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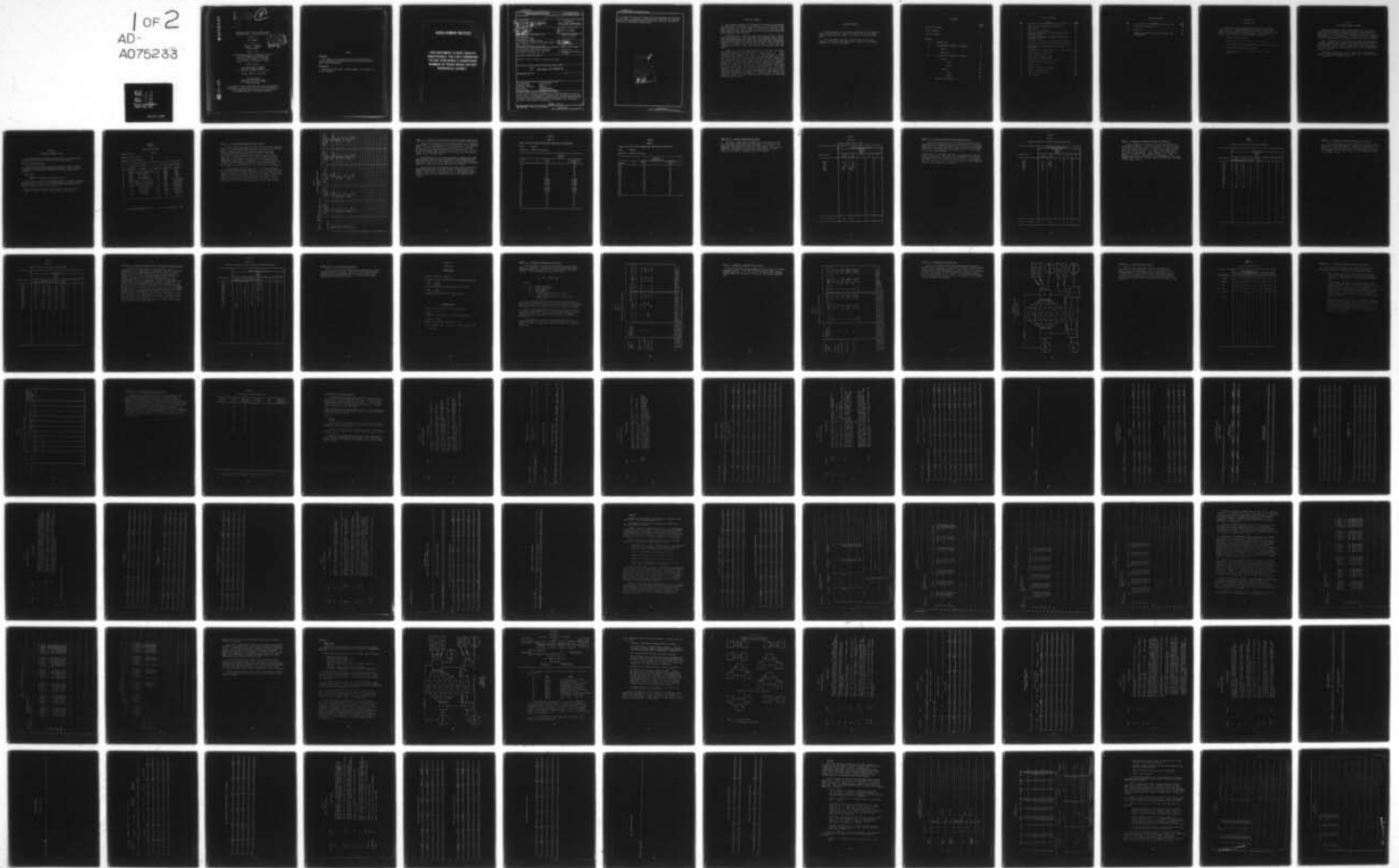
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SUBPOTABLE WATER REUSE AT ARMY FIXED  
INSTALLATIONS: A SYSTEMS APPROACH

VOLUME II

USER MANUAL

by  
Curtis J. Schmidt  
Ernest V. Clements  
LeAnne Hammer

August 1979

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Environmental Protection Research Division  
U.S. Army Medical Bioengineering  
Research and Development Laboratory  
Ft. Detrick, Frederick, MD 21701  
Project Officer: William J. Cooper

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→ All major Army activities involving water and wastewater were researched and described. In addition, a three-tiered water reuse model was developed that leads the evaluates through three phases of evaluation culminating in the use of a sophisticated computer model.

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## EXECUTIVE SUMMARY

This report concerns the treatment and reuse of wastewater at fixed Army installations. The objective was to provide a tool that could be used by the Army in assessing the potential for water reuse at all their fixed facilities; in isolating those posts with the best reuse potential; and in evaluating conceptual reuse schemes at those posts.

To achieve this objective, two paths were pursued. First, major Army activities involving water and wastewater were identified and described as to: water use and wastewater characteristics, tolerable water quality if reclaimed water were to be used, potential as a donor or recipient of reclaimed water, and the potential for internal reuse at the activity. These data are essential and form a basis for constructing feasible reuse networks.

Secondly, a water reuse evaluation model was developed. This model involves three phases or tiers. Tier I is a comprehensive questionnaire that allows a concise overall evaluation of the reuse potential of a post in a short amount of time. Posts that score well on Tier I may then be evaluated under Tier II. This tier leads the evaluator through a deeper analysis of reuse possibilities on the post, and ends with a brief economic analysis of the fundamental reuse schemes selected for the post. Should this analysis show reuse to be economically beneficial, Tier III is applied. Tier III is a detailed survey that should be used only at posts with proven reuse potential. Field data from activity records and sampling, as well as conceptual reuse networks, are used as input to a mathematical model that determines piping, pumping, storage, and treatment requirements, and costs for the entire reuse system. At this point, the Army post should be ready for full-scale engineering design of the most effective reuse system.

## ACKNOWLEDGEMENTS

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This User Manual has been slightly modified from the present contract with the Army Medical Research & Development Command, Ft. Detrick, Maryland.

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SECTION I  
INTRODUCTION

The cascade water reuse computer program has been developed to aid base engineers in designing wastewater reuse systems. The program requires various input data and human decision-making to be effective. The purpose of this manual is to explain in a comprehensive manner:

- . How the program works
- . What quantitative input data is required
- . Specifically how the data must be prepared for input
- . What output can be anticipated
- . What decisions will have to be made by base personnel

## SECTION II

### THE COMPUTER PROGRAM IN GENERAL

The program is divided into two separate phases. Phase I (Activity Description) assimilates activity data supplied by the base and prints out several forms for each activity showing flow patterns, effluent quality characteristics after various levels of treatment, the effects of recommended pretreatment units, and cascade potential. Output from Phase I is intended to assist the base engineer in selecting feasible activity cascade networks.

Phase II (Network Feasibility) evaluates the networks selected by base personnel. Output provides a comprehensive network description including the requirements for piping, pumping, storage, and treatment facilities, and finally the total cost of the entire cascade system. Continued modification of the most cost effective cascade networks should lead to an optimum reuse system for the base.

Note that the program can be used to simulate hourly flows throughout a day, or monthly flows throughout a year. The latter is important for bases with large seasonal fluctuations in water use.

## SECTION III

### THE COMPUTER PROGRAM IN DETAIL

The following sections delineate in complete detail the required input and generated output data for both phases of the cascade program.

#### Phase I - Activity Description

For all parts of the program, input goes through two stages. Firstly, base personnel complete standard engineering data forms. Secondly, the data is transferred to computer forms from which the data deck can be punched directly.

#### Base Input

##### Preparation of Standard Engineering Data Forms

The first task in using the cascade reuse program is to gather all required base data. Forms 0 through XIII, described below and shown on the following pages, are provided for this purpose. Once completed, these forms provide all the information necessary to the program.

Note that there are duplicates for some forms. Select the form that corresponds to the daily or yearly program, whichever is being used.

SAMPLE  
FORM 0

BASE DESCRIPTION

Name of Base: March  
 Number of Activities: 12  
 Number of Constituents: 15

List of Activities			List of Constituents		
No.	Code (1)	Name	No.	Code (2)	Name
1	A/AWR	Aircraft Wash Rack	1	BOD	BOD
2	HOUSE	Base Housing	2	COD	COD
3	BOQ	BOQ	3	PHNL	Phenol
4	OFF	Office/Admin.	4	SS	SS
5	PHOTO	Photo Shop	5	TDS	TDS
6	AHH	Arnold Hts. Housing	6	O&G	Oil & Grease
7	GENIR	General Irrigation	7	Cl	Chloride
8	VWR	Vehicle Wash Rack	8	NO <sub>3</sub>	Nitrate
9	OFFIR	Office Irrigation	9	NH <sub>4</sub>	Ammonium
10	GOLF	Golf Course	10	PO <sub>4</sub>	Phosphate
		Irrigation	11	Na	Sodium
11	AHIRR	Arnold Hts.	12	CaCO <sub>3</sub>	Hardness
		Irrigation	13	B	Boron
12	HOSP	Hospital	14	CN	Cyanide
			15	Fe	Iron

(1) Five letters/numbers or less

(2) Five symbols or less

FORM I - Activity Water/Wastewater Summary

Form I summarizes activity water and wastewater quality data: existing source water quality, tolerable source water quality, and existing final effluent concentrations. Typical concentrations for tolerable source water and effluent discharge are provided in Section II of the main report. These values can be substituted for actual base data if the latter is non-existent. However, it is important to note that the success of the entire program depends on the accuracy of the data. If the tolerable value of a constituent is not significant for that activity, a minus one (-1) can be entered for that concentration. This states in essence that any concentration is tolerable.

The sample Form I provided shows a water/wastewater summary for photographic processing. In this case, base data for tolerable source water quality was not available so the "typical" values provided on the form were used. Both source water quality, which is quite high, and a moderate final waste discharge with a BOD of 200 mg/l are shown. Base data was available for final effluent quality for all constituents so it was not necessary to use "typical" values.

FORM 1

ACTIVITY WATER/WASTEWATER SUMMARY

BASE: SAMPLE  
ACTIVITY: Photographic Processing

Constituent	Source Water Concentration (mg/l)	Tolerable Concentration (mg/l)	Typical, Tolerable Concentration (mg/l)	Final Effluent Concentration (mg/l)	Typical, Final Effluent Concentration (mg/l)
1. BOD	0	0.1	0.1	200	99
2. COD	0.3	1.0	1.0	395	320
3. PHNH <sub>2</sub>	0	0.001	0.001	0.001	0.001
4. SS	0	1.0	1.0	30	30
5. TDS	568	700	700	1,700	1,000
6. O <sub>2</sub> G	0.2	0.2	0.2	3.9	4.0
7. Cl	150	185	185	200	230
8. HCl	5	20	20	20	9.0
9. H <sub>2</sub> S	0	0.1	0.1	19	16
10. PO <sub>4</sub>	1.0	3.0	3.0	3.6	9.3
11. Mg	80	100	100	150	130
12. CaCO <sub>3</sub>	300	400	400	300	200
13. B	0.05	0.1	0.1	0.1	2.8
14. CN	0	0.01	0.01	0.5	0.8
15. Fe	0.2	0.3	0.3	0.4	3.8
16.					
17.					
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33.					

FORM II - Activity Water Demand and Wastewater Generation

Form II summarizes activity water demand and wastewater generation flow information on an hourly basis for a typical day. If flow information is not available for all hours of the day, at least one hourly flow should be entered. Be sure to enter zero (0) for hours of inactivity. The program will interpolate whatever hourly data are provided to obtain flows for all hours.

Alternatively, if the yearly program is being used, then water demand and wastewater generation flow information for each month of the year must be provided on the yearly form. Note that flow units are in 1,000-gal per month for the yearly program, and gallons per day for the daily program.

The sample Form II provided shows daily water demand and wastewater generation data for an aircraft wash rack. As shown, there is zero flow until 8:00 a.m. when washing commences. Also there is some water loss in the washing operation, as seen by comparing the "water in" and "water out" columns.

SAMPLE

FORM II

DAILY ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

Base: Sample

Activity: Aircraft Washing

Hours	Volume (gph)	
	Water In	Wastewater Out
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	5,000	4,000
9	5,000	4,000
10	5,000	4,000
11	5,000	4,000
12	0	0
13	5,000	4,000
14	5,000	4,000
15	2,000	1,700
16	0	0
17	0	0
18	0	0
19	0	0
20	0	0
21	0	0
22	0	0
23	0	0
24	0	0

SAMPLE

FORM II

YEARLY ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

Base: Sample

Activity: Aircraft Washing

Months	Volume (1,000 gal/mo)	
	Water In	Wastewater Out
JAN	20	16
FEB	20	16
MAR	22	18
APR	25	20
MAY	27	22
JUN	28	22
JUL	30	24
AUG	30	24
SEP	28	22
OCT	25	20
NOV	20	16
DEC	20	16

FORM III - Source Water Quality/Cost

Form III is provided to summarize source water quality for each major water source on the base. In addition, the cost of procuring and/or treating these source waters is addended. Two sources are shown in the sample with separate qualities and costs. Sources are designated by both a number and a name of not more than five letters.

SAMPLE

FORM III

SOURCE WATER QUALITY/COST

Constituent	Concentration (mg/l)				
	Sources Name (No.)				
	(1) Wells	(2) Lake	(3)	(4)	(5)
BOD	0.1	0			
COD	0.3	0.2			
SS	0.1	0			
PHNL	0.01	0.01			
TDS	300	600			
NO <sub>3</sub>	5	15			
Cost: ¢/1000 gal	50	35			

FORM IV - Effluent Discharge Requirements/Cost

Form IV is to be used for delineating required final discharge concentrations for each major point of discharge from the base. Costs assessed to this discharge (excluding treatment), such as sewer surcharges, are also to be shown. The sample form shows two discharges, one to a river, one to the city sewer system.

Minue ones (-1) indicate infinity, or in essence, that no limit is required. Note also the difference in costs for discharge; the river discharge being free of charge while the flow going to the city is surcharged at a 30¢/1,000 gal average. Discharges are designated by both a number and a name of not more than five letters.

SAMPLE

FORM IV

FINAL EFFLUENT DISCHARGE REQUIREMENTS/COST

Constituent	Concentration (mg/l)				
	Discharges Name (No.)				
	(1) River	(2) City	(3)	(4)	(5)
BOD	20	300			
COD	50	500			
SS	20	300			
PHNL	1.0	-1			
TDS	-1	-1			
NO <sub>3</sub>	30	-1			
Cost: c/1000 gal	0	30			

FORM V - Special Treatment Removal Percentages

Form V summarizes removals achieved by the special pretreatment modules. Each constituent must be assigned a removal percentage, even if it is zero. Special treatments are designated by both a number and a code name of 10 letter maximum length. The sample form designates four special treatments: metal removal, oil and grease removal, softening, and chemical coagulation. The engineer is free to choose his own pretreatment units and removal efficiencies. He may also use those four provided in the sample form.

SAMPLE  
FORM V

SPECIAL TREATMENT REMOVAL PERCENTAGES

Constituent	Removal %						
	Chain Name (No.)						
	(1) Metal Removal	(2) Oil & Grease	(3) Softening	(4) Chem. Coag.	(5)	(6)	(7)
BOD	20	25	0	50			
COD	20	30	0	50			
PHNL	20	60	0	70			
SS	20	20	0	30			
TDS	0	0	0	0			
O&G	20	75	0	20			
Cl	0	0	0	0			
NO <sub>3</sub>	0	0	0	0			
NH <sub>4</sub>	0	0	0	0			
PO <sub>4</sub>	0	0	0	85			
Na	0	0	0	0			
CaCO <sub>3</sub>	0	0	98	0			
B	85	10	0	0			
CN	85	10	0	0			
Fe	85	10	0	0			

FORM VI - Regular Treatment Removal Percentages

Form VI provides the same information as Form V for the regular treatment chains. Note that removals are for the entire chain, not specific units within the chain. Again, base personnel are free to choose their own chains and removal efficiencies or they can use those provided in the sample form.

SAMPLE

FORM VI

REGULAR TREATMENT REMOVAL PERCENTAGES

Constituent	Removal %						
	Chain Name (No.)						
	(1) Primary	(2) Secun- dary	(3) Filtration	(4) Carbon Ads.	(5) Rev. Osmos.	(6)	(7)
BOD	30	85	94	99	100		
COD	30	80	88	96	99		
PHNL	30	75	75	92	92		
SS	70	85	98	100	100		
TDS	0	0	20	20	91		
O&G	50	75	85	96	97		
Cl	0	0	0	0	80		
NO <sub>3</sub>	0	0	0	20	70		
NH <sub>4</sub>	0	95	95	100	100		
PO <sub>4</sub>	0	20	85	85	98		
Na	0	0	0	0	75		
CaCO <sub>3</sub>	0	0	0	0	90		
B	10	80	80	80	96		
CN	10	80	80	80	96		
Fe	10	60	60	60	96		

FORM VII      Special Treatment Chain Threshold Concentrations

Form VII provides data utilized in Phase I of the program only. For each special treatment, threshold concentrations for all constituents must be provided. In each case, an activity will be assigned the appropriate pretreatment if any of its raw wastewater concentrations are higher than one of the threshold concentrations. For example, assume an oil and grease threshold of 500 mg/l is assigned for the oil-and-grease-removal treatment module. Then for any activity generating a waste in excess of 500 mg/l oil and grease, the computer will not only provide the typical Phase I summary for that activity but will also provide a similar summary assuming grease and oil pretreatment at the activity. In this way, base personnel can review the Phase I output to determine the benefits of activity pretreatment. Note that for constituents that are not applicable to certain pretreatments, i.e., TDS in grease and oil removal, a minus one should be entered, which basically sets the threshold concentrations at infinity. Base personnel are free to use the values provided on the sample form or ones of their own choosing.

SAMPLE

FORM VII

SPECIAL TREATMENT CHAIN THRESHOLD CONCENTRATIONS

Constituent	Concentration (mg/l)						
	Chain Name (No.)						
	(1) Metal Removal	(2) Oil & Grease	(3) Softening	(4) Chem. Coag.	(5)	(6)	(7)
BOD	-1	-1	-1	1,000			
COD	-1	-1	-1	2,000			
PHNL	-1	-1	-1	-1			
SS	-1	-1	-1	1,000			
TDS	-1	-1	-1	-1			
O&G	-1	200	-1	-1			
Cl	-1	-1	-1	-1			
NO <sub>3</sub>	-1	-1	-1	-1			
NH <sub>4</sub>	-1	-1	-1	-1			
PO <sub>4</sub>	-1	-1	-1	100			
Na	-1	-1	-1	-1			
CaCO <sub>3</sub>	-1	-1	500	-1			
B	100	-1	-1	-1			
CN	0.5	-1	-1	-1			
Fe	100	-1	-1	-1			

FORM VIII      Cost Data/Piping Data

Form VIII provides necessary cost factors and indices as well as data on piping. The form is self-explanatory. Values shown in the sample form were those used by SCS Engineers during program testing. Naturally, the cost indices will change with time.

SAMPLE  
FORM VIII  
COST DATA

- . Rate of interest: 10 %
- . Current Engineering News Record Construction Cost  
Index: 2,103
- . Current Engineering News Record Labor Cost  
Index: 4.71
- . Estimated Equipment Life: 25 years

PIPING DATA

- . Maximum flow velocity in pressure pipes:  
5 ft/sec
- . Maximum flow velocity in gravity flow pipes:  
5 ft/sec
- . Number of possible pipe sizes: 12
- . List of pipe sizes: 1, 2, 3, 4, 6, 8, 10, 12, 15,  
18, 24, 36

FORM IX Special Treatment Chain Costs

Form IX summarizes the cost coefficients used to cost special treatments. Capital and O & M cost coefficients are taken from the cost equations delineated in the main report. These equations are all of the form:

$$S = (A + BQ^c) \frac{I}{I^1}$$

Where:

- A = fixed cost (\$)
- B = unit cost (\$/gpd)
- c = scale factor
- Q = flow (gpd)
- I = current Engineering News Record cost index
- I<sup>1</sup> = January 1975 Engineering News Record cost index

It is imperative that all cost coefficients used as input data be represented as January 1975 dollars. The program will automatically update all costs for years following 1975 according to the current indices previously supplied.

Again, base personnel are free to use the coefficients provided on the sample form, or to generate their own cost curves and equations. Care must be taken to represent equations in the standard  $A + BQ^c$  form and to update to 1975 dollars.

It is important to note that the coefficients for each component of a multi-unit treatment chain (i.e., metal removal followed by chemical coagulation) must be listed separately.

SAMPLE  
FORM IX

SPECIAL TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components* in Chain	Cost Coefficients					
		Capital			O&M		
		A	B	C	A	B	C
Metals Removal	1	0	435	0.41	16.24	57.93	0.41
Oil & Grease	1	0	36.28	0.71	0	0.31	0.82
Softening	1	5,000	0.02	1.0	0	0.36	1.0
Chem. Coag.	1	0	435	0.41	16.24	57.93	0.41

\* Be sure to include cost coefficients for each element of the treatment chain. For example, if two pretreatment units are combined in one chain, each must have its cost coefficient listed.

\* All cost coefficients must be represented in January 1975 \$.

FORM X      Regular Treatment Chain Costs

Form X provides the same data as Form IX for all regular treatment chains. Note that component coefficients are listed separately, i.e., the carbon adsorption chain shows coefficients for secondary, filtration, and carbon adsorption.

SAMPLE

FORM X

REGULAR TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components* in Chain	Cost Coefficients					
		Capital			O&M		
		A	B	C	A	B	C
Primary	1	0	36.28	0.71	0	0.31	0.82
Secondary	1	0	1,159	0.51	0	362.9	0.40
Filtration	2	0	1,159	0.51	0	362.9	0.40
		0	29.97	0.63	0	5.95	0.63
Carbon Ads.	3	0	1,159	0.51	0	362.9	0.40
		0	29.97	0.63	0	5.95	0.63
		0	128.1	0.63	0	2.73	0.72
Rev. Osmosis	4	0	1,159	0.51	0	362.9	0.40
		0	29.97	0.63	0	5.95	0.63
		0	128.1	0.63	0	2.73	0.72
		13,550	0.10	1.0	75.78	0.13	1.0

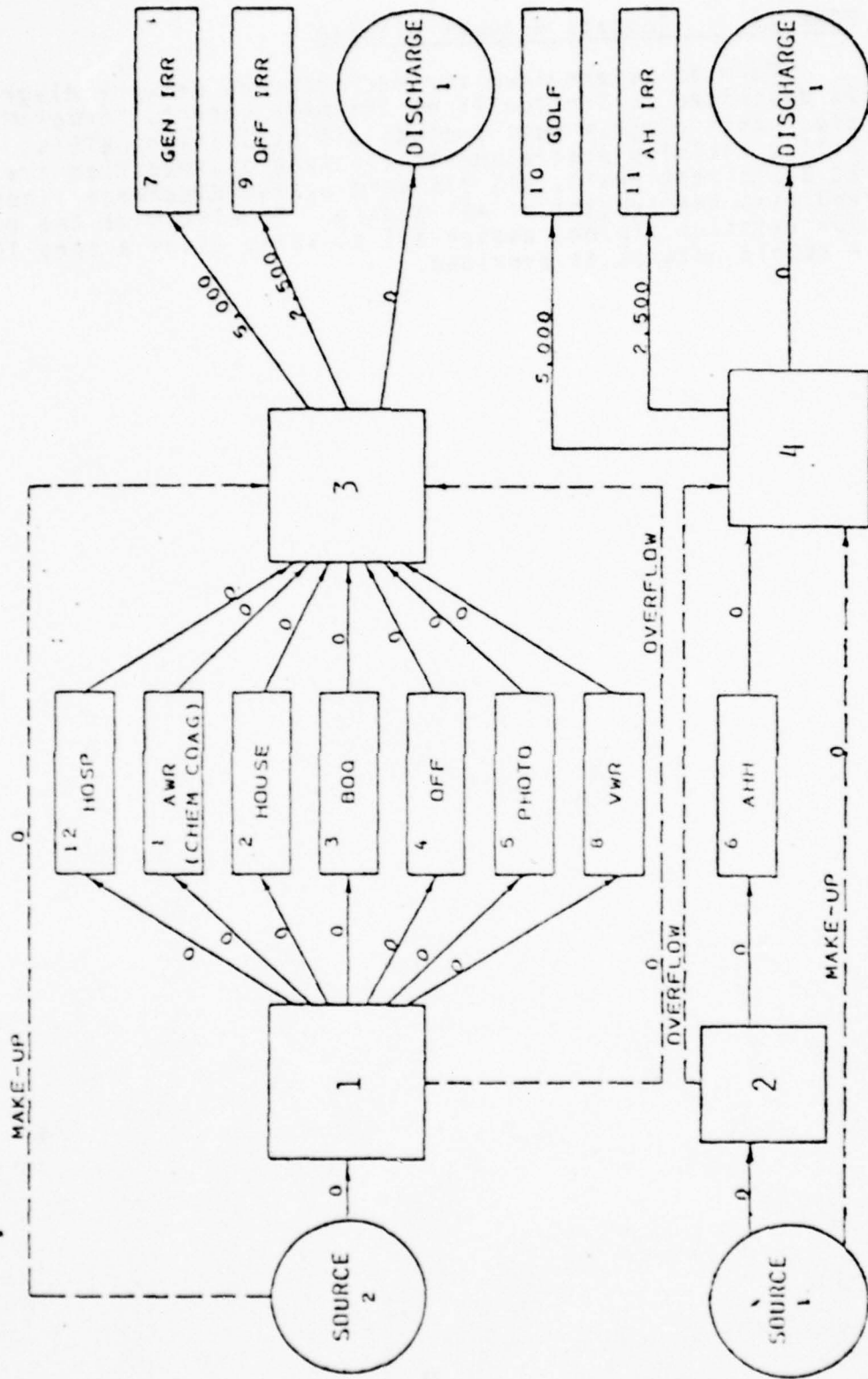
\* Be sure to include cost coefficients for each element of the treatment chains. For example, if three units are combined in one chain (i.e., secondary, filtration, and carbon adsorption), each must have its cost coefficient listed.

\* All cost coefficients must be represented in January 1975 \$.

FORM XI Cascade Network Diagram

Form XI is provided for each cascade network diagram. As described in Section IV of the main report, "Program Synopsis," this diagram must include all activities, BTS's, specified activity pretreatments (optional), specified treatment at BTS's (optional), all BTS make-up and discharge lines, and also the lengths of all piping. To eliminate the costs for existing piping, assign all existing pipes a zero length. A sample network is provided.

