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Soft-Op User Manual for Microcomputer Aided Process Control of the Oxidation Ditch Facility

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SOFT-OP

User Manual

FOR

Microcomputer aided Process Control of the Oxidation Ditch Facility

BY

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SOFT-OP

USER MANUAL

This manual is intended to be used in conjunction with the program SOFT-OP. SOFT-OP was developed at the Division of Environmental Engineering, Utah State University, Logan, Utah. Funding for program development was supplied by Tremonton City Corporation, Tremonton, Utah.

FOREWORD

SOFT-OP has been developed for use by operators of oxidation ditch wastewater treatment plants (extended aeration activated sludge). The program serves as a useful tool in daily plant operation by assisting the operator in various tasks related to process control. These tasks are grouped within the following three classifications:

1. Implementation of control parameters
2. Analysis of process characteristics
3. Data management

The program is designed to run on a Radio Shack Model III microcomputer with two disk drives. Previous computer experience is not a prerequisite since the program is user-friendly and should not intimidate those operators using a computer for the first time.

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INTRODUCTION

One of the primary applications of computers in process control today is that of data management. Operators must be able to collect, evaluate, and classify numerous types of data. SOFT-OP performs extensive data calculations, thus serving as an invaluable aid to the operator. Many of the calculations required for process evaluation and control are performed within the program. Subsequently, the operator is spared the time-consuming and complex task of performing mathematical calculations himself.

Another significant function of the program is education. Operators perform many tasks at wastewater treatment facilities. Typically, in smaller plants, the operator performs many maintenance and upkeep duties, in addition to controlling the process. Since their responsibilities are so diverse, it is quite common to find operators who have had little opportunity to learn the basic fundamentals of process control. SOFT-OP has been designed to address precisely this problem. Throughout the course of the program, operators are educated in the proper characterization and control of the oxidation ditch system.

Since SOFT-OP has been designed to link data management capabilities with fundamental process control techniques, use of the program will not only help train the operator but it should also reduce time required for consistent and thorough process control.

RECOMMENDED REFERENCE MANUALS

It is recommended that two reference manuals be used in conjunction with SOFT-OP. Both manuals are referred to periodically within the text of this user's manual. The first book is titled "Standard Methods for the Examination of Water and Wastewater." This book describes the method of analysis for several commonly required process control tests. If you do not have a copy of "Standard Methods," one can be purchased through a local chapter of the Water Pollution Control Federation. The book can also be ordered from the following office:

Publication Office:
American Public Health Association
1015 Eighteenth Street NW
Washington, DC 20036

The second recommended reference book is a process control manual for aerobic biological wastewater treatment facilities. This manual discusses troubleshooting procedures, treatment fundamentals, and laboratory control practices, in addition to process control techniques. The title of this book is "Process Control Manual for Aerobic Biological Wastewater Treatment Facilities." It is published by the U.S. Environmental Protection Agency. Copies can be obtained from the following address:

General Services Administration (8BRC)
Centralized Mailing Lists Services
Building 41, Denver Federal Center
Denver, Colorado 80225

PROGRAM STRUCTURE

The complete schematic of SOFT-OP is illustrated in Figure 1. The program consists of nine individual modules. These nine modules form what is called the master menu which is the starting point of the SOFT-OP program. To begin the program, select the menu number which corresponds to the desired module.

The PROCESS CONTROL category is divided into two sections. These sections occupy the middle and lower branch of the flow chart. Except for the HELP menu, each menu is related to a specific process control function. The middle branch of the flow chart lists Clarification, Hydraulic and Organic Loading, Solids Inventory, and Dissolved Oxygen as the four process control functions available for access. The final branch of the flow chart is accessed within the Solids Inventory category. Each of the three menus: Sludge Wasting Rate, Mean Cell Residence Time, and Sludge Production, perform separate and distinct functions.

Use SOFT-OP's schematic to identify the paths necessary to perform particular functions within the program. You have the option to return to the master menu at any point within the program. In some sections, you can return directly to the master menu, while in others, it might be necessary to first pass through an intermediate location. It is important to study Figure 1 and become familiar with the overall structure of the SOFT-OP program. Since there are many pathways within the SOFT-OP, a thorough knowledge of the program structure will be very beneficial to you.

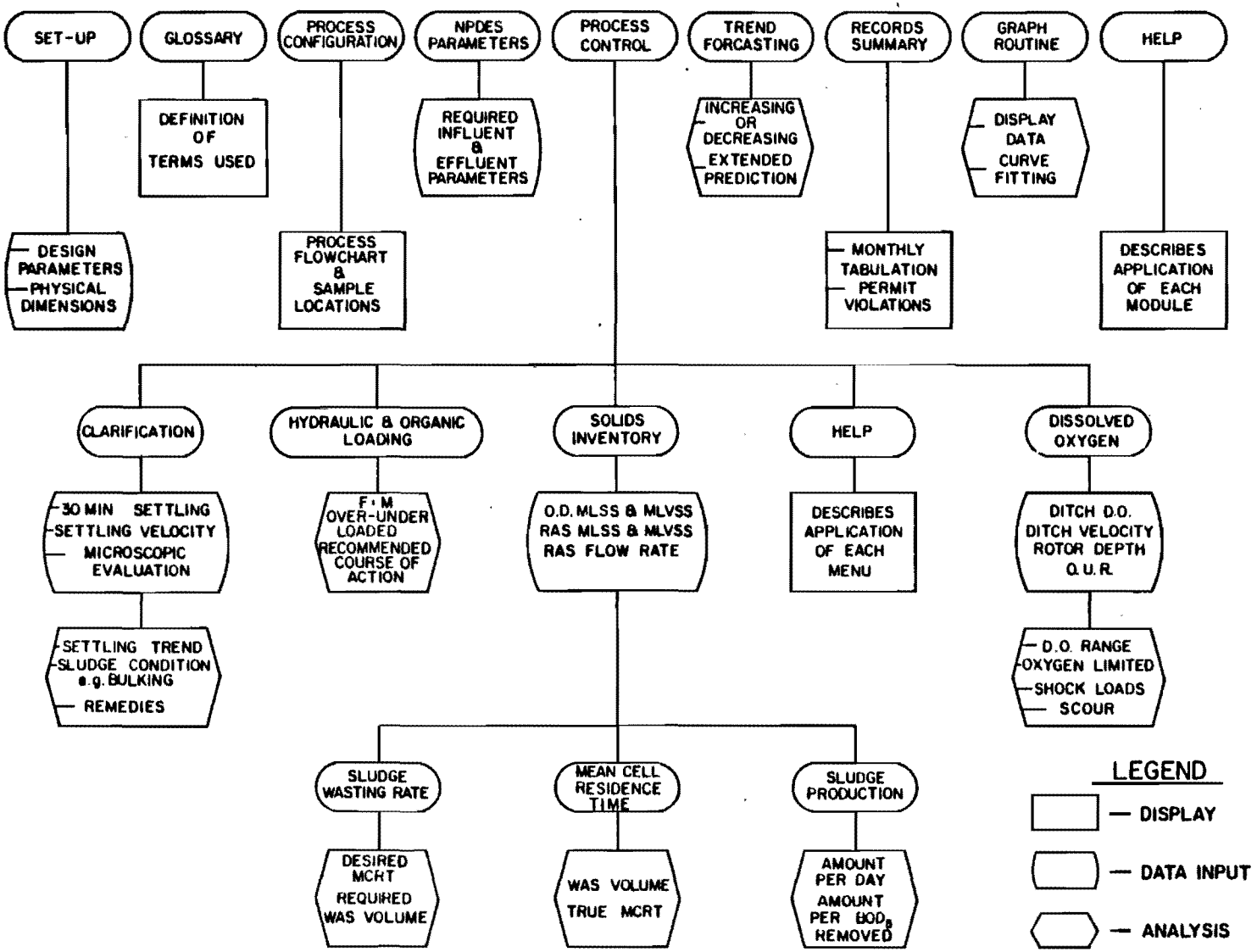

Figure 1. Schematic of program structure.

PROGRAM INPUT REQUIREMENTS

A significant amount of data is required as input by SOFT-OP. Before proceeding with program description and methods of operation, it is advantageous to ensure that all information required by the program is available, understood, and ready for use.

The first group of required data consists of process design parameters. The necessary design parameters are listed in Table 1. Remember that these parameter values are not those which you observe, but rather the design values recommended by the engineering firm that designed the facility.

Table 1: Plant design parameter limits utilized in program.

PARAMETER	UNITS
Average Hydraulic Flow Rate	mgd
Influent and Effluent Biochemical Oxygen Demand	mg/l
Influent and Effluent Total Suspended Solids	mg/l
Minimum and Maximum Oxidation Ditch MLSS	mg/l
Minimum and Maximum Oxidation Ditch F:M	1/day

The facility's National Pollutant Discharge Elimination System (NPDES) permit effluent limitations are also required as input. The specific permit parameters are tabulated in Table 2.

Table 2: Parameters regulated under plant's NPDES permit and required as program input.

PARAMETER	UNITS
Maximum Effluent Biochemical Oxygen Demand	mg/l
Average Effluent Biochemical Oxygen Demand	mg/l
Maximum Effluent Total Suspended Solids	mg/l
Average Effluent Total Suspended Solids	mg/l
Maximum Effluent pH	
Minimum Effluent pH	
Minimum BOD and TSS Treatment Efficiency	%

The physical dimensions and volumes of the unit processes within the system are also needed. The volume of the oxidation ditch as well as the diameter and depth of the secondary clarifier must be entered in the program.

So far, only data with constant values have been discussed. These values need only be entered once, unless the process is upgraded and/or a new NPDES permit is issued, thus resulting in parameter value changes. The final two groups of required input data are comprised of operating parameters. Table 3 lists those operating parameters required under the NPDES permit which are used within SOFT-OP.

Table 3: Parameters required in NPDES permit and used for process control.

PARAMETER	UNITS	LOCATION INFLUENT	LOCATION EFFLUENT
Hydraulic Flow Rate	mgd		X
Biochemical Oxygen Demand	mg/l	X	X
Total Suspended Solids	mg/l	X	X
Temperature	°C		X
pH			X

Additional parameters required for the control and evaluation of the oxidation ditch process are summarized in Table 4.

Table 4: Process control and evaluation parameters required as program input.

PARAMETER	UNITS	LOCATION OXIDATION DITCH	LOCATION CLARIFIER UNDERFLOW
MLSS Concentration	mg/l	X	X
Percent Volatile MLSS	%	X	X
Dissolved Oxygen	mg/l	X	
Fluid Velocity	ft/s	X	
Rotor Immersion Depth	in	X	
Return Activated Sludge Flow	gpd		X
Waste Activated Sludge Quantity	gal		X
Oxygen Uptake Rate	mg O_2/l/hr	X	
30 Minute Settled Sludge Volume	mg/l	X	
Sludge Settling Velocity	ft/hr	X	

Make sure that you understand and can obtain all the preceding data to ensure optimum use of SOFT-OP. You should be familiar with most of the required parameters listed in Tables 1 - 4. Three of the

parameters given in Table 4, oxygen uptake rate, 30-minute settled sludge volume, and sludge settling velocity are not generally well known to operators. If you are not familiar with these parameters (or any of the other parameters listed in Tables 3 and 4), refer to the chapter entitled "SAMPLE TECHNIQUES".

CHAPTER II

SAMPLE ANALYSIS TECHNIQUES

This chapter identifies the recommended method of analysis for most of the required input parameters. Many of the sample techniques are referenced to either "Standard Methods" or the "Process Control Manual for Aerobic Biological Wastewater Treatment Facilities."

1. Biochemical Oxygen Demand (BOD): Follow procedure outlined in section #507, Standard Methods.
2. Clarifier Sludge Blanket Depth: Sample procedures, as well as sample techniques are discussed in section IV-27, Process Control Manual.
3. Dissolved Oxygen (D.O.) (oxidation ditch): This parameter should be collected at mid-depth just prior to re-aeration. Measure the instantaneous D.O. concentration by using a portable membrane electrode. Follow procedure outlined in section #422(F), Standard Methods.
4. Fluid Velocity (oxidation ditch): If no metering devices are available, assume that the average ditch velocity equals eighty percent of the velocity of a floating object.
5. Mixed Liquor Suspended Solids (MLSS): Follow the same procedure used for calculating TSS.
6. Mixed Liquor Volatile Suspended Solids (MLVSS): First determine the MLSS value, then perform the procedure discussed in section #208(E), Standard Methods.

7. Oxygen Uptake Rate (OUR): Follow the recommended procedure outlined in section #213(B), Standard Methods. After recording the data, use SOFT-OP's general graph routine to plot the data and evaluate the slope of the best fit line. The slope is the OUR value.

8. Percent (%) Volatile MLSS: Divide the MLSS concentration by the MLVSS concentration and multiply by 100.

9. Rotor Immersion Depth: This is the depth (in inches) the rotor blades reach below the standing water level.

10. Rotor Speed: Various devices can be used to determine the rotor speed in revolutions per minute (rpm). Make sure you measure the speed of the rotor and not the motor speed!

11. Sludge Settleability (30 minute): Use the procedure given in section #213(E), Standard Methods. The volume occupied by the sludge is recorded as ml/l.

12. Sludge Settling Velocity (SSV): Follow procedure in section #213(D), Standard Methods. Use a "Mallory Settlemeter" for the settling vessel. A stirring mechanism is not necessary. Use the graph routine module to plot the recorded data. Continue with the graph analysis phase to determine the slope of the line which best fits the linear portion of the graph. The given slope is the SSV value.

13. Total Suspended Solids (TSS): Perform recommended procedure in section #208(D), Standard Methods.

CHAPTER III

PROGRAM DESCRIPTION

Each of SOFT-OP's nine modules has it's own particular function and application.

SETUP. This is the initial routine accessed within SOFT-OP. You must enter data in this routine before entering data in any of the other routines. The required information consists of design parameters, physical plant dimensions, and effluent permit limitations. Once completed, it is not necessary to return to this module unless there has been a change in process configuration and/or effluent permit requirements.

Figures 2 and 3 show the video monitor displays in their respective orders of appearance. Figure 2 shows parameters that require input relating to process design and physical size. The first value entered is the designed average hydraulic flow rate in million gallons per day (mgd). This value is the 24 hour average flow rate that the plant was designed to handle. Most operation and maintenance (O&M) manuals will also list the expected influent BOD and TSS average concentrations as well as their proposed effluent concentrations. These values are inserted after the average flow rate has been entered.

