structures, pump, and outfalls.

Since the flow and continuity are not solved simultaneously in the model, the flows computed in the links connected to node j will not satisfy equation 19. However, computing $\partial Q / \partial H_j$ for each link connected to node j , a head adjustment can be computed such that the continuity equation is satisfied. Rewriting equation 19 in terms of the adjusted head gives:

$$\Sigma(Q(t) + \frac{\partial Q(t)}{\partial H_j} \Delta H_j(t)) = 0 \quad (20)$$

which can be solved for ΔH_j as

$$\Delta H_j(t) = -\Sigma Q(t) / \Sigma \frac{\partial Q(t)}{\partial H_j} \quad (21)$$

This adjustment is made by half-steps during surcharge so that the half-step correction is given as:

$$H_j(t + \frac{\Delta t}{2}) = H_j(t) + k \Delta H_j(t + \frac{\Delta t}{2}) \quad (22)$$

where $H_j(t + \Delta t/2)$ is given by equation 21, while the full-step head is computed as:

$$H_j(t + \Delta t) = H_j(t + \frac{\Delta t}{2}) + k \Delta H_j(t) \quad (23)$$

where $\Delta H_j(t)$ is described by equation 21. The value of the constant k theoretically should be 1.0. However, it has been found that equation 22 tends to overcorrect the head; therefore, a value of 0.5 is used for k in the half-step computation which gives much better results. It has also been found that oscillations are triggered at upstream terminal junctions when these values of k are used. Therefore, to eliminate the oscillations, values of 0.3 and 0.6 are automatically set for k in the half-step and full-step computations, respectively, at these nodes.

Use of $\partial Q(t)/\partial H_j$, as mentioned above, satisfies continuity. Unfortunately, though, the explicit solution technique cannot meet the physical constraint of the inflows to surcharged areas of the system equaling the outflows. Because of this unmet constraint, the surcharge heads fall below their actual physical values. In order to boost these heads to their expected values, the full-step computations of flow and head in surcharge areas are repeated in an iteration loop. The iterations for a particular time-step continue until one of the following two conditions is met:

1. The net difference of inflows to and outflows from all nodes in surcharge is less than a tolerance, computed every time-step as a fraction of the average flow through the surcharge area. The fraction is input by the user.
2. The number of iterations exceeds a maximum set by the user.

The iteration loop has been found to produce accurate results with little continuity error. The user may need to experiment somewhat with the user input values in order to accurately simulate all surcharge points without incurring an unreasonably high computer cost due to extra iterations.

For various types of links connected to a node, $\partial Q/\partial H$ is computed as follows:

Conduits

$$\frac{\partial Q(t)}{\partial H_j} = \frac{32.2}{1-K(t)} \Delta t \left(\frac{A(t)}{L} \right) \quad (24)$$

where

$$K(t) = -\Delta t \frac{32.2 n^2}{2.208 R^{4/3}} |V(t)|$$

Δt = time interval
 $A(t)$ = flow cross sectional area in the conduit
 L = conduit length
 n = Manning n
 R = hydraulic radius for the full conduit
 $V(t)$ = velocity in the conduit

System Inflows

$$\frac{\partial Q(t)}{\partial H_j} = 0 \quad (25)$$

Orifice, Weir, Pump, or Outfall Diversions

Orifices are converted to equivalent pipes (see below); therefore, equation 24 is used to compute $\partial Q/\partial H$. For weirs, $\partial Q/\partial H$ in the weir link is taken as zero, i.e., the effect of the flow changes over the weir due to a change in head is ignored in adjusting the head at surcharged weir junctions. (The weir flow, of course, is computed in the next time-step on the basis of the adjusted head.) As a result, the solution may go unstable under surcharge conditions. If this occurs, the weir should be changed to an equivalent pipe as described in Chapter 2, under Card Group 12.

$\partial Q/\partial H$ for pump junctions is also taken as zero. For off-line pumps (with a wet well), this is a valid statement since Q_{pump} is determined by the volume in the wet well, not the head at the junction. For in-line pumps, where the pump rate is determined by the water depth at the junction, a problem could occur if the pumping rate is not set at its maximum value at a depth less than surcharge depth at the junction. This situation should be avoided, if possible, because it could cause the solution to go unstable if a large step increase or decrease in pumping rate occurs while the pump junction is surcharged.

For all outfall pipe, the head adjustment at the outfall is treated as any other junction. Outfall weir junctions are treated the same as internal weir junctions ($\partial Q/\partial H$ for the weir link is taken as zero). Thus, unstable solutions can occur at these junctions also under surcharge conditions. Converting these weirs to equivalent pipes will eliminate the stability problem.

Because the head adjustments computed in equations 22 and 23 are approximations, the computed head has a tendency to "bounce" up and down when the conduit first surcharges. This bounding can cause the solution to go unstable in some cases; therefore, a transition function is used to smooth the changeover from head computations by equations 15 and 16 to equation 22 and 23. The transition function used is:

$$\Delta H_j(t) = \frac{\partial Q(t)}{\text{DENOM}} \quad (26)$$

where

DENOM is given by

$$\text{DEMON} = \frac{\partial Q(t)}{\partial H_j} + (AS_j(t) - \frac{\partial Q(t)}{\partial H_j}) \exp(-\frac{15(y_j - D_j)}{D_j}) \quad (27)$$

and

AS = the nodal surface area at 0.96 full depth

D_j = pipe diameter

y_j = water depth.

The exponential function causes equation 27 to converge within two percent of equation 21 by the time the water depth is 1.25 times the full flow depth.

Finally, it is noted that when flooding of the node above the ground surface is detected, EXTRAN automatically resets the water surface at the ground elevation of the node. Water rising above this level under flooding conditions is then lost from the system and does not return to the EXTRAN in the present version of the program.

FLOW CONTROL DEVICES

The link-node computations can be extended to include devices which divert sanitary sewage out of the storm drainage system or relieve the storm load on sanitary interceptors. In EXTRAN, all diversions are assumed to take place at a node and are handled as internodal transfers. The special flow regulation devices treated by EXTRAN include: weirs (both sideflow and transverse), orifices, pumps, and outfalls. Each of these is discussed in the paragraphs below.

Storage Devices

Storage devices in-line or off-line act as flow control devices by providing for storage of excessive upstream flows thereby attenuating and lagging the wet weather flow hydrograph from the upstream area. The conceptual representations of a storage junction and a regular junction are illustrated in Figure 19. Note that the only difference is that added surface area in the amount of ASTORE is added to that of the connecting pipes. Note also that ZCROWN(J) is set at the top of storage "tank". When the hydraulic head at junction J exceeds ZCROWN(J), the junction goes into surcharge.

Orifices

The purpose of the orifice generally is to divert sanitary wastewater out of the stormwater system during dry weather periods and to restrict the entry of stormwater into the sanitary interceptors during periods of runoff. The orifice may divert the flow to another pipe, a pumping station or an off-line storage tank.

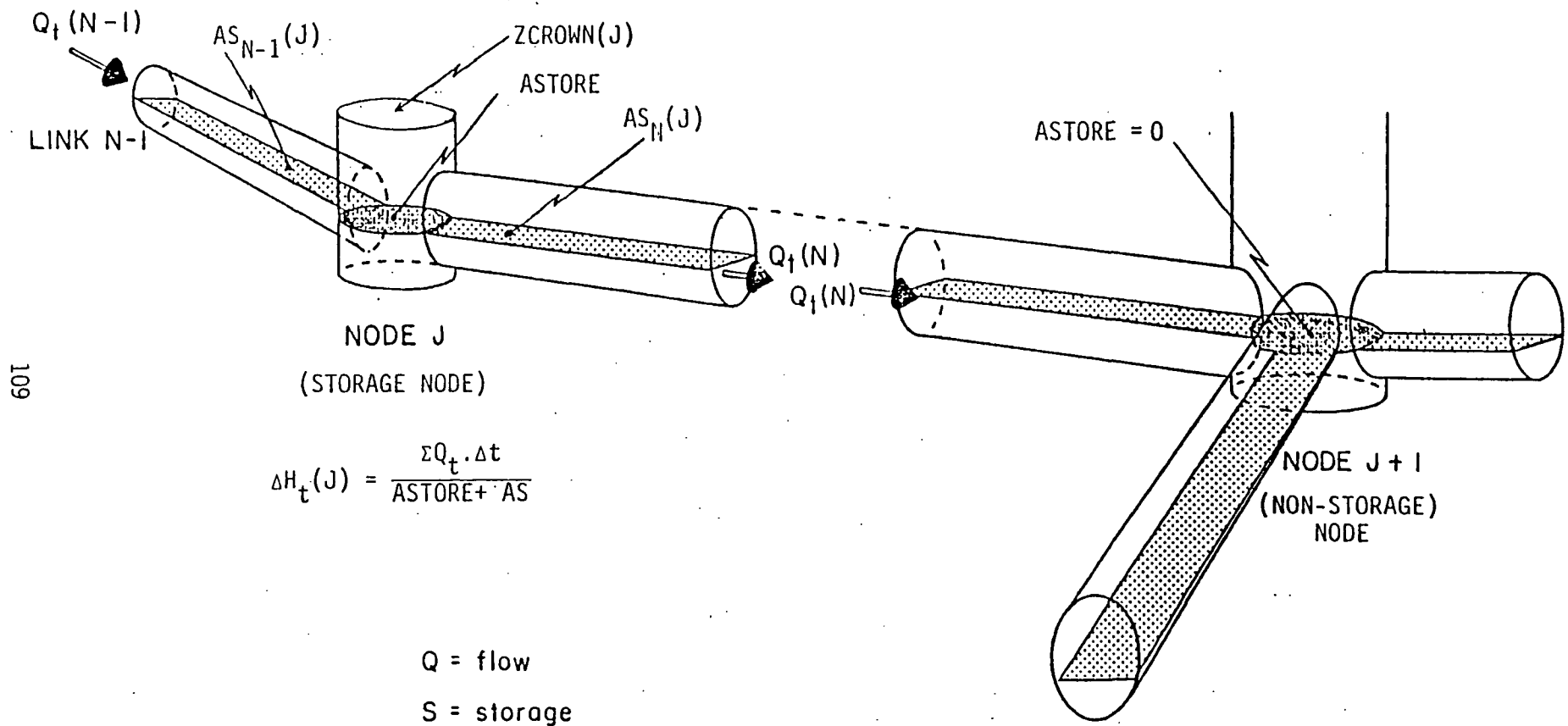


Figure 19. Conceptual representation of a storage junction.

Figure 20 shows two typical diversions: 1) a dropout or sump orifice, and 2) a side outlet orifice. EXTRAN simulates both types of orifice by converting the orifice to an equivalent pipe. The conversion is made as follows. The standard orifice equation is:

$$Q_o = C_o A \sqrt{2gh} \quad (28)$$

where C_o is the discharge coefficient (a function of the type of opening and the length of the orifice tube), A is the cross-sectional area of the orifice, g is gravity, and h is the hydraulic head on the orifice. Values of C_o and A are specified by the user. To convert the orifice to a pipe, the program equates the orifice discharge equation and the Manning pipe flow equation, i.e.,

$$\frac{1.49}{n} AR^{2/3} S^{1/2} = C_o A \sqrt{2gh} \quad (29)$$

The orifice pipe is assumed to be nearly flat, the invert on the discharge side being set 0.01 feet lower than the invert on the inlet side. In addition, for a sump orifice, the pipe invert is set by the program 0.96D below the junction invert so that the orifice pipe is flowing full before any outflow from the junction occurs in any other pipe. For side outlet orifices, the user specifies the height of the orifice invert above the junction floor.

If we write S as H_s/L where L is the pipe length, H_s will be identically equal to h when the orifice is submerged. When it is not submerged, h will be the height of the water surface above the orifice centerline while H_s will be the distance of the water surface above critical depth (which will occur at the discharge end) for the pipe. For practical purposes, we can assume that $H_s = h$ for this case also. Thus, letting $s = h/L$ and substituting $R = D/4$ (where D is the orifice diameter) into equation 29 and simplifying, we have:

$$n = \frac{1.49}{C_o \sqrt{2gL}} \left(\frac{D}{4}\right)^{2/3} \quad (30)$$

The length of the equivalent pipe is computed as the maximum of 200 feet or

$$L = 2\Delta t \sqrt{gD} \quad (31)$$

to insure that the celerity (stability) criteria for the pipe is not violated. n is then computed according to equation 30. This algorithm produces a solution to the orifice diversion that is not only as accurate as the orifice equation but also much more stable when the orifice junction is surcharged.

Weirs

A schematic illustration of flow transfer by weir diversion between two nodes is shown in Figure 21. Weir diversions provide relief to the sanitary

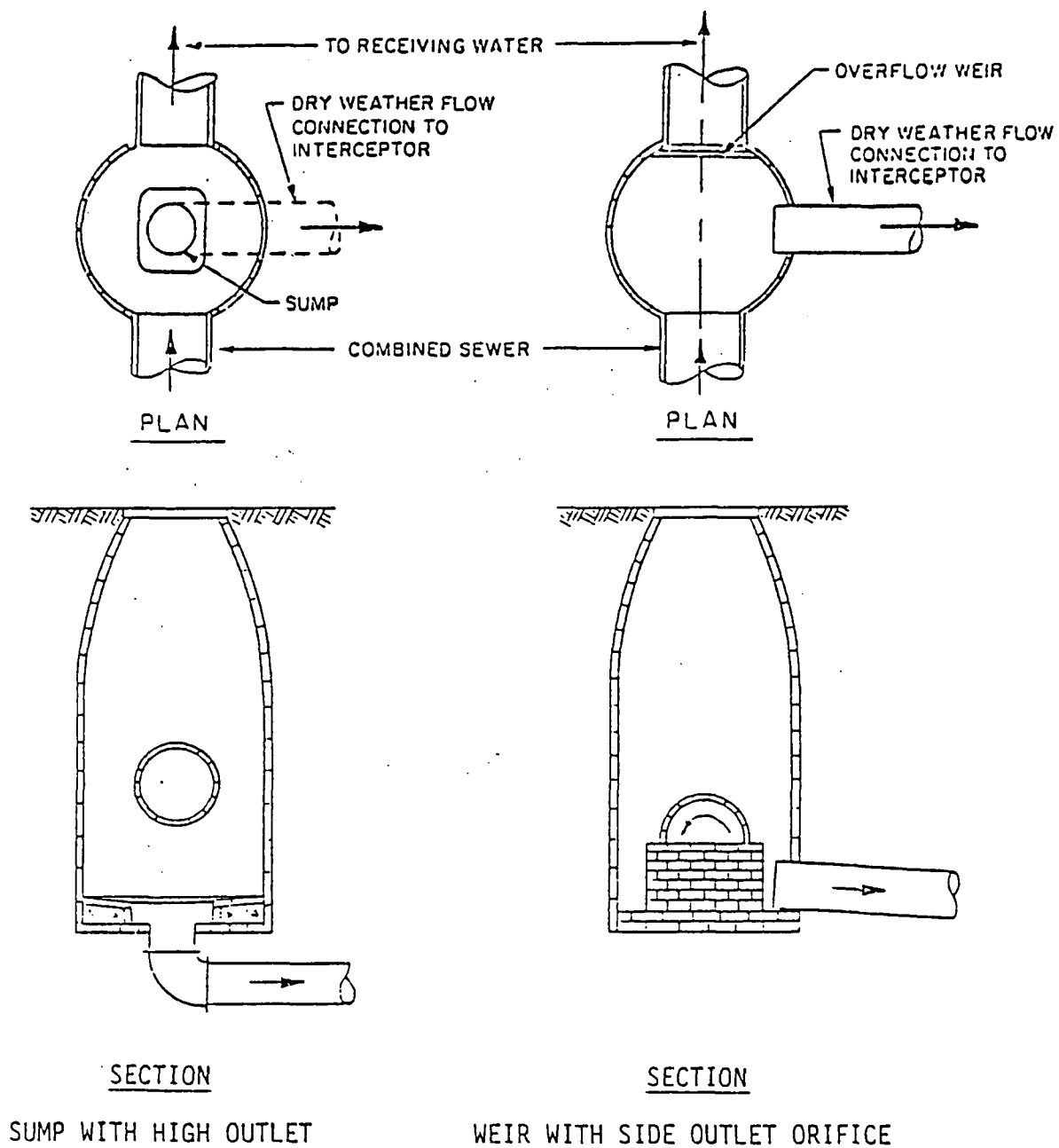
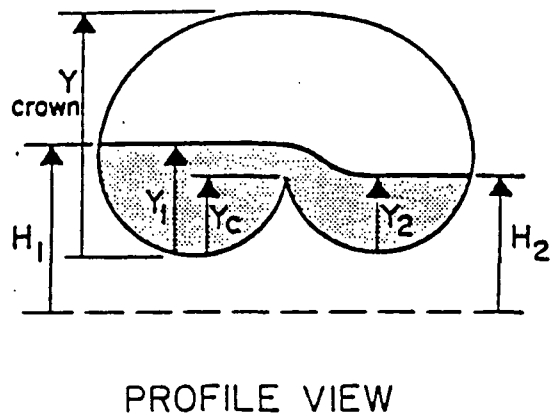
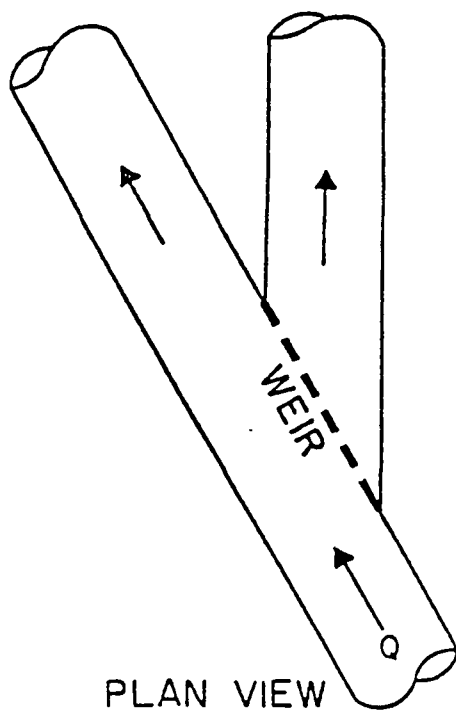
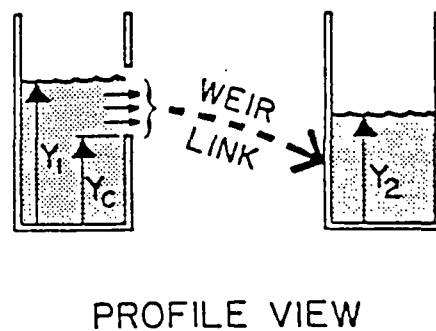
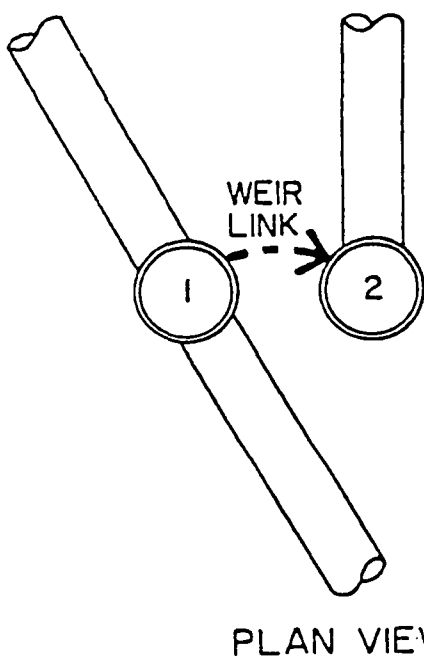


Figure 20. Typical orifice diversions.



Schematic of a Weir Diversion



Conceptual Representation of a Weir Diversion

Figure 21. Representation of weir diversions.

system during periods of storm runoff. Flow over a weir is computed by the equation:

$$Q_w = C_w L_w \left[\left(h + \frac{v^2}{2g} \right)^a - \left(\frac{v^2}{2g} \right)^a \right] \quad (32)$$

where

C_w = discharge coefficient
 L_w = weir length
 h = driving head on the weir
 v = approach velocity
 a = weir exponent; 3/2 for transverse weirs,
 5/3 for sideflow weirs

Both C_w and L_w are input values for transverse weirs. For sideflow weirs, C_w should be a function of the approach velocity, but the present version of the program does not provide for this because of the difficulty in defining the approach velocity. For this same reason, v , which is programmed into the weir solution, is set to zero prior to computing Q_w .

Normally, the driving head on the weir is computed as the difference $h = Y_1 - Y_c$, where Y_1 is the water depth on the upstream side of the weir and Y_c is the height of the weir crest above the node invert. However, if the downstream depth Y_2 also exceeds the weir crest height, the weir is submerged and the flow is computed by equation 33.

$$Q_w = C_{SUB} C_w L_w (Y_1 - Y_c)^{3/2} \quad (33)$$

where C_{SUB} is a submergence coefficient representing the reduction in driving head and all other variables are as defined above.

The submergence coefficient, C_{SUB} , is taken from Roessert's Handbook of Hydraulics by interpolation from Table 18, where C_{RATIO} is defined as:

$$C_{RATIO} = \frac{Y_2 - Y_c}{Y_1 - Y_c} \quad (34)$$

and all other variables are as previously defined.

The values of C_{RATIO} and C_{SUB} are computed automatically by EXTRAN and no input data values are needed.

If the weir is surcharged it will behave as an orifice and the flow is computed as:

$$Q_w = C_{SUR} L_w (Y_{TOP} - Y_c) \sqrt{2gh} \quad (35)$$

TABLE 18
VALUES OF C_{SUB} AS A FUNCTION OF DEGREE OF WEIR SUBMERGENCE

C_{RATIO}	C_{SUB}
0.00	1.00
0.10	0.99
0.20	0.98
0.30	0.97
0.40	0.96
0.50	0.95
0.60	0.94
0.70	0.91
0.80	0.85
0.85	0.80
0.90	0.68
0.95	0.40
1.00	0.00

where

Y_{TOP} = distance to top of weir opening shown in Figure 6

$h' = Y_1 - \text{maximum}(Y_2, Y_C)$

C_{SUR} = weir surcharge coefficient

The weir surcharge coefficient, C_{SUR} , is computed automatically at the beginning of surcharge. At the point where weir surcharge is detected, the preceding weir discharge just prior to surcharge is equated to Q_w in equation 34 and equation 35 is then solved for the surcharge coefficient, C_{SUR} . Thus, no input coefficient for surcharged weirs are required.

Finally, the present version of EXTRAN detects flow reversals at weir nodes which causes the downstream water depth, Y_2 , to exceed the upstream depth, Y_1 . All equations in the weir section remain the same except that Y_1 and Y_2 are switched so that Y_1 remains as the "upstream" head. Also, flow reversal of a sideflow weir causes it to behave more like a transverse weir and consequently the exponent as in equation 32 is set to 1.5

Weirs With Tide Gates

Frequently, weirs are installed together with a tide gate at points of overflow into the receiving waters. Flow across the weir is restricted by the tide gate, which may be partially closed at times. This is accounted for by reducing the effective driving head across the weir according to an empirical factor published by Armco(3):

$$h' = h - \frac{4}{g} v^2 \exp\left(\frac{-1.15v}{\sqrt{h}}\right) \quad (36)$$

where h is the previously computed head before correction for flap gate and v is the velocity of flow in the upstream conduit.

PUMP STATIONS

A pump station is conceptually represented as either an in-line lift station, or an off-line node representing a wet-well, from which the contents are pumped to another node in the system according to a programmed rule curve. For an in-line lift station, the pump rate is based on the water depth at the pump junction. The rule is as follows:

$$\begin{aligned} \text{Pump Rate} &= R_1 \quad \text{for } 0 < Y < Y_1 \\ &= R_2 \quad Y_1 < Y < Y_2 \\ &= R_3 \quad Y < Y_3 \end{aligned}$$

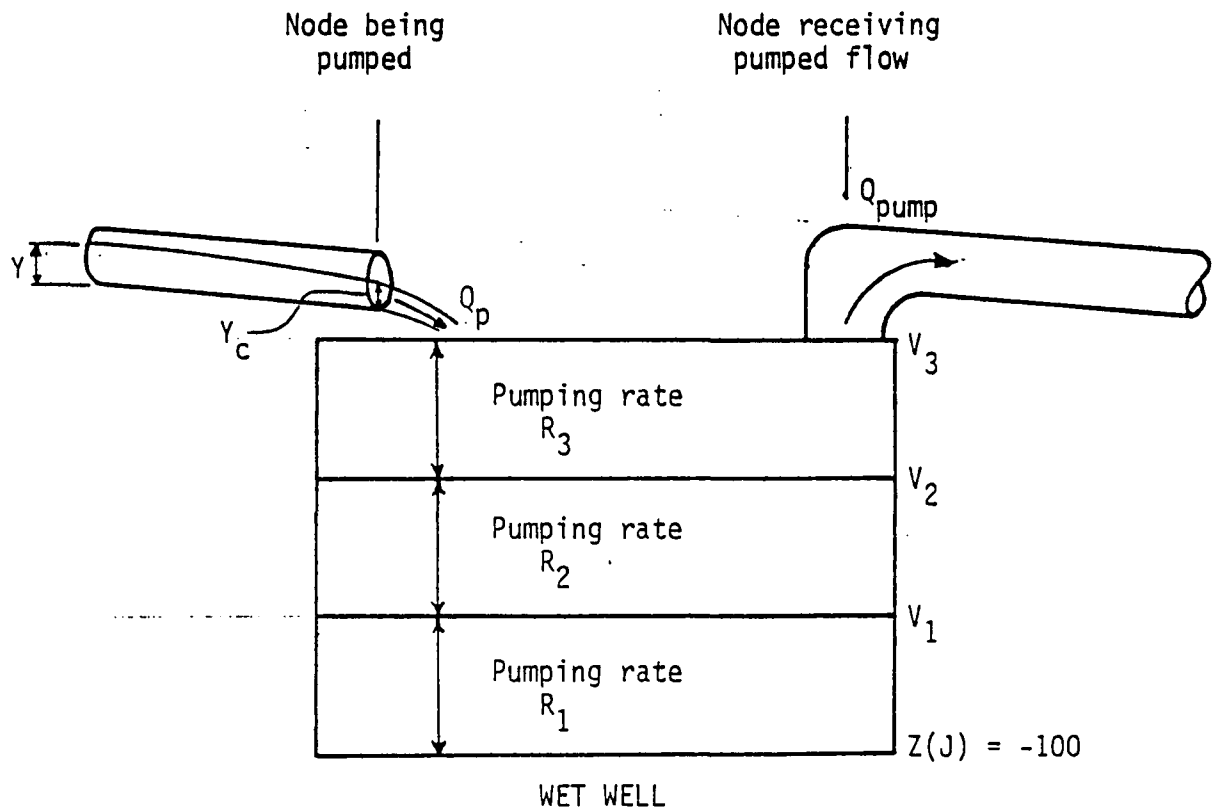
For $Y = 0$, the pump rate is the inflow rate to the pump junction.

Inflows to the off-line pump must be diverted from the main sewer system through an orifice, a weir, or a pipe. The influent to the wet-well node must be a free discharge regardless of the diversion structure. The pumping rule curve is based on the volume of water in the storage junction. A schematic presentation of the pump rule is shown in Figure 22. The rule operates as follows:

1. Up to three wet-well volumes are prespecified as input data for each pump station: $V_1 < V_2 < V_3$, where V_3 is the maximum capacity of the wet well.
2. Three pumping rates are prespecified as input data for each station. The pump rate is selected automatically by EXTRAN depending on the volume in the wet-well, as follows:

$$\begin{aligned} R_1 &\text{ for the volume in wet-well} < V_1 \\ R_2 &\text{ for } V_1 < \text{volume in wet-well} < V_2 \\ R_3 &\text{ for } V_2 < \text{volume in wet-well} < V_3 \end{aligned}$$

3. A mass balance of pumped outflow and inflow is performed in the wet-well during the model simulation period.
4. If the wet-well goes dry, the pump rate is reduced below rate R_1 until it just equals the inflow rate. When the inflow rate again equals or exceeds R_1 , the pumping rate goes back to operating on the rule curve.
5. If V_3 is exceeded in the wet-well, the inflow to the storage node is reduced until it does not exceed the maximum pumped flow. When the inflow falls below the maximum pumped flow, the inflow "gates" are opened. The program automatically steps down the pumping rate by the operating rule of (2) as inflows and wet-well volume decrease.



Pumping rate = R_1 for $V < V_1$
 = R_2 for $V_1 < V < V_2$
 = R_3 for $V_2 < V < V_3$

V is volume in wet well

Figure 22. Schematic Presentation of Pump Diversion.

OUTFALL STRUCTURES

EXTRAN simulates both weir outfalls and free outfalls. Either type may be protected by a tide gate. A weir outfall is a weir which discharges directly to the receiving waters according to relationships given previously in the weir section. The free outfall is simply an outfall conduit which discharges to a receiving water body under given backwater conditions. The free outfall may be truly "free" if the elevation of the receiving waters is low enough, or it may consist of a backwater condition. In the former case, the water surface at the free outfall is taken as critical or normal depth, whichever is less. If backwater exists, the receiving water elevation is taken as the water surface elevation at the free outfall.

When there is a tide gate on an outfall conduit, a check is made to see whether or not the hydraulic head at the upstream end of the outfall pipe exceeds that outside the gate. If it does not, the discharge through the outfall is equated to zero. If the driving head is positive, the water surface elevation at the outfall junction is set in the same manner as that for a free outfall subjected to a backwater condition.

CHAPTER 6

PROGRAM STRUCTURE OF EXTRAN

GENERAL

The EXTRAN Block is a set of computer subroutines which are organized to simulate the unsteady, gradually-varied movement of stormwater in a sewer network composed of conduits, pipe junctions, diversion structures, and free outfalls. A program flowchart for the major computation steps in the EXTRAN Block is presented in Figure 23. A full listing of the program, together with key variable definitions, is contained in Table A-3, Appendix A.

