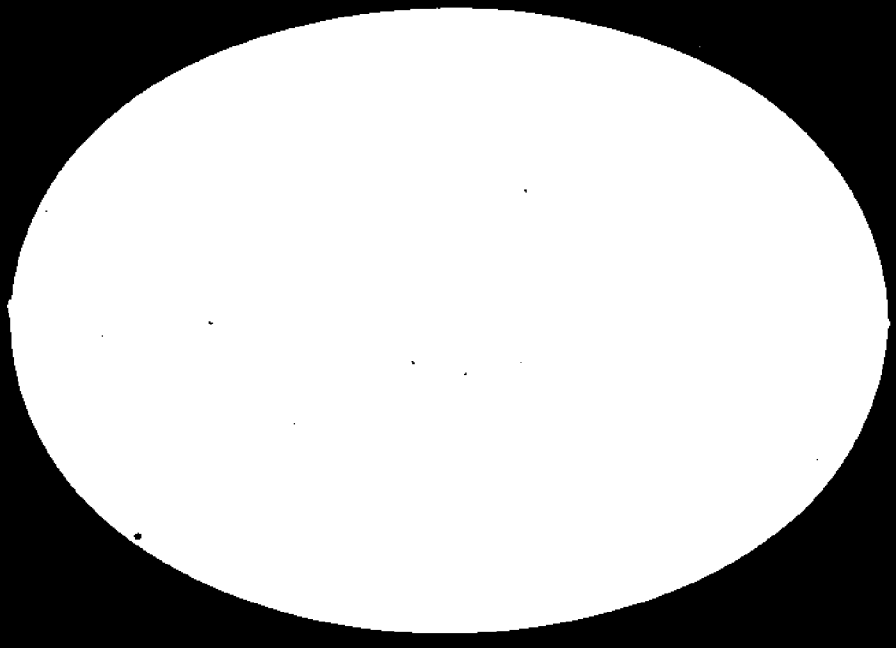

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BATHYGRAPH: A PROGRAM PACKAGE FOR MAPPING BATHYMETRIC SURFACES

A MARINE SCIENCES ORIENTED GRAPHICS PACKAGE FOR INTERDEPARTMENTAL USE ON THE BURROUGHS B-7700 AT THE UNIVERSITY OF DELAWARE

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PREFACE

The five computer programs presented in this manual are intended for use by marine scientists involved in surveying the sea floor. These programs are written in FORTRAN and are designed specifically for use on the University of Delaware Burroughs B-7700 system.

This package of programs gives the marine scientist a graphics capability in creating 2-dimensional and 3-dimensional constructions of portions of the sea floor. The programs are user interactive with a wide range of choices concerning the details of graphics design. The accompanying manual explains in explicit detail the operation of the programs and the application of the graphics.

This material is designed to interface with the active Sea Grant research of the College of Marine Studies and the Departments of Geography and Geology, with a minimum of preparation and effort. Once implemented in any specific research endeavor, BATHYGRAPH offers a rapid mechanism for producing graphic displays of a range of data types custom designed to user specifications.

This manual represents the ongoing attempts of the N.O.A.A. Sea Grant Program at the University of Delaware to investigate the form and process of marine related phenomena in the Atlantic Ocean and Delaware Bay littoral zone.

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SECTION I

INTRODUCTION

The BATHYGRAPH programming package has been created for use by marine scientists as a means of manipulating bathymetric survey data and producing hardcopy or CRT (Cathode Ray Tube) graphic projections. The package is designed for use on the University of Delaware Burroughs B-7700 system. The programs in the package are written in FORTRAN and may be edited with the CANDE language. The programs assume a fundamental computer literacy on the part of the user.

BATHYGRAPH is designed for use with vertical depth data taken in profile fashion along surveyed transects. Controls on water level fluctuation, data distortion due to unequal sample intervals, absolute elevation, and various errors transmitted from poor survey technique or digitizing technique are not provided by this package. These criteria are assumed as part of the skills of the investigating scientist. For information in conducting bathymetric surveys, the user is referred to Sallenger, 1975; U. S. Army Corps of Engineers, 1977; Jeffers, 1960; Saville and Caldwell, 1953.

The BATHYGRAPH package allows the user to enter data in a three-dimensional cartesian coordinate system format. Generally, the matrix created by the package assumes the Y direction to be distance along a profile transect, the X direction to be distance between successive transects and the Z direction to be in the vertical direction (depth). This data is manipulated by the package to conform to certain requirements of data structure and matrix orientation necessary in creating the various graphical projections. It is necessary for the user to be thoroughly familiar with the range and variation of the data as well as able to identify individual transect runs.

Outlines of the survey area may be made using the digitizing facilities available at Smith Hall through the Office of Academic Computing Services, or by special permission of Dr. Frank Gossette in the Computer Graphics Lab of the Geography Department in the basement of Hartshorn Gym. Details on the use of the digitizer will not be covered in this manual. It is strongly advised that the user become familiar with this instrumentation and its use. The most efficient method of producing a data set from fathometer records or other type of depth transducer produced records is by use of the digitizer.

This instrument is capable of creating accurate and computer compatible data from hardcopy analog signals and from maps.

The area outline used in creating contour and three-dimensional projections may usually be digitized directly from United States Geological Survey topographic sheets. These sheets are available in various scales and will suffice for most survey needs. Aerial photographs available from the U. S. Department of Agriculture or various other mapping agencies are also recommended as excellent sources for base map data. The user should be aware of the potential for error due to material distortion and changes in landform morphology relative to the age and accuracy of these data sources.

Assuming the user has created, of has access to, an appropriate data set, with points of depth control identified relative to a cartesian reference plane and a compatible outline area adjunct to the data set, the BATHYGRAPH package will allow production of the following:

1. Two-dimensional transect profiles of bottom topography.
2. A planimetric contour map of the survey area with user directed contour values and contour interval.

3. A three-dimensional conformant, contour, proximal or isometric projection of the survey area and the included bathymetry.

(Future editions of this package will have the capability of producing stereo pairs of the subject area as well as three-dimensional projections using any combination of X, Y, or Z isolines, additionally - an inversion view of the underside of the seafloor will be provided).

Various embellishments and user specified details are available to enhance the graphics products. These are made accessible to the user through interactive exchange with the programs prepatory to actual plotting. These include such items as a north arrow, map scale, titles, contour declaration, sea level horizon, multi-color output, etc. An especially convenient aspect of the profile plotting portion of BATHYGRAPH is the capability to scale profiles to a reduced size and position several plots on one 8.5 x 11 inch sheet of paper. This increases the utility of the output by enhancing comparative analysis between two or more profiles.

The BATHYGRAPH package does not directly produce three-dimensional projections. Rather, it massages the data into the proper format to permit ready use of the

SYMAP software system. This program will create a matrix from which a companion program, SYMVU, is capable of producing oblique views of conceptual surfaces with interpolated or other values provided by the SYMAP matrix file. This will be explained further in another section and the user will be provided with the necessary programming information to produce a SYMVU surface.

In summary, the BATHYGRAPH package accepts digitized, three-dimensional, cartesian reference data of changing depth as a function of distance and produces graphics output in the form of transect profiles and contour maps. The data is also manipulated for utilization by another, common, software system for final production of projected three-dimensional surfaces.

Structure

This part of the manual will detail the operation and logic of the five (5) programs which comprise the BATHYGRAPH package. Several references are made to the SYMAP and SYMVU plotting packages available at the University of Delaware. The manual supposes a user ignorance of this software and requests that the user endure references to SYMAP and SYMVU until a later section where these will be rudimentarily explained.

These five programs are:

(1) FLIP - a program which converts digitized data from English units to the metric system, and then scales the data relative to real world distances.

(2) MANIP - a program which manipulates an X, Y, Z coordinate data file of depth soundings (in this case) to SYMAP software compatible form. The output from this program, when combined with the FLIP output file, creates a data sequence file which is ready for use with the SYMAP mapping package.

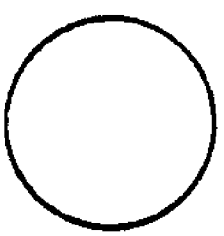
(3) ZMAXER - a program which adjusts the SYMAP created data matrix for use with the SYMVU option. The adjustment is necessary when using the matrix for activities other than SYMVU. This adjustment must also be made when plotting depth data with the SYMVU 3-D software.

(4) ISOMAP - a program which utilizes a data file created by MANIP to generate a contour map of the survey area. Several options are available to the user for enhancing the utility of the contour map.

- Symbol identifies user supplied data file(s).

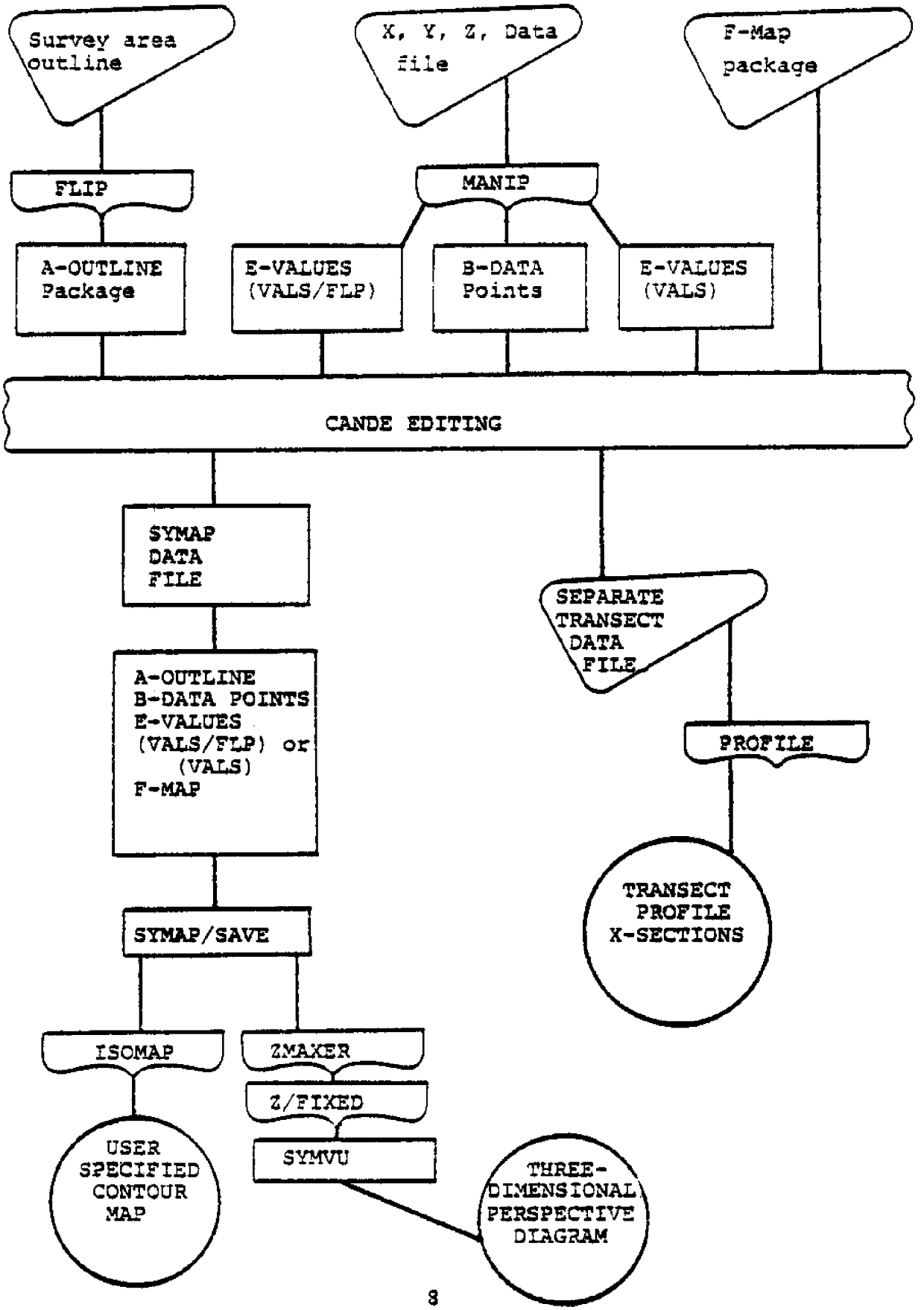
- Symbol indicates BATHYGRAPH associated program or matrix file.

- Symbol indicates SYMAP or SYMVU associated data file.



- Symbol indicates final hardcopy product.

Figure I-1. Flow chart describing the sequence of operation leading to the creation of the three basic BATHYGRAPH products. Symbology is explained above.


Survey area outline
X, Y, Z, Data file
F-Map package
FLIP
MANIP
A-OUTLINE Package
E-VALUES (VALS/FLP)
B-DATA Points
E-VALUES (VALS)
CANDE EDITING
SYMAP DATA FILE
SEPARATE TRANSECT DATA FILE
A-OUTLINE
B-DATA POINTS
E-VALUES
(VALS/FLP) or
(VALS)
F-MAP
PROFILE
TRANSECT PROFILE X-SECTIONS
SYMAP/SAVE
ISOMAP
ZMAKER
Z/FIXED
SYMVU
USER SPECIFIED CONTOUR MAP
THREE-DIMENSIONAL PERSPECTIVE DIAGRAM

(5) PROFILE - a program which will plot two-dimensional profiles of separate transects in the survey grid. User controlled options permit several embellishments to be applied.

A detailed analysis of each program follows.

FLIP

The FLIP program requires an input file consisting of the digitized outline of the survey area. This file should be constructed of two columns of data. The first column holds X-values of the vertex points making up the survey polygon. The second column holds Y-values of the vertex points. Adjacent X and Y values must correspond to the same point in the polygon outline. A requirement of this data set is that the last vertex point and the first vertex point be exactly the same value. All of the digitizers presently on the University of Delaware campus accomplish the necessary data structures. However, the user must enter the file and adjust the values of the first and last points. This may be done with the CANDE 'fix' command.

FLIP requires the following information; the input file name (name given to the digitized data file, followed

by a period (i.e. - DIGIDAT. -), the output file name (any name which the user will recognize as converted outline data, (i.e. - OUTFILE. -), followed by a period), the scale of the digitized base map (i.e., if your map is 1:80,000, the scale is 80,000, this must be entered as a real number). This is the only information the user need furnish the program. Once the program is running, the terminal will prompt the user to enter the proper information.

FLIP performs several manipulations. The program prompts the user to supply the relevant file names, and then reads and assigns these names to the appropriate files. The user is then prompted to supply the basemap scale. This is entered as a real number. The map scale is reduced four (4) orders of magnitude and applied to a metric conversion equation. The digitized data is converted from inches to a metric equivalent which is four (4) orders of magnitude too large. A reduction in magnitude and conversion to real world length scale is made with the reduced (.0001 x 80,000.) map scale coefficient. Whatever map scale is used must be entered as a real number.

Following the data conversion algorithm, the program establishes the value of Ymax (the maximum Y value). This value then serves as a reference from which each successive Y value is subtracted. This essentially flips the Y data set so that the zero value is now in the upper left corner rather than the usual lower left corner. X values may now originate at this position without manipulation. That is, the data reference system has been flipped from an origin in the lower left corner to the upper left corner. This is in compliance with the needs of the SYMAP package.

Finally, the FLIP program titles this outline data set, 'A-OUTLINE' and succeeds it with a termination flag '99999'. These additions are made in convention with SYMAP requirements.

MANIP

The MANIP program was created as a data management tool in order to process input (X, y, Z) values and structure them in a SYMAP usable format. The program assumes that all data increase in the positive direction and are derived on a typical cartesian coordinate system. Input data must be formatted as 3F10.2. This means that each line of data must consist of three variables (X, Y,

Z). Each variable must have 10 characters with 2 implied decimal places. Any of these characters may be blanks as long as the 10 character field width is obeyed. If the data is not structured in this manner, then the program will not operate properly. Further information on format procedure may be obtained from Lee (1972).

The program prompts the user to furnish the input file name which consists of the X, Y, Z data. This information is assigned to the proper file and the data is dimensioned with further user supplied information. The program presently has capability to handle 2,000 separate data points. The input file must not exceed this number of location values.

A scaling algorithm allows the user to interactively adjust the relative dimensions of any of the three (X, Y, Z) values. This option is provided for user versatility in reducing or enhancing various aspects of the matrix. A Z scaling factor of 1.5, for instance, will increase the relative height and relief of bathymetric landforms and allow for greater resolution of these features. A call to scale the X or Y dimensions will alter the length or width of the output matrix with the result that various aspects of graphics production will

be enhanced or suppressed. The user is warned that severe distortion of the data results from misuse of these capabilities and any final output should be preceeded by a thorough understanding of exactly how the data matrix was altered. These algorithms do have the potential to be quite useful if properly applied. If no scale distortion is desired then a value of 1.0 must be entered by the user. The program utilizes the user supplied scaling factors and applies them to the input file. The file is read and scaled and values of Ymax and Zmax are established.

At this point the Y axis inversion algorithm described in the FLIP program section is invoked in order to structure the data point locations (X, Y) in a SYMAP compatible fashion. The new, inverted Y values and the original X values are then internally written to the output file known as DATA/PTS. The values list is preceeded by the title 'B-DATA POINTS' and flagged with the termination symbol '99999'. These are SYMAP conventions which internally signal the SYMAP system when the data location points value list begins and ends.

The program then gives the user the option of creating a data matrix for use in producing a three-dimensional diagram or a contour map.

If the user chooses to construct a 3-D diagram, the program asks for a user supplied value below which will be drawn the sea-floor. Since the program is designed for depth data and not height data, an algorithm is performed which assigns a 'zero' surface (which acts as visual sea level) from which the sea floor descends. The algorithm subtracts each Z value from the maximum value (this flips the Z values so that the deepest point of the survey is assigned a value of zero (0), thus allowing all other features of the sea floor to be plotted as positive landforms). The new Z list is incremented an additional amount supplied by the user. This allows a base to underlie all the plotted values. This base adds perspective and reference to the final graph.

To reiterate, the algorithm just described is the crucial means of converting what would otherwise be simple topographic data to true bathymetric data. If this algorithm was not performed the real data point of <u>greatest</u> depth would actually appear as the highest landform on the seafloor map and thus be interpreted as the point of <u>least</u> depth. This new Z list is then internally written to a file called 'VALS/FLP'. The SYMAP conventions are also added as 'E-VALUES' and '99999'.

If a contour map is preferred, the program reads the unflipped Z values into a data file called 'VALS' and flags this file with the SYMAP conventions of 'E-VALUES' and '99999'. A final statement is then printed to the users terminal explaining what has been performed.

In summary, the MANIP program reads an input data file of formatted (3F10.2)X, Y, Z values and allows the user to interactively scale any of the three values. The scaling operation is performed and an algorithm is employed to make the X, Y data SYMAP compatible. The manipulated location values are then written to an output file called 'DATA/PTS'. Further manipulation is performed on the Z values to arrange them for use in producing either contour maps or three-dimensional diagrams.

The final output consists of potentially three files. They are:

DATA/PTS - This file corresponds to the 'B-Data Points' list of the SYMAP system. This file contains the location coordinates of all depth soundings.

