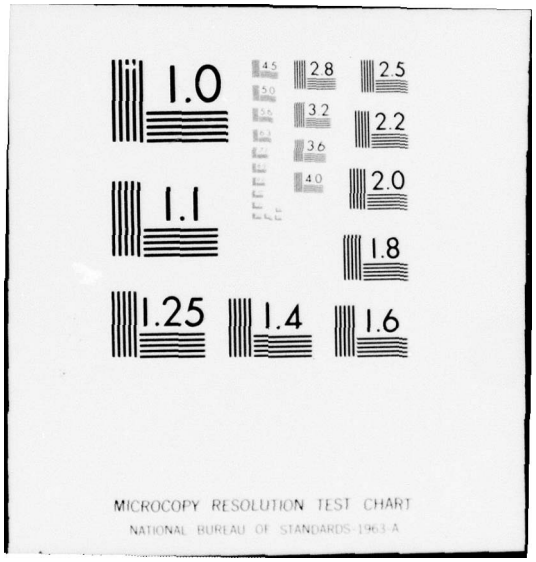
AD-A036 523 CLEMSON UNIV S C COLL OF ENGINEERING F/G 13/2
A SYSTEMS ANALYSIS OF WATER QUALITY SURVEY DESIGN. APPENDIX II.--ETC(U)
AUG 75 L C WILCOX, B E GILLILAND DADA17-72-C-2152
UNCLASSIFIED NL

1 OF 2
ADA036523


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

ADA036523

(9) Fiscal Rept.

B.S.

(6)

A SYSTEMS ANALYSIS OF WATER QUALITY SURVEY DESIGN.

[redacted] REPORT

APPENDIX II.
DOCUMENTATION
SURVEY PLANNING PROGRAM USER'S MANUAL.

(10) Lyle C. Wilcox,
Bobby E. Gilliland,
Ralph W. Gilchrist
Thomas M. Keinath

(11) AUG[redacted] 1975

(12) 112 p.

SUPPORTED BY
U.S. ARMY MEDICAL RESEARCH AND DEVELOPMENT COMMAND
WASHINGTON, D.C. 20314

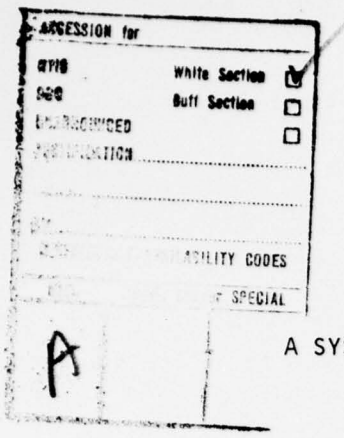
(15) [redacted] NO. DA DA 17-72-C-2152

PUBLICATION BY
ENGINEERING RESEARCH
CLEMSON UNIVERSITY
CLEMSON, S.C.

DDC
RECEIVED
MAR 8 1977
D

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

408039



A SYSTEMS ANALYSIS OF WATER QUALITY SURVEY DESIGN

Documentation of the Survey Planning
Computer Program. A User's Manual

Authors: Dr. L. C. Wilcox, Dr. B. E. Gilliland,
Dr. R. W. Gilchrist, Dr. T. M. Keinath

August 1975

Supported by

U. S. Army Medical Research and Development Command
Washington, D. C. 20314

Contract No. DA DA 17-72-C-2152

This document has been approved for public release; distribution unlimited.

The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

DDC
RECEIVED
MAR 8 1977
D

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Final Report	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) A Systems Analysis of Water Quality Survey Design		5. TYPE OF REPORT & PERIOD COVERED Final 6. PERFORMING ORG. REPORT NUMBER Final
7. AUTHOR(s) Lyle C. Wilcox Bobby E. Gilliland Thomas L. Drake Ralph W. Gilchrist		8. CONTRACT OR GRANT NUMBER(s) DADA 17-72-C-2152
9. PERFORMING ORGANIZATION NAME AND ADDRESS Clemson University College of Engineering Clemson, SC 29631		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE August 1975 13. NUMBER OF PAGES 862
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Distribution of this document is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Systems Analysis
Water Quality
Water Quality Survey
Water Quality Survey Design
Army Ammunition Plants
Modeling
Simulation
Ammunition Manufacturing Processes
Water Quality Measurements

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is the final report of a three year project titled, "A Systems Analysis of Water Quality Survey Design."

In this project a study was made of water quality surveys conducted by the United States Army Environmental Hygiene Agency (AEHA). Mainly data and reports from studies of Army Ammunition Plants (AAP) were used.

The focus of this project was the development of computer aided procedures which would assure efficient use of manpower and equipment and assure that the measurements taken give a reasonalbe representation of the system. Planning the

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unlimited

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

survey, conducting the survey and reporting on the survey were included in the study.

The site modeling program models the manufacturing processes which contribute pollutants to the system, models the sewer system, and models the treatment system including acid or caustic neutralization, settling ponds, and domestic treatment. The inputs to the model are the production levels of the manufacturing processes and the outputs are the predicted pollutant measurement values at each possible measure point in the system.

The resource matching program accepts data defining proposed measurements and matches these against the available time, manpower, and equipment. The output lists the pollutant to be measured at each measure point, the total commitment of time for each analyst and for each piece of equipment. Note is made of any overcommitment of manpower or equipment.

The model refinement or updating program accepts measurements taken during a preliminary survey or during a regular survey and computes suggested new parameters for the process models.

The indicator model program evaluates the performance of sanitary treatment facilities.

The program uses design data, data from the operating log and/or data generated during the survey and computes key operational characteristics. Comparing these with desirable values as cited in design books and manuals will give the survey planner insight into the operation of the system and suggest the need for more survey measurements or the need for changes in operation.

A system was developed for automatic instrumentation of pH, conductivity, and other parameters which use strip charp recordings. Interface hardware was selected and purchased and interface software was developed for direct connection to a digital computer.

A data handling system was developed for use during and after the survey. A PDP8-OS/8 and peripheral equipment was purchased. Software was developed to perform data handling functions and to direct the user in application of the software. The program accepts raw data from the analytical chemist and performs data conversions, transcriptions, and data logging functions. Output is available in several forms as may be needed for various reports during and at the end of the survey.

Recommendations are: the survey planner should obtain sufficient data in a proliminary survey to model and analyze the site; measurements should be automated to the maximum extent possible; data handling should be delegated to the computer when the operations are well defined and repetitive. The programs, software and hardware included here will assist the survey planner in following these recommendations and design a more effective survey.

TABLE OF CONTENTS

FIGURES

INTRODUCTION

This manual was written to assist in the use of the Survey Planning Program developed as part of the research entitled "A Systems Analysis of Water Quality Survey Design" conducted by the Engineering College at Clemson University and supported by U.S. Army Medical Research and Development Command.

The program can perform three basic functions by assembling the proper subroutines. These functions are:

1. Modeling and simulation of the plant site operation. The model includes the effluent of the manufacturing processes, the sewer system pollutants, and industrial and domestic sewage treatment.
2. Resource matching or resource commitment for a planned survey. Using the modeling and simulation results, the survey planner determines the frequency and location of the measure points for each pollutant to be measured. The RM model uses this information along with information on available resources (time, personnel and equipment) determines the required commitment of personnel and equipment. Note is made of non-feasible survey plans which would require more personnel or equipment than is available. The survey planner can then add more personnel or equipment for the survey or try another survey plan which will use different personnel and equipment. By iterating through several survey plans the planner can find a survey plan which will yield the maximum of useful data for the available time, personnel and equipment.

3. Model Verification and/or Updating.

The site model process models can be updated or improved using preliminary survey data or survey results. While the best data available were used in constructing the process models, there was considerable variation in data for a given process from one plant to another or from one season to another. Better process model values may be obtained using the CORRCT subroutine with judiciously selected grab samples taken on a preliminary survey. Survey results can also be used to verify or refine the process models. With confidence in the model, it can now be used to predict levels of potential pollutants for production levels other than those which occurred during the survey. This should give added significance to the survey report.

The site modeling and simulation uses MAIN and the following subroutines: PROCES, START, TOP, NEUTRA, SETTLE, DOME.

The resource matching application uses all of the subroutines required for site modeling plus the following subroutines: LEVEL, FLAG, RM, CONCK, TO, EQCHER, VSCHEC, CNCHEC, ADD, SET, PIEQCH, SUBT, INFORM, SAMPLE, PRPAR, USECT, TICHAN.

The model verification and/or updating uses all of the subrouintes required for site modeling plus the subroutine CORRCT.

The functions of the subroutines are discussed briefly below.

MAIN: sets the system dimensions and calls appropriate subroutines.

PROCES: This program reads in process mnemonics for processes present at the particular site being studied. Appropriate process data is called out of process library. Process data can be altered to better represent a particular site.

Process Library: Contains process models.

START: Reads in; the number of processes(sources), the number of branches, the number of parameters and the number of outfalls in this site study. Also reads in the numbers of the particular pollutants in the current study (NPLIST). Reads in branch names. Branches are named for convenient interpretation of output data. Calls CHK1.

CHK1: Reads in the number of non-competing parameters (used in RM); reads in the names of all of the pollutants in the master list, for each the number of measurement methods available and the sampling frequency. This program also prints out the input information available at this point. In particular this includes the process data and the topology matrix.

TOP: This program essentially does the following: reads in treatment data; takes process data and site topology data and calculates the flow and pollutant parameters for each branch of the system. The effects of treatments are included in the calculation; calls the treatment subroutine NEUTRA, SETTLE, and DOME; calls CHK2 to output results.

NEUTRA: This subroutine is called by TOP if acid or caustic neutralization is required in any branch.

SETTLE: This subroutine is called by TOP is a settling pond or clarifier is required in any branch.

DOME: This subroutine is called by TOP if domestic or sanitary treatment is required.

CHK2: This program essentially writes out the results of the TOP calculations, i.e., the system simulation.

FLAG: This subroutine is not used in system simulation but in system planning with RM. However, it is called by TOP to prepare data for RM.

LEVEL arranges TOP output for use in RM.

FLAG allows survey planner to specify for RM, measure points in addition to those selected by RM logic.

RM reads in and prints out resource information, allocates resources and calls subroutines when needed to relieve violations, and prints out resource allocation information.

CONCK determines feasible measure methods and allocates resources to flagged points.

TO zeros out temporary allocations for equipment times.

EQCHEC determines if any equipment time violations occur.

VSCHEC checks for van space constraint violations.

CNCHEC checks for analyst time constraint violation.

ADD adds current allocations of equipment time, analysts' times, van space and costs.

SET stores the array of methods used at a branch in a level for a given parameter.

PIEQCH searches past assignments to attempt to relieve constraint violations.

SUBT subtracts current allocations.

INFORM prints out branch names and parameters to be measured at that branch.

SAMPLE allocates analyst type 1 time required for taking samples and measuring flow.

PRPAR outputs parameter measurement information.

USECT total usage equipment.

TICHAN converts minutes to hours and minutes.

CORRCT is used for model verification or updating.

Subsequent sections of this manual define the data required by these program subroutines, list the required coding and ordering of data, and illustrate the format and computer card layout required by the subroutine. Also, the various components of the output information are listed and explained in the last section of this manual.

The programs have been written so that only the subroutines required for the particular application need to be read in. Thus, the program could be visualized as three separate decks with some of the subroutines appearing in more than one deck. Also, the complete set of subroutines can be read as one big single program. Depending on the computer facilities available, memory space available and turn-around time may be a problem if the three smaller decks are not used.

In either case flags have to be read in MAIN to define the particular application that is desired.

NFLAG = 0 call LEVEL and RM

= 1 terminate after TOP or CORRCT

EPSLON = 0 do not call CORRCT

= 1 call CORRCT

These are read in with the following statements in MAIN

```
READ (1,900)  NFLAG
READ (1,800)  EPSLON
900 FORMAT (I 5)
```

BRIEF DESCRIPTION OF FORMAT STATEMENTS

The purpose of the FORTRAN FORMAT statements is to tell the computer what kind of information is to be inputted and where to find that information on a data card. In this program, only three different types of data are inputted: integer data ("I" FORMAT), floating point data ("F" FORMAT) and alphanumeric data ("A" FORMAT).

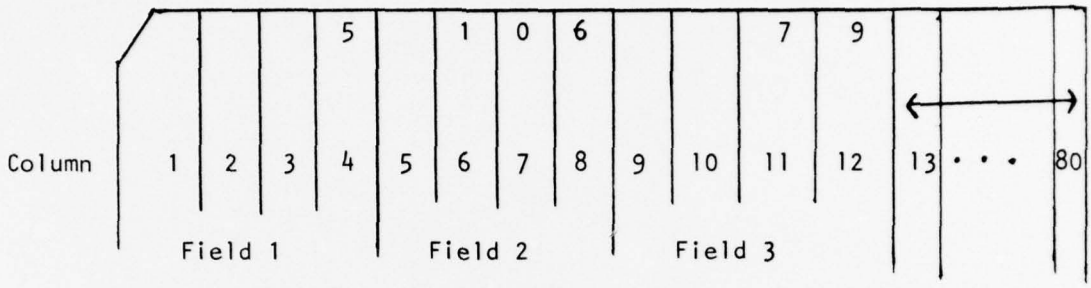
Integer Data

Integer formats are of the form wIm, where w is the number of integer data fields, and m is the length of each integer field. For example, 3I5 will read 3 items of data from a card, with each item in a field 5 card columns wide. It should be mentioned that within a field the data must be right justified. This means that if a I4 format is used to read in the number 6, 6 must appear in the 4th column of the field. If it does not, the trailing blanks are read as zeros. So, if the 6 is placed in the 3rd column, it will be read by the computer as 60, or in the 2nd column it will be read as 600. Care must be taken that integers are right justified. Many apparent programming errors may be caused by incorrect punching of data cards.

Examples:

```
    READ 100, K, L, M
100 FORMAT (3I4)
```

This will read in three integer values for the variables K, L, and M. If the desired values for those variables are 5, 106 and 79, the data card would appear as follows:



Since the computer will only look at the first 12 columns in this example, columns 13-80 could be filled with anything.

Floating Point Data

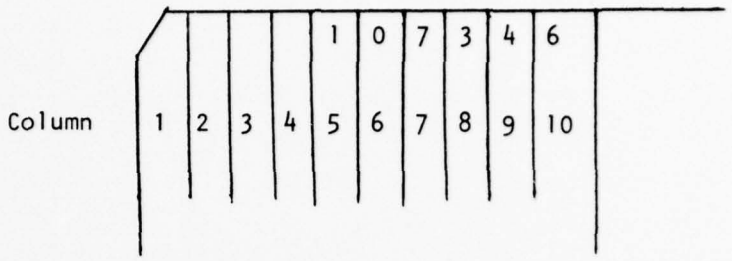
Floating Point Formats are of the Form wFm.n, where w is the number of floating point fields, m is the total width of each field, and n is the number of places to the right of the decimal point. The restriction on n is $n \leq m+1$, since one place is reserved for the decimal point. Floating point allows the user to omit the decimal point, if the data if right justified. Otherwise, data may be placed anywhere in the Field.

Example:

```
    READ 101, X
101 FORMAT (F10.3)
```

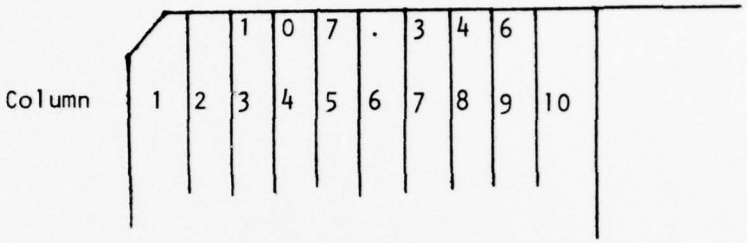
If the value desired for X is 107.346, the data card may appear as:

1)



or as

2)



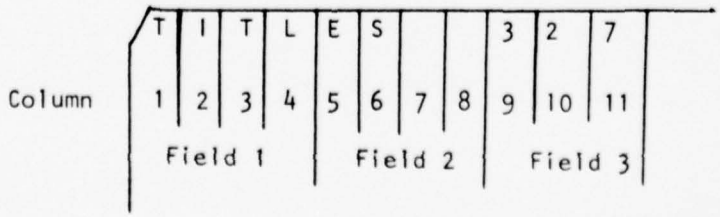
The presence of the decimal point overrides the Format specification. In the first case, if 107346 started in column 4 instead of column 5 it would be read in as 1073.460.

Alphanumeric Data

Alphanumeric formats are of the Form wAn, where w is the number of alphanumeric fields, and n is the width of each field. Any character may be read in as alphanumeric data.

Example:

```
     READ 102, NAME, N, J
102  FORMAT (2A4,A3)
```



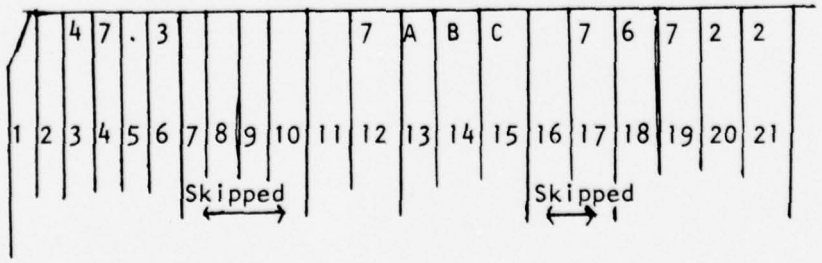
In this example, variable NAME would have the computer representation of 'TITL' stored in it, N would contain 'ES ~~b~~' (~~b~~ represents a blank) and J would contain the alphanumeric representation of '327'. It is important to note that this "value" of J does not correspond to an integer value of 327.