Two design parameters affecting plant operation are MLSS concentration and F:M ratio. Both of these parameters have minimum and maximum recommended operating values, and are entered as shown in Figure 2. Be sure to enter the lower value first, followed by the higher value. The

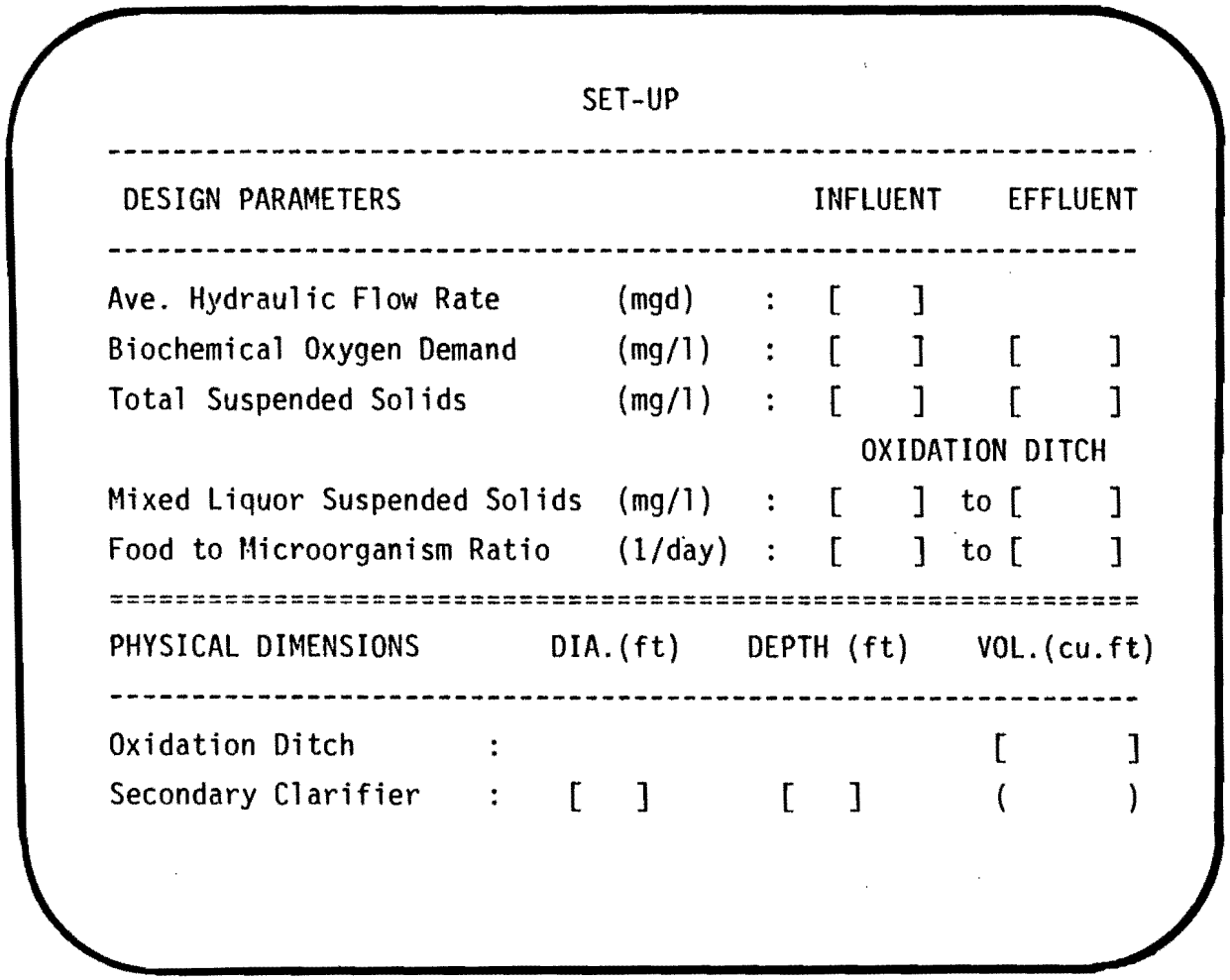

Figure 2. Design parameters and physical dimensions required in first phase of SET-UP module.

SET-UP

NPDES EFFLUENT LIMITATIONS

Max. Effluent Biochemical Oxygen Demand	(mg/l)	:	[ ]
Ave. Effluent Biochemical Oxygen Demand	(mg/l)	:	[ ]
Max. Effluent Total Suspended Solids	(mg/l)	:	[ ]
Ave. Effluent Total Suspended Solids	(mg/l)	:	[ ]
Maximum Effluent pH		:	[ ]
Minimum Effluent pH		:	[ ]
Minimum BOD & TSS Treatment Efficiency	(%)	:	[ ]

Figure 3. NPDES effluent limitations required in NPDES second phase of SET-UP module.

remaining required data in Figure 2 relate to physical dimensions of the unit processes. Make sure units of the entered dimensions match those requested.

Once the information is entered correctly in Figure 2, the program will proceed to the display illustrated in Figure 3. At this point, you must enter the requested NPDES effluent permit limitations. The "SETUP" routine is complete once you have finished entering the information required in Figure 3. You can return to this module at any time to change the recorded data values.

GLOSSARY. This module lists the definitions of various terms used throughout the program. Figure 4 shows the initial display. For example, you can enter the number 2 if you need the definition of F:M. At this point, you have the option of continuing on to further definitions, or returning to the master menu. You might find it advantageous to make a hard copy of each of the available definitions and keep them handy for future reference.

PROCESS CONFIGURATION. This routine shows the flow chart of the oxidation ditch facility. Included in the flow chart are various sample locations for required input parameters. The sample points begin at the influent station and end at the effluent station. This module can be particularly helpful if you do not know where to collect a particular sample variable. It can also be used simply to illustrate the process configuration and flow scheme of the oxidation ditch facility.

NPDES PARAMETERS. Parameters for this module which are required as input in most NPDES permits are shown in Figure 5. The first data entry is the sample data. The recorded influent and effluent permit

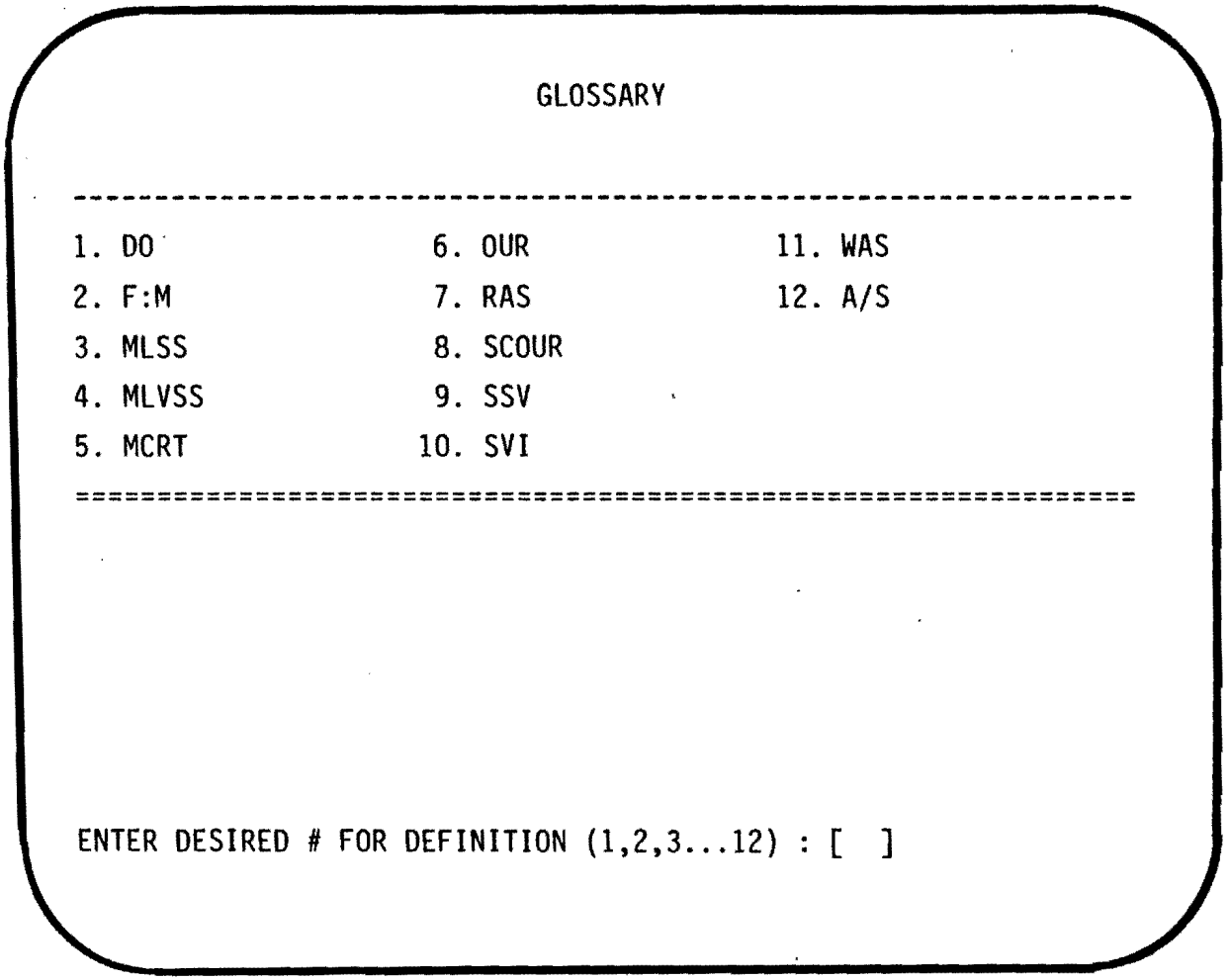

Figure 4. Available definitions in GLOSSARY module.

NPDES PARAMETERS

Date: [ ]

PARAMETER			INFLUENT	EFFLUENT
Ave. Hydraulic Flow Rate	(mgd)	:		[ ]
Max. Hydraulic Flow Rate	(mgd)	:		[ ]
Biochemical Oxygen Demand	(mg/l)	:	[ ]	[ ]
Total Suspended Solids	(mg/l)	:	[ ]	[ ]
Temperature	(cent)	:		[ ]
pH		:		[ ]

Figure 5. Input parameters required in NPDES PARAMETERS module.

parameters are entered next. Make certain that the recorded units match those shown in the figure. Temperature should be recorded in degrees Centigrade not Fahrenheit, etc. Since all values entered during this routine are subsequently utilized for many of the process control functions, it is important to make sure that they represent accurate samples of both influent and effluent wastewater characteristics. Be sure to collect composite samples of at least 8 hours duration for analysis of both BOD and TSS parameters. Any sample periods less than 8 hours should be avoided due to the inherent hourly fluctuations in wastewater quantity and quality.

PROCESS CONTROL. This is the largest and most complex module of SOFT-OP. The evaluation and control of the oxidation ditch system relies heavily on the correct use of this routine. PROCESS CONTROL is divided into four separate routines. Each requires its own set of data. Figure 6 shows the PROCESS CONTROL menu with each of the routines, including the help routine.

Solids Inventory: When the Solids Inventory category is selected, a new menu is displayed as shown in Figure 7. Process solids data are entered as shown in Figure 8 after selection of the solids input menu. This routine requires the MLSS concentration of both oxidation ditch and clarifier underflow (return activated sludge) in addition to respective percentages of volatile suspended solids (VSS). The program automatically calculates MLVSS concentrations as well as the MLSS and MLVSS weight (in kilograms) within the oxidation ditch.

Analysis for errors in process operation begins once all information has been entered correctly. Errors are initially identified by

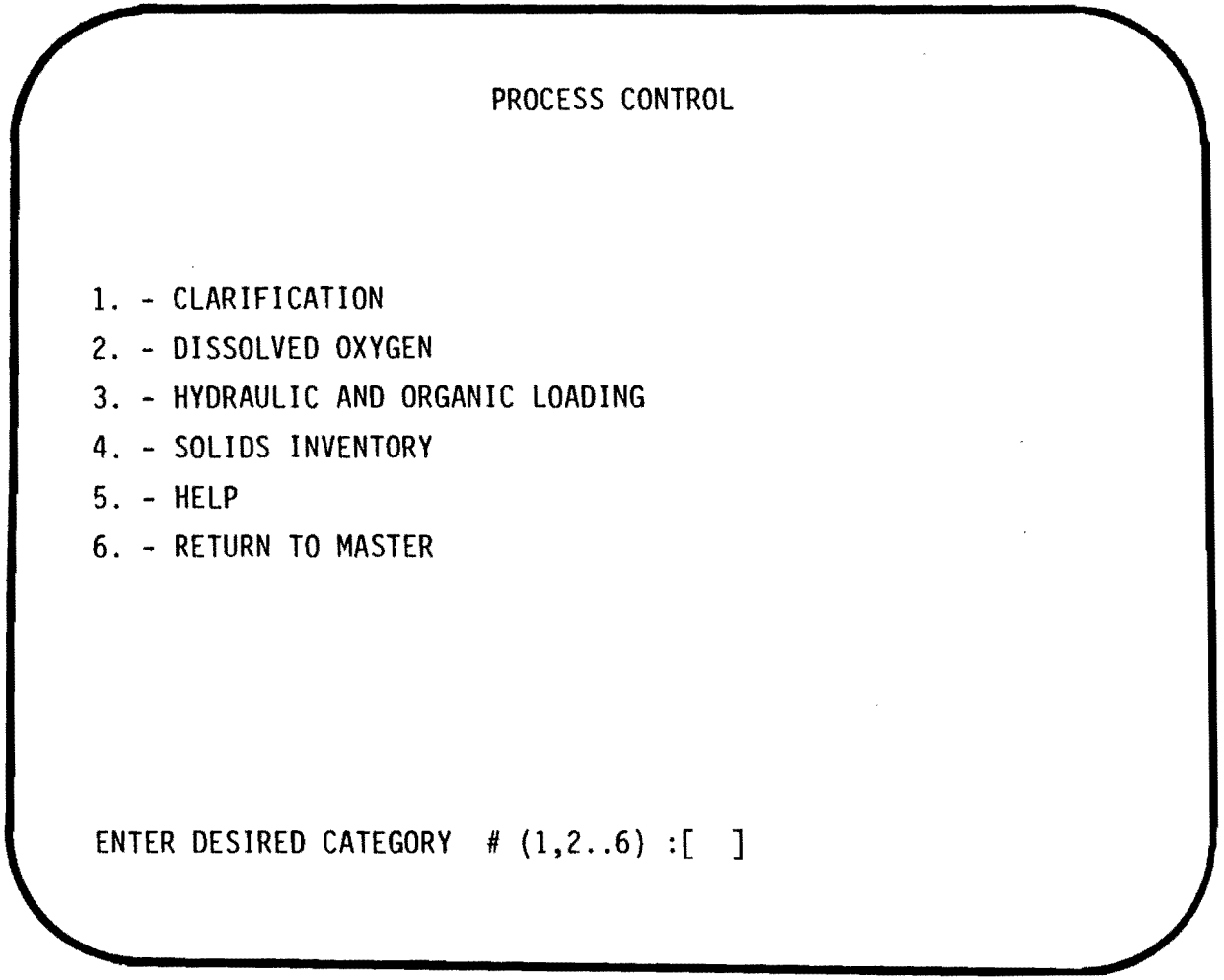

Figure 6. PROCESS CONTROL module menu.