VALS/FLP - This file consists of SYMAP compatible Z(depth) values for use in generating three (3) dimensional perspective diagrams.

VALS - This file consists of SYMAP compatible Z (depth) values for use in generating contour maps.

ZMAXER

The ZMAXER program performs a simple matrix manipulation of the SYMAP/SAVE. file which is generated by elective 21 of the SYMAP system (more on SYMAP later). Elective 21 assigns an integer value of 25 to all locations in the matrix which are not part of the interpolated surface. That is, when the SYMAP program is run and a SYMVU useable matrix is generated, the user defined area of the matrix usually contains several points which have not been assigned real values by the original data. These locations are automatically assigned integer values of 25 by SYMAP, which it recognizes and plots as zero Z values. However, in plotting depth data, these values give the illusion of a surface lower than the bottom topography. This is not desirable. It is desirable to have these values form a plane which the viewer interprets as sea level, this plane must, therefore, be above

the shallowest depth (the highest landform).

The ZMAXER program allows the user to interactively assign a new value to the integer 25 locations within the matrix. It is recommended that the user assign a value to these locations which is greater than the largest Z value in the entire data set. The greater the assigned value is above the Zmax value, the deeper the water depth will appear to be. It is recommended that the user try several values before deciding upon the value which most accurately reflects his knowledge of the true water depth.

The user should run ZMAXER after having created a SYMAP/SAVE file with elective 21 of the SYMVU system. When prompted by ZMAXER to supply the input file name, the user should enter 'SYMAP/SAVE.' (remember the period).

The ZMAXER program then prompts the user to supply the new integer 25 value. This number should be entered as a real number. An algorithm is performed by ZMAXER which reads each value of each row of the SYMAP/SAVE matrix and looks for the integer 25 assignment. Whenever this location is identified, the new user supplied value is established as a replacement to integer 25. The matrix with the new values is then written back to an output file entitled 'Z/FIXED.' Finally, a termination statement is furnished to the user to explain the use of the new file.

ISOMAP

The ISOMAP program is a completely interactive method of allowing the user to control the production of a contour map of the survey data. This program will be detailed below and a review of user options for each interaction is included.

ISOMAP begins by prompting the user to furnish the input filename of X, Y, and Z values to be contoured. The user has prepared a file for exactly this purpose with the program MANIP. The file 'VALS' created by MANIP must be entered as the E-VALUES package in a SYMAP program in order to create an interpolation matrix for use by ISOMAP. The 'VALS' data file contains the actual Z values recorded during the bathymetric survey. The Z values have not been flipped due to the desideration of having the contour values correspond to the recorded depth measurements. The file name to be entered, then, is 'SYMAP/SAVE.' (Remember, the SYMAP program using the 'VALS' E-VALUES package must be run in order to create the 'SYMAP/SAVE.' matrix file).

At this point the user should run the program and note the values of NCOLS and NROWS which are supplied by ISOMAP.

The program reads the first line of the saved matrix file. This first line furnishes several items of information about the contents of the matrix. After reading the first line the program prints the line so the user may read it. The only items of interest to the user are the values of NROWS and NCOLS. These values tell the user the number of rows and the number of columns contained in the data matrix. These values must be furnished to the SYMVU program, later, which the user must run in order to create a 3-D projection. Make a note of these values.

The numerical values associated with NCOLS (number of columns) and NROWS (number of rows) must also be used to re-dimension the ISOMAP program. This requires entering the program and editing lines 500 and 600. The CANDE FIX command must be used to replace the DIMENSION values of Z (,) and ROW ( ). Z should be dimensioned as Z (NROWS, NCOLS) and ROW as ROW (NROWS). IWORK must also be re-dimensioned as IWORK(NROWS x NCOLS). That is, IWORK is dimensioned as the number of columns <u>times</u> the number of rows.

The user must terminate the ISOMAP program (or let it terminate itself, which it will if improperly dimensioned) and use the CANDE 'FIX' command to correct the DIMENSION statements of Z, IWORK, and ROW.

The program then offers the user the option of suppressing printed contour labels. An example of this labeling may be viewed in Appendix A. The labels are unobtrusive and in most cases quite indispensable to interpreting the map. However, if the user plans on further embellishments to the output, such as various methods of data representation using the contour map as a base, then it may be an advantage to suppress these labels. Instructions are offered by the program to achieve this goal.

The option of scaling the final map is available. This may be done by entering any real number. A value of 1.0 will produce a map exactly the size of the matrix. This size may be controlled by use of certain options available on the SYMAP *F*-MAP package. These options include use of SYMAP electives such as 1, 13, and 15. Several attempts at applying various scale values may be

necessary before the product complies with the users needs (Remember, values entered less than 1.0 will make the contour map smaller and values larger than 1.0 will make the map larger. All entered values must be real numbers).

Due to the Y axis 'flip' algorithm exployed in MANIP, the data matrix is not in a normal cartesian reference form. In order to re-establish the matrix origin in the lower left-hand corner, a rotation algorithm is used to exchange matrix rows for matrix columns. This is done in a counter clockwise fashion so as to bring the origin back from its position in the upper left-hand corner. The map origin is now in normal cartesian position.

The user is prompted to enter the plotting device number. This number identifies the mechanical instrument which will physically create the map. The options are:

Device Number	Device
10	Tektronix 4662 Flatbed Plotter
21	HP 2648A Graphics Terminal
22	Tektronix 4010, 4013, 4006 Terminal
30	HP 7221A Flatbed Plotter

For final hardcopy products, device numbers 10 or 30 are suggested. But all preliminary attempts at production should be done with device 21. This prints a copy of

the map on the CRT terminal screen. This allows rapid use and familiarization of various interactive options and does not tie up the hardcopy printers which other cartographers may be waiting to use. This also saves on pen and paper expenses. Hewlett-Packard 2648A graphics terminals are available in Smith Hall and Penny Hall.

Many users will want to structure the contour map in a more liberal fashion than the computer capabilities allow. For this reason the option of not titling the map is offered. This title may include up to 30 characters including punctuation and spaces between words. The title may be placed anywhere on the map by providing the cartesian reference coordinates at which the lower left corner of the first letter of the title is to be located. These coordinates are in inches, but remember to account for the scale factor entered earlier which will change the length of a true inch to a map scaled inch. That is, if a scale factor of .75 is entered, then the title coordinates will correspond to a distance .75 times the true distance. The height of title lettering may be controlled by the user, a common value for this detail is 0.25 inches, enter 0.25 when prompted.

The contour map may be bordered by a line of any length. This option provides a frame within which to view the product. An origin for the lower left corner of the border must be provided, remember to scale this point. A good place to begin is the point 0.5, 0.5. The length of the border sides must also be furnished by the user. The scaling problem applies here also.

The next series of options available to the user concern the problem of communicating to a map user the contour information necessary to properly interpret the map. The contour interval must be supplied by the user as well as a statement ('literal string') to this effect. The statement must be less than or equal to 30 characters long. A typical statement may be 'CONTOUR INTERVAL: 4 METERS'. This example consists of 26 characters (remember to count blanks). This literal string may be positioned anywhere on the map in a fashion similar to the title. The angle of this statement is user controlled. Zero (0.0) degrees is a horizontal string and 90.0 degrees is vertical. All angles between 0.0 and 360.0 are possible. The usual angle is 0.0 degrees for easiest reading.

The map may contain a north arrow if wished. The angle of magnetic north from true north may be obtained from any U. S. Geological Survey Topographic sheet of the area surveyed. A value of 0.0 will provide a vertical arrow. The location of the arrow origin must be user supplied.

A map scale is a necessary item to properly interpret distances on any map. For whatever reason, the user has an option to delete this feature. To provide a map scale, one must be able to convert map distance to real world distance. A real number of map inches must be provided to the program. This value will be the basis of the map scale (subject to scaling factor). Since most scientists work in the metric system, this program provides an internal metric conversion algorithm. The complete process is described below.

The user must first plot a test map on one of the hardcopy flatbed plotters. From this initial map a distance should be measured which can be reproduced as a real world distance. This may be done by measuring the same line on a topographic sheet, an aerial photo, or some other medium from which may be obtained the real world distance. The real world distance may also be

derived by knowing the length of a survey transect run and applying that to the same line measured on the test map. The test map measured distance is first entered as a real number (inches) and then the real world equivalent for that same length (meters). The two are both reals, separated by a comma.

The program converts the real world measurement (entered as meters) to meters and then divides the conversion by the test map distance. This gives an inches per meter scale increment which is later passed to a subroutine to plot the map scale. In all cases, the values given to the program must be in inches and the resulting scale will be in meters per inch.

The program then prompts the user to enter values for the location of the map scale and the number of inches to be represented as real world meters. This value is referred to as 'axis length' in the program prompt; it simply means the length of the map scale. A good value for this is 3.0.

At this point the program is almost ready to create a map. The only further information it needs is the values of the contours to be plotted. The user is prompted to enter the number of contours to be plotted. As many

as 20 are allowed. One-by-one the program will ask to be given the values of the contours. These need not be given in any particular order. It is recommended that the value 0.0 be requested as a contour in order to outline the area surveyed. The maximum depth should also be requested as a contour value. These contour values may be entered as either integer or real numbers.

This is the last interactive exchange to occur between user and computer. The program assigns values of number of matrix columns and matrix rows and closes the interactive files 5 and 6. Calls to bindable subroutines follow the closing of the user interactive files. DELPLOT subroutines PLTSRT, PLOT, FACTOR, CONTR, SYMBOL, AXIS, and HOME utilize the interactively supplied information and combine to produce a contour map of user controlled specifications.

PROFILE

The last program in the BATHYGRAPH package is a totally interactive series of user options which produce two-dimensional, x-section profiles of discrete survey transects. The user must section the survey data into separate CANDE data files. These files may be created with the CANDE 'MAKE filename DATA' command, followed by

SEQ. Use of the INSERT command will fill the new file with whatever lines of data the user wishes to profile. These lines are removed from the original data file containing the survey X, Y, Z values. The profile plot may consist of only two dimensions, however. Therefore, the PROFILE program must read the data as containing only two points per line of record. These are Y (distance along transect) values and Z (depth below sea level) values. A plot of these coordinates will produce the cross-sectional display desired by the user. The program reads the input file as a 10X, 2F10.2 format. Since the data files have three variables of 1F10.2 each, and the first variable is X (distance between transects), the format statement skips the first ten columns of characters. The file is read in a loop (line by line,) and the Y, Z values are used as profile coordinates. This allows the user easy implementation of the program without editing the data files. However, the original data must be formatted as 3F10.2 with the three fields arranged as shown in Appendix C.

Field 1 (10.2) - X values, distance between transects. Within each transect this value is unchanging.

Field 2 (10.2) - Y values, distance along transect.
Within each transect this value varies.

Field 3 (10.2) - Z values, depth below sea level.
This value varies at all locations.

PROFILE provides real world distances for profile axis. This capability allows a viewer to quantitatively interpret the variation in bathymetry. This requires user supplied values for the maximum data value in the Y direction out of the whole survey data set (referred to as 'X-axis' by the user prompt, this is for ease of profile interpretation) and a Zmax. value for the deepest point of the data set. The X axis increment is established by dividing the user furnished X-axis length (Y data pts) by the Xmax value. The Y axis (Z data pts) increment is established similarly with user supplied axis length and Zmax values. These increments are used as scaling factors to be applied to scaling the data location and magnitude values. By multiplying these scaling factors by each Y and Z data point and plotting these relative to user supplied map location values, a data couplet is established which accounts for changes in axis length, transect length and final product size (as well as plotted location on the paper). This allows user versatility in plotting the transect runs at any point on the hardcopy

and as profiles of any final length, all with properly scaled landforms represented by variations in depth. This versatility is important when producing publications which have diagram size restrictions. The user must keep in mind that the coordinates given to the program as plot locations are used as plotting origins for the upper left corner of the plot and not for the lower left corner as is normally the case.

The program next requests a value for the total number of points to be plotted in the profile. This is not the number of points in the whole data set, only the number of points in the transect profiled. This number is used by the program to read the input data file, prepatory to plotting that file.

Labels for X and Y axes (Y and Z data pts) are supplied to the program by the user. These labels must be 30 characters or less in length. A recommended X axis label is 'Distance Along Transect (M)', this example is 27 characters in length. A Y axis label might be 'Depth Below Sea Level (M)', 25 characters long. A map title and plot location are also requested. The title should contain a reference to the transect number and the geographic location of the survey. A common title height

is 0.25 inches.

A description of the use and effects of various scaling factors and plotting devices is contained in the sub-section describing the operation of ISOMAP.

PROFILE requires no further user supplied information. The program first identifies the mechanical device requested by the user for plotting. On the Hewlett-Packard plotter (device 30) the user has an option of drawing various portions of the profile in different colors. The final product may have the area under the plotted curve shaded a different color than the rest of the diagram. The colored pen to be used for shading should be installed in stall #2 of the flatbed plotter device. The pen color to be used in the rest of the diagram goes in stall #1. Usually, stall #1 contains a black pen, while stall #2 is the user's choice.

PROFILE then plots the sea floor curve with the pen in stall #1. This curve is scaled and located in compliance with the users wishes. X and Y axes are drawn with increments computed by the division of Xmax by the X axis length and by scaling the Y axis (which is drawn with increments relative to the total range of the Z data). A dashed line is then drawn representing sea level at the

zero value of the Z data range. This utilizes the DELPLOT subroutine DPPLOT. The foreground is shaded with the pen in stall #2. This is possible because the program uses an algorithm which defines the area under the curve and within the axes as a polygon. A call to the subroutine SHADE will fill in this area with diagonal equi-spaced lines. Finally, the title is printed at the user specified location.

SECTION II

AN INTRODUCTION TO SYMAP/SYMVU

This section of the BATHYGRAPH users manual borrows some software descriptions from mini-manuals produced by Dr. Frank Gossetta of the University of Delaware, Geography Department.

The Laboratory for Computer Graphics and Spatial Analysis, Graduate School of Design, Harvard University developed a pair of coordinated programs for producing maps which graphically depict spatially distributed quantitative and qualitative information. These programs, SYMAP and SYMVU, are provided with a wide range of user options designed to meet a broad range of applications and requirements. Once a data set has been properly structured, the SYMAP software allows a very flexible options package to be constructed by the programmer in an effort to best meet the needs of the map user.

SYMAP

Input to SYMAP consists of sets of related data called packages. Each package begins with an identifying name such as A-OUTLINE, B-DATA POINTS, E-VALUES, or F-MAP. An example is provided in Appendix D.

The packages contain coordinate information, data values and output specifications. To the greatest extent possible, the BATHYGRAPH package has foreseen the users needs and attempted to structure the data in as compatible a SYMAP format as possible. This is one of the special features of BATHYGRAPH.

PACKAGES

A-OUTLINE

This package describes the outline of the study area in which the survey was performed. As described earlier, the most efficient method of procurring outline data is from a topographic sheet or aerial photograph of the survey area. Information of this type is best produced with use of one of the University digitizers. The outline of the study area is described by specifying the coordinate locations of the outline vertices. The FLIP program of BATHYGRAPH converts this data to metric scale and reassigns the polygon origin to the upper left corner. A location on a SYMAP produced map is expressed in terms of two coordinates, the first measured vertically from the top of the map border, the second measured horizontally from the left border.

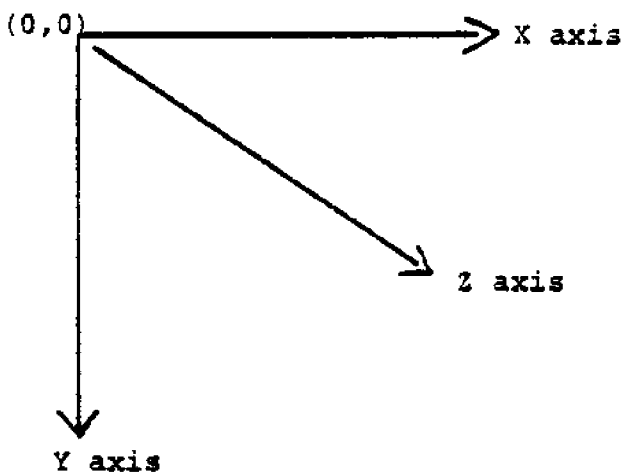


Figure II-1. SYMAP relative reference coordinates as measured from an origin at the top, left corner.

The FLIP program converts normal cartesian reference matrices to the SYMAP required form.

The A-OUTLINE package requires a package heading and a package termination line, both are provided by FLIP.

B-DATA POINTS

This package gives the coordinate locations of the data points. Data points are locations of bathymetric depth values. This package contains X, Y values which assign a two-dimensional reference list to each third dimension Z value. The Z values are located in another package.

There is an upper bound limit of 2000 data points for any one map. The BATHYGRAPH program MANIP arranges user input data files into SYMAP compatible form for use as a B-DATA POINTS file and an E-VALUES file. The MANIP program produces a file entitled 'DATA/PTS' which is ready to be used as a B-DATA POINTS package. This file must later be referenced by the user and combined with other BATHYGRAPH created files to construct a total SYMAP program.

E-VALUES

This package is used to specify the numerical values associated with each data point. All such data must be measured on a consistent and uniform basis. This package consists of one data value (Z) per line which must correspond to location data points (X, Y) on sequentially equivalent lines in the B-DATA POINTS package. BATHYGRAPH will ensure that this is the case provided the user entered values are conformant with the 3F10.2(X, Y, Z) requirements discussed earlier.

MANIP will produce not only a B-DATA POINTS package but also a choice of two types of E-VALUES packages. The user is given the option of producing either a contour map E-VALUES package or, a three-dimensional diagram

E-VALUES package. The first E-VALUES package is called 'VALS', the second is called 'VALS/FLP'. The user must access whichever of these two files he has had created and join them to the already existing A-OUTLINE package (user named file, created by FLIP) and the B-DATA POINTS package (produced by MANIP, entitled 'DATA/PTS.').

One final package remains to be created before the SYMAP program can be run to create a mappable matrix.

F-MAP

This package instructs the computer to make a map- based on the information supplied in the prior packages and is used to specify the precise form of the map in terms of possible electives. This package is required in order to run a SYMAP program. The package consists of three map title lines which are required, and a line for each elective chosen. The only elective required is elective 21. Elective 21 commands the computer to create a saved matrix of data values. This matrix is called SYMAP/SAVE. It will be automatically appended onto the users directory under user security. This matrix is the usable form of survey depth data, ready for mapping by BATHYGRAPH programs. SYMAP/SAVE is the product of the

FLIP, MANIP and ZMAXER programs in concert with SYMAP. SYMAP/SAVE may now be used with either SYMVU, or ISOMAP, to create the final, user specified, hardcopy graphics.

Electives in SYMAP are specified in columnated format, wherein call numbers or symbols located in certain columns on separate lines are recognized by the computer as instructions controlling the appearance of the SYMAP product. A sample SYMAP program is contained in Appendix D. For any of the electives which are to be used, lines specifying the elective number and other information pertaining to the elective come after the title lines. If an elective is not specified the standard for the program is assumed.