The EXTRAN Block contains 13 subroutines in addition to the main program which controls execution. The organization of each subroutine and its relation to the main program has been diagrammed in the master flowchart of Figure 24. A description of each subroutine follows in the paragraphs below.

SUBROUTINE EXTRAN

EXTRAN is the executive subroutine of the EXTRAN Block. It sets the unit numbers of the device containing the input data and the device where printed output will be directed. The device numbers of the input and output hydrograph tapes, if used, are also set here. Then the first two lines of the input hydrograph tape, if required, are read and this information is written on the output hydrograph tape, if used. Finally, subroutine TRANSX is called to perform the computations of the EXTRAN Block.

Presently, subroutine EXTRAN is set up to run the EXTRAN Block independently of the SWMM model. It can easily be changed to operate within SWMM by:

1. Removing the comment marks (C/////) from the first line of the program, leaving SUBROUTINE EXTRAN;
2. Changing the first executable line of the program from ISKIP=1 to ISKIP=0; and
3. Removing the comment marks (C/////) from the RETURN statement at the end of the subroutine.

SUBROUTINE TRANSX

TRANSX is the main controlling subprogram of the EXTRAN Block which drives all other subprograms and effectively controls the execution of EXTRAN as it has been presented graphically in the flowchart of Figure 23.

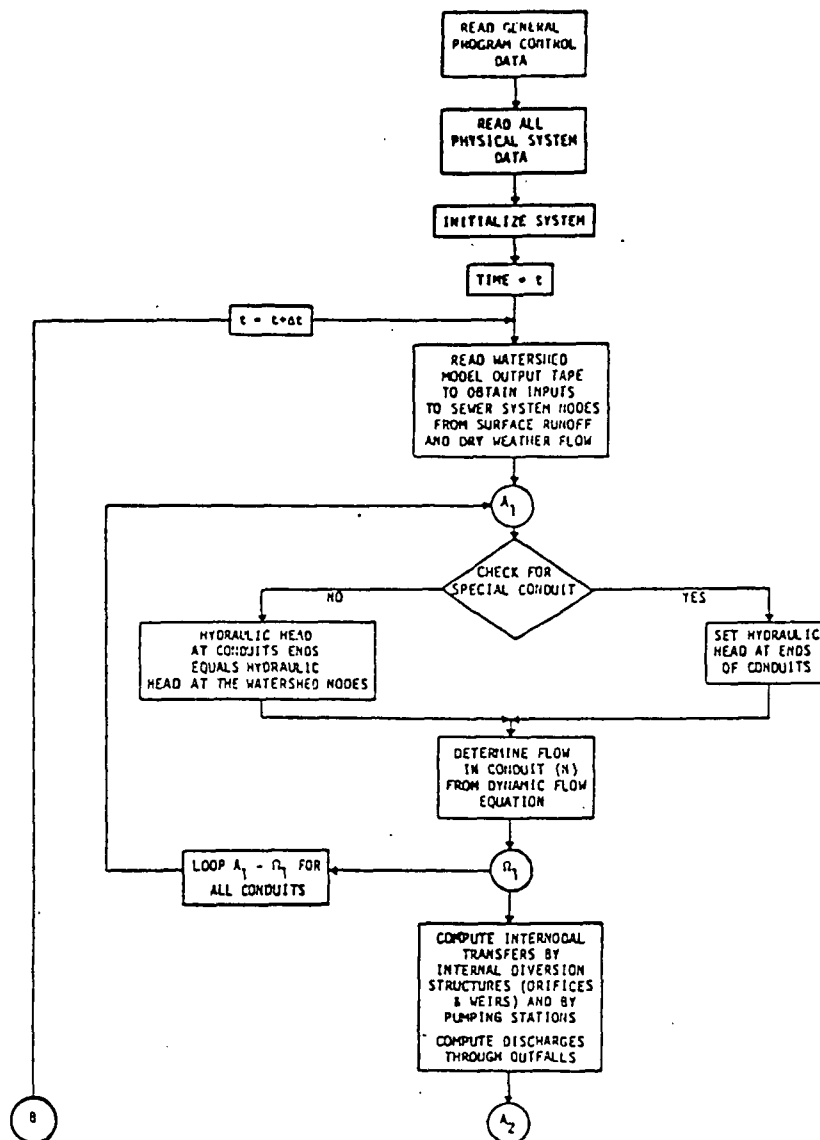


Figure 23. EXTRAN Block program flowchart

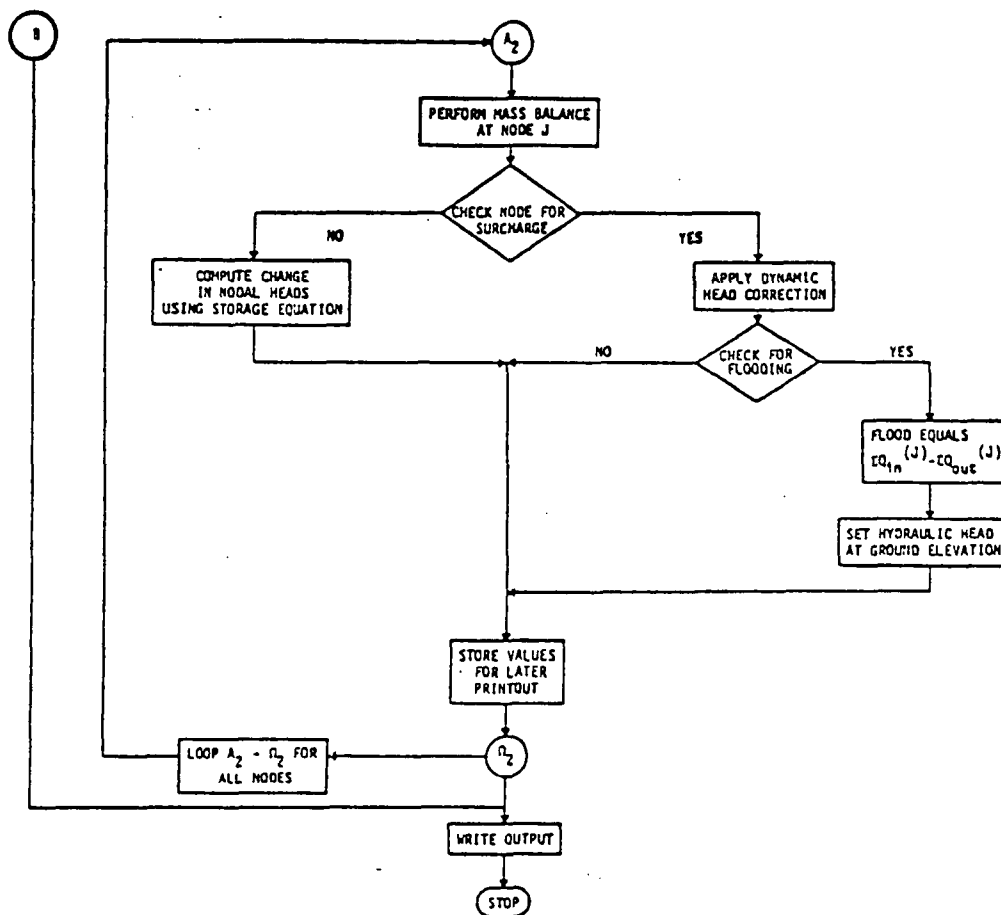


Figure 23. EXTRAN Block program flowchart
(Continued)

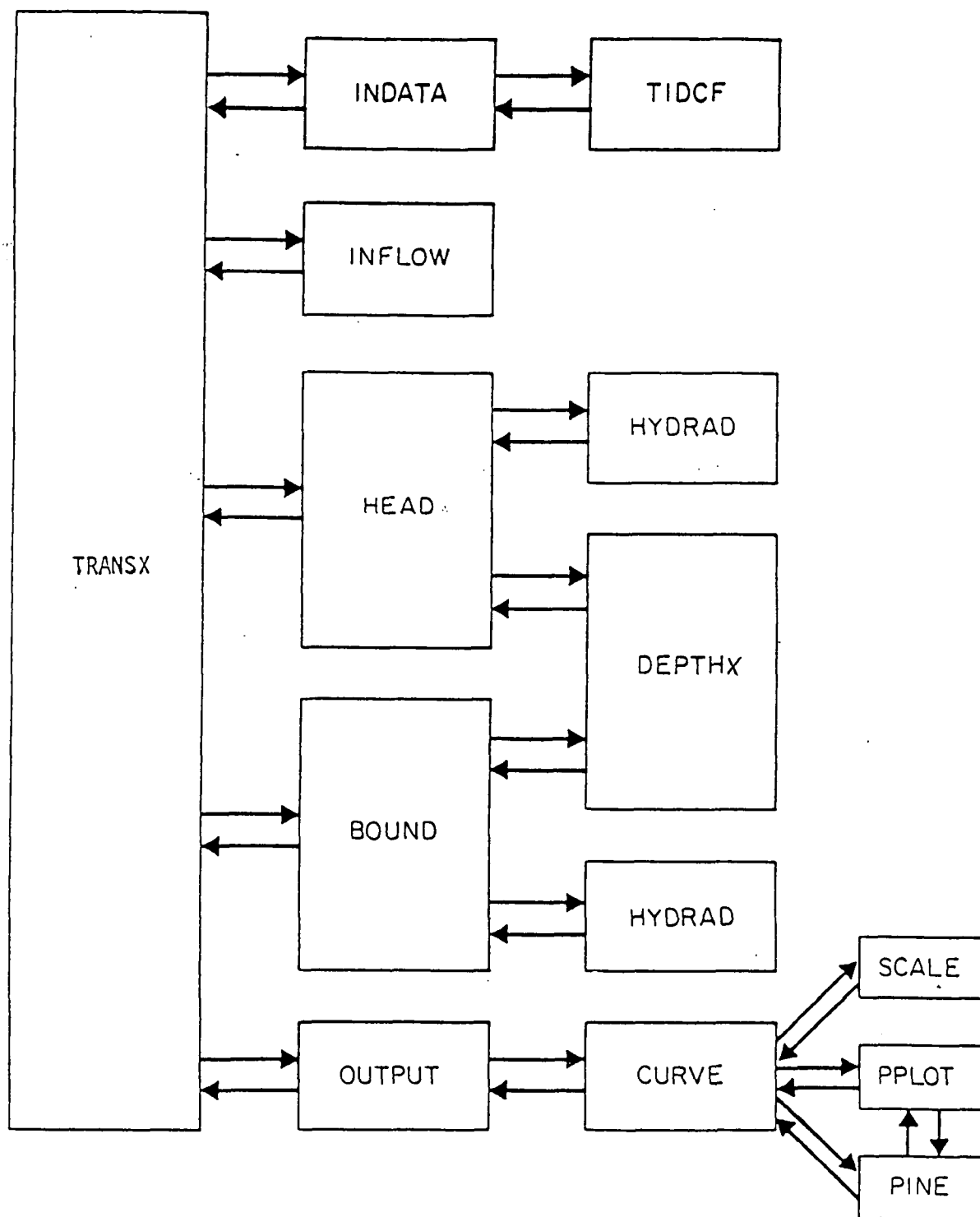


Figure 24. Master flowchart for the EXTRAN block.

Principal steps in TRANSX are outlined below in the order of their execution:

1. Call INDATA for reading all input data cards defining the length of the transport simulation run, the physical data for the transport system, and the instruction for output processing.
2. Initialize system flow properties and set time = TZERO.
3. Advance time = $t + \Delta t$ and begin main computation loop contained in steps 4 through 10 below.
4. Select current value of inflow hydrographs for all input nodes by call to INFLOW, which interpolates runoff hydrograph records either on tape unit N21 supplied by the RUNOFF Block or on data cards.
5. For all physical conduits in the system, compute the following time-changing properties based on the last full-step values of depth and flow:
 - Hydraulic head at each pipe end;
 - Full-step values of cross-sectional area, velocity, hydraulic radius, and surface area corresponding to preceding full-step flow. This is done by calling subroutine HEAD;
 - Half-step value of discharge at time $t = t + \Delta t / 2$ by modified Euler solution;
 - Check for normal flow, if appropriate;
 - Set system outflows and internal transfers at time $t + \Delta t / 2$ by call to subroutine BOUND. BOUND computes the half-step flow transfers at all orifices, weirs, and pumps at time $t = t + \Delta t / 2$. It also computes the current value of tidal stage and the half-step value of depth and discharge at all outfalls.
 - Average flow in all pipes connected to junctions in surcharge. A fraction of this value is used as the tolerance of the surcharge iteration loop.
6. For all physical junctions in the system, compute the half-step depth at time $t = t + \Delta t / 2$. This depth computation is based on the current net inflows to each node and the nodal surface areas computed previously in step 5. Check for surcharge and flooding at each node and compute water depth accordingly.

7. For all physical conduits, compute the following properties based on the last half-step values of depth and flow (repeat step 5 for time $t+\Delta t/2$):
 - Hydraulic head at each pipe end;
 - Half-step values of pipe cross-sectional area, velocity, hydraulic radius, and surface area corresponding to preceding half-step depth and discharge;
 - Full-step discharge at time $t+\Delta t$ by modified Euler solution;
 - Check for normal flow if appropriate;
 - Set system outflows and internal transfer at time $t+\Delta t$ by calling BOUND.
8. For all junctions, repeat the nodal head computation of step 6 for time $t+\Delta t$. Sum the differences between inflow and outflow for each junction in surcharge.
9. Repeat steps 7 and 8 for surcharged links and nodes until the sum of the flow differences from step 8 is less than the tolerance from step 5 or a maximum number of iterations is exceeded.
10. Store nodal water depths and water surface in junction print arrays to be used later by OUTPUT. Also, store conduit discharges and velocities for later printing. Print intermediate output.
11. Return to step 3 and repeat through step 10 until the transport simulation is complete for the entire period.
12. Call subroutine OUTPUT for printing and plotting of conduit flows and junction water surface elevations.

SUBROUTINE BOUND

The function of subroutine BOUND is to compute the half-step and full-step flow transfers by orifices, weirs, and pump stations. BOUND also computes the current level of receiving water backwater and determines discharge through system outfalls. A summary of principal calculations follows:

1. Compute current elevation of receiving water backwater. Depending on the tidal index, the backwater condition will be constant, tidal or below the system outfalls (effectively non-existent). The tidally varied backwater condition is computed by a Fourier series about a mean time equal to the first coefficient, A_1 .

2. Compute depth at orifice junction for sump orifice flowing less than full.
3. Compute discharge over transverse and sideflow weirs. Check for reverse flow, surcharge, and weir submergence. If weir is surcharged, compute flow by orifice-type equation. If weir is submerged, compute the submergence coefficient and re-compute weir flow. If a tide gate is present at weir node, then compute head loss, reduce driving head on weir and re-compute weir discharge.
4. Compute pump discharges based on current junction or wet-well level and corresponding pump rate. If wet-well is flooded, set pump rate at maximum level and reduce inflow.

SUBROUTINE DEPTH

Subroutine DEPTH computes the critical and normal depths corresponding to a given discharge using the critical flow and Manning uniform flow equations, respectively. Tables of normalized values for the cross-sectional area, hydraulic radius and surface width of each pipe class are taken from a Block Data element to speed the computations of critical and normal depth. Subroutine DEPTH is used by subroutines BOUND and HEAD.

SUBROUTINE HEAD

Subroutine HEAD is used to convert a nodal water depth to the depth of flow above the invert of a connecting pipe. Based on the depths of flow at each pipe end, HEAD computes the surface width and assigns surface area to the upstream and downstream node according to the following criteria:

1. For the normal situation in which both pipe inverts are submerged and the flow is sub-critical throughout the conduit, the surface area of that conduit is assigned equally to the two connecting junctions.
2. If a critical flow section is detected at the downstream end of a conduit, then surface area for that conduit is assigned to the upstream node.
3. If a critical section occurs at the upstream end, the conduit surface area is assigned to the downstream node.
4. For a dry pipe (pipe inverts unsubmerged), the surface area is zero. The velocity, cross-sectional area and hydraulic radius are set to zero for this case.
5. If the pipe is dry only at the upstream end, then all surface area for the conduit is assigned to the downstream junction.

Note that adverse flow in the absence of a critical section is treated as in (1) above. If a critical section occurs upstream, then all surface area for the adverse pipe is assigned downstream as in (3). The assignment of nodal surface area, based on the top width and length of conduit flow, is essential to the proper calculation of head changes computed at each node from mass continuity as discussed in Chapter 5. Following surface area assignment, HEAD computes the current weighted average values of cross-sectional area, flow velocity, and hydraulic radius for each pipe. Subroutine HEAD is called by program MAIN and it in turn uses subroutines DEPTH and HYDRAD in its surface area computations.

SUBROUTINE HYDRAD

The function of subroutine HYDRAD is to compute average values of hydraulic radius, cross-sectional area, and surface width for all conduits in the transport system. Based on the current water depth at the ends and midpoint of each conduit, HYDRAD computes from a table of normalized properties the current value of hydraulic radius, cross-sectional area, and surface width. HYDRAD is used by subroutine HEAD for computing nodal surface areas as described above. It is also called by BOUND for computing the cross-sectional area and average velocity of flow in the outfall pipe protected by a tide gate.

SUBROUTINE INDATA

INDATA is the principal input data subroutine for the EXTRAN Block which is used once at the beginning of subroutine TRANSX. Its primary function is to read all input data specifying the links, nodes, and special structures of the transport network. It also establishes transport system connectivity and sets up an internal numbering system for all transport elements by which the computations in TRANSX can be carried out. The principal operations of INDATA are listed below in the order they occur in the program:

1. Read first two title cards for output headings and run control card specifying the number of integration cycles, the length of the time-step, TZERO, and other parameters for output and run control.
2. Read external junction and conduit numbers for detailed printing and plotting of simulation output.
3. Read physical data for conduits and print a summary of all conduit data.
4. Read physical data for junctions and print summary of all junction data.
5. Set up internal numbering system for junctions and conduits and establish connectivity matrix. This matrix shows the connecting nodes at the end of each conduit and conversely the connecting links for each node in the transport system.

6. Read orifice input data and print summary. Assign internal link between orifice node and node to which it discharges.
7. Read weir input data and assign an internal link and node to each weir in the system. Print summary of all weir data.
8. Read pump data and assign an internal link number to each pump node. Print summary of all pumping input data. Set invert elevation and inflow index for pumped node.
9. Read free outfall data and print a data summary for outfalls. Assign an internal link for each free outfall in the internal numbering system.
10. Read tide-gated (non-weir) outfall data from cards and print a summary of tide gate data. Assign an internal link for each free outfall in the internal numbering system.
11. Print a summary of internal connectivity information showing the internal nodes and connecting links assigned to orifices, weirs, pumps, and free outfalls.
12. Read tidal boundary input data. Depending on the tidal index, one of the following four boundary conditions will exist:
 - No control water surface at the system outfalls;
 - All outfall control water surfaces at the same constant elevation, A1;
 - Tide coefficient read in by cards;
 - Tide coefficients A1 through A7 will be generated by TIDCF which are printed in subroutine TIDCF.

Print summary of tidal boundary input data, including the tide coefficients generated by TIDCF which are printed in subroutine TIDCF.
13. Set up print and plot arrays for output variables in the internal numbering system.
14. Initialize conduit conveyance factor in Manning equation. Also, read input data defining the initial conduit flows, velocities, and junction depths at TZERO corresponding to DWF or some antecedent flow condition.

15. Read in initial system information on tape unit N21 generated by the block immediately preceding the EXTRAN Block, usually the RUNOFF Block.
16. Read first two hydrograph records either from tape unit N21 or from data input cards.
17. Write out initial transport system information on tape unit N22 which will contain the hydraulic output from the EXTRAN Block supplied as input to any subsequent block.

SUBROUTINE INFLOW

Subroutine INFLOW is called from Subroutine TRANSX on each time-step to compute the current value of hydrograph inflow to each input node in the sewer system. INFLOW reads current values of hydrograph ordinates from tape unit N21 if the RUNOFF Block (or any other block) immediately precedes the EXTRAN Block, or from card input runoff hydrographs in cases where no other block is used as a pre-processor to EXTRAN. INFLOW performs a linear interpolation between hydrograph input points and computes the discharge at each input node at the half-step time, $t+\Delta t/2$.

SUBROUTINE TIDCF

Subroutine TIDCF is used on a one-time basis by subroutine INDATA to compute seven tide coefficients, A_1 through A_7 , which are used by subroutine BOUND to compute the current tide elevation according to the Fourier series:

$$\begin{aligned}
 H_{TIDE} = & A_1 + A_2 \sin \omega T + A_3 \sin 2\omega T \\
 & + A_4 \sin 3\omega T + A_5 \cos \omega T \\
 & + A_6 \cos 2\omega T + A_7 \cos 3\omega T
 \end{aligned}
 \tag{37}$$

where

T = current time in seconds
 ω = 2π radians/tidal period in seconds. The tidal period is 25 hours = 90,000 sec.

The coefficients A_2 through A_7 are developed by an interactive technique in TIDCF in which a sinusoidal series is fitted to the set of tidal stage-time points supplied as input data by subroutine INDATA.

SUBROUTINE OUTPUT

Subroutine OUTPUT is called by subroutine TRANSX at the end of the simulation run to print and plot the hydraulic output arrays generated by the EXTRAN Block. Printed output includes: 1) the water depths and water surface elevations at each junction, and 2) the discharge and flow velocity in each system conduit. The plotting of junction water surface elevation and conduit discharge is carried out by a printer-plot package labelled CURVE which is called by OUTPUT after printed output is complete.

SUBROUTINES CURVE, PINE, PPLOT, SCALE

The above subroutines form a general printer-plot package which is used in the EXTRAN Block to plot water surface elevation at selected nodes and conduit discharge in selected links. Subroutine CURVE is the executive program driving the other three subroutines of this package. CURVE is called at the conclusion of transport system simulation by OUTPUT. Inclusion of these subroutines in the EXTRAN Block allows EXTRAN to stand on its own as well as function with SWMM.

ENGLISH/METRIC CONVERSION FACTORS

All references in this manual, as well as all inputs to, outputs from, and calculations in the EXTRAN Block, are in English Units. The following conversion factors will allow the user to determine the equivalent Metric unit.

1 foot	=	0.3048 meters
1 square foot	=	0.0929 square meters
1 cubic foot	=	0.0283 cubic meters
1 foot/second	=	0.3048 meters/second
1 cubic foot/second	=	0.0283 cubic meters/seconds
1 inch	=	2.54 centimeters

REFERENCES

1. Shubinski, R. P., and L. A. Roesner. Linked Process Routing Models, paper presented at the Symposium on Models for Urban Hydrology, American Geophysical Union Meeting, Washington, D. C., 1973.
2. Kibler, D. F., J. R. Monser, and L. A. Roesner. San Francisco Stormwater Model, User's Manual and Program Documentation, prepared for the Division of Sanitary Engineering City and County of San Francisco, Water Resources Engineers, Walnut Creek, California, 1975.
3. Armco Water Control Gates, Armco Design Manual, Metal Products Division, Middletown, Ohio.

APPENDIX A

PROGRAM LISTING AND KEY VARIABLE DEFINITION

This Appendix is comprised of three tables. The first, Table A-1, consists of the Data Input Forms for EXTRAN. Each sheet represents one card group of the input data, as outlined in Table 1 of Chapter 2.

The second table, Table A-2, is a definition of the key variables in the EXTRAN Block. They are listed in the alphabetical order of the Common Blocks in which they are contained.

Finally, Table A-3 is a program listing of EXTRAN. The Executive Subroutine EXTRAN, which also doubles as the main program of EXTRAN when it is revised to stand alone from SWMM, is printed first. Subroutine TRANSX, which serves as the main controlling program of the EXTRAN Block, is printed next, followed by all other subprograms in alphabetical order.

TABLE A-1
DATA INPUT FORM
EXTRAN

133

[illegible]

NOTE: Card group 1 is only required if EXTRAN is to be run on its own.

Card Group 2 of 22: Title cards (2 cards)
Format: 20A4

ALPHA

Card Group 3 of 22: Run control card
Format: 15, 2F5.0, 8I5, F5.0

[illegible]

Card Group 4 of 22: Junction print control (8 junctions per card)
Format: 8110

[illegible]

137

[illegible]

Card Group 6 of 22: Junction plot control (8 junctions per card)
Format: 8110

[illegible]

Format: 8110

[illegible]

Format: 415, 9F5.0

NOTE: Last card must be 99999 in columns 1-5

[illegible]

Format: 15, 3F5.0

141

NOTE: Last card must be 99999 in columns 1-5

[illegible]

142

2: Orifice cards (1 card per orifice)
Format: 315, 3F5.0

[illegible]

NOTE: Last card must be 99999 in columns 1-5

144

[illegible]

NOTE: Last card must be 99999 in columns 1-5

Card Group 13 of 22: Pump cards (1 card per pump)
Format: 315, 7F5.0

[illegible]

NOTE: Last card must be 99999 in columns 1-5

[illegible]

NOTE: Last card must be 99999 in columns 1-5

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 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. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 84

1. $\frac{1}{2} \log 2$
 2. $\frac{1}{2} \log 2$
 3. $\frac{1}{2} \log 2$
 4. $\frac{1}{2} \log 2$

[illegible]

147

Card Group 16 of 22: Tide control card (1 card) Format: 15,8F5.0
Card Group 17 of 22: Tide computation card (1 card) Format: 315
Card Group 18 of 22: Tide stage card (4 points per card) Format: 8F10.0

[illegible]

1000

Format: 8F10.0

2 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|-----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 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 |
|---|---|---|---|---|---|---|---|---|-----|

No other cards required.

150

[illegible]

NOTE: If Q(1) is 99999, indicating zero flow, skip Card Group 19.

1. 1. 1. 1. 1.

Format: 1615

• • •

[illegible]

152

[illegible]

NOTE: If more than one card is required to list flows for all input nodes, QCARD(N) for all subsequent cards should begin in columns 1-10, 8 QCARD(N) per card.