Mixed Formats

In many instances integer, floating point, and alphanumeric data all appear on the same card. It is simply a matter of combining the different formats in the correct sequence to read this data. Also, many times certain columns of the data card will want to be skipped. To accomplish this, the *n*X Format is used where n is the number of columns to be skipped.

Example:

```
      READ 103, X, I, N, Y
103   FORMAT (F6.2, 4X, I2, A3, 2X, F4.1)
```



The value of X will be 47.3, the value of I will be 7, the "value" of N will be ABC, and the value of Y will be 672.2. Notice that the 7

which appears in column 17 is not assigned to any variable since it is in a column which is skipped.

For each item of data that is needed by the program, the associated READ statement and FORMAT statement is included, along with a sample data card in the "User's Manual."

MAIN PROGRAM USERS GUIDE

1. Required Main Data and Format

The only data required by MAIN are MASTER, NFLAG, and EPSLON.

If NFLAG is "1" the program stops after the TOP or CORRCT subroutine calculations are complete. The TOP subroutine calculates the flow, mass, and pollutant parameter for each branch of the system. If NFLAG is "0" the program goes from TOP into the RM subroutine where the survey is planned.

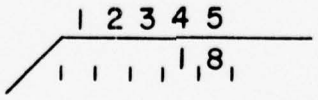
MASTER is the largest parameter number to be used in the current study. The master list of parameters is given in Table II. If in a given study no parameter listed above total phosphates is to be included then MASTER is 18.

If EPSLON = 0 the CORRCT subroutine is not called. For EPSLON = 1 the CORRCT subroutine is called.

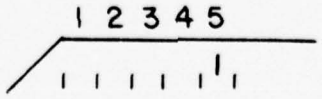
MASTER and NFLAG are read in with the following statements:

```
READ (1,900)  MASTER
READ (1,900)  NFLAG
READ (1,900)  EPSLON
900 FORMAT (I5)
```

The following card layout is for MASTER=18



The following car layout is for NFLAG= 1 or for EPSLON = 1



II. Changing System Planning Program Dimensions

The program and subroutines have been written so that only cards in the MAIN program need to be changed to redimension the system. The quantities that can be varied are: the number of pollutant parameters, the number of sources (processes), the number of branches, the number of pieces of equipment.

The specific items in the MAIN program which must be changed to redimension the system are given in the following paragraphs:

To handle more than 25 sources (where i = number of sources) in the MAIN program,

change MSORS = 25 to MSORS = i and in the Dimension statement the arrays to modify are:

XNAME (25)		XNAME (i)
YNAME (25)		YNAME (i)
FLOW (25)		FLOW (i)
SPLIST (25,25)	CHANGE	SPLIST (i,25)
CAP (25)		CAP (i)
A (25,25)		A (i,25)
C (25,25)	TO	C (i,25)
P (25,25)		P (i,25)
SUM (25)		SUM (i)
SUMA (25)		SUMA (i)

To handle more than 25 branches (where n = number of branches) in the program,

change MBRNC = 25 to MBRNC = n

and in the DIMENSION statement the arrays to modify are:

A (25,25)		A (25,n)
Y (25,25)		Y (n,25)
X (25,25)		X (n,25)
EFF (25)		EFF (n,25)
NBRNCH (25,2)		NBRNCH (n,2)
IBN (51,25)		IBN (51,n+1)
PC (25,25,25)	CHANGE	PC (25,25,n)
AMAR (25,27)		AMAR (25, n+2)
NALOW (25,25)	TO	NALOW (25,n)
BRN (25)		BRN (n)
BRANCH (25,25)		BRANCH (n,25)
NROUR (25)		NROUT (n)
NFLOW (25)		NFLOW (n)

To handle more than 25 parameters (m = number of parameters), in the MAIN program,

change MPARM = 25 to MPARM = m

and in the DIMENSION statement the arrays to modify are:

SPLIST (25,25)		SPLIST (25,m)
C (25,25)		C (25,m)
Y (25,25)		Y (25,m)
X (25,25)		X (25,m)
P (25,25)		P (25,m)
NPLIST (25)		NPLIST (m)
POLN (25,5)		POLN (m,5)
NTEMP (25)		NTEMP (m)
SAMFRE (25)	CHANGE	SAMFRE (m)
NMA (25)		NMA (m)
MENAME (25,3,5)		MENAME (m,3,5)
PCRM (25,3)	TO	PCRM (m,3)
PMDATA (25,3,4,5)		PMDATA (m,3,4,5)
IDO (25,25)		IDO (m,25)
PM (25,25,25)		PM (m,25,3)
AMAR (25,27)		AMAR (m,27)
PC (25,25,25)		PC (m,25,25)
NALOW (25,25)		NALOW (m,25)
EQUSED (25,75)		EQUSED (m,75)
NSET (25,3)		NSET (m,3)
FLGPT (25)		FLGPT (m)
RANK (25)		RANK (m)
BRANCH (25,25)		BRANCH (25,m)
ELE (25)		ELE (m)

To handle more than 75 pieces of equipment (j = number of equipment) in the MAIN program,

change MEQ = 75 to MEQ = j

and in the DIMENSION statement:

change VNSP (75) to VNSP (j)

SMEQTI (75)		SMEQTI (j)
EQUSED (25,75)	CHANGE	EQUSED (25,j)
EU (75)		EU (j)
EQTIME (75)	TO	EQTIME (j)
EQNAME (75,5)		EQNAME (j,5)

It should be noted that these are the only changes required on the array dimensions. There is no need to make modifications in the subroutines. Also, it is very important that the array parameters MSORS, MBRNC, MPARM, MEQ MBRP1, and MP2 and the array subscripts correspond exactly. For example, if MPARM = 31, then every array that is affected by an increase in parameter capability must have "31" appearing in the proper subscript position as explained in that section. Care should also be exercised that every array has its proper subscript changed. Any omission may lead to errors that may not be immediately apparent.

PROCESS MODEL USER'S GUIDE

I. PROCESS MODEL INTRODUCTION

The process model is used to define a manufacturing plant in terms of the pollutants produced by the manufacturing processes as a function of the production levels of the various plant components. In order that the model be applicable to more than one plant, manufacturing operations are subdivided on the basis of "objectives" and then further subdivided into "processes" required by these objective. "Objectives" are identified in terms of general plant products or objectives. A given plant may have one or several "objectives". Examples are: continuous TNT; TNT (batch); paint stripping of artillery shells. The processes are manufacturing operations which are definable in terms of production level and resultant pollutants. The processes are operations which may be components of one or several "objectives" and may occur in one or several plants. Models are constructed for each process which may occur in any of the plants to be surveyed. A plant process model is obtained by assembling the appropriate process models. The input to this model is the production level of each of the processes making up the plant model. The output is an ordered listing of the types and levels of pollutants generated by producing products at a certain level. Also listed are the points in the effluent drain system at which the pollutants enter. Any time variation in pollutant flow requires a new listing, a listing for each state.

The pollution potential of an effluent is measured in a number of ways. One type of measurement is to determine the concentration of a particular element or compound. An example of this type of measurement would be the measure of sulfates in milligrams per liter. Another type of measurement measures a characteristic of the system not necessarily

STNT

```
0001      SUBROUTINE STNT (FLOW, SPLIST, CAP, JM, MSORS, MPARM)
0002      DIMENSION FLOW (MSORS), SPLIST (MSORS, MPARM), CAP (MSORS)
0003      FLOW (JM) = 0.01 * CAP (JM) * 0.10
0004      SPLIST (JM,1) = 1.5
0005      SPLIST (JM,3) = 40000
0006      SPLIST (JM,4) = 40
0007      SPLIST (JM,7) = 1000
0008      SPLIST (JM,8) = 8
0009      SPLIST (JM,9) = 20000
0010      SPLIST (JM,10) = 10
0011      SPLIST (JM, 12) = 2500
0012      SPLIST (JM,15) = 1500
0013      SPLIST (JM,16) = 5.0
0014      SPLIST (JM,18) = 0.5
0015      SPLIST (JM,19) = 10.0
0016      SPLIST (JM, 20) = 20
0017      SPLIST (JM,22) = 0.0
0018      SPLIST (JM,23) = 5.0
0019      SPLIST (JM,24) = 5000
0020      RETURN
0021      END
```

EXAMPLE PROCESS

Figure 1

related to only one chemical element or compound. Examples of this type of measurement are conductivity, color, and pH. To speak of in general of the numbers that define the level of pollution potential, whether they are of one or the other of the above types, the term "pollution parameter" will be used.

Figure I is an example of a computer program subroutine model of a process. Statement 0001 gives subroutine name. Statement 0002 is the DIMENSION statement. Statement 0003 computes the effluent flow from this process in million gallons per day (MGD) for a given operating level, CAP (JM) in % capacity for JM. The remaining lines 0004 through 0019 give the pollutant parameters necessary to define this process. These parameters must be identified by a number assigned in a master list given in Table II. For example, SPLIST (JM,3) = 40000 gives the conductivity of the effluent of the process numbered JM. Three is the parameter number for conductivity from the master list.

Further, each process is identified by a mnemonic from a master list. A list is given in Table I.

Finally, the process modeling is complete for a given plant when all of the processes and their operating levels are identified for that plant and the computer program calls in the appropriate subroutines which defines these processes. This information includes a listing of the points in the drain system at which the pollutants enter.

II. GENERAL DESCRIPTION OF PROCESS MODEL PROGRAM

The process model is identified by a mnemonic name for a specific operation within a plant and is defined in terms of production level capacity and the parameters which measure the pollutants found in the effluent of that operation. A master list of process models is available in Table I. These models are contained in the main program card deck.

During the preliminary survey all processes which make up the plant operation are identified in terms of the proper mnemonic from the master list. The expected operating capacity in % of full load is noted for each process. The mnemonic and capacity are placed on a data card for read in by the PROCES subroutine. These process cards are read in the order determined by the topological numbering discussed on page 39 under ordering of data and coding. There are no restrictions on the numbering or ordering of the processes except that once the numbering has been assigned it must be used here and in the topology part of the program.

As the subroutine PROCES reads in the process data cards it forms a plant model in terms of a SPLIST matrix. The SPLIST matrix has as its rows the different processes present and as its columns the parameter values, the parameters in order as defined by the master list of Table II and processes in the order read in. An abbreviated SPLIST matrix format example for the first five process models as well as the first four pollutant parameters is described for BAAP.

ORDER IN WHICH FOUND IN PROGRAM AND MNEMONICS	CORRESPONDING SUBROUTINES
PAPC - AOP Compression	SAPC
PAOP - AOP - Flow 3	SAOP
PSAC - Sulfuric Acid Concentrator	SSAC
PNAC - Nitric Acid Concentrator	SNAC
PBDN - Blowdown at BAAP	SBDN
PBIX - Ion Exchange at BAAP	SBIX
PCOW - Cooling Water - Flow 10	SCOW
PNBP - Nitration and Boiling Operations	SNBP
PBPP - Beater and Poaching Operation	SBPP
PBEX - Benzene Extraction	SBEX
PNCS - Nitrocellulose into Ball Power	SNCS
PNGS - Ball Power with Nitroglycerin	SNGS
PPND - Pond at Head of Sewer	SPND
PAPP - AOP - Flow 4	SAPP
PSWG - Sewer Influent - Flow into STP Process	SSWG
PCWZ - AAP - Cooling Water - Flow 11	SCWZ
PPAS - Purification Acid Scrubber	SPAS
PPCU - Purification Clean-Up	SPCU
PPCW - Purification Cooling Water	SPCW
PFSW - Finishing Scrubber Water	SFSW

PROCESSES

(SOURCES)

TABLE 1

Table 1 Continued:

ORDER IN WHICH FOUND IN PROGRAM AND MNEMONICS	CORRESPONDING SUBROUTINES
PFCU - Finishing Clean-Up	SFCU
PFCW - Finishing Cooling Water	SFCW
PTCW - Tank Car Wash	STCW
PSAR - Sulfuric Acid Recovery Cooling Water	SSAR
PSAW - Sulfuric Acid Recovery Waste Acid	SSAW
PANP - Acid Neutralization Plant (Radford)	SANP
PCIX - Ion Exchange at Newport - C line	SCIX
PZBM - Ion Exchange at Newport - A line	SZBM
PCWB - Power House Cooling Water at Newport	SCWB
PAPN - AOP at Newport	SAPN
PNDN - NAC/DN at Newport	SNDN
PGRB - Grab Sample at M-6 at Newport	SGRB
PSAZ - Sulfuric Acid Recovery at Newport	SSAZ
PTNT - TNT Lab at Newport	STNT
PPHZ - Pumphouse #2 at Newport	SPHZ
PSTP - Sewage Treatment Plant Influent at Newport	SSTP

PROCESSES

(SOURCES)

TABLE 1

Table 1 Continued

PCWL - Cooling Water Blowdown	SCWL
PODW - Oil/Descalar Water	SODW
PCOA - Cutter Oil - Line A	SCOA
PCOB - Cutter Oil - Line B	SCOB
PRWS - Rinse Water Supply	SRWS
PAPS - Alkaline Paint Stripper	SAPS
PADR - Alkaline De-Rust	SADR
PZPP - Zinc Phosphate Dip - Paint Stripping	SZPP
PCAP - Chromic Acid Rinse - Paint Stripping	SCAP
PAPK - Alkaline Pre-Cleaner	SAPK
PAHC - Alkaline Hot Cleaner	SAHC
PZPD - Zinc Phosphate Dip - Detrex	SZPD
PCAD - Chromic Acid Rinse - Detrex	SCAD

PROCESSES

TABLE 1

1. pH
2. COD
3. CONDUCTIVITY
4. TOC
5. AMMONIA (NH_3) - N
6. DISSOLVED SOLIDS
7. NITRITE/NITRATE (N)
8. TOTAL N (KJELDAHL)
9. TOTAL SOLIDS
10. SUSPENDED SOLIDS
11. TOTAL HARDNESS
12. SULFATES
13. MBAS
14. SULFITES
15. CHLORIDES
16. VOL. SUSP. SOLIDS
17. SODIUM
18. TOTAL PHOSPHATES
19. TNT
20. CALCIUM
21. COLOR
22. ALKALINITY
23. TURBIDITY
24. ACIDITY
25. BOD

MASTER LIST OF PARAMETERS

TABLE II

	PH	COD	CONDUCTIVITY	TOC ← Pollutant Names in Columns
PPND	6.0	20.0	0.0	11.0
PAPC	6.2	20.0	0.0	11.0 ← Pollutant Parameters
PAOP	6.2	20.0	0.0	11.0
PAPP	6.2	20.0	0.0	11.0
PNAC	2.5	25.0	0.0	22.0

↑ Process Model names in rows

ABBREVIATED SPLIST MATRIX

TABLE III

The PROCES subroutine is written such that if a process mnemonic and capacity is read in on a data card and there is no library subroutine defining this process, a row will be reserved in SPLIST with parameter data to be supplied later.

The PROCES subroutine also accepts data which will alter one or more parameter for any process present. If the user feels that at a

particular plant site a different parameter value gives a better model, the parameter can be changed. Further in a more extreme case, all new parameters can be read in for a given process if existing data and the judgment of the user warrant the change. Clearly, this latter capability can be used to include a process in a survey planning when the process is not in the process library.

III. GENERAL DESCRIPTION OF PROCESS MODELS

Flow rates in MGD are based on the production capacity of the process model at the time it was evaluated. A summary of each process model as of July 1, 1974, is enclosed by location, code name, flow rate, capacity at 100%, capacity at evaluation, and other characteristics to clarify the process description as deemed necessary.

BAAP Badger

PAPC (.57 MGD) - 6 units at 50 T/D. Total 300 T/D. Evaluated at 75 T/D. 3-8-5. AOP Compression

PAOP (.48 MGD) - Same as PAPC - (Cooling water)

PSAC (1.6 MGD) - 3 units at 150 T/D each. 3-8-5. Evaluated at 110 T/D (Cooling water) Sulfuric Acid Concentrator

PNAC (.30 MGD) - 16 towers at 30 T/D each. 3-8-5. Evaluated at 50 T/D (Cooling water) Nitric Acid Concentrator

PBDN (.08 MGD) - 4 boilers at 175,000 lb stream/hr each. Continuous at 5 per cent of production. Blow down

PBIX (.01 MGD) - 7 columns at 150,000 lb stream/hr each. Evaluated at 4 columns. 400 GPM for 10 min. backwash. 132 GPM for 15 min. slow rinse. 264 GPM for 50 min. fast rinse. Once every 30 hours. Ion Exchange

PCOW (.30 MGD) - Cooling water from boiler at 25 percent capacity. Continuous. 1.5x stream production. Cooling Water

PNBP (.50 MGD) - 17,000 lb/day. 8 am - 3 pm weekdays. Nitration and Boiling

PBPP (.20 MGD) - 120,000 lb/day. Evaluated at 11,000 lb/day from E-line. Continuous. Beater and Poaching

PBEX (.45 MGD) - 610,000 lb/mo. of reprocessed nitrocellulose. Intermittent. Benzene Extraction

PNCS (2.0 MGD) - 2,700,000 lb/mo. of ball powder. Evaluated at 700,000 lb/mo. 3-8-5 Nitrocellulose into Ball Powder

PNGS (.09 MGD) - Same as PNCS.

PPND (.40 MGD) - Pond overflow based on the water treatment level. 45 MGD. Evaluated at 12 MGD. Continuous. Pond

PAPP (.89 MGD) - Same as PAPC - (Process water).

PSWG (.27 MGD) - Based on BAAP facilities. Continuous. Sanitary Sewer

PCWZ (.20 MGD) - Cooling water from compressors, fans, and pumps. 50 Percent of capacity on weekdays and 25 percent on weekends. Continuous.

NOTE: All values for BAAP are based on averages in the assay or data sheets. Additional element values were added to the assay values for cooling water and process water effluents by using the data sheets for raw water and process water.