FORM XI  
 Cascade Network Diagram  
 Base: March  
 Network No. 2



FORM XII    Activity Pretreatment

Form XII delineates all activity pretreatments specified by base personnel. For all networks, each activity must be designated either a zero (meaning no pretreatment) or the number of the pretreatment desired. As shown in the sample, the aircraft wash rack (A/AWR) has been assigned chemical coagulation pretreatment, and the photo shop metal-removal pretreatment for some of the networks.

SAMPLE  
FORM XII

ACTIVITY PRETREATMENT

Activities	Pretreatment No.									
	Network No.									
	1	2	3	4	5	6	7	8	9	10
1. A/AWR	4	4	4	0	4	0	4	0	4	4
2. HOUSE	0	0	0	0	0	0	0	0	0	0
3. BOQ	0	0	0	0	0	0	0	0	0	0
4. OFF	0	0	0	0	0	0	0	0	0	0
5. PHOTO	0	1	1	0	1	1	1	1	0	0
(etc.)										

FORM XIII Specified Regular Treatment at BTS's

Form XIII is provided so that base personnel may fully delineate any treatment they desire at a BTS. Three options exist in regards to treatment at a BTS:

1. The engineer specifies nothing and allows the program to compute required constituent removal percentages and select the appropriate treatment chain.
2. The engineer specifies a treatment chain. The program then proceeds to compare the removals provided by that chain with those required. If the specified chain can produce a satisfactory effluent in all constituent categories, then that chain is used. If, however, one or more of the contaminants are not satisfactorily removed, the program will assign a more advanced treatment chain to that BTS.
3. The engineer specifies removal percentages for each constituent. Again, the program will compare specified and required removals, select the larger in each case, and choose the appropriate treatment to meet those removals. As shown in the sample form, space is provided for specifying individual constituent removals or whole treatment chain at a BTS.

SAMPLE

FORM XIII

SPECIFIED REGULAR TREATMENT AT BTS'S

Network No.	BTS No.	Specified Removal Percentages						Specified Regular Treatment Chain No.
		Constituents						
		BOD	COD	SS	etc			
2	3							
4	5	90	90	90				3

FORM XIV      BTS Make-Up Water Treatment

Each BTS in a network requires a make-up water line in the event that additional water is needed to meet demand. The option exists of having this make-up water blended and treated with the rest of the influent to the BTS or of having the make-up by-pass treatment and be blended directly with the treated BTS effluent. In most cases, high quality make-up (usually the potable supply) will be used, in which case blending should occur after treatment. However, if poor quality water, from another BTS for example, is used as make-up, it may be advantageous to have it treated at the BTS it is supplying. The sample form shows instances of the latter circumstance. Note that each BTS must be accounted for.

FORM XIV

BTS MAKE-UP WATER TREATMENT

Network No.	BTS No.	Make-Up Treatment (1)	Network No.	BTS No.	Make-Up Treatment (1)
1	1	F			
	2	F			
	3	F			
2	1	F			
	2	T			
	3	F			
	4	T			
3	1	F			
	2	F			
	3	T			
4	1	F			
	2	F			
	3	F			
	4	F			
	5	T			

T - Make-up treated at BTS after blending with influent.  
 F - Untreated make-up blended with BTS effluent.

### Preparation of Computer Forms

The following sections describe the translation of all data from the engineering forms to the computer forms that will be used to punch the data deck. In each case, sample pages are provided for illustration. It is highly unlikely that all lines and pages will be used. Unused lines and pages may be left blank.

Note that throughout the computer form deck, all numbers are right justified in the field and that all words or letter codes are left justified.

#### Phase I

##### Input

As previously discussed, Phase I input provides general base data, activity descriptions, source water qualities, discharge requirements, etc.

The following section describes in detail the transferring of this information from the engineering forms to the computer forms.

Remember to use the appropriate forms for the daily or yearly program, whichever is being used. Again, note that flows for the yearly program are expressed in units of 1,000-gal per month.

PHASE I

DATA PRESENTATION

<u>Page</u>	<u>Line</u>	<u>Description</u>
1	1	T in 1st col. if Phase I printout is desired; F if it is not.
		T in 2nd col. if network flow and concentration printout is desired; F if it is not.
		T in 3rd col. if cost summary printout is desired; F if it is not. Be sure to exclude cost data from data deck if F is specified here.
1	2	The name of the base, including blank spaces, in cols. 1-25 (Form 0).
40	3	The total number of constituents (contaminants) to be monitored in the 1st 12 cols. The maximum number of contaminants is 30 (Form 0).
	4, 5	The names of all the constituents in 5 col. blocks (Form 0)

GENERAL BASE DATA

|||||

NAME OF BASE

||||| Air Force Base |||

NUMBER OF CONTAMINANTS

|||||

NAMES OF CONTAMINANTS

41

||||| P | H | M | I | S | I | O | G | K | I | W | M | P | M | C | C | C | C | B | C | I | F | I |

|||||

PHASE I

DATA PRESENTATION

<u>Page</u>	<u>Line</u>	<u>Description</u>
2	1	Total number of water sources in 1st 12 c's. Maximum number of sources is 5 (Form III).
2	2	Names of sources in 5 column blocks, starting with the 1st column (Form III).
2 3	3-10 1-15	Constituent concentrations (mg/l) for source water(s). Use as many lines as needed to complete concentration summary of source 1, 2, etc. Be sure to follow the same constituent order as listed on page 1. Place all numbers in 12 block c's (Form III).

NUMBER OF SOURCES

NAMES OF SOURCES

SOURCE WATER QUALITY  
(mg/L)

NUMBER OF SOURCES	NAMES OF SOURCES	SOURCE WATER QUALITY (mg/L)
12		
10	1019	10
10	1011	10
10	1012	10
10	1013	10
10	1014	10
10	1015	10
10	1016	10
10	1017	10
10	1018	10
10	1019	10
10	1020	10
10	1021	10
10	1022	10
10	1023	10
10	1024	10
10	1025	10
10	1026	10
10	1027	10
10	1028	10
10	1029	10
10	1030	10
10	1031	10
10	1032	10
10	1033	10
10	1034	10
10	1035	10
10	1036	10
10	1037	10
10	1038	10
10	1039	10
10	1040	10
10	1041	10
10	1042	10
10	1043	10
10	1044	10
10	1045	10
10	1046	10
10	1047	10
10	1048	10
10	1049	10
10	1050	10
10	1051	10
10	1052	10
10	1053	10
10	1054	10
10	1055	10
10	1056	10
10	1057	10
10	1058	10
10	1059	10
10	1060	10
10	1061	10
10	1062	10
10	1063	10
10	1064	10
10	1065	10
10	1066	10
10	1067	10
10	1068	10
10	1069	10
10	1070	10
10	1071	10
10	1072	10
10	1073	10
10	1074	10
10	1075	10
10	1076	10
10	1077	10
10	1078	10
10	1079	10
10	1080	10
10	1081	10
10	1082	10
10	1083	10
10	1084	10
10	1085	10
10	1086	10
10	1087	10
10	1088	10
10	1089	10
10	1090	10
10	1091	10
10	1092	10
10	1093	10
10	1094	10
10	1095	10
10	1096	10
10	1097	10
10	1098	10
10	1099	10
10	1100	10
10	1101	10
10	1102	10
10	1103	10
10	1104	10
10	1105	10
10	1106	10
10	1107	10
10	1108	10
10	1109	10
10	1110	10
10	1111	10
10	1112	10
10	1113	10
10	1114	10
10	1115	10
10	1116	10
10	1117	10
10	1118	10
10	1119	10
10	1120	10
10	1121	10
10	1122	10
10	1123	10
10	1124	10
10	1125	10
10	1126	10
10	1127	10
10	1128	10
10	1129	10
10	1130	10
10	1131	10
10	1132	10
10	1133	10
10	1134	10
10	1135	10
10	1136	10
10	1137	10
10	1138	10
10	1139	10
10	1140	10
10	1141	10
10	1142	10
10	1143	10
10	1144	10
10	1145	10
10	1146	10
10	1147	10
10	1148	10
10	1149	10
10	1150	10
10	1151	10
10	1152	10
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10	1155	10
10	1156	10
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10	1161	10
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10	1172	10
10	1173	10
10	1174	10
10	1175	10
10	1176	10
10	1177	10
10	1178	10
10	1179	10
10	1180	10
10	1181	10
10	1182	10
10	1183	10
10	1184	10
10	1185	10
10	1186	10
10	1187	10
10	1188	10
10	1189	10
10	1190	10
10	1191	10
10	1192	10
10	1193	10
10	1194	10
10	1195	10
10	1196	10
10	1197	10
10	1198	10
10	1199	10
10	1200	10

PHASE I

DATA PRESENTATION

<u>Page</u>	<u>Line</u>	<u>Description</u>
4	1-15	Repeat same procedures for required discharge qualities as used for sources on preceding pages (Form IV).
5	1-15	
6	1	Number of activities in 1st 12 c's (Form 0).
7	1	Activity code in 1st 5 c's. Activity name in columns 11-35 (Form 0). A page 7 is needed for each activity.
7	25	Water demanded by the activity in gallons per hour for all hours for which flow is known. Place zeros for hours of no flow. Place -1 where flow is not known. At least one hourly flow must be entered. Flows should be placed in 12 col blocks (Form II).
		<u>or</u>
		Water demanded by the activity in thousands of gallons per month for all months the flow is known. Place zero's for months with no flow. Place one's for months the flow is not known. At least one monthly flow must be entered. Flows should be placed in 12-column blocks (Form II).
7	6-10	Repeat same procedure as above for wastewater discharged from the activity (Form II).



NUMBER OF ACTIVITIES

|||||



ACTIVITY DATA  
 ACTIVITY CODE AND NAME  
 (YEARLY PROGRAM)

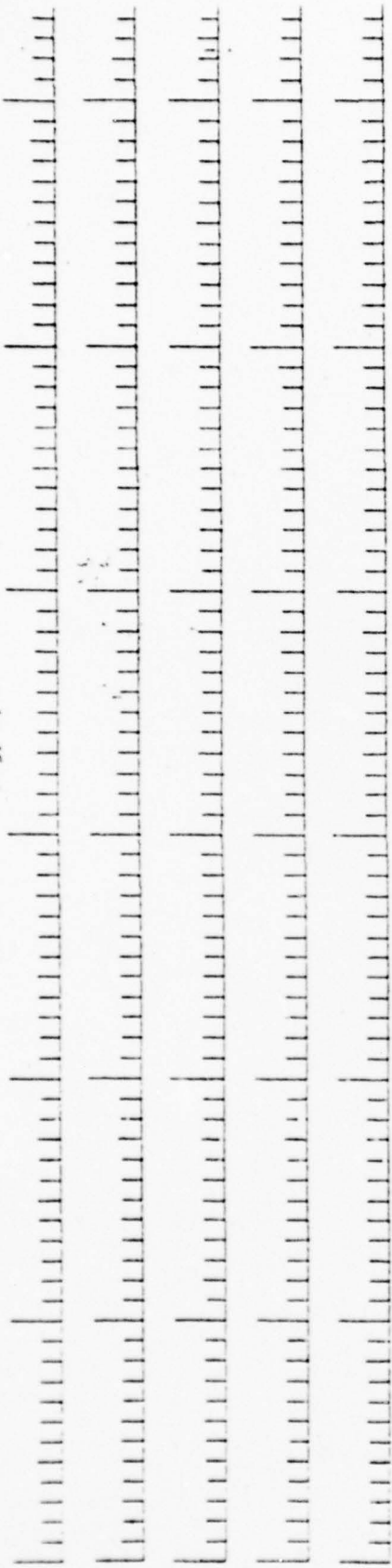
--

WATER IN  
 (1,000 GAL/MONTH)

31000	31000	35000	35000	36000
41000	45000	45000	49000	49000

WASTEWATER OUT  
 (1,000 GAL/MONTH)


CONTAMINANTS IN  
(mg/l)



CONTAMINANTS OUT  
(mg/l)



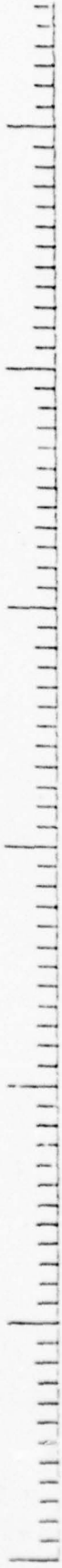
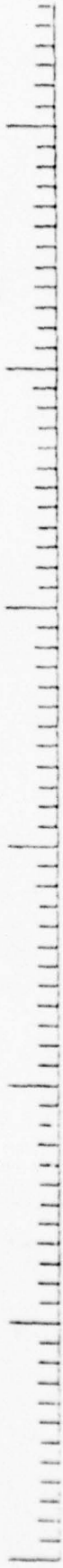
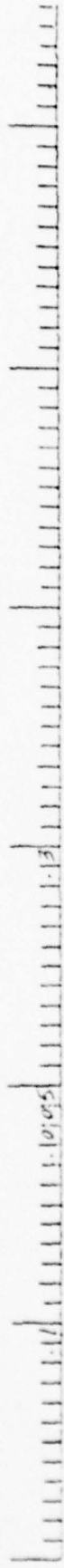
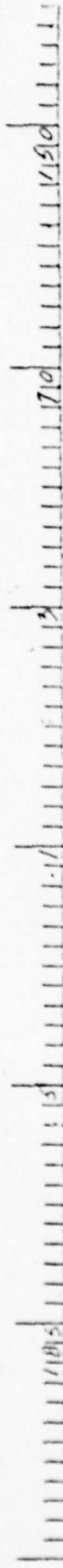
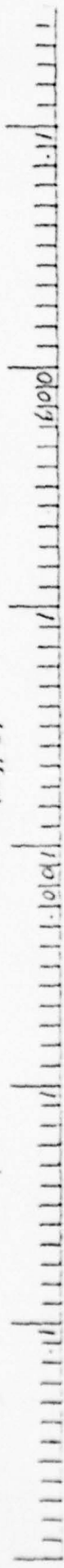
PHASE I

DATA PRESENTATION

<u>Page</u>	<u>Line</u>	<u>Description</u>
8	1-5	Constituent concentrations in mg/l for water into the activity. In nearly all instances this will merely be one of the fresh source water concentrations. Numbers are placed in 12 c blocks (Form I). Page 8 needed for each activity.
8	6-10	Constituent concentrations in mg/l for wastewater discharged from the activity. Numbers are placed in 12 c blocks (Form I).
9	1-5	Maximum tolerable constituent concentrations for water into the activity. Numbers are placed in 12 c blocks (Form I). A page 9 needed for each activity.

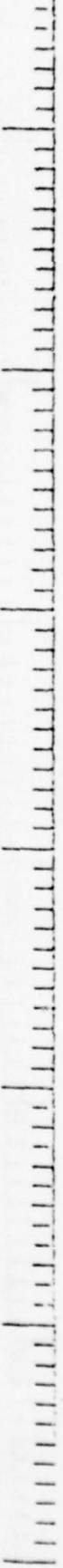
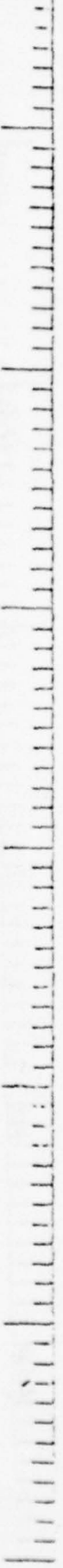
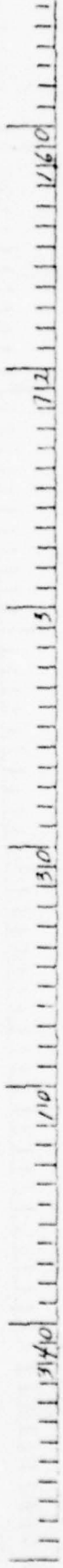
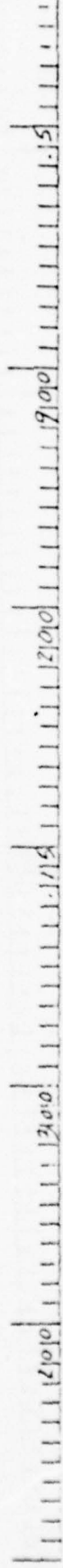
Repeat pages 7-9 for all activities.

CONTAMINANTS IN  
(mg/l)



2

CONTAMINANTS OUT  
(mg/l)



TOLERABLE CONTAMINANT LEVELS  
(mg/l)



PHASE I

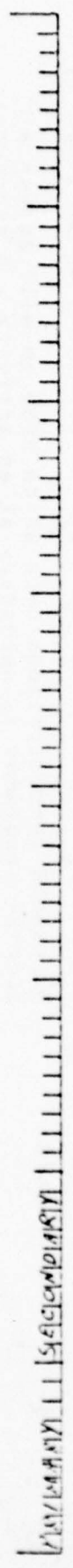
DATA PRESENTATION

<u>Page</u>	<u>Line</u>	<u>Description</u>
10	1	Number of regular treatment chains being used placed in 1st 12 c's. Maximum number of regular treatment chains is 7.
10	2	Names of regular treatment chains in 10 column blocks (Form VI).
10	3-7	Removal percentages for all constituents by each regular treatment chain. 12 col blocks. Note, begin a new line for each treatment chain (Form VI).
11	1-15	Be sure constituents and chains are taken in the initial order of their listing. Numbers are placed in 12 col blocks.
12	1-15	Same as page 10 for special treatment units. Removal percentage: for all constituents by each special treatment chain (Form V).
13	1-2	Threshold concentrations over which program will assume a special treatment is necessary at an activity. A concentration (mg/l) or a -1 (specifying ) must be used for every constituent and each special treatment. Numbers are placed in 12 block c's (Form VII).
14	1-5	
14	6-10	
15-20	1-15	Same as page 14 for all special treatment units (Form VII).

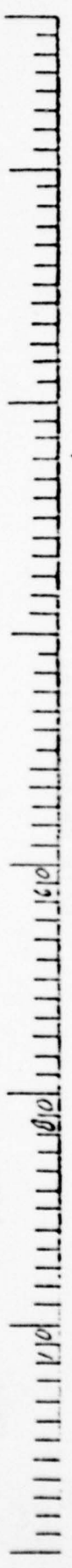
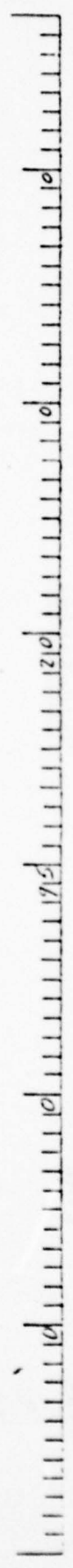
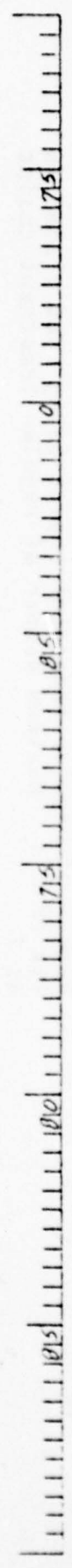
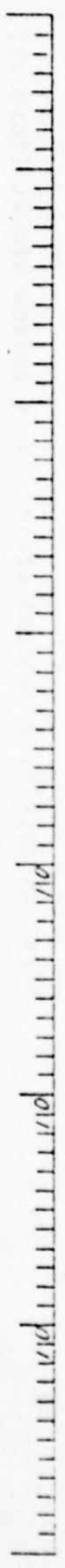
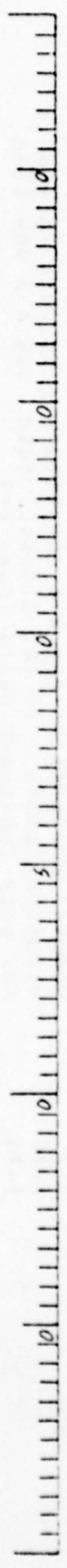
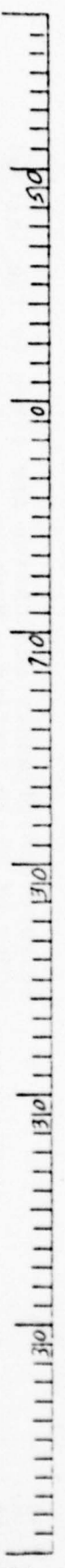
TREATMENT DATA  
 NUMBER OF REGULAR TREATMENT CHAINS



NAMES OF REGULAR TREATMENT CHAINS



REGULAR TREATMENT CHAIN REMOVAL PERCENTAGES





## Output

Output from the Phase I Program fully describes the activities and possible cascade arcs.

The tables on the following pages are examples of the information provided.

Table 1 shows a summary of the hourly and cumulative flows into and out of each activity. In addition, graphs of these flows are provided. The aircraft wash rack shown here, used only 3,000 gal per day to wash one or two planes in the middle of the day. Some water was lost of evaporation and runoff as only 2,400 gal was discharged.

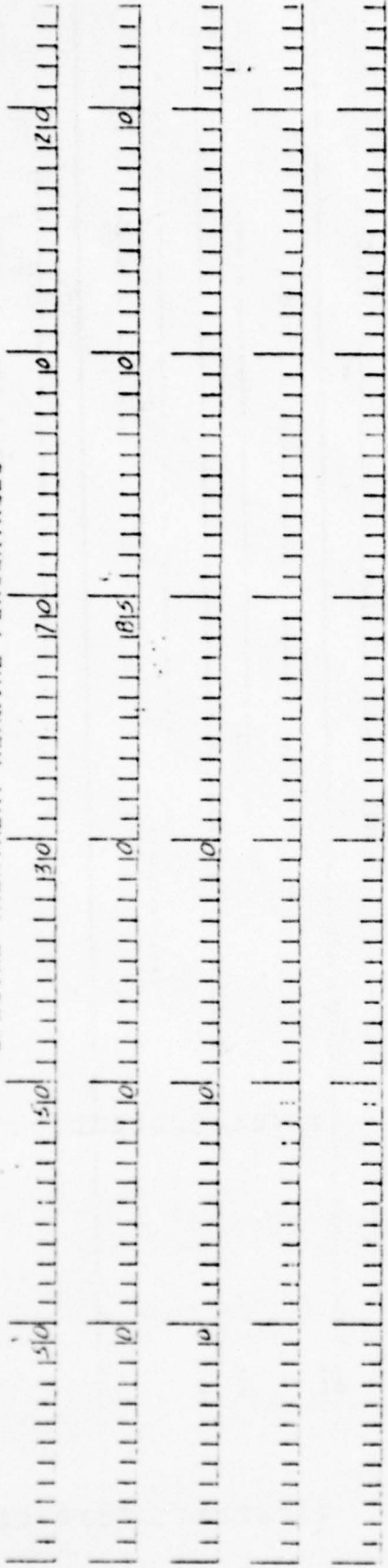
Table 2 provides a water-quality summary for each activity. The following information is shown:

- . Tolerable source water concentrations. The aircraft wash rack, for example, is estimated to be able to accept water with BOD and SS of 20 mg/l.
- . Actual concentrations into the activity.
- . Actual concentrations out of the activity.
- . Degradation through the activity in mg/l.
- . Quantity of contaminants into and out of the activity, and degradation in lbs/day.

Table 3 delineates activity wastewater concentrations after various levels of treatment; none, primary, secondary, and three tertiary systems are shown in the example. As can be seen, this wash rack discharged a very strong waste that had a significant COD concentration (337 mg/l) even after carbon adsorption tertiary treatment. The treatment chains shown in Table 3 are additive, i.e., the carbon adsorption heading represents carbon adsorption added on to filtration and secondary treatment.

Table 4 shows the same type of data as Table 3 except, in this case, the program has assigned chemical coagulation pretreatment to the aircraft wash rack wastewater which then proceeds through the other regular treatment chains. The effect of the pretreatment alone can be gauged by comparing the "none" columns (no regular treatment) on Tables 3 and 4.