All electives are specified by typing the elective number in columns 4-5 with other information (if any) typed on the rest of the line or succeeding lines. For more information on the electives available and how they are used, see pages 30-48 of the SYMAP manual available in the consultant room of the computing center in Smith Hall.

Below are a few recommended electives for your F-MAP package which may enhance the chances of producing a

useful final product with minimum confusion.

Elective 1: Map Dimensions

Col. 5 - Enter '1' to identify the elective.

Cols. 11-20 - Enter the vertical dimensions of the printed map in inches. This number must have a decimal point.

Cols. 21-30 - Enter the horizontal dimension of the printed map in inches. This number must have a decimal point.

Elective 13: Map Scale

Cols. 4-5 - Enter '13' to identify the elective.

Cols. 11-20 - Enter the desired scale. This number must have a decimal point. Refer to manual for details.'

Elective 14: Map Margins

Cols 4-5 - Enter '14' to identify the elective.

Cols. 11-20 - Enter the desired margin along the top border in inches. This number must have a decimal point.

Cols. 21-30 - Left border margin.

Cols. 31-40 - Bottom border margin.

Cols. 41-50 - Right border margin

Elective 15: Number of Characters/Inch

Cols. 4-5 - Enter '15' to identify the elective.

Cols. 11-20 - The number of rows/inch which the user desires as a matrix size. This number requires a decimal point.

Cols. 21-30 - The number of columns/inch which the user desires as a matrix size. This number requires a decimal point.

A REVIEW

At this point the user should have several files in his directory which might look something like this:

*DIGIDAT - (user created outline data of survey area)
BATHYFLIP-(converts DIGIDAT to A-OUTLINE format)
*A-OUTLINE-(user named output file from FLIP)
*SURVDAT -(user created X, Y, Z survey data)
BATHYMANIP-(Converts SURVDAT to two SYMAP usable files, they are...)
DATA/PTS -(MANIP created file = B-DATA POINTS package for SYMAP)
VALS -(MANIP created file = E-VALUES package for contour map)

or

VALS/FLP (MANIP created file = E-VALUES package for 3-D diagram)
*FMAP -(user created F-MAP package for SYMAP)

*Indicates user named files, these names are used as examples only.

The user must now combine the A-OUTLINE, DATA/PTS, either VALS or VALS/FLP and the F-MAP files as one file. They should be combined in the order listed here:

A-OUTLINE

DATA/PTS

VALS or VALS/FLP

FMAP

This file must end with a '999999' line. The CANDE insert command may be used to make the union (see CANDE reference manual). The user now has a SYMAP program which, when run, will provide a data matrix to be used in conjunction with the ZMAXER, ISOMAP, or SYMVU, programs to produce the desired graphics.

It is suggested that the user rename the SYMAP program appropriately and REMove the separate 'package' files from his directory. This will reduce the confusion of which file is which.

When the final SYMAP program is ready to be run in order to create a SYMAP/SAVE matrix of data values, the user must create a JOB file to run the program. A sample JOB file looks like this.

```
1000    DEST RJE10
2000    RUN$ DELIBR/SYMAP;%
3000    FILE FILE5(TITLE = symap filename,
                   KIND=PACK, FILETYPE = 7).
```

The user runs this JOB with the DO command. The finished data matrix will appear in the users directory when the JOB is completed. This matrix is titled SYMAP/SAVE and is to be used with ZMAXER and SYMVU or ISOMAP to create the desired surface representation.

SYMVU

SYMVU was developed as a companion program of SYMAP. Using output from SYMAP, SYMVU will produce three-dimensional pictorial representations of spatial and areal data using flatbed or CRT type plotting devices. For bathymetric data, the data matrix produced by SYMAP and used by SYMVU must be manipulated. The illusion of depth is lost if the input file is plotted as positively varying data relative to a reference plane of zero values. Additionally, when an external alteration is made to the SYMAP/SAVE matrix, certain internally recognizable values may be misinterpreted by the external program. Therefore, when altering the Z values to give a plotted illusion of depth, a simultaneous transformation must be made to the

SYMAP coded zero values. The program entitled ZMAXER allows the user to assign a new value to each matrix element that contains the integer 25. This integer is assigned by SYMAP elective 21 as a signal to SYMVU that that element of the matrix has no value attached to it. This is normally plotted as a zero value base upon which the SYMVU surface is constructed. However, in consideration of the desire to have the interpolated surface appear as a depression in an otherwise feature-less plane, the integer assignment must be replaced by an appropriate value. The new matrix created by ZMAXER is stored in a data file named Z/FIXED from which the user may create a SYMVU surface.

Three files are required to run SYMVU:
(1) a file containing a data matrix, created by using elective 21 of SYMAP and altering non-interpolated values of this matrix with ZMAXER. This file is named Z/FIXED.
(2) a sequential data (SEQ) file similar to the one used to run SYMAP. This JOB file may look like this.

```
1000   RUN $DELIBR/SYMVU;%
2000   FILE FILE9 (TITLE = Z/FIXED, KIND = PACK,
                   FILETYPE = 7);%
3000   FILE FILE5(TITLE = VUDATA, KIND=PACK,
                  FILETYPE = 7)
```

(3) A data file (i.e. 'VUDATA') containing 4 control lines which contain information from which the SYMVU program builds a user specified three-dimensional diagram.

These control lines contain the following information:

Line 0 (first line) - This line defines the device on which the SYMVU plot will be made; the device code is entered in columns 1-2. These codes are detailed in an earlier section of this manual on page 22.

Line 1 (second line) - This line contains a map title. The title is entered in columns 1-72. This title will appear on the diagram and should contain useable information pertaining to the plotted data.

Line 2 (third line) - This is a parameter line containing variables that specify the number of rows and columns of the map matrix and the view. It also contains other variables concerning the input of data, symbols, scales, etc. Some of this information must be entered on the line; other variables have default values. The following electives are required: (NOTE: all values on line 2 are in Integer (I) format - that is, no decimal point is used).

LINE 2 ELECTIVES

Elective 2-1: Rows (Cols. 1-4)

Used to specify the number of rows (excluding the border) in the map matrix. This number should be right-justified in columns 1-4 (maximum = 130). The value associated with NROWS as written out by ISOMAP must be placed in these columns.

Elective 2-2: Columns (Cols. 5-8)

Used to specify the number of columns (excluding the border) in the map matrix. This number should be right-justified in columns 5-8 (maximum = 130). The value associated with NCOLS as written out by ISOMAP must be placed in these columns.

(NOTE: The number of rows and columns must be exact; if a number specified is less than the actual value, only part of the map will be produced. If it is greater than the actual value the program will terminate prematurely.)

Elective 2-4: Line Type (Col. 16)

This elective specifies the direction in which lines will be drawn. Lines may be plotted along three different axes: along the columns, along the rows or along diagonals. For certain azimuthal angles the best view is dependent

upon the line type used. The azimuth is the horizontal angle of direction from which the plot is viewed - this is specified on line 3. The diagram on the following page will help determine which line type will be used. This is dependent upon the azimuth value specified on line 3. That is, if an azimuth angle of 90^{o} is specified then column line type should be used. If lines are desired along rows (required if the azimuth if 0^{o} or 180^{o}) specify a 2 in column 16. If lines are desired along columns (required if the azimuth is 90^{0} of 270^{o}) specify a 1 in column 16. If lines are desired along diagonals, specify 4 in column 16.

Elective 2-12: SYMAP (Col.s 45-48)

This elective is used to specify the number of vertical lines per inch in the input matrix; enter a 6 in column 48. This value may have been specified in elective 15 of the F-MAP package of SYMAP in order to prevent a map distortion.

Elective 2-18: F-DATA (Cols. 65-68)

This elective is used to specify the matrix data input type and file number; enter a 1 in col. 68. Normally a tape is created by elective 21 of SYMAP. A number of matrices are often created on the same tape with each matrix specified on a separate file.

Elective 2-3 View (Col. 12)

Elective 2-3 specifies the type of projection desired. There are three possible projections: isometric (specify a 0 or 1 in Col. 12), two-point perspective (specify 2 in col. 12), and planimetric (specify a 3 in Col. 12). Default is an isometric projection. Refer to the SYMVU users manual for explanations concerning the types of projections available.

Line 3 (fourth line)

This line of the SYMVU data file contains variables that control the size of and viewing angles of the map, as well as other variables. All numbers on line 3 are in 'F' format, that is, a decimal point is required. The following electives are not required but are normally specified.

LINE 3 ELECTIVES

Elective 3-1: Altitude (Cols. 1-5)

Used to specify the elevation of the viewing position above the horizontal plane. The position is described in terms of angle degrees, right-justified in Cols. 1-5; default is 0.0°. A suggested altitude to begin with is 45°.

Elective 3-2: Azimuth (Cols. 6-10)

This elective is used to specify the horizontal angle of direction for viewing. The viewing angle is described in degrees, and is right justified in columns 6-10. There is a default value of 0.0^{o}. A common practice is to construct diagrams viewed from two or more positions. Many features of the landforms on the seafloor are better viewed from one angle as opposed to another. A variation in the azimuth of view is important to expose all seascape features to the user.

Elective 3-3: Width (Cols. 11-15)

The 3-3 elective is used to vary the width of the plot, in inches, that the input matrix will have on the plot. There are two scaling variables in the SYMVU program: the width and height. The width refers to the distance along the bottom side of the matrix (the columns of the input matrix). Under normal situations, it is recommended that the width dimension and height dimension when combined, should not exceed 11 inches. If no specification is made, the program assumes a width of 6.0 inches.

Elective 3-4: Height (Cols. 16-25)

This elective is used to specify the height, in inches, that the input matrix will have on the plot.

Specify the height, in inches, right-adjusted in columns 16 through 25. If you specify 0.0, the height will be set to 3.0 inches. Any practical height greater than 0.0 may be specified, but the combination of width and height should not exceed 11 inches. If no specification is made, the program assumes a height of 3.0 inches.

There are a number of other electives that can be specified on lines 2 and 3; see the manual for information on these. A sample is given below as an example of a typical SYMVU data file.

SYMVU Example:

Line 0

Cols 1-2
21

Line 1

Cols 1-72
SYMVU TESTPLOT

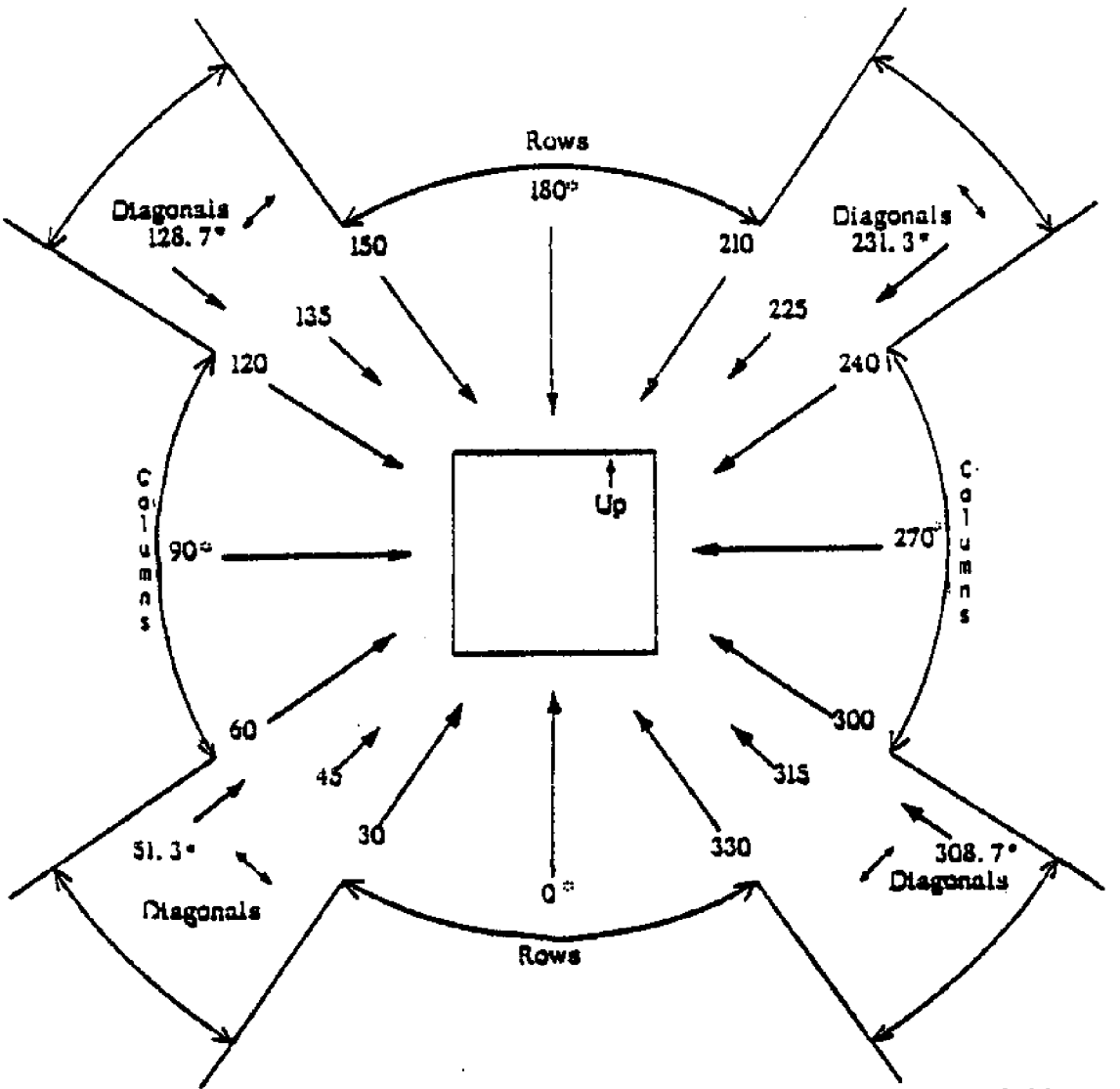
Line 2

Cols 3-4	7-8	12	16	48	68
40	35	2	1	6	1

Line 3

Cols 2-5	7-10	13-15	23-25
45.0	90.0	5.0	3.5

Prior to using either the SYMAP or SYMVU software, it is suggested that the user read the manuals which are available in the basement of Smith Hall. These manuals contain thorough descriptions of the multiplicity of electives which are offered the user to assist in developing the specific map desired. The cursory description provided here is not intended to serve as a users guide, merely as an appendage to the BATHYGRAPH description.



Note: If SYMAP is used as input, these azimuths will show plotted lines which are perpendicular to the line of sight and are therefore horizontal and parallel to the bottom edge of the paper. Decimal azimuths at the diagonals are due to the irregular SYMAP row/column matrix relationship. SYMAP and GRID, the two most commonly inputted matrices, are shown below with the recommended Line Type and Azimuth to achieve horizontally plotted lines.

#2-12 Symap	#2-4 Line Type		#3-2 Azimuth
8,10	columns	1	90,270
8,10	rows	2	0,180
8	diagonals	4	51.3,128.7,231.3,308.7
10	diagonals	4	45,135,225,315

Figure II-2.
Azimuth Orientation System

SECTION III

AN EXAMPLE OF BATHYGRAPH USE

This short section will present a case history of an example of BATHYGRAPH application. This particular application is typical of the type of Marine Sciences oriented studies which may be performed with BATHYGRAPH. Output from the package may have use as preliminary report material in preparation for some form of higher resolution research, or as an end in itself as a survey tool for sea floor landform analysis. Examples of hardcopy output, programs, data structure and typical associated data are given in the several appendices provided with this manual.

Figure III-1 shows the Indian River Inlet of Sussex County, Delaware. This inlet is located on the Atlantic coast of Delaware and functions as a sluiceway for tidal generated exchange between the waters of the Indian River/ Rehoboth Bay lagoonal system and the Atlantic Ocean. This inlet functions as an important means of access for the local fishing industry, as well as serving the natural role of maintaining the water quality of the inland lagoonal complex. Because of its importance, it became

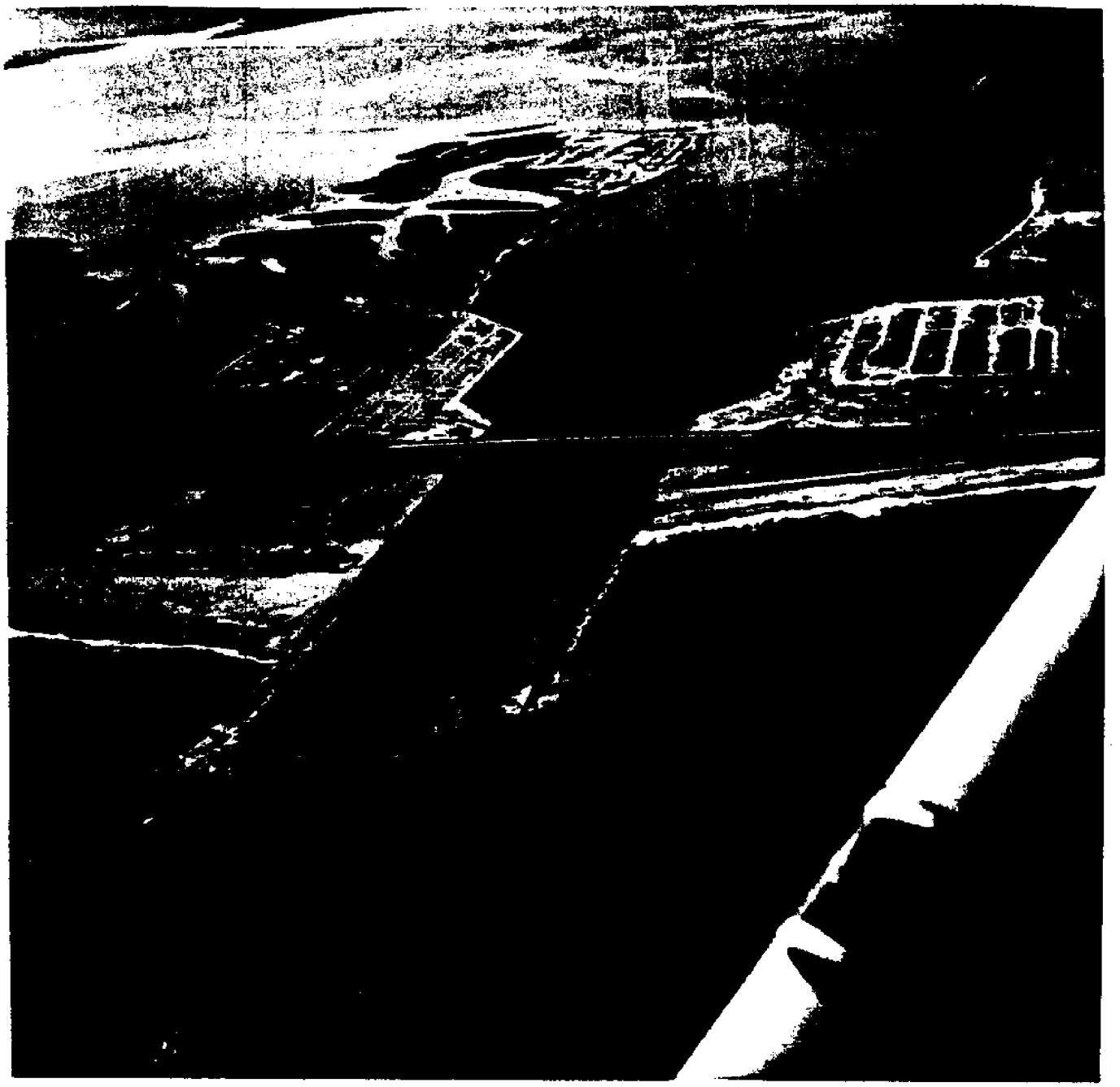


Figure III-1. Indian River Inlet, Sussex County, Delaware. View is from the east looking west to the Indian River. The survey was performed within the bounds of the stabilized channel geometry.

critical that the inlet be maintained in a navigatable condition. To ensure this, the U. S. Army Corps of Engineers began a series of construction projects designed to stablize the inlet and maintain a servicable channel depth. The inlet represented an ideal location for performing a bathymetric survey and acquiring data with which to test the BATHYGRAPH package.