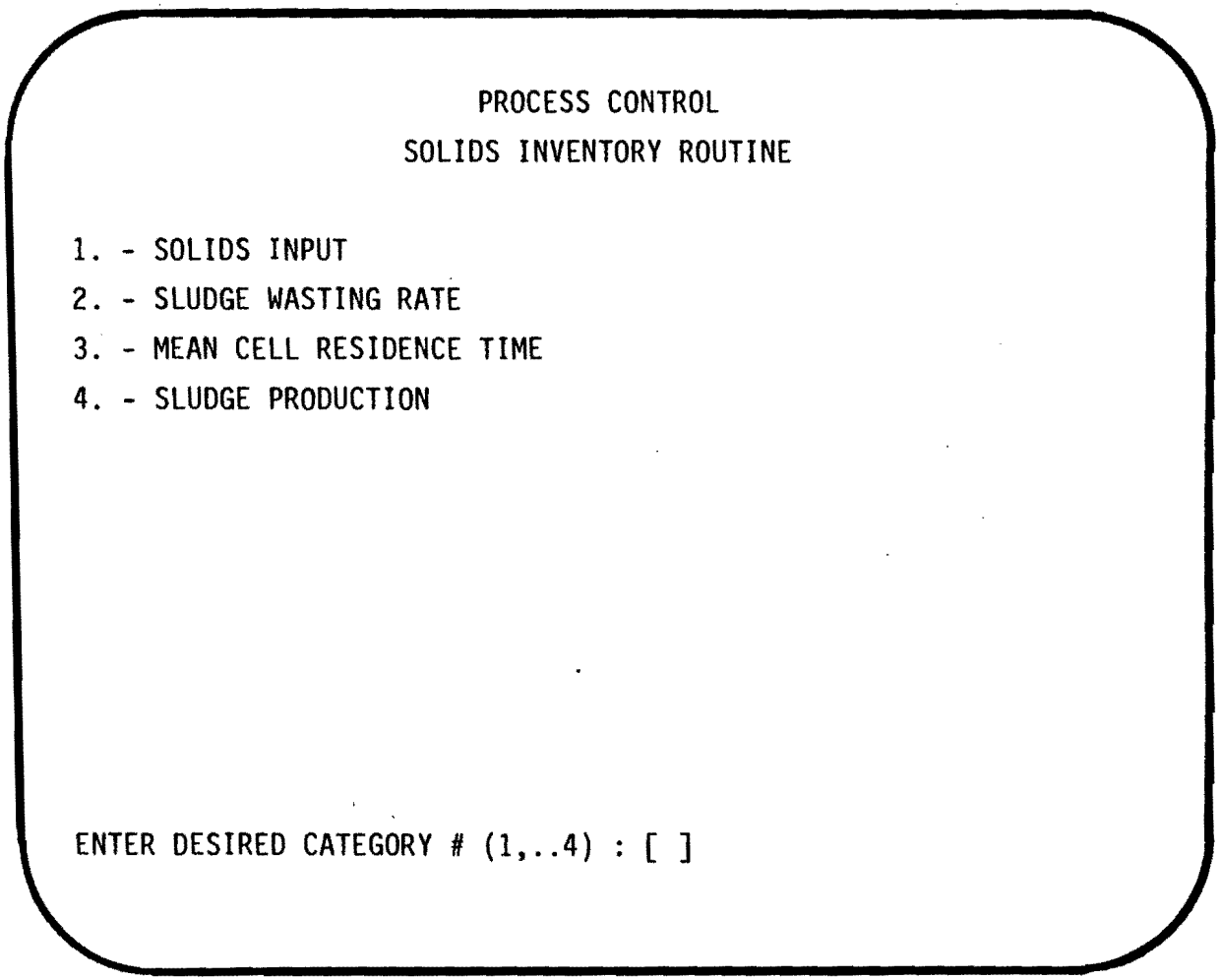

Figure 7. Solids Inventory menu in PROCESS CONTROL module.

PROCESS CONTROL

SOLIDS INVENTORY ROUTINE

Date: [ ]

PARAMETER		OXIDATION DITCH	CLARIFIER UNDERFLOW
Mixed Liquor Suspended Solids	(mg/l) :	[ ]	[ ]
Percent Volatile MLSS	(%) :	[ ]	[ ]
Mixed Liquor VSS	(mg/l) :	( )	( )
Total Weight MLSS	(kg) :	( )	
Total Weight MLVSS	(kg) :	( )	

Figure 8. Input parameters and program output in Solids Inventory routine.

alert flags. If there is an alert condition, SOFT-OP will prompt you for further analysis. The various possible alert conditions and recommended courses of action are listed as follows:

1. Oxidation ditch MLSS concentration is below normal design level. It should be above ****** (minimum level entered in SETUP routine).

Solution: Increase mean cell residence time by decreasing sludge wasting rate.

2. Oxidation ditch MLSS concentration is above normal design level. It should be below ****** (maximum level entered in SETUP routine).

Solution: Decrease mean cell residence time by increasing sludge wasting rate.

It is important to input all the requested solids data from both the oxidation ditch and clarifier since they are used during other routines. Do not enter oxidation ditch data and leave clarifier underflow data blank since this will only result in incomplete data analysis during other routines.

Hydraulic and Organic Loading: The only required input in this routine is the date of analysis. Data from both NPDES and Solids Inventory (input) routines are accessed within this routine. Therefore, be sure that the date matches a similar date entered during the previous two routines. The Hydraulic and Organic Loading routine calculates various loading rates and tabulates them as shown in Figure 9. This routine is particularly beneficial for monitoring the influent organic loading rate and also the F:M ratio.

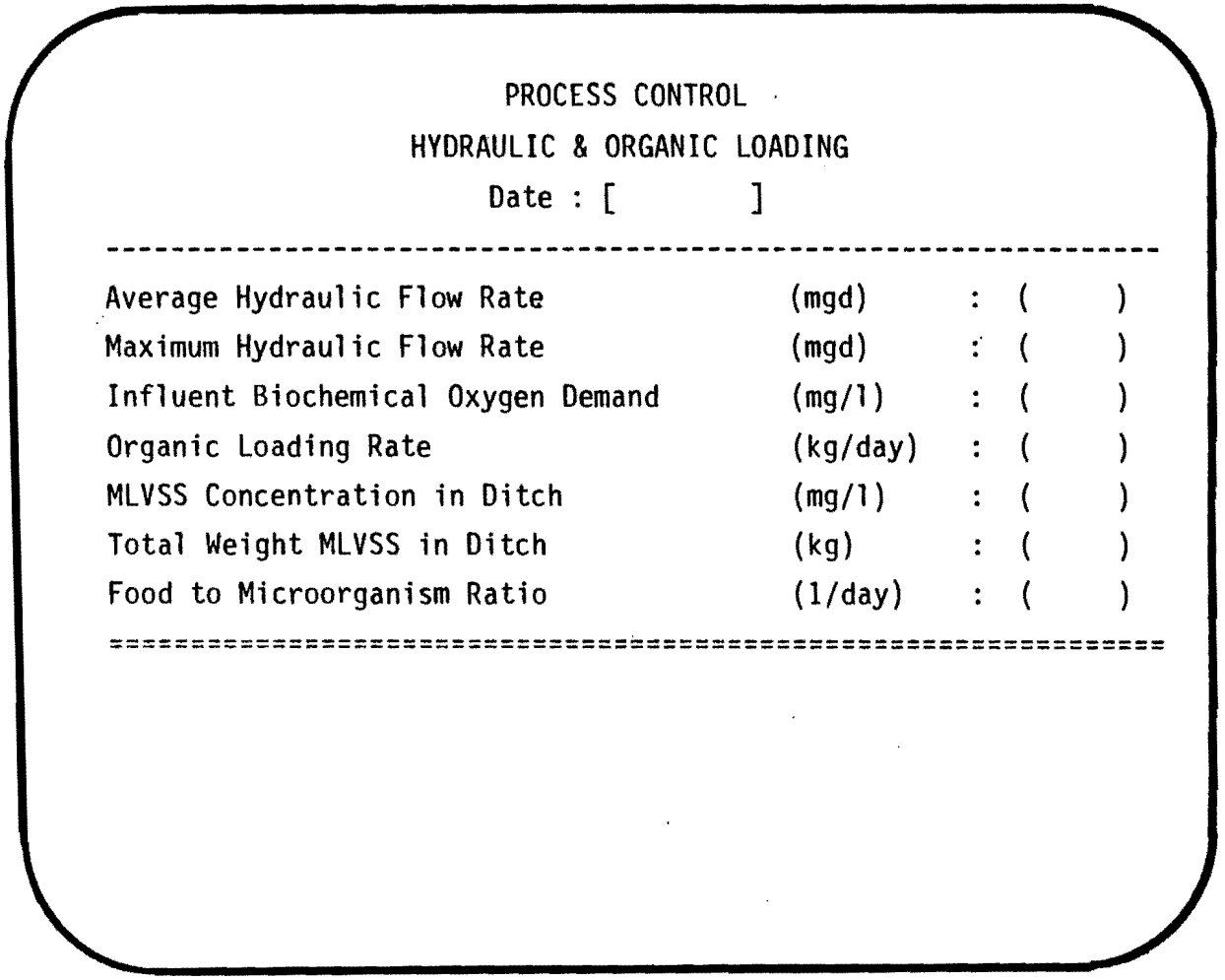

Figure 9. Loading parameters available in Hydraulic and Organic Loading routine.

Both F:M and organic loading rate parameters are significant to overall daily plant operation. Alert conditions will result if their calculated values do not fall within the range specified by the previously entered design criteria. The different possible alert conditions along with their recommended courses of action are listed as follows:

1. Food-to-microorganism ratio is too low. It should fall within **** (minimum design value) and **** (maximum design value).
Solution: Increase food-to-microorganism ratio by decreasing mixed liquor suspended solids concentration in oxidation ditch.

2. Food-to-microorganism ratio is too high. It should fall within **** (minimum design value) and **** (maximum design value).
Solution: Decrease food-to-microorganism ratio by increasing mixed liquor suspended solids concentration in oxidation ditch.

3. Organic loading rate is above the design value of ****
Watch for: Low oxidation ditch dissolved oxygen and high food-to-microorganism values.

Clarification: To enter the Clarification routine select the appropriate category number in the PROCESS CONTROL menu. The resulting display is shown in Figure 10. Since this routine utilizes information recorded in the Solids Inventory input routine, the sample collection date must also match the date of previously recorded solids inventory data.

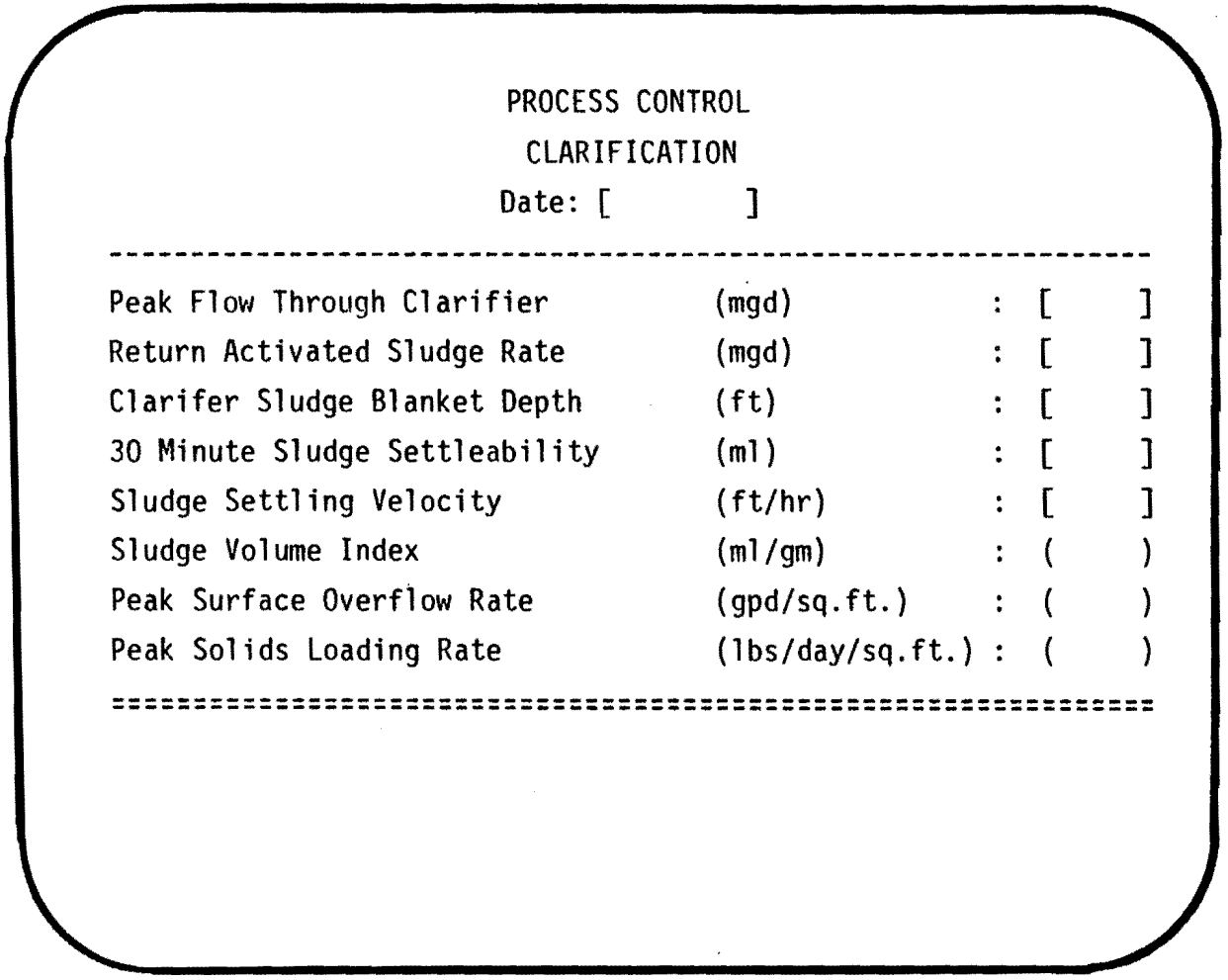

Figure 10. Input parameters and program output in Clarification routine.