SPECIAL TREATMENT REMOVAL PERCENTAGES



SPECIAL TREATMENT THRESHOLD CONCENTRATIONS

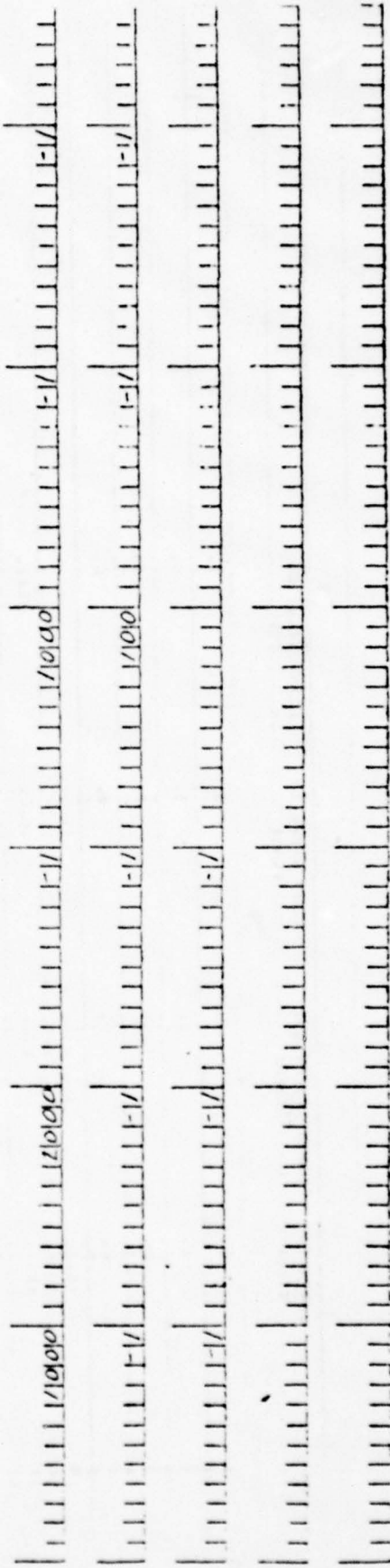


Table 1  
 ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

ISSUE: MARCH 1974  
 PROJECT: ALCOA/ALUMINA  
 REVISED: 12/1974

WEEK	WATER IN (GPH)	WASTEWATER OUT (GPH)	CUMULATIVE IN (GAL)	CUMULATIVE OUT (GAL)
1	30	30	30	30
2	30	30	60	60
3	30	30	90	90
4	30	30	120	120
5	30	30	150	150
6	30	30	180	180
7	30	30	210	210
8	30	30	240	240
9	1000	400	1000	600
10	1000	400	2000	1000
11	1000	400	3000	1400
12	30	30	3030	1730
13	30	30	3060	2060
14	30	30	3090	2390
15	30	30	3120	2720
16	30	30	3150	3050
17	30	30	3180	3380
18	30	30	3210	3710
19	30	30	3240	4040
20	30	30	3270	4370
21	30	30	3300	4700
22	30	30	3330	5030
23	30	30	3360	5360
24	30	30	3390	5690

100 GPH  
 \*\*\*

WEEK	WATER IN (GPH)	WASTEWATER OUT (GPH)	CUMULATIVE IN (GAL)	CUMULATIVE OUT (GAL)
25	30	30	3420	6020
26	30	30	3450	6350
27	30	30	3480	6680
28	30	30	3510	7010
29	30	30	3540	7340
30	30	30	3570	7670
31	30	30	3600	8000
32	30	30	3630	8330
33	30	30	3660	8660
34	30	30	3690	8990
35	30	30	3720	9320
36	30	30	3750	9650
37	30	30	3780	9980
38	30	30	3810	10310
39	30	30	3840	10640
40	30	30	3870	10970
41	30	30	3900	11300
42	30	30	3930	11630
43	30	30	3960	11960
44	30	30	3990	12290
45	30	30	4020	12620
46	30	30	4050	12950
47	30	30	4080	13280
48	30	30	4110	13610
49	30	30	4140	13940
50	30	30	4170	14270
51	30	30	4200	14600
52	30	30	4230	14930
53	30	30	4260	15260
54	30	30	4290	15590
55	30	30	4320	15920
56	30	30	4350	16250
57	30	30	4380	16580
58	30	30	4410	16910
59	30	30	4440	17240
60	30	30	4470	17570
61	30	30	4500	17900
62	30	30	4530	18230
63	30	30	4560	18560
64	30	30	4590	18890
65	30	30	4620	19220
66	30	30	4650	19550
67	30	30	4680	19880
68	30	30	4710	20210
69	30	30	4740	20540
70	30	30	4770	20870
71	30	30	4800	21200
72	30	30	4830	21530
73	30	30	4860	21860
74	30	30	4890	22190
75	30	30	4920	22520
76	30	30	4950	22850
77	30	30	4980	23180
78	30	30	5010	23510
79	30	30	5040	23840
80	30	30	5070	24170
81	30	30	5100	24500
82	30	30	5130	24830
83	30	30	5160	25160
84	30	30	5190	25490
85	30	30	5220	25820
86	30	30	5250	26150
87	30	30	5280	26480
88	30	30	5310	26810
89	30	30	5340	27140
90	30	30	5370	27470
91	30	30	5400	27800
92	30	30	5430	28130
93	30	30	5460	28460
94	30	30	5490	28790
95	30	30	5520	29120
96	30	30	5550	29450
97	30	30	5580	29780
98	30	30	5610	30110
99	30	30	5640	30440
100	30	30	5670	30770

100 GPH  
 \*\*\*

Table 2

WATER QUALITY TRENDS

BASE  
ACTIVITY  
ACTIVITY CODE

ACTIVITY CODE	IN (MG/L)	OUT (MG/L)	IN (MG/DAY)	OUT (MG/DAY)	IN (MG/DAY)	OUT (MG/DAY)
001	23.000	5711.000	3.000	114.350	114.350	114.350
002	50.000	4916.000	3.000	150.916	150.916	150.916
003	1.000	0.500	0.500	0.170	0.170	0.170
004	23.000	570.000	0.000	9.513	9.513	9.513
005	2.000	568.000	14.223	14.223	14.223	14.223
006	10.000	285.000	0.000	5.704	5.704	5.704
007	100.000	185.000	0.000	3.235	3.235	3.235
008	1.000	25.000	0.000	0.501	0.501	0.501
009	15.000	1.000	0.000	0.000	0.000	0.000
010	1.000	31.000	0.000	1.622	1.622	1.622
011	100.000	72.000	1.000	1.482	1.482	1.482
012	500.000	100.000	7.711	6.169	6.169	6.169
013	1.000	1.000	0.000	0.000	0.000	0.000
014	0.000	0.000	0.000	0.000	0.000	0.000
015	10.000	1.100	0.000	0.000	0.000	0.000

Table 3  
 ACCELERATED WASTEWATER CONCENTRATIONS AFTER TREATMENT  
 (MILL)

BASE ACCELERANT ACCELERANT SPECIAL TREATMENT	BASE ACCELERANT ACCELERANT ACCELERANT ACCELERANT	PERCENT	SECURITY	FILTRATION	CAUTION	ADJ.	ISV.	OSMS
001	5711.000	100.000	856.000	162.000	37.110			5.000
002	8516.000	300.000	1600.000	112.000	117.000			86.000
003	4.500	5.000	2.125	2.125				0.000
004	874.000	151.000	72.000	9.000	3.000			0.000
005	600.000	920.000	640.000	80.000	912.000			56.000
006	285.000	162.500	71.250	62.750	11.500			0.000
007	105.000	185.000	135.000	105.000	135.000			37.000
008	25.000	25.000	25.000	25.000	25.000			7.500
009	110.000	110.000	110.000	110.000	110.000			0.000
010	81.000	81.000	81.000	81.000	81.000			1.620
011	72.000	72.000	72.000	72.000	72.000			18.000
012	108.000	108.000	108.000	108.000	108.000			36.000
013	1.000	1.000	1.000	1.000	1.000			0.000
014	0.000	0.000	0.000	0.000	0.000			0.000
015	1.100	1.100	1.100	1.100	1.100			0.000

Table 4  
ACTIVITY WASTEWATER CONCENTRATIONS AFTER TREATMENT  
(MG/L)

DATE	DRAG AIR FLOW (L/MIN)	ACTIVITY CODE	SPECIAL TREATMENT	COAG. CODE	PH	CHLORINE	REGULATED	FILTRATION	SANDY SOLS	REV. SOLS
003	285.333	100.450	520.125	171.333	23.555	2.333				
003	5217.333	2951.333	461.500	506.500	154.500	52.173				
008	5.000	2.105	1.920	1.920	2.76	476				
05	181.333	2.104	21.150	2.020	1.21	0.23				
11	63.333	613.333	613.333	60.333	511.333	58.333				
057	225.333	116.333	17.000	18.233	1.126	6.180				
01	135.333	145.333	145.333	145.333	115.333	17.333				
011	25.333	25.333	25.333	25.333	21.333	7.500				
005	110	110	110	110	110	110				
008	12.133	12.133	1.720	1.063	1.023	283				
04	72.333	72.333	72.333	72.333	72.333	10.333				
001	105.333	105.333	105.333	105.333	105.333	15.333				
0	190	190	190	190	190	225				
00	3.230	4.023	0.203	0.203	1.203	0.203				
01	1.133	1.133	1.133	1.133	1.133	1.133				

As shown, chemical coagulation is specified as removing 50 percent of the BOD and COD and 70 percent of the suspended solids. The program assigns these pretreatments to activities whenever the raw discharge exceeds one of the pretreatment threshold concentrations designated by base personnel. Table 4 aids in determining the feasibility of activity pretreatment.

Table 5 summarizes the suitability of each activity effluent for reuse in other activities. The acceptability of each constituent for reuse after various levels of treatment is shown. This table aids the engineer in isolating troublesome contaminants and evaluating the effect of treatment on contaminant removal.

As shown in the example, under each treatment option, all base activity codes are listed vertically. An "X" means that the constituent is acceptable for reuse in the activity it falls under after going through the treatment designated. For example, looking at  $\text{NO}_3$ , it can be seen that the raw discharge from the aircraft wash rack is acceptable for reuse in all activities but the photo shop. Moving across the  $\text{NO}_3$  row, one notices that  $\text{NO}_3$  is sufficiently removed for use in photo processing only after the carbon adsorption chain. Similarly, COD is never acceptable for reuse regardless of treatment. An "X" for every constituent under one activity means that the entire effluent is acceptable for cascade to that activity.

For activities assigned pretreatment (i.e., chemical coagulation at the aircraft wash rack), a table similar to Table 5 is provided that assumes pretreatment is operative at the activity. This table allows engineers to easily evaluate the feasibility of pretreatment at an activity and its ability to enhance the quality of effluent for reuse. As shown in Table 6, the aircraft wash rack with chemical coagulation is now discharging acceptable water for reuse in several other activities after reverse osmosis (an unlikely event but one that shows the value of the table).

Table 7 is the key Phase I output table that condenses the output provided into one base summary table showing acceptable cascades between activities on the base. Activities are listed with pretreatment, if applicable. An "X" means that the effluent from the activity in that row is acceptable for cascade to the activity in the column, after the treatment designated.

A number "1" instead of an "X" indicates that only one constituent in the wastewater was not acceptable; a "2"

Table 5

SPECIFICITY OF ACTIVITY EFFICIENT FOR HOUSE

HOUSE AIR FIGHT TAIC  
 AIRCRAFTAGE WASH TANK  
 AIRCRAFT  
 AIRCRAFT

REV. OSMOS

CARDON AUS

FILTRATION

SECURARY

PRINACE

HOUSE

AUGOPAGVUGAH

AUGOPAGVUGAH

AUGOPAGVUGAH

AUGOPAGVUGAH

AUGOPAGVUGAH

AUGOPAGVUGAH

700FHHEWF0H0

700FHHEWF0H0

700FHHEWF0H0

700FHHEWF0H0

700FHHEWF0H0

700FHHEWF0H0

AUGOF0H0RFL15

AUGOF0H0RFL15

AUGOF0H0RFL15

AUGOF0H0RFL15

AUGOF0H0RFL15

AUGOF0H0RFL15

MS T I IFRP

MS T I IFRP

MS T I IFRP

MS T I IFRP

MS T I IFRP

MS T I IFRP

RE O R R R

RE O R R R

RE O R R R

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Table 1  
BASIC DATA

ACCEPTABLE GAUGES AT VARIOUS LEVELS OF TREATMENT

GAGE	PRIMARY		SECONDARY		FILTRATION		CARBON		REV. OSNOS	
	1	2	1	2	1	2	1	2	1	2
1	X	X	X	X	X	X	X	X	X	X
2	X	X	X	X	X	X	X	X	X	X
3	X	X	X	X	X	X	X	X	X	X
4	X	X	X	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X	X	X	X
6	X	X	X	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X	X	X	X
8	X	X	X	X	X	X	X	X	X	X
9	X	X	X	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X	X	X	X
11	X	X	X	X	X	X	X	X	X	X
12	X	X	X	X	X	X	X	X	X	X
13	X	X	X	X	X	X	X	X	X	X
14	X	X	X	X	X	X	X	X	X	X
15	X	X	X	X	X	X	X	X	X	X
16	X	X	X	X	X	X	X	X	X	X
17	X	X	X	X	X	X	X	X	X	X
18	X	X	X	X	X	X	X	X	X	X
19	X	X	X	X	X	X	X	X	X	X
20	X	X	X	X	X	X	X	X	X	X
21	X	X	X	X	X	X	X	X	X	X
22	X	X	X	X	X	X	X	X	X	X
23	X	X	X	X	X	X	X	X	X	X
24	X	X	X	X	X	X	X	X	X	X
25	X	X	X	X	X	X	X	X	X	X
26	X	X	X	X	X	X	X	X	X	X
27	X	X	X	X	X	X	X	X	X	X
28	X	X	X	X	X	X	X	X	X	X
29	X	X	X	X	X	X	X	X	X	X
30	X	X	X	X	X	X	X	X	X	X
31	X	X	X	X	X	X	X	X	X	X
32	X	X	X	X	X	X	X	X	X	X
33	X	X	X	X	X	X	X	X	X	X
34	X	X	X	X	X	X	X	X	X	X
35	X	X	X	X	X	X	X	X	X	X
36	X	X	X	X	X	X	X	X	X	X
37	X	X	X	X	X	X	X	X	X	X
38	X	X	X	X	X	X	X	X	X	X
39	X	X	X	X	X	X	X	X	X	X
40	X	X	X	X	X	X	X	X	X	X
41	X	X	X	X	X	X	X	X	X	X
42	X	X	X	X	X	X	X	X	X	X
43	X	X	X	X	X	X	X	X	X	X
44	X	X	X	X	X	X	X	X	X	X
45	X	X	X	X	X	X	X	X	X	X
46	X	X	X	X	X	X	X	X	X	X
47	X	X	X	X	X	X	X	X	X	X
48	X	X	X	X	X	X	X	X	X	X
49	X	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X	X
51	X	X	X	X	X	X	X	X	X	X
52	X	X	X	X	X	X	X	X	X	X
53	X	X	X	X	X	X	X	X	X	X
54	X	X	X	X	X	X	X	X	X	X
55	X	X	X	X	X	X	X	X	X	X
56	X	X	X	X	X	X	X	X	X	X
57	X	X	X	X	X	X	X	X	X	X
58	X	X	X	X	X	X	X	X	X	X
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60	X	X	X	X	X	X	X	X	X	X
61	X	X	X	X	X	X	X	X	X	X
62	X	X	X	X	X	X	X	X	X	X
63	X	X	X	X	X	X	X	X	X	X
64	X	X	X	X	X	X	X	X	X	X
65	X	X	X	X	X	X	X	X	X	X
66	X	X	X	X	X	X	X	X	X	X
67	X	X	X	X	X	X	X	X	X	X
68	X	X	X	X	X	X	X	X	X	X
69	X	X	X	X	X	X	X	X	X	X
70	X	X	X	X	X	X	X	X	X	X
71	X	X	X	X	X	X	X	X	X	X
72	X	X	X	X	X	X	X	X	X	X
73	X	X	X	X	X	X	X	X	X	X
74	X	X	X	X	X	X	X	X	X	X
75	X	X	X	X	X	X	X	X	X	X
76	X	X	X	X	X	X	X	X	X	X
77	X	X	X	X	X	X	X	X	X	X
78	X	X	X	X	X	X	X	X	X	X
79	X	X	X	X	X	X	X	X	X	X
80	X	X	X	X	X	X	X	X	X	X
81	X	X	X	X	X	X	X	X	X	X
82	X	X	X	X	X	X	X	X	X	X
83	X	X	X	X	X	X	X	X	X	X
84	X	X	X	X	X	X	X	X	X	X
85	X	X	X	X	X	X	X	X	X	X
86	X	X	X	X	X	X	X	X	X	X
87	X	X	X	X	X	X	X	X	X	X
88	X	X	X	X	X	X	X	X	X	X
89	X	X	X	X	X	X	X	X	X	X
90	X	X	X	X	X	X	X	X	X	X
91	X	X	X	X	X	X	X	X	X	X
92	X	X	X	X	X	X	X	X	X	X
93	X	X	X	X	X	X	X	X	X	X
94	X	X	X	X	X	X	X	X	X	X
95	X	X	X	X	X	X	X	X	X	X
96	X	X	X	X	X	X	X	X	X	X
97	X	X	X	X	X	X	X	X	X	X
98	X	X	X	X	X	X	X	X	X	X
99	X	X	X	X	X	X	X	X	X	X
100	X	X	X	X	X	X	X	X	X	X

means similarly that two constituents were over tolerable limits for cascade.

As shown in the sample table, the base housing effluent ("HOUSE") is acceptable for reuse after secondary treatment in all irrigational activities: general irrigation (GENIR), office area irrigation (OFFIR), golf course irrigation (GOLF), and Arnold Heights housing irrigation (AHIRR). The photo shop wastewater is acceptable for reuse as irrigation water after filtration tertiary treatment except for one constituent which proved to be cyanide.

This table should aid greatly in locating feasible cascades and pretreatments of most potential, as well as pinpointing cascades hindered by just one or two troublesome contaminants. Review of these individual activity summaries may show that the problem constituent can be eliminated or treated somehow to achieve an acceptable water for cascade.

These tables as output from Phase I should be valuable in helping base personnel construct feasible cascade reuse network diagrams.

## Phase II

### Base Input

Phase II input involves the representation of cascade networks to be analyzed and the specification of appropriate cost data.

Cost data that must be provided include the following:

- . Rate of interest (%)
- . ENR Construction Cost Index
- . ENR Labor Cost Index
- . Life of the system (yrs)
- . Costs of regular and special treatment units or chains
- . Costs of piping, pumping, and storage
- . Cost per 1,000 gal for water supply and discharge

With the aid of the Phase I output, base personnel should be able to develop feasible cascade networks. These networks have to be presented in proper format along with all lengths and possible sizes of pipe not already existing in the system.

The most difficult part of data representation is the cascade network itself. The first step for base personnel is to draw flow diagrams of possible networks similar to the one shown in Figure 1 on the following page.

As shown, the network includes two types of units: activities (base housing, vehicle wash rack, etc.), and BTS's (Blending-Treatment-Storage Units). The BTS's are the crux of the network and full understanding of their placement and function is absolutely necessary.

BTS's are to be placed between any two connected activities, between activities and sources, and between activities and discharges. They serve as focal points for computer calculations of flow, storage, concentrations, treatment, and costs. Each BTS has a make-up line and an overflow in discharge lines. Figure 2 shows a blown-up view of a BTS and its simplification into a one-square symbol. Addition of makeup water can occur before or after treatment as specified by the engineer. A complete description of the mathematics involved with blending, treatment, storage, overflow, and make-up are discussed in Appendix 3.

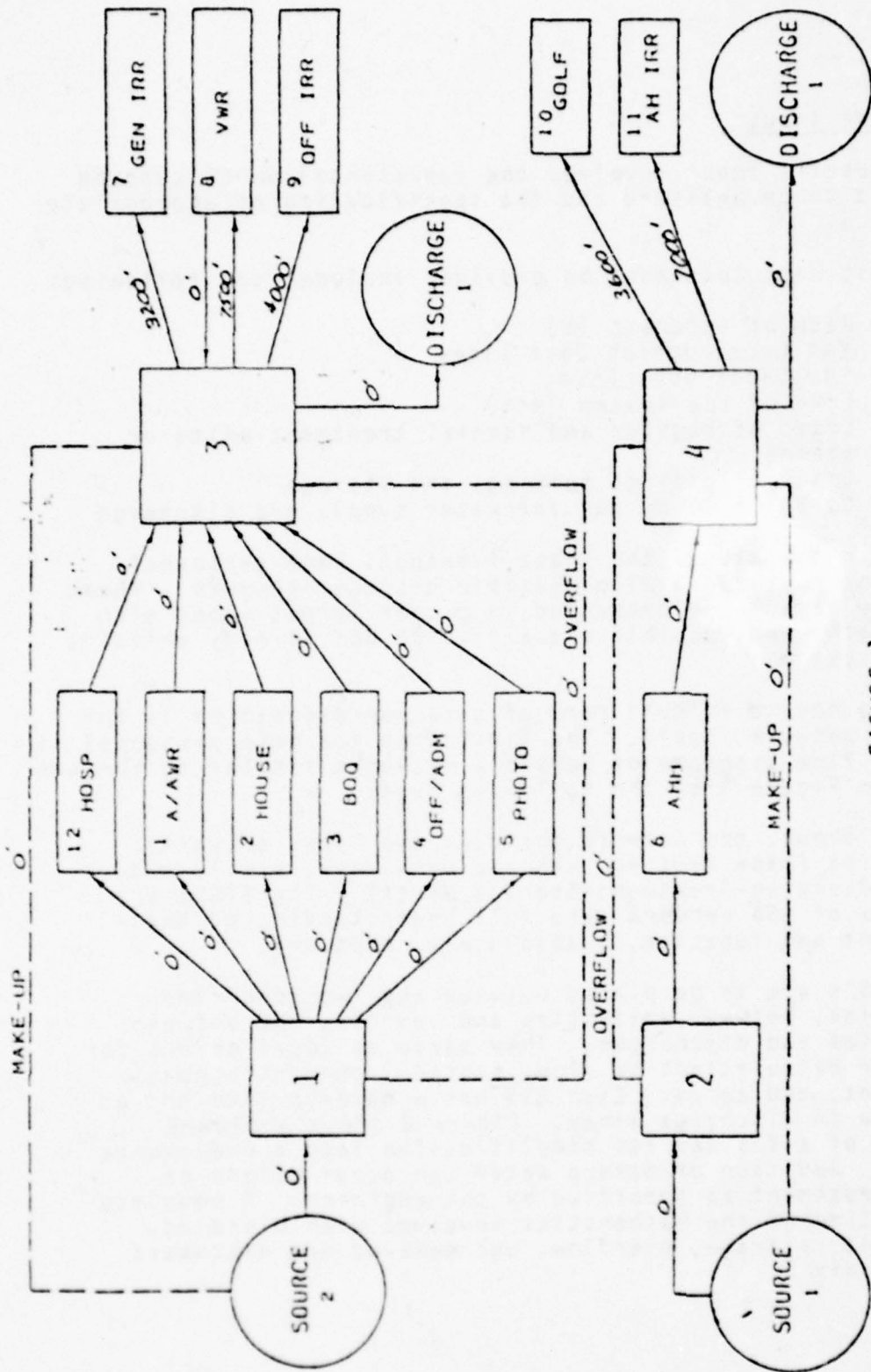
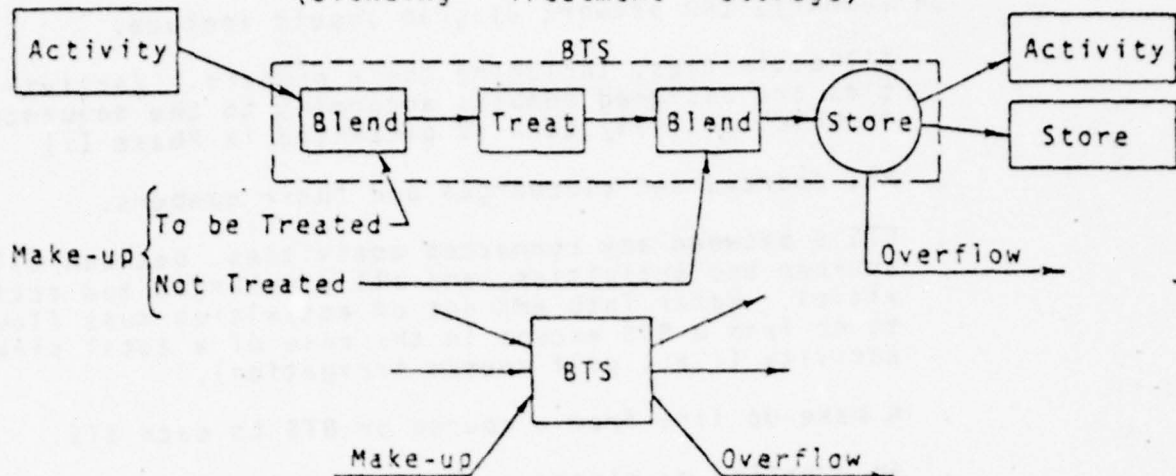


FIGURE 1  
MARCH AFB  
NETWORK NO. 1

FIGURE 2

BTS UNIT

(Blending - Treatment - Storage)



The network displayed in Figure 1 includes a total of 12 activities:

<u>No.</u>	<u>Code</u>	<u>Name</u>
1	A/AWR	Aircraft/age wash rack
2	HOUSE	Main base housing
3	BOO	Bachelor officers' quarters
4	OFF	Office/administration
5	PHOTO	Photographic processing
6	AHH	Arnold Hts. housing
7	GENIR	General grounds irrigation
8	VWR	Vehicle wash rack
9	OFFIR	Office/adm. grounds irrigation
10	GOLF	Golf course irrigation
11	AHIRR	Arnold Hts. irrigation
12	HOSP	Hospital

Also shown are the four BTS's, each with a make-up line and overflow or discharge. In actuality, Source 1 is Colorado River water with BTS 2 being the existing water treatment plant. Source 2 is well water with BTS 1 just a fresh water storage facility. BTS's 3 and 4 are the two existing base sewage treatment plants. The main purpose of this network was to test the feasibility of total effluent reuse for irrigation.

Piping lengths have been shown for new pipes. All other lines are assumed to be existing or non-functional, and were assigned 0 length.

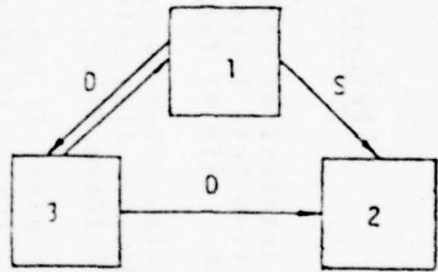
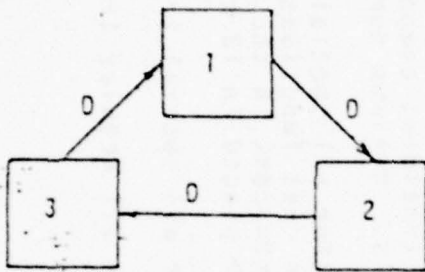
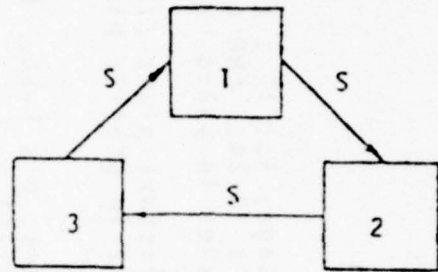
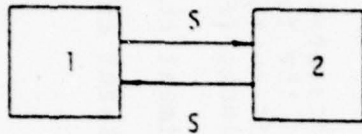
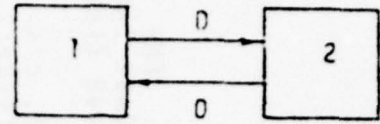
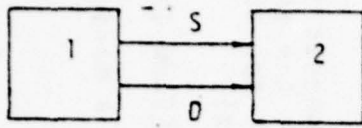
It is important that all piping be given a length, even if it is zero.

In summary, the network diagram should include:

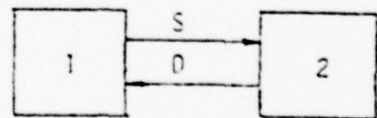
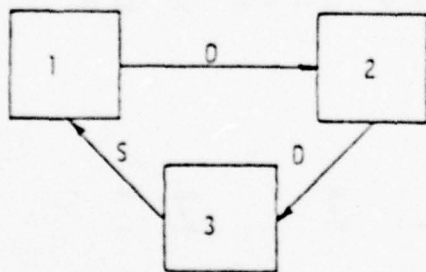
- . All activities, including their numbers. (Activities are assigned numbers according to the sequence in which activity data is presented in Phase I.)
- . All sources and discharges and their numbers.
- . BTS's between any connected activities, between all sources and activities, and all discharges and activities. Water into and out of activities must flow to or from a BTS except in the case of a total sink activity (i.e., golf course irrigation).
- . A make-up line from a source or BTS to each BTS.
- . An overflow or discharge from each BTS. (Note: One occurrence must be avoided--closed loops comprised of source and discharge lines between BTS's. A check to avoid this occurrence is to reverse the flow direction of all source lines to BTS's on the network diagram and to look for any closed loops comprised of BTS discharge lines and the reverse flow BTS source lines. See Figure 3 for examples of permissible and non-permissible loops.)
- . All pipe lengths in the system. Zero length can be specified for existing lines.

Proper translation of this network to a tabular format readable by the machine is described and illustrated in the following sections. Specific instructions follow for filling out all Phase II input forms. In each case, sample forms are provided for illustration.