TABLE A-2
DEFINITION OF KEY VARIABLES IN EXTRAN

| Variable Name | Description | Units |
|---------------|--|-------|
| COMMON/BD/ | | |
| | This common is used in the following subroutines
BLOCK DATA
BOUND
DEPTHX
HYDRAD
INDATA
TRANSX | |
| ANORM | Matrix of normalized wet cross-sectional area of
of conduit, based on shape and depth | |
| HRNORM | Matrix of normalized hydraulic radius of conduit,
based on shape and depth | |
| TWNORM | Matrix of normalized conduit width at flow line,
based on shape and depth | |
| COMMON/BND/ | | |
| | This common is used by the following subroutines
BOUND
INDATA
TRANSX | |
| JFREE | Node for free outfall | None |
| JGATE | Node for non-weir tide gate | None |
| JTIDE | Not used at this time | None |
| NFREE | Number of free outfalls | None |
| NGATE | Number of non-weir tide gates | None |
| NTIDE | Indicator for outfall tide level control
1. No water surface at outfall
2. Outfall control water surface at
constant elevation, A1
3. Tide coefficient provided
4. Program will compute tide coefficients | None |

TABLE A-2
(Continued)

DUPLICATE OF PAGE 158.
CORRECTION NOT YET AVAILABLE.

| Variable Name | Description | |
|---------------|---|------|
| YT | Depth of water at a node at half integration step | Fe |
| Z | Elevation of node invert | Feet |
| ZCROWN | Elevation of uppermost conduit crown at a node, defined as node crown elevation | Feet |

COMMON/LAB/

This common is used by the following subroutines

BLOCK DATA
CURVE
INDATA
OUTPUT
PINE
PPLOT

| | | |
|-------|------------------------------|------|
| HORIZ | Horizontal label of curve | None |
| TITLE | Title printed out on curve | None |
| VERT | Vertical label | None |
| XLAB | Numerical scale labels for X | None |
| YLAB | Numerical scale labels for Y | None |

COMMON/ORF/

This common is used by the following subroutines

BOUND
INDATA

| | | |
|-------|---------------------------------|-------------|
| AORIF | Cross-sectional area of orifice | Square Feet |
| CORIF | Orifice coefficient | None |
| LORIF | Internal orifice link number | None |
| NORIF | Number of orifices | None |

TABLE A-2
(Continued)

| Variable Name | Description | Units |
|--|--|---------------|
| NTC | Number of nodal links including internal links | None |
| NTCYC | Number of integration cycles | None |
| TIME | Time counter for hydrograph input | Seconds |
| TIME2 | TIME - DELT2 | Seconds |
| TZERO | Zero time for the simulation | Hours/Seconds |
| W | Fundamental frequency of daily tidal cycle | Rad Per Sec |
| COMMON/ELEV/ | | |
| This common is used in the following subroutines
OUTPUT
PINE
PLOT | | |
| IPLT | Plot control integer | None |
| ZCRN | Plot variable, highest crown elevation at a node | Feet |
| ZGRND | Plot variable, ground elevation | Feet |
| ZINVRT | Plot variable, node invert elevation | Feet |
| COMMON/FILES | | |
| This common is used in all subroutines of the
EXTRAN Block | | |
| IDATEZ | Date (yr-mo-da) on which the simulation begins | None |
| LOCNOS | Array containing junction numbers of any outflow point in the system | None |
| N5 | Input unit number | None |
| NLOCAT | Number of outflow junctions | None |
| NPOLL | Number of pollutants recorded on the input hydrograph tape N21 | None |

TABLE A-2
(Continued)

| Variable
Name | Description | Units |
|------------------|--|---------------|
| N6 | Output unit number | None |
| N21 | Unit number for input hydrograph tape generated
by preceding SWMM Block | None |
| N22 | Unit number for output hydrograph tape to be used
as input to subsequent SWMM Block | None |
| QCONV | Factor for converting flows on input hydrograph
tape to cfs | Vary |
| TRIBA | Tributary area drained by the system being simulated | Acres |
| | COMMON/HYFLOW/

This common is used in the following subroutines
INDATA
INFLOW
TRANSX | |
| ISW | Hydrograph input node number from tape | None |
| JSW | Hydrograph input node number from cards | None |
| NIREC | Counter for hydrograph input from tape | None |
| NSTEPS | Number of input records on input hydrograph file | None |
| QCARD | Rate of inflow, from cards | cfs |
| QTAPE | Rate of inflow, from tape | cfs |
| TE | Time of inflow for card input | Hours/Seconds |
| TE0 | Previous value of TE | Hours/Seconds |
| TIME0 | TE0 | Seconds |
| TP | TZERO | Seconds |
| T2 | Time of inflow for tape input | Seconds |

TABLE A-2
(Continued)

| Variable Name | Description | Units |
|---|---|-------------|
| T20 | Previous value of T2 | Seconds |
| WATSH | Not used at this time | None |
| COMMON/JUNC/ | | |
| This common is used in the following subroutines
BOUND
HEAD
INDATA
INFLOW
OUTPUT
TRANSX | | |
| AS | Surface area of a node | Square Feet |
| ASFULL | Surface area of a node when it enters surcharge | Square Feet |
| GRELEV | Ground elevation at a node | Feet |
| JSKIP | Internal integer control, to skip nodal head computation | None |
| JUN | External node number | None |
| NCHAN | Conduits connecting to a node | None |
| QIN | Flow into a node from an outside source | cfs |
| QINST | Dry weather flow into a node from an outside source | cfs |
| QOU | Flow from a node | cfs |
| SUMAL | Sum of $\partial Q(t)/\partial H_j$, for all pipes at node | Feet |
| SUMQ | Difference between the average inflow and outflow for a node over a time-step | cfs |
| SUMQS | Difference between the instantaneous inflow and outflow for a node | cfs |
| Y | Depth of water at a node at full integration step | Feet |

TABLE A-2
(Continued)

| Variable Name | Description | Units |
|--|---|-------------|
| YT | Depth of water at a node at half integration step | Feet |
| Z | Elevation of node invert | Feet |
| ZCROWN | Elevation of uppermost conduit crown at a node, defined as node crown elevation | Feet |
| COMMON/LAB/ | | |
| This common is used by the following subroutines | | |
| BLOCK DATA | | |
| CURVE | | |
| INDATA | | |
| OUTPUT | | |
| PINE | | |
| PLOT | | |
| HORIZ | Horizontal label of curve | None |
| TITLE | Title printed out on curve | None |
| VERT | Vertical label | None |
| XLAB | Numerical scale labels for X | None |
| YLAB | Numerical scale labels for Y | None |
| COMMON/ORF/ | | |
| This common is used by the following subroutines | | |
| BOUND | | |
| INDATA | | |
| AORIF | Cross-sectional area of orifice | Square Feet |
| CORIF | Orifice coefficient | None |
| LORIF | Internal orifice link number | None |
| NORIF | Number of orifices | None |

TABLE A-2
(Continued)

| Variable
Name | Description | Units |
|--|---|-------|
| COMMON/OUT/ | | |
| This common is used in the following subroutines
INDATA
OUTPUT
TRANSX | | |
| CRPT | Conduit numbers for detailed printing | None |
| ICOL | Not used at this time | None |
| IDUM | Dummy array | None |
| INTER | Number of integration cycles between print cycles | None |
| IPRT | Not used at this time | None |
| JPLT | Node numbers for plotting | None |
| JPRT | Node numbers for detailed printing | None |
| KPLT | Conduit numbers for plotting | None |
| LPLT | Number of conduits for detailed printing | None |
| LTIME | Counter for printed output | None |
| NHPRT | Number of nodes for detailed printing | None |
| NPLT | Number of nodes to be plotted | None |
| NPRT | Not used at the time | None |
| NPTOT | Total number of plot data points | None |
| NQPRT | Number of conduits for detailed printing | None |
| NSTART | First cycle where saved printing array will begin | None |
| PRGEL | Print matrix, ground elevation | Feet |
| PRTH | Print matrix, water surface elevation | Feet |

TABLE A-2
(Continued)

| Variable Name | Description | Units |
|--|--------------------------------------|-------------|
| PRTQ | Print matrix, flow | cfs |
| PRTV | Print matrix, velocity | fps |
| PRTY | Print matrix, water depth at node | Feet |
| QPLT | Matrix of flow values | cfs |
| TPLT | Time used for plotting | Hours |
| YPLT | Matrix of water surface elevations | Feet |
| COMMON/PIPE/ | | |
| This common is used by the following subroutines | | |
| BOUND | | |
| DEPTHX | | |
| HEAD | | |
| HYDRAD | | |
| INDATA | | |
| OUTPUT | | |
| TRANSX | | |
| A | Full-step wetted cross section | Square Feet |
| AFULL | Full cross-sectional area of conduit | Square Feet |
| AT | Half-step wetted cross section | Square Feet |
| DEEP | Vertical dimension of conduit | Feet |
| H | Depth of flow at conduit ends | Feet |
| LEN | Conduit length | Feet |
| NCOND | External conduit number | None |
| NKLASS | Conduit shape classification | None |
| | 1. circular | |
| | 2. rectangular | |
| | 3. horseshoe | |
| | 4. eggshape | |
| | 5. baskethandle | |

TABLE A-2
(Continued)

| Variable Name | Description | Units |
|---|--|------------|
| NJUNC | External nodes at each end of conduit | None |
| Q | Flow in conduit at full integration step | cfs |
| QO | Saved flow values at beginning of each integration step | cfs |
| QT | Flow in conduit at half integration step | cfs |
| RFULL | Hydraulic radius of conduit when full | Feet |
| ROUGH | Manning coefficient | |
| V | Velocity in conduit at the full integration step | fps |
| VT | Velocity in conduit at the half integration step | fps |
| WIDE | Width of conduit | Feet |
| ZP | Height of conduit invert above node invert | Feet |
| COMMON/PUMP/ | | |
| This common is used in the following subroutines
BOUND
INDATA | | |
| IPTYP | Type of pump
1 = Off-line pump - operates on wet-well volume
2 = In-line pump - operates on head at junction | None |
| JPFUL | Internal integer switch for full wet-well
0 = full
1 = not full | None |
| LPUMP | Internal pump linkage | None |
| NPUMP | Number of pumps | None |
| PRATE | Pumping rate | cfs |
| VRATE | Volume for changing pump rates | Cubic Feet |

TABLE A-2
(Continued)

| Variable Name | Description | Units |
|--|---|-------------|
| VWELL | Starting volume of pump wet-well, also current wet-well volume after pumping starts | Cubic Feet |
| COMMON/EXSTAT | | |
| This common is used in the following subroutine
OUTPUT
TRANSX | | |
| DEPMAX | Maximum depth reached at a junction | Feet |
| IDHR | Hour at which maximum depth reached | Hours |
| IDMIN | Minute at which maximum depth reached | Minutes |
| IQHR | Hour at which maximum flow reached | Hours |
| IQMIN | Minute at which maximum flow reached | Minutes |
| IVHR | Hour at which maximum velocity reached | Hours |
| IVMIN | Minute at which maximum velocity reached | Minutes |
| QMAXX | Maximum flow reached in a conduit | cfs |
| SUMQIN | Total system inflow volume during simulation | Cubic Feet |
| SURLEN | Period during which junction surcharged | Minutes |
| VLEFT | Volume left in the system at the end of the simulation | Cubic Feet |
| VMAXX | Maximum velocity reached in a conduit | Feet/Second |
| COMMON/STORE | | |
| This common is used in the following subroutines
INDATA
OUTPUT
TRANSX | | |
| ASTORE | Storage volume per foot of depth (storage facility surface area) | Square Feet |

TABLE A-2
(Continued)

| Variable Name | Description | Units |
|---|---|-------|
| JSTORE | Junction number containing storage facility | None |
| NSTORE | Number of storage facilities in system | None |
| ZTOP | Elevation of the top of the storage facility | Feet |
| COMMON/SURCHG | | |
| This common is used in the following routines
INDATA
TRANSX | | |
| ITMAX | Maximum number of iterations for surcharge computations | None |
| SURTOL | Fraction of surcharge flow used as tolerance on surcharge interactions | None |
| COMMON/TAPES | | |
| This common is passed from the SWMM executive program and is only used in subroutine EXTRAN in the EXTRAN Block | | |
| INCNT | Counter for the JIN array | None |
| IOUTCT | Counter for the JOUT array | None |
| JIN | Array containing input hydrograph tape unit numbers for all SWMM Blocks accessed during simulation | None |
| JOUT | Array containing output hydrograph tape unit numbers for all SWMM Blocks accessed during simulation | None |
| NSCRAT | Unit number of the scratch file | None |
| COMMON/TIDE/ | | |
| This common is used by the following subroutines
INDATA
TIDCF | | |
| AA | Tidal curve fit coefficients during least square process | None |

TABLE A-2
(Continued)

| Variable
Name | Description | Units |
|--|--|---------------|
| SXX | Matrix used by least square process | None |
| SXY | Vector used by least square process | None |
| TT | Clock time of tidal stage | Hours/Seconds |
| XX | Vector used in least square tide fit | None |
| YY | Stage of tidal input corresponding to TT | Feet |
| COMMON/TRAP/ | | |
| This common is used in the following subroutines
DEPTHX
HEAD
HYDRAD
INDATA
TRANSX | | |
| STHETA | Side slope 1 of a trapezoidal channel | None |
| SPHI | Side slope 2 of a trapezoidal channel | None |
| COMMON/WEIR/ | | |
| This common is used in the following subroutines
BOUND
INDATA | | |
| COEF | Coefficient of discharge for weir | None |
| COEFS | Coefficient of discharge for surcharged
condition computed internally | None |
| KWEIR | Type of weir
1. transverse
2. transverse with tide gate
3. sideflow
4. sideflow with tide gate | None |
| LWEIR | Internal link number for weir | None |

TABLE A-2
(Continued)

| Variable
Name | Description | Units |
|------------------|---|-------|
| NWEIR | Number of weirs | None |
| WLEN | Weir length | Feet |
| YCREST | Height of weir crest above node invert | Feet |
| YTOP | Distance of top of weir opening, above invert | Feet |

TABLE A-3
PROGRAM LISTING

```

00001 C/////SUBROUTINE EXTRAN
00002 C=====
00003 C
00004 C      EXTENDED TRANSPORT MODEL UPDATED APRIL, 1981
00005 C      BY
00006 C      CAMP DRESSER AND MCKEE INC.
00007 C      LARRY A. ROESNER
00008 C      ROBERT P. SHUBINSKI
00009 C      JOHN A. ALDRICH
00010 C
00011 C=====
00012 C      COMMON/TAPES/INCT,IOUTCT,JIN(10),JOUT(10),NSCRAT(5)
00013 C      COMMON/FILES/N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ
00014 C      1,LOCNOS(100),TRIBA
00015 C      DIMENSION TITLEZ(40)
00016 C      INTEGER IFNAM(3),OFNAM(3),IHFNM(3),INQTM(3)
00017 C
00018 C**** TO CHANGE THIS SECTION FROM THE MAIN PROGRAM OF EXTRAN STANDING
00019 C      ALONE TO SUBROUTINE EXTRAN OF EPA SWMM:
00020 C      1. REMOVE C///// FROM FIRST LINE (SUBROUTINE EXTRAN)
00021 C      2. SET ISKIP=0 IN THE NEXT EXECUTABLE LINE BELOW
00022 C      3. REMOVE C///// FROM RETURN STATEMENT AT END OF SUBROUTINE
00023 C
00024 C      ISKIP=1
00025 C      IF(ISKIP) 10,10,20
00026 C///// EPA SWMM I/O CONTROL ///////////////
00027 C**** SET UP TRANSFER TAPES
00028 C      10 INCT=INCT+1
00029 C      IOUTCT=IOUTCT+1
00030 C      N21=JIN(INCT)
00031 C      N22=JOUT(IOUTCT)
00032 C      N5=5
00033 C      N6=6
00034 C      GO TO 30
00035 C////////////////////////////////////
00036 C
00037 C///// DEC20 I/O CONTROL ///////////////
00038 C      EXTRAN STAND ALONE
00039 C
00040 C***** SET UP TRANSFER TAPES
00041 C      20 CONTINUE
00042 C      N5=20
00043 C      N6=21
00044 C      WRITE(5,103)
00045 C      103 FORMAT(1X,'ENTER INPUT FILE SPECIFICATIONS:',$)
00046 C      READ(5,101) IFNAM
00047 C      101 FORMAT(3A5)
00048 C      WRITE(5,102)
00049 C      102 FORMAT(1X,'ENTER OUTPUT FILE SPECIFICATIONS:',$)
00050 C      READ(5,101) OFNAM
00051 C      OPEN(UNIT=N5,DEVICE='DSK',ACCESS='SEQIN',DIALOG=IFNAM)
00052 C      OPEN(UNIT=N6,DEVICE='DSK',ACCESS='SEQOUT',DIALOG=OFNAM)
00053 C
00054 C      READ(N5,1000) N21,N22
00055 C      1000 FORMAT(2I5)
00056 C      IF(N21.LE.0)GO TO 110

```

```

00057      WRITE(5,109)
00058      109 FORMAT(1X,'ENTER INPUT HYDROGRAPH FILE SPECIFICATIONS:',$)
00059      READ(5,101)IHFNM
00060      OPEN(UNIT=N21,DEVICE='DSK',ACCESS='SEQIN',DIALOG=IHFNM)
00061      REWIND N21
00062      110 IF(N22.LE.0)GO TO 30
00063      WRITE(5,111)
00064      111 FORMAT(1X,'ENTER FILE SPECS FOR SYSTEM INFORMATION INPUT',
00065      1' TO RECEIVING WATER MODEL:',$)
00066      READ(5,101)INQTM
00067      OPEN(UNIT=N22,DEVICE='DSK',ACCESS='SEQOUT',DIALOG=INQTM)
00068      REWIND N22
00069      C/////////////////////////////////////////////////////////////////
00070      C
00071      C**** READ FIRST TWO LINES OF INPUT HYDROGRAPH FILE AND WRITE TO
00072      C**** RECEIVING WATER MODEL FILE
00073      30 IF(N21) 50,50,40
00074      40 READ(N21)(TITLEZ(I),I=1,40)
00075      READ(N21)IDATEZ,TZERO
00076      50 IF(N22) 70,70,60
00077      60 WRITE(N22)(TITLEZ(I),I=1,40)
00078      WRITE(N22) IDATEZ,TZERO
00079      C
00080      70 IF(ISKIP.EQ.0)WRITE(N5,100)
00081      100 FORMAT(/,T2,'ENTRY MADE TO EXTENDED TRANSPORT MODEL',
00082      1//,T2,'UPDATED BY CAMP DRESSER AND MCKEE INC APR. 1981')
00083      CALL TRANSX
00084      IF(ISKIP.EQ.0) WRITE(N6,150)
00085      150 FORMAT(/,T11,'* * * * * EXTENDED TRANSPORT MODEL SIMULATION',
00086      1' ENDED * * * * *',//)
00087      C/////RETURN
00088      C
00089      END

```

```

00001 C
00002 SUBROUTINE TRANSX
00003 C THIS IS SUBROUTINE TRANSX OF THE SEWER MODEL
00004 C IT DRIVES ALL OTHER SUBPROGRAMS AND PERFORMS THE
00005 C MODIFIED EULER SOLUTION OF THE MOTION
00006 C AND CONTINUITY EQUATIONS
00007 C
00008 COMMON /BD/ANORM(26,5),HRNORM(26,5),TWNORM(26,5)
00009 COMMON/BND/ NFREE,JFREE(25),NTIDE,JTIDE(25),NGATE,JGATE(25)
00010 C
00011 C
00012 COMMON/HYFLOW/ ISW(187),QTAPE(187,2),JSW(65),QCARD(65,2),
00013 1 WATSH(187),TE0,TP,T2,TE,T20,TIME0,NSTEPS,NINREC
00014 COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00015 1TRIBA
00016 COMMON/CONTR/ NTCYC,DELTA,DELT,DELT2,TZERO,ALPHA(40),
00017 1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00018 COMMON/JUNC/Y(187),YT(187),NCHAN(187,8),AS(187),Z(187),QIN(187),
00019 1 QOU(187),QINST(187),GRELEV(187),JUN(187),ZCROWN(187),JSKIP(187)
00020 2 ,SUMAL(187),SUMQ(187),SUMQS(187),ASFULL(187)
00021 C
00022 COMMON/PIPE/LEN(187),NJUNC(187,2),AFULL(187),AT(187),
00023 1 Q(187),V(187),VT(187),DEEP(187),A(187),WIDE(187),RFULL(187),
00024 2 NKCLASS(187),ZP(187,2),QT(187),QO(187),H(187,2),NCOND(187),
00025 3 ROUGH(187)
00026 COMMON/TRAP/STHETA(200),SPHI(200)
00027 C
00028 COMMON/STORE/ NSTORE,JSTORE(20),ZTOP(20),ASTORE(20)
00029 C
00030 REAL LEN
00031 C
00032 COMMON/OUT/ NPRT,IPRT,NHPRT,JPRT(20),PRTH(100,20),PRGEL(20),
00033 1 NQPRT,CPRT(20),PRTV(100,20),PRTQ(100,20),IDUM(12),ICOL(10),
00034 2 LTIME,NPLT,JPLT(20),YPLT(102,20),LPLT,KPLT(20),QPLT(102,20),
00035 3 TPLT(102),NPTOT,NSTART,INTER,PRTY(100,20)
00036 COMMON/STATS/VMAXX(187),QMAXX(187),DEPMAX(187),IVHR(187),
00037 2IVMIN(187),IQHR(187),IQMIN(187),IDHR(187),IDMIN(187),SURLN(187),
00038 3SUMQIN,VLEFT
00039 COMMON/SURCHG/SURTOL,ITMAX
00040 INTEGER CPRT
00041 DIMENSION ICHECK(187),JCHECK(187),IND(2),ROUT(100)
00042 DATA IND/1H ,1H*/
00043 C
00044 C
00045 C
00046 C
00047 COUNT=0.0
00048 NDIM=187
00049 DO 5 N=1,NDIM
00050 ICHECK(N)=IND(1)
00051 DO 5 M=1,8
00052 5 NCHAN(N,M)=0
00053 C
00054 C***** INPUT DATA
00055 CALL INDATA
00056 C