Clarifier peak flowrate is the first parameter required as input. This value is the maximum instantaneous flow recorded during a 24 hour period. It is used for calculation of both peak surface overflow and peak solids loading rates. The return activated sludge (RAS) rate is the quantity (in mgd) of sludge pumped from the bottom of the clarifier back into the oxidation ditch. The clarifier sludge blanket depth should be measured at the same time and location each day. Thirty-minute sludge settleability and sludge settling velocity (SSV) are the last two parameters needed as input. The latter parameter, SSV, is calculated with the help of the general GRAPH routine.

The preceding parameters, together with information recorded in the Solids Inventory input routine, are used for calculation of the sludge volume index (SVI), peak surface overflow rate and peak solids loading rate. Both SVI and SSV parameters can be used to evaluate sludge settling characteristics. It is recommended that SSV be the primary evaluation parameter due to the inherent inabilities of the SVI parameter to adequately identify changes in sludge settling characteristics.

Optimal operation of the oxidation ditch process is directly related to settling characteristics of the activated sludge. By monitoring clarification records, you have the ability to notice early changes in sludge settling characteristics. If the SSV parameter is shown to be decreasing (i.e., there is a decrease in sludge settleability) then you should note the possible reasons for such change. The same is true for the reverse situation. Obviously, a situation where the SSV value is increasing is usually the preferred situation.

The Clarification routine also helps the operator evaluate the maximum hydraulic and solids loading rates that can be safely handled by the clarifier for a particular range of SSV values. However, this function requires a significant data history. Should clarification abilities decrease to a new level, it is possible that the same level could be found in previous records, thus providing recommended decreases in maximum loading rates. If a decrease in sludge settleability occurred and loading rates were not reduced, the potential for solids washout would be much greater.

Once the clarification data has been entered correctly, SOFT-OP analyzes the SSV parameter for changes in sludge settling characteristics. Each SSV entry is checked against the previous month's average SSV value. An alert condition will result if the new value is less than 80 percent of last month's average value. The alert condition and resulting recommendation is as follows:

1. Sludge is settling at a slower rate than previous month's average.

   Check for: Low oxidation ditch dissolved oxygen conc., bulking sludge and high MLSS concentration.

If the SSV values continue to decrease, refer to the reference book "Process Control Manual for Aerobic Biological Wastewater Treatment Facilities." You should find the troubleshooting guides particularly helpful in determining the possible causes of decreased sludge settleability.

Dissolved Oxygen: All pertinent variables that relate to the supply and/or consumption of dissolved oxygen are entered in this

routine and are shown in Figure 11. The first entry is the sample date. Be sure to have solids inventory data stored with the same sample date since this routine accesses data within the Solids Inventory routine.

The fluid velocity in the oxidation ditch is an important parameter to monitor since it controls the degree of mixing within the process. It is important to prevent the formation of dead zones within the ditch where solids might settle out and become stagnant. A minimum fluid velocity of 1 foot per sec (ft/sec) should be maintained throughout the ditch at all times to ensure adequate mixing conditions.

Rotor immersion depth and rotor speed are used to control fluid velocity and oxygen transfer rate. An increase in fluid velocity and/or dissolved oxygen concentration requires an increase in the rotor immersion depth and/or an increase in the speed of the rotors. Rotor depth is recorded in inches and generally ranges from 3 to 10 inches. The rotation speed of the rotors is measured in revolutions per minute (rpm). Be sure to check your O&M manual for the specific minimum and maximum rotor submergence depths recommended for your facility. Severe blade damage and/or motor overloads can occur if the rotors are operated at levels greater than the maximum immersion depth.

The fourth required input parameter is the instantaneous dissolved oxygen concentration within the oxidation ditch. The dissolved oxygen concentration should be measured immediately within the MLSS by a portable oxygen meter and probe. Make sure the reading is taken at mid-depth just prior to re-aeration by one of the ditch rotors. The dissolved oxygen concentration is recorded in the usual units,

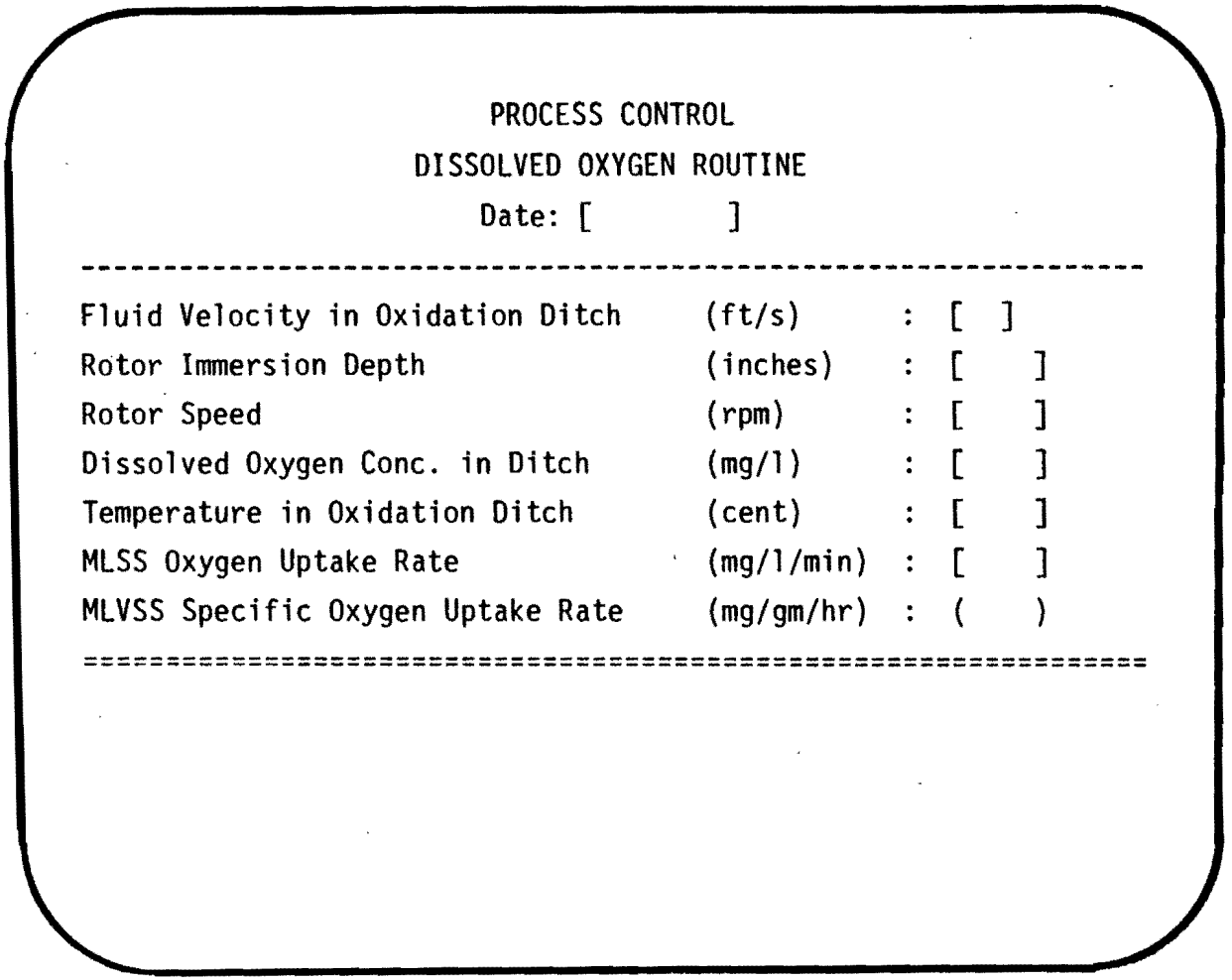

Figure 11. Input parameters and program output in Dissolved Oxygen routine.

milligrams per liter (mg/l). Temperature has an affect on the solubility of dissolved oxygen within the MLSS and is therefore required as input. Note that the temperature should be recorded in degrees Centigrade not Fahrenheit.

The MLSS oxygen uptake rate (OUR) parameter is used to evaluate the oxygen consumption rate of the viable (active) organisms within the mixed liquor. This parameter is particularly important since it helps identify sudden changes in the oxygen demand within the process. As with the SSV parameter, the OUR is calculated with help from the general GRAPH routine accessed in the master menu. The OUR should be recorded as milligrams of oxygen consumed per liter of MLSS per minute (mg/l/min). Refer to the chapter on sample techniques for a further description of OUR determination. The specific oxygen uptake rate (SCOUR) is the final parameter calculated in the dissolved oxygen routine. This variable is determined by dividing the OUR of the mixed liquor by the MLVSS concentration. The resulting SCOUR value represents the oxygen consumption per unit weight of active organisms. This value is expressed in units of milligrams of oxygen utilized per gram of MLVSS per hour (mg/gm/hr).

Fluid temperature, rotor immersion depth and rotor speed all influence the dissolved oxygen concentration present within the mixed liquor. You should continually monitor each of these variables for their specific effect on the overall ability to transfer atmospheric oxygen into solution. Once a history of operating data is developed, you should be able to better identify the changes necessary for maintaining the D.O. concentration within the recommended range of 1 to 3 mg/l.

The SCOUR variable should be the primary variable used for identifying sudden changes in organism viability. If the SCOUR value increases dramatically, watch for possible organic overloads to the process. Toxic shock loads can also be quickly identified by watching for sudden sharp decreases in the SCOUR value. By developing trends in the observed SCOUR of the organisms, you should develop a better understanding of the factors that affect organism activity within the oxidation ditch.

The program proceeds to the analysis of alert conditions as soon as the user has correctly entered all requested information. The various alert conditions as well as their recommended courses of action are summarized as follows:

1. Fluid velocity in oxidation ditch should be at least 1 ft/sec.
Solution: Increase rotor immersion depth and/or speed.
2. Oxidation ditch dissolved oxygen concentration is too low.
The correct range is between 1 and 3 mg/l.
Solution: Increase rotor immersion depth and/or speed.
3. Oxidation ditch dissolved oxygen concentration is too high.
The correct range is between 1 and 3 mg/l.
Solution: Decrease rotor immersion depth and/or speed.

Sludge Wasting Rate: This routine is accessed through the Solids Inventory category in the PROCESS CONTROL menu and is shown in Figure 12. This routine is designed to be used for determining the daily amount of sludge that needs to be wasted in order to maintain a specific mean cell residence time (MCRT). The estimated oxidation ditch MLVSS concentration and return activated sludge MLVSS concentration are

PROCESS CONTROL

SOLIDS INVENTORY ROUTINE

SLUDGE WASTING RATE

Desired Mean Cell Residence Time	(days)	:	[ ]
Estimated Ditch MLVSS Concentration	(mg/l)	:	[ ]
Estimated RAS MLVSS Concentration	(mg/l)	:	[ ]
Waste Activated Sludge Pumping Rate	(gpm)	:	[ ]
Estimated MLVSS Weight in Ditch	(kg)	:	( )
Waste Activated Sludge Quantity	(kg/day)	:	( )
Waste Activated Sludge Volume	(gal/day)	:	( )
Required WAS Pumping Duration	(min/day)	:	( )

Figure 12. Input parameter and program output in Sludge Wasting Rate routine.

entered after the desired MCRT is recorded. Estimated, rather than actual MLVSS concentrations are entered since the exact concentrations are ordinarily not known until the day after wasting. This delay is due to the time necessary for laboratory analysis of solids concentrations.

The waste activated sludge (WAS) pumping rate is the rate in gallons per minute (gpm) that solids from the secondary clarifier underflow line are pumped to the solids handling facility (e.g., digester, drying beds, etc.). The pumping rate should be slow enough to prevent "coning" of the sludge within the clarifier.

SOFT-OP calculates and records the estimated weight of the MLVSS within the oxidation ditch in kilograms (kg). The last three variables within the Sludge Wasting Rate routine are calculated using previous parameter values. The first variable, WAS quantity, is recorded in kilograms per day (kg/day). This value represents the estimated weight of solids that need to be wasted each day to maintain the desired MCRT. The next variable is the WAS volume in gallons per day. This variable represents the estimated number of gallons that need to be wasted daily. The final variable is the time required for WAS pumping in minutes each day (min/day).

Once this routine is completed, you can use the results for maintaining a particular MCRT. You should return to this routine when a new MCRT is desired, or to update wasting rate parameters due to variations between the true and estimated MLVSS concentrations.

Mean Cell Residence Time: This routine is designed to be used to enter and store actual sludge wasting data on a continual basis. The

format for data entry is shown in Figure 13. It is very important to remember to input data for every day that sludge is wasted. Failure to do so will result in inaccurate MCRT calculations.

The first data entry is the date of sludge wasting. This date must match a date already stored within the Solids Inventory input routine. The actual volume and concentration of the WAS MLVSS are entered after the date. SOFT-OP uses this information together with information stored in the Solids Inventory input routine to calculate the remaining parameter values.

It is important to remember that the MCRT value given in this routine assumes that the entered WAS volume and concentration data remain constant, and that the sludge is wasted each day. If this criteria is not met, the MCRT value will not reflect the true MCRT within the process. However, as long as data is entered in the MCRT routine each time sludge is wasted, the true MCRT will always be recorded in the RECORDS SUMMARY module.

Sludge Production: This routine summarizes various solids inventory data for a specified month of operation (illustrated in Figure 14). The only input required is entry of the specified month. The rest of the required data are accessed from varous routines within SOFT-OP. You should use the average change in the MLSS concentration from the first week to the fourth as an indicator of a net gain or loss in solids within the process. The quantity of TSS lost in the effluent should be helpful in identifying those months which exhibited good A/S clarification.