RAAP (The ten processes for one 50 T/D continuous TNT line). (Radford)

PPAS (.0015 MGD) Purification Acid Scrubber

PPCU (.02 MGD) Purification Clean Up

PPCW (.90 MGD) Purification Cooling Water

PFSW (.0024 MGD) Finishing Scrubber Water

PFCU (.01 MGD) Finishing Clean Up

PFCW (.15 MGD) Finishing Cooling Water

PTCW (.015 MGD) Tank Car wash

PSAR (1.5 MGD) Sulfuric Acid Recovery Cooling Water

PSAW (.01 MGD) Sulfuric Acid Recovery Waste Acid

PANP (.135 MGD) - unique to RAAP. Acid Neutralization Plant

NAAP Newport

PCIX (.3214 MGD) - 3 cation exchanges with 2 operations during evaluation. 6,000 gal. tank for bulk storage. Evaluated at 90 percent capacity. Ion exchange Newport-A

PZBM (.0381 MGD) - 2 anion exchanges with 1 operating during evaluation. Evaluated at 90 percent capacity. Ion exchange Newport-C

PCWB (.17 MGD) - 120 GPM normal blowdown. Evaluated at 90 percent capacity. Power House Cooling Water Newport

PAPN (.30 MGD) - 350 T/D of 65 percent HNO3. 100 percent acid basis. AOP at Newport

PNDN (.30 MGD) - 2 NAC units with 100 T/D capacity of 98.5 percent acid. 4 denitiating units with 290 T/D of TNT waste acid each. Nitric Acid Concentrator-Newport

PGRB (.002 MGD) - Unique to NAAP Grap Sample at M-6 Newport

PSAZ (.30 MGD) - Regeneration of 7.4 T/D of 40 percent Oleum and 326 T/D of 20 percent Oleum. Sulfuric Acid Recovery-Newport

PTNT (.10 MGD) - 5 lines at 50 T/D each. Evaluated at one line with outfall unique to NAAP. TNT Lab-Newport

PPHZ (.02 MGD) - Evaluated at 90 percent capacity. Pumphouse #2-Newport

PSTP (.50 MGD) - Based on NAAP facilities. Sewage Treatment Plant Influent-Newport

NOTE: Values were based on conference at Clemson University in January 1974. All operations are continuous and 100 percent capacity was used unless noted otherwise.

LAD Letterkenney

Shell Production - 160,000/mo. Evaluated at 100,000/mo.

PCWL (.0286 MGD) - Sample Point J Cooling Water Blowdown

PODW (.154 MGD) - Sample Point K Oil/Descaler Water

PCOA (.01 MGD) - G-12 (10,000 gal. cap. tank) Cutter Oil Line A

PCOB (.01 MGD) - G-13 (10,000 gal. cap. tank) Cutter Oil Line B

Paint Stripping - 3 to 5 percent of the shells are rejected. Capacity is 500-700 shells/day/shift. There are 2 lines of which 1 line was used during evaluation not at fall capacity. Continuous overflow for rinse is 2 GPM.

PRWS (.0056 MGD) Rinse Water Supply

PAPS (.00035 MGD) Alkaline Paint Stripper

PADR (.00035 MGD) Alkaline Derust

PZPP (.00035 MGD) Zinc Phosphate Dip

PCAP (.00035 MGD) Chromic Acid Dip

Point Preparation - "DEXTREX" process of batch dumps which last 10 minutes at the end of each work period. Continuous overflow for pre-cleaner and hot cleaner 4 GPM.

PAPK (.001 MGD Weekly) Alkaline Pre-Cleaner

PAHC (.0012 MGD Monthly) Alkaline Hot Cleaner

PZPD (.0011 MGD Monthly) Zinc Phosphate Dip- Detrex

PCAD (.0009 MGD Daily) Chromic Acid Dip-Detrex

Notes: Averages of days 2, 6, and 9 were used for point "J". Averages for days 8-13 were used for point "K".

IV. REQUIRED PROCESS SUBROUTINE DATA INPUT AND FORMAT

The following paragraphs describe the data required by the PROCES subroutine and the card format required by the subroutine. The cards and data will be discussed in the order in which they must be read in. The data required is:

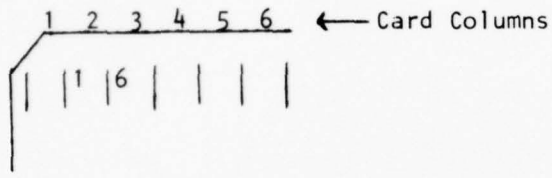
1. The number of processes in the plant model, N
2. The process names, XNAME (JM), and the percent of full production capacity, CAP (JM)*
3. A flag indicating whether or not there are to be pollutant parameter modification for any of the processes, NOD
4. If there are modifications, give the number of parameters to be changed, NMOD
5. For each parameter to be changed, give the process name, the pollutant number, and the new pollutant value. YNAME (NM), ELE (NM), VAL (NM) - One card for each parameter to be changed.
6. A flag indicating whether or not there are to be any complete processes changed, NPRO (Could be a new process)
7. If there are processes to be changed, give the number of processes to be changed, NUMP
8. Read in the number of parameters currently in the master list, NELE.
9. For the first process to be changed, read in the process name and the % of full capacity flow. ZNAME (JN), FLW (JN)
10. One card for each parameter in the master list in the same order as in the master list, giving the new parameter values, SPLIST (JE, JK)
11. Repeat 9 and 10 for each process to be modified.

*Must be readin in the same order as topological numbering.

The data card formats are read in statements for the PROCESS data and are now given.

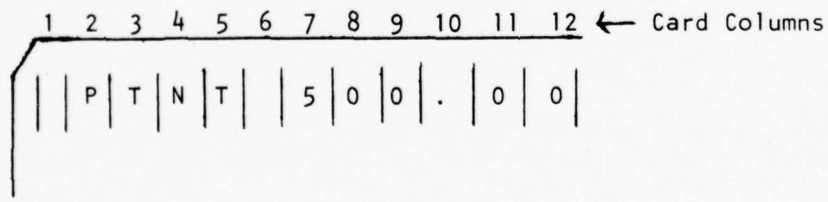
1. The number of processes in the plant model N. Example for 16 proceses:

```
      READ (1, 10)N
10    FORMAT (1X, I2)
```



2. One card for each process giving process mnemonic and the % of full production capacity. Example: PTNT at 500% capacity.

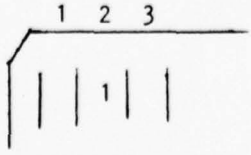
```
      READ (1,200) XNAME (JM), CAP (JM)
200   FORMAT (1X, A4, 1X, F6.2)
```



3. Flag to indicate pollutant parameter modifications. If there are modifications NOD=1. If there are no modifications NOD=0.

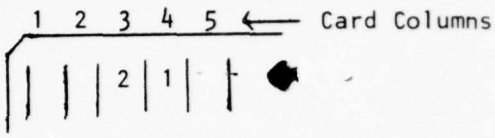
Example: NOD=1

```
      READ (1,400) NOD
400   FORMAT (1X, I1)
```



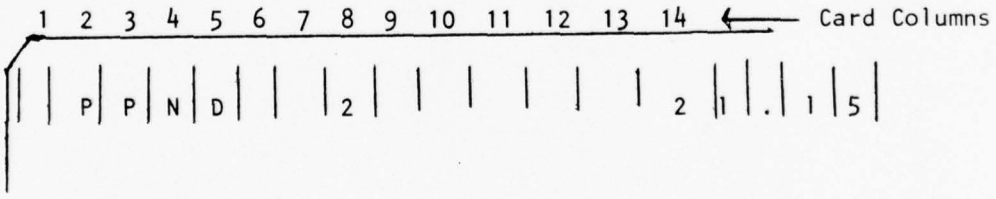
4. If there are modifications the next card gives the number of parameters to be modified. Example: 21 (bypassed if NOD=0)

```
      READ (1,700) NMOD
  700 FORMAT (1X, I3)
```



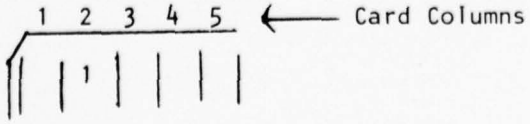
5. In this group, one card for each parameter to be changed. Give the process mnemonic, the pollutant number and the pollutant parameter value. Example: PPND, pollutant number 2, pollutant parameter value 21.15 (number 2 is COD)

```
      READ (1,750) YNAME (NM), ELE (NM), VAL (NM)
  750 FORMAT (1X, A4, 1X, I2, 1X, F9.2)
```



6. This is a flag card to indicate if any complete processes are to be changed. If there are modifications NPRO=1. If there are no modifications NPRO=0. Example: NPRO=1

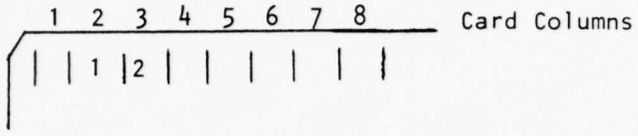
```
      READ (1,875) NPRO
  875 FORMAT (1X, I1)
```



7. If there are complete processes to be modified, this card gives the number of processes to be changed. Example: 12

(bypassed if NPRO=0)

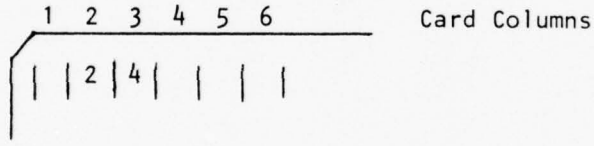
```
     READ (1,890) NUMP
 890 FORMAT (1X, I2)
```



8. Next read in the number of parameters currently in the master list.

NELE Example:24

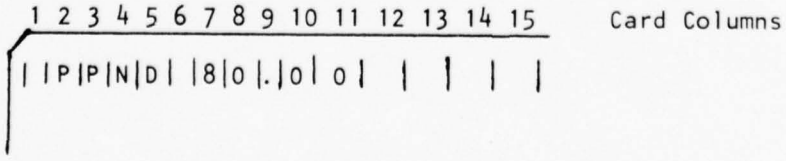
```
     READ (1,890)NELE
890  FORMAT (1X, I2)
```



9. For the first process to be changed, read in the process mnemonic and the % full load capacity.

Example: ZNAME (JN) = PPND,FLW (JN) = 80

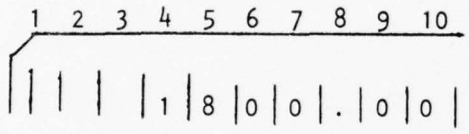
```
     READ (1,895) ZNAME (JN), FLW (JN)
895  FORMAT (1X, A4, 1X, F6.4)
```



10. This next group of cards (NELE in number), one for each parameter in the master list, gives the value for each parameter defining the process. These must be in the same order as in the master list of parameters.

Example card: the third card - conductivity = 1800.

```
      DO  897 JK=1, NELE
      READ (1,898) SPLIST (JE,JK)
898   FORMAT (1X, F9.2)
897   CONTINUE
```



11. Cards described in 7 through 10 are bypassed if NPRO = 0. Procedures described in 9 and 10 are repeated for each process to be modified. Clearly this procedure can be used to include processes in a survey plan when these processes are not included in the process library. However, this use does not place the new process in the library. The next section explains how a new process may be added to the library.

V. Procedure for Adding a Process Model to the Library:

A. Add a DATA statement to the existing set of data statements to initialize the new process name.

```
DATA P 1 2 3/4HP 1 2 3/
```

B. Add an IF statement to the existing set of IF statements to allow the main program to call the new process

```
IF(XNAME(JM). EQ. P 1 2 3 CALL S 1 2 3
```

New Process Name 4 Characters	Subroutine Name for Subroutine that Defines the New Process

Positions 1 2 3 being the same.

C. Add a subroutine with the following form to define the new process.

```
SUBROUTINE S 1 2 3   (FLOW, SPLIST, CAP, JM, MSORS, MPARM)
DIMENSION   FLOW (MSORS), SPLIST (MSORS,MPARM), CAP (MSORS)
FLOW (JM) = 0.01 * CAP(JM) * {Some value to represent the flow
  of the process at 100% capacity}
SPLIST (JM,1) = {value of first element in process}
SPLIST (JM,2) = {value of second element in process}
      .
      .
      .
      .        These are values of pollutant 1 through N
      .
SPLIST (JM,N) = {value of Nth element in process}
RETURN          The SPLIST array must be redimensioned
END             if N > 25.
```

If a pollutant's value is not known or is zero, then the statement defining that pollutant may be omitted and the program will insert a zero into the SPLIST array for that pollutant.

VI. Summary:

The user must be aware of the most recent master lists of process models and pollutant names contained in the system library so that he can plan his overall data gathering requirements during the preliminary survey. He must not feel that each new operation is unique, requiring the development of data for the addition of new process models.

As more process models are added to the library, the emphasis in preliminary surveys can be placed on the determination of the flow rate at full production, the production operating capacity during measurement periods; and a few measurements of operations similar to the process models in the library to verify previously recorded data. When there is a large deviation in a pollutant parameter the methods and procedures of the operation which contributed the unfavorable parameter should be investigated and compared to the favorable operation to possibly recommend improvement rather than merely record the unfavorable parameter as a modification. Confidence in the validity of the data will increase as the surveys improve in quality.

TOPOLOGY MODEL USER'S GUIDE

I. Collection of Data:

The topology data of a site consists of the following:

1. A map of the sewer lines (include flow direction).
2. Identification of all processes (sources) noting where these processes empty into the sewer system.
3. Identification of all treatment facilities and where these treatments occur in the sewer system.
4. Note the location of all manholes, weirs or other possible sample points in the sewer system.
5. Identification of pollutant parameters to be measured.
6. Settling pond areas if any-type of neutralization if any-type of domestic treatment if any

Figure II a and II b give the topology data for Badger AAP and serves as a good example of how to record the necessary data.

The sewers are represented as directed line segments showing the flow directions and interconnections.

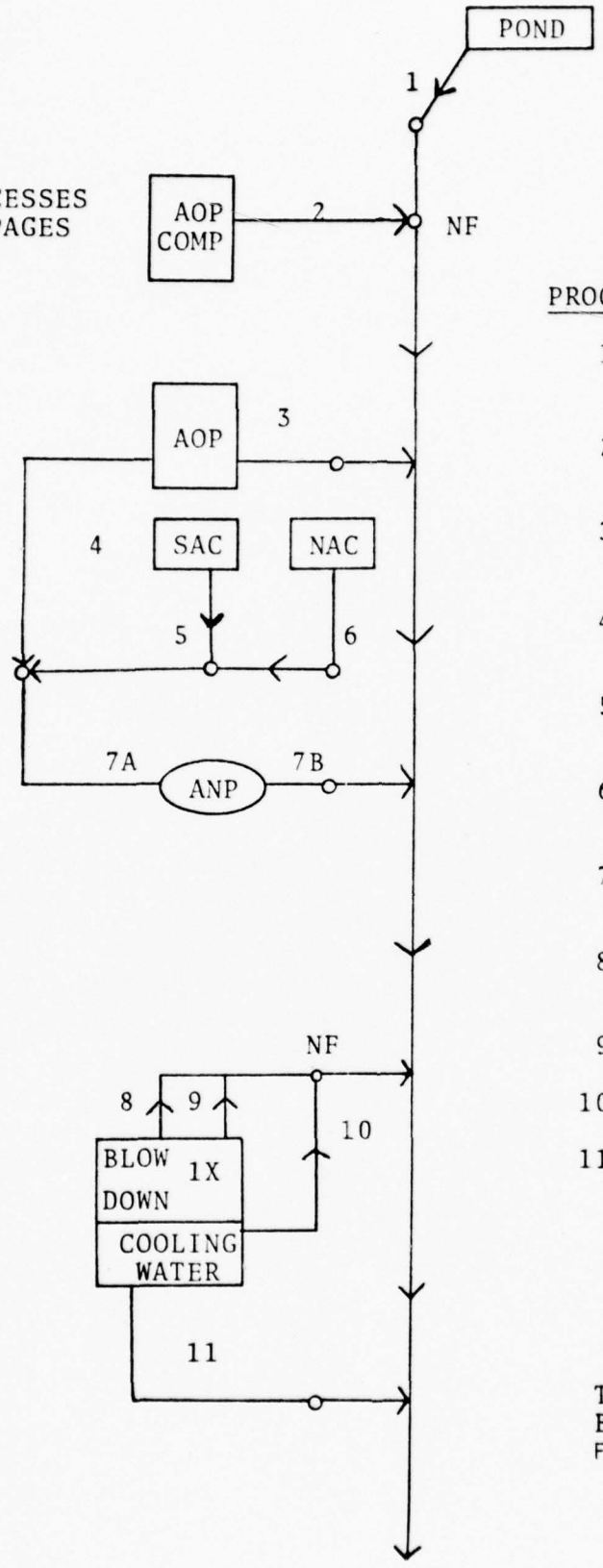
The processes are represented as rectangles and are identified by number and/or some meaningful acronym. The location of the point where each process discharges its effluent into the sewer is also known.

Treatment facilities are represneted by ovals and are identified by an acronym describing the type of treatment. (Acid or caustic neutralization, settling, domestic sewage treatment.)

The location of all manholes, weirs, or other possible sample points are represented as circles on the sewer line. Further identifying and describing information can be included if necessary as shown by the collumn on the right side of Figures I a and I b.