Survey Technique

Transects were traversed in a lengthwise and widthwise fashion in an attempt to survey the bottom topography of the inlet channel. A precision fathometer mounted in a 16 foot, plane-hulled boat powered by a single 60 h.p. engine was used to record the variation in depth. Reference marks were made on the strip chart of the depth recorder to record the instrument position relative to known landmarks. The time of day was also recorded. The depth records were then analyzed and marked relative to position sightings and elapsed time between sightings. A method was employed to assign X, Y values to equally incremented depth soundings. This method assumed a constant boat speed and constant water level for each transect run. The real world distance between position landmarks was used to assign Y values to the depth records. The fathometer signal on these

records was then digitized and a file created containing the depth soundings (Z), the associated distance along transect runs (Y), and the baseline position of each transect (X). This file was formated X, Y, Z - 3F10.2. A sample of the data file is presented in Appendix C.

Outline File

Following the construction of a suitable data file, a survey area outline was created. This was accomplished by digitizing the U. S. Geological Survey 7.5 minute series topographic sheet of Bethany Beach Quadrangle. This topographic map contains the Indian River Inlet and is an appropriate scale for digitizing the outline of the inlet. The inlet outline data was entered into a data file called BATHYOUTLINE (Appendix B). The topographic sheet was scaled at 1:24,000, thus, the data in BATHYOUTLINE was at a scale of 1:24,000 also. In order to bring this data to real world length scales, it was necessary to utilize the FLIP program. The output file was named BATHYAOUTLINE and consisted of the scaled-up digitized inlet outline as well as SYMAP required particulars (Appendix B).

3-D Plot

A decision was then made to produce a three-dimensional surface representation of the study area. The MANIP program was employed to manipulate the cartesian reference data to a SYMAP compatible form. The depth data file (BATHYINLET) was entered to MANIP and no scaling factor was employed. The program created an output file named 'DATA/PTS' which was used as the SYMAP, B-DATA POINTS package.

MANIP was then instructed to arrange the data file (BATHYINLET) for use in generating an interpolated matrix to use in SYMVU. A value of 5.0 was entered as a Z-value increment to provide a surface representing base level. This value was determined based on an aforehand knowledge of the deepest point of the survey. The maximum Z-value was known to be approximately 24. The choice of the incremented Z-value is arbitrary other than as directed by user aesthetics. A second output file was then appended onto the project directory by MANIP, this file was called 'VALS/FLP'.

A file called 'FMAP' was created by the authors in consideration of the requirements of the SYMAP program. The 'FMAP' file contained electives to guide the SYMAP

program in creating a 'SYMAP/SAVE' interpolation matrix for use with SYMVU. The 'FMAP' file contained formated characters to identify the SYMAP electives: 1, 9, 15, 17, and 21. These electives are identified in the SYMAP users manual. A completed SYMAP data file was then constructed with the BATHYAOUTLINE, DATA/PTS, VALS/FLP, and FMAP data files.

The SYMAP data file is shown in Appendix D. This is not the full file, an abbreviated version is used due to the number of data points produced by the survey.

The SYMAP file was run with a job file named SYMAP/DO (Appendix B) and the matrix SYMAP/SAVE was entered in the ZMAXER program for final preparation prior to creation of a SYMVU plot. The ZMAXER program assigned user specified values of 30.0 to all Z-values outside of the interpolation matrix. These locations are identified by an integer Z-value of 25. The output file matrix named Z/FIXED is ready for use with the SYMVU software.

Two files were created by the authors in order to create a three-dimensional perspective diagram. The first file is a data file named BATHYSYMV/INLET. This file contains the user specified attributes which the SYMVU software will use to create the plot. The second

file named BATHYSMV/IR is a job file which calls the SYMVU software to plot the Z/FIXED matrix in a manner detailed by the BATHYSYMV/INLET data file. Both BATHYSYMV/INLET and BATHYSMV/IR are presented in Appendix B. Further plots of the Z/FIXED matrix were made and are presented in Appendix A. These program files may be modified by the user and utilized in creating similar plots.

Contour Map

The authors then desired a contour map of the survey area with a north arrow, a scale, a contour interval statement, a title, and a border around the whole plot.

The MANIP program was utilized to create a SYMAP data file. This file consisted of the BATHYAOUTLINE, data file created by FLIP, the DATA/PTS and VALS data files created by MANIP and an FMAP file created by the authors. These various units were joined together in a manner similar to the creation of the SYMAP data file used in creating the SYMAP/SAVE matrix discussed previously. A new SYMAP/SAVE interpolation matrix was created by using the VALS data file rather than the VALS/FLP data file. The new interpolation matrix is

suitable for use in constructing a contour map of the inlet bottom topography.

The program ISOMAP was then used to plot the SYMAP/SAVE matrix.

The various responses given by the authors to the program prompts were specific to this data set and map configuration. The user will have to experiment with various possibilities of map design in order to achieve the desired results. The hardcopy output for the Indian River Inlet data is displayed in Appendix A.

Transect Profiles

Cross-sectional profiles of individual transect runs were plotted with the BATHYGRAPH program PROFILE. These cross sections were constructed from data files extracted from the general data set (BATHYINLET). An example transect file is presented in Appendix C as BATHYL/RUNS5. This file was created with the CANDE INsert command and was named based on an internal code of transect identification. The user may name these profile data files as desired.

The PROFILE program requires the following specific information:

- the maximum, along transect, distance of the total data set (Xmax)
- the maximum depth of the total data set (Zmax)
- the number of data points in the data file to be plotted for one transect

as well as user supplied information pertaining to the structure of the final product.

Transects were plotted on fold-out pages in an effort to most closely approximate the real world scale of the inlet bathymetry. Titles were used to identify the location of the transect in the inlet and indicate the azimuthal direction of the traverse.

Profiles are available for viewing in Appendix A. There are six profiles presented on three fold-out pages. The multi-color shading of the section may not be apparent in the black and white copies contained in this version of the manual.

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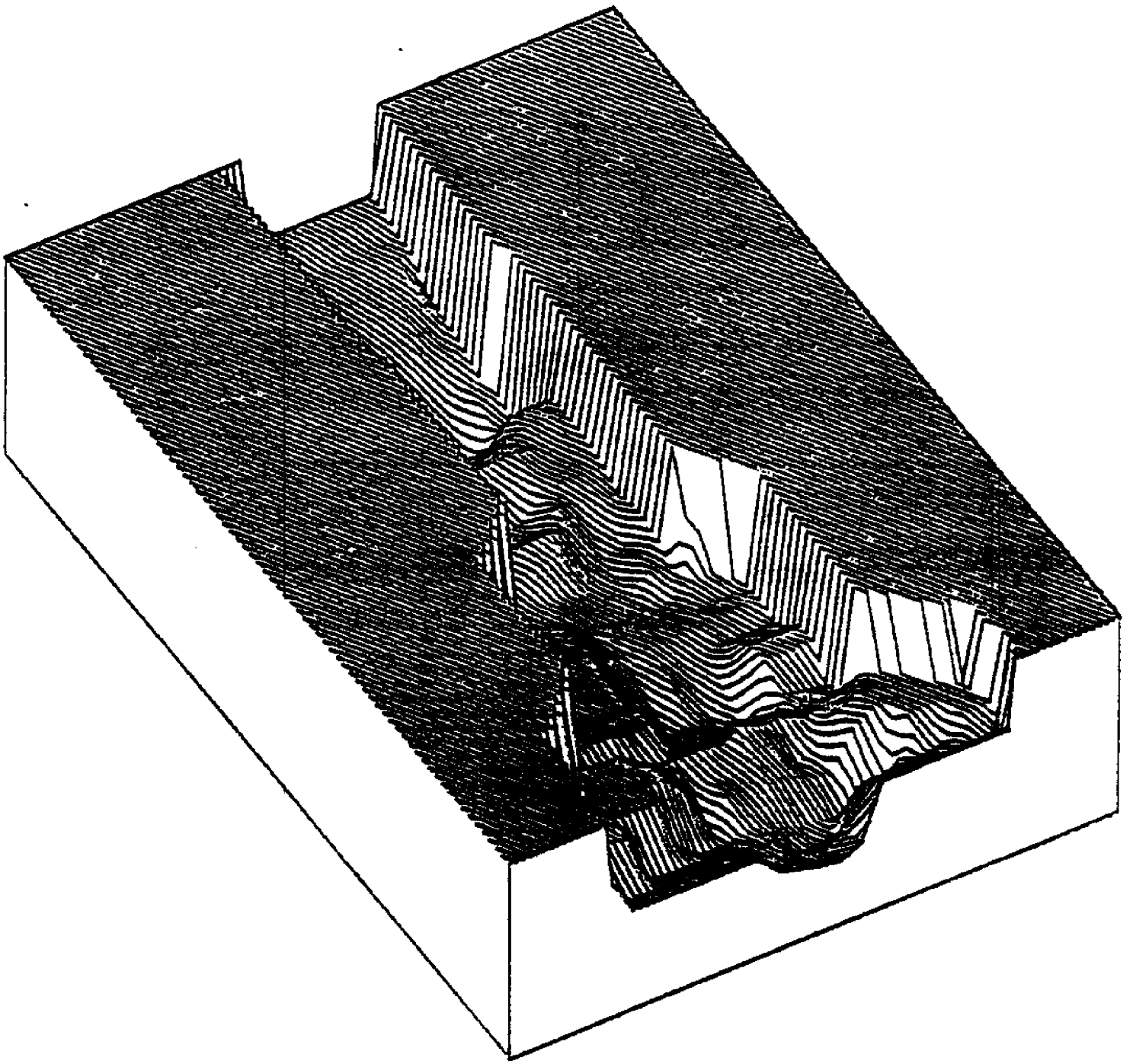
APPENDIX A

Examples of BATHYGRAPH production

- Three-Dimensional Plots, Views from:
  - Southwest (330°)
  - West (0°)
  - Northwest (30°)

- Planimetric View Contour Map with
  - North Arrow and Label
  - Identifying Title
  - Map Scale (Metric)
  - Contour Interval Statement
  - Contour Labels
  - Map Border
  - Study Area Outline

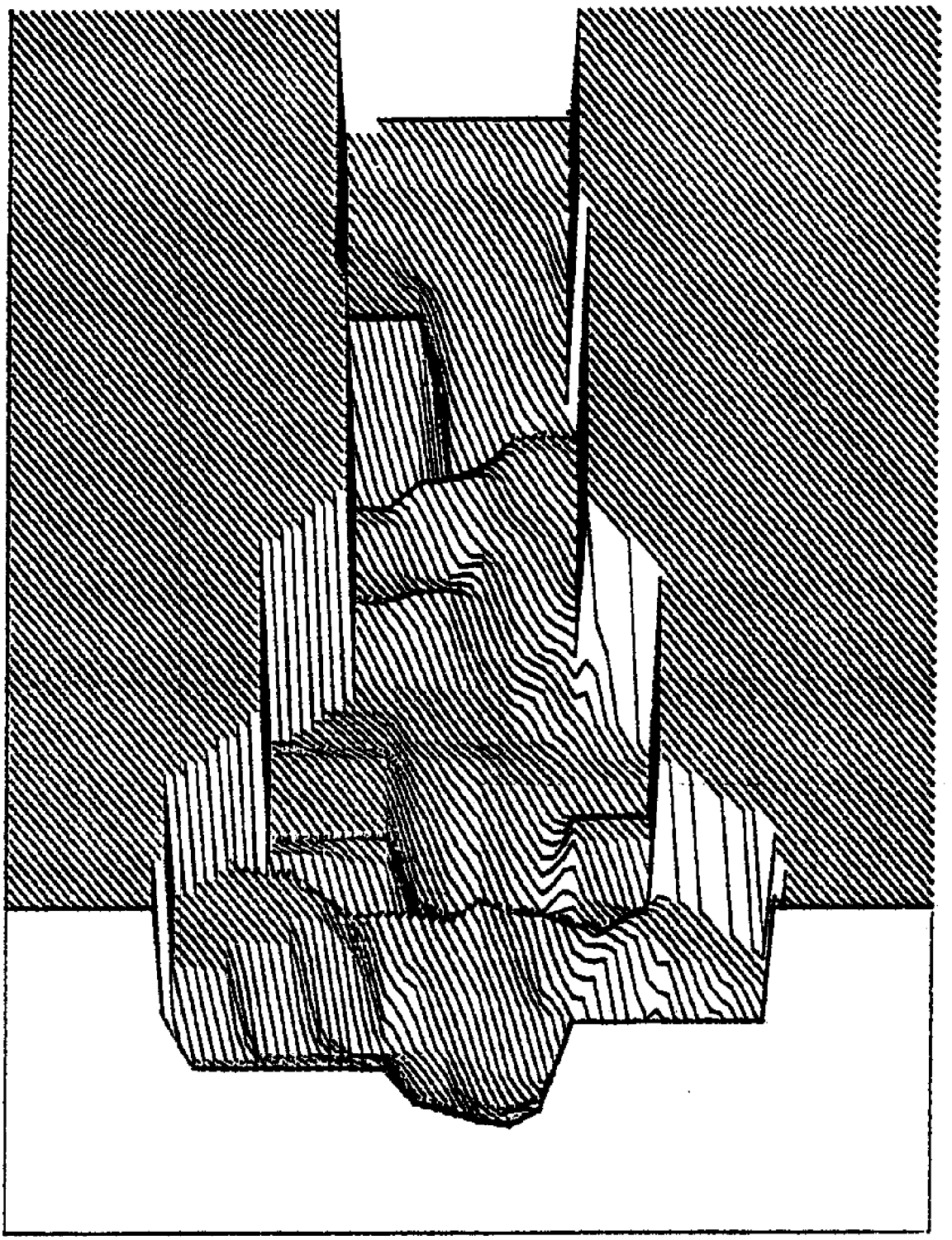
- Transect Cross-Sectional Profiles with:
  - Vertical Scale and Label
  - Horizontal Scale and Label
  - Sea Level Reference
  - Identifying Title