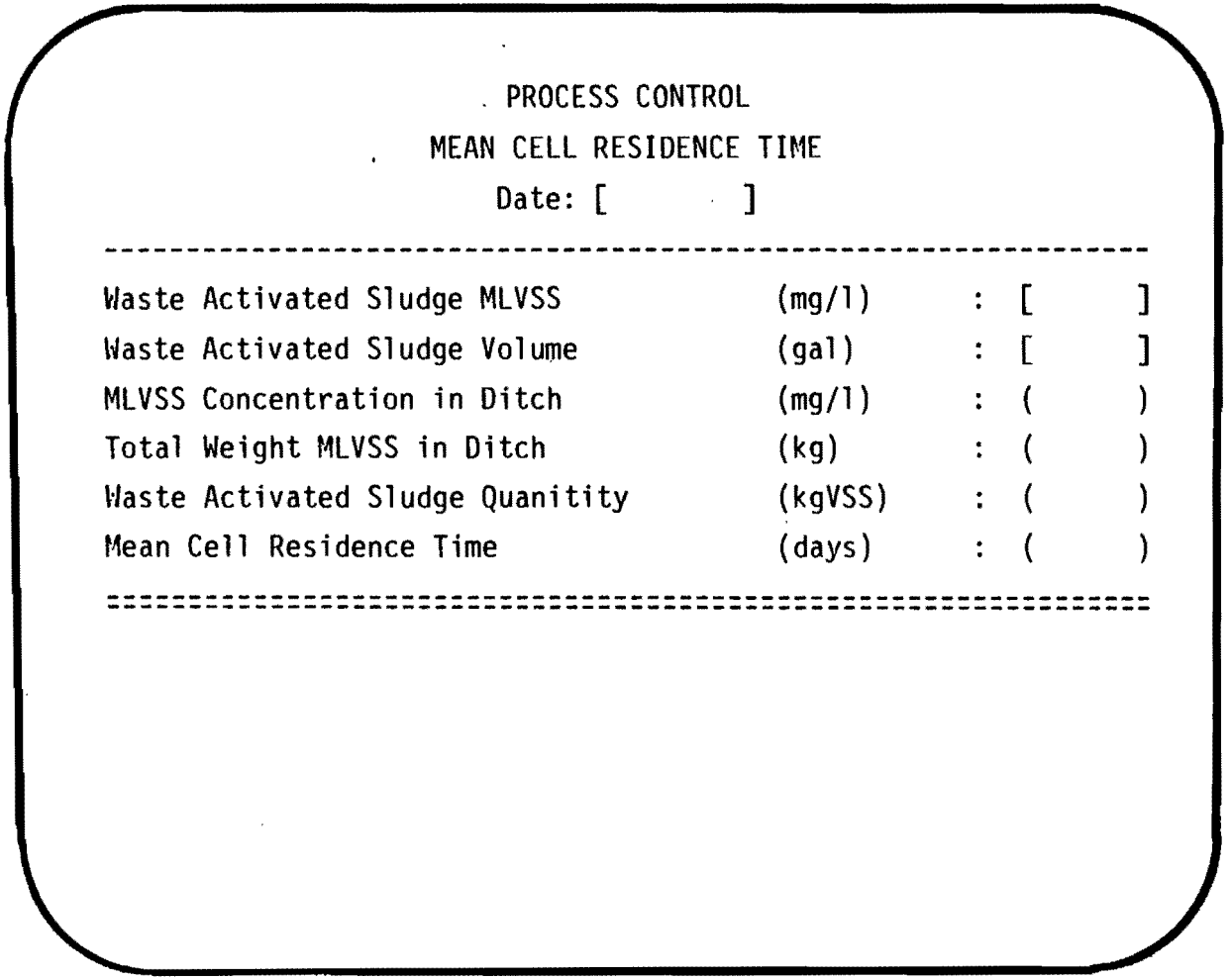

Figure 13. Input parameters and program output in Mean Cell Residence Time routine.

SLUDGE PRODUCTION

Mnth/Yr : [ ]

Ave. MLSS Concentration for Week 1	(mg/l)	:	( )
Ave. MLSS Concentration for Week 4	(mg/l)	:	( )
Ave. MLSS Concentration Change	(mg/l)	:	( )
Ave. MLSS Quantity Change	(kg)	:	( )
Effluent TSS Quantity Lost	(kg)	:	( )
Total Waste Activated Sludge Quantity	(kgVSS)	:	( )
Average Percent VSS	(%)	:	( )
Total Waste Activated Sludge Quantity	(kgTSS)	:	( )
Total Solids Production	(kgTSS)	:	( )
Total Ave. 5-Day BOD Quantity Removed	(kg)	:	( )
Total Solids Production Per BOD(5) Removed		:	( )

Figure 14. Program output in Sludge Production routine.

The total amount of activated sludge wasted during the month is calculated in both kilograms VSS and kilograms TSS. The final parameter is the ratio between the amount of TSS produced and the average quantity of 5-day BOD removed (TSS/BOD). This ratio is used to evaluate the rate of solids growth versus the amount of substrate (BOD) received by the process. Comparison of TSS/BOD and MCRT parameters is used to indicate particular ranges of MCRT values where lower solids production levels occur for an equivalent amount of applied substrate (i.e., BOD). This analysis can be used in an effort to minimize the production of solids within the process.

TREND FORECASTING. This routine is used to monitor trends in various process control and evaluation parameters. There are a total of 14 parameters available for analysis. These are shown in Figure 15 as they appear on the video monitor. The first input required is the starting month of the parameter to be graphed. Starting with January as number "1", succeeding months are entered numerically, ending with "12" for December. The second entry is the number of months of data to be graphed. Remember that the records stored on the data diskette should cover just one year of operation. Therefore, if the starting month is "12" (December), then the length of the time period can only be one month. Due to graph limitations, only six month's worth of data can be analyzed at one time.

Once you have selected the appropriate parameter number, SOFT-OP proceeds to a new format (illustrated in Figure 16). At this stage, the selected parameter to be graphed is identified. You are then prompted to fill in descriptions of vertical (Y) and horizontal (X)

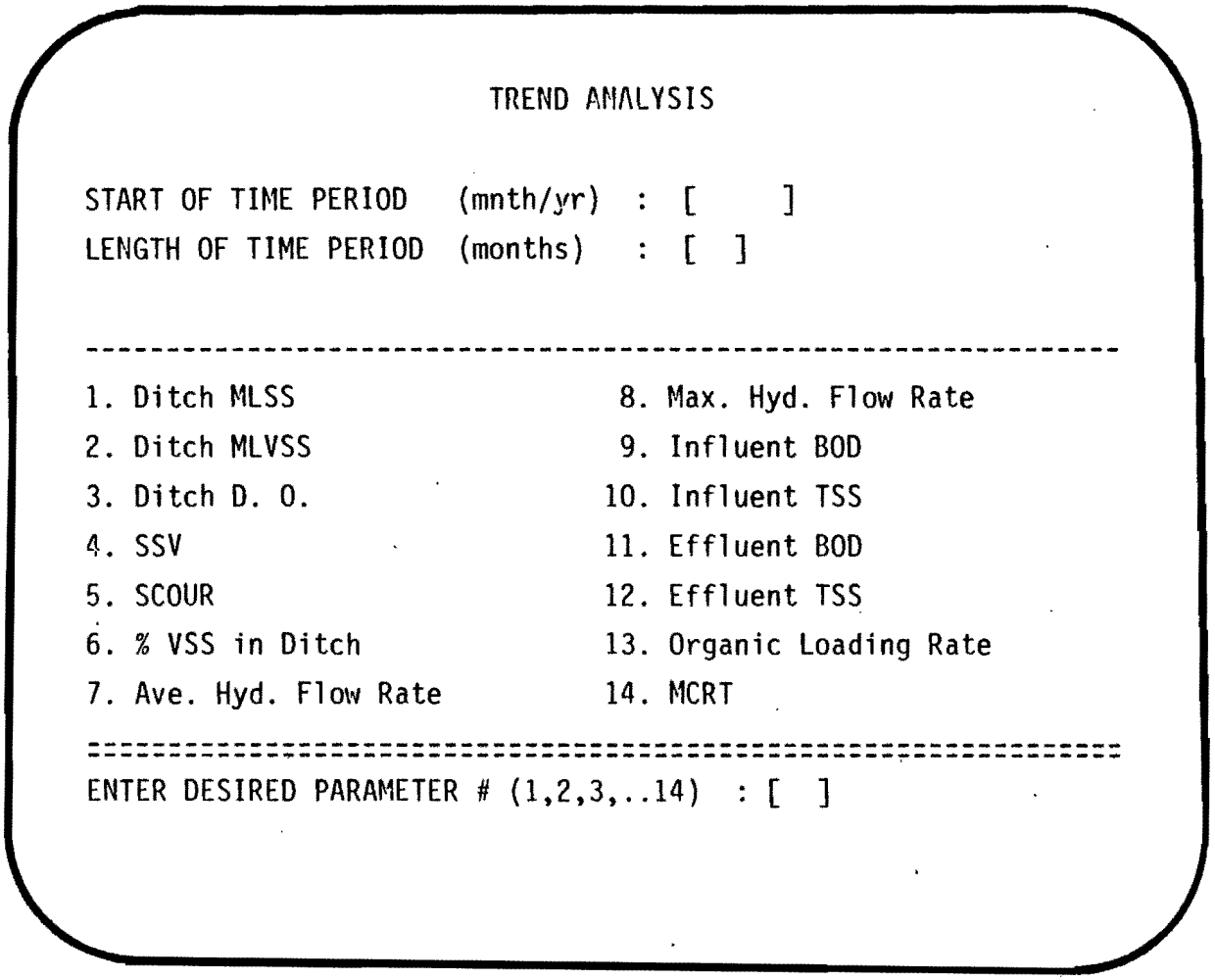

Figure 15. Input parameters required in first phase of Trend Forecasting module.

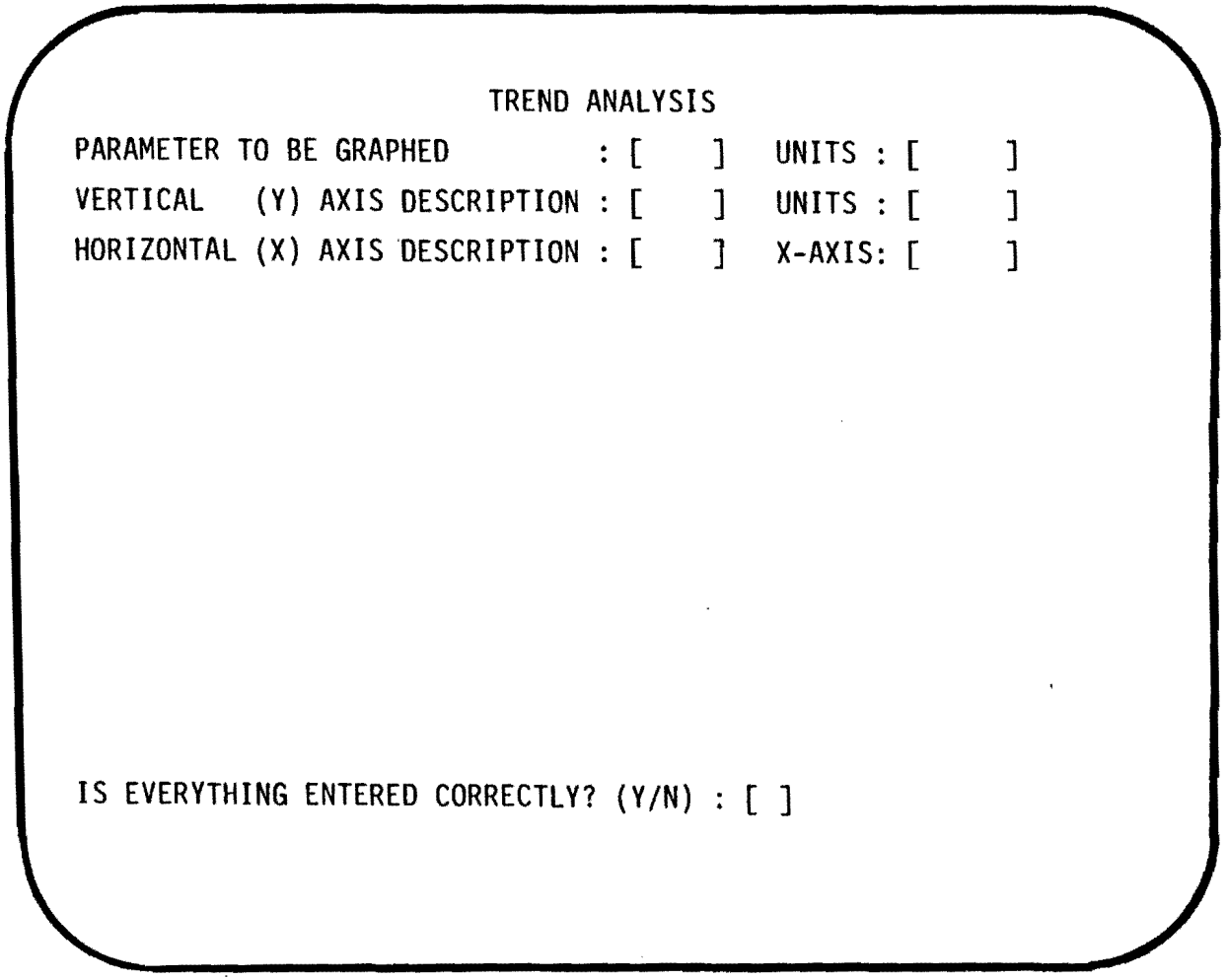

Figure 16. Input parameters required in second phase of Trend Forecasting module.

axes, units, and maximum coordinate values. In this routine, the X-axis always represents time, and the description should be labeled as such. The maximum coordinate values must be greater than or equal to the values that are to be graphed or else an error message will occur.

Each of the values tabulated for the Y-axis are weekly averages of the specified parameter. In other words, four data points comprise one month's worth of data, eight data points comprise two month's worth of data, etc. Remember that the X-axis values always represent time in weeks. Once the coordinate descriptions, units, and maximum values are entered correctly, the program will proceed to graph the information on the video monitor.

Press the letter "C" (make sure it is a capital "C") to continue. At this stage, you have three options available. You can make a hard copy of the graphed parameter, perform further graph analyses, or return to the master menu. If you wish to make a hard copy of the graph, first make sure that the printer is turned on and ready to receive data transmissions. After selecting the hard copy function, the program will prompt you to enter a title for the graph. The program will proceed to print a copy of the graph once the title is entered correctly.