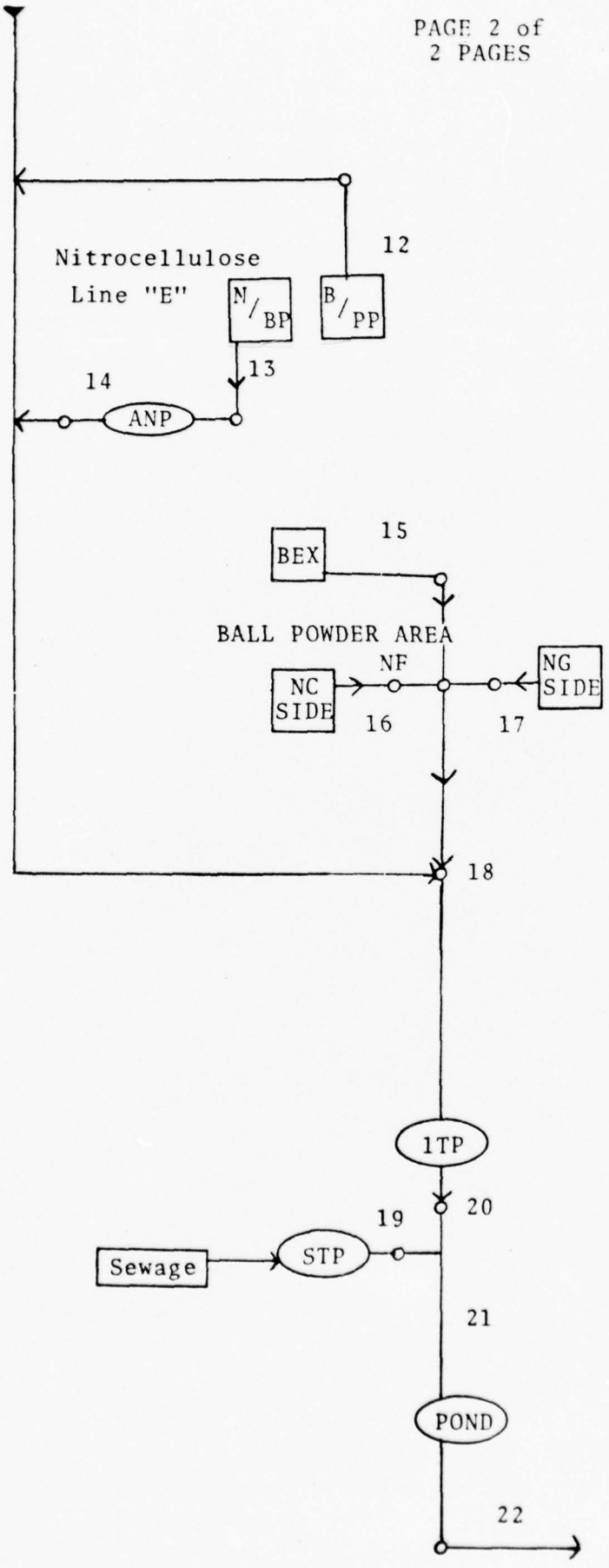
BADGER
ARMY
AMMO
PLANT

TOPOLOGY PROCESSES
PAGE 1 of 2 PAGES



PROCESS	DESCRIPTION
1	overflow from pond
2	AOP compression house
3	AOP (cooling water)
4	AOP (process water)
5	sulfuric acid concentrator
6	nitric acid concentrator
7B	acid neutralization plant
8	automatic boiler blowdown
9	ion exchange
10	boiler
11	compressors, fans, pumps

TOPOLOGY
BADGER AAP
FIGURE II A



PROCESS	DESCRIPTION
12	Beater & Poaching Operation
13	Nitration & Boiling Operation
14	Acid Neutralization Plant
15	Benzene Extraction of Additive for NC in smokeless powder
16	Processing of NC for Ball Powder
17	Processing of Ball Powder with Nitroglycerin (NG)
19	Sewage Treatment
20	Industrial Wastewater Treatment Plant
21	Mixed Unsettled Waters
22	Settled Water - Discharged

TOPOLOGY
BADGER AAP
FIGURE II B

II. Ordering of Data and Coding

All of the data must be ordered (numbered) and coded.

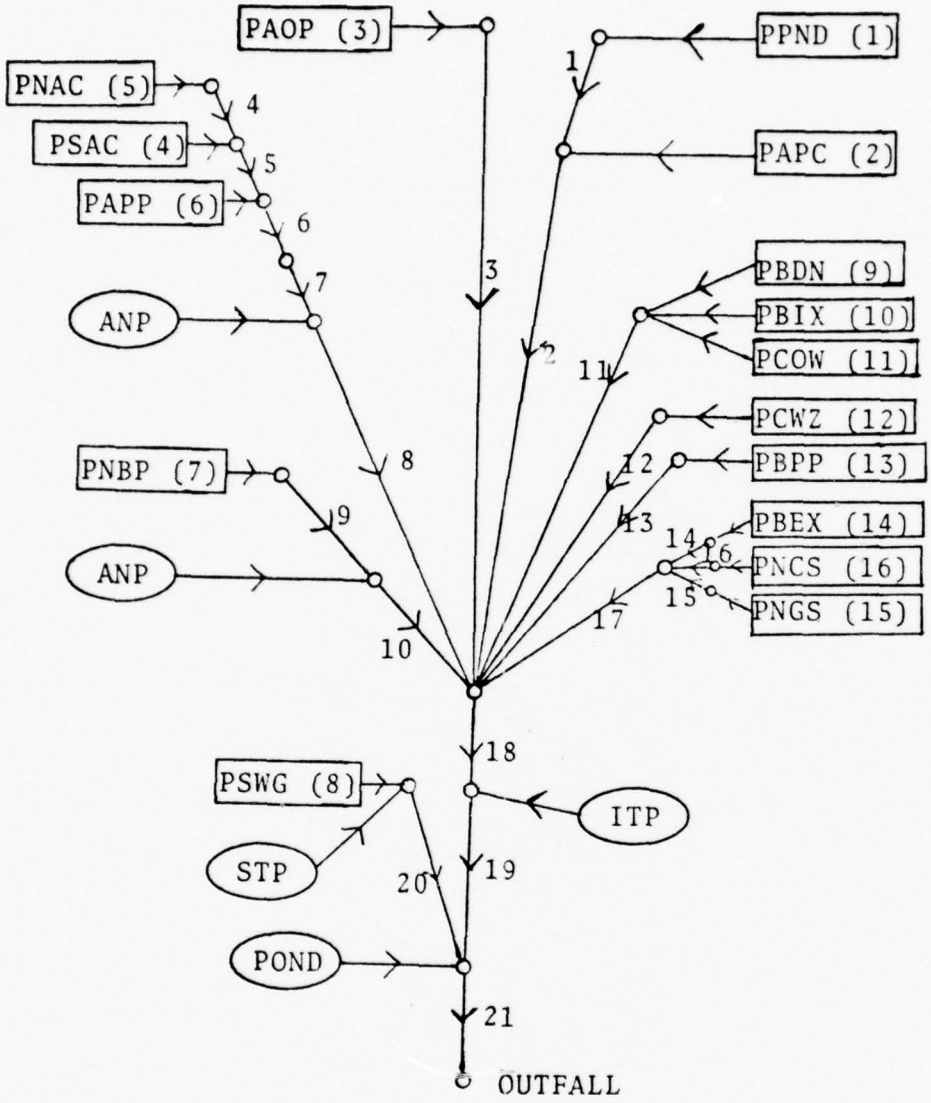
All processes (sources) must be identified on the master list for which subroutine exist in the porcess model. This master list is given in Table I. Each process is then assigned the proper mnemonic listed in the left column of Table I. This correct coding is necessary if the program is to call the correct subroutine (named in the right hand column) which defines that process. Note: In the section describing "Processes," it is explained how a process in the master list can be modified to fit the needs of the user.

After the processes have been assigned their appropriate mnemonic, the processes must be numbered. The numbering order is arbitrary but when assigned it must be used consistently throughout the program (In both "Process" and "Topology").

Next one needs to identify and order the measure points and identify the flows of all processes which pass through each measure point. This ordering and identifying is best done by using a linear graph as shown in Figure III for the Badger AAP system of Figure II a and II b.

The rules for constructing the linear graph are:

1. Each process is represented by a rectangle containing the process mnemonic code and a line from the rectangle to the point where the process discharges into the system.



Linear Graph for Badger AAP
Sewer System
Figure III

2. Each manhole or other measure point is represented by a directed line segment on the graph.

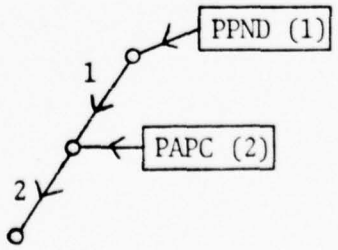
3. Each leg of the sewer system that does not contain a manhold or measure point is contracted to "zero" length.

4. The direction of flow in each line segment is indicated by an arrow head.

5. Partial treatments are represented by ovals containing an identifying code and a line from the oval to the point in the system where the flow is treated.

6. The essential information on the linear graph includes the identity and ordering of all processes, identity and ordering of measure points, and flows from each process which pass through each possible measure point.

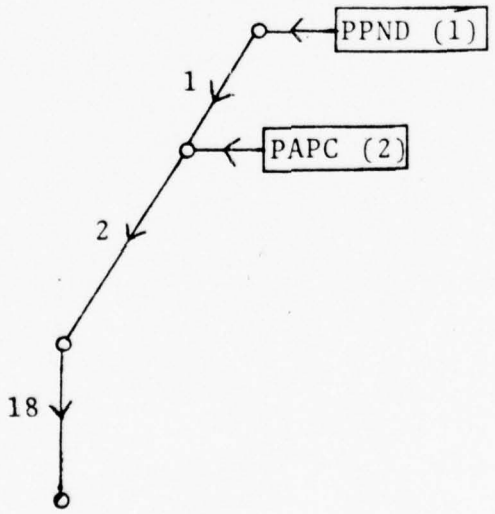
As a rule of thumb, one can begin the construction of the system linear graph by going to the "preliminary survey" data such as shown in Figures II a and II b and start by listing a process approximately the greatest number of measure points away from the outfall. In the example this is the "overflow from pond", its mnemonic is PPND. We shall assign this as process number one (1) and note that the flow enters the system at a manhole which we will identify as measure point number one (1) and represent as a directed line segment on our graph in Figure IV.



Beginning Construction of
System Linear Graph
(Step 1)
Figure IV

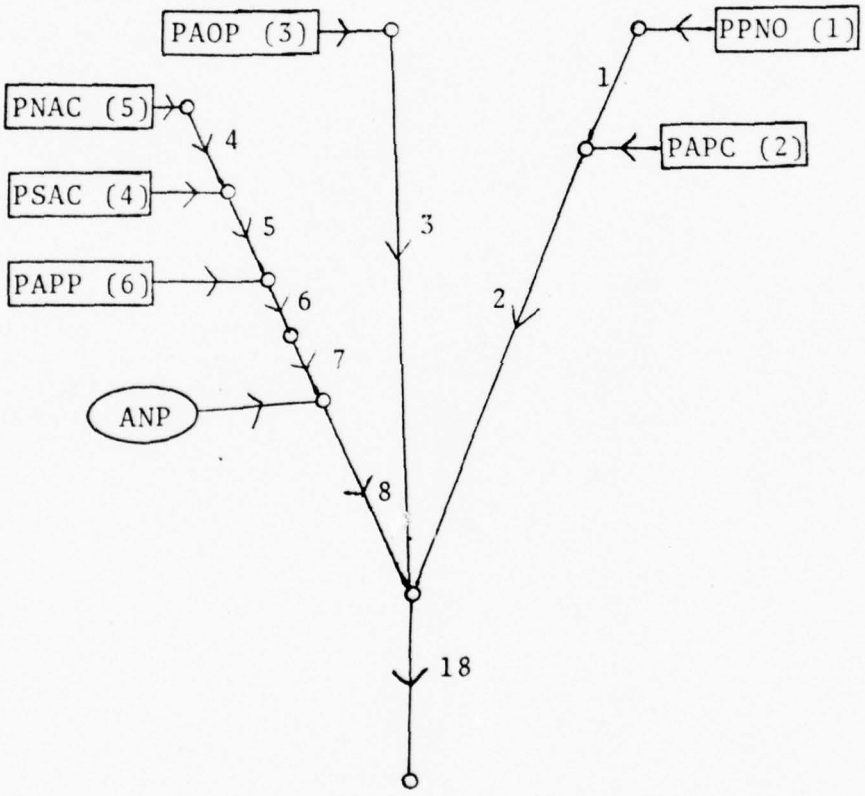
Next as we proceed from measure point number one to the next measure point to which we assign number two, note that flow from the process identified as "AOP Compression House" must be included at measure point two. The process is identified by its mnemonic, PAPC, and assigned the number two, (2). In Figure IV the flows from processes 1 and 2 are included at measure point number 2 represented by a directed line segment

Figures I a and I b show no manholes or other measure points in the sewer system from the point marked NF on Fig. II a to the point marked 18 on Fig. II b. Thus, all these sections of sewer line are contracted to a single point and the Figure V shows the linear graph including measure point 18.



Construction of System
Linear Graph
(Step 2)
Figure V

It is noted from Figures II a and II b that several other flows are included at measure point 18. In Figure VI several of these are added and Figure III shows the completed linear graph. Figure VI shows the addition of processes PAOP (3), PAPP (6), PSAC (4), and PNAC (5). Measure points 4, 5, 6, 7, and 8 are included. Acid neutralization treatment is included as ANP oval acting on flow entering measure point 8.

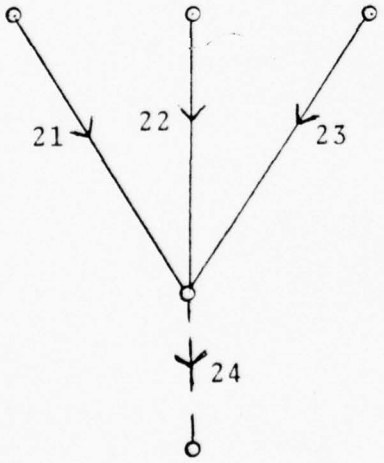


Construction of System
Linear Graph
(Step 3)
Figure VI

There are restrictions in numbering the measure points (branches of the linear graph). The restrictions are:

1. The numbering must start at 1 and continue consecutively to the highest number.
2. The numbering must be such that in tracing from any branch j to the outfall only higher numbered branches will be encountered.
3. Thus, the outfall branch must have the highest number.

If the sewer system is in separate parts and hence has multiple outfalls, the outfall elements of the separate parts are connected together and a fictitious new outfall element is included in the linear graph. In the input data a data item designated NTOP gives the program the information necessary to handle this situation. *Figure VII illustrates the addition* of the fictitious outfall.



21 - outfall of Part 1
22 - outfall of Part 2
23 - outfall of Part 3
24 - fictitious outfall.

Multiple Outfalls
Figure VII

III. Construction of the Topology Matrix

A convenient way of tabulating the flow information for entering into the computer program is to put the information in a matrix form. The information required for each branch of the linear graph (each possible measure point) includes:

1. Does the flow of source i flow through branch j?

2. Does the flow undergo any treatment in branch j? If so, what treatment?

A matrix is constructed with a column, j, for each branch of the system and a row, i, for each source of the system. The entries for the i^{th} row are obtained by starting at the i^{th} process on the linear graph and tracing a path through the branches to the outfall. If the path does not include the j^{th} branch the ij entry is zero. If the path does include the j^{th} branch an appropriate number is entered in the ij position. That appropriate number depends upon whether or not the flow undergoes treatment in that branch and specifically which treatment. If the flow of source i passes through branch j and no treatment occurs at branch j, then the ij entry is 1. If the flow of source i passes through branch j and the composite flow in branch j is treated at branch j, then the ij entry is 2,3, or 4 depending on the type of treatment as follows:

acid or caustic neutralization	-2
settling pond	-3
domestic sewage treatemnt	-4

Figure VIII gives the topology matrix for the system of Figure III.

IV. Identification of Pollutant Parameters

It is necessary to supply information to the programs which tell the particular pollutant parameters that are to be measured on a survey. Each of the processes are defined in terms of 25 parameters. However, all of these may not be measured in a given survey. These 25 parameters are listed and numbered in a master list given in Table II. These are in the same order used in the process model. The table numbers for specific parameters is supplied to the program on a data card. Also, another set of cards is used to read in the names of the parameters to be measured.

PROCESSES

BRANCHES

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	1	1																1	2		3
2		1																1	2		3
3			1															1	2		3
4					1	1	1	2										1	2		3
5				1	1	1	1	2										1	2		3
6						1	1	2										1	2		3
7									1	2								1	2		3
8																				2	3
9											1							1	2		3
10											1							1	2		3
11											1							1	2		3
12												1						1	2		3
13													1					1	2		3
14														1			1	1	2		3
15															1		1	1	2		3
16																1	1	1	2		3

TOPOLOGY MATRIX

FIGURE VIII

V. Names of System Branches

The program was written to require names as well as numbers to be assigned to the branches. Up to an eight letter mnemonic is used here. Meaningful names assigned here will allow more rapid interpretation of print outs.

VI. Treatment Facilities Data

The TOP subroutine, in calculating the pollutant valves for each branch of the system, takes into consideration any treatment facilities in the system. Treatment types modeled include acid or caustic neutralization, settling pond (industrial), and domestic sewage treatment.

Data required to identify and define the types of treatment used follows.