THE BATHYMETRY OF THE INDIAN RIVER INLET

AZIMUTH = 30 ALTITUDE = 45
*WIDTH = 3.00 *HEIGHT = 2.00

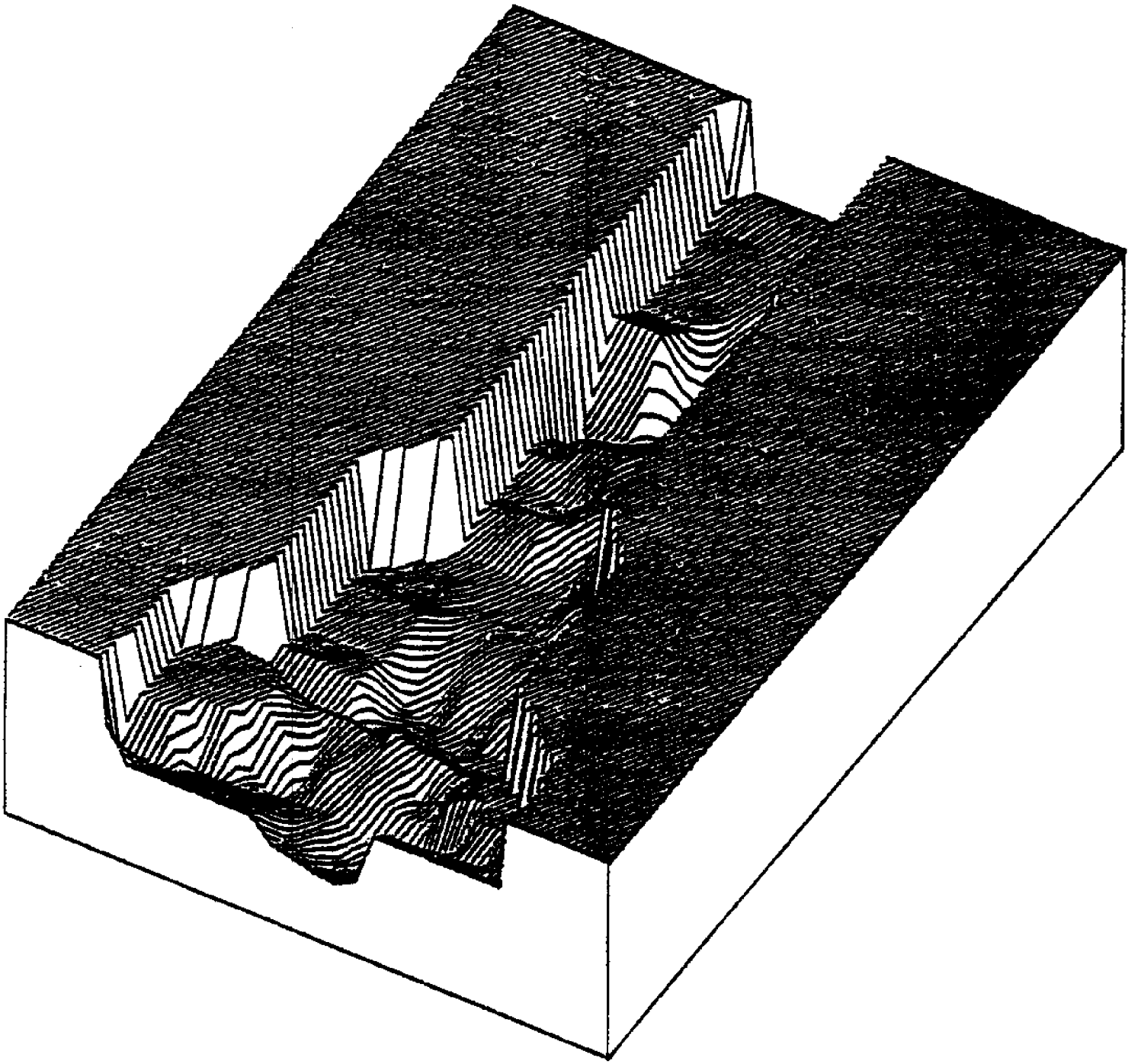
* BEFORE FORESHORTENING 04/28/89



THE BATHYMETRY OF THE INDIAN RIVER INLET

AZIMUTH = 0 ALTITUDE = 45
*WIDTH = 6.00 *HEIGHT = 3.00

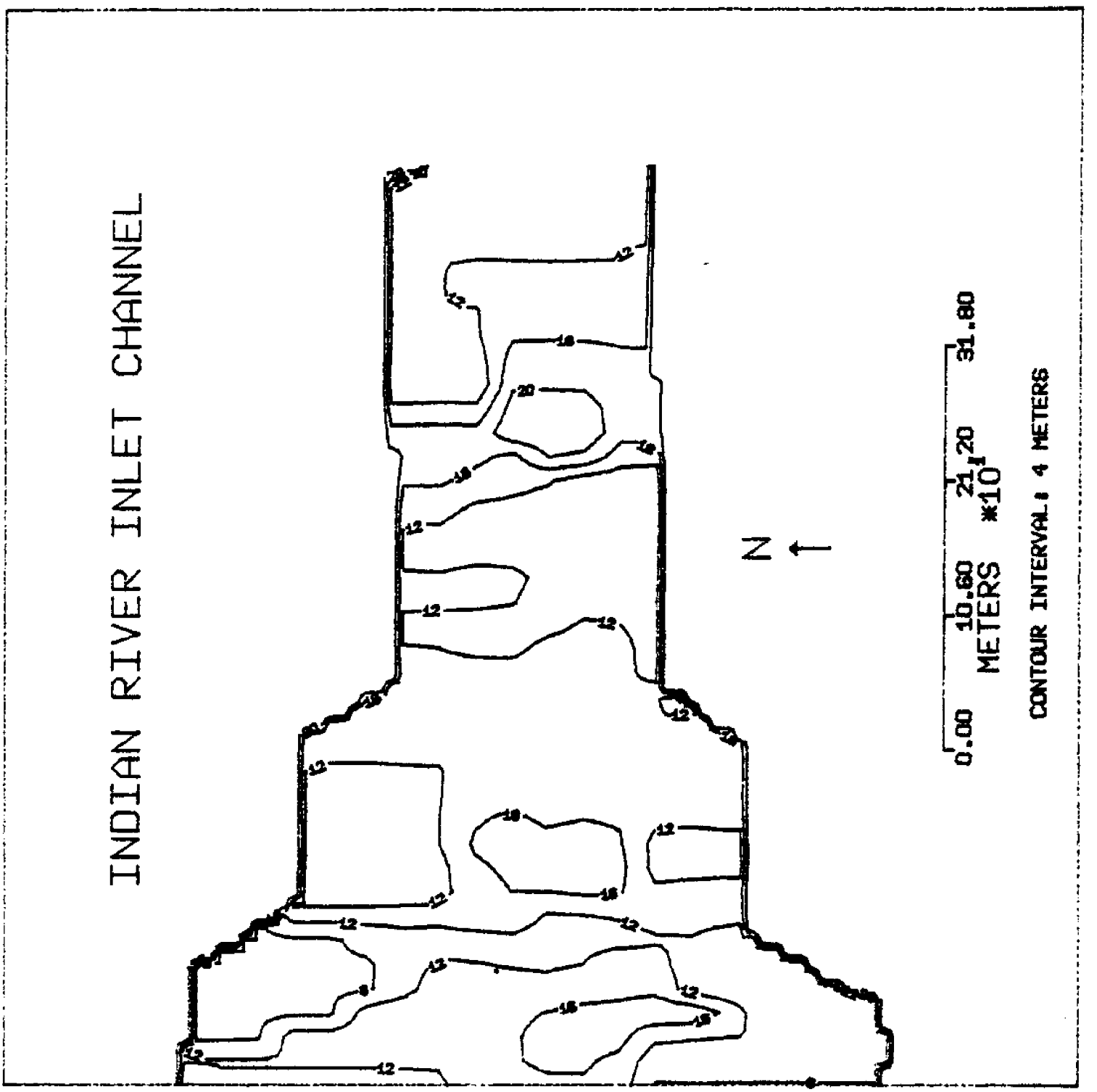
* BEFORE FORESHORTENING 04/26/89

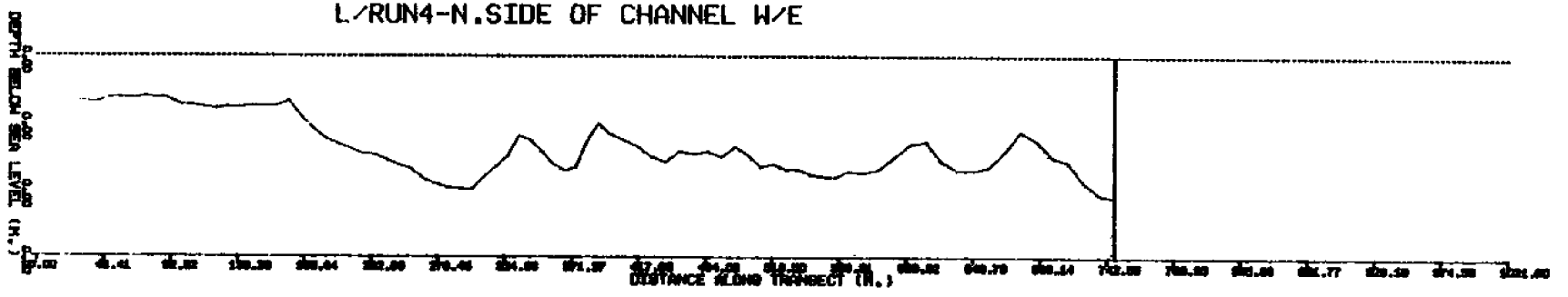


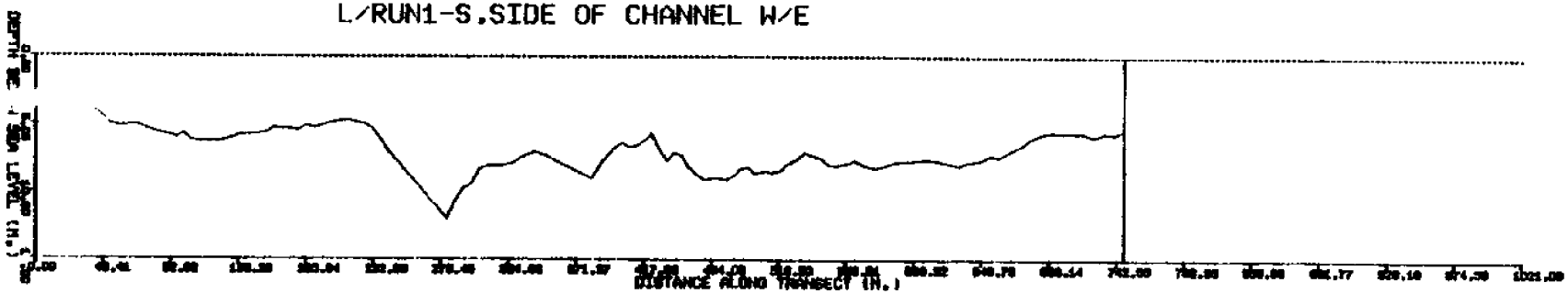
THE BATHYMETRY OF THE INDIAN RIVER INLET

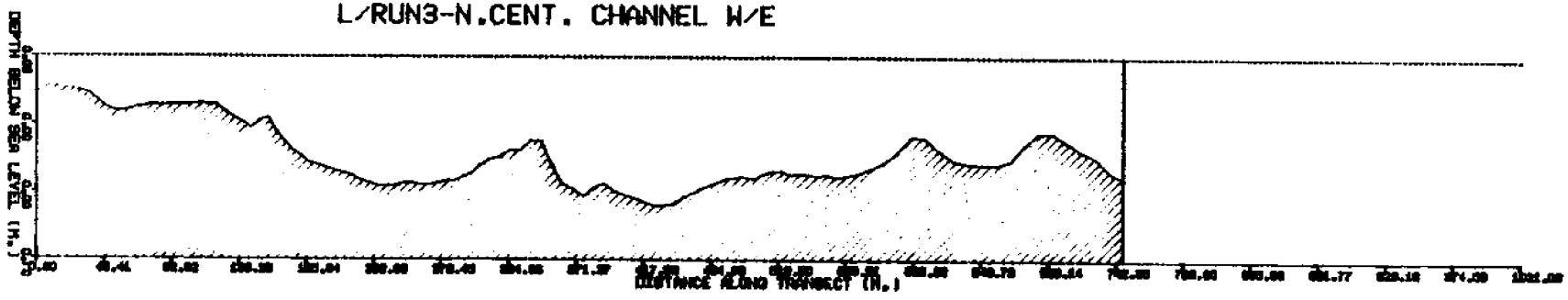
AZIMUTH = 330 ALTITUDE = 45
=WIDTH = 5.00 =HEIGHT = 2.00

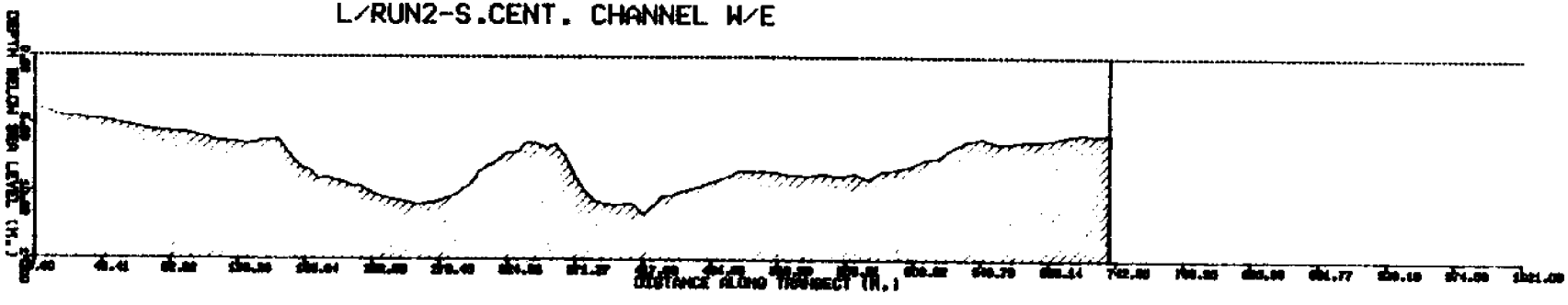
= BEFORE FORESHORTENING 04/26/83

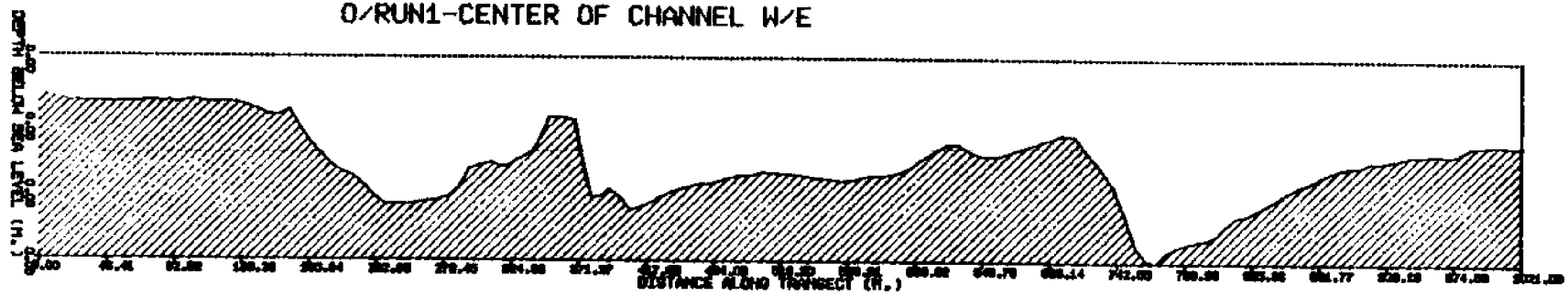

INDIAN RIVER INLET CHANNEL
N
0.00
10.60
21.20
31.80
METERS *10
CONTOUR INTERVAL: 4 METERS

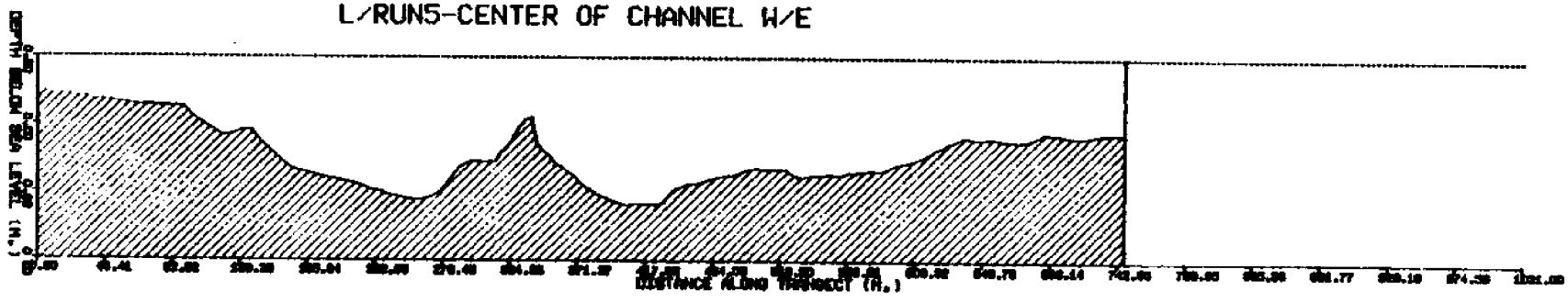

L/RUN4-N.SIDE OF CHANNEL W/E
DISTANCE ALONG TRANSECT (IN.)


L/RUN1-S.SIDE OF CHANNEL W/E
DISTANCE ALONG TRANSECT (IN.)


L/RUN3-N.CENT. CHANNEL W/E


L/RUN2-S.CENT. CHANNEL W/E


O/RUN1-CENTER OF CHANNEL W/E
DISTANCE ALONG TRANSECT (ft.)


L/RUN5-CENTER OF CHANNEL W/E
DISTANCE ALONG TRANSECT (ft.)

APPENDIX B

Programs and some data output used in producing BATHYGRAPH plots:

BATHYOUTLINE - User created data file of survey area (digitized)
BATHYAOUTLINE-SYMAP compatible A-OUTLINE package, produced by FLIP
SYMAP/DO - Job file to run SYMAP
BATHYSMV/IR - Job file to run SYMVU
BATHYSYMV/INLET - SYMVU electives data file
FLIP - BATHYGRAPH program to create A-OUTLINE
MANIP - BATHYGRAPH program to manipulate data
ZMAXER - BATHYGRAPH program to alter SYMAP/SAVE
ISOMAP - BATHYGRAPH program to create contour maps
PROFILE - BATHYGRAPH program to create transect profiles

BATHYOUTLINE

```
0.000,    0.000
0.012,    0.186
0.100,    0.281
0.098,    0.506
0.181,    0.591
0.177,    1.316
0.404,    1.336
0.407,    0.590
0.487,    0.493
0.484,    0.235
0.524,    0.195
0.569,    0.151
0.588,    0.155
0.605,    0.078
0.594,    0.004
```

A-OUTLINE

BATHYAOUTLINE

```
814.43      0.00
701.04      7.32
643.13     60.96
505.97     59.74
454.15    110.34
 12.19    107.90
  0.00    246.28
454.76    248.11
513.89    296.88
671.17    295.05
695.55    319.43
722.38    346.86
719.94    358.44
766.88    368.81
811.99    362.10
```

99999

SYMAP/DO

```
DEST RJE10    ;
RUN$ DELIBR/SYMAP;%
FILE FILE5(TITLE=MAPSYM,KIND=PACK,FILETYPE=7)
```

BATHYSMV/IR

```
RUN $DELIBR/SYMVU;%
FILE FILE9(TITLE=Z/FIXED,KIND=PACK,FILETYPE=7);%
FILE FILE5(TITLE=BATHYSYMV/INLET,KIND=PACK,FILETYPE=7);
```

BATHYSYMV/INLET

```
21
BATHYMETRY OF INDIAN RIVER INLET
  75  58   2   2                          10   1              1
 60.0   0.  2.0       1.0
```