Statistical calculations can be performed by selecting the graph analysis function. This function fits a curve to the plotted data and can be used to estimate various parameter values along the fitted line. Figure 17 shows the format of the graph analysis phase. SOFT-OP calculates and displays the total number of plotted data points. The data set can be fit to either a linear (straight line) or logarithmic (curved line) equation. After choosing the desired equation, you must input the

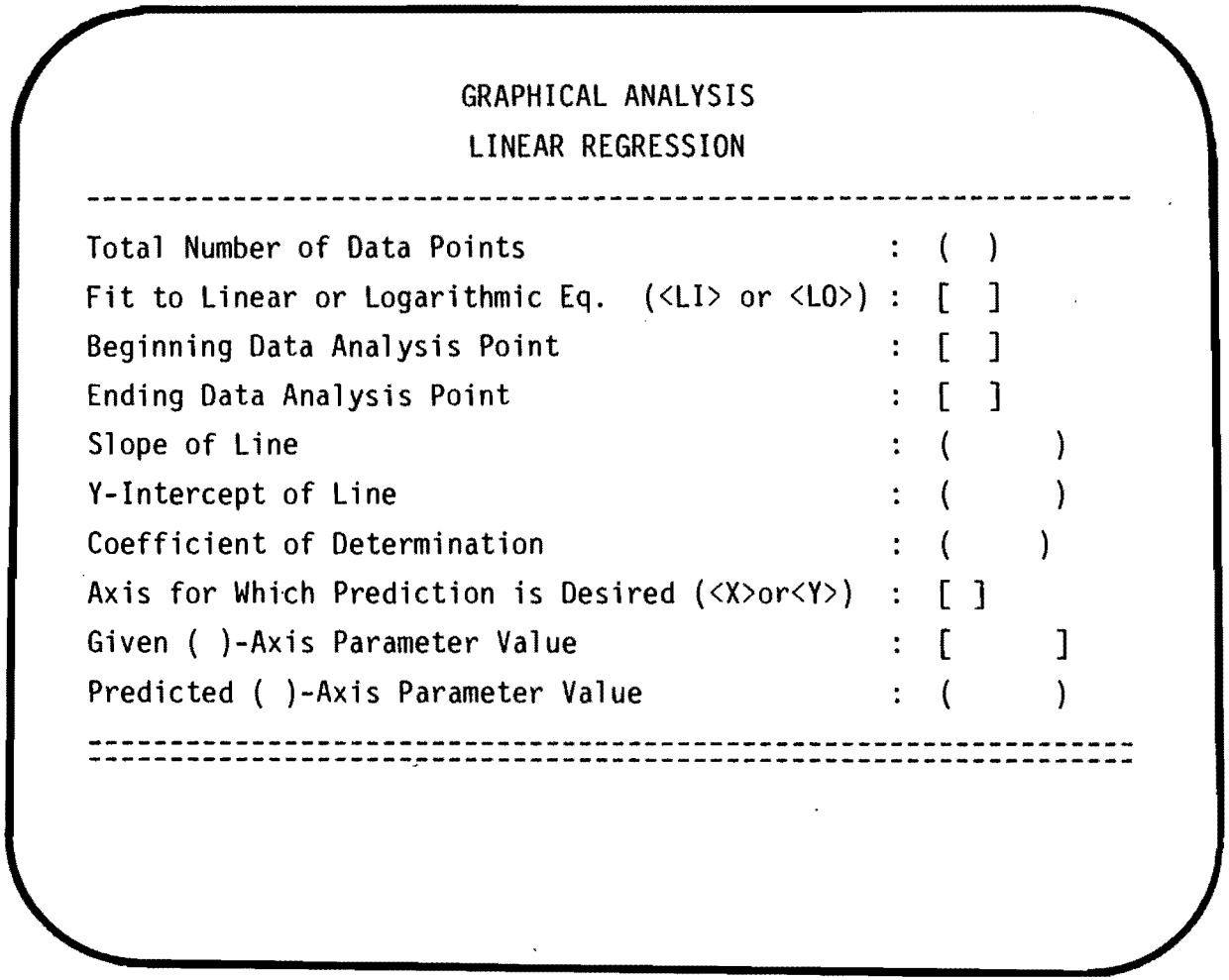

Figure 17. Input parameters and program output in graph phase of Trend Forecasting module.

beginning and ending data analysis points. These two values do not have to be the first and last data points since you might not want to analyze the entire group of data.

Once you have entered the desired range of data, SOFT-OP calculates the slope and Y-axis intercept of the curve which best fits the data. Particular care must be exercised when curve-fitting data. Oftentimes, the resulting equation does not sufficiently represent the trend of the actual data. For this reason, the coefficient of determination is included in this routine. This coefficient is used to evaluate the degree of accuracy between the actual data set and the estimated equation. The coefficient of determination ranges from 0.0 to 1.0. A value of 1.0 represents a perfect fit between the data and equation. When the coefficient is below 0.80 the accuracy of the fitted equation should be questioned.

If error between the fitted equation and the actual data is small (coefficient > = 0.80), SOFT-OP can be used to predict data points along the fitted line. The desired parameter value is determined by first selecting the axis for which the prediction is desired, followed by entering a given value for the opposite axis.

RECORDS SUMMARY. This module is used to obtain a monthly summary of previously recorded data within SOFT-OP. Figure 18 shows the RECORDS SUMMARY display menu which is accessed from SOFT-OP's master menu.

Each of the process control categories (number 2-6) have their monthly averages tabulated in the identical format used within the PROCESS CONTROL module. The first category summarizes the entered NPDES

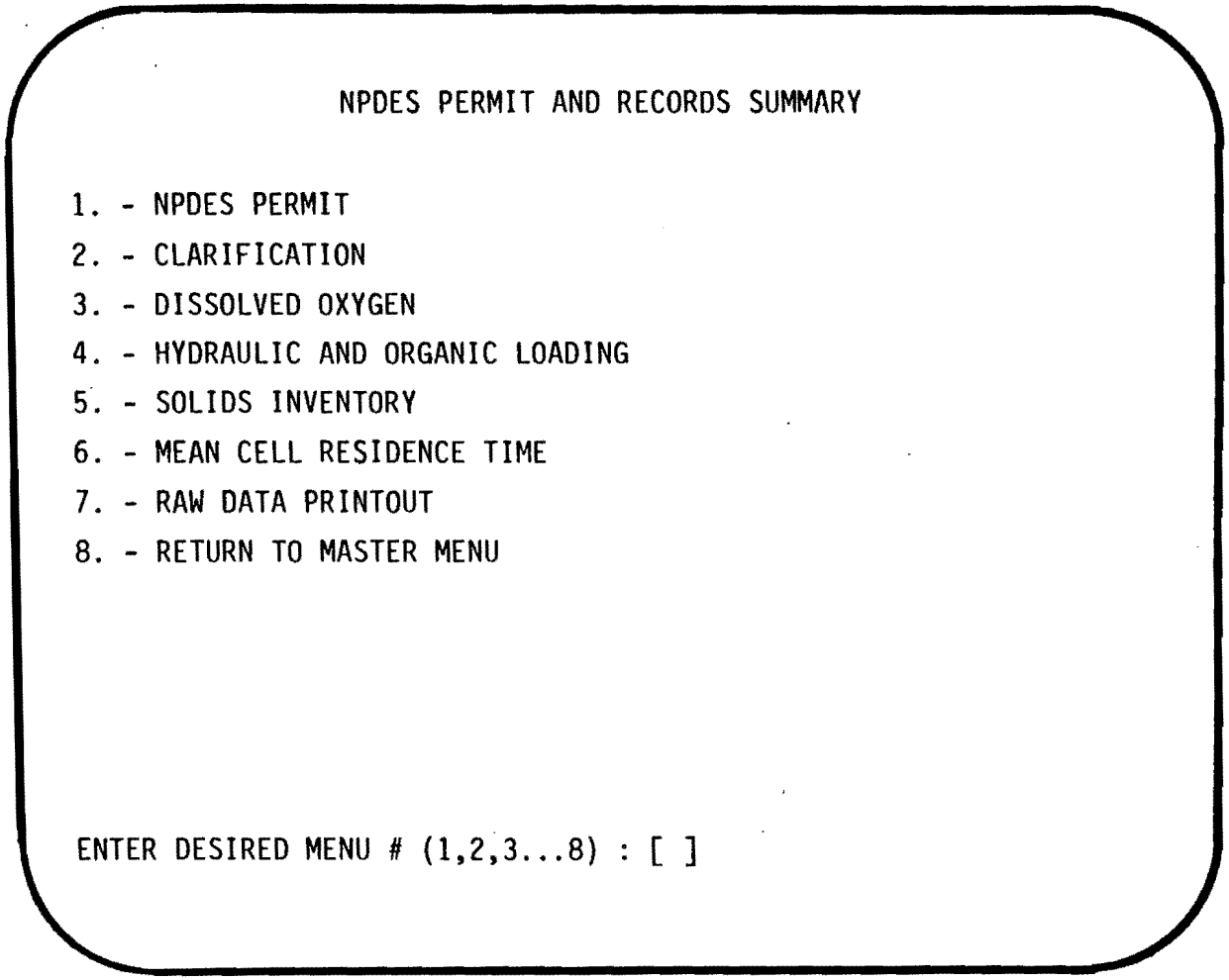

Figure 18. RECORDS SUMMARY module menu.

parameters. This routine displays the tabulated data in a somewhat different format from which they were entered. Figure 19 shows the summary format. This format is designed to assist in the completion of the monthly discharge monitoring report (DMR) required by the U.S. Environmental Protection Agency (EPA). The program tabulates the minimum, maximum, and average values of each variable.

Alert conditions are also identified within the NPDES permit summary. These alerts include various effluent NPDES permit violations as well as influent design overloads. There are a total of 14 different alert conditions, eight of which identify effluent discharge violations.

It is recommended that a hard copy of each record summary routine is made at the end of each month. By doing so, you can easily access monthly operating records of the oxidation ditch facility. These records should be reviewed periodically to evaluate the operation of the process under the varying conditions typically observed at wastewater treatment facilities.

In addition to providing a data summary, the RECORDS SUMMARY routine allows you to list individual parameter values stored on the data diskette. You can do so by selecting the raw data printout menu (#7). This function can only be used for a hard copy listing, so make sure your printer is ready for use. Desired information is printed by selecting the appropriate menu within the raw data printout routine.

GRAPH ROUTINE. This general graph routine is designed to be used for evaluating the SSV and OUR parameters. In addition, this routine can be used for the general plotting and analysis of any particular group of data. The format of the graph routine is very similar to that

RECORDS SUMMARY

MNTH/YR : [ ]

PARAMETER		MIN. VALUE	AVE. VALUE	MAX. VALUE	TRTMNT EFF.
Ave. Hydraulic Flow Rate	(mgd) :	[ ]	[ ]	[ ]	
Max. Hydraulic Flow Rate	(mgd) :	[ ]	[ ]	[ ]	
Influent BOD	(mg/l) :	[ ]	[ ]	[ ]	
Effluent BOD	(mg/l) :	[ ]	[ ]	[ ]	[ ]
Influent TSS	(mg/l) :	[ ]	[ ]	[ ]	
Effluent TSS	(mg/l) :	[ ]	[ ]	[ ]	[ ]
Effluent Temperature	(cent) :	[ ]	[ ]	[ ]	
Effluent pH	:	[ ]	[ ]	[ ]	

Figure 19. Program output of NPDES permit data in RECORDS SUMMARY module.

discussed in TREND FORECASTING. The layout of the graph routine is shown in Figure 20. The first entry required is the number of data points to be graphed. Note that this value must be less than or equal to 31. The sample data is entered next, followed by the Y and X axis descriptions, units, and maximum coordinate values. Once these variables are entered correctly, you must then input the Y and X axis coordinate values. SOFT-OP then plots the data on the video monitor as soon as it has been entered correctly.

The remainder of the routine is identical in nature to the TREND FORECASTING routine. Both SSV and OUR parameter values are determined from the slope of line variable within the graph analysis phase of the routine. If necessary, refer to the chapter on sample techniques for further discussion of SSV and OUR determination.

HELP. There are two HELP routines available within SOFT-OP. The first HELP routine is accessed within the master menu and describes the function of each of the other eight master menu modules. The second HELP routine is available inside the PROCESS CONTROL module and describes the function of each of the other four process control sub-routines. Both routines can be used for a quick review of a particular routine's function. However, the HELP function should not be used in place of the user's manual, since each description within the HELP routine is relatively brief and concise. For in-depth descriptions, you should always refer to the appropriate section within the user's manual.

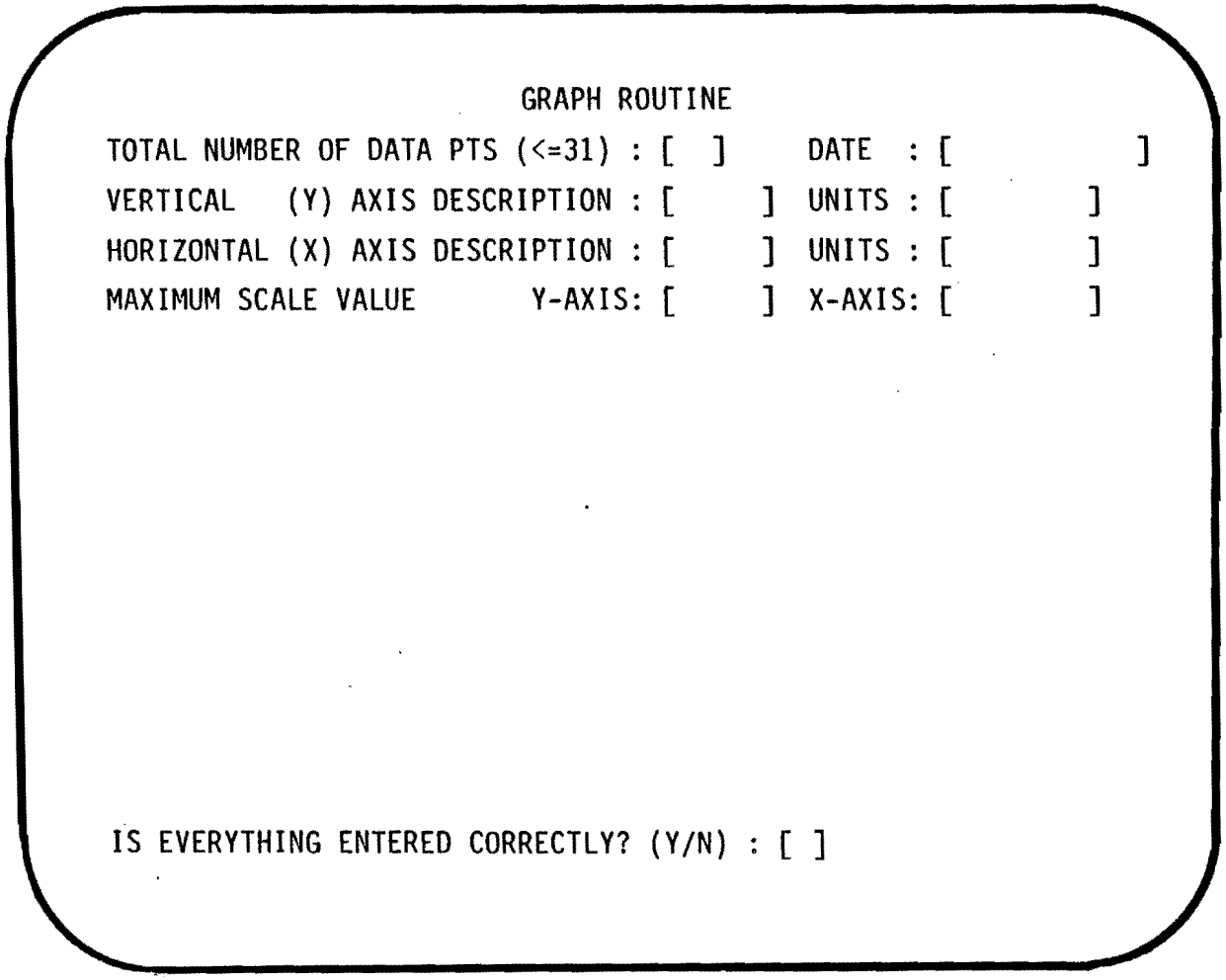

Figure 20. Input parameters required in GRAPH routine.