1. Clarifier or settling pond area in acres (industrial treatment)
2. Acid or caustic neutralization (industrial treatment)

MNEUT { 1 acid neutralization
2 caustic neutralization

If MNEUT = 1 then for neutralizing agent

MENU { 1 $Ca(OH)_2$
2 $CaCO_3$
3 Na_2CO_3
4 NaOH

If MNEUT = 2

NCAUS { 1 H_2SO_4, HCl or HNO_3
2 CO_2

If NCAUS = 1

MACY { 1 H_2SO_4
2 HCl
3 HNO_3

3. Domestic sewage treatment.

ITYPE = 0 trickling filter
= 1 activated sludge

TRICKLING FILTER

AREAP primary clarifier area in acres

TVOL trickling filter volume in acre-feet

TEMP wastewater temperature (°C)

R2 recycle from filter effluent (MGD)

R3 recycle from secondary clarifier (MGD)

R4 recycle to filter (MGD)

TFAREA trickling filter area in acres

K20 = 0.23 for 1" rock media

= 0.13 for 2½" rock media

AREAS secondary clarifier area in acres

ACTIVATED SLUDGE

AREAP as above

AREAS as above

ABVOL aeration basin volume in (MG)

MLSS mixed liquor suspended solids (Mg/l)

YN net yield from plant log data

RI activated sludge recycle (MGD)

VII. Flagging

The flagging information required by the program is generally not data collected on the preliminary survey but rather is data based on the judgement of the survey officer. The judgement may be based on experience but will also be based on results of trial runs of the planning programs during the survey planning operation. If a flag is associated with a

particular pollutant at a particular point in the system, measurement will be made of that pollutant at that point and resources will be committed before assignments are made by the Resource Matching Model.

Three types of flagging procedures are available.

1. Automatic flagging.
2. Manual flagging of sources
3. Manual flagging of branches

For automatic flagging a subroutine is included which will check the total mass of any pollutant discharged at the outfall. The program will then automatically flag any source which contributes more than X (decimal fraction) to this total. The source is flagged for the measurement of this parameter only. The survey officer can specify the value of X for each parameter.

The subroutine also permits the survey officer to flag for measurement any particular source for any particular parameter or any particular branch for any particular parameter.

VIII. Required Topology Subroutine Data Input and Format

The input data required by the topology part of the survey planning program are:

1. The number of sources, NS
2. The number of branches, NB
e. The number of pollutant parameters, NP
4. The number of outfalls, NTOP
5. The number designation from Table II of the parameters to be measured on the survey, NPLIST (I)
6. The topology matrix data, A (J.I)
7. The branch names, NBRNCH (I,J)

*8. The length of the survey in days (LENGTH)

*9. The number of noncompeting parameters (ISTOP)

10. The parameter names POLN (N,I)

*11. The number of measure methods for each parameter (NMA(N))

*12. The sampling frequency per day (SAMFRE(N))

13. Sewage treatment data

14. The flagging levels FLGPT(I)

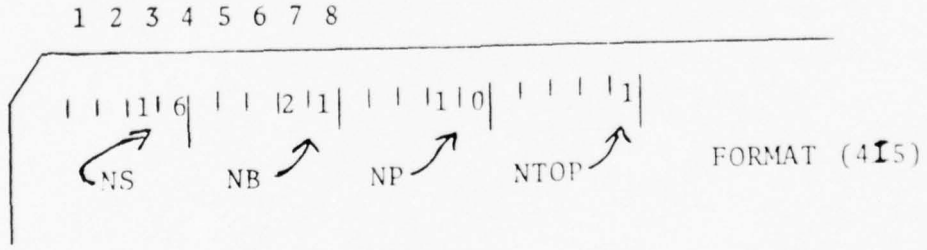
15. The source and parameter manual flags NF, NX(I), NY(I)

16. The branch and parameter manual flags NFB, NX(I), NY(I)

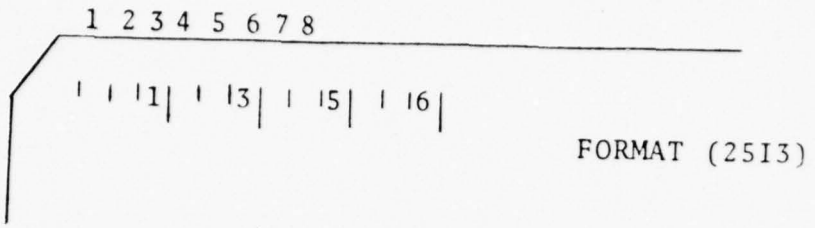
*These data are read in here by subroutine CHKI but are used in Resource Matching.

The data cards for these data are read in the order listed above immediately after the process model data cards. The card formats are described below: (this data is called for by topology subroutines.)

The NS, NB, NP, NTOP are read in on one card, the first card, with four fields each five long and right justified.



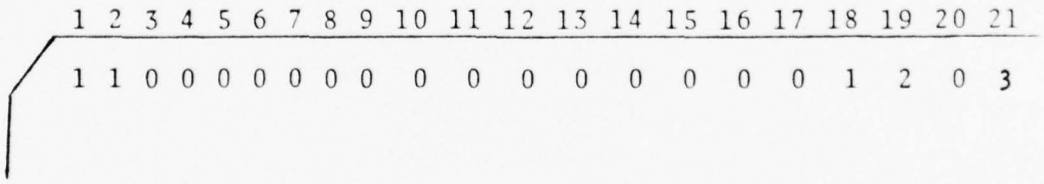
The number designations from Table II of the parameters to be measured are read in on one card, with 25 fields each three long and right justified. These are read in as NPLIST. The following card layout is for measurement of parameters: 1, 3, 5, 6 etc.



The topology matrix is read in next, one row of the matrix per card and the rows in the same order as in the topology matrix. The cards are read in with the following statements:

```
      DO 2 J = 1, NS
      READ (1,3) (A(J,I), I = NB))
3 FORMAT ((80I1))
2 CONTINUE
```

As an example, the following card layout is for the first row of the topology matrix of Figure VIII:

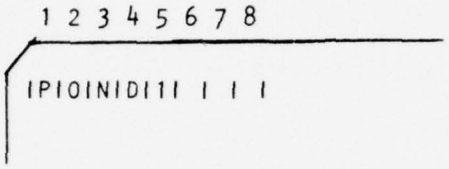


The branch names are read in an order with the following statements:

```
      DO 30 I = 1, NB
```

```
30  READ (1, 901) (NBRANCH (I,J), J = 1,2)
901 FORMAT (2A4)
```

For example, branch #1 may be assigned the name POND1. The card format would be as shown below. One card is used for each branch. (up to 8 characters can be used)

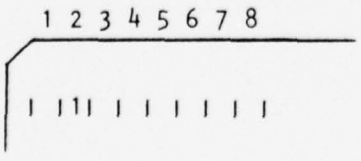


The length of the survey design in days is read in at this point, by CHK 1 subroutine. The information is used in the resource matching subroutine. The sampling frequency and constraints are given on a per day basis. If survey periods different from a per day basis need to be considered in planning this entry allows such periods to be considered.

The number of days is read in with the following statements:

```
READ (1, 903) LENGTH
903 FORMAT (I2)
```

For a one day period the card layout is as follows:

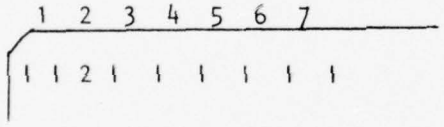


The number of noncompeting parameters is read in at this point by CHK1. The information is used in the resource

matching subroutine. The program is written so that parameters which have only one measurement method available can be listed first. Available resources are assigned for these parameters first. If an ISTOP number is entered to designate the number of these parameters, then when the program is later searching for alternatives it will not search back through these. The designation is ISTOP and it is read in with the following statements:

```
    READ (1,100) ISTOP
100 FORMAT (I2)
```

And for 2 noncompeting parameters the card layout follows:



The names of all parameters in the master list (Table II) must be listed in the same order. The program saves the names of those parameters previously designated to be included in this survey. One parameter is listed per card. On the same card, for each parameter the number of measure methods available (NMA (N)) and the sampling frequency (SAMFRE (N)) for that parameter are listed. The NMA(N) and the SAMFRE(N) are used in the resource matching subroutine but are read in here by subroutine CHKI while entering the parameter name. The significance of the NMA(N) is discussed in the resource matching section of the manual. The SAMFRE(N) is the

number of samples for day per measure point for the N^{th} parameter.

The data card layout is according to the format statement:

FORMAT (5A4, 5X, I1, 4X, F6.1)

and for the parameter alkalinity, 2 measure methods, and 4 samples per day per measure point:

```
1 2 3 4 5 6 7 8 9 10                    20        25 26          30          36
|A|L|K|A|L|I|I|N|I|I|T|Y| | | | | | | | | | | | | | | |2| | | | | | | |4|.|
  POLN (N)                                        NMA(N)      SAMFRE(N)
```

The sewage treatment data is read in next. The reading format and the programs using the data are written so that all cards listed must be included. Appropriate data is included on the cards. When a particular treatment is not included, the cards normally carrying this data are left blank. (i.e. zeros are read in) This data is read in by the TOP subroutine.

The area of the settling pond or clarifier is read in (for industrial treatment). This area is in acres and is read in with the statements:

READ 20, AREA

20 FORMAT (F5.2)

The card layout for an 8 acre pond is

```
1 2 3 4 5 6 7
| 8|.|0|0|0|0| | |
```

If the treatment is for industrial waste and involves acid or caustic neutralization the next card supplies the value for MNEUT.

MNEUT = 1 for acid neutralization and

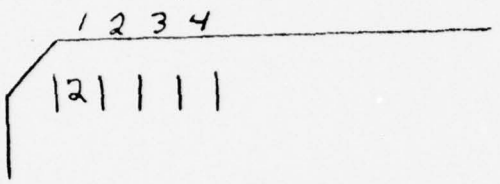
MNEUT = 2 for caustic neutralization

MNEUT is read in with the following statements

READ 21, MNEUT

21 FORMAT (I1)

The card layout for MNEUT = 2 is



If the treatment is acid neutralization, then MENU indicates the neutralizing agent.

$Ca(OH)_2$ - 1

$CaCO_3$ - 2

$Na\ Co_3$ - 3

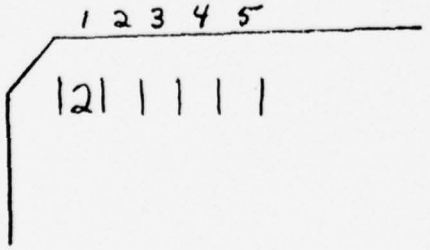
NaOH - 4

MENU is read in with the following statements:

READ 22, MENU

22 FORMAT (I1)

The card layout for MENU = 2 is



If the treatment is caustic neutralization, then NCAUS indicates the neutralizing agent

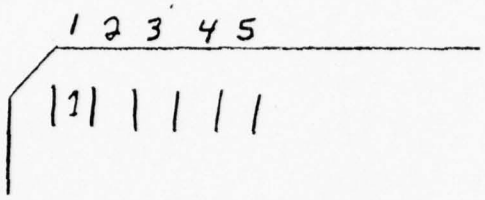
H_2SO_4, HCl or HNO_3 - 1

CO_2 - 2

NCAUS is read in with the following statements:

```
READ 23, NCAUS
23 FORMAT (I1)
```

The card layout for NCAUS = 1 is



If NCAUS = 1 then MACY gives the neutralization agent

H_2SO_4 - 1 = MACY

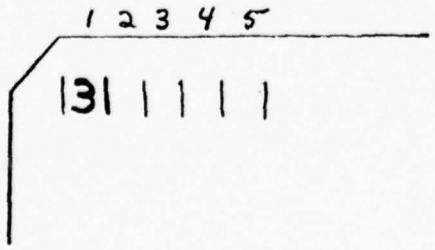
HCl - 2 = MACy

HNO_3 - 3 = MACY

MACY is read in with the following statements

```
READ 24, MACY
24 FORMAT (I1)
```

The card layout for MACY = 3 is



If the treatment is for domestic waste there are two types modeled, trickling filter and activated sludge. ITYPE supplies the program with this information

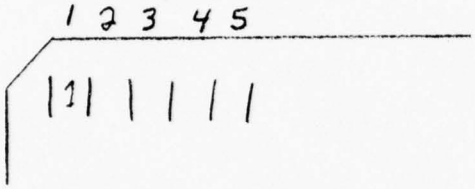
ITYPE = 0 trickling filter

ITYPE = 1 activated sludge

ITYPE is read in with the following statements:

```
READ 25, ITYPE
25 FORMAT, (I1)
```

The card layout for ITYPE = 1 is



The domestic treatment data is read in on two cards. Appropriate numbers are entered for the particular type of treatment used. The appropriate data for each type is as follows:

TRICKLING FILTER

AREP primary clarifier area in acres

TVOL trickling filter volume in acre-feet

TEMP wastewater temperature in °C

R2 recycle from filter effluent (MGD)

R3 recycle from secondary clarifier (MGD)

R4 recycle to filter (MGD)

TFAREA trickling filter area in acres

K20 = 0.23 for 1" rack media

= 0.13 for 2½" rock media

AREAS secondary clarifier area in acres

ACTIVATED SLUDGE

AREP as above

AREA as above

ABVOL aeration basin volume (MG)

MLSS mixed liquor suspended solids (mg/l)

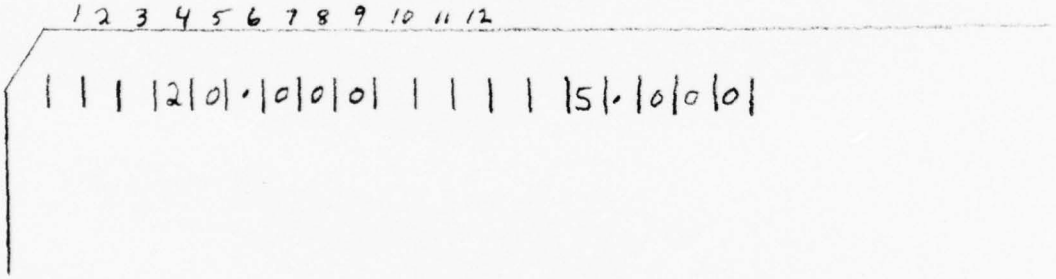
YN net yield from plant log data

RI activated sludge recycle (MGD)

The data are read in with the following statements:

```
READ 26, TEMP, AREAP, AREAS, ABVOL, TFAREA, TFVOL
26 FORMAT (F9.3, 1X, F9.3, 1X, F9.3, 1X, F9.3, 1X, F9.3, 1X, F9.3)
READ 27, MLSS, YN, R1, R2, R3, R4
27 FORMAT (F9.3, 1X, F9.3, 1X, F9.3, 1X, F9.3, 1X, F9.3, 1X, F9.3)
```

The card layout illustrating the first two of these values TEMP = 20°C and AREAP = 5 acres is as follows:



Next the flagging data discussed above is read in by the FLAG(P) subroutine. First the X flagging level is read in for each parameter of the survey in the same parameter order used in previous data. All X's are read in on the same card with the statements:

```
READ (1,900) (FLGPT (I), I = 1, (NP)
900 FORMAT (25F3.2)
```

and for flag levels of .10, .10, .10, .99, .05 etc., the card layout is:

```
 1   3     6    9    12 15          20        25
|.1110|.1110|.1110|.9999|.1015| | |9999| | | |15| | |
```

The manual flagging is done in two parts, the flags for the sources and the flags for the branches. First a card reads in NF the number of flags for parameters to be measured at sources, then the cards which designate the source number NX(I) and the parameter number of that source NY(I) as determined by the consecutive ordering, not the master list number. One card is used for each pair to be designated. The NF is the number of pairs to be read in. The statement and the card layout follow:

```
      READ (1, 903) NF
  903 FORMAT (I2)
```

For 9 source flags the card layout is:

```
  1 2 3 4 5 6 7
| |9| | | | | |
```

```
      DO 60 I = 1, NF
   60 READ (1, 904) NX(I), NY(I)
  904 FORMAT (I2, 1X, I2)
```

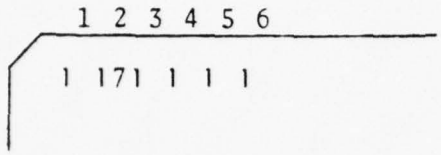
The card flagging source 3 parameter 11 follows:

```
  1 2 3 4 5 6 7
| |3| |1111| | |
```

In similar manner the branch flags are entered

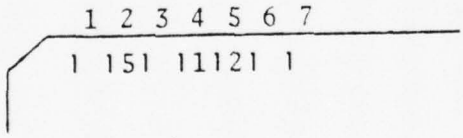
```
      READ 903, NFB
  903 FORMAT (12)
```

For 7 branch flags the card layout is




```
      DI 81 I = 1, NFB
      81 READ 904, NX(I), NY(I)
  904 FORMAT ( I2, 1X, I2)
```

The card flagging branch 5 parameter 12 follows



This completes the data called by the START and TOP and their subroutines.

RESOURCE MATCHING MODEL USER'S GUIDE

1. Data Required:

Data required by the resource matching model can be divided into two classifications. First, there is data generated in the process and topology models; and secondly, there is data that must be supplied by the user.

The data generated in the process and topology model are the parameter concentrations or other measure number for each parameter for each branch of the system. These values are computed for a given set of process states and are available to the resource matching program and its subroutines through the common dimension statements.

The data to be supplied by the user consists of the following:

*1. The number of measure methods available for each parameter (NMA(N))

*2. The sampling frequency for each parameter (SAMFRE(N))

3. The number of pieces of equipment in all resource data (NPOFEQ)

4. The names of the pieces of equipment and time constraints on each piece (EQNAME), (EQTIME)

5. The data defining the measurement methods for each parameter (PMDATA)

6. Constraints other than on pieces of equipment

7. Sampler assignments

8. Flow measurement data

---

*This information was supplied to a subroutine of the TOP program, CHK1, but it is used here.

1. EXPD SCALE PH MET
2. VIS SPECTROPHOT
3. PH PREPARATION
4. PH MEASUREMENT
5. AUTOMATIC BURET
6. HEATER, EXTRACT RACK
7. CONDUCTIVITY METER
8. ANAL BALANCE
9. OVEN (105C)
10. Oven (180C)
11. DESSICATOR
12. TECHNICON
13. CARBON ANALYZER
14. BLENDER
15. LAB HOOD
16. KJDL DIGEST RACK
17. VACUUM SOURCE
18. MAGNETIC STIRRER
19. NEPHELOMETER (HACH)
20. SEPERATORY FUNNELS
21. FUNNEL RACK
22. MUFFLE FURNACE
23. AA SPECTROPHOT
24. TECH AUTOANALYZER
25. GAS CHROM WI FID
26. CENTRIFUGE
27. HACH TURBIDMETER
28. HOTPLATE

EQUIPMENT INCLUDED IN THE RESOURCE MODELS

TABLE III

For each parameter to be measured there are 1 to 3 methods defined for making the measurement. The different methods may involve different techniques, different equipment or different personnel. The number of methods available for each parameter is needed and is read in as NMA(N).