FLIP

```
$RESET FREE
$SET AUTOBIND
C***INPUT FILE WHICH IS TO BE AUGMENTED***
FILE  4(KIND=PACK,MAXRECSIZE=14,FILETYPE=7)
C***OUTPUT FILE WHICH WILL BE WRITTEN TO***
FILE  3(KIND=PACK,MAXRECSIZE=50,AREASIZE=50,FILETYPE=7,
     %BLOCKSIZE=420,PROTECTION=SAVE,FLEXIBLE)
      DIMENSION X(1000), Y(1000), GDF(5), OUT(5)
      WRITE(6,1)
    1 FORMAT(8X,'THIS PROGRAM IS USED TO CONVERT YOUR',/,
     $3X,'DIGITIZED OUTLINE FILE FROM INCHES TO THE METRIC SCALE',/,
     $3X,'IF NEED BE. ALSO, THIS PROGRAM WILL MAKE ADJUSTMENTS',/,
     $3X,'ACCORDING TO THE SCALE OF THE MAP FROM WHICH YOU',/,
     $3X,'GENERATED THE DIGITIZED OUTLINE FILE.',//,
     $8X,'FOR EXAMPLE, IF YOU DIGITIZED THE OUTLINE IN INCHES',/,
     $3X,'AND WANT METRIC UNITS TO COORESPOND WITH YOUR REAL',/,
     $3X,'WORLD DATA, YOU WOULD FIRST MULTIPLY EVERY COORDINATE',/,
     $3X,'BY THE CONVERSION FACTOR 2.54. NOW EVERY COORDINATE',/,
     $3X,'WOULD BE IN CENTIMETERS. THEN IF YOU WANTED THEM IN',/,
     $3X,'METERS YOU WOULD MULTIPLY BY 100.0. FINALLY, YOU',/,
     $3X,'MUST MULTIPLY EACH COORDINATE BY A SCALING FACTOR',/,
     $3X,'TO COORECT FOR THE SCALE OF THE MAP. IF YOUR BASE',/,
     $3X,'MAP WAS AT A 1:24,000 SCALE, THE SCALING FACTOR FOR',/,
     $3X,'THIS PROBLEM WOULD BE 2.4. THIS IS DUE TO THE FACT',/,
     $3X,'THAT ONE(1) UNIT ON YOUR BASE MAP WOULD EQUAL',/,
     $3X,'24,000 UNITS IN THE REAL WORLD.')
      WRITE(6,2)
    2 FORMAT(3X,'ENTER THE INPUT FILE NAME.',/,
     $3X,'INCLUDE A PERIOD AT THE END.')
   10 FORMAT(5A6)
      READ(5,10) GDF
      CALL INPUT(4,GDF)
      WRITE(6,3)
    3 FORMAT(3X,'ENTER THE OUTPUT FILE NAME.',/,
     $3X,'INCLUDE A PERIOD AT THE END.')
      READ(5,10) OUT
      CALL INPUT(3,OUT)
      WRITE(6,22)
   22 FORMAT('ENTER THE MAP SCALE FROM YOUR',//,
     $3X,'BASE MAP HERE (IN DECIMAL FORM). FOR',//,
     $3X,'EXAMPLE, IF YOUR DIGITIZED OUTLINE CAME',//,
     $3X,'FROM A MAP WITH A SCALE OF 1:24,000,',//,
     $3X,'ENTER 24000.')
      READ(5,/) MPSCL
      MPSCL=MPSCL*0.0001
C***THIS LOOP READS THE INPUT AND THEN MAKES CHANGES***
      DO 100 I=1,15
      READ(4,/) X(I),Y(I)
      X(I)=(X(I)*254.0)*MPSCL
      Y(I)=(Y(I)*254.0)*MPSCL
      IF(Y(I).GT.YMAX) YMAX=Y(I)
  100 CONTINUE
C***THIS LOOP FLIPS THE Y-AXIS AND THEN WRITES THE NEW X&Y'S TO THE
C***NEW FILE***
      WRITE(3,18)
   18 FORMAT('A-OUTLINE')
      DO 200 J=1,15
      Y(J)=YMAX-Y(J)
      WRITE(3,20) Y(J), X(J)
   20 FORMAT(10X,2F10.2)
```

```
200 CONTINUE
    WRITE(3,19)
 19 FORMAT('99999')
    WRITE(6,21)
 21 FORMAT(//,3X,'YOU HAVE NOW CREATED A SYMAP',//,
   $3X,'A-OUTLINE PACKAGE. YOU MUST NOW JOIN THIS',//,
   $3X,'FILE WITH THE B-DATA POINTS AND E-VALUES',//,
   $3X,'PACKAGES THAT CAN BE GENERATED BY RUNNING',//,
   $3X,'THE PROGRAM ENTITLED "MANIP". USE THE',//,
   $3X,'CANDE "INSERT" COMMAND TO JOIN THESE FILES',//,
   $3X,'TOGETHER. HAPPY TRAILS!')
    STOP
    END
```

```
$RESET FREE
$SET AUTOBIND
C***INPUT FILE
FILE  2(KIND=PACK,MAXRECSIZE=14,FILETYPE=7)
C***OUTPUT FILE FOR B-DATA POINTS.
FILE  4(TITLE='DATA/PTS',KIND=PACK,MAXRECSIZE=14,
     %BLOCKSIZE=420,PROTECTION=SAVE,FLEXIBLE)
C***OUTPUT FILE FOR E-VALUES PACKAGE.
FILE  7(TITLE='VALS/FLP',KIND=PACK,MAXRECSIZE=14,BLOCKSIZE=420,
     %PROTECTION=SAVE,FLEXIBLE)
C***OUTPUT FILE FOR E-VALUES USED IN CONTOUR MAPPING.
FILE  9(TITLE='VALS',KIND=PACK,MAXRECSIZE=14,BLOCKSIZE=420,
     %PROTECTION=SAVE,FLEXIBLE)
      DIMENSION X(2000), Y(2000), Z(2000), GDF(5)
      YMAX=0.00
      ZMAX=0.00
      WRITE(6,2)
    2 FORMAT(1X,'THIS IS A PROGRAM TO ARRANGE YOUR DATA',/,
     $1X,'FILE SO THAT IT CAN BE APPLIED TO THE SYMAP',/,
     $1X,'MAPPING PACKAGE. IT ASSUMES THAT YOUR DATA',/,
     $1X,'HAS BEEN DERIVED FROM A TYPICAL CARTESIAN',/,
     $1X,'COORDINATE SYSTEM WITH ALL POINTS X AND Y,',/,
     $1X,'AND ALL Z VALUES IN THE POSITIVE DIRECTION.')
      WRITE(6,3)
    3 FORMAT(1X,'IS YOUR DATA FILE ARRANGED IN X, Y, Z',/,
     $1X,'WITH A FORMAT OF 3F10.2 ?')
      WRITE(6,4)
    4 FORMAT(1X,'IF YES TYPE IN THE NUMBER 1.',/,
     $1X,'IF NO TYPE IN THE NUMBER 0.')
      READ(5,/) ONE
      IF(ONE.EQ.0) GOTO 50
      IF(ONE.EQ.1) CONTINUE
   14 FORMAT(5A6)
      WRITE(6,13)
   13 FORMAT(//,3X,'ENTER THE INPUT FILE NAME.',//,
     $3X,'INCLUDE A PERIOD AT THE END.')
      READ(5,14) GDF
      CALL INPUT(2,GDF)
      WRITE(6,1)
    1 FORMAT(1X,'HOW MANY SETS OF X AND Y COORDINATES',/,
     $1X,'ARE THERE IN YOUR DATA FILE?',/,
     $1X,'(THE NUMBER OF X & Y COORDS. CANNOT EXCEED 2000).')
      READ(5,/) N
      WRITE(6,6)
    6 FORMAT(1X,'DO YOU WISH TO SCALE YOUR DATA SET?',/,
     $1X,'IF SO, PLEASE TYPE IN THE DESIRED SCALING',/,
     $1X,'FACTOR FOR EACH PARAMETER AS THEY APPEAR.',/,
     $1X,'IF YOU DO NOT WANT YOUR DATA SCALED, TYPE',/,
     $1X,'IN THE NUMBER 1.0 FOR EACH SCALING FACTOR.',/,
     $1X,'(SCALING FACTORS MUST BE GIVEN IN DECIMAL FORM).')
      WRITE(6,7)
    7 FORMAT(//,2X,'ENTER SCALING FACTOR FOR X.')
      READ(5,/) XSCL
      WRITE(6,8)
    8 FORMAT(//,2X,'ENTER SCALING FACTOR FOR Y.')
      READ(5,/) YSCL
      WRITE(6,9)
    9 FORMAT(//,2X,'ENTER SCALING FACTOR FOR Z.')
      READ(5,/) ZSCL
      DO 100 I=1,N
```

```
      READ(2,10) X(I), Y(I), Z(I)
   10 FORMAT(3F10.2)
      X(I)=X(I)*XSCL
      Y(I)=Y(I)*YSCL
      Z(I)=Z(I)*ZSCL
      IF(Y(I).GT.YMAX) YMAX=Y(I)
      IF(Z(I).GT.ZMAX) ZMAX=Z(I)
  100 CONTINUE
   18 FORMAT('B-DATA POINTS')
      WRITE(4,18)
      DO 200 J=1,N
      Y(J)=YMAX-Y(J)
      WRITE(4,20) Y(J), X(J)
   20 FORMAT(10X,2F10.2)
  200 CONTINUE
   19 FORMAT('99999')
      WRITE(4,19)
      WRITE(6,12)
   12 FORMAT(3X,'DO YOU WISH THIS FILE TO BE ARRANGED FOR',/,
     $3X,'USE IN GENERATING AN INTERPOLATED MATRIX THAT',/,
     $3X,'CAN LATER BE USED FOR PLOTTING A CONTOUR MAP?',/,
     $3X,'IF SO TYPE IN THE INTEGER 1. IF NO TYPE IN 0.',//,
     $3X,'DEFAULT IS A FILE TO BE USE IN GENERATING',//,
     $3X,'AN INTERPOLATED MATRIX FOR USE IN SYMVU.')
      READ(5,/) ANS
      IF(ANS.EQ.1) GOTO 40
      IF(ANS.EQ.0) CONTINUE
      WRITE(6,88)
   88 FORMAT(//,3X,'ENTER A VALUE YOU WOULD ',//,
     $3X,'LIKE ALL Z-VALUES TO BE INCREMENTED. THIS',//,
     $3X,'IS NECESSARY TO AVOID THE PROBLEM OF',//,
     $3X,'HAVING SOME AREA OF THE INTERPOLATED',//,
     $3X,'SURFACE APPROACHING OR EQUALING ZERO.',//,
     $3X,'IN EFFECT, THIS JUST ADDS A BASE FROM',//,
     $3X,'WHICH YOUR 3-D BLOCK DIAGRAM WILL BE',//,
     $3X,'DRAWN.')
      READ(5,/) INCRE
   21 FORMAT('E-VALUES')
      WRITE(7,21)
      DO 300 K=1,N
      Z(K)=(ZMAX-Z(K))+INCRE
      WRITE(7,30) Z(K)
   30 FORMAT(10X,F10.2)
  300 CONTINUE
      WRITE(7,19)
      GOTO 400
   40 CONTINUE
      WRITE(9,21)
      DO 350 L=1,N
      WRITE(9,30) Z(L)
  350 CONTINUE
      WRITE(9,19)
      GOTO 400
   50 WRITE(6,5)
    5 FORMAT(1X,'YOU MUST FIRST HAVE YOUR DATA ARRANGED',/,
     $1X,'IN A FORMAT OF 3F10.2. PLEASE MAKE THE PROPER',/,
     $1X,'CORRECTIONS AND TRY AGAIN. GOODBYE.')
      GOTO 500
  400 CONTINUE
      WRITE(6,11)
```

```
 11 FORMAT(//,3X,'YOU HAVE NOW CREATED TWO DATA FILES;',/,
   $3X,'"DATA/PTS" AND EITHER "VALS/FLP" OR "VALS".',/,
   $3X,'"VALS/FLP" IS THE E-VALUES FILE USED IN',/,
   $3X,'GENERATING AN INTERPOLATION MATRIX FOR USE IN',/,
   $3X,'SYMVU. "VALS/FLP" IS CREATED BY DEFAULT.',/,
   $3X,'"VALS"IS GENERATED WHEN YOU HAVE DECIDED',/,
   $3X,'TO ARRANGE AN E-VALUES FILE FOR CREATING A',/,
   $3X,'SYMAP/SAVE FILE TO BE USED FOR PLOTTING',/,
   $3X,'CONTOUR MAPS. "DATA/PTS" IS YOUR SYMAP B-DATA',/,
   $3X,'POINTS PACKAGE.',/,
   $3X,'BY USING THE CANDE "INSERT" COMMAND, YOU MUST',/,
   $3X,'JOIN THESE FILES TOGETHER WITH YOUR A-OUTLINE',/,
   $3X,'PACKAGE. CONSULT THE SYMAP MANUAL FOR REQUIRED',/,
   $3X,'INFORMATION THAT YOUR FILE MUST CONTAIN, AS',/,
   $3X,'WELL AS, ANY EMBELISHMENTS YOU WISH TO GIVE',/,
   $3X,'YOUR MAP. GOOD LUCK!')
500 CONTINUE
    STOP
    END
```

```
$RESET FREE
$SET AUTOBIND
C***INPUT FILE
FILE  1(KIND=PACK,FILETYPE=7)
C***OUTPUT FILE
FILE  4(TITLE='Z/FIXED',KIND=PACK,MAXRECSIZE=100,
     %BLOCKSIZE=100,AREASIZE=100,PROTECTION=SAVE,FLEXIBLE)
      DIMENSION ROW(100)
      DIMENSION GDF(5)
      NCOLS=99
      NROWS=47
      WRITE(6,2)
    2 FORMAT(//,3X,'ENTER THE INPUT FILE.',//,
     $3X,'INCLUDE A PERIOD AT THE END.')
      READ(5,3) GDF
    3 FORMAT(5A6)
      CALL INPUT(1,GDF)
      READ(1)NROWS,NCOLS
      WRITE(6,/)'NROWS=',NROWS,'NCOLS=',NCOLS
      REWIND 1
      WRITE(6,4)
    4 FORMAT(//,3X,'THE SYMAP ELECTIVE-21 ASSIGNS THE INTEGER',//,
     $3X,'25 TO EACH LOCATION IN THE MATRIX THAT HAS NO',//,
     $3X,'INTERPOLATED VALUE ASSIGNED TO IT. THIS PROGRAM',//,
     $3X,'CHANGES ALL OCCURANCES OF INTEGER 25 TO THE USER',//,
     $3X,'SUPPLIED VALUE. ENTER THE NEW VALUE AS A REAL NUMBER.')
      READ(5,/)NVAL
      DO 300 I=1,NROWS
      READ(1)(ROW(J),J=1,NCOLS)
      DO 200 J=1,NCOLS
      IF(ROW(J).IS.25) ROW(J)=NVAL
  200 CONTINUE
      WRITE(4) (ROW(J),J=1,NCOLS)
  300 CONTINUE
      WRITE(6,7)
    7 FORMAT(//,3X,'YOU HAVE NOW CREATED A MATRIX CALLED "Z/FIXED"',//,
     $3X,'THAT CAN BE USED WITH THE SYMVU 3-D PLOTTING SOFTWARE.THE',//,
     $3X,'AREA SURROUNDING THE INTERPOLATED SURFACE THAT IS',//,
     $3X,'CONTAINED WITHIN THE MATRIX WILL BE RAISED TO',//,
     $3X,'THE NEW VALUE.')
      STOP
      END
```

```
$RESET FREE
$SET AUTOBIND
$BIND=FROM (2591)SYSLIB/=
FILE  8(KIND=REMOTE)
FILE  1(KIND=PACK,FILETYPE=7)
      DIMENSION Z(58,103),IWORK(5974),VAL(20)
      DIMENSION ROW(58), GDF(5)
      DIMENSION ISOB(5), UNITS(1), LABL(5)
      WRITE(6,1)
    1 FORMAT(//,3X,'ENTER THE INPUT FILE NAME.',//,
     $3X,'INCLUDE A PERIOD AT THE END.')
   25 FORMAT(5A6)
      READ(5,25) GDF
      CALL INPUT(1,GDF)
      WRITE(6,2)
    2 FORMAT(//,3X,'IF YOU WANT TO SUPRESS THE PRINTING OF',//,
     $3X,'CONTOUR VALUES ENTER 0.0.',//,
     $3X,'IF YOU WANT THE VALUES PRINTED ON EACH CONTOUR ENTER 1.0')
      READ(5,/) PR
      WRITE(6,3)
    3 FORMAT(//,3X,'ENTER THE DESIRED SCALING FACTOR. IF NO',//,
     $3X,'SCALING IS NEEDED ENTER 1.0')
      READ(5,/) SCL
      READ(1) NROWS,NCOLS,SCLX,SCLY,ZMIN,ZMAX
      WRITE(6,/) 'NROWS',NROWS,'NCOLS',NCOLS,'SCLX',SCLX,
     %'SCLY',SCLY,'ZMIN',ZMIN,'ZMAX',ZMAX
      DO 10 I=1,NROWS
      READ(1)(ROW(J),J=1,NCOLS)
      JCOL=NROWS+1-I
      DO 15 J=1,NCOLS
      Z(J,JCOL)=ROW(J)
   15 CONTINUE
   10 CONTINUE
      WRITE(6,/)'ENTER THE DEVICE NUMBER.'
      READ(5,/) IDEV
      WRITE(6,60)
   60 FORMAT(//,3X,'IF YOU WOULD LIKE TO TITLE YOUR MAP ENTER',//,
     $3X,'THE NUMBER 1.0. IF NO TITLE, ENTER 0.0')
      READ(5,/) TL
      IF(TL.EQ.0.0) GOTO 80
      IF(TL.EQ.1.0) CONTINUE
      DO 35 I=1,5
   35 LABL(I)='      '
      WRITE(6,40)
   40 FORMAT(//,3X,'ENTER THE TITLE-MAXIMUM OF 30 CHARACTERS.')
      READ(5,45) (LABL(I),I=1,5)
   45 FORMAT(5A6)
      WRITE(6,50)
   50 FORMAT(//,3X,'ENTER THE X AND Y COORDINATE AT WHICH THE TITLE',//,
     $3X,'WILL BEGIN. ENTER THEM ON THE SAME LINE AND SEPARATE',//
     $3X,'WITH A COMMA. EXAMPLE: 1.0,5.0.')
      READ(5,/) XL,YL
      WRITE(6,55)
   55 FORMAT(//,3X,'ENTER THE HEIGHT OF THE LETTERING IN INCHES.')
      READ(5,/) HT
   80 WRITE(6,101)
  101 FORMAT(//,3X,'WOULD YOU LIKE A BORDER AROUND',//,
     $3X,'YOUR MAP? IF YES TYPE 1.0. IF NO TYPE 0.0.')
      READ(5,/) SAN
      IF(SAN.EQ.0.0) GOTO 91
```

```
      IF(SAN.EQ.1.0) CONTINUE
      WRITE(6,102)
  102 FORMAT(3X,'WHAT IS THE X AND Y ORIGIN OF YOUR',//,
     $3X,'BORDER? SEPARATE WITH A COMMA.')
      READ(5,/) XORIG,YORIG
      WRITE(6,103)
  103 FORMAT(3X,'ENTER THE X AND Y DIMENSIONS IN INCHES',//,
     $3X,'ON THE SAME LINE SEPARATED BY A COMMA.')
      READ(5,/) BLX,BLY
   91 CONTINUE
      WRITE(6,104)
  104 FORMAT(3X,'IF YOU HAVE PLOTTED CONTOURS BY INTERVALS,',//,
     $3X,'WHAT IS THE CONTOUR INTERVAL? IF NOT, TYPE 0.0.')
      READ(5,/) INTVL
      IF(INTVL.EQ.0.0) GOTO 121
      IF(INTVL.GT. 0.0) CONTINUE
      DO 105 I=1,5
      ISOB(I)='      '
      WRITE(6,106)
  106 FORMAT(3X,'ENTER A LITERAL STRING STATING THE CONTOUR',//,
     $3X,'INTERVAL. MAXIMUM OF 30 CHARS.',//,
     $6X,'EXAMPLE: CONTOUR INTERVAL: 1000 METERS')
      READ(5,107)(ISOB(I),I=1,5)
  107 FORMAT(5A6)
  105 CONTINUE
      WRITE(6,108)
  108 FORMAT(3X,'WHAT IS THE X AND Y COORD. OF THE CONTOUR',//,
     $3X,'INTERVAL STATEMENT? SEPARATE WITH COMMA.')
      READ(5,/) CLX,CLY
      WRITE(6,109)
  109 FORMAT(3X,'WHAT IS THE ANGLE OF THIS LITERAL STRING?')
      READ(5,/) DEG
  121 CONTINUE
C*** DRAW A NORTH ARROW
      WRITE(6,126)
  126 FORMAT(//,3X,'WOULD YOU LIKE TO INCLUDE A NORTH ARROW?',//,
     $3X,'YES=1.0, NO=0.0.')
      READ(5,/) NRD
      IF(NRD.EQ.0.0) GOTO 112
      IF(NRD.EQ.1.0) CONTINUE
      WRITE(6,110)
  110 FORMAT(//,3X,'ENTER THE ANGLE OF MAGNETIC NORTH FROM',//,
     $3X,'TRUE NORTH IN DEGREES.')
      READ(5,/) ANGL
      WRITE(6,111)
  111 FORMAT(//,3X,'ENTER THE X AND Y COORD. FROM WHICH',//,
     $3X,'THE NORTH ARROW WILL ORIGINATE. SEPARATE WITH A COMMA.')
      READ(5,/) XD,YD
      DIMENSION NAR(1), DIR(1)
      NAR(1)=18
      DIR(1)=63
  112 CONTINUE
C*** MAP SCALE.
      WRITE(6,113)
  113 FORMAT(//,3X,'IF YOU WOULD LIKE A SCALE PRINTED ON YOUR',//,
     $3X,'MAP TYPE IN 1.0. IF NOT, TYPE 0.0.')
      READ(5,/) RESP
      IF(RESP.EQ.0.0) GOTO 120
      IF(RESP.EQ.1.0) CONTINUE
      WRITE(6,114)
```

```
114 FORMAT(//,3X,'ENTER THE MEASURED LENGTH IN INCHES',//,
   $3X,'(SEE DOCUMENTATION) AND THE REAL WORLD DISTANCE FOR',//,
   $3X,'THAT SAME MEASUREMENT. SEPARATE WITH A COMMA.')
    READ(5,/) LN,DIST
    UNITS(1)='      '
    WRITE(6,115)
115 FORMAT(//,3X,'WHAT WILL BE THE UNITS OF THE SCALE?',//,
   $3X,'(MAXIMUM OF 6 CHARACTERS).',//,
   $6X,'EXAMPLE: METERS.')
    READ(5,118) UNITS
118 FORMAT(A6)
    CENT=(DIST*100.0)/2.54
    WRITE (6,117)
117 FORMAT(//,3X,'ENTER THE X AND Y COORD. AT WHICH THE',//,
   $3X,'SCALE WILL BEGIN, AND THE AXIS LENGTH IN INCHES.',//,
   $3X,' SEPARATE WITH A COMMA.')
    READ(5,/) XA,YA,AXLEN
    INC=CENT/LN
    INC=INC*(2.54/100.0)
120 CONTINUE
    WRITE(6,/)'ENTER THE NUMBER OF CONTOURS'
    READ(5,/)NCNT
    DO 20 I=1,NCNT
    WRITE(6,/)'ENTER THE CONTOUR VALUE',I
    READ(5,/)VAL(I)
 20 CONTINUE
    N=NCOLS
    M=NROWS
    CLOSE 5
    CLOSE 6
    CALL PLTSRT('INLET',IDEV)
    CALL PLOT(1.0,1.0,-3)
    CALL FACTOR(SCL)
    DO 30 I=1,NCNT
    CNTVAL=VAL(I)
    CALL CONTR(Z,N,M,IWORK,CNTVAL,PR,.1)
 30 CONTINUE
    CALL FACTOR(1.0)
    IF(TL.EQ.0.0) GOTO 85
    IF(TL.EQ.1.0) CONTINUE
    CALL SYMBOL(XL,YL,HT,LABL,0.0,30.0)
 85 CONTINUE
    IF(SAN.EQ.0.0) GOTO 122
    CALL PLOT(XORIG,YORIG,3)
    CALL PLOT((XORIG+BLX),YORIG,2)
    CALL PLOT((XORIG+BLX),(YORIG+BLY),2)
    CALL PLOT(XORIG,(YORIG+BLY),2)
    CALL PLOT(XORIG,YORIG,2)
122 IF(INTVL.EQ.0.0) GOTO 123
    CALL SYMBOL(CLX,CLY,.1,ISOB,DEG,30.0)
123 IF(NRD.EQ.0.0) GOTO 124
    CALL SYMBOL(XD,YD,0.3,NAR,ANGL,-1)
    IF(ANGL.LT.90.0) YD=YD+.4
    IF(ANGL.GE.90.0) XD=XD-.4
    CALL SYMBOL(XD,YD,0.2,DIR,ANGL,-1)
124 IF(RESP.EQ.0.0) GOTO 125
    CALL AXIS(XA,YA,UNITS,-6.0,AXLEN,DEG,0.0,INC)
125 CALL HOME
    STOP
    END
```

```
$RESET FREE
$SET AUTOBIND
$BIND=FROM(2591)SYSLIB/HATCH/SUBS
C***GEOGRAPHIC DATA FILE
FILE  4(KIND=PACK,FILETYPE=7)
C***DEFAULT OUTPUT FILE
FILE  8(KIND=REMOTE)
      DIMENSION Y(2000), Z(2000), XLAB(5), YLAB(5), LABL(5)
      DIMENSION GDF(5)
      DIMENSION XP(2000), YP(2000), WKAR(1001)
      DIMENSION XFXD(2000), YFXD(2000)
      WRITE(6,2)
    2 FORMAT(//,3X,'THIS IS AN INTERACTIVE PROGRAM TO',//,
     $3X,'PLOT PROFILES OF YOUR BATHIMETRIC DATA RUNS.')
      WRITE(6,1)
    1 FORMAT(3X,'ENTER THE INPUT FILE NAME',/,
     $3X,'INCLUDE A PERIOD AT THE END.')
      READ(5,10) GDF
   10 FORMAT(5A6)
      CALL INPUT(4,GDF)
      WRITE(6,3)
    3 FORMAT(3X,'ENTER THE MAXIMUM DATA VALUE THAT WILL BE',/,
     $3X,'PLOTTED ON THE X-AXIS OUT OF YOUR ENTIRE DATA SET.',/,
     $3X,'THIS IS THE LARGEST VALUE THAT CAN OCCUR IN',/,
     $3X,'ANY TRANSECT.')
      READ(5,/) XMAX
      WRITE(6,4)
    4 FORMAT(3X,'SIMILARLY ENTER THE MAXIMUM Z-VALUE',/,
     $3X,'THAT CAN BE PLOTTED ON ANY PROFILE.')
      READ(5,/) ZMAX
      WRITE(6,5)
    5 FORMAT(3X,'ENTER THE LENGTH OF THE X AND Y AXES.',/,
     $3X,'TYPE THESE VALUES IN ON THE SAME LINE BUT',/,
     $3X,'MAKE SURE TO SEPARATE THEM WITH A COMMA.',/,
     $6X,'EXAMPLE: 5.0, 7.0')
      READ(5,/) XSIZE, ZSIZE
C***CALCULATE SCALING FACTORS
      XFACT=XSIZE/XMAX
      ZFACT=ZSIZE/ZMAX
C*** STARTING POINT PLEASE
      WRITE(6,6)
    6 FORMAT(3X,'ENTER THE X,Y COORDINATE AT WHICH YOUR PLOT',/,
     $3X,'WILL BEGIN. THE Y-COORDINATE SHOULD BE > OR = TO',/,
     $3X,'THE VALUE ENTERED FOR THE Y-AXIS IN INCHES. ENTER',/,
     $3X,'YOUR X,Y COORD. ON THE SAME LINE, SEPARATED BY A',/,
     $3X,'COMMA. A GOOD PLACE TO START WOULD BE 2.0,6.0.')
      READ(5,/) XBEG, YBEG
      WRITE(6,8)GDF
    8 FORMAT(3X,'HOW MANY DATA POINTS OCCUR IN THE',/,
     $3X,'FILE:',5A6,/,
     $3X,'PLEASE ENTER AN INTEGER NUMBER,(i.e. NO DECIMAL POINT).')
      READ(5,/) N
   20 FORMAT(10X,2F10.2)
      DO 100 I=1,N
      READ(4,20,END=100) Y(I), Z(I)
  100 CONTINUE
      NUMPTS=0
      DO 150 I=1,N
      XFXD(I)=XBEG+(Y(I)*XFACT)
      YFXD(I)=YBEG-(Z(I)*ZFACT)
```

```
      NUMPTS=NUMPTS+1
  150 CONTINUE
      DO 23 I=1,5
   23 XLAB(I)='      '
      WRITE(6,123)
  123 FORMAT(//,3X,'ENTER THE X-AXIS LABEL.',//,
     $3X,'MAXIMUM OF 30 CHARS., INCLUDING BLANKS.')
      READ(5,124)(XLAB(I),I=1,5)
  124 FORMAT(5A6)
      DO 24 I=1,5
   24 YLAB(I)='      '
      WRITE(6,126)
  126 FORMAT(//,3X,'ENTER THE Y-AXIS LABEL.',//,
     $3X,'MAXIMUM OF 30 CHARS., INCLUDING BLANKS.')
      READ(5,124)(YLAB(I),I=1,5)
      DO 25 I=1,5
   25 LABL(I)='      '
      WRITE(6,102)
  102 FORMAT(3X,'ENTER TITLE-MAXIMUM OF 30 CHARACTERS')
      READ(5,124) (LABL(I),I=1,5)
      WRITE(6,106)
  106 FORMAT(3X,'ENTER THE X AND Y COORDINATES AT WHICH YOU',/,
     $3X,'WANT YOUR TITLE TO BEGIN. ENTER ON THE SAME',/,
     $3X,'LINE AND SEPARATE WITH A COMMA.',/,
     $6X,'EXAMPLE: 2.5,6.5')
      READ(5,/) XL,YL
      WRITE(6,107)
  107 FORMAT(3X,'ENTER THE HEIGHT OF THE LETTERING IN INCHES.')
      READ(5,/) HT
      WRITE(6,9)
    9 FORMAT(3X,'ENTER A SCALING FACTOR WHICH WILL BE',/,
     $3X,'USED TO SCALE DOWN THE WHOLE GRAPH. IF NO',/,
     $3X,'SCALING IS DESIRED, TYPE IN 1.0.')
      READ(5,/) SCL
      WRITE(6,7)
    7 FORMAT(3X,'WHAT IS THE DEVICE NUMBER OF THE PLOTTER THAT',/,
     $3X,'YOUR OUTPUT WILL BE PLOTTED ON?')
      READ(5,/) IDEV
      CLOSE 5
      CLOSE 6
      CALL PLTSRT('PROFILE',IDEV)
      CALL DPPEN(1)
      CALL PLOT(1.0,1.0,-3)
      CALL FACTOR(SCL)
      CALL PLOT(XBEG,YBEG,3)
      CALL PLOT(XBEG,YFXD(1),3)
      DO 300 I=2,N
      CALL PLOT(XFXD(I),YFXD(I),2)
  300 CONTINUE
      YORIG=(YBEG-ZSIZE)
      CALL PLOT(XFXD(N),YBEG,3)
      CALL PLOT(XFXD(N),YORIG,2)
C***PLOT AXES
      CALL SCALE(Y,XSIZE,N,1)
      DINC=XMAX/XSIZE
      CALL AXIS(XBEG,YORIG,XLAB,-30,XSIZE,0.0,0.0,DINC)
      CALL SCALE(Z,ZSIZE,N,1)
      CALL AXIS(XBEG,YBEG,YLAB,-30,ZSIZE,270.0,0.0,Z(N+1))
C***DRAW A LINE AT SEA LEVEL
      CALL PLOT(XBEG,YBEG,3)
```

```
      CALL DPPLOT((XBEG+XSIZE),YBEG,4)
C*** SHADE THE FOREGROUND
      XP(1)=XBEG
      YP(1)=YBEG-(Z(1)*ZFACT)
      DO 400 I=2,N
      XP(I)=XFXD(I)
      YP(I)=YFXD(I)
  400 CONTINUE
  500 CONTINUE
      XP(I)=XFXD(N)
      N=N+1
      I=N
      YP(I)=YBEG-ZSIZE
      I=I+1
      XP(I)=XBEG
      YP(I)=YBEG-ZSIZE
      I=I+1
      XP(I)=XBEG
      YP(I)=YBEG-(Z(1)*ZFACT)
      N=I
      NUMPTS=N
      VAL=(NUMPTS/2)+1
      WRITE(6,/) NUMPTS,VAL
      CALL DPPEN(2)
      CALL SHADE(XP,YP,NUMPTS,WKAR,VAL,45.0,.1,ERRCOD)
      CALL DPPEN(1)
      CALL SYMBOL(XL,YL,HT,LABL,0.0,24.0)
      CALL HOME
      STOP
      END
```