```

```
00057 C***** INITIALIZATION
00058     ICYC=0
00059     LTIME=0
00060     NPTOT=0
00061     NERROR=0
00062     TIME=TZERO
00063     IDATE=IDATEZ
00064     TIMDAY=TZERO/3600.
00065     DO 901 N=1,NC
00066         VMAXX(N)=0.0
00067         QMAXX(N)=0.0
00068         IVHR(N)=0
00069         IVMIN(N)=0
00070         IQHR(N)=0
00071         IQMIN(N)=0
00072 901    CONTINUE
00073         SUMQIN = 0.
00074         VLEFT = 0.
00075         DO 911 J=1,NJ
00076             SUMQS(J)=0.
00077             JCHECK(J)=IND(1)
00078             SURLN(J)=0.0
00079             DEPMAX(J)=0.0
00080             IDHR(J)=0
00081             IDMIN(J)=0
00082             QQU(J) = 0.
00083 911    CONTINUE
00084 C
00085 C ***** INITIALIZATION FOR DRY WEATHER FLOWS
00086 C     IS NOW DONE IN INDATA (BEFORE READING INFLOW HYDROGRAPHS)
00087 C
00088 C
00089     DO 20 N=1,NTL
00090         QT(N)=Q(N)
00091         AT(N)=0.
00092         IF(N.GT.NTC.OR.QT(N).EQ.0.) GO TO 20
00093         NL=NJUNC(N,1)
00094         NH=NJUNC(N,2)
00095         HNL=Y(NL)+Z(NL)
00096         HNH=Y(NH)+Z(NH)
```

```

00097      CALL HEAD(N,NL,NH,HNL,HNH,QT(N),AT(N),VT(N),HRAD,ANL,ANH,RNL,TZERO
00098      ,1)

00099      20 CONTINUE
00100      DO 30 J=1,NJ
00101      YT(J)=Y(J)
00102      30 CONTINUE
00103      C
00104      C***** MAJOR PROGRAM LOOP THROUGH TIME
00105      MP=(NTCYC+99)/100
00106      DO 760 MCY=1,NTCYC,MP
00107      NPTOT=NPTOT+1
00108      DO 640 MCYY=1,MP
00109      TIME=TIME+DELT
00110      TIME2=TIME-DELT2
00111      TIMDAY=TIMDAY+DELT/3600.
00112      IF(TIMDAY-24.) 34,32,32
00113      32 TIMDAY=TIMDAY-24.
00114      IDATE=IDATE+1
00115      34 ICYC=ICYC+1
00116      ERROR=0.
00117      IT=0
00118      TOL=1.
00119      NSUR=1
00120      C
00121      C***** SELECT INPUT HYDROGRAPHS
00122      CALL INFLOW
00123      C
00124      C***** STORE OLD FLOW VALUES
00125      DO 60 N=1,NTL
00126      60 QO(N)=Q(N)
00127      C
00128      C***** INITIALIZE CONTINUITY PARAMETERS
00129      DO 80 J=1,NJ
00130      AS(J)=0.
00131      SUMQ(J)=QIN(J)
00132      SUMQS(J)=QIN(J)
00133      80 SUMAL(J)=0.
00134      C
00135      C***** FULL-STEP AREA, RADIUS : VELOCITY
00136      C***** HALF-STEP FLOW
00137      90 DO 120 N=1,NTC
00138      NL=NJUNC(N,1)
00139      NH=NJUNC(N,2)
00140      H(N,1)=Y(NL)+Z(NL)
00141      H(N,2)=Y(NH)+Z(NH)
00142      CALL HEAD(N,NL,NH,H(N,1),H(N,2),Q(N),A(N),V(N),HRAD,ANH,ANL,RNL,
00143      1TIME,ICYC)

00144      DELQ4=+DELT2*V(N)**2*(ANH-ANL)/LEN(N)
00145      DELQ3=2.*V(N)*(A(N)-AT(N))
00146      DELQ2=-(DELT2*32.2*(H(N,2)-H(N,1))/LEN(N))*A(N)
00147      QNEW=QO(N)+DELQ2+DELQ3+DELQ4
00148      AKON=-DELT2*(ROUGH(N)/HRAD**1.33333)*ABS(V(N))
00149      DELQ1=AKON*QNEW/(1.-AKON)
00150      QT(N)=QNEW+DELQ1

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```

00151 C***** CHECK FOR NORMAL FLOW
00152 IF(H(N,1) .GT. ZCROWN(NL)) GO TO 101
00153 DELH=H(N,1)-H(N,2)
00154 DELZP=ZP(N,1)-ZP(N,2)
00155 IF(QT(N).LE.0.) GO TO 101
00156 IF(DELH-DELZP) 100,101,101
00157 100 QNORM=SQRT(32.2*(ZP(N,1)-ZP(N,2))/(LEN(N)*ROUGH(N)))
00158 1 *ANL*RNL**0.6667
00159 IF(QNORM.GT.QT(N)) GO TO 101
00160 QT(N)=QNORM
00161 C***** COMPUTE CONTINUITY PARAMETERS
00162 101 DQDH=1./(1.-AKON)*32.2*DELT2*A(N)/LEN(N)
00163 SUMQ(NL)=SUMQ(NL)-0.5*(QT(N)+QO(N))
00164 SUMQS(NL)=SUMQS(NL)-QT(N)
00165 SUMAL(NL)=SUMAL(NL)+DQDH
00166 SUMQ(NH)=SUMQ(NH)+0.5*(QT(N)+QO(N))
00167 SUMQS(NH)=SUMQS(NH)+QT(N)
00168 SUMAL(NH)=SUMAL(NH)+DQDH
00169 120 CONTINUE
00170 C
00171 C***** SET HALF STEP OUTFLOWS AND INTERNAL TRANSFERS
00172 CALL BOUND(Y,YT,QT,TIME2,DELT2,IT)
00173 N1=NTC+1
00174 DO 130 N=N1,NTL
00175 NL=NJUNC(N,1)
00176 SUMQ(NL)=SUMQ(NL)-0.5*(QT(N)+QO(N))
00177 SUMQS(NL)=SUMQS(NL)-QT(N)
00178 NH=NJUNC(N,2)
00179 IF(NH.EQ.0)GO TO 130
00180 SUMQ(NH)=SUMQ(NH)+0.5*(QT(N)+QO(N))
00181 SUMQS(NH)=SUMQS(NH)+QT(N)
00182 130 CONTINUE
00183 C
00184 C***** HALF-STEP HEAD
00185 DO 320 J=1,NJ
00186 IF(JSKIP(J)) 140,140,300
00187 140 IF(AS(J).GT.0.0 .OR. Y(J).GE.(ZCROWN(J)-Z(J))) GO TO 135
00188 IF(NERROR.LE.10) WRITE(N6,2400) ICYC,JUN(J)
00189 2400 FORMAT(' ***** WARNING ***** ICYC=',I5,' ZERO SURFACE AREA COMPUT
00190 ED AT JUNCTION',I6,' CHECK INPUT DATA FOR HIGH PIPE ')
00191 NERROR=NERROR+1
00192 YT(J)=0.0
00193 GO TO 300
00194 135 CONTINUE
00195 YCROWN=0.96*(ZCROWN(J)-Z(J))
00196 IF(Y(J)-YCROWN) 240,240,260
00197 C
00198 C***** COMPUTE YT FOR FREE SURFACE JUNCTIONS
00199 240 YT(J)=Y(J)+SUMQ(J)*DELT2/AS(J)
00200 IF(YT(J).LT.0.) YT(J)=0.
00201 C***** WHEN JUNCTION SURCHARGES, 'ASFULL' WILL BE THE LAST
00202 C VALUE OF 'AS' UNDER FREE SURFACE FLOW
00203 ASFULL(J) = AS(J)
00204 GO TO 300
00205 C
00206 C***** ADJUST HEAD AT SURCHARGED JUNCTIONS

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00207 C.....APPLY 1/2 OF COMPUTED CORRECTION
00208 260 DENOM=SUMAL(J)
00209 IF(Y(J).LT.1.25*YCROWN) DENOM=SUMAL(J)+(ASFULL(J)/DELT2-SUMAL(J))
00210 , *EXP(-15.*(Y(J)-YCROWN)/YCROWN)
00211 CORR=0.50
00212 C**** DECREASE THE HEAD CORRECTION FACTOR FOR UPSTREAM TERMINAL JUNCTIONS
00213 IF(NCHAN(J,2).EQ.0) CORR=0.30
00214 YT(J)=Y(J)+CORR*SUMQS(J)/DENOM
00215 IF((YT(J)+Z(J)).GT.GRELEV(J)) YT(J)=GRELEV(J)-Z(J)
00216 IF(YT(J).LT.YCROWN) YT(J)=YCROWN-0.001
00217 C**** COMPUTE THE CONVERGENCE CRITERIA FOR FLOW ERRORS IN SURCHARGED AREAS
00218 QAVE=0.
00219 DO 280 K=1,8
00220 IF(NCHAN(J,K)) 290,290,280
00221 280 QAVE=QAVE+ABS(Q(NCHAN(J,K)))
00222 290 K=K-1
00223 QAVE=SURTOL*QAVE/K
00224 TOL=(TOL*(NSUR-1)+QAVE)/NSUR
00225 NSUR=NSUR+1
00226 C
00227 C***** INITIALIZE FOR FULL STEP FLOWS
00228 300 AS(J)=0.
00229 SUMQ(J)=QIN(J)
00230 SUMQS(J)=QIN(J)
00231 SUMAL(J)=0.
00232 320 CONTINUE
00233 C
00234 C***** HALF-STEP AREA, RADIUS : VELOCITY
00235 C***** FULL-STEP FLOW
00236 330 ERROR=0.
00237 DO 360 N=1,NTC
00238 NL=NJUNC(N,1)
00239 NH=NJUNC(N,2)
00240 C**** CHECK WHETHER SURCHARGE ITERATIONS OCCURRING
00241 IF(IT) 335,335,333
00242 333 IF(JCHECK(NH).EQ.IND(2)) GO TO 335
00243 IF(JCHECK(NL).NE.IND(2)) GO TO 360
00244 335 H(N,1)=YT(NL)+Z(NL)
00245 H(N,2)=YT(NH)+Z(NH)
00246 CALL HEAD(N,NL,NH,H(N,1),H(N,2),QT(N),AT(N),VT(N),HRAD,ANH,ANL,
00247 1RNL,TIME,ICYC)

00248 DELQ4=+DELT*VT(N)**2*(ANH-ANL)/LEN(N)
00249 DELQ3=4.*VT(N)*(AT(N)-A(N))
00250 DELQ2=-(DELT*32.2*(H(N,2)-H(N,1))/LEN(N))*AT(N)
00251 QNEW=QO(N)+DELQ2+DELQ3+DELQ4
00252 AKON=-DELT*(ROUGH(N)/HRAD**1.33333)*ABS(VT(N))
00253 DELQ1=AKON*QNEW/(1.-AKON)
00254 Q(N)=QNEW+DELQ1
00255 C***** DO NOT ALLOW A FLOW REVERSAL IN ONE TIME STEP
00256 DIRQT=SIGN(1.,QT(N))
00257 DIRQ=SIGN(1.,Q(N))
00258 IF(DIRQT/DIRQ.LT.0.) Q(N)=0.001*DIRQ
00259 C***** CHECK FOR NORMAL FLOW
00260 ICHECK(N)=IND(1)
00261 IF(H(N,1).GT.ZCROWN(NL)) GO TO 341

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00262      DELH=H(N,1)-H(N,2)
00263      DELZP=ZP(N,1)-ZP(N,2)
00264      IF(Q(N).LE.0.) GO TO 341
00265      IF(DELH-DELZP) 340,341,341
00266      340 QNORM=SQRT(32.2*(ZP(N,1)-ZP(N,2))/(LEN(N)*ROUGH(N)))
00267      1 *ANL*RNL**0.6667
00268      IF(QNORM.GT.Q(N)) GO TO 341
00269      ICHECK(N)=IND(2)
00270      Q(N)=QNORM
00271      C***** COMPUTE CONTINUITY PARAMETERS
00272      341 DQDH=1./(1.-AKON)*32.2*DELT*AT(N)/LEN(N)
00273      SUMQ(NL)=SUMQ(NL)-0.5*(Q(N)+QO(N))
00274      SUMQS(NL)=SUMQS(NL)-Q(N)
00275      SUMAL(NL)=SUMAL(NL)+DQDH
00276      SUMQ(NH)=SUMQ(NH)+0.5*(Q(N)+QO(N))
00277      SUMQS(NH)=SUMQS(NH)+Q(N)
00278      SUMAL(NH)=SUMAL(NH)+DQDH
00279      360 CONTINUE
00280      C
00281      C***** SET FULL STEP OUTFLOWS AND INTERNAL TRANSFERS
00282      CALL BOUND(YT,Y,Q,TIME,DELT,IT)
00283      N1=NTC+1
00284      DO 370 N=N1,NTL
00285      C***** DO NOT ALLOW FLOW REVERSAL IN ONE TIME STEP
00286      DIRQ=SIGN(1.,QT(N))
00287      DIRQ=SIGN(1.,Q(N))
00288      IF(DIRQ/DIRQ.LT.0.) Q(N)=0.001*DIRQ
00289      NL=NJUNC(N,1)
00290      SUMQ(NL)=SUMQ(NL)-0.5*(Q(N)+QO(N))
00291      SUMQS(NL)=SUMQS(NL)-Q(N)
00292      NH=NJUNC(N,2)
00293      IF(NH.EQ.0)GO TO 370
00294      SUMQ(NH)=SUMQ(NH)+0.5*(Q(N)+QO(N))
00295      SUMQS(NH)=SUMQS(NH)+Q(N)
00296      370 CONTINUE
00297      C
00298      C***** FULL-STEP HEAD
00299      DO 560 J=1,NJ
00300      IF(JSKIP(J)) 380,380,560
00301      380 IF(AS(J).GT.0.0 .OR. YT(J).GE.(ZCROWN(J)-Z(J))) GO TO 375
00302      IF(NERROR.LE.10) WRITE(N6,2400) ICYC,JUN(J)
00303      NERROR=NERROR+1
00304      Y(J)=0.0
00305      GO TO 560
00306      375 CONTINUE
00307      YCROWN=0.96*(ZCROWN(J)-Z(J))
00308      IF(YT(J)-YCROWN) 480,480,500
00309      C
00310      C**** CHECK WHETHER SURCHARGE ITERATIONS OCCURRING
00311      480 IF(IT) 490,490,560
00312      C
00313      C***** COMPUTE Y FOR FREE SURFACE JUNCTIONS
00314      490 Y(J)=Y(J)+SUMQ(J)*DELT/AS(J)
00315      JCHECK(J)=IND(1)
00316      IF(Y(J).LT.0.) Y(J)=0.
00317      C***** AT INCIPIENT SURCHARGE, 'AS(J)' WILL BE THE ACTUAL

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00318 C          VALUE OF 'ASFULL'
00319         ASFULL(J) = AS(J)
00320         GO TO 560
00321 C
00322 C***** ADJUST HEAD AT SURCHARGED JUNCTIONS
00323 C.....APPLY 1/2 OF COMPUTED CORRECTION
00324     500 DENOM=SUMAL(J)
00325         IF(YT(J).LT.1.25*YCROWN) DENOM=SUMAL(J)+(ASFULL(J)/DELT-SUMAL(J))
00326         *EXP(-15.*(YT(J)-YCROWN)/YCROWN)
00327         CORR=1.00
00328 C**** DECREASE THE HEAD CORRECTION FACTOR FOR UPSTREAM TERMINAL JUNCTIONS
00329         IF(NCHAN(J,2).EQ.0) CORR=0.60
00330         Y(J)=YT(J)+CORR*SUMQS(J)/DENOM
00331         IF((Y(J)+Z(J)).GT.GRELEV(J)) Y(J)=GRELEV(J)-Z(J)
00332         IF(Y(J).LT.YCROWN) Y(J)=YCROWN-0.001
00333         JCHECK(J)=IND(2)
00334 C**** COMPUTE SURCHARGE FLOW ERROR IN JUNCTIONS NOT FLOODED
00335         IF((Y(J)+Z(J)).LT.GRELEV(J)) ERROR=ERROR+SUMQS(J)
00336     560 CONTINUE
00337 C**** CHECK CONVERGENCE OF THE FLOW ERROR IN SURCHARGED AREAS
00338         IF(ABS(ERROR)-TOL) 565,565,561
00339     561 IT=IT+1
00340         IF(IT-30)562,562,564
00341 C**** INITIALIZE FOR NEXT ITERATION
00342     562 DO 563 J=1,NJ
00343         IF(JCHECK(J).EQ.IND(1)) GO TO 563
00344         YT(J)=Y(J)
00345         SUMQ(J)=QIN(J)
00346         SUMQS(J)=QIN(J)
00347         SUMAL(J)=0.
00348     563 CONTINUE
00349         GO TO 330
00350     564 IT=IT-1
00351 C
00352 C***** COMPUTE CONTINUITY PARAMETERS
00353 C
00354     565 DO 950 J=1,NJ
00355         SUMQIN = SUMQIN + QIN(J)*DELT
00356         IF(Y(J).EQ.GRELEV(J)-Z(J)) QOU(J)=QOU(J)+SUMQS(J)*DELT
00357     950 CONTINUE
00358         NL = NTC + 1
00359 C***** SYSTEM OUTFLOWS
00360         I=0
00361         DO 960 N=NL,NTL
00362             J=NJUNC(N,1)
00363             IF(NJUNC(N,2).NE.0) GO TO 960
00364             QOU(J)=QOU(J)+Q(N)*DELT
00365             I=I+1
00366             QOUT(I)=Q(N)
00367     960 CONTINUE
00368 C
00369 C***** WRITE HYDRAULIC DATA FOR INPUT TO QUALITY TRANSPORT MODEL
00370         DUM=0.
00371         NHOURL=TIME/3600.
00372         IF(N22.GT.0) WRITE(N22) NHOURL,IDATE,TIMDAY,
00373                               (QOUT(N),DUM,N=1,NLOCAT)

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00374 C
00375 C***** CHECK FOR MAXIMUM FLOW AND VELOCITY IN CONDUITS
00376     TMIN=(TIME-NHOUR*3600.)/60.
00377     DO 902 N=1,NC
00378     IF(Q(N).GT.QMAXX(N)) GO TO 903
00379     GO TO 904
00380 903 QMAXX(N)=Q(N)
00381     IQHR(N)=NHOUR
00382     IQMIN(N)=TMIN+0.5
00383 904 IF(V(N).GT.VMAXX(N)) GO TO 905
00384     GO TO 902
00385 905 VMAXX(N)=V(N)
00386     IVHR(N)=NHOUR
00387     IVMIN(N)=TMIN+0.5
00388 902 CONTINUE
00389
00390 C
00391 C***** CHECK FOR SURCHARGE AND MAXIMUM DEPTH AT JUNCTIONS
00392     DO 906 J=1,NJ
00393     IF((Z(J)+Y(J)).GT.ZCROWN(J)) SURLN(J)=SURLN(J)+DELT/60.0
00394     IF(Y(J).GT.DEPMAX(J)) GO TO 907
00395     GO TO 906
00396 907 DEPMAX(J)=Y(J)
00397     IDHR(J)=NHOUR
00398     IDMIN(J)=TMIN+0.5
00399 906 CONTINUE
00400
00401 C
00402 C***** CHECK PRINTOUT REQUIREMENTS
00403 C.... INTERMEDIATE PRINTOUT
00404     IF(MOD(ICYC,INTER).NE.0) GO TO 570
00405     WRITE(N6,1504)
00406     IF(IT) 566,566,568
00407     566 WRITE(N6,1499) ICYC,NHOUR,TMIN
00408 1499 FORMAT(1X,'CYCLE ',I5,6X,'TIME ',I4,' HRS - ',F5.2,
00409     *' MIN',//)
00410     GO TO 569
00411     568 WRITE(N6,1500)ICYC,NHOUR,TMIN,ERROR,IT
00412 1500 FORMAT(1X,'CYCLE ',I5,6X,'TIME ',I4,' HRS - ',F5.2,
00413     *' MIN FLOW DIFFERENTIAL IN SURCHARGED AREA=',F6.2,
00414     *'CFS ITERATIONS REQUIRED=',I2,//)
00415     569 WRITE(N6,1501)
00416 1501 FORMAT(1X,'JUNCTIONS / DEPTHS ',//)
00417     WRITE(N6,1502)((JUN(J),Y(J),JCHECK(J)),J=1,NJ)
00418 1502 FORMAT(2X,I5,' ',F7.2,A1,7(2X,I5,' ',F7.2,A1)//)
00419     WRITE(N6,1503)
00420 1503 FORMAT(/,1X,'CONDUITS / FLOWS ',//)
00421     WRITE(N6,1502)((NCOND(N),Q(N),ICHECK(N)),N=1,NTL)
00422 1504 FORMAT(/,64(2H- ),//)
00423     570 CONTINUE
00424     IF(ICYC-NSTART) 640,580,580
00425     580 NSTART=NSTART+INTER
00426     LTIME=LTIME+1
00427 C***** STORE HGL FOR PRINTOUT
00428     DO 600 I=1,NHPRT
00429     J=JPRT(I)

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00430      YMAX=ZCROWN(J)-Z(J)
00431      PRTY(LTIME,I)=AMIN1(Y(J),YMAX)
00432      600 PRTH(LTIME,I)=Y(J)+Z(J)
00433      C***** STORE FLOW * VELOCITY FOR PRINTOUT
00434      DO 620 I=1,NQPRT
00435      L=CPRT(I)
00436      NL=NJUNC(L,1)
00437      NH=NJUNC(L,2)
00438      PRTQ(LTIME,I)=Q(L)
00439      620 PRTV(LTIME,I)=V(L)
00440      640 CONTINUE
00441
00442      C
00443      C***** STORE HGL * FLOW FOR PRINTER PLOT ROUTINE
00444
00445      TPLT(NPTOT)=TIME/3600.
00446      IF(NPLT) 700,700,660
00447      660 DO 680 N=1,NPLT
00448      J=JPLT(N)
00449      680 YPLT(NPTOT,N)=Y(J)+Z(J)
00450      700 IF(LPLT) 760,760,720
00451      720 DO 740 N=1,LPLT
00452      L=KPLT(N)
00453      740 QPLT(NPTOT,N)=Q(L)
00454      760 CONTINUE
00455      C***** COMPUTE WATER VOLUME LEFT IN STORAGE
00456      IF(NSTORE.EQ.0) GO TO 801
00457      DO 800 I=1,NSTORE
00458      J=JSTORE(I)
00459      800 VLEFT=VLEFT+Y(J)*ASTORE(J)
00460      801 CONTINUE
00461      DO 810 N=1,NC
00462      NL = NJUNC(N,1)
00463      NH = NJUNC(N,2)
00464      C**** VOLUME REMAINING IN CONDUIT WITH TIDE GATE NOT INCLUDED IN VLEFT
00465      IF(NGATE) 807,807,803
00466      803 DO 805 I=1,NGATE
00467      IF(JGATE(I).EQ.NH.OR.JGATE(I).EQ.NL) GO TO 810
00468      805 CONTINUE
00469      807 H1 = Y(NL) + Z(NL)
00470      H2 = Y(NH) + Z(NH)
00471      CALL HEAD(N,NL,NH,H1,H2,Q(N),A(N),V(N),HRAD,ANH,ANL,
00472      *RNL,TIME,ICYC)
00473
00473      VLEFT = VLEFT + 0.5*(ANH + ANL)*LEN(N)
00474      810 CONTINUE
00475      C
00476      C***** PRINT * PLOT OUTPUT
00477      CALL OUTPUT
00478      STOP
00479
00480      END

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00001      BLOCK DATA
00002      C
00003      COMMON /BD/ANORM(26,5),HRNORM(26,5),TWNORM(26,5)
00004      COMMON/LAB/ TITLE(40),XLAB(11),YLAB(6),HORIZ(5),VERT(6)
00005      C
00006      C***** NORMALIZED CROSS-SECTIONAL AREA
00007      DATA ANORM/
00008      1 .0000,.0134,.0374,.0680,.1033,.1423,.1845,.2292,.2759,.3242,
00009      2 .3736,.4237,.4745,.5255,.5763,.6264,.6758,.7241,.7708,.8154,
00010      3 .8576,.8967,.9320,.9626,.9866,1.000,
00011      4 .0000,.0400,.0800,.1200,.1600,.2000,.2400,.2800,.3200,.3600,
00012      5 .4000,.4400,.4800,.5200,.5600,.6000,.6400,.6800,.7200,.7600,
00013      6 .8000,.8400,.8800,.9200,.9600,1.000,
00014      7 .0000,.0181,.0508,.0908,.1326,.1757,.2201,.2655,.3118,.3587,
00015      8 .4064,.4542,.5023,.5506,.5987,.6462,.6931,.7387,.7829,.8253,
00016      9 .8652,.9022,.9356,.9645,.9873,1.000,
00017      1 .0000,.0150,.0400,.0550,.0850,.1200,.1555,.1900,.2250,.2750,
00018      2 .3200,.3700,.4200,.4700,.5150,.5700,.6200,.6800,.7300,.7800,
00019      3 .8350,.8850,.9250,.9550,.9800,1.000,
00020      4 .0000,.0173,.0457,.0828,.1271,.1765,.2270,.2775,.3280,.3780,
00021      5 .4270,.4765,.5260,.5740,.6220,.6690,.7160,.7610,.8030,.8390,
00022      6 .8770,.9110,.9410,.9680,.9880,1.000/
00023      C
00024      C***** NORMALIZED HYDRAULIC RADIUS
00025      C***** SECOND SHAPE IS RECTANGULAR - BUT DO NOT USE - CANNOT NORMALIZ
00026      C      A GENERAL RECTANGULAR HYDRAULIC RADIUS
00027      DATA HRNORM/
00028      1 .0100,.1048,.2052,.3016,.3944,.4824,.5664,.6456,.7204,.7912,
00029      2 .8568,.9176,.9736,1.024,1.070,1.110,1.144,1.174,1.194,1.210,
00030      3 1.217,1.215,1.203,1.178,1.132,1.000,
00031      4 .0000,.0400,.0800,.1200,.1600,.2000,.2400,.2800,.3200,.3600,
00032      5 .4000,.4400,.4800,.5200,.5600,.6000,.6400,.6800,.7200,.7600,
00033      6 .8000,.8400,.8800,.9200,.9600,1.000,
00034      7 .0100,.1040,.2065,.3243,.4322,.5284,.6147,.6927,.7636,.8268,
00035      8 .8873,.9417,.9905,1.036,1.077,1.113,1.143,1.169,1.189,1.202,
00036      9 1.208,1.206,1.195,1.170,1.126,1.000,
00037      1 .0100,.0970,.2160,.3020,.3860,.4650,.5360,.6110,.6760,.7350,
00038      2 .7910,.8540,.9040,.9410,1.008,1.045,1.076,1.115,1.146,1.162,
00039      3 1.186,1.193,1.186,1.162,1.107,1.000,
00040      4 .0100,.0952,.1890,.2730,.3690,.4630,.5600,.6530,.7430,.8220,
00041      5 .8830,.9490,.9990,1.055,1.095,1.141,1.161,1.188,1.206,1.206,
00042      6 1.206,1.205,1.196,1.168,1.127,1.000/
00043      C
00044      C***** NORMALIZED SURFACE WIDTH
00045      DATA TWNORM/
00046      1 .3919,.3919,.5426,.6499,.7332,.8000,.8542,.8980,.9330,.9600,
00047      2 .9798,.9928,.9992,.9992,.9928,.9798,.9600,.9330,.8980,.8542,
00048      3 .8000,.7332,.6499,.5426,.3919,.3919,
00049      4 1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,
00050      5 1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,1.000,
00051      6 1.000,1.000,1.000,1.000,1.000,1.000,
00052      7 .5878,.5878,.8772,.8900,.9028,.9156,.9284,.9412,.9540,.9668,
00053      8 .9798,.9928,.9992,.9992,.9928,.9798,.9600,.9330,.8980,.8542,
00054      9 .8000,.7332,.6499,.5426,.3919,.3919,
00055      1 .2980,.2980,.4330,.5080,.5820,.6420,.6960,.7460,.7910,.8360,
00056      2 .8660,.8960,.9260,.9560,.9700,.9850,1.000,.9850,.9700,.9400,

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.BLOCK NTRNJA FORTRAN V.5A(621) /KI/C/L 20-MAY-81 15:57 PAGE 1-1

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00057      3 .8960,.8360,.7640,.6420,.3100,.3100,
00058      4 .4900,.4900,.6670,.8200,.9300,1.000,1.000,1.000,.9970,.9940,
00059      5 .9880,.9820,.9670,.9480,.9280,.9040,.8740,.8420,.7980,.7500,
00060      6 .6970,.6370,.5670,.4670,.3420,.3420/
00061      C
00062      DATA VERT      /4HJUNC,4HTION,4HWATR,4H SUR,4HELEV,4H(FT)/
00063      C
00064      END
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00001      SUBROUTINE BOUND(YDEP,YDEPT,QP,T,DT,IT)
00002      C
00003      C      THIS SUBROUTINE COMPUTES THE LINK FLOW 'QP(LINK)' FOR
00004      C      EACH EXTERNAL * INTERNAL NODE TO NODE TRANSFER
00005      C
00006      COMMON /BD/ANORM(26,5),HRNORM(26,5),TWNORM(26,5)
00007      COMMON/TRAP/STHETA(200),SPHI(200)
00008      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00009      1TRIBA
00010      COMMON/CONTR/ NTCYC,DELTAQ,DELTA,DELTA2,TZERO,ALPHA(40),
00011      1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00012      C
00013      COMMON/JUNC/Y(187),YT(187),NCHAN(187,8),AS(187),Z(187),QIN(187),
00014      1 QOU(187),QINST(187),GRELEV(187),JUN(187),ZCROWN(187),JSKIP(187)
00015      2 ,SUMAL(187),SUMQ(187),SUMQS(187),ASFULL(187)
00016      C
00017      COMMON/PIPE/LEN(187),NJUNC(187,2),AFULL(187),AT(187),
00018      1 Q(187),V(187),VT(187),DEEP(187),A(187),WIDE(187),RFULL(187),
00019      2 WLEN(60),COEF(60),COEFS(60)
00020      3 ROUGH(187)
00021      REAL LEN
00022      C
00023      DIMENSION YDEP(187),YDEPT(187),QP(187)
00024      C
00025      COMMON/STORE/ NSTORE,JSTORE(20),ZTOP(20),ASTORE(20)
00026      COMMON/ORF/ NORIF,LORIF(60),AORIF(60),CORIF(60)
00027      COMMON/WEIR/ NWEIR,LWEIR(60),KWEIR(60),YTOP(60),YCREST(60),
00028      2 WLEN(60),COEF(60),COEFS(60)
00029      COMMON/PUMP/ NPUMP,LPUMP(20),PRATE(20,3),VRATE(20,3),VWELL(20),
00030      1 JPFUL(20),IPTYP(20)
00031      COMMON/BND/ NFREE,JFREE(25),NTIDE,JTIDE(25),NGATE,JGATE(25)
00032      C
00033      C      E X E C U T I O N
00034      C
00035      C**** CHECK WHETHER SURCHARGE ITERATIONS OCCURRING
00036      IF(IT)105,105,200
00037      105 HTIDE=-9999.
00038      C
00039      C
00040      C***** COMPUTE NEW ELEVATION OF TIDE
00041      GO TO (110,109,108,108), NTIDE
00042      108 HTIDE=A1+A2*SIN(W*T)+A3*SIN(2.*W*T)+A4*SIN(3.*W*T)
00043      1 +A5*COS(W*T)+A6*COS(2.*W*T)+A7*COS(3.*W*T)
00044      IF(MOD(ICYC,30).EQ.0) WRITE(N6,1234) ICYC,HTIDE
00045      1234 FORMAT(' CYCLE',IS,' HTIDE=',F10.2)
00046      GO TO 110
00047      109 HTIDE=A1
00048      110 CONTINUE
00049      C
00050      C***** ASSIGN SURFACE AREA TO STORAGE JUNCTIONS
00051      C
00052      IF (NSTORE) 116,116,112
00053      112 DO 114 I=1,NSTORE
00054      J = JSTORE(I)
00055      AS(J) = AS(J) + ASTORE(I)
00056      114 CONTINUE

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00057      116 CONTINUE
00058      C
00059      C***** COMPUTE HEAD AT JUNCTIONS WITH SUMP ORIFICES WHERE
00060      C          DEPTH IS BELOW JUNCTION INVERT
00061          IF(NORIF)200,200,120
00062      120 DO 180 I=1,NORIF
00063          LINK=LORIF(I)
00064          J1=NJUNC(LINK,1)
00065          JSKIP(J1)=0
00066          IF(NKCLASS(LINK) .EQ. 7 .OR. YDEP(J1) .GT. 0.) GO TO 180
00067          JSKIP(J1)=1
00068          YNL=0.96*DEEP(LINK)+YDEP(J1)
00069          CALL HYDRAD(LINK,NKCLASS(LINK),YNL,RNL,ANL,BNL)
00070          YDEPT(J1)=Y(J1)+SUMQ(J1)*DT/(BNL*LEN(LINK)/2.)
00071          IF(YDEPT(J1).GT.0.) YDEPT(J1)=0.001
00072      180 CONTINUE
00073      C
00074      C***** COMPUTE DISCHARGE OVER TRANSVERSE AND SIDEFLOW WEIRS
00075      200 IF(NWEIR) 580,580,220
00076      220 DO 560 I=1,NWEIR
00077      C**** INITIALIZE
00078          WK=COEF(I)
00079          POWER=1.5
00080          V2=0.0
00081          LINK=LWEIR(I)
00082          DIR=+1.
00083          J1=NJUNC(LINK,1)
00084          J2=NJUNC(LINK,2)
00085          Y1=YDEP(J1)
00086          IF(J2) 240,240,260
00087      240 Y2=AMAX1((HTIDE-Z(J1)),YCREST(I))
00088          HEADW=Y1-YCREST(I)
00089          IF(HEADW) 480,480,320
00090      260 Y2=YDEP(J2)
00091          HEADW=AMAX1(Y1,Y2)-YCREST(I)
00092          IF(HEADW) 480,480,280
00093      C**** CHECK FOR BACKFLOW
00094      280 IF(Y1-Y2) 300,320,320
00095      300 DIR=-1.
00096          Y1=Y2
00097          Y2=YDEP(J1)
00098          J1=J2
00099          J2=NJUNC(LINK,1)
00100      C**** CHECK WHETHER SURCHARGE ITERATIONS OCCURRING
00101          IF(IT)320,320,310
00102      310 IF(Y1.GT.0.96*(ZCROWN(J1)-Z(J1))) GO TO 320
00103          IF(Y2.LT.0.96*(ZCROWN(J2)-Z(J2))) GO TO 560
00104      C**** CHECK FOR SURCHARGE
00105      320 IF(Y1.GT.YTOP(I)) GO TO 440
00106          IF(DIR) 380,340,340
00107      340 IF(KWEIR(I)-3) 380,360,360
00108      C**** WK IS A FUNCTION OF APPROACH VELOCITY FOR SIDEFLOW WEIRS
00109      360 WK=COEF(I)
00110          V2=0.0
00111          POWER=1.67
00112      C**** WEIR DISCHARGE

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00113      380 QWEIR=WK*WLEN(I)*((HEADW+V2/64.4)**POWER-(V2/64.4)**POWER)
00114      KW=KWEIR(I)
00115      GO TO (420,400,420,400) KW
00116 C**** APPLY ARMC0 TIDE GATE CORRECTION
00117 C**** (ARMC0 WATER CONTROL GATES CATALOG)
00118      400 IF(HTIDE,GE.(YDEP(J1)+Z(J1))) GO TO 480
00119      VEL1=COEF(I)*HEADW**(POWER-1.)
00120      HLOSS=(4./32.2)*VEL1**2*EXP(-1.15*VEL1/SQRT(YTOP(I)-YCREST(I)))
00121      HEADW=HEADW-HLOSS
00122      IF(HEADW.LE.0) GO TO 480
00123      IF((YCREST(I)+Z(J)+HEADW).LE.HTIDE) GO TO 480
00124      QWEIR=COEF(I)*WLEN(I)*HEADW**POWER
00125 C
00126 C***** SUBMERGED WEIR COMPUTATIONS, DFK, 8/74
00127 C
00128      420 RATIO=(Y2-YCREST(I))/(Y1-YCREST(I))
00129      IF((Y2-YCREST(I)).LE.0) GO TO 500
00130      IF(RATIO.LE.0.3) GO TO 421
00131      IF(RATIO.LE.0.75) GO TO 422
00132      IF(RATIO.LE.0.85) GO TO 423
00133      IF(RATIO.LE.0.95) GO TO 424
00134      CONST=0.4-0.3*(RATIO-0.95)/0.05
00135      GO TO 430
00136      421 CONST=1.
00137      GO TO 430
00138      422 CONST=1.0-0.1*(RATIO-0.3)/0.45
00139      GO TO 430
00140      423 CONST=0.9-0.1*(RATIO-0.75)/0.1
00141      GO TO 430
00142      424 CONST=0.8-0.4*(RATIO-0.85)/0.1
00143      430 QWEIR=CONST*COEF(I)*WLEN(I)*(Y1-YCREST(I))**1.5
00144      GO TO 500
00145 C**** OUTFLOW IN SURCHARGED CONDITION
00146      440 IF(Y1-Y2) 480,480,460
00147      460 HEADW=Y1-AMAX1(Y2,YCREST(I))
00148      IF(COEF(I).GT.0.0) GO TO 470
00149      ARE=(YTOP(I)-YCREST(I))*WLEN(I)
00150      COEF(I)=ABS(QP(LINK))/(ARE*SQRT(64.4*HEADW+V2))
00151      470 QWEIR=COEF(I)*WLEN(I)*(YTOP(I)-YCREST(I))*SQRT(64.4*HEADW+V2)
00152      GO TO 500
00153      480 QWEIR=0.
00154      500 QP(LINK)=DIR*QWEIR
00155      560 CONTINUE
00156 C
00157 C***** COMPUTE PUMP DISCHARGES
00158 C
00159 C***** NOTE -- ONLY ONE INFLUENT PIPE CAN BE CONNECTED TO A PUMP NODE
00160 C
00161      580 IF(NPUMP) 920,920,600
00162      600 DO 900 I=1,NPUMP
00163      LINK=LPUMP(I)
00164      J1=NJUNC(LINK,1)
00165      J2=NJUNC(LINK,2)
00166      GO TO (710,880) IPTYP(I)
00167 C***** COMPUTE INFLOW TO WET WELL FOR GATES OPEN CONDITION
00168      710 N=NCHAN(J1,1)

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00169      QINJ=QP(N)
00170      JUP=NJUNC(N,1)
00171      IF(JUP.NE.J1) GO TO 711
00172      JUP=NJUNC(N,2)
00173      QINJ=-QP(N)
00174      C**** CHECK WHETHER SURCHARGE ITERATIONS OCCURING
00175      711 IF(IT) 715,715,712
00176      712 IF(Y(JUP).GT.0.96*(ZCROWN(JUP)-Z(JUP))) GO TO 715
00177      IF(Y(J1).LE.0.96*(ZCROWN(J1)-Z(J1))) GO TO 900
00178      715 IF(QINJ.LT.0.) QINJ=0.
00179      CALL DEPTH(N,NKCLASS(N),QP(N),YCRIT,YNORM,TIME,ICYC)
00180      C***** SET CRITICAL DEPTH AT WET WELL FOR OFF-LINE PUMP
00181      YDEPT(J1)=AMIN1(YCRIT,YNORM)
00182      VWELL(I)=VWELL(I)+QINJ*DELT2
00183      C***** SET PUMP RATE
00184      720 QOUT=0.0
00185      IF(VWELL(I)) 800,800,740
00186      740 QOUT=PRATE(I,1)
00187      IF(VWELL(I)-VRATE(I,1)) 800,760,760
00188      760 QOUT=PRATE(I,2)
00189      IF(VWELL(I)-VRATE(I,2)) 800,780,780
00190      780 QOUT=PRATE(I,3)
00191      C***** COMPUTE NEW WET WELL VOLUME
00192      800 VNEW=VWELL(I)-QOUT*DELT2
00193      C***** CHECK FOR DRY WELL
00194      IF(VNEW) 820,820,840
00195      820 QOUT=VWELL(I)/DELT2
00196      VWELL(I)=0.0
00197      QP(LINK)=QOUT
00198      JPFUL(I)=1
00199      GO TO 900
00200      C***** CHECK FOR FLOODED WELL
00201      840 IF(VRATE(I,3)-VNEW) 860,860,870
00202      860 DIFF=(VNEW-VRATE(I,3))/DELT2
00203      VWELL(I)=VRATE(I,3)
00204      QOUT=PRATE(I,3)
00205      QP(LINK)=QOUT
00206      N=NCHAN(J1,1)
00207      C....THROTTLE PUMP STATION INFLOW
00208      QP(N)=QP(N)-SIGN(DIFF,QP(N))
00209      SUMQ(JUP)=SUMQ(JUP)+0.5*DIFF
00210      SUMQS(JUP)=SUMQS(JUP)+DIFF
00211      GO TO 900
00212      C***** NORMAL WET WELL CONDITION
00213      870 VWELL(I)=VNEW
00214      QP(LINK)=QOUT
00215      GO TO 900
00216      C
00217      C***** SET PUMP RATE FOR IN-LINE PUMP
00218      C**** CHECK WHETHER SURCHARGE ITERATIONS OCCURING
00219      880 IF(IT) 875,875,872
00220      872 IF(Y(J1).LE.0.96*(ZCROWN(J1)-Z(J1))) GO TO 900
00221      875 JSKIP(J1)=0
00222      IF(YDEP(J1)-0.001) 882,882,885
00223      882 QINJ=0.
00224      DO 883 K=1,8