A sampling frequency, SAMFRE(N), is required for each parameter. This is the number of samples measured per day per measure point for the given parameter. When the commitment of equipment and personnel per sample is combined with the total number of sample points and the samples per day for the length of the survey the total commitment for that parameter is determined for the survey.

The resources available for use in planning a survey are defined in a resource model. The resource model defines one to three measurement methods for each parameter. Each measure method model lists the following information about that method in matrix form: (Figure IX)

1. Parameter name
2. Method name and number
3. Minimum acceptable concentration
4. Equipment items (name and number)
5. Time commitment of personnel and equipment for sample
6. Space commitment
7. Miscellaneous, including cost, set-up time, location of tests, and time period in which tests must be run.

This data is supplied to the program in the Resource Matching subroutine. The cards defining measure methods for each parameter should be considered a library of methods and the library can be updated by including the latest or best values on the method cards used.

PARAMETER NAME AMMONIA (NH3)-N NUMBER OF METHODS AVAILABLE FOR ANALYSIS 2

METHOD I NAME SPEC. ION ELECTRODE MINIMUM ACCEPTABLE CONCENTRATION 0.0500

EQUIPMENT NAME	CODE #	EQ. TIME PER SAMPLE	VAN SPACE	AVG. ANALYSTS TIME/SAMPLE		MISCELLANEOUS
EXPD SCALE PH MET	1	2.00	10.00	0.0 Class 1	0.0	COST SAMPLE
SPEC ION ELECTRODE	2	2.00	0.0	0.0 Class 2	10.0	SET-UP TIME
	0	0.0	0.0	8.0 Class 3	1.00	WHERE ANALYSIS DONE
	0	0.0	0.0	0.0 Class 4	24.00	TIME CONSTRAINT

METHOD 2 NAME 132C PHENATE MINIMUM ACCEPTABLE CONCENTRATION 0.0500

EQUIPMENT NAME	CODE #	EQ. TIME PER SAMPLE	VAN SPACE	AVG. ANALYSTS TIME/SAMPLE		MISCELLANEOUS
VIS SPECTROPHOT	3	0.50	10.00	0.0 Class 1	0.0	COST SAMPLE
	0	0.0	0.0	2.50 Class 2	10.0	SET-UP TIME
	0	0.0	0.0	10.00 Class 3	1.00	WHERE ANALYSIS DONE
	0	0.0	0.0	0.0 Class 4	24.00	TIME CONSTRAINT

PM DATA

PARAMETER MEASURE METHOD DATA

FIGURE IX

The program reads resource information in as follows:

1. The number of pieces of equipment included in all measure methods is read in. (NPOFEQ)

2. The names of the pieces of equipment are read in along with the total amount of time available for the survey on that piece of equipment (the order in which pieces of equipment are read in assigns them a number). EQNAME(I), EQTIME(I).

3. The parameter method data is now read in in matrix form. One set of five cards for each method for each parameter. The first card for each parameter gives the method name and the minimum concentration. (MENAME) (PCRM). The next four cards read in the five numbers on each line of the PMDATA model illustrated in Figure IX. One line is read in per card. (PMDATA)

The next resource matching data required is a listing of constraints other than those already listed for each piece of equipment. These constraints are given on a total survey basis and are: Total Van Space, analysts (1) time, analyst (2) time, analyst (3) time, analyst (4) time and cost. The different classes of analysts have been defined by AEHA Chemists in terms of abilities and preferences for performing certain functions. Analyst (Class 1), for example, would be used to collect samples and subdivide them into test size samples. Analyst (Class 2) could perform most routine analyses. Analyst (Class 3) could perform the more complicated analyses and would be used on routine analyses only as second choice. Analyst (Class 4) mostly supervisory but could fill in for Class 2 and 3 if needed.

If the data for the van space is properly defined, this information can be used to determine if additional facilities

will be needed for the survey, (e.g., additional wet chemistry laboratory facilities).

Other resources in the survey separate from the analytical chemistry are the resources required for collecting the samples. These resources include sampler equipment, equipment time, and personnel time commitment to collect the samples. The information required by the SAMPLE subroutine is shown in Table IV. The personnel time requires a commitment of analyst (Class I) time.

#	Sampler Name	Time/Sample	Set-Up Time
1	EASY GRAB	5.0	5.0
2	HARD GRAB	15.0	5.0
3	ISCO	20.0	5.0
4	PROTECH	5.0	5.0

SAMPLER DATA
TABLE IV

In addition to the sampler data of Table IV, the survey officer must decide during the preliminary survey which samplers will be used at each branch if the survey plan calls for a measurement at that branch. This data is supplied to the SAMPLE subroutine by reading in the appropriate sampler number from the left-hand column of Table IV for each branch. NROUT(I).

The last items of data required are for the flow measurement. The flow measure method, time per measurement and set-up time are given in Table V.

#	Flow Meter	Time/Meas.	Set-up Time
1	Stevens Recorder	--	20.0
2	Gurley Meter	--	30.0

FLOW METER DATA
Table V

This information is supplied to the SAMPLE subroutine. In addition, the survey officer must decide for each branch if a flow measurement is to be made and if the measurement is to be made will meter type #1 or #2 be used. This information is supplied to the program by reading in for each branch a zero for no measurement, a one for a measurement using a Stevens recorder, or a two for a measurement with a Gurley meter.

II. Data Format

The formats and card layout for reading in the resource matching data is given next.

The first card read in by the resource matching model is the one giving the number of pieces of equipment in PMDATA. This is NPOFEQ and is read in by statements

```
     READ 135, NPOFEQ
 135 FORMAT (I3)
```

the card layout for 32 pieces is

```
 1  2  3  4  5
|13|21|  |  |  |
```

The next group of cards list equipment names and the time

available on that item of equipment. Two items of equipment per card (one item shown). See Figure XIX.

```
READ 145, ((EQNAME (I,J) J = 1,5), EQTIME (I), I = 1, NPOFEQ)
145 FORMAT (2(5A4, F10.1, 10X))
```

```
1 2 3 4 5 6 7                    20                  30    40
|E|X|P|D| |S|C|A|L|E| |P|H| |M|E|T| | | | | | |5|8|8|0|.|0 ↵|
```

The next set of data cards contain the parameter measurement method data (PMDATA).

Five cards are used for each parameter for each method. The first in each group of five gives the method name and the minimum concentrations required by the method. The read and format statement are:

```
READ 410, (MENAME (N, J, II), II = 1,5), PCRM (N,J)
410 FORMAT (5X, 5A4, F10.5)
```

Example Card

```
5                        25                  35
| | | | |E|L|E|C|T|R|O|M|E|T|R|I|C| | | | | | | | | | |.|0|1|0|0|0|
```

MENAME (N,J) PCRM (N,J)

Nth parameter Jth method

The next four cards supply the four lines of data of the parameter measure method matrix; One line/card in proper order. The read-in and format statement are:

```
      DO30 L = 1,4
      30 READ 430, (PMDATA (N, J, L, L1), L1 = 1,5)
    430 FORMAT (F5.0, F10.2, F10.3, F10.2, F10.3)
```

Example card for first line of data

```
1        5              15              25              35              45
|  |  |4|.|0|→|1|.|0|0|→|3|.|0|0|0|→|0|.|0|→|0|.|1|0|
   EQ #     T/SAMP       VAN/SP          ANAL/TIME    COST
```

The other three lines are read in on the next three cards as L iterates from 1 to 4.

If there is a second method (J) for the same parameter (N), PMDATA is read in for the next method (five cards). The next parameter is then considered as N goes to N + 1.

After all of the PMDATA cards, the constraint card follows. This lists any constraints on Van space, analyst's time, costs or other. This program is set up to consider six constraints in addition to the constraints on equipment time.

The read and format statement are:

```
      READ 650, (CNSTAR (M), M = 1,6)
    650 FORMAT (4F 20.3)
```

Example card

```
   20                  40                  60                  80
|1|0|0|0|.|0|0|0|→|6|3|0|0|.|0|0|0|→|6|3|0|0|.|0|0|0|→|1|2|6|0|.|0|0|0|
   VAN SPACE          ANAL 1              ANAL 2              ANAL 3
```

A second card using the same format is required to list ANAL 4 and cost constraints.

The format for reading in the sampler name, sample time and set-up time is illustrated by the statements

```
      DO30 I = 1,4
   30 READ 903, (NSAMPL (I, K), K = 1,5) SAMPTI (I), SET UP (I)
  903 FORMAT (5A4, 2F6.1)
```

An example card for reading in EASY GRAB, 5.0 minutes per sample, and 5.0 minutes set-up time is shown

```
1 2 3 4 5 6 7 8 9                    26                    32
|E|A|S|Y| |G|R|A|B| <--2--> | |5|.|0| <--2--> | |5|.|0|
```

The listing of the sampler type to be used for each branch if a sample is to be taken at that branch is read in by the following statements

```
      READ 906, (NROUT (I), I = 1,NB)
  906 FORMAT (40I2)
```

The card layout for reading in sampler 1 for branch 1, sampler 3 for branch 2, etc.

```
1 2 3 4 5 6 7 8
| |1| |3| |1| |2|
```

The format for reading in the flow meter name, sample time, and set-up time is given by the statements (this is an extension of the sampler read in).

```
      DO50 I = 5, 6
   50 READ 903, (NSAMPL (I,K), K = 1,5), SAMPTI(I), SET UP(I)
  903 FORMAT (5A4, 2F6.1)
```

An example card for reading in STEVENS RECORDER, 0 sample time and 20.0 minutes set-up time is shown

```
1 2 3 4 5 6                                   26              32
|S|T|E|V|E|N|S| |R|E|C|O|R|D|E|R| ↪ |0|.|0| ↪ |2|0|.|0|
```

The listing of the flow measure method to be used for each branch

```
      READ 906, (NFLOW(I), I = 1, NB)
  906 FORMAT (40I2)
```

Example card with no flow reading on branches 1, 2, 4, 5, and a Stevens recorder on 3 and a Gurley meter on 6.

```
1 2 3 4 5 6 7 8
| |0| |0| |1| |0| |0| |2| ↪ other branches
```

MODEL VERIFICATION AND/OR UPDATING

I. INTRODUCTION

The model verification and or updating is done using the CORRCT subroutine. The CORRCT subroutine accepts site measurement data, compares it with model predicted measurement data and computes and prints out suggested new values for the parameters of the process models.

The subroutine CORRCT is used in conjunction with the program subroutines which make up the site model. They are MAIN, PROCES, START, TOP, NEUTRA, SETTLE, DOME, CHK1, and CHK 2.

The site model package with CORRCT has two objectives. First, the process models can be updated or improved using preliminary survey data. While the best data available were used in constructing the process models, there was considerable variation in data for a given process from one plant to another or from one season to another. Better process model values may be obtained with CORRCT using measurements from judiciously selected grab samples taken on a preliminary survey. The output of CORRCT lists new values for certain process parameters. If the survey officer wishes, he may enter these new values into the process models using procedures outlined in the discussion of the PROCES subroutine.

A second use of the site model package with CORRCT would be verification of the model. After the survey, measurements are available for obtaining max, min, average or other expected values for each parameter at each branch for known levels of production. These values can be entered into the site model package with CORRCT to determine values for process model parameters which can be used to verify the model or refine the model as appropriate.

With confidence in the model, one can now use it to predict levels of potential pollutants for production levels other than those which occurred during the survey. This should give added significance to the survey report.

Ideally, if measurements are to be made to verify the process models, the measurepoints should be chosen such that each process will be determined uniquely by the measurements. However, if the survey officer who determines the measure points does not visualize the system in terms of the same processes as are used in the process model, measurements may not uniquely determine process parameters. The program is designed to accept such non-unique measurement data and uniquely determine processes, where possible, and make approximations on other processes informing the user of the determination is non-unique.

The measure points for uniquely determining all processes can be identified by referring to the linear graph of the system (Figure III for example) which display all processes and all possible measure points. On the linear graph, identify all of the vertices (junctions) nearest to the processes. If at a vertex there are N branches incident to a vertex, then measurements must be taken or implied at N-1 of these branches. By taking N-1 measurements, the N^{th} measurement is implied. Note that one of the N-1 measurements at a vertex A may be implied by measurements at a vertex B or other vertices.

II. INPUT DATA AND OUTPUT DATA

After the decisions are made which determine where measurements are to be made, this information is supplied to the CORRCT subroutine in the form of the MESUR(I) matrix. The MESUR(I) matrix contains a "0" for each branch where measurements are not taken and a "1" for each branch where measurements are taken.

It may not be appropriate or even possible to check every parameter in a process model. The subroutine CORRCT only applies to conservative parameters [i.e. only those measured in mass terms (mg/l) or flow]. The program allows the user to select the one, two, or several (up to 20) parameters to be included in each model verification. The parameters to be considered in a particular study are identified by their numbers in the master list of Table II. The Flows must be included in any branch where other parameters are considered.

The number of parameters and the parameter numbers are supplied to CORRCT for each branch where measurements are to be taken using BPLIST (IB,N), where IB is the branch number and N is the parameter number. The first number N for each branch is the number of parameters considered in that branch. The subsequent numbers N are the parameter numbers for that branch.

The next inputs to CORRCT are the measured parameter values YM(IB,N). For each branch IB the first value, for N=1, must be the flow in MGD. The remaining YM(IB,N) input for a branch are the measure values of the parameters listed in BPLIST(IB,N).

The subroutine CORRCT output lists each source (process) by number, notes if the determination is unique or estimated, and gives the old parameter and the suggested new parameter for each parameter verified. If the determination is unique, the branch where the defining measurement was taken is listed.

III. DATA FORMAT

The data required by CORRCT is:

1. MESUR(I), indicating if a measurement is made in branch I
2. BPLIST(IB,N) listing for N=1, the number of parameters to be verified in this branch and for other N is the parameter numbers for parameters to be verified for branch IB.

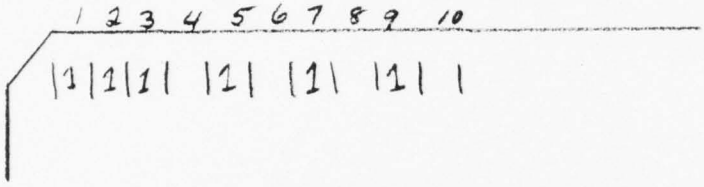
3. YM(IB,N), listing for N=1, the flow in branch IB and for other N's the measurement values for each parameter listed in BPLIST(IB,N).

MESUR(I) is read in by:

```
READ(1,1) (MESUR(I), I = 1, NB)
1  FORMAT (80 I 1)
```

Card layout for measurements in branches.

1, 2, 3, 5, 7, 9.

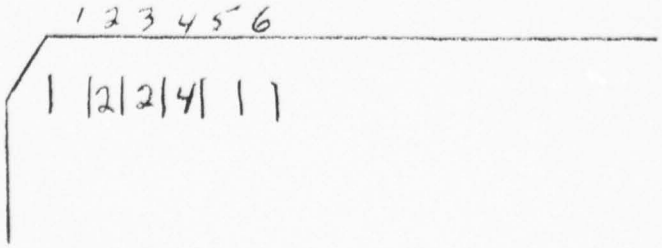


BPLIST(IB,N) and YM(IB,N): are read in one branch at a time by the statements.

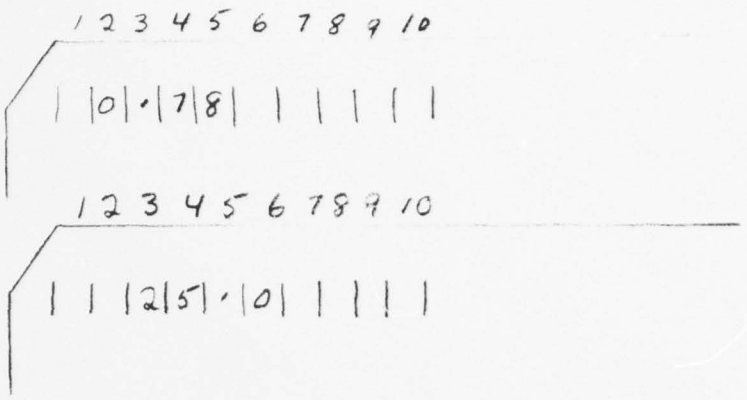
```
DO 2 IB = 1, NB
IF (MESUR(IB). EQ. 0)  GO TO 2
READ (1,3) (BPLIST (IB,N), N = 1,20
3  FORMAT (20I 2)
IBPLIST = BPLIST (IB,1)
READ(1,4) YM (IB,N), N = 1,  BPLIST
4  FORMAT (F 20.6)
```

Card layout for two measurements on a branch IB, one flow and the other acidity. Note the parameter number for flow does not exist and is not given in BPLIST. (Acidity number is 24)

BPLIST Card



YM card for flow = 0.78 and acidity = 25.



Review of Input Data

The Diagrams on the next three pages serve as a review of the data required by the Survey Planning Program and also it serves to emphasize that the order in which the data is read in must be exactly as shown in these diagrams.

ORDERING OF INPUT DATA

MASTER = largest parameter number

NFLG Flag to bypass RM

EPSLON Flag to call CORRCT

N the number of procener in the plast model

XNAME (JM), CAP (JM) process model name and capacity and card per process in topological

NOD Flag to indicate modifications

NMOD The number of modifications

YNAME (NM), ELE(MN), VAL (NM) Process name, parameter member, parameter value. One card per modification

NPRO Flag to indicate complete processes to be changes

NUMP Number of parameter in the master list

ZNAME (JN), FLW (JN) Name and Flow of processes to be changed

SPLIST (JE, JK) Parameter value, one card for each parameter in the master list for each changed process.