APPENDIX C

BATHYGRAPH example data from the survey of Indian River Inlet, Sussex County, Delaware. This appendix consists of two data files, they are:

BATHYL/RUNS5 - Depth and transect distance data for a single traverse through the inlet (10x, 1F10.2).

BATHYINLET - Total survey data (X, Y, Z) for the inlet (3F10.2).

BATHYL/RUNS5

0.00	4.11
5.54	4.27
11.16	4.57
16.78	4.57
22.40	4.57
28.02	4.88
33.64	4.88
39.26	5.18
44.88	5.18
50.50	5.33
56.12	5.49
61.74	5.64
67.36	5.79
72.98	5.79
78.60	5.79
84.22	5.94
89.84	5.94
95.46	5.94
101.08	6.10
106.70	7.16
113.42	7.92
120.24	8.69
127.06	9.45
133.88	9.30
140.70	8.84
147.52	8.84
154.34	10.36
161.16	11.43
167.98	12.50
174.80	13.41
181.62	13.72
188.44	14.02
195.26	14.33
202.08	14.63
208.90	14.78
215.72	15.09
222.54	15.39
229.36	15.85
236.18	16.15
243.00	16.61
249.82	16.76
256.64	17.07
263.46	17.07
270.28	16.76
277.10	16.15
283.92	14.63
290.74	13.11
297.56	12.50
304.38	12.50
311.20	12.50
315.30	12.50
319.41	11.28
323.52	10.67
327.63	9.45
331.74	8.23
335.85	7.46
339.96	7.16
344.07	10.52
348.18	11.28
352.29	11.89

356.40	12.80
360.51	13.11
364.62	13.72
368.73	14.15
372.84	15.09
376.95	15.54
381.06	16.00
385.17	16.46
389.28	16.76
393.39	17.07
397.50	17.37
402.88	17.68
408.24	17.53
413.60	17.53
418.96	17.53
424.32	17.68
429.68	17.37
435.04	16.15
440.40	15.54
445.76	15.24
451.12	15.09
456.48	14.92
461.84	14.63
467.20	14.33
472.56	14.17
477.92	14.17
483.28	13.72
488.64	13.41
494.00	13.26
499.24	13.41
504.52	13.41
509.80	13.41
515.08	13.41
520.36	14.17
525.64	14.33
530.92	14.17
536.20	14.17
541.48	14.02
546.76	14.02
552.04	14.17
557.32	13.72
562.60	13.72
571.87	13.56
581.14	13.56
590.41	12.80
599.68	12.50
608.95	11.89
618.22	10.97
627.49	10.21
636.76	9.45
646.03	9.75
655.30	9.60
664.57	9.91
673.84	10.06
683.11	9.75
692.38	3.99
701.65	9.14
710.92	9.45
720.19	9.45
729.46	9.14

738.73	8.99
748.00	9.14

BATHYINLET

0.00	0.00	6.71
8.28	0.00	6.55
16.56	0.00	6.71
24.84	0.00	6.55
33.12	0.00	6.40
41.40	0.00	6.40
49.68	0.00	6.40
57.96	0.00	6.40
66.24	0.00	6.40
74.52	0.00	5.79
82.80	0.00	5.33
91.08	0.00	5.18
99.36	0.00	5.18
107.64	0.00	4.88
115.92	0.00	4.72
124.20	0.00	4.57
132.48	0.00	4.27
140.76	0.00	4.11
149.04	0.00	3.96
157.32	0.00	4.11
165.60	0.00	4.27
173.88	0.00	4.72
182.16	0.00	5.03
190.44	0.00	5.49
198.72	0.00	5.79
207.00	0.00	6.40
215.28	0.00	6.86
223.56	0.00	6.71
231.84	0.00	7.16
240.12	0.00	7.62
248.40	0.00	7.62
256.68	0.00	7.92
264.96	0.00	7.16
273.24	0.00	6.55
281.52	0.00	6.10
289.80	0.00	5.94
298.08	0.00	6.10
306.36	0.00	5.79
314.64	0.00	5.64
322.92	0.00	5.49
331.20	0.00	4.72
339.48	0.00	4.27
347.76	0.00	4.11
356.04	0.00	3.96
364.32	0.00	3.96
372.60	0.00	3.96
304.80	106.70	8.84
299.88	106.70	10.82
294.96	106.70	10.52
290.04	106.70	10.21
285.12	106.70	10.06
280.20	106.70	9.75
275.28	106.70	9.30
270.36	106.70	9.14
265.44	106.70	9.75
260.52	106.70	10.97
255.60	106.70	11.28
250.68	106.70	11.28
245.76	106.70	11.13
240.84	106.70	10.97

235.92	106.70	10.52
231.00	106.70	10.36
226.08	106.70	9.91
221.16	106.70	9.75
216.24	106.70	9.60
211.32	106.70	9.30
206.40	106.70	8.53
201.48	106.70	7.77
196.56	106.70	7.16
191.64	106.70	6.25
186.72	106.70	5.49
181.80	106.70	4.88
176.88	106.70	4.88
171.96	106.70	5.33
167.04	106.70	5.18
162.12	106.70	5.49
157.20	106.70	5.64
152.28	106.70	5.64
147.36	106.70	5.79
142.44	106.70	6.10
137.52	106.70	5.94
132.60	106.70	5.94
127.68	106.70	6.40
122.76	106.70	6.40
117.84	106.70	6.71
112.92	106.70	6.71
108.00	106.70	7.01
103.08	106.70	7.01
98.16	106.70	7.16
93.24	106.70	7.32
88.32	106.70	7.77
83.40	106.70	8.08
78.48	106.70	8.23
73.56	106.70	8.69
68.64	106.70	8.38
63.50	106.70	7.32
114.30	311.20	8.23
122.32	311.20	11.43
130.34	311.20	12.80
138.36	311.20	13.11
146.38	311.20	12.50
154.40	311.20	12.34
162.42	311.20	12.04
170.44	311.20	12.04
178.46	311.20	11.73
186.48	311.20	12.80
194.50	311.20	12.50
202.56	311.20	11.58
210.54	311.20	11.58
218.56	311.20	12.80
226.58	311.20	13.41
234.60	311.20	15.54
242.62	311.20	15.54
250.64	311.20	13.41
258.66	311.20	11.28
266.70	311.20	9.45
114.30	562.60	13.41
119.38	562.60	13.87
124.46	562.60	13.41
129.54	562.60	13.56

134.62	562.60	13.87
139.70	562.60	14.02
144.78	562.60	13.72
149.86	562.60	13.72
154.94	562.60	13.41
160.02	562.60	13.87
165.10	562.60	13.72
170.18	562.60	13.72
175.26	562.60	13.87
180.34	562.60	14.02
185.42	562.60	13.87
190.50	562.60	14.02
195.50	562.60	14.02
200.66	562.60	14.02
205.74	562.60	14.17
210.82	562.60	13.72
215.90	562.60	13.41
220.98	562.60	13.11
226.06	562.60	12.95
231.14	562.60	12.19
236.22	562.60	11.28
241.30	562.60	10.36
246.38	562.60	8.53
251.46	562.60	7.01
256.54	562.60	5.79
261.62	562.60	3.96
266.70	562.60	5.49
190.70	0.00	4.42
190.70	4.27	4.72
190.70	8.54	4.88
190.70	12.81	5.03
190.70	17.08	5.18
190.70	21.35	5.49
190.70	25.62	5.33
190.70	29.89	5.49
190.70	34.16	5.49
190.70	38.43	5.49
190.70	42.70	5.49
190.70	46.97	5.49
190.70	51.24	5.64
190.70	55.51	5.49
190.70	59.78	5.49
190.70	64.05	5.49
190.70	68.32	5.49
190.70	72.59	5.33
190.70	76.86	5.33
190.70	81.13	5.33
190.70	84.40	5.49
190.70	89.67	5.33
190.70	93.94	5.64
190.70	98.21	5.49
190.70	102.48	5.33
190.70	106.70	5.18
190.70	114.00	5.49
190.70	121.30	5.64
190.70	128.60	5.49
190.70	135.9	5.64
190.70	143.20	5.94
190.70	150.50	6.40
190.70	157.80	7.01