```

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| 16. ABSTRACT
<p>This report contains the documentation and user's manual for the Extended Transport (EXTRAN) Block of the Storm Water Management Model (SWMM). EXTRAN is a dynamic flow routing model used to compute backwater profiles in open channel and/or closed conduit systems experiencing unsteady flow. It represents the drainage system as links and nodes, allowing parallel or looped pipe networks; weirs, orifices, and pumps; and system surcharges to be simulated. EXTRAN is used most efficiently if it is only applied to those parts of the drainage system which cannot be simulated accurately by simpler, less costly models.</p> <p>The EXTRAN manual is designed to give the user complete information on executing of the model both as a block of the SWMM package and as an independent model. Formulation of the input data is discussed in detail and demonstrated by seven example problems. Typical computer output is also discussed. Problem areas which the user may confront are described, as well as the theory on which the EXTRAN model rests. The manual concludes with a comprehensive discussion of the EXTRAN code.</p> | | |
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00225      N=NCHAN(J1,K)
00226      IF(N.GT.NC) GO TO 884
00227      IF(NJUNC(N,2).EQ.J1) QINJ=QINJ+QP(N)
00228      883 CONTINUE
00229      884 QOUT=QINJ
00230      GO TO 888
00231      C***** SET PUMP RATE
00232      885 QOUT = PRATE(I,1)
00233      IF(YDEP(J1).GT.VRATE(I,1)) QOUT = PRATE(I,2)
00234      IF(YDEP(J2).GT.VRATE(I,2)) QOUT = PRATE(I,3)
00235      888 QP(LINK) = QOUT
00236      900 CONTINUE
00237      C
00238      C***** SET DEPTH AT FREE OUTFALL * TIDAL NODES (ONE PIPE/NODE)
00239      920 IF(NFREE) 980,980,940
00240      940 DO 960 I=1,NFREE
00241          J=JFREE(I)
00242          N=NCHAN(J,1)
00243          LINK=NCHAN(J,2)
00244          QP(LINK)=QP(N)
00245      C.... CHECK FOR OUTFALL PIPE ON AN ADVERSE SLOPE
00246      IF(NJUNC(N,1).EQ.J) QP(LINK)=-QP(LINK)
00247      CALL DEPTH(N,NKCLASS(N),QP(N),YCRIT,YNORM,TIME,ICYC)
00248      YDEPT(J)=AMIN1(YCRIT,YNORM)
00249      C***** CHECK FOR FULL PIPE OR SURCHARGE
00250      IF(YDEPT(J).GT.DEEP(N)) YDEPT(J)=DEEP(N)
00251      C***** CHECK FOR TIDAL INFLUENCE
00252      IF((YDEPT(J)+Z(J)).LT.HTIDE) YDEPT(J)=HTIDE-Z(J)
00253      960 CONTINUE
00254      C
00255      C***** SET DEPTH AT TIDE GATE OR CLOSE GATE
00256      980 IF(NGATE) 1080,1080,1000
00257      1000 DO 1060 I=1,NGATE
00258          J=JGATE(I)
00259          N=NCHAN(J,1)
00260          LINK=NCHAN(J,2)
00261          QP(LINK)=QP(N)
00262      C**** CHECK FOR OUTFALL PIPE ON AN ADVERSE SLOPE
00263      JUP=1
00264      JDN=2
00265      IF(NJUNC(N,2).EQ.J) GO TO 1010
00266      QP(LINK)=-QP(LINK)
00267      JUP=2
00268      JDN=1
00269      1010 IF(H(N,JUP)-HTIDE) 1020,1020,1030
00270      C***** GATE CLOSED
00271      1020 YDEPT(J)=H(N,JUP)-Z(J)
00272      QP(LINK)=0.0
00273      IF(YDEPT(J).LT.0.) YDEPT(J)=0.
00274      GO TO 1060
00275      C***** GATE OPEN
00276      1030 CALL DEPTH(N,NKCLASS(N),QP(N),YCRIT,YNORM,TIME,ICYC)
00277      YDEPT(J)=AMIN1(YCRIT,YNORM)
00278      C***** CHECK FOR FULL PIPE OR SURCHARGE
00279      IF(YDEPT(J).GT.DEEP(N)) YDEPT(J)=DEEP(N)
00280      C***** CHECK FOR TIDE ELEVATION

```

```
00281      IF((YDEPT(J)+Z(J)).LT.HTIDE) YDEPT(J)=HTIDE-Z(J)
00282      1060 CONTINUE
00283      C
00284      1080 RETURN
00285      END
```

```

00001      SUBROUTINE CURVE(X,Y,NPT,NCV,NPLOT)
00002      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00003      1TRIBA
00004      DIMENSION X(202,5),Y(202,5),NPT(5)
00005      1,DUMX(4),DUMY(4)
00006      COMMON/LAB/ALPHA(40),XLAB(11),YLAB(6),HORIZ(5),VERT(6)
00007      C
00008      C
00009      C          SET UP X AND Y SCALES
00010      XMAX = -1.0E30
00011      XMIN = 1.0E30
00012      YMAX = -1.0E30
00013      YMIN = 1.0E30
00014      DO 100 K = 1, NCV
00015      N = NPT(K)
00016      DO 100 J = 1, N
00017      IF( X(J,K) .GT. XMAX ) XMAX = X(J,K)
00018      IF( X(J,K) .LT. XMIN ) XMIN = X(J,K)
00019      IF( Y(J,K) .GT. YMAX ) YMAX = Y(J,K)
00020      IF( Y(J,K) .LT. YMIN ) YMIN = Y(J,K)
00021      100 CONTINUE
00022      DUMX(1) = XMIN
00023      DUMX(2) = XMAX
00024      CALL SCALE(DUMX,10.0,2,1)
00025      DUMY(1) = YMIN
00026      DUMY(2) = YMAX
00027      CALL SCALE(DUMY,4.0,2,1)
00028      DO 120 K = 1, NCV
00029      N = NPT(K)
00030      X(N+1,K) = DUMX(3)
00031      X(N+2,K) = DUMX(4)
00032      Y(N+1,K) = DUMY(3)
00033      Y(N+2,K) = DUMY(4)
00034      120 CONTINUE
00035      C
00036      C
00037      C          FORM X LABELS AND FACTORS
00038      XMIN= DUMX(3)
00039      DELTX= DUMX(4)
00040      XLAB(1)=XMIN
00041      DO 140 I=1,10
00042      140 XLAB(I+1)=XLAB(I)+DELTX
00043      XSCAL=100./ (XLAB(11)-XMIN)
00044      C
00045      C
00046      C          FORM Y LABELS AND FACTORS
00047      YMIN= DUMY(3)
00048      DELTY= DUMY(4)
00049      YLAB(5)=YMIN
00050      DO 160 I=1,4
00051      160 YLAB(5-I)=YLAB(6-I)+DELTY
00052      YSCAL=40./ (YLAB(1)-YMIN)
00053      C
00054      C
00055      C          INITIALIZE PLOT OUTLINE
00056      NCD=100

```

```
00057      CALL PLOT(0,0,NC,NPLOT)
00058      K = 1
00059      C
00060      C      DRAW IN EACH CURVE
00061      C
00062      DO 240 L=1,NCV
00063      IF(NPT(L).EQ.0) GO TO 220
00064      C
00065      C      JOINING XO YO AND XT YT
00066      C
00067      XO=XSCAL*(X(1,L)-XMIN)
00068      YO=YSCAL*(Y(1,L)-YMIN)
00069      NPOINT = NPT(L)
00070      DO 180 N = 2,NPOINT
00071      XT = XSCAL*(X(N,L) - XMIN)
00072      YT = YSCAL*(Y(N,L) - YMIN)
00073      CALL PLINE(XO,YO,XT,YT,K,NPLOT)
00074      XO = XT
00075      YO = YT
00076      180 CONTINUE
00077      200 CONTINUE
00078      220 K = K + 1
00079      240 CONTINUE
00080      C
00081      C      OUTPUT FINAL PLOT
00082      C
00083      NC=99
00084      CALL PLOT(0,0,NC,NPLOT)
00085      RETURN
00086      END
```

```

00001      SUBROUTINE DEPTHX(N,KLASS,QPO,YC,YNORM,TIME,ICYC)
00002      C
00003      C          THIS SUBROUTINE FINDS THE CRITICAL DEPTH
00004      C          AND THE NORMAL DEPTH CORRESPONDING TO THE FLOW QP
00005      C
00006      COMMON /BD/ANORM(26,5),HRNORM(26,5),TWNORM(26,5)
00007      C
00008      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00009      1TRIBA
00010      COMMON/PIPE/LEN(187),NJUNC(187,2),AFULL(187),AT(187),
00011      1 Q(187),V(187),VT(187),DEEP(187),A(187),WIDE(187),RFULL(187),
00012      2 NKCLASS(187),ZP(187,2),QT(187),QD(187),H(187,2),NCOND(187),
00013      3 ROUGH(187)
00014      COMMON/TRAP/STHETA(200),SPHI(200)
00015      DIMENSION KCRIT(187)
00016      REAL LEN
00017      C
00018      C          E X E C U T I O N
00019      C
00020      QP=ABS(QPO)
00021      YC=0.
00022      YNORM=0.
00023      IF(QP.LE.0.) RETURN
00024      NDIM=187
00025      NTYPE=KLASS
00026      IF(NTYPE.EQ.6) GO TO 640
00027      C***** SPECIFY NTYPE FOR ORIFICES
00028      IF(NKCLASS(N).EQ. 7 .OR. NKCLASS(N).EQ. 8) NTYPE=1
00029      C*****INITIALIZE KCRIT
00030      C
00031      IF(ICYC.GT.1) GO TO 100
00032      DO 50 I=1,NDIM
00033      KCRIT(I)=0
00034      50 CONTINUE
00035      C***** SEARCH AREA * WIDTH TABLES FOR PROPER LOCATION
00036      100 QCO=0.
00037      DO 300 I=2,26
00038      AREA=AFULL(N)*ANORM(I,NTYPE)
00039      WIDTH=WIDE(N)*TWNORM(I,NTYPE)
00040      QC=AREA*SQRT(32.2*AREA/WIDTH)
00041      IF(QC-QP) 250,200,200
00042      200 DELTA=(QP-QCO)/(QC-QCO)
00043      YC=0.04*(FLOAT(I-2)+DELTA)*DEEP(N)
00044      GO TO 400
00045      250 QCO=QC
00046      300 CONTINUE
00047      C
00048      C***** PIPE SURCHARGED AT THIS SECTION
00049      YC=DEEP(N)
00050      C
00051      C***** SEARCH AREA * RADIUS TABLES FOR PROPER LOCATION
00052      400 QNORM=0.
00053      DO 600 I=2,26
00054      AREA=AFULL(N)*ANORM(I,NTYPE)
00055      HRAD=RFULL(N)*HRNORM(I,NTYPE)
00056      IF(NTYPE.EQ. 2) HRAD=WIDE(N)+2.*(I-1)/25.*DEEP(N)

```



```

00057      QNORM=SQRT(32.2*(ZP(N,1)-ZP(N,2))/(LEN(N)*ROUGH(N)))
00058      1 *AREA*HRAD**0.6667
00059      IF(QNORM-QP) 550,500,500
00060      500 DELTA=(QP-QNORM)/(QNORM-QNORMO)
00061      YNORM=0.04*(FLOAT(I-2)+DELTA)*DEEP(N)
00062      GO TO 620
00063      550 QNORMO=QNORM
00064      600 CONTINUE
00065      C***** PIPE SURCHARGED AT THIS SECTION
00066      YNORM=DEEP(N)
00067      C
00068      620 RETURN
00069      C
00070      C***** YC AND YNORM FOR TRAPEZOIDAL CHANNELS
00071      C
00072      C**** COMPUTE YC
00073      640 QCO=0.
00074      DO 660 I=2,26
00075      YI=0.04*FLOAT(I-1)*DEEP(N)
00076      WIDTH=YI*(STHETA(N)+SPHI(N))+WIDE(N)
00077      AREA=0.5*YI*(WIDTH+WIDE(N))
00078      QC=AREA*SQRT(32.2*AREA/WIDTH)
00079      IF(QC-QP) 650,645,645
00080      645 DELTA=(QP-QCO)/(QC-QCO)
00081      YC=0.04*(FLOAT(I-2)+DELTA)*DEEP(N)
00082      GO TO 665
00083      650 QCO=QC
00084      660 CONTINUE
00085      C
00086      C**** PIPE SURCHARGED AT THIS SECTION
00087      YC=DEEP(N)
00088      C
00089      C**** COMPUTE YNORM
00090      665 QNORMO=0.
00091      SROOTS=SQRT(1.+STHETA(N)**2.)+SQRT(1.+SPHI(N)**2.)
00092      DO 680 I=2,26
00093      YI=0.04*FLOAT(I-1)*DEEP(N)
00094      AREA=YI*(WIDE(N)+YI/2.*(STHETA(N)+SPHI(N)))
00095      HRAD=AREA/(WIDE(N)+DTEMP*SROOTS)
00096      QNORM=SQRT(32.2*(ZP(N,1)-ZP(N,2))/(LEN(N)*ROUGH(N)))*AREA*HRAD**0.
00097      2677
00098      IF(QNORM-QP) 675,670,670
00099      670 DELTA=(QP-QNORMO)/(QNORM-QNORMO)
00100      YNORM=0.04*(FLOAT(I-2)+DELTA)*DEEP(N)
00101      RETURN
00102      675 QNORMO=QNORM
00103      680 CONTINUE
00104      C**** PIPE SURCHARGED AT THIS SECTION
00105      YNORM=DEEP(N)
00106      RETURN
00107      END

```

Replace DTEMP
by YI

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00001      SUBROUTINE HEAD(N,NL,NH,HEAD1,HEAD2,QP,AREA,VEL,HRAD,ANH,ANL,RNL,
00002      1TIME,ICYC)
00003      C
00004      C          THIS SUBROUTINE CONVERTS NODAL DEPTHS TO PIPE DEPTHS
00005      C          IT ALSO ASSIGNS SURFACE AREAS TO THE PROPER NODES
00006      C          SURFACE AREA IS NOT ASSIGNED TO ORIFICE OR WEIR LINKS
00007      C
00008      COMMON /BD/ANORM(26,5),HRNORM(26,5),TWNORM(26,5)
00009      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00010      1TRIBA
00011      COMMON/TRAP/STHETA(200),SPHI(200)
00012      COMMON/JUNC/Y(187),YT(187),NCHAN(187,8),AS(187),Z(187),QIN(187),
00013      1 QOU(187),QINST(187),GRELEV(187),JUN(187),ZCROWN(187),JSKIP(187)
00014      2 ,SUMAL(187),SUMQ(187),SUMQS(187),ASFULL(187)
00015      C
00016      COMMON/PIPE/LEN(187),NJUNC(187,2),AFULL(187),AT(187),
00017      1 Q(187),V(187),VT(187),DEEP(187),A(187),WIDE(187),RFULL(187),
00018      2 NKCLASS(187),ZP(187,2),QT(187),QO(187),H(187,2),NCOND(187),
00019      3 ROUGH(187)
00020      REAL LEN
00021      C
00022      C          E X E C U T I O N
00023      C
00024      YNL=HEAD1-ZP(N,1)
00025      YNH=HEAD2-ZP(N,2)
00026      C
00027      C***** CHECK FOR DRY PIPE
00028      IF(YNL.LE.0..AND.YNH.LE.0.) GO TO 220
00029      IF(YNL)10,10,20
00030      C***** YNL.LE.0, YNH..GT.0 (CRIT OR NORM UPSTRM OR STORAGE DWNSTRM)
00031      10 IF(HEAD2-ZP(N,1)) 240,15,15
00032      15 IF(ZP(N,1).LE.Z(NL)) GO TO 160
00033      CALL DEPTH(N,NKCLASS(N),QP,YC,YNORM,TIME,ICYC)
00034      GO TO 200
00035      C***** YNH LE 0, YNL GT 0, CRITICAL OR NORM DOWNSTREAM
00036      20 IF(YNH) 25,25,30
00037      25 IF(ZP(N,2).LE.Z(NH)) GO TO 160
00038      CALL DEPTH(N,NKCLASS(N),QP,YC,YNORM,TIME,ICYC)
00039      Y2=AMIN1(YC,YNORM)
00040      GO TO 180
00041      C***** YNL AND YNH GT 0
00042      30 IF(QP) 35,50,50
00043      C***** ADVERSE FLOW
00044      35 IF(ZP(N,1)-Z(NL)) 160,160,40
00045      40 CALL DEPTH(N,NKCLASS(N),QP,YC,YNORM,TIME,ICYC)
00046      IF(YC-YNL) 160,160,200
00047      C***** POSITIVE FLOW
00048      50 IF(ZP(N,2)-Z(NH)) 160,160,55
00049      55 CALL DEPTH(N,NKCLASS(N),QP,YC,YNORM,TIME,ICYC)
00050      Y2=AMIN1(YC,YNORM)
00051      IF(Y2-YNH) 120,120,180
00052      120 IF(YNH-AMAX1(YC,YNORM)) 140,140,160
00053      140 FASHN=(YNH-Y2)/ABS(YNORM-YC)
00054      GO TO 165
00055      C
00056      C***** NORMAL SITUATION' HALF SURFACE AREA AT EACH END

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00057      160 FASN=1.0
00058      165 YMID=0.5*(YNL+YNH)
00059          IF (YMID.LE.0.0) YMID=0.0
00060          CALL HYDRAD(N,NKCLASS(N),YNL,RNL,ANL,BNL)
00061          CALL HYDRAD(N,NKCLASS(N),YMID,RMID,AMID,BMID)
00062          CALL HYDRAD(N,NKCLASS(N),YNH,RNH,ANH,BNH)
00063          IF(NKCLASS(N).GT. 6) GO TO 260
00064          AS(NL)=AS(NL)+0.25*(BNL+BMID)*LEN(N)
00065          AS(NH)=AS(NH)+0.25*(BMID+BNH)*LEN(N)*FASN
00066          GO TO 260
00067      C
00068      C***** CRITICAL SECTION DOWNSTREAM' SURFACE AREA UPSTREAM
00069          180 YNH=Y2
00070          HEAD2=YNH+ZP(N,2)
00071          YMID=0.5*(YNL+YNH)
00072          IF (YMID.LE.0.0) YMID=0.0
00073          CALL HYDRAD(N,NKCLASS(N),YNL,RNL,ANL,BNL)
00074          CALL HYDRAD(N,NKCLASS(N),YMID,RMID,AMID,BMID)
00075          CALL HYDRAD(N,NKCLASS(N),YNH,RNH,ANH,BNH)
00076          IF(NKCLASS(N).GT. 6) GO TO 260
00077          AS(NL)=AS(NL)+0.25*(BNL+BMID)*LEN(N)
00078          GO TO 260
00079      C
00080      C***** CRITICAL SECTION UPSTREAM' SURFACE AREA DOWNSTREAM
00081          200 HEAD1=YC+ZP(N,1)
00082          YNL=YC
00083          YMID=0.5*(YNL+YNH)
00084          IF (YMID.LE.0.0) YMID=0.0
00085          CALL HYDRAD(N,NKCLASS(N),YNL,RNL,ANL,BNL)
00086          CALL HYDRAD(N,NKCLASS(N),YMID,RMID,AMID,BMID)
00087          CALL HYDRAD(N,NKCLASS(N),YNH,RNH,ANH,BNH)
00088          IF(NKCLASS(N).GT. 6) GO TO 260
00089          AS(NH)=AS(NH)+0.25*(BMID+BNH)*LEN(N)
00090          GO TO 260
00091      C
00092      C***** DRY PIPE' NO SURFACE AREA FOR ENDS WITH NEGATIVE Y
00093          220 HEAD1=HEAD2
00094          YMID=0.
00095          CALL HYDRAD(N,NKCLASS(N),YMID,RMID,AMID,BMID)
00096          ANH=0.
00097          ANL=0.
00098          RNL=0.
00099          AREA=0.
00100          VEL=0.
00101          HRAD=.01
00102          QD(N)=0.0
00103          IF(NKCLASS(N).GT. 6) RETURN
00104          IF(YNL.LT.-0.001) GO TO 230
00105          AS(NL)=AS(NL)+BMID*LEN(N)/2.
00106          230 IF(YNH.LT.-0.001) RETURN
00107          AS(NH)=AS(NH)+BMID*LEN(N)/2.
00108
00109          RETURN
00110      C
00111      C***** DRY UPSTREAM' SURFACE AREA DOWNSTREAM
00112          240 HEAD1=HEAD2