NS, NB, NP, NTOP The number of sources, branches, parameters, and outfalls

NPLIST (I) List of the pollutent number used

A (J,I) The topology matrix, one card per row

NBRANCH Branch names

LENGTH Length of survey is days

ISTOP The nubmer of non-competing parameters

POLN, NMA, SAMFRE The names of all parameters in the master up to MASTER, the number of measure methods avoilable and the sampling frequency

Treatment Facilities Data

AREA,NNEUT,NENG,NCAUS,NACY,ITYPE,TEMP,AREAP,AREAS,ABVOL,TFAREA,TFVOL, MLSS,R1,R2,R3,R4.

FLGPT The flagging level is read in for each parameter

NF The number of manual source flags

NX, NY The source and parameter flagged one card for each NF

NFB The number of manual branch flags

NX, NY The branch and parameter flagged one card for each NFB

NPOFEQ The number of pieces of equipment in the resource data

EQNAME, EQTIME Equipment name and time avoilable during survey

MENAME, PCRM Method name and minimum concentration for each parameter for each method

PMDATA Method resource data - four cards for each parameter for each method

CNSTAR Lists constraints on van space, analysts time, etc, two cards

NSAMPLE, SAMPTI, SETUP Sampler name, time per sample, set up time for each type of sampler

NROUT List the sampler to be used for each branch if a sample may be taken there

NSAMPL, SAMPTI, SETUP Flow meter name, sample time, and set up time for each type of meter

NFLOW Lists the flow meter to be used for each branch where a reading may be taken

MEASUR Lists branches where measurement data is taken

BPLIST For each branch measured, give the number of parameters to be verified and lists them by numbers.

YM Gives the appropriate measured values.

Output Data

The output data falls into two general classifications, output which affirms the input data and output which is a result of analysis. In this section the output data will be reviewed. If the data is a reiteration of input, it will be identified and no further discussion will be given. Other output will be considered in more detail.

All of the output data shown on Figure X are reiterations of input data. The first 10 lines give the mnemonics of the processes in the survey and their operating levels. The "1" in line eleven indicates that a process model is to be altered. The "1" in line 12 indicates that there is to be one alteration. Line 13 defines that change. The "1" in line 14 indicates that there are new processes to be read in.

The output data shown on Figure XI are mostly reiterations of input data. The first line is NP, the number of parameters to be measured in the survey. The second line indicates that the survey planning period is one day. The remaining 17 lines list the parameters to be measured on this survey, their assigned number, (left hand column), NMA and SAMFRE. The last column on the right gives the total number of samples per point. This is the product of sample frequency and the length of the survey in days.

Figure XII shows the next groups of output data. All of these are reiterations of input with an ordering assignment.

for the processes. At the top of the page three numbers, NS, NB, and NTOP are given. The next block of output is a relisting of the topology matrix, A(J,I). The last group in this figure is headed pollutant matrix data which lists the process names, their assigned number and their flows in MGD.

The next block of data is illustrated in Figure XIII. It is a listing of each source mnemonic, its assigned number and the parameter value for each of the pollutants for each process. This is essentially a reiteration of the input process data.

The output data in Figure XIV illustrates the flagging information. The first block of data gives the flagging levels for each parameter for automatic flagging. The second block of data is a list of the manual flags at sources. Not shown but also part of the output is a listing of the manual flags at the branches.

Figure XV lists the assigned branch numbers and names and also includes the calculated flow for each branch.

Figure XVI lists, at the top of the page, the number of branches, NB, and the number of parameters, NP, in the study. The remaining data on the Figure XVI illustrates the results of the TOP calculations. For each branch the name and number of the branch is listed and along with this the parameter value is listed for each pollutant in the study. The negative signs on certain of the numbers is not to be interpreted as indicating negative values. Rather, it is an indication that

this parameter is flagged for that particular branch. Figure XVI gives only an illustrative sample of this output data.

Figure XVII lists the mass in pounds per day that passes through each branch of the system. This mass number is meaningful for such parameters as TOC and NITRITE/NITRATE but has no meaning in the case of pH and Conductivity. Again the negative numbers are flagged points and not negative quantities.

Figure XVIII shows the ordering of the measure points as done by the level subroutine. This data tells the number of measure points required to detect all of a parameter if measurements are made at levels different from the outfall. For example, if the measurements are to be made at level 2 then there are three measure points required.

Figure XIX is a reiteration of input data including NPOFEQ, equipment name and number, and time available on each piece of equipment.

Figure XX illustrates the next groups of data read out. This is the PMDATA, the measurement method data for each measure method. This is read out for each parameter for each method.

Figure XXI is a reiteration of the constraint data input.

The next output data is a listing of each branch of the system and the parameters that are to be measured at each branch. Figure XXII illustrates this output for several branches.

Figure XXIII lists the sampler data at the top. The figure also lists computed sampler commitment for each branch

as a result of the completed survey plan.

Figure XXIV lists the flow meter data at the top of the page. The figure also lists computed flow meter time commitments as a result of the completed survey plan.

The next group of data is illustrated by Figure XXV. This output lists the following data for each parameter measured:

(1) The parameter name at the upper left corner.

(2) At the upper right corner the output lists the branches in which the measurements are to be made in the survey, the measure method to be used at each branch, and the expected value of the parameter at that branch. The asterisks indicate flagged measure points.

(3) The total number of samples of that parameter during the survey planning period.

(4) The items of equipment required in measuring this parameter, the total time commitment on each for these measurements, and an indication if a time constraint was violated (for the survey, as a whole, does not indicate at which parameter the violation occurred).

(5) The time commitment of each of the types of analyst in making these measurements and an indication of time constraints violated.

Figure XXVI shows the read out data which is a summing up of total commitments of all the equipment and analysts for the total survey planning period. Along with the total commitments, violations are indicated and the amount noted.

Figure XXVII shows the output data of the CORRCT subroutines. When CORRCT is used the usual site model output from TOP is read out and in addition the data in the form of Figure XXVII is output to give the suggested new values for process parameters. There are two types of outputs. In one type where the values are determined directly from measurements, values are listed as unique determinations. For other types, where the values cannot be determined directly from measurements, values are listed as estimated values.

```
PCIX        90.00
PZBM        90.00
PCWB        90.00
PAPN       100.00
PNDN       100.00
PGRB       100.00
PSAZ       100.00
PTNT       100.00
PPHZ        90.00
PSTP       100.00
1
  1
PCIX 12    10000.00
1
```

PROCESS LEVEL
OUTPUT DATA
FIGURE X

THE NUMBER OF PARAMETERS = 16
THE FIRST 0 ARE NON-COMPETING PARAMETERS

THE LENGTH OF THE SURVEY IS 1 DAYS

PARAMETER #	PARAMETER NAME	# OF METHODS AVAIL. FOR ANAL.	# OF SAMPLES TO BE ANALYZED/DAY/SAMPLE POINT.	TOTAL #SAMPLES/POINT
1	PH	3	12.0	12.0
2	CONDUCTIVITY	3	12.0	12.0
3	TOC	2	4.0	4.0
4	NITRITE/NITRATE(N)	3	4.0	4.0
5	TOTAL N(KJEHDAHL)	3	4.0	4.0
6	TOTAL SOLIDS	3	1.0	1.0
7	SUSPENDED SOLIDS	3	1.0	1.0
8	SULFATES	3	4.0	4.0
9	CHLORIDES	3	4.0	4.0
10	VOL SUSP SOLIDS	3	4.0	4.0
11	TOTAL PHOSPHATES	3	4.0	4.0
12	TNT	2	4.0	4.0
13	CALCIUM	2	4.0	4.0
14	ALKALINITY	3	4.0	4.0
15	TURBIDITY	3	4.0	4.0
16	ACIDITY	3	4.0	4.0

PARAMETER

OUTPUT DATA

Figure XI

TOPOLOGICAL DEFINITION DATA

NUMBER OF SOURCES	NUMBER OF BRANCHES	NUMBER OF OUTFALLS
10	18	1

TOPOLOGY MATRIX DATA

SOURCE 1	PCIX	1010101010125005
SOURCE 2	PZBM	1010101010125005
SOURCE 3	PCWB	0110101010125005
SOURCE 4	PAPN	0001101010125005
SOURCE 5	PNDN	0000011010125005
SOURCE 6	PGRB	0000000110125005
SOURCE 7	PSAZ	0000000011125005
SOURCE 8	PTNT	0000000000125005
SOURCE 9	PPHZ	0000000000000101
SOURCE10	PSTP	0000000000000011

POLLUTANT MATRIX DATA

SOURCE	1	PCIX	FLOW	0.289
SOURCE	2	PZBM	FLOW	0.090
SOURCE	3	PCWB	FLOW	0.153
SOURCE	4	PAPN	FLOW	0.300
SOURCE	5	PNDN	FLOW	0.300
SOURCE	6	PGRB	FLOW	0.002
SOURCE	7	PSAZ	FLOW	0.300
SOURCE	8	PTNT	FLOW	0.100

TOPOLOGY AND PROCESS FLOWS
OUTPUT DATA

Figure XII

PARAMETER SOURCE	SUSPENDED SOLIDS	SULFATES	CHLORIDES	VOL SUSP SOLIDS
1 PCIX	3.000	10000.000	35.000	1.000
2 PZBM	3.000	2500.000	30.000	5.000
3 PCWB	3.000	500.000	100.000	1.000
4 PAPN	5.000	600.000	15.000	1.000
5 PNDN	5.000	1000.000	25.000	1.000
6 PGRB	10.000	100.000	15.000	2.000
7 PSAZ	10.000	96000.000	15.000	2.000
8 PTNT	10.000	2500.000	1500.000	5.000
9 PPHZ	10.000	240.000	20.000	2.000
10 PSTP	12.000	120.000	28.000	10.000

PARAMETER SOURCE	CALCIUM	ALKALINITY	TURBIDITY	ACIDITY
1 PCIX	2000.000	0.0	3.000	500.000
2 PZBM	0.0	200.000	5.000	80.000
3 PCWB	20.000	100.000	3.000	
4 PAPN	20.000	60.000	10.000	
5 PNDN	20.000	0.0	10.000	
6 PGRB	20.000	0.0	5.000	
7 PSAZ	20.000	0.0	10.000	
8 PTNT	20.000	0.0	5.000	
9 PPHZ	7.000	200.000	8.000	
10 PSTP	159.000	79.000	12.000	

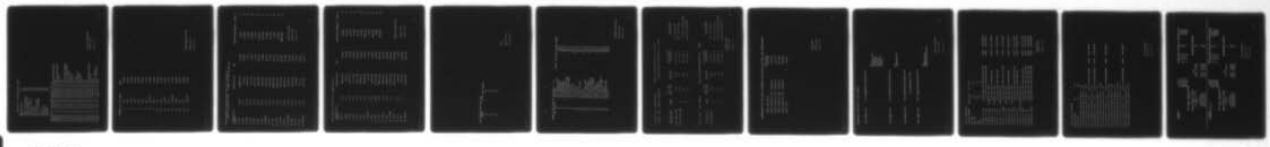
PROCESS-PARAMETER

OUTPUT DATA

Figure XIII

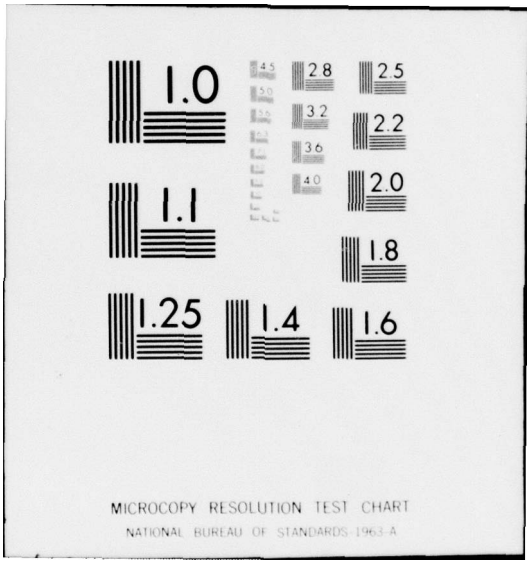
AD-A036 523 CLEMSON UNIV S C COLL OF ENGINEERING F/G 13/2
A SYSTEMS ANALYSIS OF WATER QUALITY SURVEY DESIGN. APPENDIX II.--ETC(U)
AUG 75 L C WILCOX, B E GILLILAND DADA17-72-C-2152
UNCLASSIFIED NL

2 OF 2
ADA036523



END

DATE
FILMED
3-77


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

```
   PARAMETER  MINIMUM FLAG LEVELS
PH                      .0
CONDUCTIVITY            .0
TOC                     .10
NITRITE/NITRATE(N)      .10
TOTAL N(KJEHDAHL)       .10
TOTAL SOLIDS            .99
SUSPENDED SOLIDS        .99
SULFATES                .05
CHLORIDES               .10
VOL SUSP SOLIDS         .99
TOTAL PHOSPHATES        .99
TNT                     .10
CALCIUM                 .10
ALKALINITY              .99
TURBIDITY               .99
ACIDITY                 .99

THE NUMBER OF FLAGGED POINTS IS 32
SOURCE  4 , PAPN THE PARAMETER IS NITRITE/NITRATE(N)
SOURCE  5 , PNDN THE PARAMETER IS TOC
SOURCE  5 , PNDN THE PARAMETER IS NITRITE/NITRATE(N)
SOURCE  5 , PNDN THE PARAMETER IS SULFATES
SOURCE  5 , PNDN THE PARAMETER IS TNT
SOURCE  6 , PGRB THE PARAMETER IS TOC
SOURCE  6 , PGRB THE PARAMETER IS NITRITE/NITRATE(N)
SOURCE  6 , PGRB THE PARAMETER IS TOTAL N(KJEHDAHL)
SOURCE  6 , PGRB THE PARAMETER IS TOTAL SOLIDS
SOURCE  6 , PGRB THE PARAMETER IS SULFATES
SOURCE  6 , PGRB THE PARAMETER IS CHLORIDES
SOURCE  6 , PGRB THE PARAMETER IS TNT
SOURCE  6 , PGRB THE PARAMETER IS CALCIUM
SOURCE  6 , PGRB THE PARAMETER IS ALKALINITY
SOURCE  6 , PGRB THE PARAMETER IS TURBIDITY
SOURCE  6 , PGRB THE PARAMETER IS ACIDITY
SOURCE  7 , PSAZ THE PARAMETER IS TOC
SOURCE  7 , PSAZ THE PARAMETER IS TNT
SOURCE  8 , PTNT THE PARAMETER IS TOC
SOURCE  8 , PTNT THE PARAMETER IS NITRITE/NITRATE(N)
SOURCE  8 , PTNT THE PARAMETER IS SULFATES
SOURCE  8 , PTNT THE PARAMETER IS TNT
SOURCE  9 , PPHZ THE PARAMETER IS TOTAL SOLIDS
SOURCE  9 , PPHZ THE PARAMETER IS TOTAL PHOSPHATES
SOURCE 10 - PSTP THE PARAMETER IS TOC
```

FLAGGING INFORMATION

OUTPUT DATA

Figure XIV

BRANCH NO.	AND NAME	FLOW
1	IXG	0.379
2	CWB	0.153
3	MH1A	0.532
4	AOP	0.300
5	MH2	0.832
6	NDN	0.300
7	MH4	1.132
8	CASUAL	0.002
9	MHG	1.134
10	SAC	0.300
11	MH10	1.434
12	TNT16	0.100
13	PH4	1.534
14	NEUTRAL	1.534
15	POND	1.534
16	PH2	0.018
17	STP	0.500
18	OUTFALL	2.052

BRANCH NAMES AND FLOWS

OUTPUT DATA

Figure XV

OUTPUT POLLUTANT DATA MATRIX FROM TOP SUBROUTINE
NUMBER OF BRANCHES= 18 NUMBER OF PARAMETERS= 16

	PARAMETER PH ELEMENT		CONDUCTIVITY	TOC	NITRITE/NITRATE(N)	TOTAL NI
1	IXG	2.218	12288.078	6.187	7.523	1.
2	CWB	7.500	600.000	10.000	10.000	0.
3	MH1A	2.365	8928.293	7.283	8.235	1.
4	AOP	7.000	600.000	5.000	11.000	0.
5	MH2	2.559	5926.234	6.460	9.232	0.
6	NDN	2.000	4999.996	10.000	300.000	5.
7	MH4	2.330	5680.820	7.398	86.273	1.
8	CASUAL	3.000	-1000.000	10.000	10.000	1.
9	MHG	2.330	5672.563	7.402	86.138	1.
10	SAC	0.300	199999.938	20.000	0.500	5.
11	MH10	0.964	46319.492	10.037	68.226	2.
12	TNT16	1.500	39999.996	40.000	-1000.000	8.
13	PH4	0.985	45907.574	11.990		
14	NEUTRAL	7.056	8617.082	11.990		
15	POND	7.056	8617.082	11.990		
16	PH2	7.400	999.999	9.000		
17	STP	7.000	800.000	25.000		
18	OUTFALL	7.044	6645.766	15.134		