FIGURE 3  
 EXAMPLES OF NON-PERMISSIBLE  
 CLOSED LOOP BTS NETWORKS



EXAMPLES OF PERMISSIBLE NETWORKS



Note: S = Water supply  
 d = Wastewater discharge

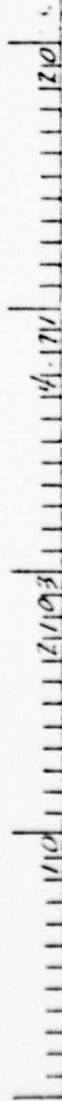
PHASE II

DATA PRESENTATION

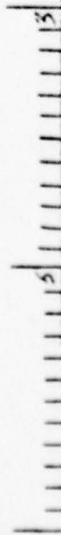
<u>Page</u>	<u>Line</u>	<u>Description</u>
21	1	Rate of interest as percentage, 1st 12 c blocks. ENR Construction Cost Index, c's 13-24. ENR Labor Cost Index, c's 25-36. Life of facilities in years, c's 37-48 (Form VIII).
21	2	Maximum flow velocity in pressure pipes (ft/sec), c's 1-12. Maximum flow velocity in gravity pipes (ft/sec), c's 13-24 (Form VIII).
21	3	Number of possible pipe sizes, c's 1-12. Maximum number of pipe sizes is 15 (Form VIII).
21	4-6	Pipe sizes (diameter in inches), 12 c blocks (Form VIII).
22	1	Number of special treatment components comprising treatment chain in 1st 12 c's. Maximum number is 7 (Form IX).
22	2-8	Cost coefficients for all special treatment components in the chain from the cost functions of the form $\$ = A + BQc$ where A is the fixed cost, B the unit cost, and C the scale cost. Numbers are placed in 12 c blocks (Form IX).
23-28	1-8	Repeat page 22 for all special treatment chains (Form IX).
29-35	1-8	Repeat page 22 for all regular treatment chains, a maximum of 7 (Form X).

COST DATA

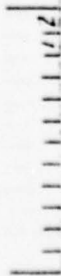
INTEREST      CCI      LCI      LIFE  
(YEARS)



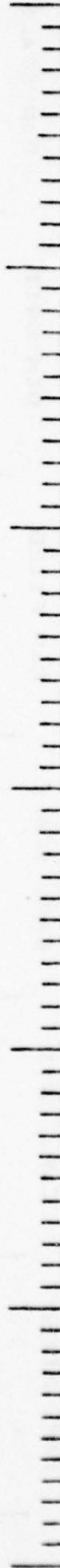
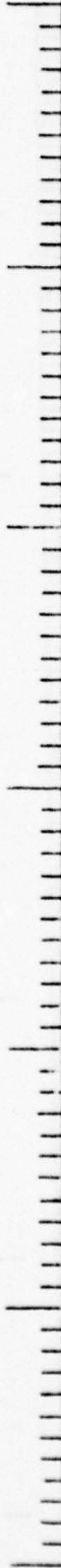
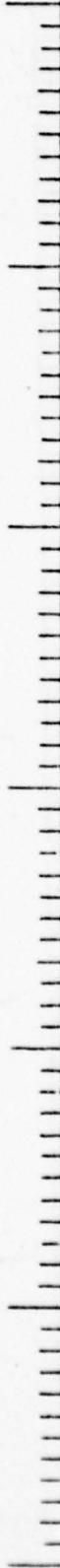
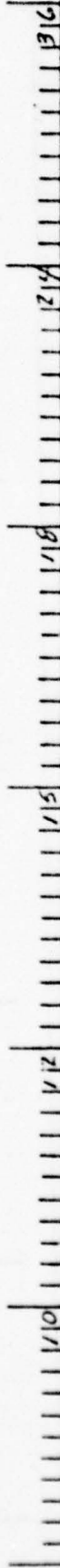
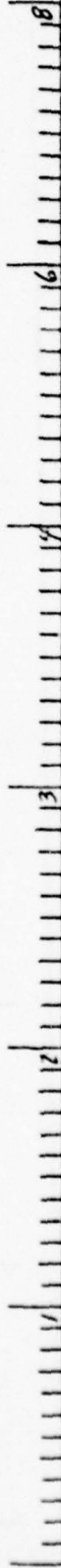
MAX. VELOCITY IN PIPES (FT/SEC)



NUMBER OF PIPE SIZES



PIPE SIZES



PROPERTY

PROPERTY OF THE U.S. GOVERNMENT  
NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS

SPECIAL TREATMENT COSTS  
NUMBER OF TERMS

COST COEFFICIENTS					
CAP. FIXED	CAP. UNIT	CAP. SCALE	CAP. FIXED	OCM UNIT	OCM SCALE
0	1/10	1/10	1/10	12.1310	1/10

PHASE II

DATA PRESENTATION

Description

Line

Page

36 1 Cost of water ( $\$/1000$  gal) for each source, 1st 12 c block (Form III).

36 2 Cost of final discharge ( $\$/1000$ ) gal for each final effluent, 1st 12 c block (Form IV).

37 1 Number of BTS's in network, 1st 12 c block. Maximum number of BTS's is 20 (Form XI).

38 1 Number of activities out of 1st BTS, c's 1-12. The number of source feeding BTS 1, c's 13-24. If another BTS is the source, then put that BTS number in preceded by a minus sign. The number of discharge taking water from BTS 1, c's 25-36. If another BTS is accepting the overflow or discharge, then put that BTS number in preceded by a minus sign (Form XI).

C's 37-48 are provided for specification of regular treatment at the BTS (Form XIII):

0 denotes no treatment specified by the user. Let program calculate necessary removals and facilities.

1, 2, up to 7 (number of regular treatment chain) denotes that user is specifying the removals provided by that treatment chain at BTS 1. Program will calculate required removals regardless, compare them to those specified, and select the larger for each constituent.

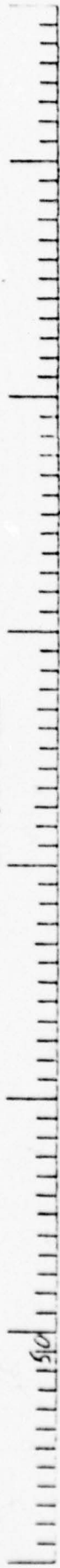
-1 denotes that user is specifying particular removal percentages at BTS 1. Again, program will calculate removals required, compare to those specified, select the larger for each constituent.

PHASE II

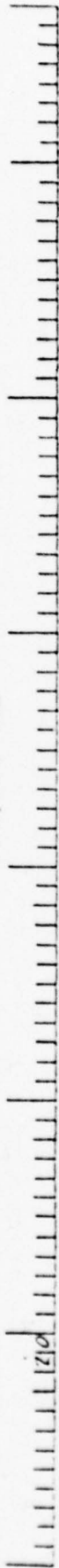
DATA PRESENTATION

<u>Page</u>	<u>Line</u>	<u>Description</u>
38	1	Column 60, place T if make-up water to BTS is to be treated at that BTS; F if make-up water is to by-pass treatment and to be blended with treated effluent from the BTS (Form XIV).
38	2	C's 1-12, number of 1st activity out of BTS 1 (numbers must coincide to activity number from initial activity list) (Form XI).
		C's 13-24 number of BTS accepting discharge from that activity. If activity is a total sink (i.e., golf course), then denote BTS out by a zero (Form XI).
		C's 25-72 continue same procedure for 2nd and 3rd activity out of BTS (Form XI).
38	3-6	Continue same procedure as line 2 for remaining activities out of BTS.
39	1-5	If regular treatment removals have been specified by user (-1 in c 48 of line 1), these percent removals are placed in 12 c blocks (Form XIII).
40-57	All	Repeat pages 38 and 39 for each BTS in the network. Note that if no treatment is specified, then page 28 is not necessary.

SOURCE WATER COST  
¢/1,000 GAL



COST OF FINAL DISCHARGE  
¢/1,000 GAL



NETWORK SUMMARY

NUMBER OF BTS'S

|||||



SPECIFIED BY TREATMENT REMOVALS (OPTIONAL)

1915	1910	1915	1915	1915
10	10	10	10	10
1910	1910	1915	1910	1910
10	10	10	10	10
1910	1910	1910	1910	1910
10	10	10	10	10

PHASE I

DATA PRESENTATION

<u>Page</u>	<u>Line</u>	<u>Description</u>
58	1	For activity No. 1, specify pretreatment at the activity by placing either a zero for no treatment or the number of the desired special treatment unit in c's 1-12. Repeat for activities 2-6 in the remaining 12 c blocks (Form XI).
58	2-6	Repeat line 1 for remaining activities in numerical order (Form XI).
59	1-5	Length in feet for pipe into each activity. If piping already exists, use zero length. Be sure to take activities in numerical order. Lengths are placed in 12 c blocks (Form XI).
60	6-10	Same as c's 1-5 above for length of pipe out of each activity (Form XI).
61	1-5	Length in feet for pipe supplying make-up to each BTS. If piping already exists, use zero length. Be sure to take BTS's in numerical order. Lengths are placed in 12 c blocks (Form XI).
62	6-10	Same as c's 1-5 but for overflow pipes from BTS's (Form XI).
63-87	All	Repeat pages 38-62 for second network.
Remaining	All	Repeat pages 38-62 for all remaining networks.
Last	1	Minus 1 in first c. Ends data.

PIPE LENGTHS INTO ACTIVITIES

Handwriting practice for 'PIPE LENGTHS INTO ACTIVITIES'. The page contains five horizontal lines of a five-line staff. The first two lines feature the word 'stand' written in a cursive script. The first line has the word written in a larger size, and the second line has it written in a smaller size. The remaining three lines are blank, showing only the staff lines.

PIPE LENGTHS OUT OF ACTIVITIES

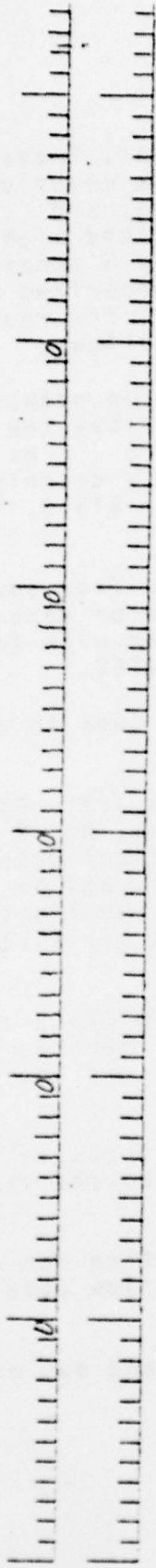
Handwriting practice for 'PIPE LENGTHS OUT OF ACTIVITIES'. The page contains five horizontal lines of a five-line staff. The first two lines feature the word 'stand' written in a cursive script. The first line has the word written in a larger size, and the second line has it written in a smaller size. The remaining three lines are blank, showing only the staff lines.

PRE-TREATMENT AT ACTIVITIES

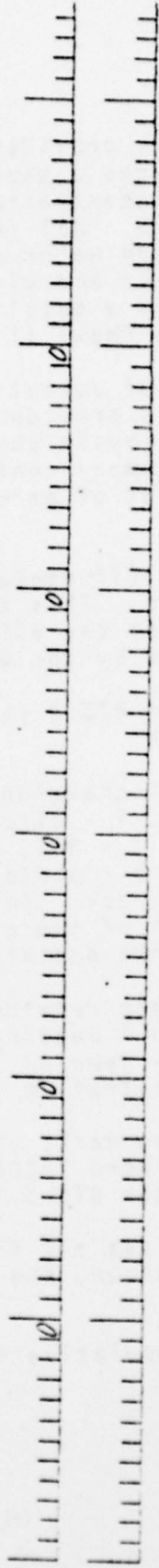
Handwriting practice on a four-line grid. The first line contains the letter 'd' written multiple times. The second line contains the letter 'o' written multiple times. The third and fourth lines contain continuous horizontal strokes, likely for tracing or rhythm exercises.



LENGTH OF PIPE FOR MAKE-UP TO BTS'S



LENGTH OF PIPE FOR OVERFLOW FROM BTS'S



## Output

For each network provided by the user, Phase II of the program produces a tabular network description and summarizes flows, concentrations, storage, and treatment at each BTS. All costs associated with the reuse system including water purchase and discharge fees are clearly delineated and ultimately summarized on an annual basis to yield a total yearly cost for reuse. A description of the Phase II printout follows.

The first page of output describes the network to be evaluated. Table 8, provided here, describes the sample cascade network previously shown in Figure 1. As can be seen, the network summary centers around a description of the flows into and out of each BTS unit. BTS 3, for example, shows the following:

- . Source water (if needed) is drawn from source No. 2 - Wells. This source water or make-up is not treated at the BTS but blended with the effluent as designated by the word "UNTREATED."
- . Overflow from BTS 3 (if needed) goes to discharge No. 1 - DISCH.
- . Activities discharging into BTS 3 are: No. 12 - hospital, No. 1 - aircraft washing, No. 2 - base housing, No. 3 - BOD, No. 4 - office/administration, No. 5 - photo processing, and No. 8 - vehicle wash rack. In addition, the BTS's supplying water to each of these activities are listed adjacent to the activity.
- . Activities that receive water from BTS 3 are listed under the "OUT" heading: No. 8 - vehicle wash rack, No. 7 - general irrigation, and No. 9 - office/administration irrigation.
- . The table also marks all recycle loops as designated by the word "RECYCLE" next to the vehicle wash rack under BTS 3.

Table 9 summarizes all flow information for each BTS in the network. As shown, the following flow data is provided:

- . Hourly and cumulative flows into and out of the BTS

TABLE B

UNITA DESIGNATION 41404K NO. 1  
MARCH 1944 FIVE

414 1

SOURCE	2	MELT	UNREMOVED
OUT	1	1022	
	1	A/A41	
	2	1022	
	3	1022	
	4	OFF	
	5	PIRIF	
	6	OVERFLOW	

414 2

SOURCE	1	COLD	UNREMOVED
OUT	5	AH1	
	6	OVERFLOW	

414 3

SOURCE	2	MELT	UNREMOVED
OVERFLOW	1	1151	
OUT	1	1022	
	1	A/A41	
	2	1022	
	3	1022	
	4	OFF	
	5	PIRIF	
	6	OVERFLOW	

414 4

SOURCE	1	RECYCLE
OUT	1	
	2	
	3	

414 5

SOURCE	1	COLD	UNREMOVED
OVERFLOW	1	1151	
OUT	2	AH1	
	3	OVERFLOW	

TABLE 9  
FLOW SUMMARY FOR J1

LINE	INLET (GPM)	OUTLET (GAL)	CUR. STOR. (GAL)	ACCUM. IN (GAL)	MIN. STOR. (GAL)	ACC. STOR. (GAL)	MAKE-UP (GPM)
1	0	1	100	0	0	0	0
2	0	100	0	100	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0

EXCESS STORAGE REQUIRED J. GALLONS REQUIRED STORAGE CAPACITY J. GALLONS MAKE-UP 1000. GPM

LINE	INLET (GPM)	OUTLET (GAL)	CUR. STOR. (GAL)	ACCUM. IN (GAL)	MIN. STOR. (GAL)	ACC. STOR. (GAL)	MAKE-UP (GPM)
1	0	1	100	0	0	0	0
2	0	100	0	100	0	0	0
3	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0

- . Modified flows into or out of the BTS due to the effects of storage or make-up
- . Minimum storage capacity and required capacity to provide a safety factor
- . Required hourly make-up water if necessary
- . Graphs of the above

In the example shown here, no storage was required, but make-up was needed as can be seen by the hourly flows under the last column.

Table 10 delineates source water usage on an hourly basis for a typical day. The "SUMMARY" section on the left side of the table gives a comparison of water usage for a once-through network with no reuse versus the cascade network and displays the water saved by reuse. On the right side of the table, hourly water drawn from each source is listed.

Table 11 supplies the same information as Table 9 for final effluent discharged from the base. Again, a comparison is made between a once-through and the cascade system.

Table 12 summarizes the following for each BTS in a network:

- . Removal percentages specified by base personnel. As previously discussed, removals may be specified either by designating a treatment chain to be used at a BTS, or individual-constituent removals.
- . Actual removals used at the BTS to meet all tolerable requirements. If removals are specified in the first column, the program will compare these percentages with those calculated as necessary and place the higher one in column two in each case.
- . The most-stringent tolerable concentration required in the BTS effluent for each constituent.

This table is valuable in that it shows in concise form the degree of treatment necessary at each BTS. From this table, base personnel can isolate those constituents forcing higher levels of treatment and investigate activity pretreatment options to reduce a critical contaminant and perhaps lower the level of BTS treatment.

Table 11

ERRORS OF OBSERVATION  
(1944)

	INDICATOR	GAUSSIAN	ALL	INDICATOR
	INDICATOR	GAUSSIAN	ALL	INDICATOR
1	9898.3	4	9348	01524
2	9898.3	4	9348	
3	9898.3	4	9348	
4	9898.3	4	9348	
5	9898.3	4	9348	
6	9898.3	4	9348	
7	9898.3	4	9348	
8	9898.3	4	9348	
9	9898.3	4	9348	
10	9898.3	4	9348	
11	9898.3	4	9348	
12	9898.3	4	9348	
13	9898.3	4	9348	
14	9898.3	4	9348	
15	9898.3	4	9348	
16	9898.3	4	9348	
17	9898.3	4	9348	
18	9898.3	4	9348	
19	9898.3	4	9348	
20	9898.3	4	9348	
21	9898.3	4	9348	
22	9898.3	4	9348	
23	9898.3	4	9348	
24	9898.3	4	9348	
25	9898.3	4	9348	
26	9898.3	4	9348	
27	9898.3	4	9348	
28	9898.3	4	9348	
29	9898.3	4	9348	
30	9898.3	4	9348	
31	9898.3	4	9348	
32	9898.3	4	9348	
33	9898.3	4	9348	
34	9898.3	4	9348	
35	9898.3	4	9348	
36	9898.3	4	9348	
37	9898.3	4	9348	
38	9898.3	4	9348	
39	9898.3	4	9348	
40	9898.3	4	9348	
41	9898.3	4	9348	
42	9898.3	4	9348	
43	9898.3	4	9348	
44	9898.3	4	9348	
45	9898.3	4	9348	
46	9898.3	4	9348	
47	9898.3	4	9348	
48	9898.3	4	9348	
49	9898.3	4	9348	
50	9898.3	4	9348	
51	9898.3	4	9348	
52	9898.3	4	9348	
53	9898.3	4	9348	
54	9898.3	4	9348	
55	9898.3	4	9348	
56	9898.3	4	9348	
57	9898.3	4	9348	
58	9898.3	4	9348	
59	9898.3	4	9348	
60	9898.3	4	9348	
61	9898.3	4	9348	
62	9898.3	4	9348	
63	9898.3	4	9348	
64	9898.3	4	9348	
65	9898.3	4	9348	
66	9898.3	4	9348	
67	9898.3	4	9348	
68	9898.3	4	9348	
69	9898.3	4	9348	
70	9898.3	4	9348	
71	9898.3	4	9348	
72	9898.3	4	9348	
73	9898.3	4	9348	
74	9898.3	4	9348	
75	9898.3	4	9348	
76	9898.3	4	9348	
77	9898.3	4	9348	
78	9898.3	4	9348	
79	9898.3	4	9348	
80	9898.3	4	9348	
81	9898.3	4	9348	
82	9898.3	4	9348	
83	9898.3	4	9348	
84	9898.3	4	9348	
85	9898.3	4	9348	
86	9898.3	4	9348	
87	9898.3	4	9348	
88	9898.3	4	9348	
89	9898.3	4	9348	
90	9898.3	4	9348	
91	9898.3	4	9348	
92	9898.3	4	9348	
93	9898.3	4	9348	
94	9898.3	4	9348	
95	9898.3	4	9348	
96	9898.3	4	9348	
97	9898.3	4	9348	
98	9898.3	4	9348	
99	9898.3	4	9348	
100	9898.3	4	9348	
TOTAL	21256.0		21256.0	

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Table 12

CONCENTRATION SUMMARY FOR JES S

	SPEC. NUMBER	REMARKS	TOTAL (MG/L)
403	3.2	46.4	33.03
404	3.2	70.2	52.03
405	3.2	4.4	52
406	3.2	67.2	52.302
407	3.2	3.6	248.03
408	3.2	3.2	32.42
409	3.2	3.2	35.03
410	3.2	3.2	31.03
411	3.2	19.2	23.03
412	3.2	3.2	31.03
413	3.2	3.2	31.03
414	3.2	3.2	35.03
415	3.2	3.2	31.03
416	3.2	3.2	31.03
417	3.2	3.2	31.03
418	3.2	3.2	31.03
419	3.2	3.2	31.03
420	3.2	3.2	31.03
421	3.2	3.2	31.03
422	3.2	3.2	31.03
423	3.2	3.2	31.03
424	3.2	3.2	31.03
425	3.2	3.2	31.03
426	3.2	3.2	31.03
427	3.2	3.2	31.03
428	3.2	3.2	31.03
429	3.2	3.2	31.03
430	3.2	3.2	31.03
431	3.2	3.2	31.03
432	3.2	3.2	31.03
433	3.2	3.2	31.03
434	3.2	3.2	31.03
435	3.2	3.2	31.03
436	3.2	3.2	31.03
437	3.2	3.2	31.03
438	3.2	3.2	31.03
439	3.2	3.2	31.03
440	3.2	3.2	31.03
441	3.2	3.2	31.03
442	3.2	3.2	31.03
443	3.2	3.2	31.03
444	3.2	3.2	31.03
445	3.2	3.2	31.03
446	3.2	3.2	31.03
447	3.2	3.2	31.03
448	3.2	3.2	31.03
449	3.2	3.2	31.03
450	3.2	3.2	31.03
451	3.2	3.2	31.03
452	3.2	3.2	31.03
453	3.2	3.2	31.03
454	3.2	3.2	31.03
455	3.2	3.2	31.03
456	3.2	3.2	31.03
457	3.2	3.2	31.03
458	3.2	3.2	31.03
459	3.2	3.2	31.03
460	3.2	3.2	31.03
461	3.2	3.2	31.03
462	3.2	3.2	31.03
463	3.2	3.2	31.03
464	3.2	3.2	31.03
465	3.2	3.2	31.03
466	3.2	3.2	31.03
467	3.2	3.2	31.03
468	3.2	3.2	31.03
469	3.2	3.2	31.03
470	3.2	3.2	31.03
471	3.2	3.2	31.03
472	3.2	3.2	31.03
473	3.2	3.2	31.03
474	3.2	3.2	31.03
475	3.2	3.2	31.03
476	3.2	3.2	31.03
477	3.2	3.2	31.03
478	3.2	3.2	31.03
479	3.2	3.2	31.03
480	3.2	3.2	31.03
481	3.2	3.2	31.03
482	3.2	3.2	31.03
483	3.2	3.2	31.03
484	3.2	3.2	31.03
485	3.2	3.2	31.03
486	3.2	3.2	31.03
487	3.2	3.2	31.03
488	3.2	3.2	31.03
489	3.2	3.2	31.03
490	3.2	3.2	31.03
491	3.2	3.2	31.03
492	3.2	3.2	31.03
493	3.2	3.2	31.03
494	3.2	3.2	31.03
495	3.2	3.2	31.03
496	3.2	3.2	31.03
497	3.2	3.2	31.03
498	3.2	3.2	31.03
499	3.2	3.2	31.03
500	3.2	3.2	31.03

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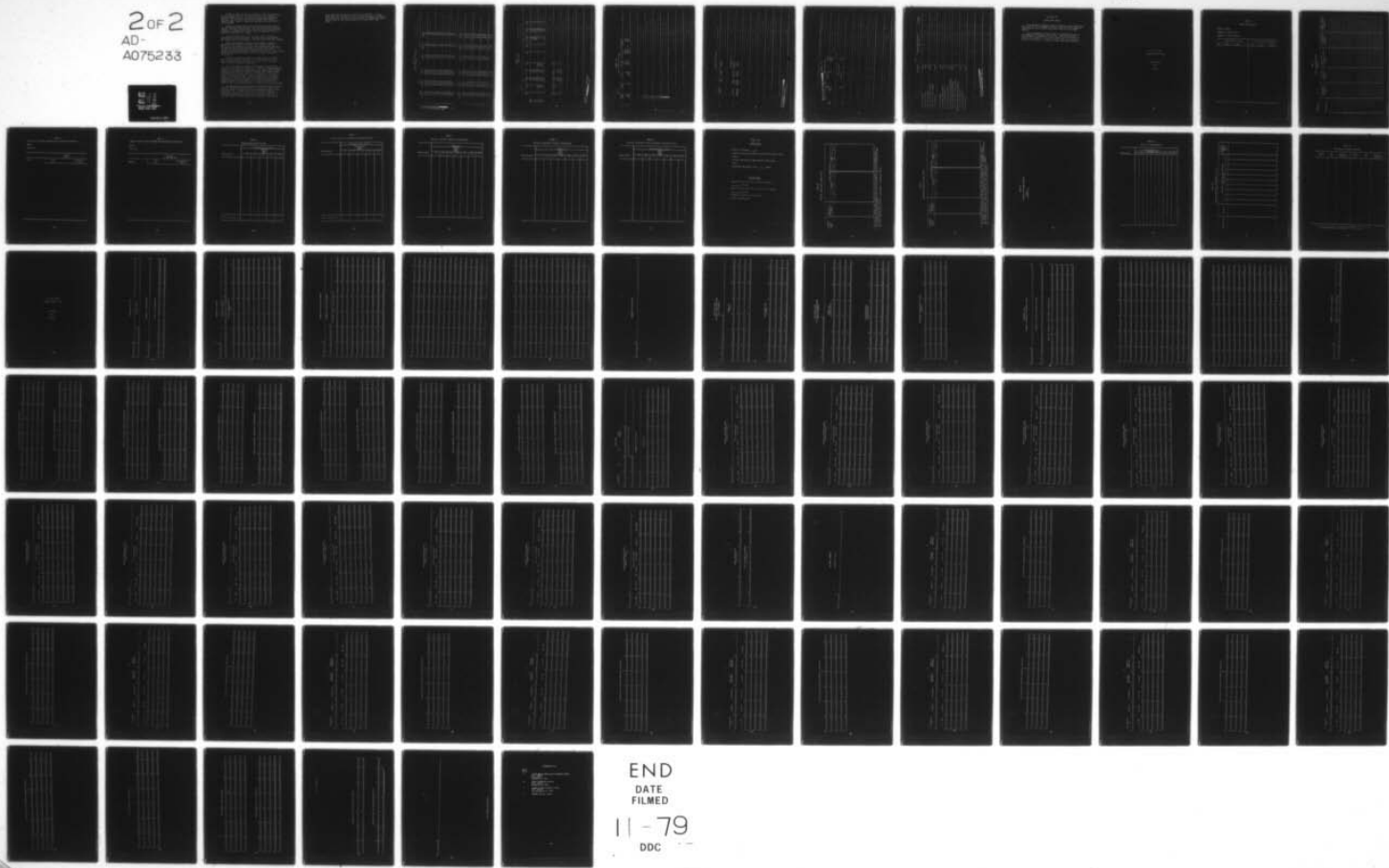
SCS ENGINEERS LONG BEACH CALIF  
SUBPOTABLE WATER REUSE AT ARMY FIXED INSTALLATIONS: A SYSTEMS A--ETC(U)  
AUG 79 C J SCHMIDT, E V CLEMENTS, L HAMME DAMD17-78-C-8080

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Table 13 shows an hourly summary of the concentration of each constituent as it enters the BTS, as it exits BTS treatment, and as it is finally discharged from BTS storage. In this way, the hourly fluctuations and effects of peak loads on required treatment can more easily be evaluated.