```

```
00113      YNL=0.
00114      YMID=HEAD2-0.5*(ZP(N,1)+ZP(N,2))
00115      IF(YMID.LT.0.) YMID=0.
00116      CALL HYDRAD(N,NKCLASS(N),YNL,RNL,ANL,BNL)
00117      CALL HYDRAD(N,NKCLASS(N),YMID,RMID,AMID,BMID)
00118      CALL HYDRAD(N,NKCLASS(N),YNH,RNH,ANH,BNH)
00119      AREA=0.25*(ANL+2.*AMID+ANH)
00120      VEL=0.0
00121      HRAD=0.5*(RMID+RNH)
00122      QO(N)=0.0
00123      IF(NKCLASS(N).GT. 6) RETURN
00124      AS(NH)=AS(NH)+0.25*(BMID+BNH)*LEN(N)
00125      IF(ZP(N,1)-Z(NL).LT.0.001) AS(NL)=AS(NL)+.25*(BNL+BMID)*LEN(N)
00126      RETURN
00127 C
00128 C***** COMPUTE CROSS-SECTION AREA, VELOCITY * HYDRAULIC RADIUS
00129 260 AREA=0.25*(ANL+2.*AMID+ANH)
00130      VEL=0.
00131      IF(AREA.GT.0.) VEL=QO/AREA
00132      HRAD=0.25*(RNL+2.*RMID+RNH)
00133      IF (AREA.LE.0.0) QO(N)=0.0
00134      RETURN
00135      END
```

```

00001      SUBROUTINE HYDRAD (N,KLASS,DEPTH,HRAD,AREA,WIDTH)
00002      C
00003      C          THIS SUBROUTINE COMPUTES THE HYDRAULIC RADIUS,
00004      C          SURFACE WIDTH, * CROSS-SECTION AREA FOR PIPE 'N'
00005      C
00006      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00007      1TRIBA
00008      COMMON /BD/ANORM(26,5),HRNORM(26,5),TWNORM(26,5)
00009      C
00010      COMMON/PIPE/LEN(187),NJUNC(187,2),AFULL(187),AT(187),
00011      1 Q(187),V(187),VT(187),DEEP(187),A(187),WIDE(187),RFULL(187),
00012      2 NKCLASS(187),ZP(187,2),QT(187),QO(187),H(187,2),NCOND(187),
00013      3 ROUGH(187)
00014      COMMON/TRAP/STHETA(200),SPHI(200)
00015      REAL LEN
00016      C
00017      C          E X E C U T I O N
00018      C
00019      NTYPE=KLASS
00020      IF(DEPTH) 200,100,100
00021      C***** SPECIFY NTYPE FOR ORIFICES
00022      100 IF(NKCLASS(N).EQ. 7 .OR. NKCLASS(N).EQ. 8) NTYPE=1
00023      GO TO (120,180,120,120,120,190),NTYPE
00024      120 FDEPTH=DEPTH/DEEP(N)
00025      IF(FDEPTH-1.) 140,140,160
00026      C
00027      C***** INTERPOLATE TABLE OF PROPERTIES
00028      140 I=1+IFIX(FDEPTH/0.04)
00029      DELTA=(FDEPTH-0.04*FLOAT(I-1))/0.04
00030      WIDTH = WIDE(N)*(TWNORM(I,NTYPE)+(TWNORM(I+1,NTYPE)-TWNORM(I,NTYPE
00031      1))*DELTA)
00032      AREA = AFULL(N)*(ANORM(I,NTYPE) + (ANORM(I+1,NTYPE)-ANORM(I,NTYPE)
00033      1))*DELTA)
00034      HRAD = RFULL(N)*(HRNORM(I,NTYPE)+(HRNORM(I+1,NTYPE)-HRNORM(I,NTYPE
00035      1))*DELTA)
00036      RETURN
00037      C
00038      C***** FULL PIPE
00039      160 WIDTH = 0.
00040      AREA=AFULL(N)
00041      HRAD=RFULL(N)
00042      RETURN
00043      C***** RECTANGULAR SECTION (SPECIAL CASE)
00044      C
00045      180 WIDTH=WIDE(N)
00046      AREA=WIDTH*DEPTH
00047      HRAD=AREA/(WIDTH+2.*DEPTH)
00048      HRAD=AMAX1(HRAD,0.01)
00049      RETURN
00050      C
00051      C***** TRAPEZOIDAL SECTION (SPECIAL CASE)
00052      190 CONTINUE
00053      DEPTT=DEPTH
00054      FDEP=DEPTH-DEEP(N)
00055      IF(FDEP) 196,196,194
00056      194 DEPTT=DEEP(N)

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00057      196 CONTINUE
00058      WIDTH=WIDE(N)+DEPTT*(STHETA(N)+SPHI(N))
00059      AREA=DEPTT*(WIDE(N)+(DEPTT/2.)*(STHETA(N)+SPHI(N)))
00060      WETPER=WIDE(N)+DEPTT*(SQRT(1.+STHETA(N)**2.)+SQRT(1.+SPHI(N)**2.))
00061      HRAD=AREA/WETPER
00062      HRAD=AMAX1(HRAD,0.01)
00063      RETURN
00064      C
00065      C***** NEGATIVE DEPTH
00066      200 WRITE(N6,5000) NCOND(N),DEPTH
00067      5000 FORMAT('NEGATIVE DEPTH ENTERED TO HYDRAD, COND.',I6,E16.4)
00068      DEPTH=0.
00069      GO TO 100
00070      END
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00001      SUBROUTINE INDATA
00002      C
00003      C      THIS SUBROUTINE READS AND PRINTS ALL INPUT DATA
00004      C      EXCEPT FOR HYDROGRAPH CARDS IN 'INFLOW'
00005      C      IT ALSO PERFORMS SOME INITIALIZATION
00006      C      ALL NODE-CONDUIT LINKAGES ARE SET UP AND
00007      C      CONVERTED TO THE INTERNAL NUMBER SYSTEM
00008      C
00009      INTEGER IFNAM(3),OFNAM(3),IHFNM(3),INQTM(3)
00010      COMMON /BD/ANORM(26,5),HRNORM(26,5),TWNORM(26,5)
00011      C
00012      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00013      1TRIBA
00014      COMMON/CONTR/ NTCYC,DELTQ,DELT,DELT2,TZERO,ALPHA(40),
00015      1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00016      C
00017      COMMON/JUNC/Y(187),YT(187),NCHAN(187,8),AS(187),Z(187),QIN(187),
00018      1 QOU(187),QINST(187),GRELEV(187),JUN(187),ZCROWN(187),JSKIP(187)
00019      2 ,SUMAL(187),SUMQ(187),SUMQS(187),ASFULL(187)
00020      C
00021      COMMON/PIPE/LEN(187),NJUNC(187,2),AFULL(187),AT(187),
00022      1 Q(187),V(187),VT(187),DEEP(187),A(187),WIDE(187),RFULL(187),
00023      2 NKLASS(187),ZP(187,2),QT(187),QO(187),H(187,2),NCOND(187),
00024      3 ROUGH(187)
00025      COMMON/TRAP/STHETA(200),SPHI(200)
00026      C
00027      REAL LEN
00028      C
00029      COMMON/STORE/ NSTORE,JSTORE(20),ZTOP(20),ASTORE(20)
00030      COMMON/ORF/ NORIF,LORIF(60),AORIF(60),CORIF(60)
00031      COMMON/WEIR/ NWEIR,LWEIR(60),KWEIR(60),YTOP(60),YCREST(60),
00032      2 WLEN(60),COEF(60),COEFS(60)
00033      COMMON/PUMP/ NPUMP,LPUMP(20),PRATE(20,3),VRATE(20,3),VWELL(20),
00034      1 JPFUL(20),IPTYP(20)
00035      COMMON/BND/ NFREE,JFREE(25),NTIDE,JTIDE(25),NGATE,JGATE(25)
00036      C
00037      COMMON/OUT/ NPRT,IPRT,NHPRT,JPRT(20),PRTH(100,20),PRGEL(20),
00038      1 NQPRT,CPRT(20),PRTV(100,20),PRTQ(100,20),IDUM(12),ICOL(10),
00039      2 LTIME,NPLT,JPLT(20),YPLT(102,20),LPLT,KPLT(20),QPLT(102,20),
00040      3 TPLT(102),NPTOT,NSTART,INTER,PRTY(100,20)
00041      INTEGER CPRT
00042      C
00043      COMMON/TIDE/ YY(50) ,TT(50) ,AA(10),XX(10),SXX(10,10),SXY(10)
00044      C
00045      COMMON/HYFLOW/ ISW(187),QTAPE(187,2),JSW(65),QCARD(65,2),
00046      1 WATSH(187),TE0,TP,T2,TE,T20,TIME0,NSTEPS,NINREC
00047      C
00048      COMMON/LAB/ TITLE(40),XLAB(11),YLAB(6),HORIZ(5),VERT(6)
00049      C
00050      COMMON/SURCHG/SURTOL,ITMAX
00051      C
00052      DIMENSION OTYPE(2),EXTRAN(5),SOURCE(5),QOUT(100)
00053      C
00054      DATA OTYPE/'SIDE','SUMP'/
00055      DATA ENOTE/6HERROR ,6HERRORS/
00056      DATA EXTRAN/4HEXTE,4HNDED,4H TRA,4HNSPO,4HRT /

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00057 C
00058 C
00059 C
00060 NSTOP=0
00061 NDIM=187
00062 C
00063 C***** HEADING (TITLE) CARDS
00064 C
00065 READ(N5,5040) ALPHA
00066 5040 FORMAT(20A4)
00067 WRITE(N6,2999)
00068 2999 FORMAT('1',64(2H--))' ', 'ENVIRONMENTAL PROTECTION AGENCY',13X,40H*
00069 2*** EXTENDED TRANSPORT PROGRAM ****,8X,'WATER RESOURCES DIVISI
00070 30N'/' ', 'WASHINGTON, D.C. ',16X,4H****,32X,4H****,8X,
00071 4'CAMP DRESSER & MCKEE INC.'/' ', ' ',28X,4H
00072 5****,6X,' ANALYSIS MODULE ',6X,4H****,8X,'ANNANDALE, VIRGINIA
00073 6')
00074 WRITE(N6,5060) ALPHA
00075 5060 FORMAT(' ',20A4/' ',20A4//)
00076 C
00077 C***** GENERAL CONTROL PARAMETERS
00078 C
00079 READ(N5,5080) NTCYC,DELT,TZERO,NHPRT,NQPR,T,NPLT,LPLT,NSTART,INTER,
00080 1 NJSW,ITMAX,SURTOL
00081 5080 FORMAT(I5,2F5.0,8I5,F5.0)
00082 DELT2=DELT/2.
00083 IF(N22.EQ.0)NJSW=0
00084 WRITE(N6,5100) NTCYC
00085 5100 FORMAT (19H0INTEGRATION CYCLES,I5)
00086 WRITE(N6,5120) DELT
00087 5120 FORMAT (30H0LENGTH OF INTEGRATION STEP IS,F6.0,8H SECONDS)
00088 IF (NSTART.LE.0) NSTART = 1
00089 INTEMP=(NTCYC-NSTART)/100 + 1
00090 IF (INTEMP.GE.INTER) INTER=INTEMP
00091 WRITE(N6,5140) NSTART,INTER
00092 5140 FORMAT('0PRINTING STARTS IN CYCLE',I5,' AND PRINTS AT INTERVALS OF
00093 1',I4,' CYCLES')
00094 WRITE(N6,5160) TZERO
00095 5160 FORMAT (13H0INITIAL TIME,F6.2,6H HOURS)
00096 TZERO=3600.*TZERO
00097 C
00098 C***** PRINT AND PLOT DATA
00099 C
00100 C***** JUNCTION NUMBERS FOR DETAILED PRINTOUT
00101 READ(N5,5180)(JPRT(I),I=1,NHPRT)
00102 5180 FORMAT(8I10)
00103 WRITE(N6,5200)NHPRT,(JPRT(I),I=1,NHPRT)
00104 5200 FORMAT (32H0PRINTED OUTPUT AT THE FOLLOWING,I3,10H JUNCTIONS,//
00105 1 (10X,9I10))
00106 C***** CONDUIT NUMBERS FOR DETAILED PRINTOUT
00107 READ(N5,5180)(CPRT(I),I=1,NQPR)
00108 WRITE(N6,5220)NQPR,(CPRT(I),I=1,NQPR)
00109 5220 FORMAT (/ ,11X,'AND FOR THE FOLLOWING',I3,' CONDUITS'//(10X,9I10))
00110 C***** JUNCTION NUMBERS FOR PLOTTING
00111 IF (NPLT.LE.0) GO TO 100
00112 READ (N5,5180) (JPLT(N),N=1,NPLT)

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00113      WRITE(N6,5240) NPLT,(JPLT(N),N=1,NPLT)
00114      5240 FORMAT ('OWATER SURFACE ELEVATIONS WILL BE PLOTTED FOR THE FOLLOWI
00115      ING ',I5,' JUNCTIONS'//(10X,9I10))
00116      C***** CONDUIT NUMBERS FOR PLOTTING
00117      100 IF (LPLT.LE.0) GO TO 120
00118      READ (N5,5180) (KPLT(N),N=1,LPLT)
00119      WRITE(N6,5260) LPLT,(KPLT(N),N=1,LPLT)
00120      5260 FORMAT('OWFLOW RATE WILL BE PLOTTED FOR THE FOLLOWING',I5,' CONDUIT
00121      1S'//(10X,9I10))
00122      120 CONTINUE
00123      C
00124      C***** CONDUIT DATA
00125      C
00126      DO 260 N=1,NDIM
00127      READ (N5,5280) NCOND(N),(NJUNC(N,K),K=1,2),NKCLASS(N),AFULL(N)
00128      1 ,DEEP(N),WIDE(N),LEN(N),(ZP(N,K),K=1,2),ROUGH(N),STHETA(N),
00129      2 SPHI(N)
00130      5280 FORMAT (4I5,9F5.0)
00131      IF (NCOND(N).GT.90000) GO TO 280
00132      IF(ROUGH(N).LE. 0.0) ROUGH(N) = 0.014
00133      KCLASS=NKCLASS(N)
00134      C          NKCLASS=1 CIRCULAR PIPE
00135      C          NKCLASS=2 RECTANGULAR PIPE
00136      C          NKCLASS=3 HORSESHOE PIPE
00137      C          NKCLASS=4 EGGSHAPED PIPE
00138      C          NKCLASS=5 BASKETHANDLE PIPE
00139      C          NKCLASS=6 TRAPEZOIDAL CHANNEL
00140      C          NKCLASS=7-8 ORIFICES (SEE BELOW)
00141      GO TO (140,160,180,200,220,230),KCLASS
00142      140 RFULL(N)=DEEP(N)/4.
00143      AFULL(N)=(3.1415926/4.)*DEEP(N)**2
00144      WIDE(N)=DEEP(N)
00145      GO TO 240
00146      160 RFULL(N)=(WIDE(N)*DEEP(N))/(2.*WIDE(N)+2.*DEEP(N))
00147      AFULL(N)=WIDE(N)*DEEP(N)
00148      GO TO 240
00149      180 RFULL(N)=0.25381*DEEP(N)
00150      GO TO 240
00151      200 RFULL(N)=0.19311*DEEP(N)
00152      GO TO 240
00153      220 RFULL(N)=0.28800*DEEP(N)
00154      GO TO 240
00155      230 AFULL(N)=DEEP(N)*(WIDE(N)+DEEP(N)/2.*(STHETA(N)+SPHI(N)))
00156      RFULL(N)=AFULL(N)/(WIDE(N)+DEEP(N)*(SQRT(1.+STHETA(N)**2.))
00157      1 +SQRT(1.+SPHI(N)**2.)))
00158      IF(WIDE(N).LE.0.) WIDE(N) = 0.01
00159      240 CONTINUE
00160      260 CONTINUE
00161      280 NC=N-1
00162      NTC=NC
00163      C***** PRINT CONDUIT DATA
00164

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00165      WRITE(N6,2999)
00166      WRITE(N6,5060) ALPHA
00167      WRITE(N6,5300)
00168 5300 FORMAT(1H,'          CONDUIT   LENGTH   CLASS   AREA   MANNING
00169      1   MAX WIDTH      DEPTH   JUNCTIONS   INVERT HEIGHT   T
00170      2RAPEZOID'/,
00171      27X,'NUMBER      (FT)
00172      3   (FT)      AT ENDS      (SQ FT)   COEF.      (FT)
                                ABOVE JUNCTIONS   SIDE SLOPE')
00173      NSPRT=-1
00174      DO 300 N=1,NC
00175      IF((ZP(N,1).EQ.0.).AND.(ZP(N,2).EQ.0.)) GO TO 296
00176      GO TO 297
00177 296 IF(NKCLASS(N).EQ.6) WRITE(N6,5320)N,NCOND(N),LEN(N),NKCLASS(N),
00178      *AFULL(N),ROUGH(N),WIDE(N),DEEP(N),(NJUNC(N,K),K=1,2),
00179      *STHETA(N),SPHI(N)
00180      IF(NKCLASS(N).NE.6) WRITE(N6,5321)N,NCOND(N),LEN(N),NKCLASS(N),
00181      *AFULL(N),ROUGH(N),WIDE(N),DEEP(N),(NJUNC(N,K),K=1,2)
00182      GO TO 300
00183 297 IF(NKCLASS(N).EQ.6) WRITE(N6,5322)N,NCOND(N),LEN(N),NKCLASS(N),
00184      *AFULL(N),ROUGH(N),WIDE(N),DEEP(N),(NJUNC(N,K),K=1,2),
00185      *(ZP(N,K),K=1,2),STHETA(N),SPHI(N)
00186      IF(NKCLASS(N).NE.6) WRITE(N6,5323)N,NCOND(N),LEN(N),NKCLASS(N),
00187      *AFULL(N),ROUGH(N),WIDE(N),DEEP(N),(NJUNC(N,K),K=1,2),
00188      *(ZP(N,K),K=1,2)
00189 5320 FORMAT(I4,I9,F9.0,I7,F12.2,F9.3,F15.2,F13.2,2X,2I6,
00190      *28X,2F5.2)
00191 5321 FORMAT(I4,I9,F9.0,I7,F12.2,F9.3,F15.2,F13.2,2X,2I6)
00192 5322 FORMAT(I4,I9,F9.0,I7,F12.2,F9.3,F15.2,F13.2,2X,2I6,8X,F5.2,
00193      *2X,F5.2,8X,2F5.2)
00194 5323 FORMAT(I4,I9,F9.0,I7,F12.2,F9.3,F15.2,F13.2,2X,2I6,8X,F5.2,
00195      *2X,F5.2)
00196      300 CONTINUE
00197  C
00198  C***** CHECK FOR VIOLATION OF WAVE TRAVEL/CONDUIT LENGTH RATIO
00199      DO 320 N=1,NC
00200      RATIO=SQRT(DEEP(N)*32.2)*DELT/LEN(N)
00201      IF(RATIO.GT.1.)WRITE(N6,5335)NCOND(N),RATIO
00202 5335 FORMAT(' **** WARNING **** (C*DELT/LEN) IN CONDUIT',
00203      ' I6,' IS',F5.1,' AT FULL DEPTH.')
00204      320 CONTINUE
00205  C
00206  C***** JUNCTION DATA
00207  C
00208      DO 380 J=1,NDIM
00209      READ (N5,5340) JUN(J),GRELEV(J),Z(J),QINST(J)
00210 5340 FORMAT (I5,3F5.0)
00211      IF (JUN(J).GT.90000) GO TO 400
00212      ZCROWN(J)=Z(J)
00213      JSKIP(J)=0
00214  C***** SET UP JUNCTION CONNECTIVITY ARRAY FROM PIPE DATA
00215      LOC=1
00216      SUMAL(J)=0.
00217      DO 360 N=1,NC
00218      DO 360 K=1,2
00219      IF(NJUNC(N,K)-JUN(J)) 360,340,360
00220      340 NCHAN(J,LOC)=N

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00221      LOC=LOC+1
00222      360 CONTINUE
00223      IF(LOC.GT.1) GO TO 380
00224      WRITE(N6,5350) JUN(J)
00225      5350 FORMAT('0**** WARNING *** JUNCTION',I6,' IS NOT ASSOCIATED WITH
00226      .          'ANY PIPE')
00227      JSKIP(J)=1
00228      380 CONTINUE
00229      400 NJ=J-1
00230      C
00231      C***** CONVERT CONDUIT CONNECTIVITY NUMBERS TO INTERNAL SYSTEM
00232      C***** ASSIGN POSITIVE DOWNSTREAM FLOW CONVENTION
00233      DO 600 N=1,NC
00234      DO 540 K=1,2
00235      DO 500 J=1,NJ
00236      IF(NJUNC(N,K)-JUN(J)) 500,520,500
00237      500 CONTINUE
00238      WRITE(N6,5390) NJUNC(N,K),NCOND(N)
00239      5390 FORMAT('0**** ERROR *** JUNCTION',I6,' ON CONDUIT',I6,' IS NOT
00240      .          'CONTAINED IN JUNCTION DATA')
00241      NSTOP=NSTOP+1
00242      520 NJUNC(N,K)=J
00243      540 CONTINUE
00244      NL=NJUNC(N,1)
00245      NH=NJUNC(N,2)
00246      ZP(N,1) = Z(NL) + ZP(N,1)
00247      ZP(N,2)=Z(NH)+ZP(N,2)
00248      IF(ZP(N,1)-ZP(N,2)) 560,580,580
00249      560 TEMP=ZP(N,1)
00250      ZP(N,1)=ZP(N,2)
00251      ZP(N,2)=TEMP
00252      NJUNC(N,1) = NH
00253      NJUNC(N,2)=NL
00254      NL=NJUNC(N,1)
00255      NH=NJUNC(N,2)
00256      580 IF((ZP(N,1)+DEEP(N)).GT.ZCROWN(NL)) ZCROWN(NL)=ZP(N,1)+DEEP(N)
00257      IF((ZP(N,2)+DEEP(N)).GT.ZCROWN(NH)) ZCROWN(NH)=ZP(N,2)+DEEP(N)
00258
00259
00260      IF(ZCROWN(NL).LE.GRELEV(NL)+0.001) GO TO 590
00261      WRITE(N6,5395) NCOND(N),JUN(NL)
00262      ZCROWN(NL)=GRELEV(NL)-0.01
00263      NSTOP=NSTOP+1
00264      590 IF(ZCROWN(NH).LE.GRELEV(NH)+0.001) GO TO 600
00265
00266      WRITE(N6,5395) NCOND(N),JUN(NH)
00267      5395 FORMAT('0**** ERROR *** CONDUIT',I6,' HAS CAUSED ZCROWN OF '
00268      .          'JUNCTION',I6,' TO LIE ABOVE THE SPECIFIED GROUND ELEV.')
00269      ZCROWN(NH)=GRELEV(NH)-0.01
00270      NSTOP=NSTOP+1
00271      600 CONTINUE
00272      C***** PRINT JUNCTION DATA
00273      WRITE(N6,2999)
00274      WRITE(N6,5060) ALPHA
00275      WRITE(N6,5360)
00276      5360 FORMAT(1H,5X,' JUNCTION          GROUND          CROWN          INVERT          QINST'

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00277      1,15X,'CONNECTING CONDUITS'/7X,'NUMBER',7X,'ELEV.',5X,'ELEV.',6X,
00278      1'ELEV.',5X,'(CFS)'/)
00279      DO 460 J=1,NJ
00280      MPT=0
00281      NZP = 0
00282      DO 420 I=1,8
00283      K1 = NCHAN(J,I)
00284      IF(K1.EQ.0) GO TO 440
00285      IDUM(I) = NCOND(K1)
00286      MPT=MPT+1
00287      C***** CHECK FOR ALL CONDUITS ABOVE JUNCTION INVERT
00288      JJ = 0
00289      IF(NJUNC(K1,1).EQ.J) JJ = 1
00290      IF(JJ.NE.1) JJ = 2
00291      IF(ZP(K1,JJ).GT.Z(J)) NZP = NZP + 1
00292      420 CONTINUE
00293      440 CONTINUE
00294      C
00295      WRITE(N6,5380) J,JUN(J),GRELEV(J),ZCROWN(J),Z(J),QINST(J),
00296      1(IDUM(K),K=1,MPT)
00297      5380 FORMAT(I4,I9,F12.2,F10.2,F10.2,15X,8I7)
00298      IF(NZP.LT.MPT) GO TO 450
00299      WRITE(N6,5381) JUN(J)
00300      5381 FORMAT(1X,'**** ERROR **** ALL CONDUITS CONNECTING',
00301      *' TO JUNCTION ',I6,' LIE ABOVE THE JUNCTION INVERT')
00302      NSTOP = NSTOP + 1
00303      450 CONTINUE
00304      QINST(J)=QINST(J)*DELT
00305      460 CONTINUE
00306      480 CONTINUE
00307      WRITE(N6,5382)
00308      5382 FORMAT(///,64(2H--)/)
00309      C***** CHECK FOR HIGH PIPE
00310      DO 495 N=1,NC
00311      DO 495 K=1,2
00312      J = NJUNC(N,K)
00313      IF(ZP(N,K).EQ.Z(J)) GO TO 495
00314      DO 490 KK = 1,8
00315      NKK = NCHAN(J,KK)
00316      IF(NKK.EQ.N) GO TO 490
00317      IF(NKK.EQ.0.OR.NKK.GT.NC) GO TO 495
00318      JJ = 0
00319      IF(NJUNC(NKK,1).EQ.J) JJ = 1
00320      IF(JJ.NE.1) JJ = 2
00321      IF(ZP(N,K).LE.ZP(NKK,JJ) + DEEP(NKK)) GO TO 495
00322      490 CONTINUE
00323      491 WRITE(N6,5392) NCOND(N),JUN(J)
00324      5392 FORMAT(' ***** ERROR ***** THE INVERT OF ',
00325      *'CONDUIT',I6,' LIES ABOVE THE CROWN OF ALL OTHER ',
00326      *'CONDUITS AT JUNCTION',I6)
00327      NSTOP = NSTOP + 1
00328      495 CONTINUE
00329      C
00330      C***** STORAGE JUNCTION DATA
00331      C
00332      DO 640 I=1,20

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00333      READ(N5,5391) JSTORE(I),ZTOP(I),ASTORE(I)
00334      5391 FORMAT(I5,2F10.0)
00335      IF(JSTORE(I).GT.90000) GO TO 645
00336      640 CONTINUE
00337      645 NSTORE=I-1
00338      IF(NSTORE) 647,647,644
00339      644 WRITE(N6,2999)
00340      WRITE(N6,5060) ALPHA
00341      WRITE(N6,5398)
00342      5398 FORMAT('0',27(2H- ),'STORAGE JUNCTION DATA',27(2H-),/)
00343      WRITE(N6,5495)
00344      5495 FORMAT(1X,'STORAGE JUNCTION',6X,'SURFACE AREA',6X,'VOLUME',
00345      *6X,'CROWN ELEVATION',/,26X,'(FT2)',11X,'(CF)',12X,'(FT)')
00346      C***** CONVERT TO INTERNAL NUMBER SYSTEM
00347      DO 646 I=1,NSTORE
00348      DO 648 J=1,NJ
00349      IF(JSTORE(I)-JUN(J)) 648,650,648
00350      648 CONTINUE
00351      WRITE(N6,5494) JSTORE(I)
00352      5494 FORMAT('0**** ERROR **** STORAGE JUNCTION ',I6,' IS NOT
00353      * CONTAINED IN JUNCTION DATA')
00354      NSTOP=NSTOP+1
00355      650 JSTORE(I)=J
00356      ZCROWN(J) = ZTOP(I)
00357      IF(ZCROWN(J).GT.GRELEV(J)) GRELEV(J) = ZCROWN(J) + 0.1
00358      JSKIP(J)=0
00359      CF = ASTORE(I)*(ZTOP(I)-Z(J))
00360      WRITE(N6,5399)(JUN(JSTORE(I)),ASTORE(I),CF,ZTOP(I)
00361      5399 FORMAT(6X,I5,13X,F8.2,7X,F8.2,10X,F6.2)
00362      646 CONTINUE
00363      NTL=NTL+NSTORE
00364      647 CONTINUE
00365      C
00366      C***** INITIALIZE NTC AND NTL
00367      NTC=NC
00368      NTL=NC
00369      C
00370      C***** ORIFICE DATA
00371      C
00372      DO 690 I=1,60
00373      N=NTC+I
00374      READ(N5,5400) (NJUNC(N,K),K=1,2),NKCLASS(N),AORIF(I),CORIF(I),
00375      *ZP(N,1)
00376      5400 FORMAT(3I5,3F5.0)
00377      IF(NJUNC(N,1).GE.90000) GO TO 695
00378      690 CONTINUE
00379      695 NORIF = I-1
00380      NTC = NTC + NORIF
00381      NTL = NTL + NORIF
00382      790 IF(NORIF) 696,696,697
00383      697 WRITE(N6,5420)
00384      DO 780 I=1,NORIF
00385      N = NTC - NORIF + I
00386      WRITE(N6,5440)(NJUNC(N,K),K=1,2),NKCLASS(N),AORIF(I),
00387      *CORIF(I),ZP(N,I)
00388      C

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Replace I by 1

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00389 C***** CONVERT TO INTERNAL NUMBER SYSTEM
00390 LORIF(I)=N
00391 NCOND(N)=N+90000
00392 DEEP(N)=SQRT(4.*AORIF(I)/3.14159)
00393 WIDE(N)=DEEP(N)
00394 AFULL(N)=AORIF(I)
00395 RFULL(N)=DEEP(N)/4.
00396 CLEN=2.*DELT*SQRT(32.2*DEEP(N))
00397 LEN(N)=AMAX1(200.,CLEN)
00398 ROUGH(N)=1.49*RFULL(N)**.67/(CORIF(I)*SQRT(LEN(N)*64.4))
00399 NKCLASS(N)=NKCLASS(N)+6
00400 C NKCLASS(N)=1, NKCLASS(N)=7 - SIDE OUTLET
00401 C NKCLASS(N)=2, NKCLASS(N)=8 - BOTTOM OUTLET (SUMP)
00402 C***** SET ZP(N,1) FOR BOTTOM OUTLET
00403 IF(NKCLASS(N).EQ. 8) ZP(N,1)=-0.96*DEEP(N)
00404 DO 770 K=1,2
00405 DO 700 J=1,NJ
00406 IF(NJUNC(N,K)-JUN(J)) 700,720,700
00407 700 CONTINUE
00408 WRITE(N6,5450) NJUNC(N,K)
00409 5450 FORMAT('0**** ERROR **** ORIFICE JUNCTION',I6,' IS NOT CONTAINED '
00410 , 'IN JUNCTION DATA')
00411 NSTOP=NSTOP+1
00412 720 NJUNC(N,K)=J
00413 C***** SET ZP(N,1) AND ZP(N,2) ELEVATIONS
00414 IF(K.EQ.2) GO TO 725
00415 ZP(N,K)=ZP(N,K)+Z(J)
00416 ZP(N,2) = ZP(N,1) - 0.1
00417 725 CONTINUE
00418 C
00419 C.... CHECK GROUND ELEVATION
00420 IF(ZP(N,K)+DEEP(N).LT. GRELEV(J)) GO TO 730
00421 WRITE(N6,5455) JUN(J)
00422 5455 FORMAT('0**** ERROR **** ORIFICE TOP LIES ABOVE GROUND ELEVATION'
00423 , ' AT JUNCTION',I7)
00424 NSTOP=NSTOP+1
00425 C
00426 730 CONTINUE
00427 DO 740 KK=1,8
00428 IF(NCHAN(J,KK)) 760,760,740
00429 740 CONTINUE
00430 760 NCHAN(J,KK)=N
00431 770 CONTINUE
00432 C***** CHECK GRAVITY FLOW DIRECTION
00433 IF(ZP(N,1) .GT. ZP(N,2)) GO TO 780
00434 J2=NJUNC(N,2)
00435 WRITE(N6,5458) JUN(J2)
00436 5458 FORMAT('0**** ERROR **** ORIFICE OUTLET AT JUNCTION',I7, 'IS
00437 1HIGHER THAN INLET')
00438 NSTOP=NSTOP+1
00439 780 CONTINUE
00440 5420 FORMAT('0',28(2H- ),'ORIFICE DATA',28(2H- ),/,
00441 ,*14X,' JUNCTION',18X,' TYPE',20X,' AREA',18X,' DISCHARGE',
00442 ,*13X,' HEIGHT ABOVE',/,10X,' FROM',9X,' TO',39X,' (FT2)',
00443 ,*18X,' COEFF.',17X,' JUNCTION')
00444 5440 FORMAT(9X,I5,7X,I5,14X,I4,18X,F7.2,18X,F6.4,

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00445      *18X,F6.3,4X,F6.3)
00446      696 CONTINUE
00447      C
00448      C***** WEIR DATA
00449      C
00450      C**** THIS ROUTINE HAS BEEN MODIFIED TO TRANSFER
00451      C**** WEIR DISCHARGES FROM NODE TO NODE RATHER
00452      C**** THAN FROM NODE TO CONDUIT
00453      DO 820 I=1,60
00454      N=NTC+I
00455      READ(N5,5460) (NJUNC(N,K),K=1,2),KWEIR(I),YCREST(I),YTOP(I),
00456      2 WLEN(I),COEF(I)
00457      5460 FORMAT(3I5,4F5.0)
00458      IF(NJUNC(N,1).GE.90000) GO TO 840
00459      820 CONTINUE
00460      840 NWEIR=I-1
00461      IF(NWEIR) 1040,1040,860
00462      860 WRITE(N6,5480)
00463      5480 FORMAT(/,'0',29(2H-),'WEIR DATA',29(2H-),/,
00464      *8X,'JUNCTION',17X,'LINK',11X,'TYPE',11X,'CREST',11X,'WEIR',
00465      *11X,'WEIR',9X,'DISCHARGE',/,2X,'FROM',12X,'TO',12X,
00466      *'NUMBER',23X,'HEIGHT(FT)',7X,'TOP(FT)',6X,'LENGTH(FT)',
00467      *8X,'COEFF. ')
00468      5487 FORMAT(1X,I5,10X,I5,12X,I5,11X,I2,12X,F5.2,10X,F5.2,
00469      *10X,F5.2,10X,F5.2)
00470      DO 1020 I=1,NWEIR
00471      N1=NTC+I
00472      LWEIR(I)=N1
00473      NCOND(N1)=90000+N1
00474      COEFS(I)=0.
00475      WRITE(N6,5487) (NJUNC(N1,K),K=1,2),NCOND(N1),KWEIR(I),
00476      *YCREST(I),YTOP(I),WLEN(I),COEF(I)
00477      DO 875 K=1,2
00478      IF(NJUNC(N1,K).EQ.0) GO TO 875
00479      DO 870 J=1,NJ
00480      IF(NJUNC(N1,K).EQ.JUN(J)) GO TO 871
00481      870 CONTINUE
00482      WRITE(N6,5490) NJUNC(N1,K)
00483      5490 FORMAT('0**** ERROR **** WEIR JUNCTION',I6,' IS NOT CONTAINED IN J
00484      2UNCTION DATA')
00485      NSTOP=NSTOP+1
00486      871 NJUNC(N1,K)=J
00487      DO 873 KK=1,8
00488      IF(NCHAN(J,KK)) 874,874,873
00489      873 CONTINUE
00490      874 NCHAN(J,KK) = N1
00491      875 CONTINUE
00492      1020 CONTINUE
00493      NTL=NTL+NWEIR
00494      1040 CONTINUE
00495      C
00496      C***** PUMP DATA
00497      C
00498      C**** NOTE -- ONLY ONE INFLUENT PIPE MAY BE CONNECTED TO AN OFF-LINE
00499      C      PUMP NODE
00500      DO 1060 I=1,20

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00501      N=NTL+I
00502      READ(N5,5540) (NJUNC(N,K),K=1,2),IPTYP(I),VWELL(I),
00503      *(PRATE(I,K),K=1,3),(VRATE(I,K),K=1,3)
00504      5540 FORMAT(3I5,7F5.0)
00505      C
00506      C      IPTYP = 1  OFF-LINE PUMP OPERATES ON WET WELL VOLUME
00507      C
00508      C      IPTYP = 2  IN-LINE PUMP OPERATES ON HEAD AT JUNCTION
00509      C
00510      IF(NJUNC(N,1).GE.90000) GO TO 1080
00511      1060 CONTINUE
00512      1080 NPUMP=I-1
00513      C***** PRINT PUMP NODES
00514      IF(NPUMP) 1260,1260,1100
00515      1100 WRITE(N6,5560)
00516      5560 FORMAT('0',30(2H-),'PUMP DATA',30(2H-),/,
00517      *10X,'JUNCTIONS',8X,'TYPE',9X,'INITIAL VOLUME',14X,
00518      *'PUMP RATE, CFS',15X,'VOL STAGES, FT3',11X,'WET WELL',
00519      */,8X,'FROM',5X,'TO',21X,'IN WELL, FT3',11X,'1',11X,'2',
00520      *11X,'3',10X,'1',11X,'2',11X,'VOLUME, FT3')
00521      DO 1120 I=1,NPUMP
00522      N=NTL+I
00523      1120 WRITE(N6,5580) I,(NJUNC(N,K),K=1,2),IPTYP(I),VWELL(I),
00524      *(PRATE(I,K),K=1,3),(VRATE(I,K),K=1,3)
00525      5580 FORMAT(1X,I3,2(3X,I5),6X,I5,10X,F10.0,8X,F10.0,1X,
00526      *F10.0,1X,F10.0,3X,F10.0,1X,F10.0,7X,F10.0)
00527      C***** CONVERT TO INTERNAL NUMBER SYSTEM
00528      DO 1240 I=1,NPUMP
00529      N=NTL+I
00530      LPUMP(I)=N
00531      NCOND(N)=N+90000
00532      DO 1220 K=1,2
00533      DO 1140 J=1,NJ
00534      IF(NJUNC(N,K)-JUN(J)) 1140,1160,1140
00535      1140 CONTINUE
00536      WRITE(N6,5590) NJUNC(N,K)
00537      5590 FORMAT('0**** ERROR **** PUMP JUNCTION'I6,' IS NOT CONTAINED IN '
00538      'JUNCTION DATA')
00539      NSTOP=NSTOP+1
00540      1160 NJUNC(N,K)=J
00541      DO 1180 KK=1,8
00542      IF(NCHAN(J,KK)) 1200,1200,1180
00543      1180 CONTINUE
00544      1200 NCHAN(J,KK)=N
00545      IF(IPTYP(I).EQ.2) GO TO 1220
00546      IF(KK.LE.2) GO TO 1220
00547      IF(K.EQ.2) GO TO 1220
00548      WRITE(N6,5595) JUN(J)
00549      5595 FORMAT('0**** ERROR **** MORE THAN ONE PIPE IS INFLUENT TO PUMP JU
00550      'NCTION ',I6)
00551      NSTOP=NSTOP+1
00552      1220 CONTINUE
00553      C***** SET JSKIP AND INFLOW INDEX FOR PUMP NODE
00554      JP=NJUNC(N,1)
00555      JSKIP(JP) = 0
00556      IF(IPTYP(I).EQ.2) GO TO 1235

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00557      JSKIP(JP) = 1
00558      Z(JP) = -100.
00559      1235 CONTINUE
00560      JPFUL(I)=1
00561      C
00562      1240 CONTINUE
00563      NTL=NTL+NPUMP
00564      1260 CONTINUE
00565      C
00566      C***** OUTFLOW DATA FOR OUTFALLS WITHOUT TIDE GATES
00567      C
00568      DO 1280 I=1,25
00569      READ(N5,5600) JFREE(I)
00570      5600 FORMAT(I5)
00571      IF(JFREE(I).GE.90000) GO TO 1300
00572      1280 CONTINUE
00573      1300 NFREE=I-1
00574      C***** PRINT OUTFLOW NODES
00575      IF(NFREE) 1400,1400,1320
00576      1320 WRITE(N6,5616)
00577      5616 FORMAT(//,'0',27(2H-),'FREE OUTFALL DATA',27(2H-)//)
00578      WRITE(N6,5620) (JFREE(I),I=1,NFREE)
00579      5620 FORMAT (10X,'FREE OUTFLOW AT JUNCTIONS',4X,9I7/(39X,9I7))
00580      C***** CONVERT TO INTERNAL NUMBER SYSTEM
00581      1340 DO 1390 I=1,NFREE
00582      DO 1360 J=1,NJ
00583      IF(JFREE(I)-JUN(J)) 1360,1380,1360
00584      1360 CONTINUE
00585      WRITE(N6,5630) JFREE(I)
00586      5630 FORMAT('0**** ERROR **** FREE OUTFALL JUNCTION',I6,' IS NOT '
00587      'CONTAINED IN JUNCTION DATA')
00588      NSTOP=NSTOP+1
00589      1380 JFREE(I)=J
00590      N=NTL+I
00591      NJUNC(N,1)=J
00592      NJUNC(N,2)=0
00593      NCHAN(J,2)=N
00594      NCOND(N)=N+90000
00595      JSKIP(J)=1
00596      1390 CONTINUE
00597      NTL=NTL+NFREE
00598      1400 CONTINUE
00599      C
00600      C***** OUTFALL DATA FOR OUTFALLS WITH TIDE GATES
00601      C
00602      DO 1420 I=1,25
00603      READ(N5,5640) JGATE(I)
00604      5640 FORMAT(I5)
00605      IF(JGATE(I).GE.90000) GO TO 1440
00606      1420 CONTINUE
00607      1440 NGATE=I-1
00608      C***** PRINT TIDE GATE NODES
00609      IF(NGATE) 1520,1520,1460
00610      WRITE(N6,5656)
00611      5656 FORMAT(//,'0',25(2H-),'TIDE GATE OUTFALL DATA',25(2H-),//)
00612      1460 WRITE(N6,5660) (JGATE(I),I=1,NGATE)

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00613 5660 FORMAT(10X,'PIPE OUTFALLS WITH TIDE GATES AT JUNCTIONS',8I7/
00614 *(52X,8I7))
00615 C***** CONVERT TO INTERNAL NUMBER SYSTEM
00616 DO 1510 I=1,NGATE
00617 DO 1480 J=1,NJ
00618 IF(JGATE(I)-JUN(J)) 1480,1500,1480
00619 1480 CONTINUE
00620 WRITE(N6,5662) JGATE(I)
00621 5662 FORMAT('0**** ERROR **** TIDE GATE JUNCTION',I6,' IS NOT '
00622 'CONTAINED IN JUNCTION DATA')
00623 NSTOP=NSTOP+1
00624 1500 JGATE(I)=J
00625 N=NTL+I
00626 NJUNC(N,1)=J
00627 NJUNC(N,2)=0
00628 NCHAN(J,2)=N
00629 NCOND(N)=N+90000
00630 JSKIP(J)=1
00631 1510 CONTINUE
00632 NTL=NTL+NGATE
00633 1520 CONTINUE
00634 C***** INTERNAL CONNECTIVITY INFORMATION
00635 WRITE(N6,2999)
00636 WRITE(N6,5060) ALPHA
00637 WRITE(N6,5665)
00638 5665 FORMAT (////'0',23(2H- ),' INTERNAL CONNECTIVITY INFORMATION',
00639 *23(2H- )//)
00640 WRITE(N6,5670)
00641 5670 FORMAT (' CONDUIT JUNCTION JUNCTION//)
00642 N1=NC+1
00643 DO 1525 N=N1,NTL
00644 J1=NJUNC(N,1)
00645 J2=NJUNC(N,2)
00646 IF(J2.GT.0) J2 = JUN(J2)
00647 WRITE(N6,5675) NCOND(N),JUN(J1),J2
00648 5675 FORMAT(4X,I11,2I13)
00649 1525 CONTINUE
00650 1527 CONTINUE
00651 IF(NJ.LE.NDIM) GO TO 1530
00652 WRITE(N6,5676)
00653 5676 FORMAT('0**** ERROR **** TOTAL NUMBER OF JUNCTIONS(INCLUDING WEIRS
00654 ') EXCEED PROGRAM DIMENSIONS, NJ=',I4)
00655 NSTOP=NSTOP+1
00656 1530 CONTINUE
00657 IF(NTL.LE.NDIM) GO TO 1535
00658 WRITE(N6,5677) NTL
00659 5677 FORMAT('0**** ERROR **** TOTAL NUMBER OF LINKS EXCEEDS PROGRAM DIM
00660 ENSIONS,NTL=',I4)
00661 NSTOP=NSTOP+1
00662 1535 CONTINUE
00663 C
00664 C***** TIDAL BOUNDARY DATA
00665 C
00666 READ(N5,5720) NTIDE,A1,A2,A3,A4,A5,A6,A7,W
00667 5720 FORMAT (I5,8F5.0)
00668 GO TO (1800,1790,1780,1760),NTIDE

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00669 C
00670 C      NTIDE=1 NO CONTROL WATERSURFACE AT THE OUTFALLS
00671 C      2 OUTFALL CONTROL WATERSURFACE AT CONSTANT ELEVATION=A1
00672 C      3 TIDE COEFFICIENTS READ IN
00673 C      4 COMPUTE TIDE COEFFICIENTS
00674 C
00675 1760 READ(N5,5740) KO,NI,NCHTID
00676 5740 FORMAT (3I5)
00677 READ (N5,5760) (TT(I),YY(I),I=1,NI)
00678 5760 FORMAT (8F10.0)
00679 CALL TIDCF(KO,NI,NCHTID)
00680 GO TO 1800
00681 1780 WRITE(N6,5780) A1,A2,A3,A4,A5,A6,A7,W
00682 W=2.*3.14159/W
00683 5780 FORMAT('OTIDAL COEFFICIENTS.',7F10.4/'OTIDAL PERIOD (HRS).',F8.2)
00684 GO TO 1800
00685 1790 WRITE(N6,5790) A1
00686 5790 FORMAT('OUTFLOW CONTROL WATER SURFACE ELEVATION IS',F7.2,' FEET')
00687 1800 CONTINUE
00688 W=W/3600.
00689 C
00690 C***** SET PRINT : PLOT ARRAYS IN INTERNAL NUMBER SYSTEM
00691 DO 1550 K=1,NQPRT
00692 DO 1540 N=1,NTC
00693 IF(NCOND(N)-CPRT(K)) 1540,1545,1540
00694 1540 CONTINUE
00695 WRITE(N6,5678) CPRT(K)
00696 5678 FORMAT('O**** ERROR **** CONDUIT',I6,' REQUESTED FOR PRINTOUT IS '
00697 , 'NOT CONTAINED IN CONDUIT DATA')
00698 NSTOP=NSTOP+1
00699 1545 CPRT(K)=N
00700 1550 CONTINUE
00701 IF(LPLT) 1640,1640,1560
00702 1560 DO 1620 K=1,LPLT
00703 DO 1580 N=1,NTL
00704 IF(NCOND(N)-KPLT(K)) 1580,1600,1580
00705 1580 CONTINUE
00706 WRITE(N6,5680) KPLT(K)
00707 5680 FORMAT('O**** ERROR **** CONDUIT',I6,' REQUESTED FOR PLOTTING IS '
00708 , 'NOT CONTAINED IN CONDUIT DATA')
00709 NSTOP=NSTOP+1
00710 GO TO 1620
00711 1600 KPLT(K)=N
00712 1620 CONTINUE
00713 1640 DO 1660 I=1,NHPRT
00714 DO 1650 J=1,NJ
00715 IF(JUN(J)-JPRT(I)) 1650,1655,1650
00716 1650 CONTINUE
00717 WRITE(N6,5690) JPRT(I)
00718 5690 FORMAT('O**** ERROR **** JUNCTION',I6,' REQUESTED FOR PRINTOUT '
00719 , 'IS NOT CONTAINED IN JUNCTION DATA')
00720 NSTOP=NSTOP+1
00721 1655 JPRT(I)=J
00722 1660 CONTINUE
00723 IF(NPLT,LE,0) GO TO 1740
00724 DO 1720 N=1,NPLT

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00725      DO 1680 J=1,NJ
00726      IF (JUN(J).EQ.JPLT(N)) GO TO 1700
00727 1680 CONTINUE
00728      WRITE(N6,5700) JPLT(N)
00729 5700 FORMAT('0*** ERROR *** JUNCTION',I6,' REQUESTED FOR PLOTTING
00730      , 'IS NOT CONTAINED IN JUNCTION DATA')
00731      NSTOP=NSTOP+1
00732      GO TO 1720
00733 1700 JPLT(N) = J
00734 1720 CONTINUE
00735 1740 CONTINUE
00736 C
00737 C***** CONDUIT INITIALIZATION
00738      DO 1820 N=1,NTC
00739 1820 ROUGH(N)=32.2*ROUGH(N)**2/2.208
00740 1824 CONTINUE
00741 C
00742 C**** READ AND WRITE INITIAL FLOWS, VELOCITIES, AND HEADS
00743 C**** FOR ALL CONDUITS AND JUNCTIONS (INCLUDING INTERNAL).
00744 C
00745      WRITE(N6,2999)
00746      WRITE(N6,5060) ALPHA
00747      WRITE(N6,11)
00748 11 FORMAT(1X,20(2H- ),' SUMMARY OF INITIAL HEADS, FLOWS AND
00749      * VELOCITIES ',22(2H- ),/)
00750      READ(N5,10) (Q(N),V(N),N=1,4)
00751      IF (Q(1).LT.99999.) GO TO 5
00752      DO 7 I = 1 , NTL
00753      Q(I)=0.
00754      V(I)=0.
00755 7 CONTINUE
00756      DO 8 J = 1 , NJ
00757      Y(J) = 0.
00758 8 CONTINUE
00759      WRITE(N6,31)
00760      GO TO 32
00761 5 CONTINUE
00762      IF (NTC.LT.5) GO TO 6
00763      READ(N5,10) (Q(N),V(N),N=5,NTL)
00764 6 READ(N5,10) (Y(J),J=1,NJ)
00765 10 FORMAT(8F10.0)
00766      WRITE(N6,12)
00767 12 FORMAT(1H0,' CONDUIT NO.',3X,' FLOW(CFS)',3X,' VELOCITY(FPS)',7X,' CON
00768      DUIT NO.',3X,' FLOW(CFS)',3X,' VELOCITY(FPS)',7X,' CONDUIT NO.',3X,' F
00769      LOW(CFS)',3X,' VELOCITY(FPS)')
00770 3-----', 7X,'-----',
00771 47X,'-----'///)
00772      DO 15 KKK=1,NTL,3
00773      KSTOP=KKK+2
00774      IF(KSTOP.GT,NTL) KSTOP=NTL
00775 15 WRITE(N6,16) (NCOND(KK), Q(KK),V(KK),KK=KKK,KSTOP)
00776 16 FORMAT(4X,I5,8X,F5.1,9X,F5.1,14X,I5,8X,F5.1,9X,F5.1,14X,I5,8X,F5.1
00777      2,9X,F5.1)
00778      WRITE(N6,2999)
00779      WRITE(N6,5060) ALPHA
00780      WRITE(N6,20)

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00781      20 FORMAT(1X,26(2H- ),' SUMMARY OF INITIAL DEPTHS ',26(2H- ),/)
00782      WRITE(N6,22)
00783      22 FORMAT(1H0,7X,' JUNCTION NO.',3X,' DEPTH(FT)',7X,' JUNCTION NO.',
00784      *3X,' DEPTH(FT)',7X,' JUNCTION NO.',3X,' DEPTH(FT)',7X,
00785      *' JUNCTION NO.',3X,' DEPTH(FT)',/,8X,'-----'
00786      *-----',3(7X,'-----')///)
00787      DO 25 KKK=1,NJ,4
00788      KSTOP=KKK+3
00789      IF(KSTOP.GT.NJ) KSTOP=NJ
00790      25 WRITE(N6,26)(JUN(KK),Y(KK),KK=KKK,KSTOP)
00791      26 FORMAT(4(11X,I5,9X,F5.1))
00792      31 FORMAT(///,1X,' INITIAL HEADS, FLOWS AND VELOCITIES ARE ZERO')
00793      32 CONTINUE
00794      C
00795      C***** HYDROGRAPH INPUT INITIALIZATION
00796      TP=TZERO
00797      TEO=TZERO
00798      DO 1840 L=1,NDIM
00799      ISW(L)=0
00800      DO 1840 K=1,2
00801      1840 QTAP(L,K)=0.
00802      DO 1841 L=1,20
00803      JSW(L)=0
00804      DO 1841 K=1,2
00805      1841 QCARD(L,K)=0.
00806      C
00807      C***** INPUT HYDROGRAPH INFORMATION (TAPE)
00808      C
00809      IF(N21) 1940,1940,1860
00810      1860 CONTINUE
00811      REWIND N21
00812      READ(N21) TITLE
00813      READ(N21)(SOURCE(I),I=1,5),NSTEPS,DUM,MJSW,NPOLL,TRIBA
00814      READ(N21)(ISW(L),L=1,MJSW)
00815      READ(N21)(DUM,DUM,J=1,NPOLL)
00816      READ(N21)(DUM,DUM,J=1,NPOLL)
00817      READ(N21)(DUM,J=1,NPOLL)
00818      READ(N21) QCONV
00819      WRITE(N6,2999)
00820      WRITE(N6,5060) ALPHA
00821      WRITE(N6,5840)(SOURCE(I),I=1,5),MJSW
00822      5840 FORMAT(' TAPE INPUT HYDROGRAPHS FROM ',5A4,' BLOCK AT ',
00823      1I6,' JUNCTIONS')
00824      C***** CONVERT TO INTERNAL NUMBERS
00825      DO 1920 L=1,MJSW
00826      DO 1880 J=1,NJ
00827      IF(ISW(L)-JUN(J)) 1880,1900,1880
00828      1880 CONTINUE
00829      WRITE(N6,5820) ISW(L)
00830      5820 FORMAT(' OPROGRAM CANNOT MATCH HYDROGRAPH AT NODE',I7,' TO JUNCTION
00831      1 DATA')
00832      NSTOP=NSTOP+1
00833      GO TO 1920
00834      1900 ISW(L)=J
00835      1920 CONTINUE
00836      C***** READ FIRST TWO HYDROGRAPH RECORDS

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00837      READ(N21) T20,DUM,DUM,(QTAP(L,1),(DUM,J=1,NPOLL),L=1,MJSW)
00838      WRITE(N6,5800) T20,MJSW
00839      5800 FORMAT('0***** SYSTEM INFLOWS (TAPE) AT ',F8.2,' HOURS FOR
00840      *IS,' JUNCTIONS',/,50X,' JUNCTION/INFLOW(CFS)',/)
00841      WRITE(N6,5830)((JUN(ISW(L)),QTAP(L,1)),L=1,MJSW)
00842      T20=T20*3600.
00843      READ(N21) T2,DUM,DUM,(QTAP(L,2),(DUM,J=1,NPOLL),L=1,MJSW)
00844      DO 1930 L=1,MJSW
00845      DO 1930 K=1,2
00846      1930 QTAP(L,K)=QTAP(L,K)*QCONV
00847      WRITE(N6,5810) T2
00848      5810 FORMAT('0***** SYSTEM INFLOWS (TAPE) AT ',F8.2,' HOURS',
00849      *' ( JUNCTION / INFLOW, CFS)',/)
00850      WRITE(N6,5830)((JUN(ISW(L)),QTAP(L,2)),L=1,MJSW)
00851      T2=T2*3600.
00852      NINREC=2
00853      C
00854      C***** INPUT HYDROGRAPH DATA (CARDS)' TYPE L
00855      C
00856      1940 IF(NJSW) 2040,2040,1960
00857      1960 READ(N5,5860) (JSW(L),L=1,NJSW)
00858      5860 FORMAT(16I5)
00859      WRITE(N6,2999)
00860      WRITE(N6,5060) ALPHA
00861      C***** CONVERT TO INTERNAL NUMBERS
00862      DO 2020 L=1,NJSW
00863      DO 1980 J=1,NJ
00864      IF(JSW(L)-JUN(J)) 1980,2000,1980
00865      1980 CONTINUE
00866      WRITE(N6,5820) JSW(L)
00867      NSTOP=NSTOP+1
00868      GO TO 2020
00869      2000 JSW(L)=J
00870      2020 CONTINUE
00871      C***** READ FIRST TWO HYDROGRAPH RECORDS
00872      READ(N5,5900) TE0,(QCARD(L,1),L=1,NJSW)
00873      5900 FORMAT(8F10.0)
00874      WRITE(N6,5829) TE0,NJSW
00875      WRITE(N6,5830)((JUN(JSW(L)),QCARD(L,1)),L=1,NJSW)
00876      5829 FORMAT('0***** SYSTEM INFLOWS (CARDS) AT ',F8.2,' HOURS',
00877      *' FOR',IS,' JUNCTIONS',/)
00878      5830 FORMAT(1X,IS,'/',F7.2,7(3X,IS,'/',F7.2))
00879      READ(N5,5900) TE,(QCARD(L,2),L=1,NJSW)
00880      WRITE(N6,5831) TE
00881      5831 FORMAT('0***** SYSTEM INFLOWS (CARDS) AT ',F8.2,' HOURS',
00882      *' ( JUNCTION / INFLOW,CFS )',/)
00883      C
00884      WRITE(N6,5830)((JUN(JSW(L)),QCARD(L,2)),L=1,NJSW)
00885      TE0 = TE0*3600.
00886      TE=TE*3600.
00887      TIME0=TE0
00888      2040 CONTINUE
00889      C***** OUTPUT HYDROGRAPH INITIALIZATION
00890      IF(N22.EQ.0) GO TO 2050
00891      WRITE(N22)(ALPHA(I),I=1,40)
00892      C**** DETERMINE OUTFLOW NODES

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```
00893      N1=NTC+1
00894      I=0
00895      DO 2045 N=N1,NTL
00896      IF(NJUNC(N,2).NE.0) GO TO 2045
00897      I=I+1
00898      QOUT(I)=Q(N)
00899      LOCNOS(I)=JUN(NJUNC(N,1))
00900 2045  CONTINUE
00901      NLOCAT=I
00902      IF(NLOCAT.LE.100) GO TO 2048
00903      WRITE(N6,5850)
00904 5850  FORMAT(1X,'***ERROR--MORE THAN 100 OUTFALL JUNCTIONS***')
00905      NSTOP=NSTOP+1
00906 2048  DUM=0.
00907      NDUM=0
00908      WRITE(N22)(EXTRAN(I),I=1,5),NTCYC,DELT,NLOCAT,NDUM,TRIBA
00909      WRITE(N22)(LOCNOS(K),K=1,NLOCAT)
00910      WRITE(N22) DUM,DUM
00911      WRITE(N22) DUM,DUM
00912      WRITE(N22) DUM
00913      CONV=1.
00914      WRITE(N22) CONV
00915      NHOUR=TZERO/3600.
00916      WRITE(N22) NHOUR,IDATEZ,NHOUR,(QOUT(K),DUM,K=1,NLOCAT)
00917 2050  IF(NSTOP.EQ.0) GO TO 2060
00918      WRITE(N6,5920)NSTOP
00919 5920  FORMAT('0***** EXECUTION TERMINATED BECAUSE OF ',
00920      *12,' DATA ERROR(S) *****')
00921      STOP
00922 2060  CONTINUE
00923      C
00924      RETURN
00925      END
```

```

00001      SUBROUTINE INFLOW
00002      C
00003      C      THIS SUBROUTINE SELECTS THE INPUT HYDROGRAPH
00004      C      ORDINATE FROM TAPE AND/OR CARDS
00005      C
00006      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00007      1TRIBA
00008      COMMON/CONTR/ NTCYC,DELTQ,DELT,DELT2,TZERO,ALPHA(40),
00009      1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00010      C
00011      COMMON/JUNC/Y(187),YT(187),NCHAN(187,8),AS(187),Z(187),QIN(187),
00012      1 QOU(187),QINST(187),GRELEV(187),JUN(187),ZCROWN(187),JSKIP(187)
00013      2 ,SUMAL(187),SUMQ(187),SUMQS(187),ASFULL(187)
00014      C
00015      C
00016      C
00017      COMMON/HYFLOW/ ISW(187),QTAPE(187,2),JSW(65),QCARD(65,2),
00018      1 WATSH(187),TED,TP,T2,TE,T20,TIMED,NSTEPS,NINREC .
00019      C
00020      C      E X E C U T I O N
00021      C
00022      DO 100 J=1,NJ
00023      100 QIN(J)=QINST(J)
00024      C
00025      C***** TAPE VALUES FROM WATERSHED MODEL ARE INTERPOLATED
00026      IF(MJSW) 280,280,120
00027      120 CONTINUE
00028      IF (TZERO-T2) 135,125,125
00029      C***** NEW INPUT DATA REQUIRED
00030      125 CONTINUE
00031      T20=T2
00032      TP=T20
00033      DO 130 L=1,MJSW
00034      130 QTAPE(L,1)=QTAPE(L,2)
00035      IF (NINREC-NSTEPS) 132,132,131
00036      131 WRITE(N6,4980)
00037      4980 FORMAT ('0', ' TZERO IS LATER IN TIME THAN LAST RECORD ON TAPE FROM
00038      1 WATERSHED')
00039      STOP
00040      132 CONTINUE
00041      READ(N21) T2,DUM,DUM,(QTAPE(L,1),(DUM,J=1,NPOLL),L=1,MJSW)
00042      DO 133 L=1,MJSW
00043      QTAPE(L,2)=QTAPE(L,2)*QCONV
00044      133 CONTINUE
00045      NINREC=NINREC+1
00046      WRITE(N6,4999)
00047      4999 FORMAT(/,1X,64(2H- ),//)
00048      WRITE(N6,5000)T2
00049      WRITE(N6,5030)((JUN(ISW(L)),QTAPE(L,2)),L=1,MJSW)
00050      T2=T2*3600.
00051      GO TO 120
00052      135 CONTINUE
00053      IF (TIME-T2) 220,140,140
00054      140 DO 160 L=1,MJSW
00055      J=ISW(L)
00056      SLOPE=(QTAPE(L,2)-QTAPE(L,1))/(T2-T20)

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00057      Q1=QTAP(L,1)+SLOPE*(TP-T20)
00058      Q2=QTAP(L,2)
00059      160 QIN(J)=QIN(J)+0.5*(Q1+Q2)*(T2-TP)
00060      T20=T2
00061      TP=T20
00062      DO 180 L=1,MJSW
00063      180 QTAP(L,1)=QTAP(L,2)
00064      IF(NINREC-NSTEPS) 200,220,220
00065      200 READ(N21) T2,(QTAP(L,2),L=1,MJSW)
00066      TPT=T2/3600.
00067      NINREC=NINREC+1
00068      WRITE(N6,4999)
00069      WRITE(N6,5000) TPT
00070      5000 FORMAT(/,'***** SYSTEM INFLOWS (TAPE) AT',F8.2,' HOURS',
00071      *' ( JUNCTION / INFLOW, CFS)',/)
00072      WRITE(N6,5830)((JUN(ISW(L)),QTAP(L,2)),L=1,MJSW)
00073      GO TO 120
00074      C***** NO NEW INPUT DATA REQUIRED
00075      220 DO 240 L=1,MJSW
00076      J=ISW(L)
00077      SLOPE=0.
00078      IF(T2.GT.T20) SLOPE=(QTAP(L,2)-QTAP(L,1))/(T2-T20)
00079      Q1=QTAP(L,1)+SLOPE*(TP-T20)
00080      Q2=QTAP(L,1)+SLOPE*(TIME-T20)
00081      240 QIN(J)=QIN(J)+0.5*(Q1+Q2)*(TIME-TP)
00082      TP=TIME
00083      C
00084      C***** CARD INPUT VALUES ARE INTERPOLATED
00085      280 IF(NJSW) 420,420,300
00086      300 CONTINUE
00087      IF (TZERO-TE) 335,320,320
00088      C***** NEW INPUT DATA REQUIRED
00089      320 CONTINUE
00090      TEO=TE
00091      TIMEO=TEO
00092      DO 325 L=1,NJSW
00093      325 QCARD(L,1)=QCARD(L,2)
00094      READ(N5,5020) TE,(QCARD(L,2),L=1,NJSW)
00095      C
00096      WRITE(N6,4999)
00097      WRITE(N6,5831) TE
00098      5831 FORMAT('***** SYSTEM INFLOWS (CARDS) AT',F8.2,' HOURS',
00099      *' ( JUNCTION / INFLOW,CFS)',/)
00100      C
00101      WRITE(N6,5830)((JUN(JSW(L)),QCARD(L,2)),L=1,NJSW)
00102      5830 FORMAT(3X,I5,'/',F7.2,7(3X,I5,'/',F7.2))
00103      WRITE(N6,5832)
00104      5832 FORMAT(/)
00105      TE=3600.*TE
00106      GO TO 300
00107      335 CONTINUE
00108      IF (TIME-TE) 380,338,338
00109      338 CONTINUE
00110      DO 340 L=1,NJSW
00111      J=JSW(L)
00112      SLOPE=(QCARD(L,2)-QCARD(L,1))/(TE-TEO)

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```
00113      Q1=QCARD(L,1)+SLOPE*(TIME0-TE0)
00114      Q2=QCARD(L,2)
00115      340 QIN(J)=QIN(J)+0.5*(Q1+Q2)*(TE-TIME0)
00116      TE0=TE
00117      TIME0=TE0
00118      DO 360 L=1,NJSW
00119      360 QCARD(L,1)=QCARD(L,2)
00120      READ(N5,5020) TE,(QCARD(L,2),L=1,NJSW)
00121      WRITE(N6,4999)
00122      WRITE(N6,5831) TE
00123      WRITE(N6,5830)((JUN(JSW(L)),QCARD(L,2)),L=1,NJSW)
00124      TE=3600.*TE
00125      WRITE(N6,5832)
00126      5020 FORMAT(8F10.0)
00127      GO TO 300
00128      C***** NO NEW INPUT DATA REQUIRED
00129      380 DO 400 L=1,NJSW
00130      J=JSW(L)
00131      SLOPE=(QCARD(L,2)-QCARD(L,1))/(TE-TE0)
00132      Q1=QCARD(L,1)+SLOPE*(TIME0-TE0)
00133      Q2=QCARD(L,1)+SLOPE*(TIME-TE0)
00134      TTT=TIME-TIME0
00135      IF (TTT.GT.DELT) TTT=DELTA
00136      400 QIN(J)=QIN(J)+0.5*(Q1+Q2)*TTT
00137      TIME0=TIME
00138      C
00139      420 DO 440 J=1,NJ
00140      440 QIN(J)=QIN(J)/DELTA
00141      RETURN
00142      END
```