BRANCH POLLUTANTS
OUTPUT DATA
Figure XVI

MASS OUTPUT INFORMATION, POUNDS PER DAY

PARAMETER ELEMENT	PH	CONDUCTIVITY	TOC	NITRITE/NITRATE(N)	TOTAL N
1 IXG	0.019	38892.691	19.581	23.812	5
2 CWB	0.000	766.107	12.768	12.768	0
3 MH1A	0.019	39658.773	32.349	36.580	5
4 AOP	0.000	1512.171	12.518	27.540	0
5 MH2	0.019	41170.910	44.867	64.120	5
6 NDN	0.025	12518.090	25.036	751.085	12
7 MH4	0.044	53678.980	69.904	815.206	17
8 CASUAL	0.000	16.691	0.167	0.167	0
9 MHG	0.044	53695.637	70.070	815.372	17
10 SAC	1.255	500723.688	50.072	1.252	12
11 MH10	1.299	554419.313	120.143	816.624	30
12 TNT16	0.026	33381.566	33.382		
13 PH4	1.325	587800.375	153.524		
14 NEUTRAL	0.000	110333.063	153.524		
15 POND	0.000	110333.063	153.524		
16 PH2	0.000	-150.217	1.352		
17 STP	0.000	-3338.158	104.317		
18 OUTFALL	0.000	113821.375	259.193		

BRANCH POLLUTANT MASS

OUTPUT DATA

Figure XVII

THE TOPOLOGY OF THE SITE

LEVEL	# OF TEST POINTS
1	1
2	3
3	3
4	3
5	4
6	5
7	6
8	7

LEVEL

OUTPUT DATA

Figure XVIII

TOTAL # OF ITEMS OF EQUIPMENT = 28

EQ. CODE #	EQ. NAME	TOTAL TIME AVAIL./TIME PERIOD
1	EXPD SCALE PH MET	420.0
2	VIS SPECTROPHOT	420.0
3	PH PREPARATION	420.0
4	PH MEASUREMENT	420.0
5	AUTOMATIC BURET	1680.0
6	HEATER,EXTRACT RACK	420.0
7	CONDUCTIVITY METER	420.0
8	ANAL BALANCE	420.0
9	OVEN (105 C)	1440.0
10	OVEN (180 C)	1440.0
11	DESSICATOR	1440.0
12	TECHNICON	420.0
13	CARBON ANALYZER	420.0
14	BLENDER	420.0
15	LAB HOOD	1440.0
16	KJDL DIGEST RACK	420.0
17	VACUUM SOURCE	420.0
18	MAGNETIC STIRRER	1260.0
19	NEPHELOMETER(HACH)	420.0
20	SEPERATORY FUNNELS	420.0
21	FUNNEL RACK	420.0
22	MUFFLE FURNACE	1440.0
23	AA SPECTROPHOT	420.0
24	TECH AUTOANALYZER2	420.0
25	GAS CHROM WI FID	420.0
26	CENTRIFUGE	420.0
27	HACH TURBIDMETER	420.0
28	HOTPLATE	420.0

EQUIPMENT CONSTRAINTS

OUTPUT DATA

Figure XIX

PARAMETER NAME AMMONIA (NH3)-N NUMBER OF METHODS AVAILABLE FOR ANALYSIS 2

METHOD 1 NAME SPEC. ION ELECTRODE MINIMUM ACCEPTABLE CONCENTRATION 0.0500

EQUIPMENT NAME	CODE #	EQ. TIME PER SAMPLE	VAN SPACE	AVG. ANALYSTS TIME/SAMPLE	MISCELLANEOUS
EXPD SCALE PH MET	1	2.00	10.00	0.0 Class 1	0.0 COST SAMPLE
SPEC ION ELECTRODE	2	2.00	0.0	0.0 Class 2	10.0 SET UP TIME
	0	0.0	0.0	8.0 Class 3	1.00 WHERE ANALYSIS DONE
	0	0.0	0.0	0.0 Class 4	24.00 TIME CONSTRAINT

METHOD 2 NAME 132C PHENATE MINIMUM ACCEPTABLE CONCENTRATION 0.0500

EQUIPMENT NAME	CODE #	EQ. TIME PER SAMPLE	VAN SPACE	AVG. ANALYSTS TIME/SAMPLE	MISCELLANEOUS
VIS SPECTROPHOT	3	0.50	10.00	0.0 Class 1	0.0 COST SAMPLE
	0	0.0	0.0	2.50 Class 2	10.0 SET UP TIME
	0	0.0	0.0	10.00 Class 3	1.00 WHERE ANALYSIS DONE
	0	0.0	0.0	0.0 Class 4	24.00 TIME CONSTRAINT

RESOURCE MODEL
OUTPUT DATA

Figure XX

CONSTRAINTS ON AVAILABLE RESOURCES (EXCLUDING EQUIPMENT TIME CONSTRAINTS)

		CONSTRAINT
TOTAL VAN SPACE		1000.000
TOTAL ANALYSTS TIME	(CLASS 1)	840.000
TOTAL ANALYSTS TIME	(CLASS 2)	840.000
TOTAL ANALYSTS TIME	(CLASS 3)	1260.000
TOTAL ANALYSTS TIME	(CLASS 4)	420.000
TOTAL COST		$ 100.00

CONSTRAINTS

OUTPUT DATA

Figure XXI

PARAMETERS MEASURED AT EACH BRANCH

FOR BRANCH IXG THE PARAMETERS MEASURED ARE:

PH
CONDUCTIVITY
SULFATES
CHLORIDES
CALCIUM
ALKALINITY
ACIDITY

FOR BRANCH CW8 THE PARAMETERS MEASURED ARE:

PH
CONDUCTIVITY

FOR BRANCH MH1A THE PARAMETERS MEASURED ARE:

NO MEASUREMENTS MADE

FOR BRANCH ACP THE PARAMETERS MEASURED ARE:

PH
CONDUCTIVITY
NITRITE/NITRATE(N)

BRANCH MEASUREMENTS

OUTPUT DATA

Figure XXII

SAMPLING INFORMATION

SAMPLING TECHNIQUE	SAMPLE TIME	SET UP TIME
EASY GRAB	5.0	5.0
HARD GRAB	15.0	5.0
ISCO	20.0	5.0
PROTECH	5.0	5.0

AT BRANCH 1 , IXG	12.00 SAMPLES WERE TAKEN USING EASY GRAB	TAKING	65.00	MINUTES
AT BRANCH 2 , CWB	12.00 SAMPLES WERE TAKEN USING EASY GRAB	TAKING	65.00	MINUTES
AT BRANCH 3 , MH1A	NO SAMPLES WERE TAKEN			
AT BRANCH 4 , AOP	12.00 SAMPLES WERE TAKEN USING ISCO	TAKING	245.00	MINUTES
AT BRANCH 5 , MH2	NO SAMPLES WERE TAKEN			
AT BRANCH 6 , NON	12.00 SAMPLES WERE TAKEN USING ISCO	TAKING	245.00	MINUTES
AT BRANCH 7 , MH4	NO SAMPLES WERE TAKEN			
AT BRANCH 8 , CASUAL	12.00 SAMPLES WERE TAKEN USING EASY GRAB	TAKING	65.00	MINUTES
AT BRANCH 9 , MHG	NO SAMPLES WERE TAKEN			
AT BRANCH 10 , SAC	12.00 SAMPLES WERE TAKEN USING ISCO	TAKING	245.00	MINUTES
AT BRANCH 11 , MH10	NO SAMPLES WERE TAKEN			
AT BRANCH 12 , TNT16	12.00 SAMPLES WERE TAKEN USING HARD GRAB	TAKING	185.00	MINUTES
AT BRANCH 13 , PH4	12.00 SAMPLES WERE TAKEN USING ISCO	TAKING	245.00	MINUTES
AT BRANCH 14 , NEUTRAL	NO SAMPLES WERE TAKEN			
AT BRANCH 15 , POND	12.00 SAMPLES WERE TAKEN USING PROTECH	TAKING	65.00	MINUTES
AT BRANCH 16 , PH2	12.00 SAMPLES WERE TAKEN USING EASY GRAB	TAKING	65.00	MINUTES
AT BRANCH 17 , STP	12.00 SAMPLES WERE TAKEN USING EASY GRAB	TAKING	65.00	MINUTES
AT BRANCH 18 , OUTFALL	12.00 SAMPLES WERE TAKEN USING EASY GRAB	TAKING.	65.00	MINUTES

SAMPLER DATA
OUTPUT DATA

Figure XXIII

```
FLOW MEASUREMENT INFORMATION

STEVENS RECORDER                0.0             20.0
GURLEY METER                    0.0             30.0
NO FLOW MEASUREMENTS WERE MADE AT BRANCH  1  IXG
NO FLOW MEASUREMENTS WERE MADE AT BRANCH  2  CWB
NO FLOW MEASUREMENTS WERE MADE AT BRANCH  3  MH1A
FLOW WAS MEASURED AT BRANCH  4 , AOP      USING THE STEVENS RECORDER     TAKING    20.00 MINUTES
NO FLOW MEASUREMENTS WERE MADE AT BRANCH  5  MH2
FLOW WAS MEASURED AT BRANCH  6 , NDN      USING THE STEVENS RECORDER     TAKING    20.00 MINUTES
NO FLOW MEASUREMENTS WERE MADE AT BRANCH  7  MH4
NO FLOW MEASUREMENTS WERE MADE AT BRANCH  8  CASUAL
NO FLOW MEASUREMENTS WERE MADE AT BRANCH  9  MHG
FLOW WAS MEASURED AT BRANCH 10 , SAC      USING THE STEVENS RECORDER     TAKING    20.00 MINUTES
NO FLOW MEASUREMENTS WERE MADE AT BRANCH 11  MH10
NO FLOW MEASUREMENTS WERE MADE AT BRANCH 12  TNT16
NO FLOW MEASUREMENTS WERE MADE AT BRANCH 13  PH4
NO FLOW MEASUREMENTS WERE MADE AT BRANCH 14  NEUTRAL
NO FLOW MEASUREMENTS WERE MADE AT BRANCH 15  POND
FLOW WAS MEASURED AT BRANCH 16 , PH2      USING THE STEVENS RECORDER     TAKING    20.00 MINUTES
NO FLOW MEASUREMENTS WERE MADE AT BRANCH 17  STP
NO FLOW MEASUREMENTS WERE MADE AT BRANCH 18  OUTFALL
```

FLOW MEASUREMENT
OUTPUT DATA

Figure XXIV

PARAMETER	METHOD		MEASURE POINT, BRANCH NO., EXPECTED VALUE		
TOC	138A ORG C		(1, 1)	18	15.134
	138A ORG C	*	(2, 1)	17	25.000
	138A ORG C	*	(5, 3)	12	40.000
	138A ORG C	*	(6, 4)	10	20.000
	138A ORG C	*	(7, 5)	8	10.000
	138A ORG C	*	(8, 6)	6	10.000

TOTAL SAMPLE NUMBER EXPECTED
24.0 SAMPLES

TOTAL RESOURCES ASSIGNED			WAS CONSTRAINT VIOLATED
ITEMS	TIMES		
1 CARBON ANALYZER	0 HRS.	36 MINS.	NO
2 BLENDER	2 HRS.	0 MINS.	NO
ANALYST			
CLASSIFICATION 1	0 HRS.	0 MINS.	YES
CLASSIFICATION 2	1 HRS.	22 MINS.	YES
CLASSIFICATION 3	2 HRS.	10 MINS.	NO
CLASSIFICATION 4	0 HRS.	0 MINS.	NO

PARAMETER	METHOD		MEASURE POINT, BRANCH NO., EXPECTED VALUE		
NITRITE/NITRATE(N)	TECHNICON		(1, 1)	18	97.417
	TECHNICON	*	(2, 3)	15	128.957
	TECHNICON	*	(5, 3)	12	1000.000
	TECHNICON	*	(7, 5)	8	10.000
	TECHNICON	*	(8, 6)	6	300.000
	TECHNICON	*	(9, 7)	4	11.000

TOTAL SAMPLE NUMBER EXPECTED
24.0 SAMPLES

TOTAL RESOURCES ASSIGNED			WAS CONSTRAINT VIOLATED
ITEMS	TIMES		
1 TECHNICON	1 HRS.	12 MINS.	NO
ANALYST			
CLASSIFICATION 1	0 HRS.	0 MINS.	YES
CLASSIFICATION 2	0 HRS.	0 MINS.	YES
CLASSIFICATION 3	3 HRS.	18 MINS.	NO
CLASSIFICATION 4	0 HRS.	0 MINS.	NO

SURVEY COMMITMENTS

OUTPUT DATA

Figure XXV

TOTAL_ELIGIBILITY_FOR_THESE_ITEMS

	ITEM	# OF PARAMETERS ITEM IS USED FOR	TOTAL TIME	WAS CONSTRAINT VIOLATED	AMOUNT OF VIOLATION	VAN SPACE REQUIRED
1	EXPD SCALE PH MET	2	1 HRS. 12 MIN.	NO	0 HRS. 0 MINS.	4.00
3	PH PREPARATION	3	3 HRS. 48 MIN.	NO	0 HRS. 0 MINS.	8.00
4	PH MEASUREMENT	1	2 HRS. 24 MIN.	NO	0 HRS. 0 MINS.	3.00
5	AUTOMATIC BURET	2	1 HRS. 7 MIN.	NO	0 HRS. 0 MINS.	8.00
7	CONDUCTIVITY METER	1	2 HRS. 24 MIN.	NO	0 HRS. 0 MINS.	6.00
8	ANAL BALANCE	3	3 HRS. 0 MIN.	NO	0 HRS. 0 MINS.	4.00
9	OVEN (105 C)	3	22 HRS. 26 MIN.	NO	0 HRS. 0 MINS.	4.00
10	OVEN (180 C)	1	0 HRS. 6 MIN.	NO	0 HRS. 0 MINS.	4.00
11	DESSICATOR	3	32 HRS. 40 MIN.	YES	8 HRS. 40 MINS.	4.00
12	TECHNICON	2	3 HRS. 12 MIN.	NO	0 HRS. 0 MINS.	15.00
13	CARBON ANALYZER	1	0 HRS. 36 MIN.	NO	0 HRS. 0 MINS.	10.00
14	BLENDER	1	2 HRS. 0 MIN.	NO	0 HRS. 0 MINS.	4.00
17	VACUUM SOURCE	2	6 HRS. 0 MIN.	NO	0 HRS. 0 MINS.	0.0
18	MAGNETIC STIRRER	2	1 HRS. 10 MIN.	NO	0 HRS. 0 MINS.	1.00
19	NEPHELOMETER(HACH)	1	2 HRS. 8 MIN.	NO	0 HRS. 0 MINS.	6.00
24	TECH AUTOANALYZER2	1	0 HRS. 36 MIN.	NO	0 HRS. 0 MINS.	5.00
25	GAS CHROM WI FID	1	0 HRS. 0 MIN.	NO	0 HRS. 0 MINS.	0.0
27	HACH TURBIDMETER	1	0 HRS. 16 MIN.	NO	0 HRS. 0 MINS.	4.00
28	HOTPLATE	1	0 HRS. 24 MIN.	NO	0 HRS. 0 MINS.	18.00

TOTAL_VAN_SPACE

TOTAL VAN SPACE ALLOCATED = 93.000 WAS CONSTRAINT VIOLATED? NO AMOUNT OF VIOLATION = 0.0

GRAND_TOTAL_ANALYSIS_TIME

ANALYST	TOTAL TIME	CONSTRAINT VIOLATED?	AMOUNT OF VIOLATION
CLASSIFICATION 1	28 HRS. 20 MIN.	YES	14 HRS. 20 MIN.
CLASSIFICATION 2	19 HRS. 27 MIN.	YES	5 HRS. 27 MIN.
CLASSIFICATION 3	14 HRS. 21 MIN.	NO	0 HRS. 0 MIN.
CLASSIFICATION 4	1 HRS. 0 MIN.	NO	0 HRS. 0 MIN.

TOTAL_COST

TOTAL COST = $ 0.0 WAS CONSTRAINT VIOLATED? NO AMOUNT OF VIOLATION = $ 0.0

CONSTRAINTS

OUTPUT DATA

Figure XXVI

```
SOURCE NUMBER      1    IS UNIQUELY DETERMINED ON   BRANCH  1 WHERE  3  PARAMETERS WERE MEASURED.

                    FLOW              MODEL          0.400000   MODIFIED TO     0.340000

       DISSOLVED SOLIDS              MEASURED        200.000000       CALCULATED     249.999954
                 SOURCE CORRECTED TO                 200.000000

       ACIDITY                       MEASURED        370.000000       CALCULATED     385.175537


SOURCE NUMBER      2   IS UNIQUELY DETERMINED ON    BRANCH 2 WHERE  2 PARAMETERS WERE MEASURED.
  OTHER SOURCE(S)    ALSO CONTRIBUTE TO THIS BRANCH AS INDICATED.

SOURCE NUMBER      1        FLOW RATE         0.340000   PERCENT CONTRIBUTION    99.707


FLOW RATE OF SOURCE   2 IS MODIFIED TO     0.001000 A PERCENT CONTRIBUTION OF    0.293

OTHER PARAMETERS FOLLOW.
     ACIDITY                MEASURED        260.000000                      CALCULATED   384.077393
                SOURCE CORRECTED TO         260.00


FLOW OF SOURCE    4 IS ESTIMATED FROM BRANCH    5 AS  0.045803

FLOW OF SOURCE    5 IS ESTIMATED FROM BRANCH    5 AS  0.090197

       DISSOLVED SOLIDS        OF SOURCE   4   IS ESTIMATED FROM BRANCH   5AS       321.847900

       DISSOLVED SOLIDS        OF SOURCE   5   IS ESTIMATED FROM BRANCH   5AS       530.155273

       SULFATES                OF SOURCE   4   IS ESTIMATED FROM BRANCH   5AS       250.000107

       SULFATES                OF SOURCE   5   IS ESTIMATED FROM BRANCH   5AS       249.999969

       ACIDITY                 OF SOURCE   4   IS ESTIMATED FROM BRANCH   5AS        74.800873

       ACIDITY                 OF SOURCE   5   IS ESTIMATED FROM BRANCH   5AS         7.646317
```

CORRCT OUTPUT

Figure XXVII