Table 14 summarizes piping specifications and costs for the cascade reuse system. For each activity, the size, length, and cost of each pipe into and out of the activity is shown. In addition, similar data for make-up to and overflow from BTS's is listed.

Table 15 summarizes size and cost of all required storage facilities and pumps. Storage tank size includes the safety factor discussed in Section III of the main report.

Table 16 summarizes special pretreatment costs at activities and regular treatment chain costs at BTS's. As shown in the example, no activity pretreatment was specified and the program selected the carbon adsorption chain for BTS 3 and the secondary treatment chain for BTS 4 as being the least expensive treatment to meet all requirements. Costs are summarized on both a total capital and yearly O & M basis.

Table 17 summarizes costs for procurement and treatment of source water for each major source on the base, and also the costs associated with each final discharge from the base (excluding treatment).

Table 18 shows the major total system cost summary. Firstly, capital costs for piping, pumping, storage, regular treatment, and special pretreatment are listed and totaled. These capital costs are then translated into annual costs by applying the capital recovery factor that utilizes the cost information supplied by base personnel on interest rates and equipment life. Annual capital and O & M costs are added to source water and discharge costs previously summarized to provide a total yearly cost for the entire cascade network. This cost can be used to compare the benefits and cost effectiveness of different cascade networks.

As can be seen in the example provided, another heading labeled "EXISTING FACILITIES COST" is also provided. In the case where portions of the cascade network are already existing (i.e., source water pumps, secondary sewage treatment plants, etc.), the costs for facilities can be listed and subtracted from the cost summary to obtain the "NET COST" for the cascade reuse system. Many bases

have some type of central wastewater treatment. In the case where the program calls for a more advanced treatment chain than that existing, only the cost of upgrading should be assigned to the reuse system and listed under "NET COST."

TABLE 13  
CONCENTRATION, THROUGH UFS 1  
(HW/L)

INFO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE	INFO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE
1	0.030	568.001	1.030	.200	.200
2	0.030	568.001	1.030	.200	.200
3	0.030	568.001	1.030	.200	.200
4	0.030	568.001	1.030	.200	.200
5	0.030	568.001	1.030	.200	.200
6	0.030	568.001	1.030	.200	.200
7	0.030	568.001	1.030	.200	.200
8	0.030	568.001	1.030	.200	.200
9	0.030	568.001	1.030	.200	.200
10	0.030	568.001	1.030	.200	.200
11	0.030	568.001	1.030	.200	.200
12	0.030	568.001	1.030	.200	.200
13	0.030	568.001	1.030	.200	.200
14	0.030	568.001	1.030	.200	.200
15	0.030	568.001	1.030	.200	.200
16	0.030	568.001	1.030	.200	.200
17	0.030	568.001	1.030	.200	.200
18	0.030	568.001	1.030	.200	.200
19	0.030	568.001	1.030	.200	.200
20	0.030	568.001	1.030	.200	.200
21	0.030	568.001	1.030	.200	.200
22	0.030	568.001	1.030	.200	.200
23	0.030	568.001	1.030	.200	.200
24	0.030	568.001	1.030	.200	.200

INFO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE	INFO TREATMENT	OUT OF TREATMENT	OUT OF STORAGE
1	0.030	105.001	1.030	20.000	20.000
2	0.030	105.001	1.030	20.000	20.000
3	0.030	105.001	1.030	20.000	20.000
4	0.030	105.001	1.030	20.000	20.000
5	0.030	105.001	1.030	20.000	20.000
6	0.030	105.001	1.030	20.000	20.000
7	0.030	105.001	1.030	20.000	20.000
8	0.030	105.001	1.030	20.000	20.000
9	0.030	105.001	1.030	20.000	20.000
10	0.030	105.001	1.030	20.000	20.000
11	0.030	105.001	1.030	20.000	20.000
12	0.030	105.001	1.030	20.000	20.000
13	0.030	105.001	1.030	20.000	20.000
14	0.030	105.001	1.030	20.000	20.000
15	0.030	105.001	1.030	20.000	20.000
16	0.030	105.001	1.030	20.000	20.000
17	0.030	105.001	1.030	20.000	20.000
18	0.030	105.001	1.030	20.000	20.000
19	0.030	105.001	1.030	20.000	20.000
20	0.030	105.001	1.030	20.000	20.000
21	0.030	105.001	1.030	20.000	20.000
22	0.030	105.001	1.030	20.000	20.000
23	0.030	105.001	1.030	20.000	20.000
24	0.030	105.001	1.030	20.000	20.000

THIS PAGE IS BEST QUALITY FRAGRANCE  
FROM COPY FURNISHED TO DDO

TABLE 1A

COST OF PIPE

ITEM	SIZE (IN.)	LENGTH (FT.)	MAX FLOW (GPM)	COST/FT (¢)	COST (\$)	SIZE (IN.)	LENGTH (FT.)	MAX FLOW (GPM)	COST/FT (¢)	COST (\$)	OUT	
											LENGTH (FT.)	MAX FLOW (GPM)
AVAGE	2	2	1200	5.23	10.46	4	2	400	0.00	0.00	0.00	0.00
1077E	1	3	5000	6.23	18.69	4	3	5000	0.00	0.00	0.00	0.00
003	1	2	500	2.30	4.60	4	2	500	3.00	6.00	0.00	0.00
3F	6	3	15000	12.00	36.00	6	3	15000	12.00	36.00	0.00	0.00
PHOED	2	2	2000	4.30	8.60	4	2	2000	0.23	4.60	0.00	0.00
ATE	6	3	18000	12.00	36.00	6	3	18000	12.00	36.00	0.00	0.00
ONEE	6	1200	18000	12.00	14400	6	1200	18000	3.00	3600	0.00	0.00
4E	1	7500	2500	2.00	15000	4	7500	2250	4.00	30000	0.00	0.00
DIFF 4	8	5000	10500	8.00	40000	8	5000	3000	3.00	24000	0.00	0.00
60F	16	1600	60000	20.00	32000	16	1600	60000	0.00	0.00	0.00	0.00
4014E	8	7000	28000	16.00	112000	8	7000	28000	3.00	21000	0.00	0.00
403P	2	3	2500	4.23	12.69	4	3	2500	0.00	0.00	0.00	0.00

ITEM	SIZE (IN.)	LENGTH (FT.)	MAX FLOW (GPM)	COST/FT (¢)	COST (\$)
1	6	2	26000	12.00	72.00
2	6	3	18000	12.00	36.00
3	6	3	26000	12.00	36.00
4	10	3	59000	20.00	60.00

THIS PAGE IS BEST QUALITY PRACTICABLE FROM COPY MADE BY J.D.D.

TABLE 15

COST OF PUMPING AND STORAGE

STORAGE (GAL)	HEAD (FT)	310. COST (¢)	HEAD (FT)	PUMP CAP COST (¢)	PUMP O/M COST (¢/YR)
4.	4.	2000.	2000.	28000.	1670.
8.	8.	1000.	1000.	22000.	851.
1200.	5.	1356.	25150.	26575.	1075.
7000.	33.	16500.	67000.	51750.	2329.

THIS PAGE IS BEST QUALITY PRACTICAL FROM NAVY PUBLISHED TO GPO

SPECIAL TREATMENT COSTS

ACT.	TREATMENT	FLO4 (GPD)	CAP. COST (\$)	OTH COST (\$/GPD)

TREATMENT COSTS

ACT.	TREATMENT	FLO4 (GPD)	CAP. COST (\$)	OTH COST (\$/GPD)
1	CAUTION ADS	22033	103213	6487
2	SECONDARY	28138	63636	5462

THIS PAGE IS BEST QUALITY PRACTICE  
FROM 90% RECYCLED PAPER

TABLE 17

**THIS PAGE IS BEST QUALITY AVAILABLE**

COST OF SOCIAL WATER

PER 1000 GAL

	GPD	1/1000 GAL	1/FEET
1 GILD	7115.3	.54	134805
2 WELLS	63212	.49	127882

COST OF DISCHARGE

GPD	1/1000 GAL	1/FEET
6		

DISCH



## SECTION IV

### BLANK DATA DECKS

This section includes a copy of each of the engineering forms that will be needed and also an entire blank computer form booklet, that contains at least one of every page needed.

It is extremely unlikely that all pages and lines of the computer form deck will be used. The data booklet is provided to accept the maximum amount of data that the program can handle. A typical network will use roughly one-third to one-half of the available deck provided here.



U.S. AIR FORCE  
CASCADE WATER REUSE

ENGINEERING  
FORM  
BOOKLET



FORM 1

ACTIVITY WATER/WASTEWATER  
SUMMARY

BASE: \_\_\_\_\_  
ACTIVITY: \_\_\_\_\_

Constituent	Source Water Concentration (mg/l)	Tolerable Concentration (mg/l)	Typical, Tolerable Concentration (mg/l)	Final Effluent Concentration (mg/l)	Typical, Final Effluent Concentration (mg/l)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
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26					
27					
28					
29					
30					
31					
32					
33					

FORM II

DAILY ACTIVITY WATER DEMAND AND WASTEWATER GENERATION

Base:

Activity:

---

	Volume (gph)	
Hours	Water In	Wastewater Out

---



FORM III

SOURCE WATER QUALITY/COST

Constituent	Concentration (mg/l)				
	Sources Name (No.)				
	(1)	(2)	(3)	(4)	(5)
Cost: c/1000 gal					



FORM V

SPECIAL TREATMENT REMOVAL PERCENTAGES

Constituent	Removal %						
	Chain Name (No.)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)



FORM VII

SPECIAL TREATMENT CHAIN THRESHOLD CONCENTRATIONS

Constituent	Concentration (mg/l)						
	Chain Name (No.)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)

FORM VIII

COST DATA

- . Rate of interest: \_\_\_\_\_ %
- . Current Engineering News Record Construction Cost Index:
- . Current Engineering News Record Labor Cost Index:
- . Estimated Equipment Life: \_\_\_\_\_ years

PIPING DATA

- Maximum flow velocity in pressure pipes:  
\_\_\_\_\_ ft/sec
- . Maximum flow velocity in gravity flow pipes:  
\_\_\_\_\_ ft/sec
  - . Number of possible pipe sizes:
  - . List of pipe sizes:

FORM IX

SPECIAL TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components in Chain	Cost Coefficients					
		Capital			O&M		
		A	B	C	A	B	C

- \* Be sure to include cost coefficients for each element of the treatment chain. For example, if two pretreatment units are combined in one chain, each must have its cost coefficient listed.
- \* All cost coefficients must be represented in January 1975 \$.

FORM X

REGULAR TREATMENT CHAIN COSTS

Treatment Chain Name	No. of Components* in Chain	Cost Coefficients		
		Capital		O&M
		A	B	C
		A	B	C

\* Be sure to include cost coefficients for each element of the treatment chains. For example, if three units are combined in one chain (i.e., secondary, filtration, and carbon adsorption), each must have its cost coefficient listed.  
 \* All cost coefficients must be represented in January 1975 \$.

FORM XI

CASCADE NETWORK DIAGRAM

Base  
Network No.:



FORM XIII

SPECIFIED REGULAR TREATMENT AT BTS'S

Network No.	BTS No.	Specified Removal Percentages Constituents								Regular Treatment Chain No.

FORM XIV

BTS MAKE-UP WATER TREATMENT

Network No.	BTS No.	Make-Up Treatment (1)	Network No.	BTS No.	Make-Up Treatment (1)

T - Make-up treated at BTS after blending with influent.  
 F - Untreated make-up blended with BTS effluent.

U.S. AIR FORCE  
CASCADE WATER REUSE

COMPUTER  
FORM  
BOOKLET

GENERAL BASE DATA

|||||

NAME OF BASE

|||||

NUMBER OF CONTAMINANTS

|||||

NAMES OF CONTAMINANTS

|||||

|||||



NUMBER OF FINAL DISCHARGES

|||||

NAMES OF FINAL DISCHARGES

|||||

REQUIRED FINAL DISCHARGE QUALITY

|||||

|||||

|||||

|||||

|||||

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|||||

|||||

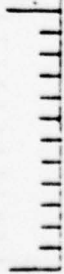
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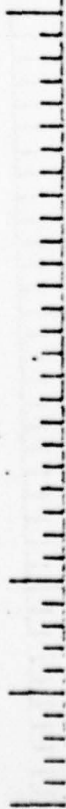
Handwritten musical notation consisting of 14 staves. Each staff contains a series of rhythmic markings, likely representing a specific musical exercise or piece. The notation is dense and repetitive, suggesting a focus on rhythm and pitch contour.

Handwritten musical notation consisting of 14 staves. Each staff contains a series of rhythmic markings, likely representing a specific musical exercise or piece. The markings are organized into groups of vertical stems with horizontal lines, suggesting a structured rhythmic pattern.

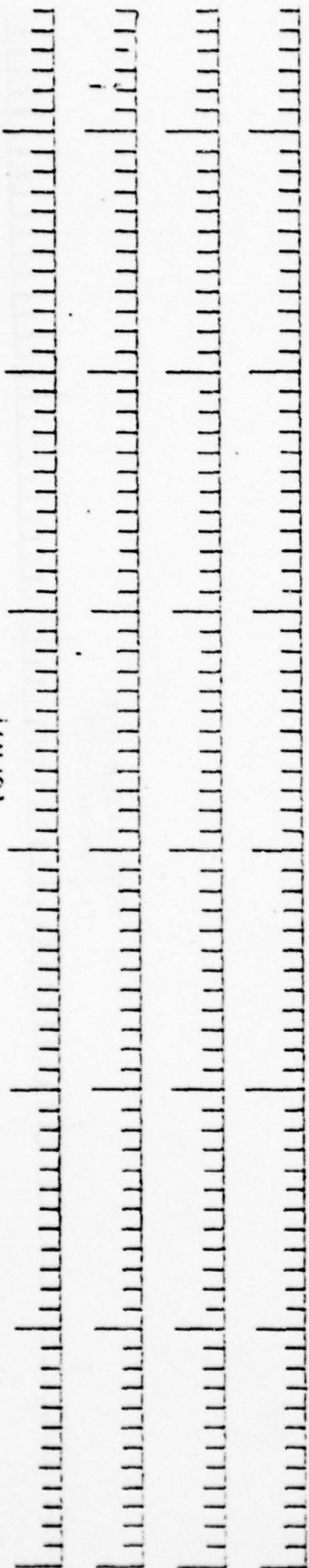
NUMBER OF ACTIVITIES



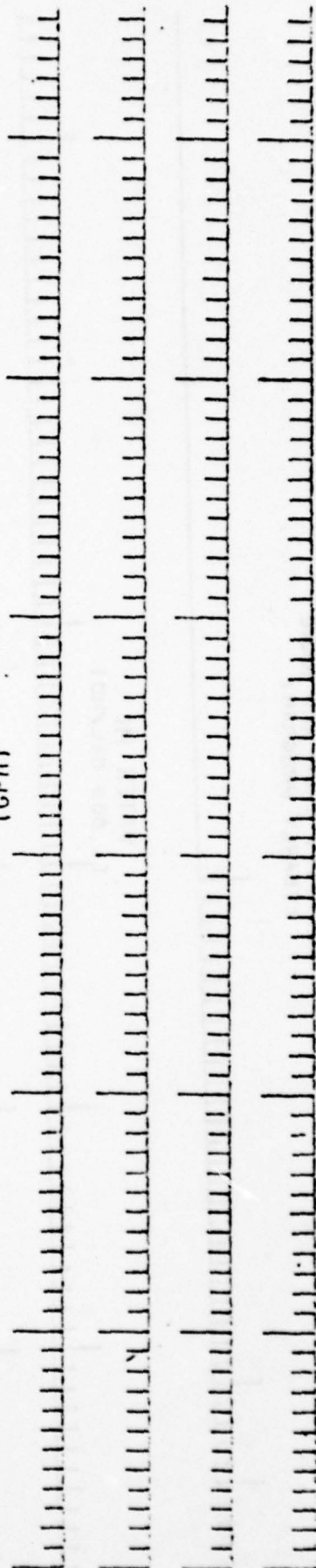
ACTIVITY DATA  
ACTIVITY CODE AND NAME  
(DAILY PROGRAM)



WATER IN  
(GPH)



WASTEWATER OUT  
(GPH)



ACTIVITY DATA  
ACTIVITY CODE AND NAME  
(YEARLY PROGRAM)

.....

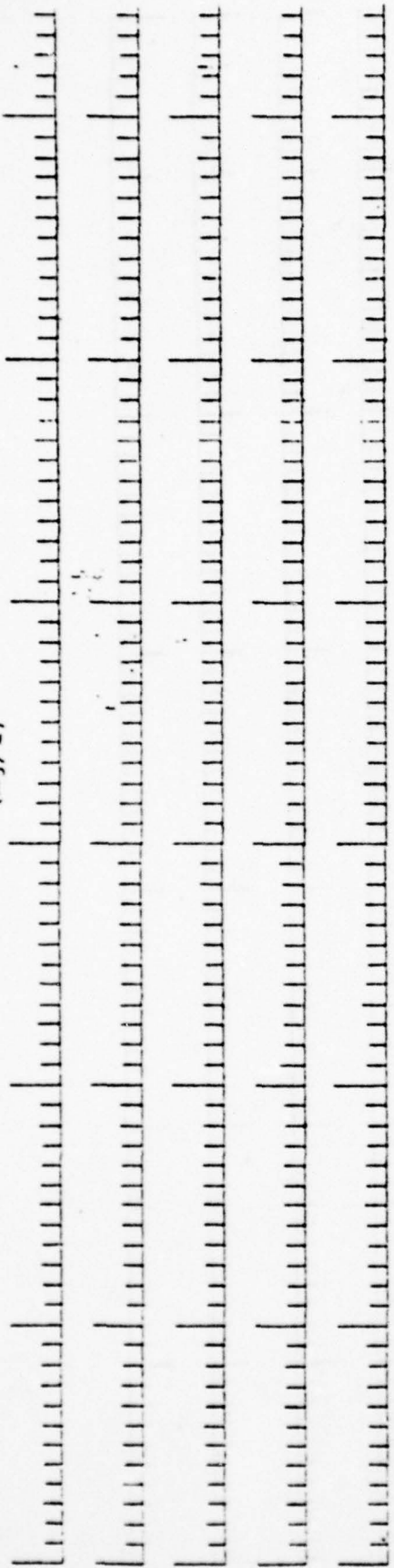
WATER IN  
(1,000 GAL/MO)

.....  
.....  
.....  
.....

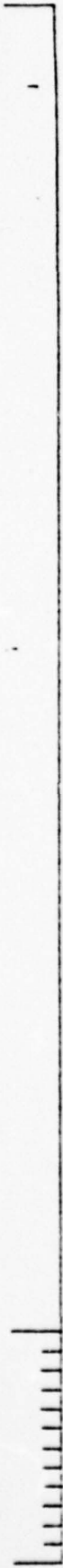
WASTEWATER OUT  
(1,000 GAL/MO)

.....  
.....  
.....  
.....

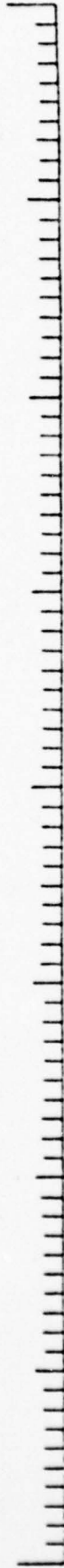
TOLERABLE CONTAMINANT LEVELS  
(mg/l)



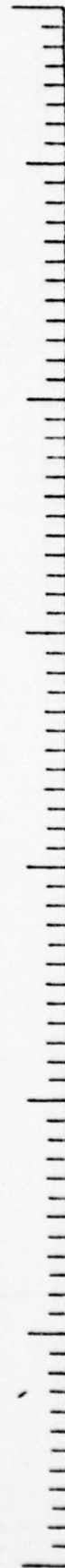
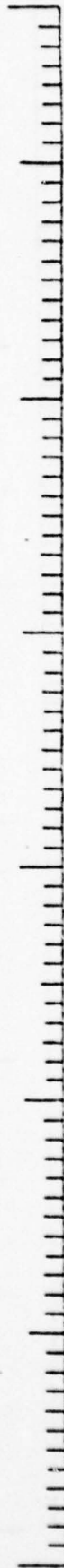
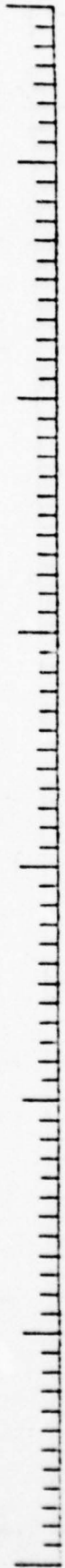
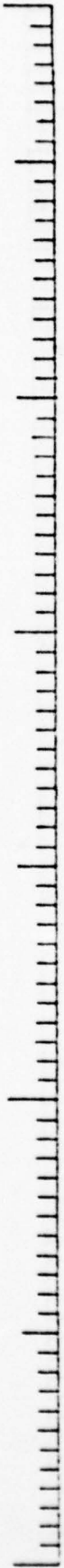
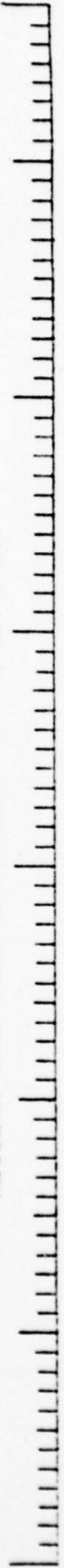
TREATMENT DATA  
NUMBER OF REGULAR TREATMENT CHAINS



NAMES OF REGULAR TREATMENT CHAINS



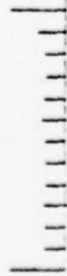
REGULAR TREATMENT CHAIN REMOVAL PERCENTAGES



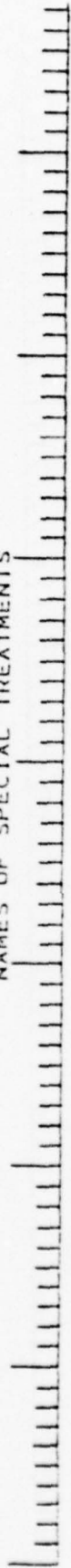
Handwritten musical notation consisting of 13 staves. Each staff contains a series of rhythmic markings, likely representing a specific musical exercise or piece. The markings are organized into groups of vertical stems with horizontal lines, suggesting a structured rhythmic pattern. The notation is consistent across all staves, indicating a single melodic or rhythmic line.

Handwritten musical notation consisting of 14 staves. Each staff contains a series of rhythmic markings, likely representing a specific musical exercise or piece. The notation is dense and repetitive, suggesting a focus on rhythm and pitch contour.