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00001      SUBROUTINE OUTPUT
00002      C
00003      C      THIS SUBROUTINE PRINTS OUTPUT
00004      C      * CONTROLS THE PRINTER PLOT ROUTINES
00005      C
00006      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00007      1TRIBA
00008      COMMON/CONTR/NTCYC,DELTQ,DELT,DELT2,TZERO,ALPHA(40),
00009      1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00010      C
00011      COMMON/JUNC/Y(187),YT(187),NCHAN(187,8),AS(187),Z(187),QIN(187),
00012      1 QOU(187),QINST(187),GRELEV(187),JUN(187),ZCROWN(187),JSKIP(187)
00013      2 ,SUMAL(187),SUMQ(187),SUMQS(187),ASFULL(187)
00014      C
00015      COMMON/PIPE/LEN(187),NJUNC(187,2),AFULL(187),AT(187),
00016      1 Q(187),V(187),VT(187),DEEP(187),A(187),WIDE(187),RFULL(187),
00017      2 NKCLASS(187),ZP(187,2),QT(187),QO(187),H(187,2),NCOND(187),
00018      3 ROUGH(187)
00019      REAL LEN
00020      C
00021      COMMON/STORE/ NSTORE,JSTORE(20),ZTOP(20),ASTORE(20)
00022      C
00023      COMMON/OUT/ NPRT,IPRT,NHPRT,JFRT(20),PRTH(100,20),PRGEL(20),
00024      1 NPRT,CPRT(20),PRTV(100,20),PRTQ(100,20),IDUM(12),ICOL(10),
00025      2 LTIME,NPLT,JPLT(20),YPLT(102,20),LPLT,KPLT(20),QPLT(102,20),
00026      3 TPLT(102),NPTOT,NSTART,INTER,PTY(100,20)
00027      COMMON/ELEV/ ZINVRT,ZCRN,ZGRND,IPLT
00028      INTEGER CPRT
00029      C
00030      COMMON/LAB/TITLE(40),XLAB(11),YLAB(6),HORIZ(5),VERT(6)
00031      COMMON/STATS/UMAXX(187),QMAXX(187),DEPMAX(187),IVHR(187),
00032      2IVMIN(187),IQHR(187),IQMIN(187),IDHR(187),IDMIN(187),SURLEN(187),
00033      3SUMQIN,VLEFT
00034      C
00035      DIMENSION VERTQ(6)
00036      DATA VERTQ/4HCOND,4HUIT ,4H FLO,4HW ,4HIN ,4HCFS /
00037      C
00038      C      E X E C U T I O N
00039      C***** PRINT CONTINUITY SUMMARY
00040      C
00041      C
00042      WRITE(N6,5002)
00043      5002 FORMAT(////,' ',23(2H- ),' CONTINUITY BALANCE AT END OF RUN ',
00044      *23(2H- ),/)
00045      5001 FORMAT(' TOTAL SYSTEM INFLOW VOLUME =',F12.0,' CU FT',/)
00046      WRITE(N6,5001) SUMQIN
00047      WRITE(N6,5004)
00048      5004 FORMAT(' JUNCTION OUTFLOWS AND',/, ' STREET FLOODING',/)
00049      WRITE(N6,5005)
00050      5005 FORMAT(4X,' JUNCTION',2X,' OUTFLOW, FT3',/)
00051      DO 119 J=1,NJ
00052      IF(QOU(J).GT.0.) WRITE(N6,5003) JUN(J),QOU(J)
00053      5003 FORMAT(7X,I5,2X,F12.0)
00054      SUMOUT = SUMOUT + QOU(J)
00055      119 CONTINUE
00056      WRITE(N6,5007)