CHAPTER IV

PROGRAM OPERATION

Before continuing, it should be noted that the possibility of program errors exists with any newly developed software. SOFT-OP is no exception. If a program error occurs, an error message will appear on the screen and program operation will cease. Most errors will occur when the program is not used correctly. If an error occurs, enter the letters "RUN" to return to initial program operation.

Make sure that all alphabetic letters required as input are capital letters. SOFT-OP will not recognize lower-case alphabetic letters. If you're in the lower-case mode of operation refer to Radio Shack's basic user's manual for the correct procedure to switch back into the upper-case mode. All input, whether numeric or alphabetic, must be followed by the <ENTER> key. The only time the <ENTER> key need not be pressed is when you are entering the total number of digits (letters) allowed. For example, let's say that a required input parameter can have at most a five-digit value. If you only need to enter from one to four digits for the value, then you must press the <ENTER> key after entering the digits. If, however, you enter the maximum five digits, SOFT-OP will automatically proceed to the next function.

This chapter is designed to guide you through correct data entry procedures in SOFT-OP. Clarity of the guide, in addition to the time required in learning the correct data entry procedures, is dependent

upon your knowledge of the program format discussed thus far. If you do not feel as though you understand the information discussed in the previous chapters, please stop now and read them again, until you feel comfortable with the covered topics.

SYSTEM COMPONENTS. SOFT-OP is designed to run on a Radio Shack Model III microcomputer. The Model III must have 48K of random access memory (RAM) and two floppy disk drive units. In addition to the microcomputer, a standard Radio Shack (or compatible make) line printer is recommended.

SYSTEM REQUIREMENTS. If you are using the Radio Shack Model III computer for the first time, make sure you read Radio Shack's user's manuals thoroughly so you are familiar with use of the system hardware. You should already know how to:

1. Handle a floppy diskette
2. Make a backup copy
3. Format a blank diskette
4. Write protect a diskette with tape

STARTUP PROCEDURE. SOFT-OP requires two floppy diskettes. One has the program information stored on it, and the other holds the operational data entered by the operator. The program diskette always needs to be kept in drive #0 (lower drive unit). The data diskette goes in to drive #1 (upper drive unit). Make sure you have at least one backup copy of the program diskette stored in a safe location. The backup copy should only be used for making additional copies, should the need arise. Be sure to "write protect" this and all other program diskettes with tape, except when you are making a backup.

The data diskettes must not have their "write protect" notch covered since they will be updated continually with new data. Be sure to backup your data diskette at the end of each work day. The program is designed to read from and write to the data diskette. There should be a data diskette for each operational year. Each data diskette should be labeled with the corresponding year of the data stored on it. Even if you begin using SOFT-OP with only one month remaining in the current year, switch to a new diskette at the beginning of the new year.

To begin use of the SOFT-OP program perform the following instructional steps:

STEP 1: Check to see that both drive units are open and that they do not contain any floppy diskettes. Turn on microcomputer. Insert program diskette (with "write protect" notch covered!) into drive #0, and data diskette into drive #1. Press reset button.

STEP 2: The system should prompt you to enter the date first, then the time. If you do not wish to enter the date and time, you can bypass this procedure by pressing the reset button again.

STEP 3: At this point the system should say "TRSDOS READY." Type the word 'BASIC' and press the <ENTER> key (note: the < > symbol denotes a terminal key, and the ' ' symbol denotes typed letters and/or numbers). The computer should now ask "HOW MANY FILES?" followed by "MEMORY SIZE?". For the first question type '13V' and press <ENTER>. Since you will need the maximum amount of memory available, press the <ENTER> key in response to memory size and the computer will automatically reserve all usable memory.

STEP 4: The computer should now say "READY". At this point you are almost ready to use SOFT-OP. The final step is to load and run the program. Type the command 'RUN "INTRO"'. The computer will now load the program into memory and proceed to run it. You have just finished the startup routine. Now you are ready to use SOFT-OP.

INPUT PROCEDURE: A specific pattern must be followed when entering information in SOFT-OP. Figure 21 is a flow chart of the correct data entry procedure to be employed in SOFT-OP. Use of the flow chart is mandatory if you are just learning to use SOFT-OP. Continued use of the chart is recommended until such a time when you are completely competent in entering data in the proper sequence.

The following steps have been developed to illustrate the correct entry procedure. This guide assumes that you have the required data ready for input and that SOFT-OP has been logged onto the computer. Refer to Figure 21 during each of the following steps.

STEP 1: SOFT-OP's master menu should be on the video monitor (see Figure 22). The first decision block encompasses both facility design parameters and the limits imposed by the NPDES permit. If this information has not been entered, the diagram directs you to complete the SETUP routine. This routine is accessed by typing the number '1' in the master menu.

After typing '1', SOFT-OP queries whether you want to enter or change data. Type the letter 'E' if you are entering data for the first time. If you need to change data at a later date, type 'C'. After pressing 'E', the program displays various design parameters which require input. Enter each appropriate value and pay particular attention to the parameter units. When entering values which are less

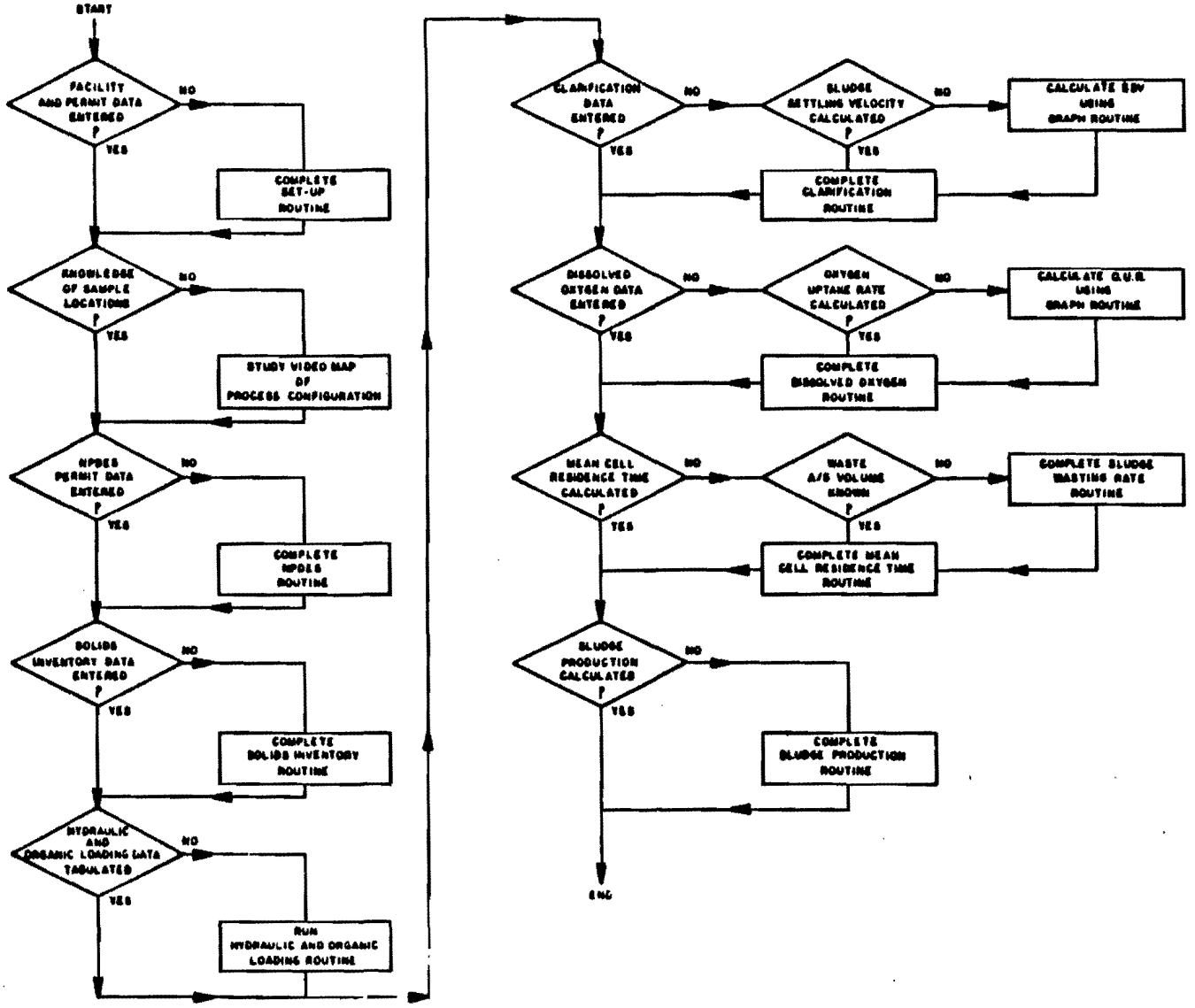

Figure 21. Flow chart of correct data entry procedure in program.

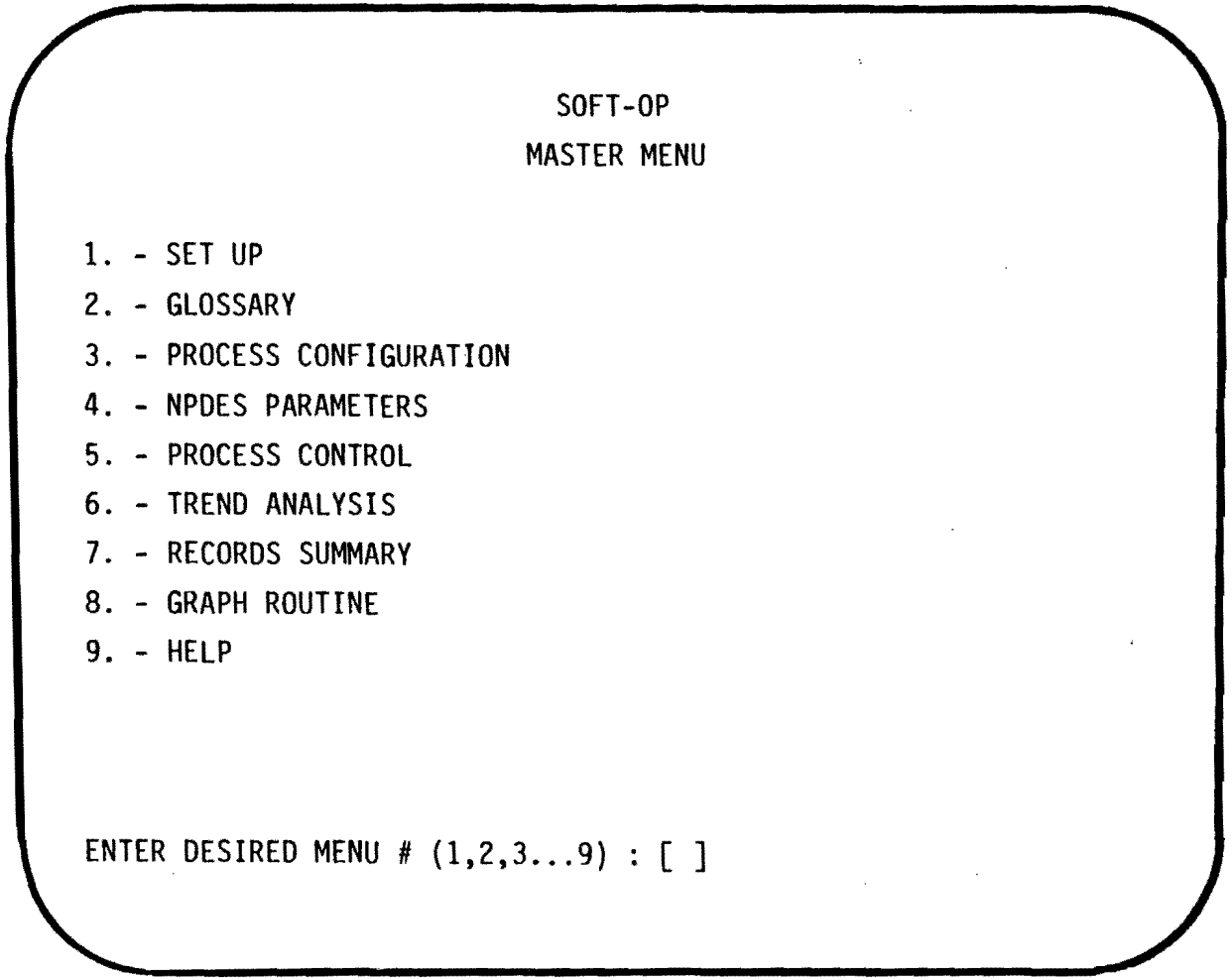

Figure 22. Master menu of program.

than 1, you need not place a zero in front of the decimal point. For example, if the minimum F:M ratio is two one hundredths (2/100), then you have the option of entering either '0.02' or '.02'.

After the last entry has been made, SOFT-OP will ask whether all the data has been entered correctly. At this point, make sure you go over each value and double check for errors in input. (Important: failure to adequately check data for input errors could result in the incorrect storage of data values.) If everything has not been entered correctly, type the letter 'N' for no. The cursor will return to the first data entry location. Press the <ENTER> key for each value you do not want to change. Once the cursor is positioned at the incorrect value, type the correct value and press <ENTER>. When all corrections have been made, bring the cursor back down to the bottom of the screen by pressing <ENTER> for each successive parameter value location. The cursor should once again prompt you as to whether everything is entered correctly. Since the corrections have now been made, type 'Y' for yes.

After typing 'Y', SOFT-OP continues with the SETUP routine by listing those parameters which make up the NPDES permit limitations. Enter these values in the same fashion as earlier, and type 'Y' once you have determined that they are entered correctly. Next, SOFT-OP will ask if the data record should be saved. By typing 'N' (No), the program will return to the master menu (without saving the information). You must enter the letter 'Y' to permanently store the entered data. Note: SOFT-OP can only access data that has been permanently saved on the data diskette. Once SETUP information has been entered and

recorded, you need not return to this routine unless changes occur in the NPDES permit and/or facility design.