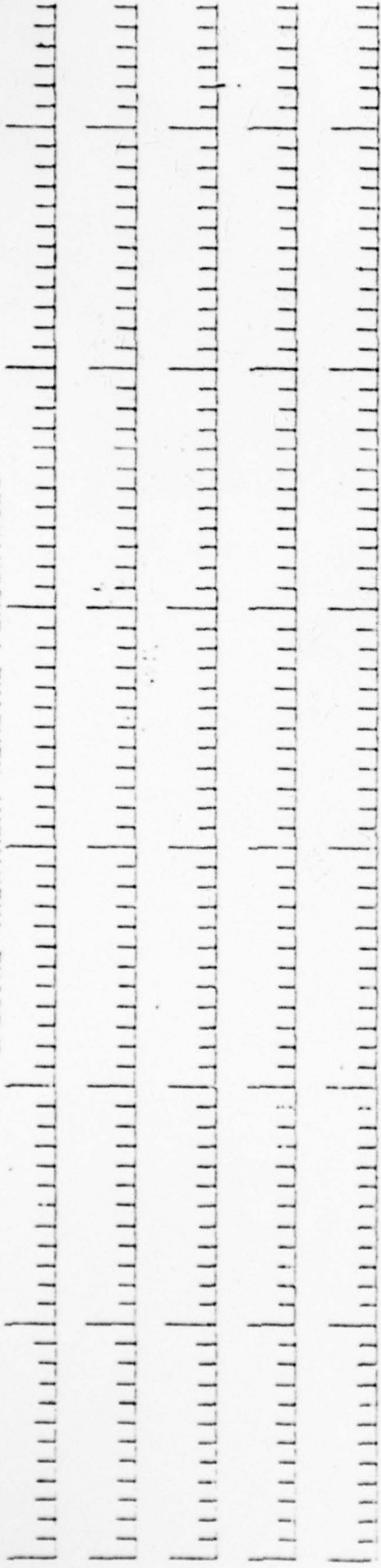
NUMBER OF SPECIAL TREATMENT



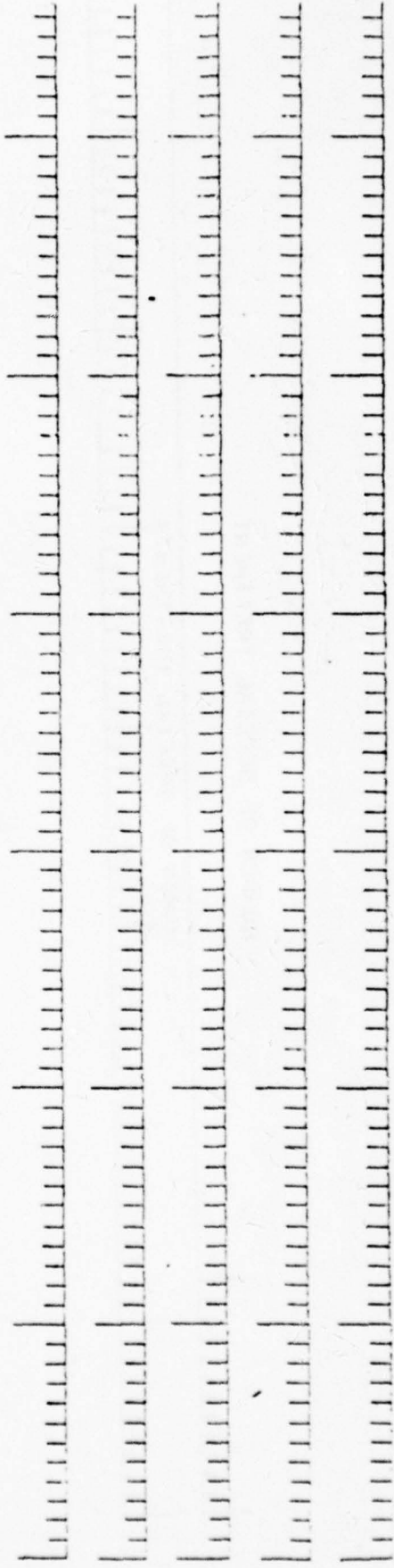
NAMES OF SPECIAL TREATMENTS



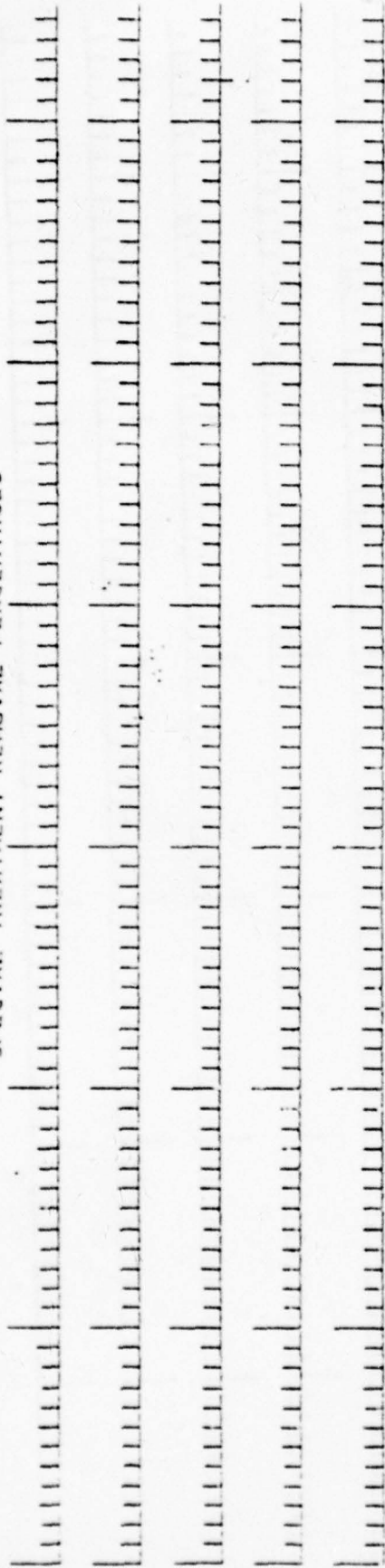
SPECIAL TREATMENT REMOVAL PERCENTAGES



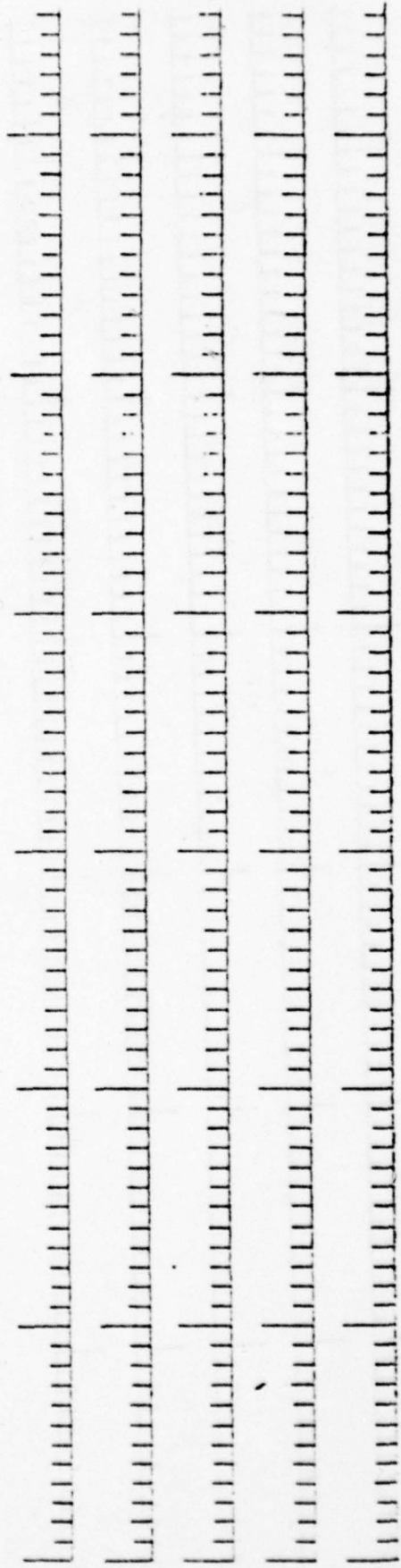
SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



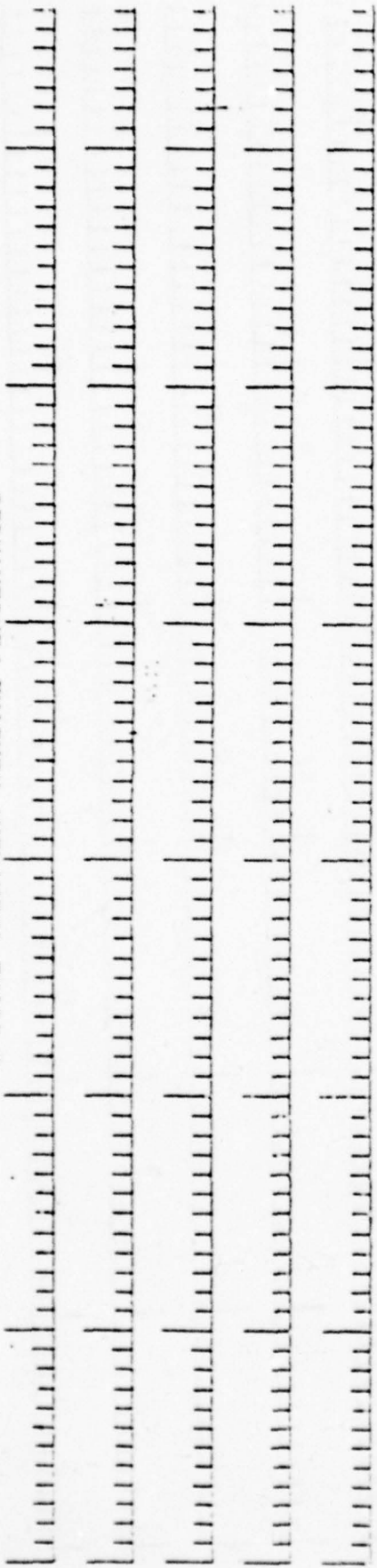
SPECIAL TREATMENT REMOVAL PERCENTAGES



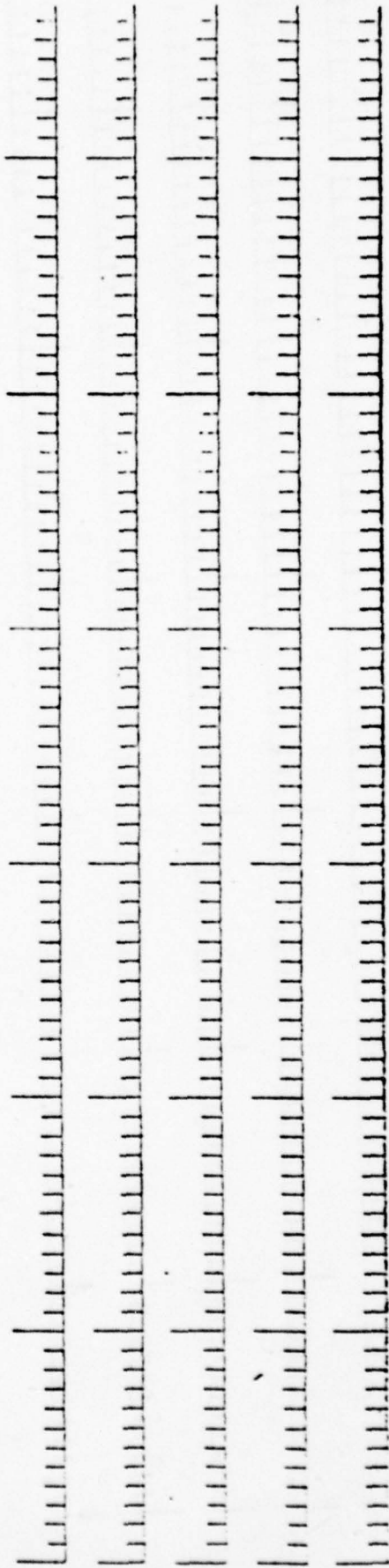
SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



SPECIAL TREATMENT REMOVAL PERCENTAGES



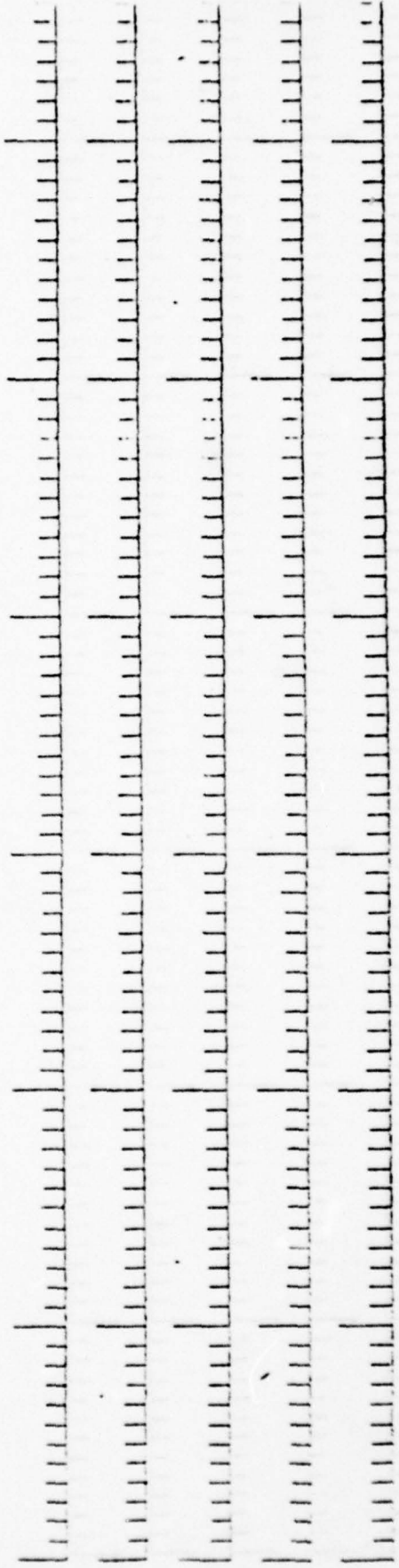
SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



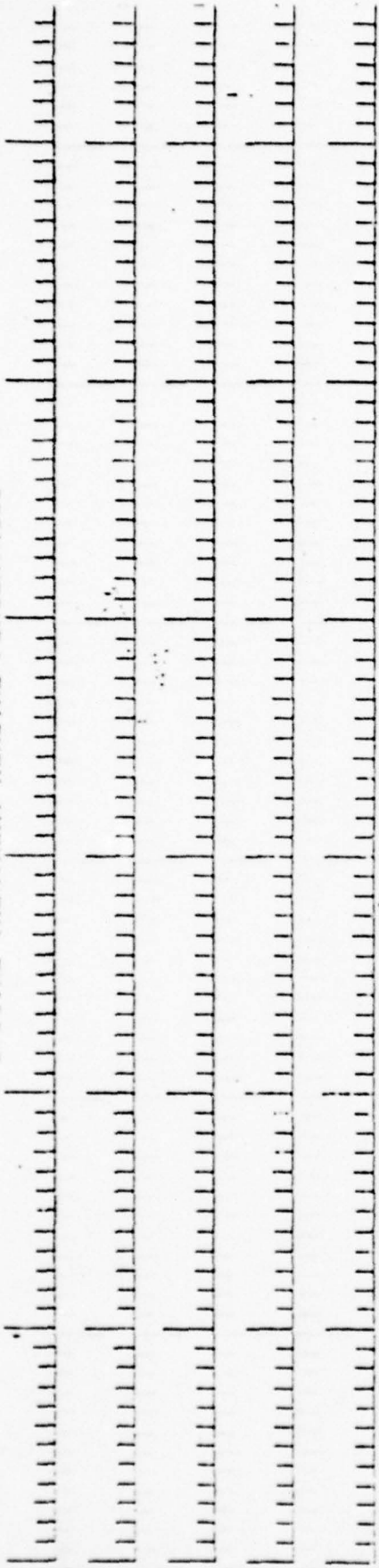
SPECIAL TREATMENT REMOVAL PERCENTAGES



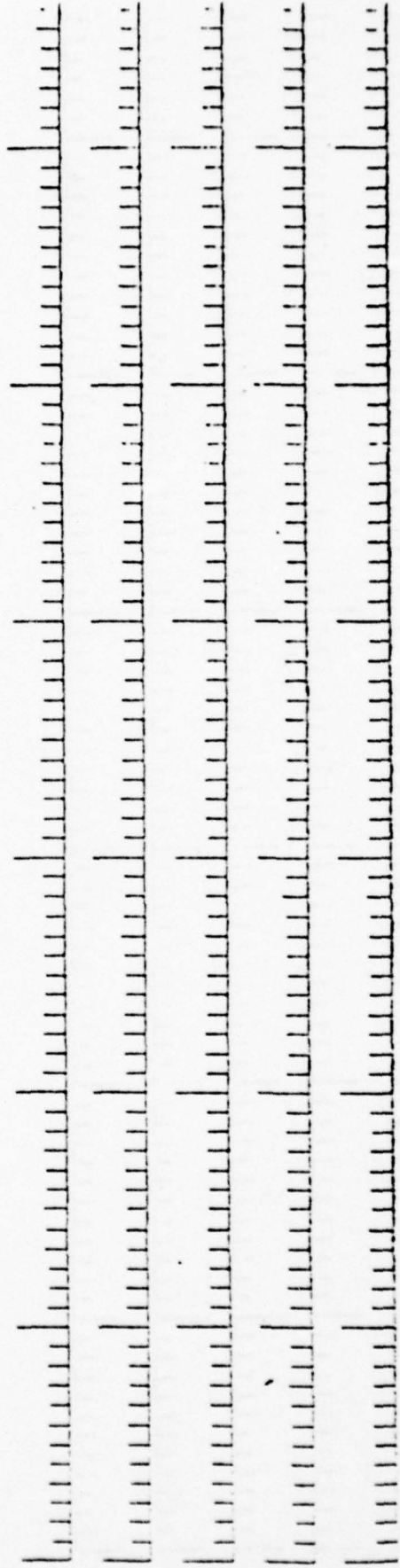
SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



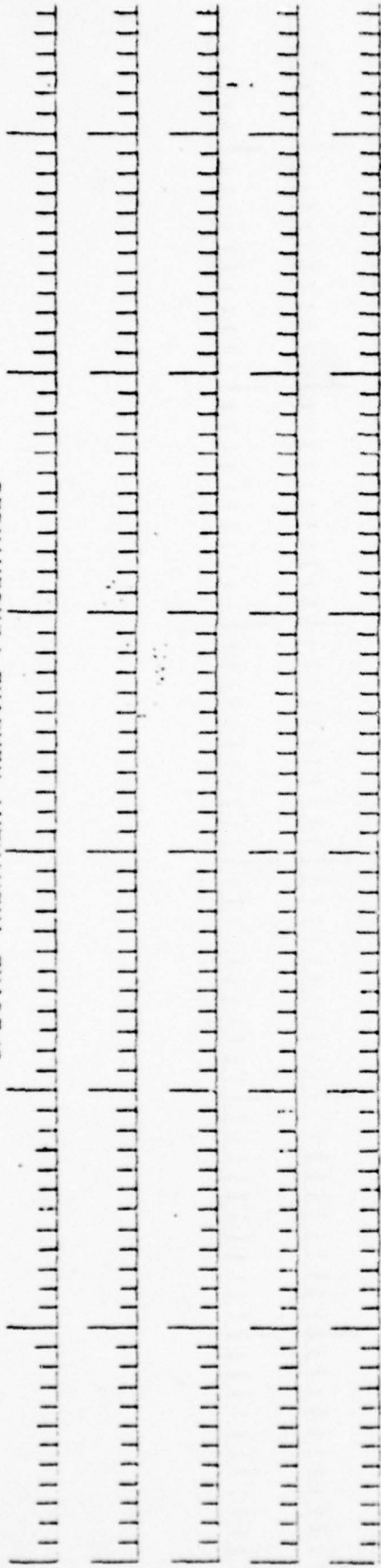
SPECIAL TREATMENT REMOVAL PERCENTAGES



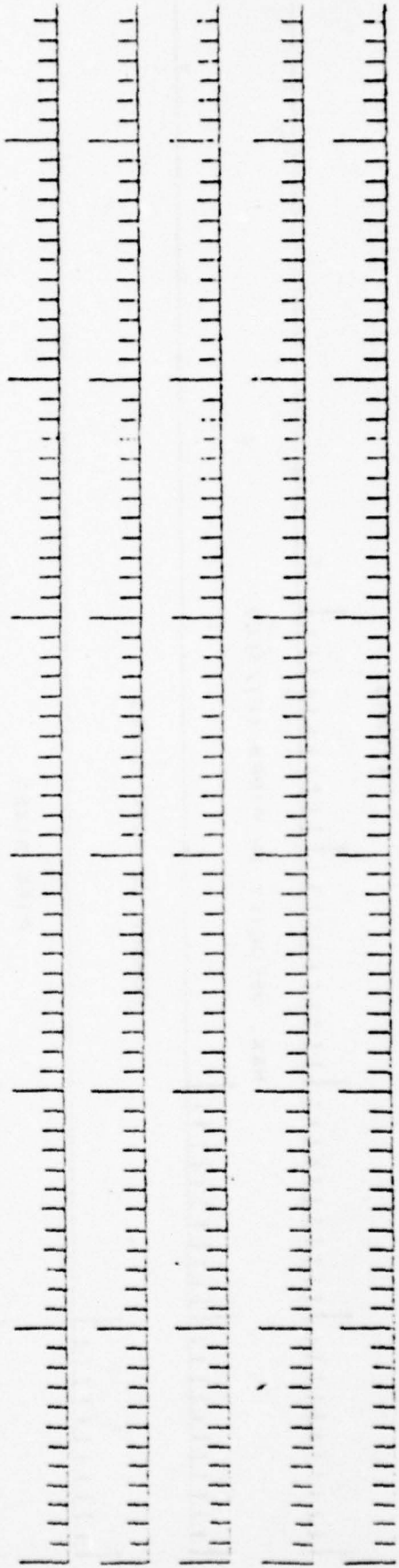
SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



SPECIAL TREATMENT REMOVAL PERCENTAGES



SPECIAL TREATMENT THRESHOLD CONCENTRATIONS



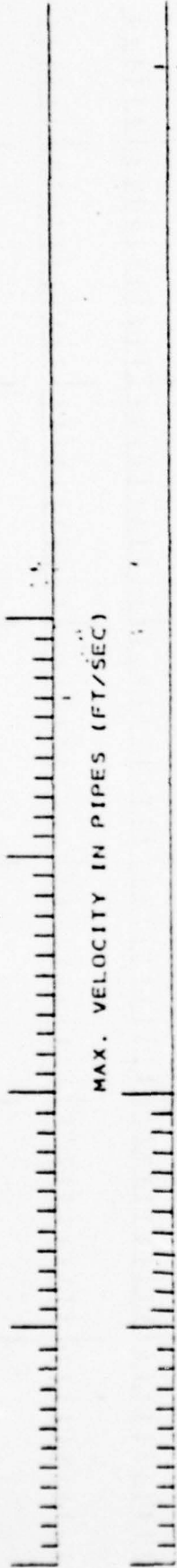
COST DATA

LIFE (YEARS)

LCI

CCI

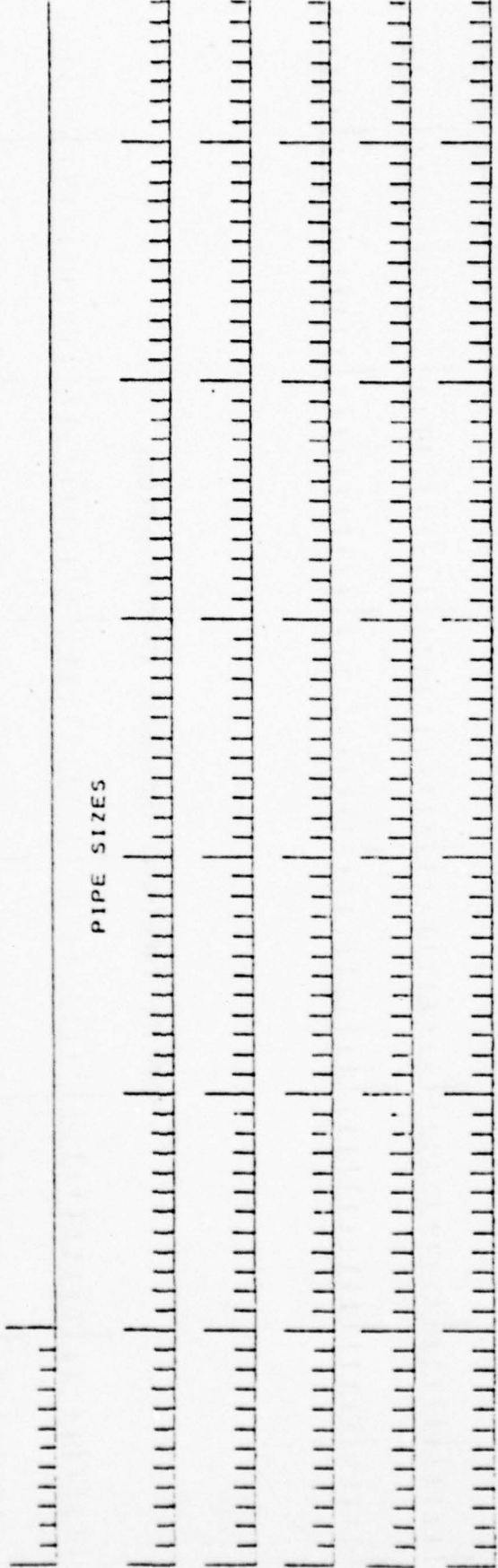
INTEREST



MAX. VELOCITY IN PIPES (FT/SEC)

NUMBER OF PIPE SIZES

PIPE SIZES





SPECIAL TREATMENT COSTS  
NUMBER OF TERMS.

COST COEFFICIENTS								
CAP. FIXED	CAP. UNIT	CAP. SCALE	CAP. FIXED	CAP. UNIT	CAP. SCALE	CAP. FIXED	CAP. UNIT	CAP. SCALE





SPECIAL TREATMENT COSTS  
NUMBER OF TERMS, 1944

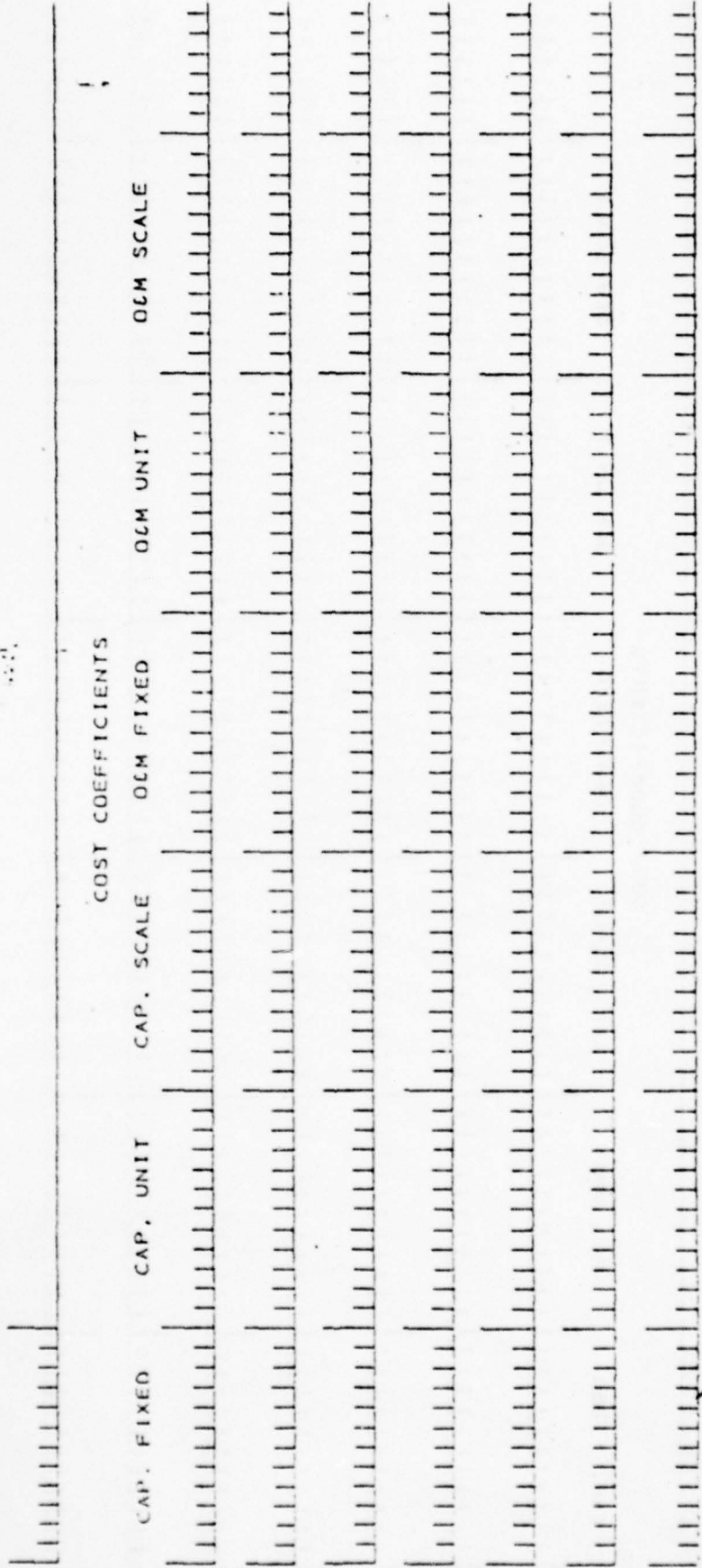
COST COEFFICIENTS					
CAP. FIXED	CAP. UNIT	CAP. SCALE	OCM FIXED	OCM UNIT	OCM SCALE

SPECIAL TREATMENT COSTS  
 NUMBER OF TERMS

COST COEFFICIENTS					
CAP. FIXED	CAP. UNIT	CAP. SCALE	CAP. FIXED	OGM UNIT	OGM SCALE



REGULAR TREATMENT COSTS  
 NUMBER OF TERMS.