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00057 5007 FORMAT(15X,7(2H--))  
00058 WRITE(N6,5008) SUMOUT  
00059 5008 FORMAT(13X,'TOTAL',11X,F12.0,' CU FT',/)  
00060 WRITE(N6,5009) VLEFT  
00061 5009 FORMAT(' VOLUME LEFT IN SYSTEM =',5X,F12.0,' CU FT',/)  
00062 PCTERR = ((SUMQIN-SUMOUT-VLEFT)/SUMQIN)*100.  
00063 WRITE(N6,5006) PCTERR  
00064 5006 FORMAT(' ERROR IN CONTINUITY, PERCENT =',F6.2)  
00065 C***** PRINT H.G.L. AND WATER DEPTH AT NODES  
00066 C  
00067 NSTART=NSTART-LTIME*INTER  
00068 TIMEQ=TZERO+FLOAT(NSTART)*DELT  
00069 DO 100 I=1,NHPRT  
00070 MJprt=JPrt(I)  
00071 JPrt(I)=JUN(MJprt)  
00072 100 PRGEL(I)=GRELEV(MJprt)  
00073 5000 FORMAT(' ',20A4/' ',20A4//)  
00074 DO 120 I=1,NHPRT,6  
00075 WRITE(N6,2999)  
00076 2999 FORMAT('1',64(2H--)//' ','ENVIRONMENTAL PROTECTION AGENCY',13X,40H*  
00077 2*** EXTENDED TRANSPORT PROGRAM ****,3X,'WATER RESOURCES DIVISI  
00078 3ON''','WASHINGTON, D.C.',16X,4H****,32X,4H****,8X,  
00079 4'CAMP DRESSER & MCKEE INC.'//'',',28X,4H  
00080 5****,6X,' ANALYSIS MODULE ',6X,4H****,8X,'ANNANDALE, VIRGINIA  
00081 6')  
00082 WRITE(N6,5000) ALPHA  
00083 WRITE(N6,5020)  
00084  
00085 5020 FORMAT(1H0' *****',  
00086 2'TIME HISTORY OF H. G. L. *****',  
00087 3'*****')  
00088 WRITE(N6,5030)  
00089  
00090 5030 FORMAT(56X,' (VALUES IN FEET)')  
00091 IT=I+5  
00092 IF(IT.GT.NHPRT) IT=NHPRT  
00093 WRITE(N6,5040) (JPrt(L),L=I,IT)  
00094 5040 FORMAT(1H0,8X,6(7X,' JUNCTION',I5))  
00095 WRITE(N6,5060) (PRGEL(L),L=I,IT)  
00096 5060 FORMAT(' TIME',2X,6(8X,' GRND',F7.2),/, ' HR . MIN',6(7X,' ELEV  
00097 1 DEPTH'),/)  
00098 LT=MNO(I+5,NHPRT)  
00099 DO 120 L=1,LTIME  
00100 TIME=(TIMEQ+FLOAT((L-1)*INTER)*DELT)/3600.  
00101 LTIMEH=IFIX(TIME)  
00102 LTIMEH=IFIX((TIME-FLOAT(LTIMEH))*60.0+0.5)  
00103 120 WRITE(N6,5080) LTIMEH,LTIMEN,(PRTH(L,K),K=I,LT)  
00104 5080 FORMAT(' ',I3,',',I2,2X,6(F12.2,F8.2))  
00105 C  
00106 C***** COMPUTE AND PRINT SUMMARY STATISTICS FOR JUNCTIONS  
00107 C  
00108 DO 700 J=1,NJ  
00109 IF(J.EQ.1.OR.(J/39*39).EQ.J) GO TO 701  
00110 GO TO 702  
00111 701 WRITE(N6,2999)  
00112 WRITE(N6,5000) ALPHA
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00113      WRITE(N6,750)
00114      750 FORMAT(//',16(2H'),2X,'SUMMARY STATISTICS F O
00115      2R J U N C T I O N S',2X,16(2H')//)
00116      WRITE(N6,751)
00117      751 FORMAT(' ',36X,'UPPERMOST',9X,'MAXIMUM',5X,'TIME',11X,'FEET OF',
00118      211X,'FEET MAX.',11X,'LENGTH',//',20X,'GROUND',9X,'PIPE CROWN',8X,
00119      3'COMPUTED',6X,'OF',11X,'SURCHARGE',10X,'DEPTH IS',14X,'OF',//',
00120      42X,'JUNCTION',8X,'ELEVATION',9X,'ELEVATION',10X,'DEPTH',3X,
00121      5'OCCURENCE',9X,'AT MAX.',9X,'BELOW GROUND',8X,'SURCHARGE',//',
00122      63X,'NUMBER',12X,'(FT)',2(13X,'(FT)'),4X,'HR.',2X,'MIN.',10X,
00123      7'DEPH',12X,'ELEVATION',11X,'(MIN)',//',2X,8('-',),8X,9('-',),8X,
00124      810('-',),8X,19('-',),8X,9('-',),8X,12('-',),8X,9('-',)//)
00125      C
00126      C***** COMPUTE FEET MAXIMUM DEPTH IS BELOW GROUND ELEVATION
00127      702 FTBLG=GRELEV(J)-(DEPMAX(J)+Z(J))
00128      IF(FTBLG.LE.0.0)FTBLG=0.
00129      C
00130      C***** COMPUTE FEET OF SURCHARGE AT MAXIMUM DEPTH
00131      SURMAX=DEPMAX(J)+Z(J)-ZCROWN(J)
00132      IF(SURMAX.LE.0.0) SURMAX=0.0
00133      C
00134      C***** PRINT JUNCTION STATISTICS
00135      WRITE(N6,752) JUN(J),GRELEV(J),ZCROWN(J),DEPMAX(J),IDHR(J),
00136      2IDMIN(J),SURMAX,FTBLG,SURLN(J)
00137      752 FORMAT(' ',4X,I5,10X,F7.2,11X,F7.2,10X,F6.2,3X,I3,3X,I2,11X,F5.2,
00138      214X,F5.2,13X,F5.1)
00139      700 CONTINUE
00140      C
00141      C***** PRINT FLOWS & VELOCITIES IN PIPES
00142      C
00143      DO 140 I=1,NQPRT
00144      L=CPRT(I)
00145      140 CPRT(I)=NCOND(L)
00146      DO 160 I=1,NQPRT,6
00147      WRITE(N6,2999)
00148      WRITE(N6,5000) ALPHA
00149      WRITE(N6,5100)
00150      5100 FORMAT (125H0 * * * * * T I M E H I S T O R
00151      1 Y O F F L O W A N D V E L O C I T Y * * * * *
00152      1* * * /,49X,'Q(CFS), VEL(FPS)')
00153      IT=I+5
00154      IF(IT.GT.NQPRT) IT=NQPRT
00155      WRITE(N6,5120) (CPRT(L),L=I,IT)
00156      C
00157      5120 FORMAT (1H0,' TIME',6(4X,'CONDUIT',I5,4X),/
00158      1 ' HR . MIN',6(2X,'FLOW VEL '))
00159      LT=MINO(I+5,NQPRT)
00160      DO 160 L=1,LTIME
00161      TIME=(TIME0+FLOAT((L-1)*INTER)*DELT)/3600.
00162      LTIMEH=IFIX (TIME)
00163      LTIMEM=IFIX((TIME-FLOAT(LTIMEH))*60.0+0.5)
00164      160 WRITE(N6,5140) LTIMEH,LTIMEM,(PRTQ(L,K),PRTV(L,K),K=I,LT)
00165      5140 FORMAT (1H ,I3,',',I2,2X,6(F7.2,F5.1,8X))
00166      C
00167      C***** COMPUTE AND PRINT SUMMARY STATISTICS FOR CONDUITS
00168      C

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00169      DO 900 N=1,NC
00170      IF(N.EQ.1.OR.(N/39*39).EQ.N) GO TO 901
00171      GO TO 902
00172  901  WRITE(N6,2999)
00173      WRITE(N6,5000) ALPHA
00174      WRITE(N6,800)
00175  800  FORMAT(/' ',16(2H' '),1H',2X,'S U M M A R Y   S T A T I S T I C S
00176      2F 0 R   C O N D U I T S',2X,1H',16(2H' ')/')
00177      WRITE(N6,801)
00178  801  FORMAT(' ',35X,'CONDUIT',5X,'MAXIMUM',5X,'TIME',7X,'MAXIMUM',
00179      25X,'TIME',6X,'RATIO OF',6X,'MAXIMUM DEPTH ABOVE',/' ',12X,
00180      32('DESIGN',5X),'VERTICAL',4X,'COMPUTED',6X,'OF',7X,'COMPUTED',
00181      46X,'OF',8X,'MAX. TO',4X,'INVERT AT CONDUIT ENDS',/' ',1X,'CONDUIT',
00182      55X,'FLOW',5X,'VELOCITY',6X,'DEPTH',7X,'FLOW',4X,'OCCURENCE',4X,
00183      6'VELOCITY',2X,'OCCURENCE',5X,'DESIGN',5X,'UPSTREAM',4X,
00184      7'DOWNSTREAM',/' ',2X,'NUMBER',5X,'(CFS)',6X,'(FPS)',7X,'(IN)',2X,
00185      8'(CFS)',3X,'HR.',2X,'MIN.',6X,'(FPS)',3X,'HR.',2X,'MIN.',6X,
00186      9'FLOW',8X,'(FT)',9X,'(FT)',/' ',1X,7(' '),4X,6(' '),2(4X,8(' ')),
00187      12(4X,19(' ')),4X,8(' '),4X,22(' ')/')
00188  C
00189  C***** COMPUTE DESIGN VELOCITY AND FLOW IN CONDUIT
00190  902  NL=NJUNC(N,1)
00191      NH=NJUNC(N,2)
00192      SLOPE=(ZF(N,1)-ZF(N,2))/LEN(N)
00193      VDSGN=SQRT(32.2*SLOPE/ROUGH(N))*RFULL(N)**0.6666667
00194      QDSGN=AFULL(N)*VDSGN
00195  C
00196  C***** COMPUTE RATIO OF MAX TO DESIGN FLOW IN CONDUIT
00197      QRATIO=0.
00198      IF(QDSGN.GT.0.) QRATIO=QMAXX(N)/QDSGN
00199  C
00200  C***** COMPUTE MAX WATER DEPTH ABOVE CONDUIT INVERT AT BOTH ENDS
00201      DMAXNL=DEPMAX(NL)-(ZF(N,1)-Z(NL))
00202      DMAXNH=DEPMAX(NH)-(ZF(N,2)-Z(NH))
00203      VHGT=DEEP(N)*12.0
00204  C
00205  C***** PRINT CONDUIT STATISTICS
00206      WRITE(N6,802) NCOND(N),QDSGN,VDSGN,VHGT,QMAXX(N),IQHR(N),
00207      2IQMIN(N),VMAXX(N),IVHR(N),IVMIN(N),QRATIO,DMAXNL,DMAXNH
00208  802  FORMAT(' ',2X,I5,2(5X,F6.1),7X,F5.1,2(6X,F6.1,3X,I3,3X,I2),6X,
00209      2F6.1,7X,F5.2,8X,F5.2)
00210  900  CONTINUE
00211  C
00212  C***** PRINTER PLOT PACKAGE
00213      IF(NPLT) 220,220,180
00214  180  DO 200 N=1,NPLT
00215      IPLT=1
00216      J=JPLT(N)
00217      ZINVRT=Z(J)
00218      ZCRN=ZCROWN(J)
00219      ZGRND=GRELEV(J)
00220      NJUN=JUN(J)
00221      CALL CURVE(TPLT,YPLT(1,N),NPTDT,1,NJUN)
00222  200  WRITE(N6,5160) NJUN
00223  5160  FORMAT(100X,'JUNCTION NUMBER',I7)
00224  220  IF(LPLT) 300,300,240

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00225      240 DO 260 L=1,6
00226      260 VERT(L)=VERTQ(L)
00227          DO 280 N=1,LPLT
00228              IPLT=2
00229              L=KPLT(N)
00230              NKON=NCOND(L)
00231              CALL CURVE(TPLT,QPLT(1,N),NPTOT,1,NKON)
00232      280 WRITE(N6,5180) NKON
00233      5180 FORMAT(100X,'CONDUIT NUMBER',I7)
00234      300 RETURN
00235      END
```

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00001      SUBROUTINE PINE(X1,Y1,X2,Y2,NSYM,NCT)
00002      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNDS(100),
00003      1TRIBA
00004      COMMON/CONTR/ NTCYC,DELTQ,DELT,DELT2,TZERO,ALPHA(40),
00005      1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00006      COMMON/ELEV/ ZINVRT,ZCRN,ZGRND,IPLT
00007      C
00008      COMMON/LAB/TITLE(40),XLAB(11),YLAB(6),HORIZ(5),VERT(6)
00009      C
00010      AXA=X1
00011      AXB=X2
00012      AYA=Y1
00013      AYB=Y2
00014      IF((AXB.EQ.AXA).AND.(AYB.EQ.AYA)) RETURN
00015      N=1
00016      IF(ABS(AXB-AXA).LT.ABS(AYB-AYA)) GO TO 160
00017      C
00018      C      SET PARAMETERS FOR X DIRECTION
00019      C
00020      IF(AXB.GT.AXA) GO TO 100
00021      AXA=X2
00022      AXB=X1
00023      AYA=Y2
00024      AYB=Y1
00025      100 CONTINUE
00026      IXA=AXA+.5
00027      IXB=AXB+.5
00028      IYA=AYA+.5
00029      IYB=AYB+.5
00030      120 CONTINUE
00031      IF(IXA.LT.0.OR.IXA.GT.100) GO TO 140
00032      IF(IYA.LT.0.OR.IYA.GT.40) GO TO 140
00033      CALL PPLOT(IXA,IYA,NSYM,NCT)
00034      140 CONTINUE
00035      IXA=IXA+1
00036      YA=(N*(AYB-AYA))/(AXB-AXA)
00037      IYA=AYA+YA+0.5
00038      N=N+1
00039      IF(IXA.LE.IXB) GO TO 120
00040      GO TO 260
00041      C
00042      C      SET PARAMETERS FOR Y DIRECTION
00043      C
00044      160 CONTINUE
00045      IF(AYB.GT.AYA) GO TO 180
00046      AYB=Y1
00047      AYA=Y2
00048      AXB=X1
00049      AXA=X2
00050      180 CONTINUE
00051      IXA=AXA+.5
00052      IXB=AXB+.5
00053      IYA=AYA+.5
00054      IYB=AYB+.5
00055      200 CONTINUE
00056      IF(IXA.LT.0.OR.IXA.GT.100) GO TO 220

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00057      IF(IYA.LT.0.OR.IYA.GT.40) GO TO 220
00058      CALL PPLOT(IXA,IYA,NSYM,NCT)
00059      220 CONTINUE
00060      IYA=IYA+1
00061      XA=(N*(AXB-AXA))/(AYB-AYA)
00062      IXA=XA+AXA+0.5
00063      N=N+1
00064      IF(IYA-IYB) 200,240,260
00065      240 IXA = IXB
00066      GO TO 200
00067      260 RETURN
00068      END

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00001      SUBROUTINE PFL0T(IX,IY,K,NCT)
00002      DIMENSION A(51,101),SYM(9)
00003      C
00004      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00005      1TRIBA
00006      COMMON/CONTR/ NTCYC,DELTO,DELT,DELT2,TZERO,ALPHA(40),
00007      1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00008      C
00009      COMMON/ELEV/ ZINVRT,ZCRN,ZGRND,IPLT
00010      C
00011      COMMON/LAB/TITLE(40),XLAB(11),YLAB(6),HORIZ(5),VERT(6)
00012      C
00013      DATA SYM / 4H****,4H++++, 4H''''', 4HXXXX, 4H...., 4H2222,
00014      1 4H , 4HIIII, 4H--- /
00015      IF(K-99) 100,120,260
00016      100 A(41-IY,IX+1)=SYM(K)
00017      RETURN
00018      120 CONTINUE
00019      I=0
00020      J2=1
00021      WRITE(N6,2999)
00022      2999 FORMAT('1',64(2H--))' ', 'ENVIRONMENTAL PROTECTION AGENCY',13X,40H*
00023      2*** EXTENDED TRANSPORT PROGRAM ****,8X,'WATER RESOURCES DIVISI
00024      3ON'/' ', 'WASHINGTON, D.C. ',16X,4H****,32X,4H****,8X,
00025      4'CAMP DRESSER & MCKEE INC.'/' ', ' ',29X,4H
00026      5****,6X,' ANALYSIS MODULE ',6X,4H****,8X,'ANNANDALE, VIRGINIA
00027      6')
00028      WRITE(N6,1300) ALPHA
00029      DO 220 II=1,5
00030      I=I+1
00031      IF(IPLT.EQ.2)GO TO 130
00032      125 IF (II.NE.1) GO TO 130
00033      WRITE(N6,1050) YLAB(II),A(1,1),ZINVRT,(A(1,J),J=29,101)
00034      WRITE(N6,1051) A(2,1),ZCRN,(A(2,J), J=29,101)
00035      WRITE(N6,1052) A(3,1),ZGRND,(A(3,J),J=29,101)
00036      I=3
00037      J2=3
00038      GO TO 135
00039      130 WRITE(N6,1100) YLAB(II),(A(I,J),J=1,101)
00040      IF(II.EQ.5) GO TO 240
00041      135 DO 200 JJ=J2,9
00042      I=I+1
00043      IF(I.NE.28) GO TO 140
00044      WRITE(N6,1500) VERT(5),VERT(6),(A(I,J),J=1,101)
00045      GO TO 200
00046      140 IF(I.NE.24) GO TO 160
00047      WRITE(N6,1500) VERT(1),VERT(2),(A(I,J),J=1,101)
00048      GO TO 200
00049      160 IF(I.NE.26) GO TO 180
00050      WRITE(N6,1500) VERT(3),VERT(4),(A(I,J),J=1,101)
00051      GO TO 200
00052      180 WRITE(N6,1000) (A(I,J),J=1,101)
00053      200 CONTINUE
00054      J2=1
00055      220 CONTINUE
00056      240 CONTINUE

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00057      WRITE(N6,1200) XLAB
00058      WRITE(N6,1400) HORIZ
00059      1000 FORMAT(18X,101A1)
00060      1050 FORMAT (F17.3,1X,A1,2X,'INVERT ELEV-',F8.2,' FEET',73A1)
00061      1051 FORMAT (18X,A1,2X,' CROWN ELEV-',F8.2,' FEET',73A1)
00062      1052 FORMAT (18X,A1,2X,'GROUND ELEV-',F8.2,' FEET',73A1)
00063      1100 FORMAT(F17.3,1X,101A1)
00064      1200 FORMAT(F20.1,10F10.1)
00065      1300 FORMAT(' ',20A4/' ',20A4//)
00066      1400 FORMAT(/45X,20A4)
00067      1500 FORMAT(3X,2A4,7X,101A1)
00068      260 DO 300 I=1,40
00069           DO 280 J=1,101
00070      280 A(I,J)=SYM(7)
00071           A(I,1)=SYM(8)
00072      300 CONTINUE
00073           DO 320 J=1,101
00074      320 A(41,J)=SYM(9)
00075           DO 340 I=1,101,10
00076      340 A(41,I)=SYM(8)
00077           DO 360 I=11,31,10
00078           A(I,1)=SYM(9)
00079      360 CONTINUE
00080      RETURN
00081      END
```



```

00057 C
00058 C CHECK FOR MAX VALUE IN RANGE
00059 C
00060 IF(AMAX.GT.(K+AXLEN)*RANGE) GO TO 260
00061 I=NPTS*INCT+1
00062 ARRAY(I)=K*RANGE
00063 I=I+INCT
00064 ARRAY(I)=RANGE
00065 RETURN
00066 C
00067 C IF OUTSIDE RANGE RESET L AND N
00068 C
00069 260 L=L+1
00070 IF(L.LT.11) GO TO 200
00071 L=2
00072 N=N+1
00073 280 GO TO 200
00074 C
00075 C SET UP NEGATIVE STEPS
00076 C
00077 300 K=AMAX/RANGE
00078 IF(AMAX.GT.0.) K=K+1
00079 IF(AMIN.LT.(K+AXLEN)*RANGE) GO TO 260
00080 I=INCT*NPTS+1
00081 ARRAY(I)=K*RANGE
00082 I=I+INCT
00083 ARRAY(I)=-RANGE
00084 RETURN
00085 320 WRITE(N6,1000)
00086 1000 FORMAT( // 10X, 'RANGE AND SCALE ARE ZERO ON PLOT ATTEMPT' )
00087 RETURN
00088 END

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00001      SUBROUTINE TIDCF(KO,NI,NCHTID)
00002      C
00003      C          THIS SUBROUTINE COMPUTES SEVEN COEFFICIENTS
00004      C          FOR A FOURIER EXPANSION OF THE DIURNAL TIDE STAGE
00005      C
00006      COMMON/FILES/ N5,N6,N21,N22,NPOLL,NLOCAT,QCONV,IDATEZ,LOCNOS(100),
00007      1TRIBA
00008      COMMON/CONTR/ NTCYC,DELTD,DELT,DELT2,TZERO,ALPHA(40),
00009      1 NJ,NC,NTC,NTL,ICYC,NJSW,MJSW,TIME,TIME2,A1,A2,A3,A4,A5,A6,A7,W
00010      C
00011      COMMON/TIDE/ YY(50) ,TT(50) ,AA(10),XX(10),SXX(10,10),SXY(10)
00012      C
00013      C          TIDE COEFFICIENTS
00014      C          TIDAL CURVE FIT, 7 TERM
00015      C          SINUSOIDAL EQUATION
00016      C
00017      WRITE(N6,140) KO,NI,NCHTID
00018      140 FORMAT (7H0 KO IS,I3,19H NUMBER OF POINTS =,I4,35H MAXIMUM NUMBER
00019      1 OF ITERATIONS IS 50,21H TIDE CHECK (TCH IS,I2)
00020      C
00021      C          IF KO EQUALS ONE, PROGRAM WILL
00022      C          READ FOUR POINTS OF INFORMATION
00023      C          AND EXPAND THEM FOR A FULL TIDE
00024      C
00025      C          NT IS THE NUMBER OF INFORMATION
00026      C          POINTS
00027      C          IF NCHTID EQUALS ONE, TIDAL
00028      C          INPUT-OUTPUT WILL BE PRINTED
00029      C
00030      C          MAXIT IS THE MAXIMUM NUMBER OF
00031      C          ITERATIONS
00032      C          DELTA IS THE ACCURACY
00033      C          LIMIT IN FEET
00034      C
00035      PERIOD = 25.
00036      MAXIT = 50
00037      DELTA = 0.005
00038      NTT=7
00039      W = 2.*3.14159 /PERIOD
00040      IF(KO.EQ.0) GO TO 225
00041      TT(50) =TT(1)+PERIOD
00042      YY(50)=YY(1)
00043      DO 220 I=1,4
00044      J=I+1
00045      IF (J.GT.4) J=50
00046      NI=NI+1
00047      TT(NI)=(3.*TT(I)+TT(J))/4.
00048      YY(NI)=0.8535*YY(I)+0.1465*YY(J)
00049      NI=NI+1
00050      TT(NI)=(TT(I)+TT(J))/2.
00051      YY(NI)=(YY(I)+YY(J))/2.
00052      NI=NI+1
00053      TT(NI)=(TT(I)+3.*TT(J))/4.
00054      YY(NI)=0.1465*YY(I)+0.8535*YY(J)
00055      220 CONTINUE
00056      225 CONTINUE

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00057       IF (NCHTID.NE.1) GO TO 240
00058       WRITE(N6,146)
00059   146   FORMAT (29H0 NO.          TIME          VALUE )
00060       WRITE(N6,148) (I,TT(I), YY(I), I=1,NI)
00061   148   FORMAT (I4, 2F12.3 )
00062   240   CONTINUE
00063       DO 280 J=1,NTT
00064       DO 260 K=1,NTT
00065   260   SXX(K,J) = 0.
00066       AA(J) = 0.
00067   280   SXY(J) = 0.
00068       NJ2 = NTT/2 + 1
00069       DO 360 I = 1,NI
00070       DO 320 J = 1,NTT
00071       FJ1 = FLOAT(J-1)
00072       FJ3 = FLOAT ( J-NJ2 )
00073       IF ( J.LE.NJ2 ) GO TO 300
00074       XX(J) = COS(FJ3*W*TT(I))
00075       GO TO 320
00076   300   XX(J) = SIN(FJ1*W*TT(I))
00077       IF( J.EQ.1 )XX(J) = 1.
00078   320   SXY(J) = SXY(J) +XX(J) *YY(I)
00079       DO 340 J = 1,NTT
00080       DO 340 K = 1,NTT
00081   340   SXX(K,J) = SXX(K,J) +XX(K) *XX(J)
00082   360   CONTINUE
00083       IT = 0
00084   380   IT = IT + 1
00085       DELMAX = 0.
00086       DO 420 K = 1,NTT
00087       SUM = 0.
00088       DO 400 J = 1,NTT
00089       IF (J.EQ.K) GO TO 400
00090       SUM = SUM -AA(J)*SXX(K,J)
00091   400   CONTINUE
00092       SUM = (SUM+SXY(K))/SXX(K,K)
00093       DEL = ABS(SUM-AA(K))
00094       IF (DEL.GT.DELMAX ) DELMAX = DEL
00095   420   AA(K) = SUM
00096       IF ( IT.GE.MAXIT ) GO TO 440
00097       IF (DELMAX.GT.DELTA ) GO TO 380
00098       GO TO 460
00099   440   WRITE(N6,150)
00100   150   FORMAT ( '  CANNOT REACH DESIRED DELTA, INCREASE EITHER NI OR DELTA
00101         1 AND TRY AGAIN' )
00102       STOP
00103   460   CONTINUE
00104       A1 = AA(1)
00105       A2 = AA(2)
00106       A3 = AA(3)
00107       A4 = AA(4)
00108       A5 = AA(5)
00109       A6 = AA(6)
00110       A7 = AA(7)
00111       IF (NCHTID.NE.1) GO TO 540
00112       WRITE(N6,152)

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00113      152 FORMAT (46H0      TIME      OBSERVED      COMPUTED      DIFF )
00114      RES = 0.
00115      DO 520 I = 1,NI
00116      SUM = 0.
00117      DO 500 J = 2,NTT
00118      FJ1 = FLOAT ( J-1 )
00119      FJ3 = FLOAT ( J-NJ2 )
00120      IF ( J.LE,NJ2 ) GO TO 480
00121      SUM = SUM +AA(J) *COS(FJ3*W*TT(I))
00122      GO TO 500
00123      480 SUM = SUM +AA(J) *SIN(FJ1*W*TT(I))
00124      500 CONTINUE
00125      SUM = SUM +AA(1)
00126      DIFF = SUM -YY(I)
00127      RES = RES + ABS(DIFF)
00128      520 WRITE(N6,154) TT(I),YY(I),SUM,DIFF
00129      154 FORMAT ( 4F12.4 )
00130      WRITE(N6,156) RES
00131      156 FORMAT (6H0TOTAL , 30X, F12.4 )
00132      540 CONTINUE
00133      C
00134      C
00135      C
00136      WRITE(N6,158)A1,A2,A3,A4,A5,A6,A7
00137      158 FORMAT(///46H COEFFICIENTS FOR TIDAL STAGE ARE //85H
00138      1      A1      A2      A3      A4      A5      A6
00139      2A7      //7F10.3,F12.2//31H WHERE THE WAVEFORM IS GIVE
00140      3N BY//92H H(J) = A1 + A2*SIN(WT) + A3*SIN(2WT) + A4*SIN(3WT) + A5*
00141      4COS(WT) + A6*COS(2WT) + A7*COS(3WT))
00142      RETURN
00143      END

```