STEP 2: The second decision block asks if you are familiar with the sample locations requiring data collection. If not, you should analyze the configuration of the oxidation ditch process as well as the sample locations and required parameters shown on the monitor within the PROCESS CONFIGURATION routine. This routine is accessed by typing '3' within the master menu. To exit the PROCESS CONFIGURATION routine and return to the master menu, press the letter 'R' for return.

STEP 3: If NPDES permit data has not been entered, the third decision block instructs you to complete the NPDES PARAMETERS routine accessed by entering the number '4' in the master menu. The first entry required is the date of analysis. Pay particular attention to the format in which the date must be entered. The first two digits represent the month, followed by a '/' then two digits for the day, followed by another '/' and ending with the last two digits for the year. For example, the 5th of August, 1983 must be entered as '08/05/83'.

Once the date is entered the cursor moves to the first NPDES parameter. Continue to input the various requested data until the program prompts whether everything is entered correctly. Press the letter 'Y' once you have checked the values to ensure that they are correct. To permanently store the information, type 'Y' when asked whether or not to save the data record.

STEP 4: The fourth decision block pertains to the input of solids inventory data. The schematic of SOFT-OP (see Figure 1) shows that you

must access the Solids Inventory routine by first entering the PROCESS CONTROL category. After typing '5' in the master menu, the program enters the PROCESS CONTROL routine and displays the menu for various process control subroutines. The fourth category menu is the Solids Inventory routine. After entering the Solids Inventory routine, a new menu is displayed (refer to the program schematic if you are unsure of your location within SOFT-OP). The Solids Inventory menu is used to access the four separate functions within the Solids Inventory routine.

Note that the first category is for solids input. Type '1' to access the data input routine. Once accessed, the cursor will be positioned at the date of sample. Always enter the date in the format previously discussed in STEP 3. Important: This date must also match the date recorded for NPDES data if the full data capabilities of SOFT-OP are to be utilized. Failure to do so will result in future "NSD" (not sufficient data) flags for many of the parameters calculated by the program.

After the date, both oxidation ditch and clarifier underflow MLSS concentrations and percent volatile MLSS values are required. The volatile MLSS fraction is recorded in units of percent (%). A 70 percent MLVSS is recorded as '70' not '0.70'. SOFT-OP calculates the remaining three parameter values and prompts for correct data entry. SOFT-OP proceeds to check for any alert conditions once the user has indicated that the entered information is correct. If and when alert flags are posted, you will have the option of obtaining further descriptions of alert conditions.

STEP 5: Hydraulic and organic loading data can be accessed within

the fifth decision block. This category is a subroutine within PROCESS CONTROL and can be entered by typing the number '3' within the PROCESS CONTROL menu. The only required input is the desired date of data tabulation. Be sure the date corresponds to actual dates entered in both NPDES PARAMETERS and Solids Inventory input routines. This is necessary because SOFT-OP accesses information from both of these routines to calculate various loading values. Once the parameter values are calculated, you have the opportunity to go back and change the date if it is incorrect. After indicating that the entered data (i.e., date) is correct, SOFT-OP checks the tabulated data for alert conditions.

STEP 6: The sixth decision block pertains to clarification data collected from the process. If the data has not yet been entered, the flow chart directs you to another decision block. This block deals with the calculation of the SSV parameter. If, at this point, you still need to calculate the SSV value, enter the GRAPH routine to do so. To return to the GRAPH routine from the PROCESS CONTROL menu type '6'. Once you're in the master menu, type '8' to enter the general GRAPH routine.

After entering the sludge settling data, SOFT-OP will calculate the slope of the equation during the graph analysis phase. Pay particular attention to units when plotting the data and make sure the slope of the line is expressed in units of feet per hour (ft/hr). (Note: Temporarily record this value on a sheet of paper and reserve it for later entry into the program as the SSV value.) At this point, you are ready to return to the Clarification routine. Return to the master menu and input the number '5' to enter the PROCESS CONTROL routine, followed by '1' to enter the Clarification routine.

Once in the Clarification routine, the cursor will prompt you to enter the sample date. This date must match a date already recorded in the Solids Inventory input routine in order to prevent "NSD" output. After input of requested parameter values, the program performs a few calculations and then prompts for correct data entry. SOFT-OP enters the alert analysis phase after you have correctly entered the information. The program returns to the PROCESS CONTROL menu upon completion of the routine.

STEP 7: Parameters affecting the control of the dissolved oxygen concentration within the A/S are entered following the Clarification routine as Figure 21. If the OUR value has not been calculated, the next decision block directs you to the GRAPH routine. It is within the GRAPH routine that you obtain the actual OUR value (refer to the chapter on sample techniques if further explanation is needed). Complete the Dissolved Oxygen routine once the OUR parameter has been calculated. Access the Dissolved Oxygen routine by entering the number '2' from within the PROCESS CONTROL menu.

Be sure that the sample date you enter matches a date already stored in the Solids Inventory input routine. This is necessary since SOFT-OP uses information from the Solids Inventory routine during calculation of the SCOUR parameter. After the requested data is correctly entered, the program analyzes the information for any possible alert conditions. If alert conditions exist, SOFT-OP will display alert flags. At this point, you have the option of obtaining a detailed description of the alert condition(s). Once the routine has been completed SOFT-OP returns to the PROCESS CONTROL master menu.

STEP 8: Calculation of the actual MCRT is performed within the eighth decision block. The Sludge Wasting Rate routine should be used if you do not know the volume of sludge that needs to be wasted each day for maintenance of a particular MCRT. To access the Sludge Wasting Rate routine, you must first enter the Solids Inventory category shown in the PROCESS CONTROL menu. Once the Solids Inventory menu is displayed, type the number '2' to enter the Sludge Wasting Rate routine.

No information is stored during use of the Sludge Wasting Rate routine. Note that this routine does not require any date of analysis. Its sole function is to assist in the determination of the quantity of sludge that must be wasted daily. After entry of the desired MCRT, you must also input the various estimated sludge concentrations. Remember that these values are estimated since laboratory analysis for suspended solids usually takes one day to perform.

The pumping rate of the waste activated sludge is the last value required as input. SOFT-OP proceeds to calculate the required pumping duration as well as sludge quantity and volume. It is important to note that the requested MCRT will only be maintained if the estimated sludge concentrations closely resemble the true values, and also if the sludge is wasted daily.

Each time sludge is wasted from the oxidation ditch process, you should enter the wasting data in the Mean Cell Residence Time routine. Failure to do so will result in inaccurate calculation of the true MCRT of the process. You should complete this routine only after you have the true WAS concentration and volume for the day of wasting. Access the Mean Cell Residence Time routine from the Solids Inventory menu.

The date of sludge wasting is the first entry required. This date must match the date of previous Solids Inventory input data.

After entry of the actual WAS MLVSS concentration, you must enter the actual volume of sludge pumped. SOFT-OP will use this data to evaluate the MCRT. The calculated MCRT is not the true value, however, unless the same amount of sludge is wasted each day. (Note: Use the RECORDS SUMMARY routine to determine the true) monthly average MCRT.

STEP 9: Calculation of sludge production within the process can be performed inside the final decision block of the flow chart. This routine enables you to monitor the total solids inventory in the process on a monthly basis. To access the Sludge Production routine, enter the Solids Inventory menu and type the number '4'. You need only enter the month and year for the desired analysis. The format must be two digits for the month, a '/' and two digits for the year. For example, if you wish to analyze process data during the month of September, 1983, you must enter '09/83'.

Make sure that the data diskette already contains a month's worth of information for the date entered in this routine. You should not access a particular month which only has a week's worth of data stored thus far. Once the date has been entered, SOFT-OP calculates many different parameter values related to sludge production. Since this routine does not supply data to other routines within SOFT-OP, the calculated parameter values are not stored on the data diskette.

By following the preceding steps, the user is able to correctly enter the numerous parameter values required by SOFT-OP. It is highly recommended that you strictly adhere to the proposed method of data

entry as well as the collection of required data. The ability of SOFT-OP to assist in the evaluation and control of the system is severely impaired if parameter values are omitted and/or entered in a random fashion.

DATA ANALYSIS PROCEDURES

Optimum performance of the oxidation ditch system is dependent upon the control strategies applied during daily plant operation. Consistent and rational process control relies heavily upon your ability to evaluate the ever-changing system characteristics. SOFT-OP strives to assist in maximizing plant performance by addressing these concerns. Through use of the program, you are able to sufficiently monitor conditions in the process with respect to time.

In addition, when process control changes are undertaken, SOFT-OP assists in determining the modifications in operating procedures that are required to bring about these changes. These built-in features enable you to easily evaluate cause-and-effect relationships between the various control strategies that might be applied. This insight is beneficial for determining the process control level that yields optimum plant performance.

Various data analysis functions are performed within SOFT-OP during and after the input of process control and evaluation parameters. As information is entered in each of the PROCESS CONTROL subroutines, SOFT-OP checks for operating procedure errors as well as impending changes in process characteristics. The correct use of the PROCESS CONTROL subroutines was discussed in the previous chapter. In this chapter, you will learn how to access and use the TREND FORECASTING, RECORDS SUMMARY and GRAPH routines. Each of these routines is designed to assist you in monitoring process conditions.

TREND FORECASTING: This routine is accessed from the master menu by entering the category number '6'. Once in the routine, you can plot, display and analyze any of 14 different parameters. The first entry required is the beginning month of data analysis. Enter the month and year in the format used previously (e.g., August, 1983 = '08/83'). The second entry is the number of months to be plotted. For example, if you want to plot the SSV from March to April, 1983, the first entry will be '03/83' followed by '02' (representing the number of months to be plotted.) Be particularly careful that the information for the requested time period is already stored on the data diskette.

The next input is the specific parameter to be graphed. Enter the corresponding category number of the parameter. After everything has been entered correctly, SOFT-OP will continue with the plotting routine. A new screen format will be displayed so that the user can enter the vertical (Y) and horizontal (X) axis descriptions, units, and maximum coordinate values. Again, note that the maximum coordinate value for each axis must be greater than or equal to the maximum value of the group of data to be plotted. Once these values are correctly entered, SOFT-OP will tabulate each weekly average value of the selected parameter during the specified time period. The X-axis values represent the time, in weeks, for each corresponding Y-axis value. Enter the letter 'C' to continue with the program.

At this point, SOFT-OP displays the plotted data. You should observe the data and note whether the trend more closely resembles a linear or logarithmic equation. After pressing 'C' to continue, you have the choice of either making a hard copy of the graph, analyzing

the plotted data, or returning to the master menu.

To perform statistical calculations, select the graph analysis phase. The first value calculated is the total number of plotted data points. You must then select whether the data is to be fitted to a linear (type 'LI') or logarithmic (type 'LO') equation. Next, enter the beginning and ending data points desired for analysis. In most cases, you will use the maximum set of data for curve fitting. If, for example, you have ten data points, the beginning and ending data points should be '1' and '10', respectively.

After the beginning and ending data points have been entered, SOFT-OP calculates the slope and Y-intercept of the fitted equation. If a logarithmic equation is selected, be sure to note that the fitted equation follows the format of "ln(y)=mx+b" (not the linear form of "y=mx+b"). In other words, the resulting Y-intercept value is the value of "ln(y)" not "y", and the slope of the line represents the change in "ln(y)" over the change in "x".

The coefficient of determination is calculated by SOFT-OP and should be used to evaluate the degree of accuracy between the data set and the fitted equation. If you are not sure whether a linear of logarithmic equation best fits the data, run through the analysis routine twice and observe which function yields the highest coefficient of determination value. Remember that a coefficient value closest to "1" is the most desirable.

After the data has been entered correctly, you have the option of predicting values along the fitted equation line (if the coefficient of determination indicates a reasonable fit). If you wish to use the

prediction function type 'Y', SOFT-OP will prompt you to enter the desired axis you wish to predict a value on. After axis entry, input the given value (from other axis) and the program will calculate the estimated value. You can predict numerous values by returning to the prediction function by typing 'N' for whether or not the data is entered correctly. At the end of the graph analysis phase, you have the option of making a hard copy of the plotted data or returning to the master menu.

GRAPH Routine: This routine is similar in format to the TREND FORECASTING routine. The two routines do, however, have one significant difference. Use of the GRAPH routine allows you to plot any desired data, whereas in the TREND FORECASTING routine, only specific parameters can be graphed and analyzed. One particularly important function of this generalized GRAPH routine is the calculation of both SSV and OUR parameter values.

Access the GRAPH routine by typing '8' from within the master menu. After entering the routine, SOFT-OP first prompts you for the total number of data points to be plotted. Noice that there can be at most, 31 data points. The second entry is the graph date, followed by the vertical (Y) and horizontal (X) axis descriptions, units, and maximum coordinate values. The vertical axis data can be entered in any order, however, the corresponding horizontal values must be entered in increasing order. For example, say that you need to plot the following three data points, (5,2), (4,8) and (10,5), (note that the points are in the (X,Y) format), the horizontal (X) axis values must be entered in increasing order: (4,8), (5,2), and (10,5). The

Y-axis values 8, 2 and 5 are entered first, followed by the X-axis values 4, 5 and 10.

After the X and Y-axis values are entered correctly, SOFT-OP graphs the data on the video monitor. Press 'C' to continue with the routine. SOFT-OP will prompt you as to whether you would like to continue on with the graph analysis phase, receive a hard copy print-out, or return to the master menu.

RECORDS SUMMARY: The RECORDS SUMMARY routine is entered through the master menu by selecting the number '7'. Once in the RECORDS SUMMARY routine, you have the option of obtaining the monthly averages for any or all of the PROCESS CONTROL subroutines, in addition to receiving a NPDES permit summary. The easiest way to produce a complete records summary of entered data is to select the NPDES permit category (#1) and continue with the summary from this routine. If only one particular routine summary is desired, select the specific category number. Before the summary can begin, you must enter the desired month and year of the data to be summarized. Be sure to follow the previously used format for date entry (e.g., August, 1983 = '08/83') and make sure that the requested month is stored on the data diskette.

Alert flags will appear in the NPDES permit summary if there are violations in design and/or NPDES permit limits. Should alert flags appear, you can obtain a listing of the specific alert conditions by entering 'Y'.

To obtain a hard copy of the information recorded within each routine, enter the raw data printout routine (#7) shown in the RECORDS

SUMMARY menu. Since this routine sends the results to the line printer, make sure that the printer is connected and ready to receive data. All printed information is first listed by the date of entry, followed by the specific parameter values. SOFT-OP returns to the RECORDS SUMMARY menu after the last data record from each routine has been printed.