REGULAR TREATMENT COSTS  
NUMBER OF TERMS.

COST COEFFICIENTS				
CAP. FIXED	CAP. UNIT	CAP. SCALE	CUM. UNIT	CUM. SCALE

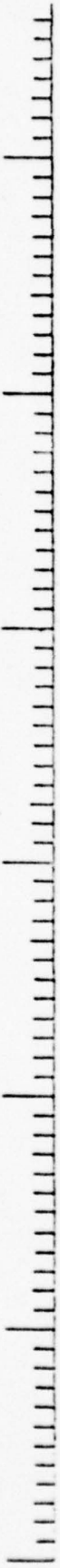
REGULAR TREATMENT COSTS  
NUMBER OF TERMS.

COST COEFFICIENTS					
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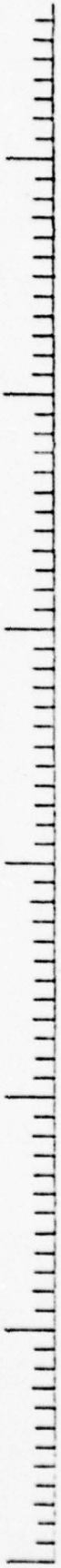




SOURCE WATER COST  
¢/1,000 GAL



COST OF FINAL DISCHARGE  
¢/1,000 GAL



NETWORK SUMMARY

NUMBER OF BTS'S

|||||

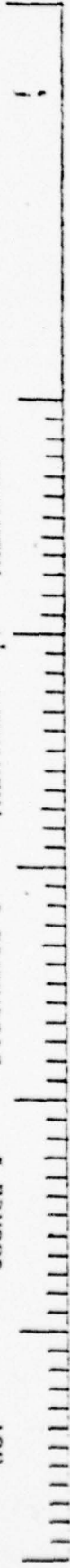
# ACTIVITIES  
OUT

SOURCE #

DISCHARGE #

REGULAR  
TREATMENT

MAKE-UP  
TREATMENT



ACT. OUT

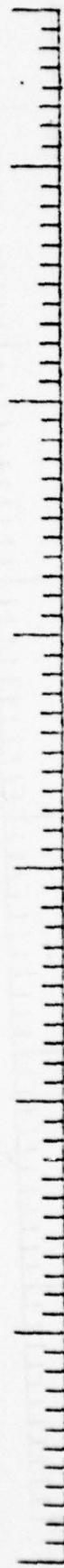
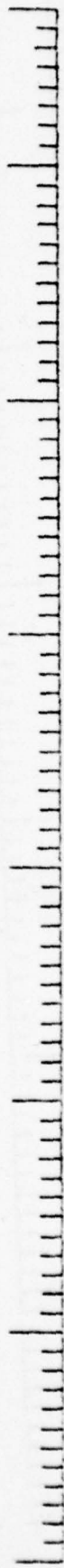
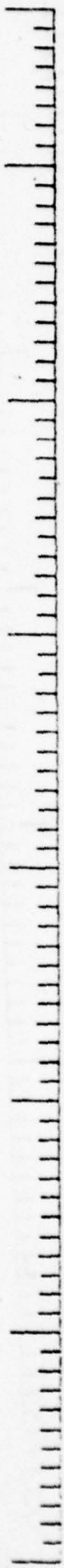
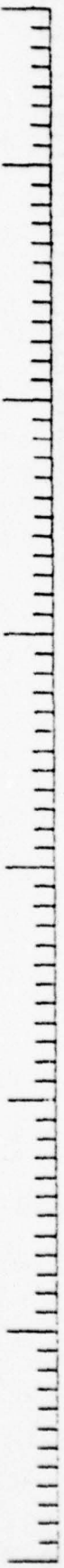
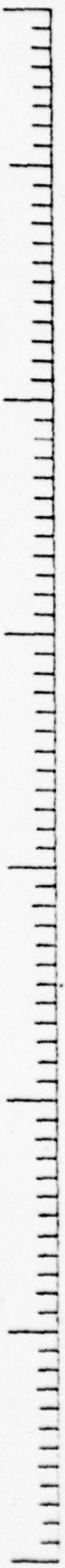
BTS OUT

ACT. OUT

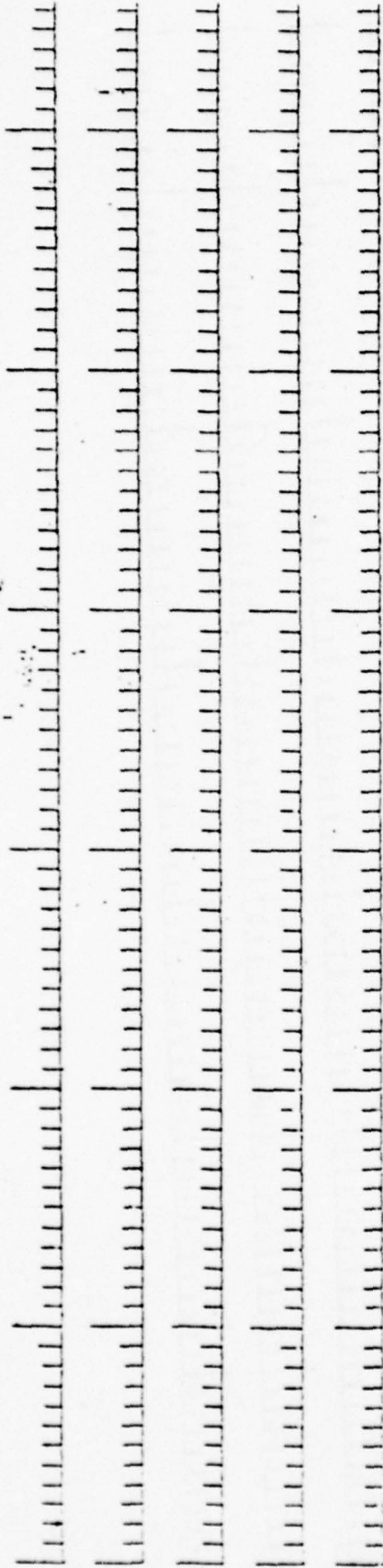
BTS OUT

ACT. OUT

BTS OUT



SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)



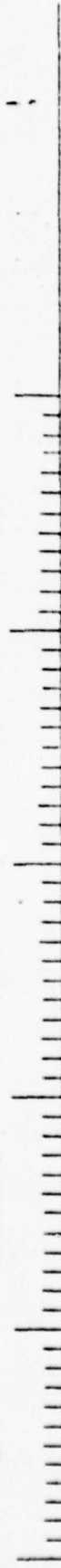
ACTIVITIES  
OUT

SOURCE

DISCHARGE

REGULAR  
TREATMENT

MAKE-UP  
TREATMENT



ACT. OUT

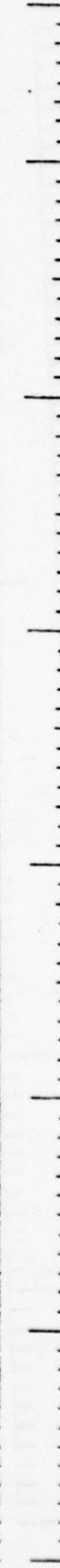
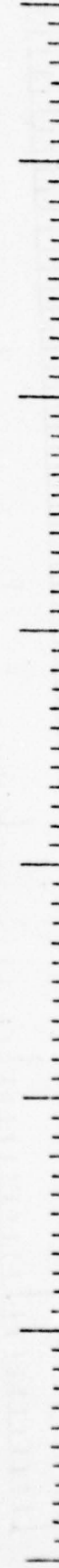
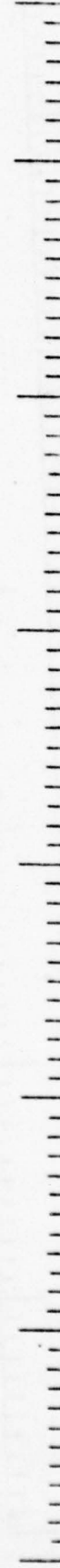
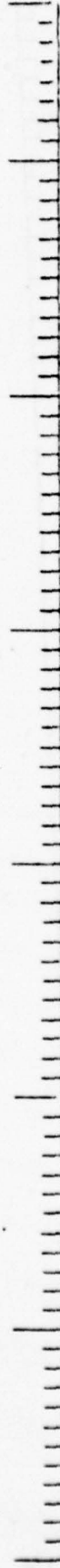
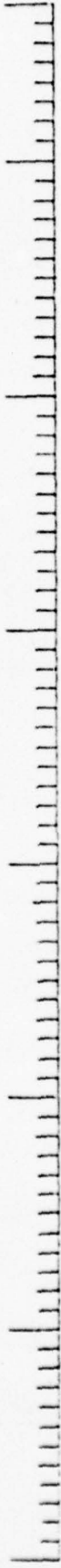
BTS OUT

ACT. OUT

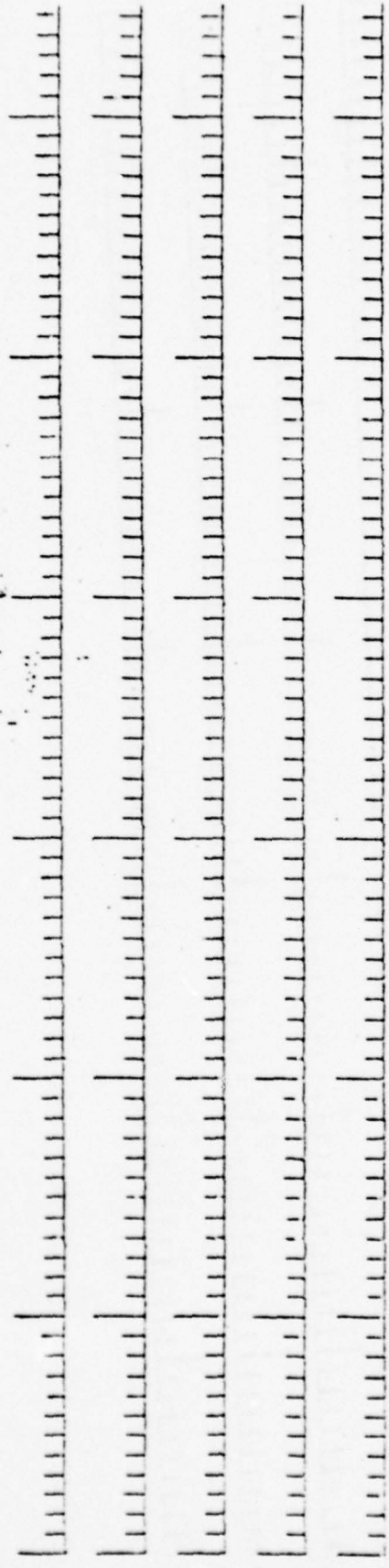
BTS OUT

ACT. OUT

BTS OUT



SPECIFIED B15 TREATMENT REMOVALS (OPTIONAL)



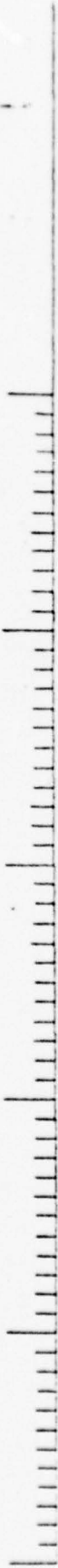
#ACTIVITIES  
OUT

SOURCE

DISCHARGE

REGULAR  
TREATMENT

MAKE-UP  
TREATMENT



ACT. OUT

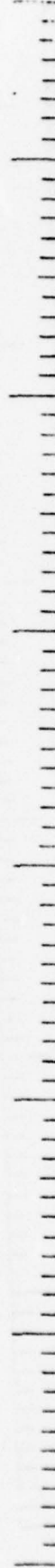
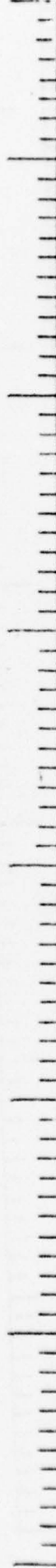
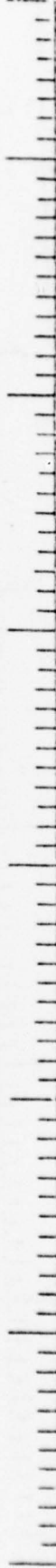
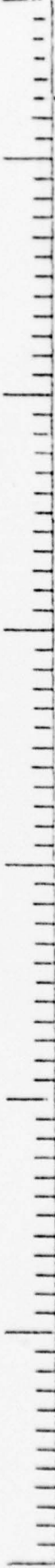
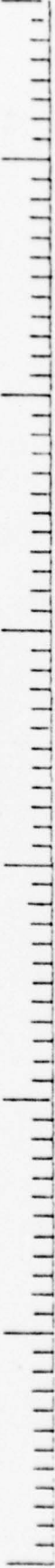
BTS OUT

ACT. OUT

BTS OUT

ACT. OUT

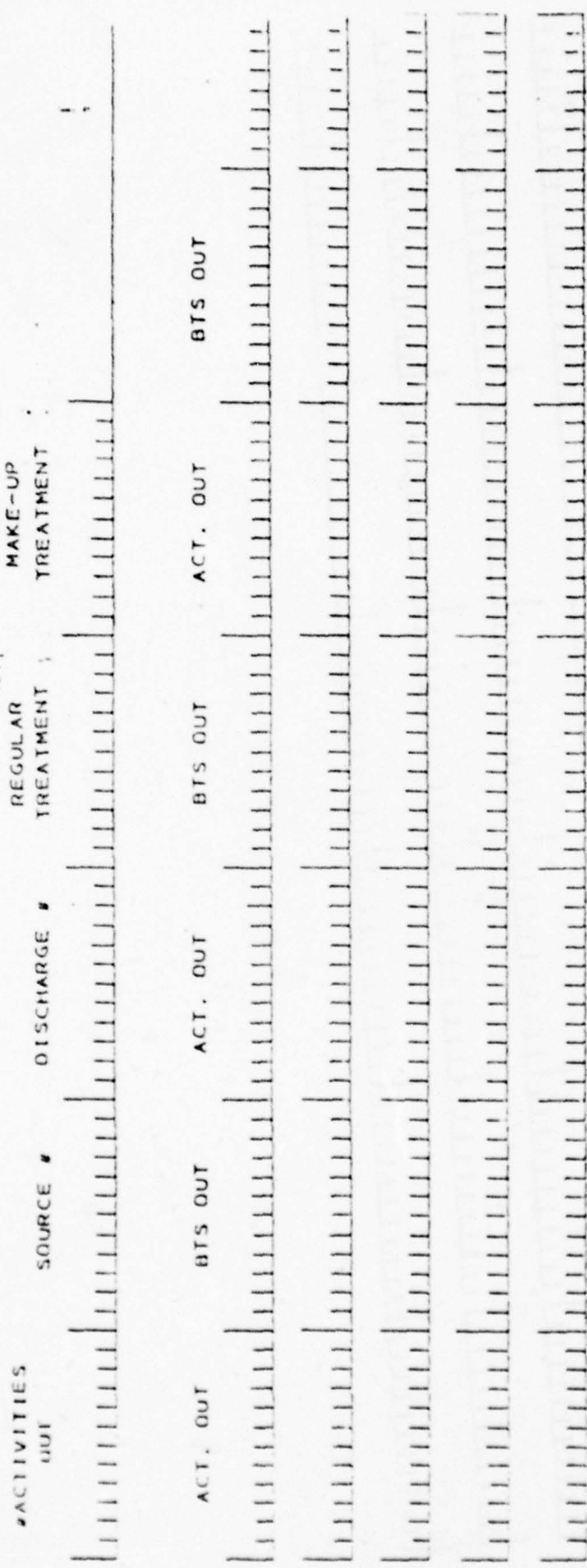
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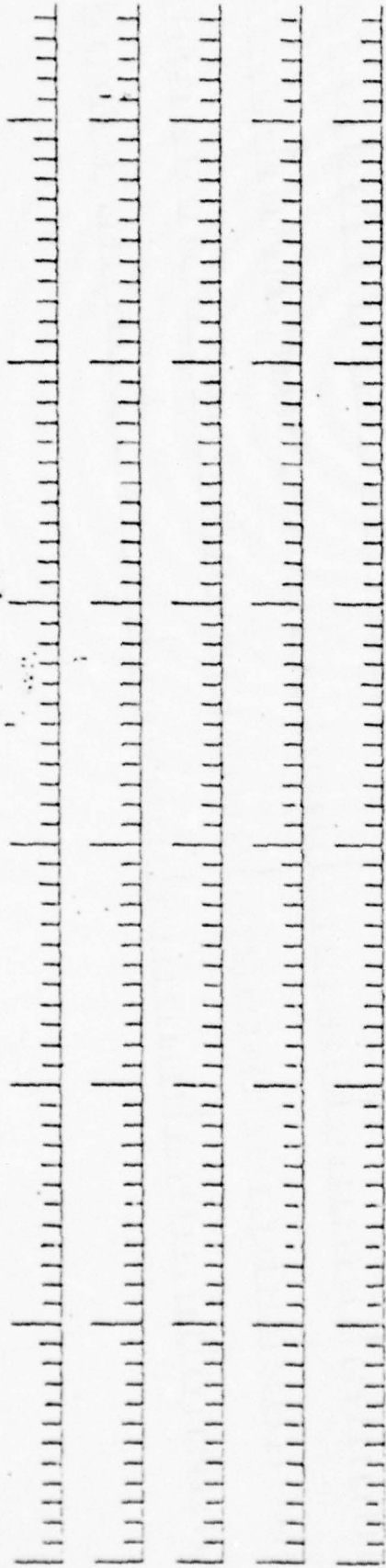
SPECIFIED DTS TREATMENT REMOVALS (OPTIONAL)



10-10-54



SPECIFIED BY TREATMENT REMOVALS (OPTIONAL)



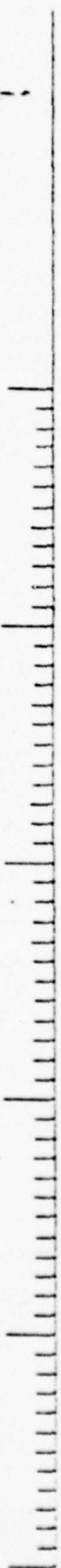
# ACTIVITIES  
OUT

SOURCE #

DISCHARGE #

REGULAR  
TREATMENT #

MAKE-UP  
TREATMENT #



ACT. OUT

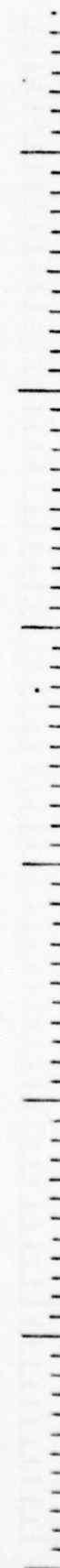
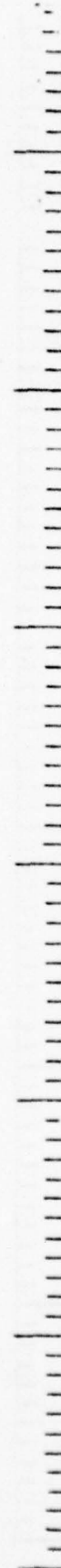
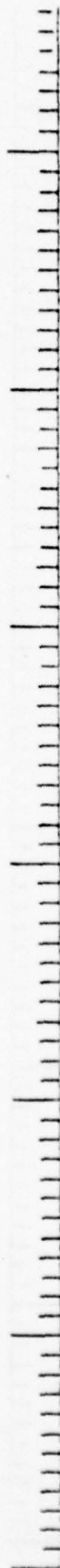
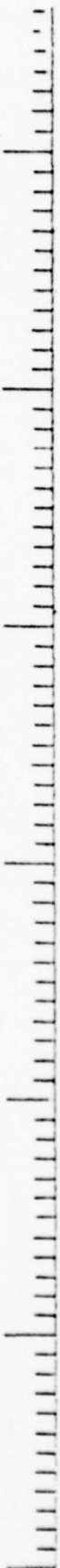
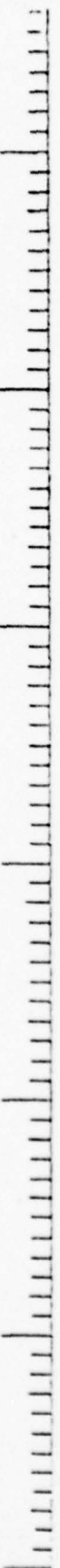
BTS OUT

ACT. OUT

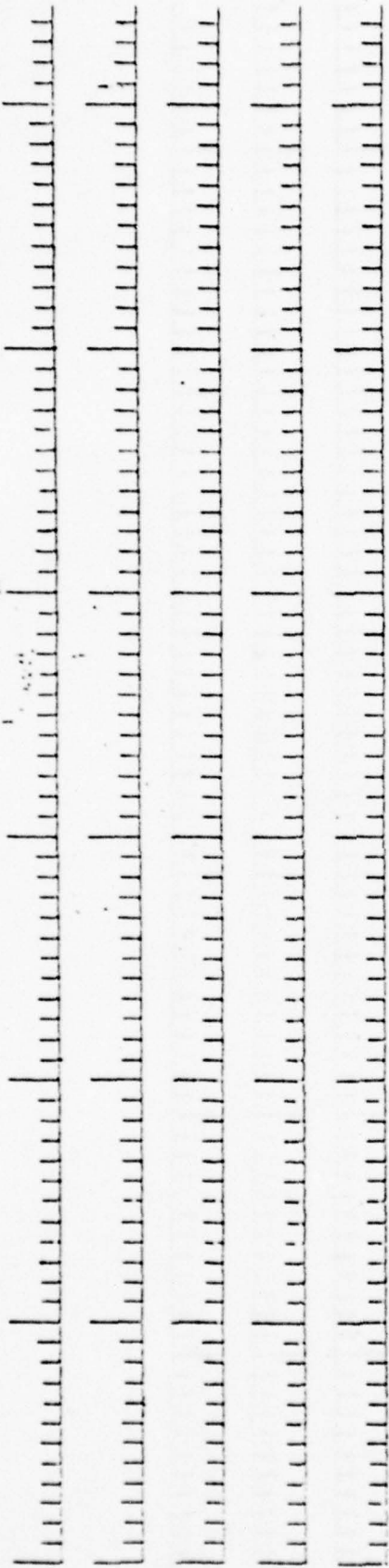
BTS OUT

ACT. OUT

BTS OUT



SPECIFIED QTS TREATMENT REMOVALS (OPTIONAL)



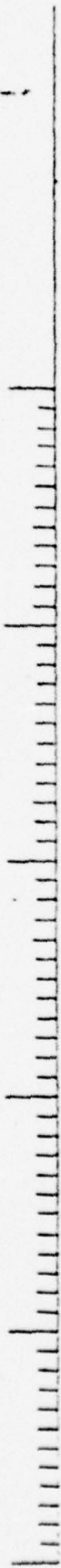
ACTIVITIES  
OUT

SOURCE

DISCHARGE

REGULAR  
TREATMENT

MAKE-UP  
TREATMENT



ACT. OUT

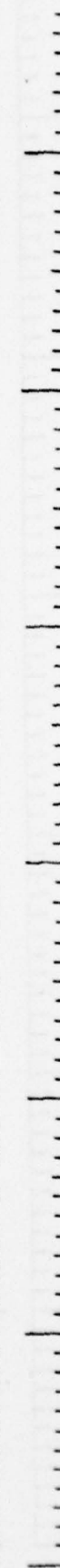
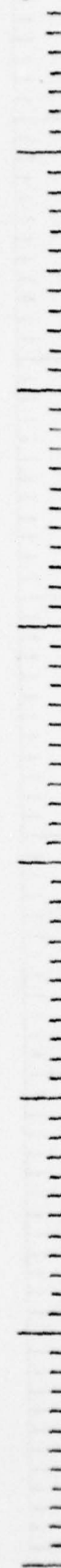
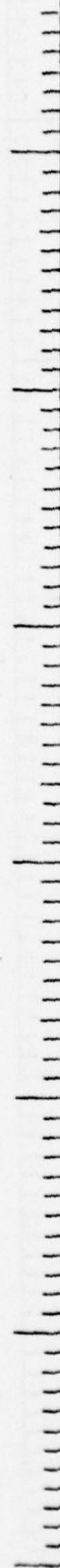
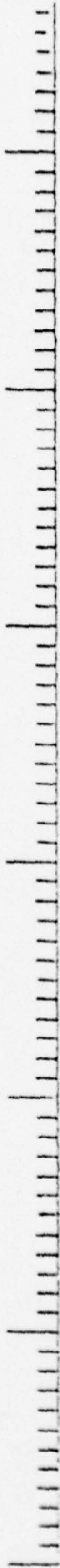
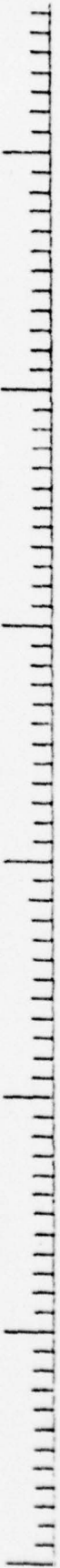
BTS OUT

ACT. OUT

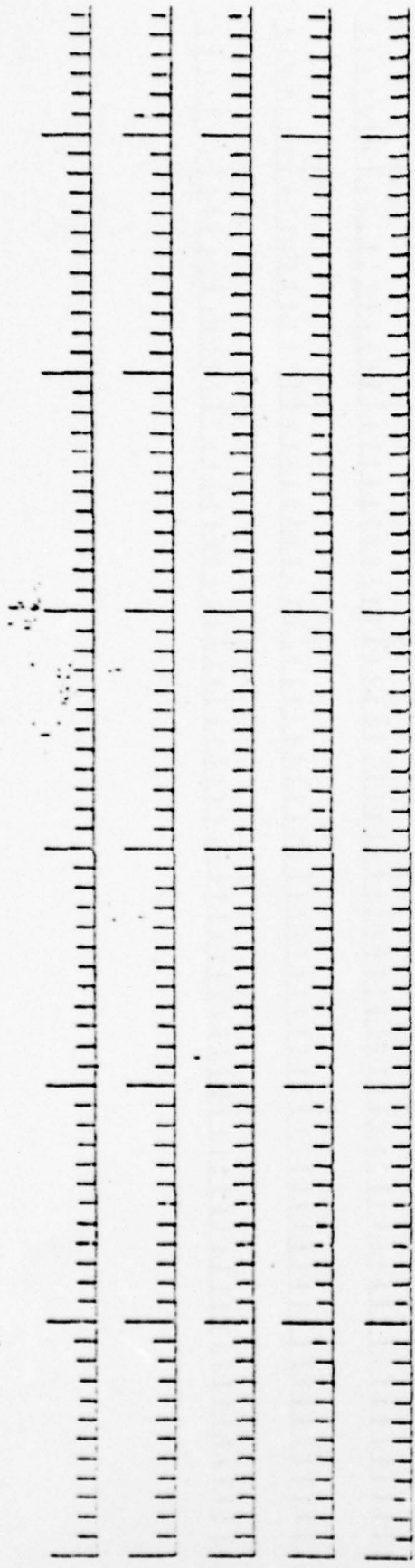
BTS OUT

ACT. OUT

BTS OUT



SPECIFIED BVS TREATMENT REMOVALS (OPTIONAL)



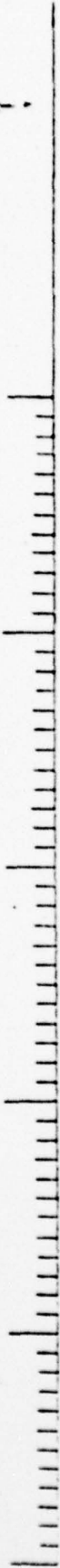
#ACTIVITIES  
OUT

SOURCE #

DISCHARGE #

REGULAR  
TREATMENT :

MAKE-UP  
TREATMENT :



ACT. OUT

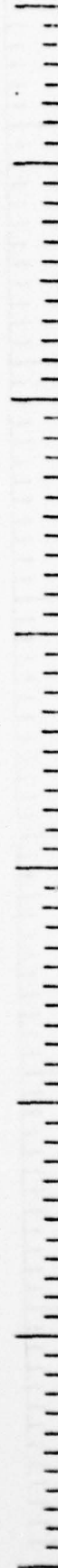
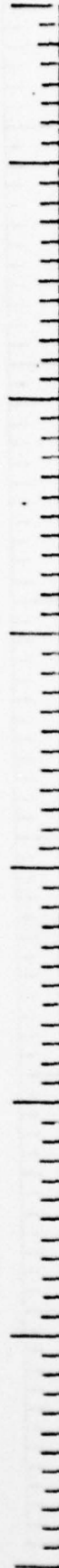
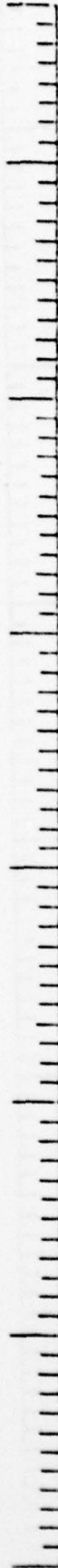
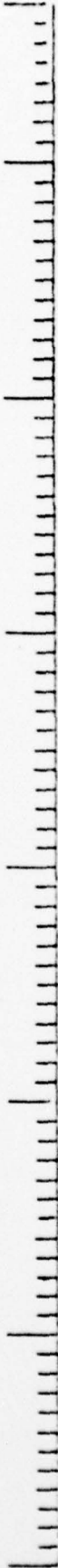
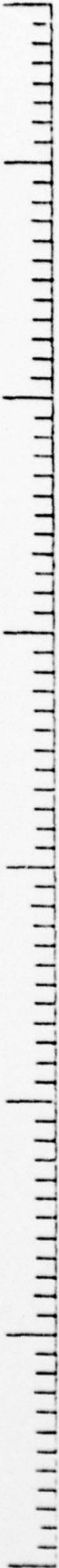
BTS OUT

ACT. OUT

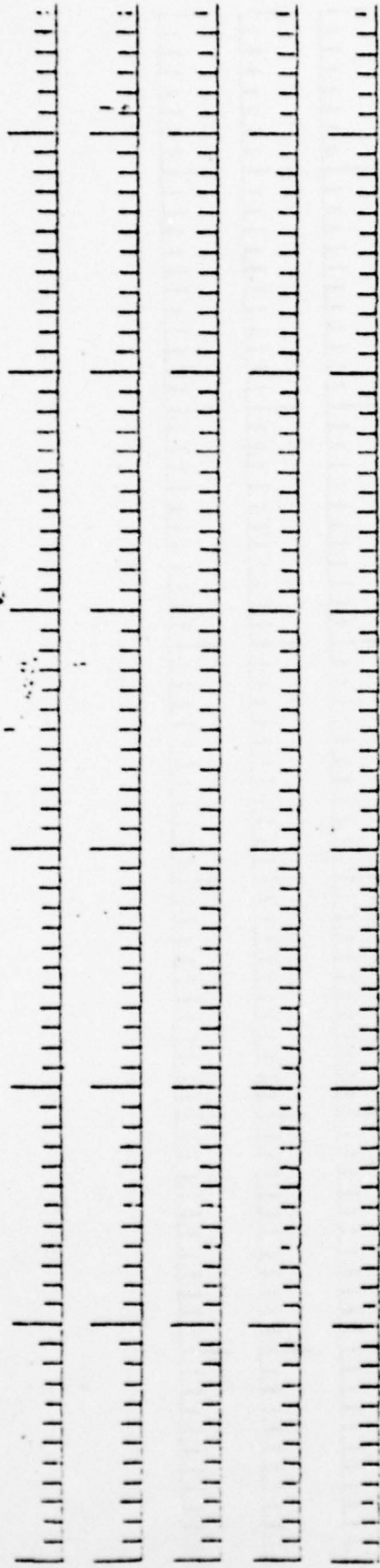
BTS OUT

ACT. OUT

BTS OUT



SPECIFIED BVS TREATMENT REMOVALS (OPTIONAL)



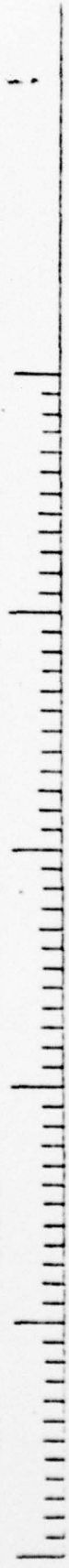
ACTIVITIES  
OUT

SOURCE #

DISCHARGE #

REGULAR  
TREATMENT

MAKE-UP  
TREATMENT



ACT. OUT

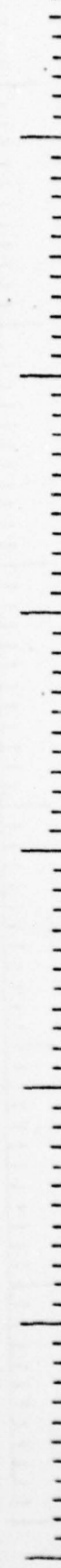
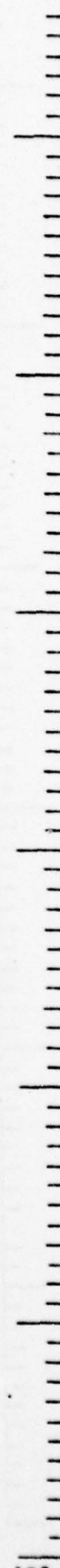
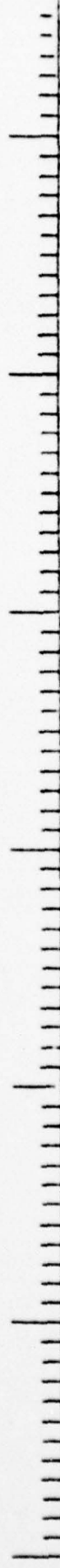
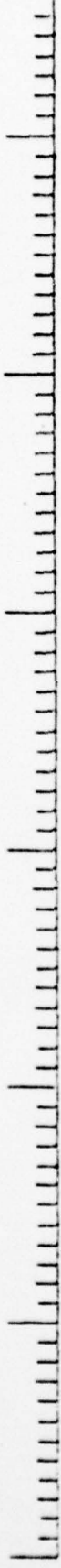
BTS OUT

ACT. OUT

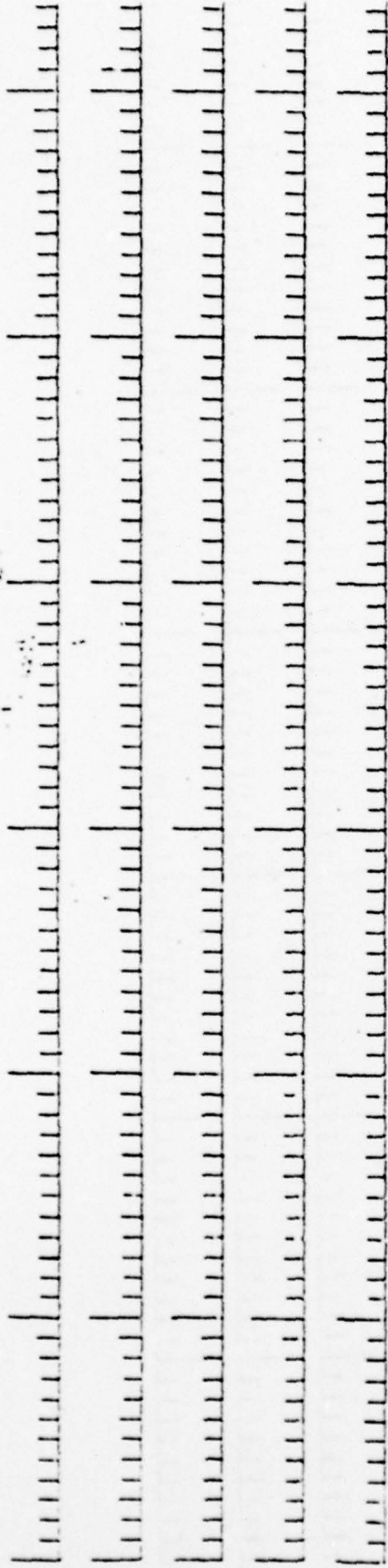
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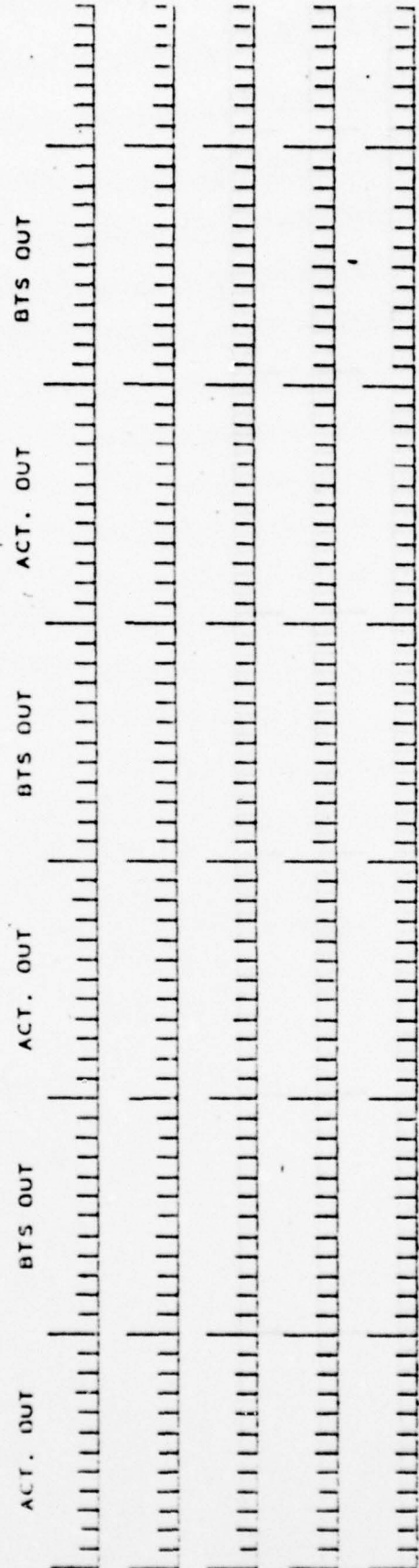
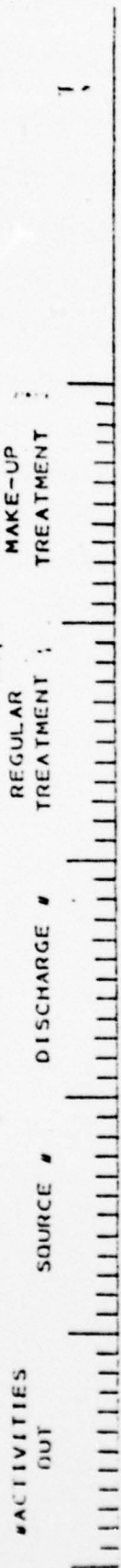
ACT. OUT

BTS OUT

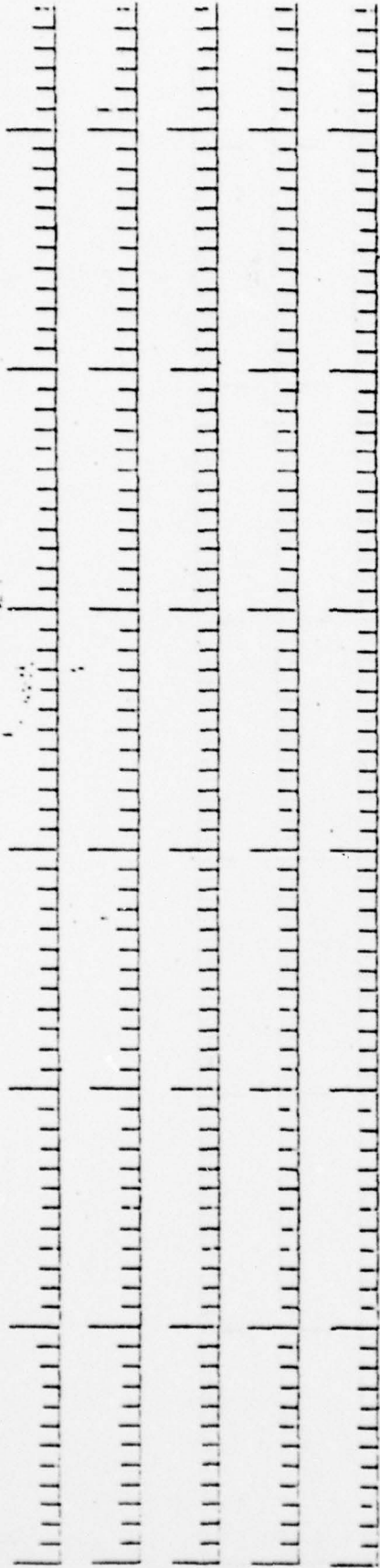


SPECIFIED BIS TREATMENT REMOVALS (OPTIONAL)





SPECIFIED BTS TREATMENT REMOVALS (OPTIONAL)



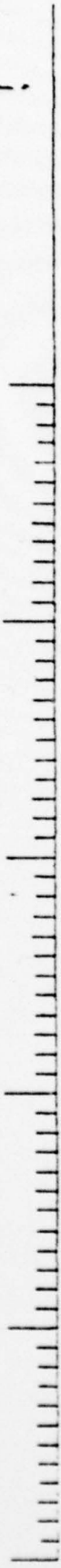
ACTIVITIES  
OUT

SOURCE

DISCHARGE

REGULAR  
TREATMENT

MAKE-UP  
TREATMENT



ACT. OUT

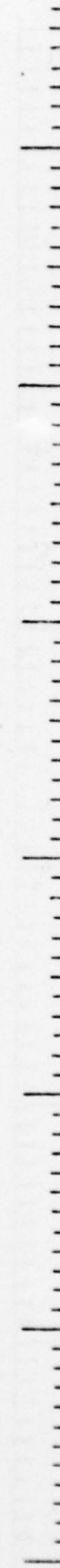
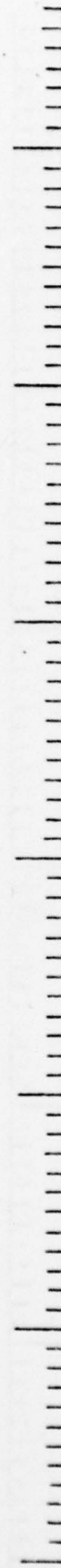
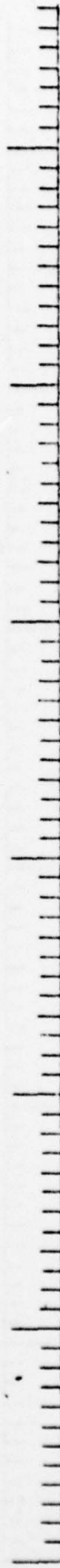
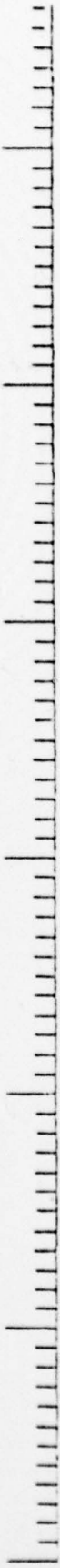
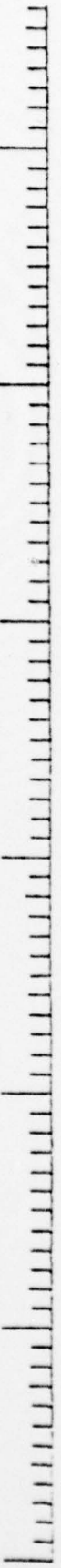
BTS OUT

ACT. OUT

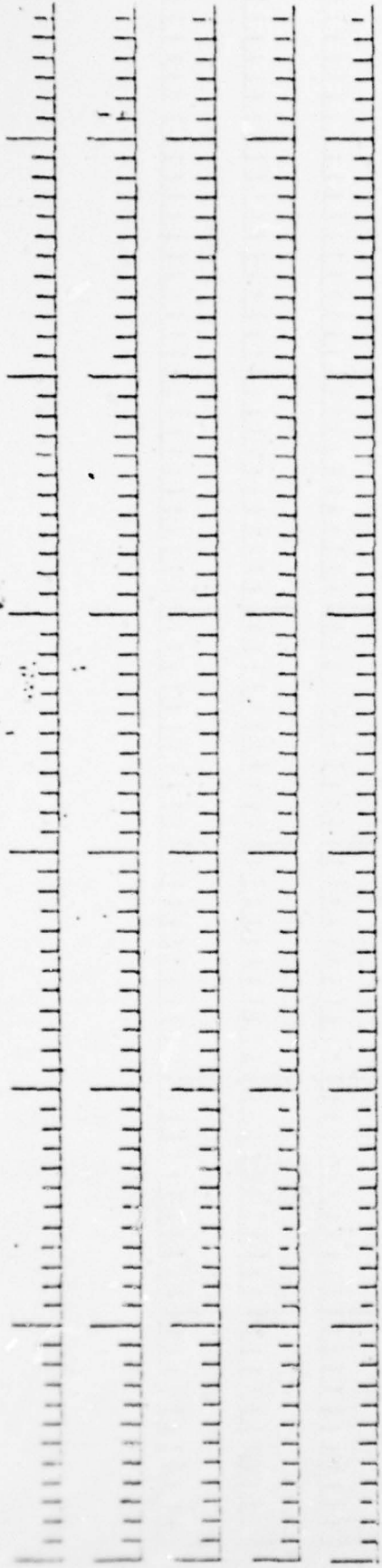
BTS OUT

ACT. OUT

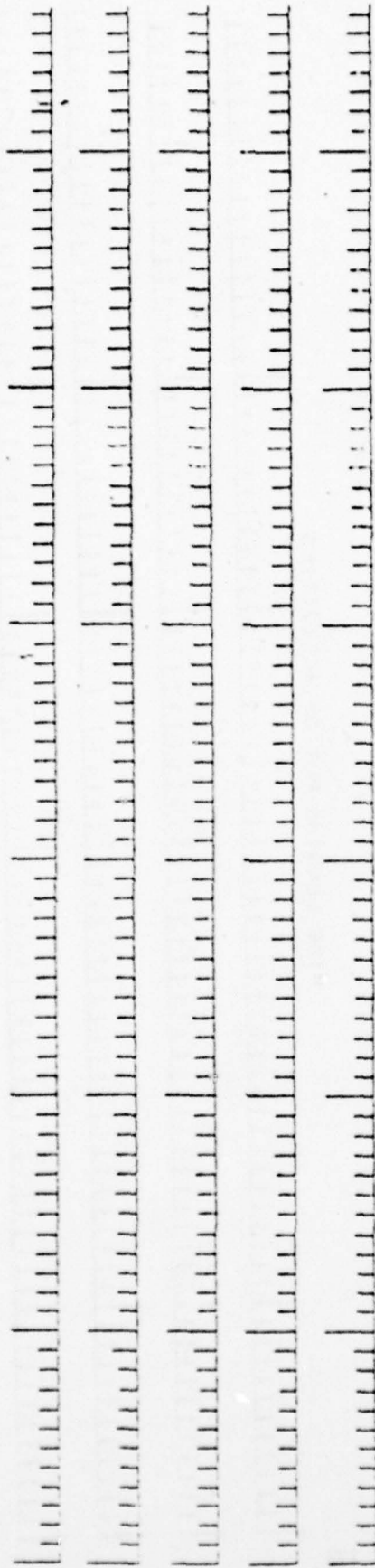
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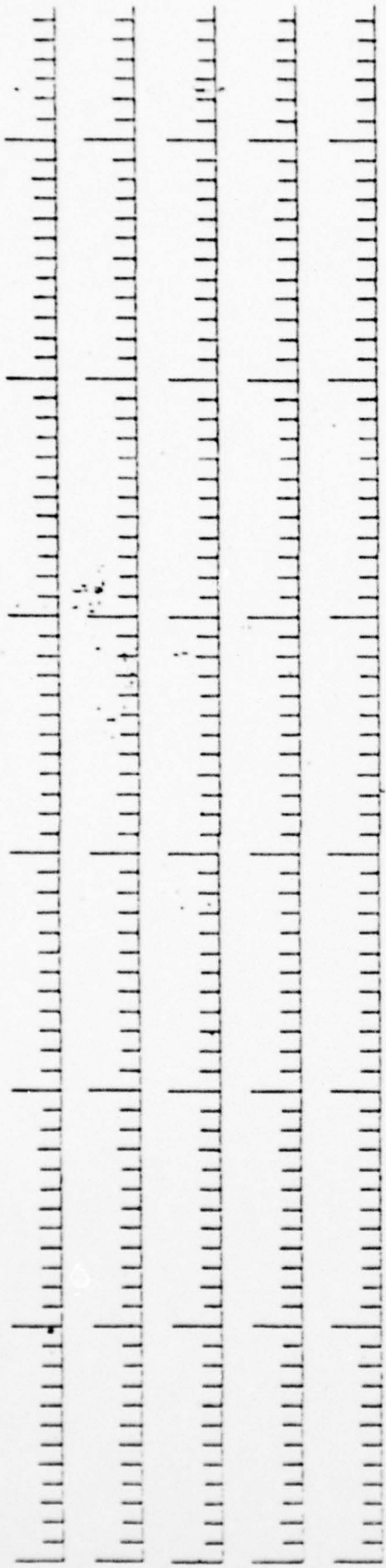
SPECIFIED BVS TREATMENT REMOVALS (OPTIONAL)



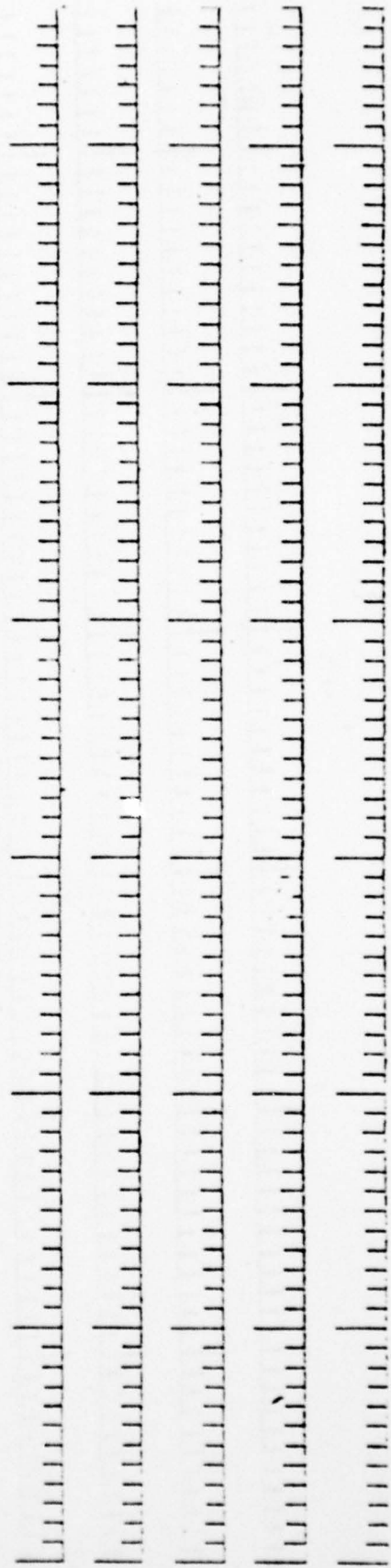
PRE-TREATMENT AT ACTIVITIES



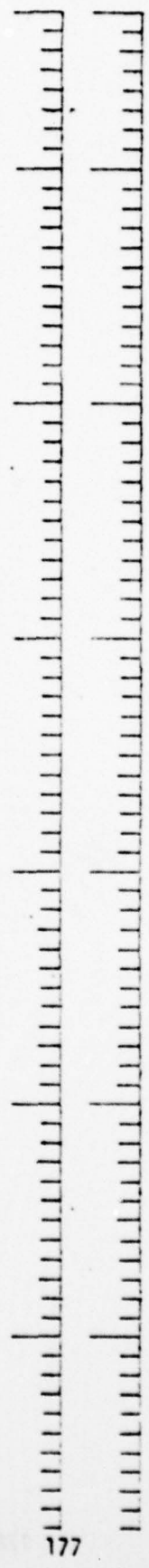
PIPE LENGTHS INTO ACTIVITIES



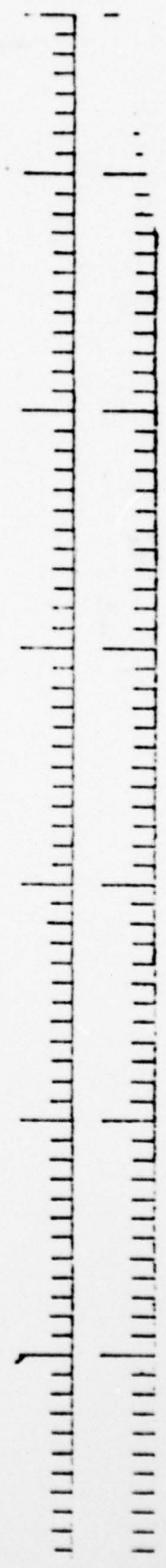
PIPE LENGTHS OUT OF ACTIVITIES

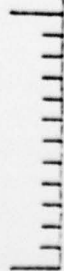


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LENGTH OF PIPE FOR OVERFLOW FROM BTS'S





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