190.70	165.10	7.01
190.70	172.40	6.40
190.70	179.70	8.53
190.70	187.00	10.36
190.70	194.30	11.73
190.70	201.60	13.11
190.70	208.90	13.87
190.70	216.20	14.33
190.70	223.50	15.39
190.70	230.80	16.76
190.70	238.10	17.83
190.70	245.40	17.68
190.70	252.70	17.83
190.70	260.00	17.53
190.70	267.30	17.37
190.70	274.60	17.22
190.70	281.90	16.76
190.70	289.20	15.70
190.70	296.50	13.41
190.70	303.80	12.95
190.70	311.20	12.65
190.70	316.95	13.11
190.70	322.70	13.11
190.70	328.45	12.34
190.70	334.20	11.89
190.70	339.95	11.28
190.70	345.70	9.45
190.70	351.45	7.16
190.70	357.20	7.16
190.70	362.95	7.32
190.70	368.70	7.62
190.70	374.45	12.80
190.70	380.20	16.76
190.70	385.95	16.76
190.70	391.70	15.85
190.70	397.50	16.46
190.70	406.67	18.29
190.70	415.84	17.83
190.70	425.01	16.92
190.70	434.18	16.15
190.70	443.35	15.70
190.70	452.52	15.24
190.70	461.69	15.09
190.70	470.86	14.63
190.70	480.03	14.17
190.70	489.20	14.17
190.70	498.37	13.72
190.70	507.54	13.87
190.70	516.71	14.02
190.70	525.88	14.17
190.70	535.05	14.48
190.70	544.22	14.62
190.70	553.39	14.78
190.70	562.60	14.63
190.70	571.43	14.17
190.70	580.26	14.17
190.70	589.09	13.87
190.70	597.92	13.41
190.70	606.75	12.19
190.70	615.58	11.28

190.70	624.41	10.36
190.70	633.24	10.36
190.70	642.07	11.28
190.70	650.90	11.73
190.70	659.73	11.73
190.70	703.88	9.14
190.70	712.71	9.30
190.70	721.54	11.28
190.70	730.37	13.11
190.70	739.20	15.24
190.70	748.00	18.90
190.70	755.00	22.56
190.70	762.00	24.06
190.70	769.00	24.38
190.70	776.00	23.16
190.70	783.00	22.56
190.70	790.00	22.10
190.70	797.00	21.79
190.70	804.00	21.64
190.70	811.0	21.03
190.70	818.00	19.81
190.70	825.00	18.90
190.70	832.00	18.59
190.70	839.00	17.98
190.70	846.00	17.37
190.70	853.00	16.61
190.70	860.00	15.85
190.70	867.00	15.24
190.70	874.00	14.78
190.70	881.00	14.17
190.70	888.00	13.56
190.70	895.00	13.11
190.70	902.00	12.80
190.70	909.00	12.80
190.70	916.00	12.19
190.70	923.00	12.19
190.70	930.00	12.04
190.70	937.00	11.73
190.70	944.00	11.43
190.70	951.00	11.43
190.70	958.00	11.28
190.70	965.00	11.28
190.70	972.00	11.43
190.70	979.00	10.97
190.70	986.00	10.36
190.70	1000.00	10.06
190.70	1007.00	10.06
190.70	1014.00	10.21
190.70	1021.00	10.36
248.80	397.50	11.28
248.80	411.29	11.13
248.80	425.08	11.28
248.80	438.87	11.28
248.80	452.66	11.89
248.80	466.45	13.11
248.80	480.24	12.65
248.80	494.00	13.11
248.80	500.24	13.87
248.80	506.48	13.72
248.80	512.72	13.72

248.80	518.96	13.72
248.80	525.20	13.87
248.80	531.44	14.02
248.80	537.68	14.02
248.80	543.92	13.87
248.80	550.16	13.87
248.80	556.40	13.87
248.80	562.60	13.56
248.80	570.02	12.04
248.80	577.44	11.28
248.80	584.86	9.75
248.80	592.28	9.30
248.80	599.70	9.60
248.80	607.12	10.36
248.80	614.54	9.75
248.80	621.96	9.45
248.80	629.38	10.36
248.80	636.80	11.28
248.80	644.22	10.36
248.80	651.64	9.75
248.80	659.06	9.45
248.80	666.48	9.14
248.80	673.90	9.14
248.80	681.32	9.30
248.80	688.74	9.14
248.80	696.16	9.45
248.80	703.58	10.06
248.80	711.00	10.36
248.80	718.42	9.75
248.80	725.84	9.45
248.80	733.26	10.06
248.80	740.68	11.13
248.80	748.00	11.58
248.80	754.30	12.80
248.80	760.60	14.02
248.80	766.90	15.24
248.80	773.20	16.48
248.80	779.50	17.68
248.80	785.80	17.98
248.80	792.10	18.59
248.80	798.40	18.29
248.80	804.70	18.29
248.80	811.00	17.83
248.80	817.30	17.37
248.80	823.60	16.92
248.80	829.90	16.76
248.80	836.2	16.76
248.80	842.50	16.76
248.80	848.80	16.46
248.80	855.10	15.85
248.80	861.40	15.54
248.80	867.70	15.24
248.80	874.00	14.94
132.20	397.50	11.28
132.20	408.22	11.43
132.20	418.94	11.58
132.20	429.66	11.43
132.20	440.38	11.58
132.20	451.10	11.58
132.20	461.82	11.58

132.20	472.54	11.58
132.20	483.26	11.73
132.20	494.00	11.73
132.20	503.80	11.89
132.20	513.60	11.89
132.20	523.40	12.19
132.20	533.20	11.89
132.20	543.00	12.19
132.20	552.80	12.65
132.20	562.60	13.26
132.20	570.66	12.50
132.20	578.72	12.50
132.20	586.78	11.89
132.20	594.84	12.19
132.20	602.90	11.89
132.20	610.96	11.58
132.20	619.02	11.58
132.20	627.08	11.73
132.20	635.14	11.73
132.20	643.20	11.89
132.20	651.26	11.58
132.20	659.32	11.58
132.20	667.38	11.43
132.20	675.44	11.43
132.20	683.50	11.43
132.20	691.56	11.58
132.20	699.62	11.89
132.20	707.68	12.34
132.20	715.74	12.19
132.20	723.80	13.72
132.20	731.86	16.31
132.20	765.19	20.12
132.20	770.92	18.59
132.20	776.65	17.68
132.20	782.38	16.76
132.20	788.11	16.76
132.20	793.84	15.85
132.20	799.57	14.63
132.20	805.30	11.28
132.20	811.03	9.14
132.20	816.76	8.53
132.20	822.49	8.23
132.20	828.22	8.23
132.20	833.95	8.53
132.20	839.68	9.30
132.20	845.41	10.36
132.20	851.14	11.43
132.20	856.87	11.58
132.20	862.60	11.58
132.20	868.33	11.58
132.20	874.00	11.89
248.80	0.00	5.94
248.8	5.08	5.94
248.8	10.16	5.94
248.8	15.24	6.25
248.8	20.32	6.25
248.8	25.40	6.10
248.8	30.48	6.40
248.8	35.56	6.40
248.8	40.64	6.55

248.8	45.73	7.16
248.8	50.80	8.08
248.8	55.88	8.38
248.8	60.96	8.38
248.8	66.04	8.23
248.8	71.12	8.38
248.8	76.20	8.69
248.8	81.28	8.99
248.8	86.36	9.30
248.8	91.44	9.45
248.8	96.52	9.75
248.8	101.60	9.30
248.8	106.70	10.06
248.8	112.38	10.21
248.8	118.06	10.21
248.8	123.74	10.21
248.8	129.42	10.06
248.80	135.11	9.75
248.8	140.78	9.45
248.8	146.46	9.45
248.8	152.14	9.30
248.8	157.82	9.14
248.8	163.50	8.53
248.8	169.18	8.69
248.8	174.86	8.69
248.8	180.54	8.84
248.8	186.22	8.38
248.8	191.90	8.53
248.8	197.58	8.23
248.8	203.26	7.92
248.8	208.94	7.77
248.8	214.62	7.62
248.8	220.30	7.92
248.8	225.98	8.08
248.8	231.66	8.69
248.8	237.34	10.06
248.8	243.02	11.58
248.8	282.78	19.51
248.8	288.46	17.37
248.8	294.14	15.85
248.8	299.82	15.24
248.8	305.50	13.41
248.8	311.20	13.11
248.8	319.05	13.11
248.8	326.89	12.80
248.8	334.74	12.04
248.8	342.58	11.43
248.8	350.43	11.89
248.8	358.27	12.65
248.8	366.12	13.26
248.8	373.96	14.02
248.8	381.81	14.63
248.8	389.65	12.50
248.8	397.50	10.97
248.8	402.58	10.36
248.8	407.66	10.82
248.8	412.74	10.67
248.8	417.82	10.06
248.8	422.90	9.30
248.8	427.98	10.97

248.8	433.06	12.50
248.8	438.14	11.58
248.8	443.22	11.89
248.8	448.30	13.26
248.8	453.38	14.17
248.8	458.46	14.78
248.8	463.54	14.63
248.8	468.62	14.63
248.8	473.70	14.78
248.8	478.78	14.33
248.8	483.86	13.56
248.8	488.94	13.26
248.8	494.00	14.02
248.8	499.72	13.72
248.8	505.44	13.87
248.8	511.16	13.72
248.8	516.88	12.80
248.8	522.60	12.34
248.8	528.32	11.58
248.8	524.04	11.89
248.8	539.76	12.19
248.8	545.48	13.11
248.8	551.20	13.11
248.8	556.92	12.80
248.8	562.60	12.50
248.8	569.73	13.11
248.8	576.86	13.41
248.8	583.99	13.11
248.8	591.12	12.65
248.8	612.51	12.34
248.8	619.64	12.50
248.8	633.90	13.11
248.8	641.03	12.65
248.8	648.16	12.50
248.8	655.29	11.89
248.8	622.42	12.04
248.8	669.55	11.28
248.8	676.68	10.67
248.8	683.81	9.75
248.8	690.94	9.30
248.8	698.07	8.99
248.8	705.20	9.14
248.8	712.33	9.14
248.8	719.46	9.14
248.8	726.59	9.60
248.8	733.72	9.14
248.8	740.85	9.30
248.8	748.00	8.84
210.80	0.00	6.25
210.80	5.93	6.55
210.80	11.86	6.86
210.80	17.79	7.23
210.80	23.72	7.32
210.80	29.65	7.32
210.8	35.58	7.62
210.8	41.51	7.62
210.8	47.44	7.77
210.8	53.37	7.92
210.8	59.30	8.23
210.8	65.23	8.38

210.8	71.16	8.53
210.8	77.09	8.84
210.8	83.02	8.99
210.8	88.95	8.99
210.8	94.88	9.14
210.8	100.81	9.14
210.8	106.70	9.30
210.8	112.23	9.60
210.8	117.76	9.75
210.8	123.29	10.06
210.8	128.82	10.21
210.8	134.35	10.21
210.8	139.88	10.36
210.8	145.41	10.52
210.8	150.94	10.36
210.8	156.47	10.06
210.8	162.00	10.06
210.8	167.53	9.91
210.8	173.06	11.28
210.8	178.59	12.50
210.8	184.12	13.41
210.8	189.65	13.72
210.8	195.18	14.72
210.8	200.71	14.48
210.8	206.24	14.94
210.8	211.77	15.09
210.8	217.30	15.54
210.8	222.83	15.54
210.8	228.36	16.15
210.8	233.89	16.61
210.8	239.42	16.92
210.8	256.01	17.53
210.8	261.54	17.83
210.8	267.07	17.68
210.8	272.60	17.53
210.8	278.13	17.37
210.8	283.66	16.92
210.8	289.19	16.61
210.8	294.72	15.85
210.8	300.25	15.24
210.8	305.78	13.72
210.8	311.20	13.11
210.8	317.84	12.50
210.8	324.48	11.58
210.8	331.72	11.43
210.8	337.76	10.36
210.8	344.40	10.36
210.8	351.04	10.97
210.8	357.68	10.52
210.8	364.32	11.89
210.8	370.96	14.33
210.8	377.60	16.15
210.8	384.24	17.37
210.8	390.88	17.68
210.8	397.50	17.83
210.8	404.10	17.68
210.8	410.70	17.68
210.8	417.30	18.90
210.8	423.90	17.98
210.8	430.50	16.76

210.8	437.10	16.61
210.8	443.70	16.15
210.8	450.30	15.85
210.8	456.90	15.54
210.8	463.50	15.09
210.8	470.10	14.78
210.8	476.70	14.33
210.8	483.30	13.72
210.8	489.90	13.72
210.8	496.50	13.72
210.8	503.10	13.72
210.8	509.70	13.87
210.8	516.30	14.17
210.8	522.90	14.17
210.8	529.50	14.33
210.8	536.10	14.17
210.8	542.70	14.02
210.8	549.30	14.33
210.8	555.90	14.33
210.8	562.60	14.02
210.8	572.36	14.72
210.8	582.12	13.72
210.8	591.88	13.56
210.8	601.64	13.11
210.8	611.40	12.34
210.8	621.16	12.04
210.8	630.92	10.82
210.8	640.68	10.06
210.8	650.44	9.75
210.8	660.20	10.36
210.8	669.96	10.36
210.8	679.72	10.06
210.8	689.48	10.06
210.8	699.24	9.91
210.8	709.00	9.45
210.8	718.76	9.14
210.8	728.52	9.45
210.8	738.28	9.14
210.80	738.28	10.36
170.5	0.00	3.96
170.50	4.10	3.96
170.50	8.20	3.66
170.50	12.30	3.66
170.50	16.40	3.66
170.50	20.50	3.96
170.50	24.60	3.96
170.50	28.70	4.11
170.50	32.80	4.27
170.50	36.90	4.57
170.50	41.00	5.18
170.50	45.10	5.79
170.50	49.20	6.25
170.50	53.30	6.55
170.50	57.40	6.71
170.50	61.50	6.55
170.50	65.60	6.40
170.50	69.70	6.10
170.50	73.80	6.10
170.50	77.90	5.79
170.50	82.00	5.79

170.50	86.10	5.94
170.50	90.20	5.79
170.50	94.30	5.79
170.50	98.40	5.79
170.50	102.50	5.79
170.50	106.70	5.79
170.50	112.54	5.64
170.50	118.38	5.79
170.50	124.22	5.79
170.50	130.06	6.71
170.50	135.90	7.32
170.50	141.74	7.92
170.50	147.58	8.53
170.50	153.42	7.77
170.50	159.26	7.32
170.50	165.10	8.99
170.50	170.94	10.21
170.50	176.78	11.28
170.50	182.62	12.04
170.50	188.46	12.80
170.50	194.30	13.11
170.50	200.14	13.41
170.50	205.98	13.72
170.50	211.82	14.02
170.50	217.66	14.33
170.50	223.50	14.94
170.50	229.34	15.24
170.50	235.18	15.54
170.50	241.02	15.54
170.50	246.86	15.54
170.50	252.70	15.24
170.50	258.54	15.24
170.50	264.38	15.39
170.50	270.22	15.39
170.50	276.06	15.24
170.50	281.90	14.94
170.50	287.74	14.94
170.50	293.58	14.48
170.50	299.42	14.02
170.50	305.26	13.11
170.50	311.20	12.34
170.50	318.39	12.04
170.50	325.58	11.28
170.50	332.77	11.28
170.50	339.96	10.06
170.50	347.15	10.06
170.50	354.34	12.80
170.50	361.53	15.24
170.50	368.72	15.85
170.50	375.91	16.76
170.50	383.10	15.70
170.50	390.29	15.24
170.50	397.50	16.15
170.50	407.15	16.76
170.50	416.80	17.37
170.50	426.45	17.98
170.50	436.10	17.68
170.50	445.75	16.76
170.50	455.40	15.85
170.50	465.05	15.24

170.50	474.70	14.63
170.50	484.35	14.33
170.50	494.00	14.63
170.50	500.24	14.02
170.50	506.48	13.72
170.50	512.72	13.72
170.50	518.96	14.17
170.50	525.20	14.02
170.50	531.44	14.17
170.50	537.68	14.33
170.50	543.92	14.17
170.50	550.16	14.48
170.50	556.40	14.33
170.50	562.60	14.17
170.50	572.36	13.56
170.50	582.12	12.80
170.50	591.88	11.58
170.50	601.64	9.60
170.50	611.40	9.75
170.50	621.16	11.28
170.50	630.92	12.50
170.50	640.68	12.80
170.50	650.44	12.95
170.50	660.20	12.95
170.50	669.96	12.50
170.50	679.72	10.52
170.50	689.48	9.14
170.50	699.24	9.14
170.50	709.00	10.21
170.50	718.76	11.28
170.50	728.52	12.04
170.50	738.28	13.72
170.50	748.00	14.63
132.20	0.00	5.03
132.20	6.28	5.18
132.20	12.56	5.18
132.20	18.84	5.49
132.20	25.12	5.49
132.20	31.40	5.49
132.20	37.68	5.64
132.20	43.96	5.49
132.20	50.24	5.18
132.20	56.52	5.03
132.20	62.80	5.18
132.20	69.08	5.18
132.20	75.36	4.88
132.20	81.64	5.18
132.20	87.92	5.03
132.20	94.20	5.49
132.20	100.48	5.94
132.20	106.70	5.94
132.20	115.22	6.25
132.20	123.74	6.40
132.20	132.26	6.25
132.20	140.78	6.25
132.20	149.30	6.10
132.20	157.82	6.10
132.20	166.34	6.10
132.20	174.86	5.49
132.20	183.38	7.32

132.20	191.90	8.84
132.20	200.42	10.06
132.20	208.94	10.67
132.20	217.46	11.28
132.20	225.98	11.89
132.20	234.50	12.04
132.20	243.02	12.65
132.20	251.54	13.26
132.20	260.06	13.72
132.20	268.58	14.94
132.20	277.10	15.54
132.20	285.62	16.00
132.20	294.14	16.15
132.20	302.66	16.15
132.20	311.20	14.63
132.20	319.05	13.41
132.20	326.90	12.19
132.20	334.75	9.75
132.20	342.60	10.21
132.20	350.45	11.58
132.20	358.30	13.11
132.20	366.15	13.87
132.20	374.00	13.56
132.20	381.85	10.36
132.20	389.70	8.23
132.20	397.50	9.45
132.20	407.15	10.21
132.20	416.80	10.97
132.20	426.45	12.19
132.20	436.10	12.80
132.20	445.75	11.58
132.20	455.40	11.89
132.20	465.05	11.58
132.20	474.70	12.19
132.20	484.35	10.97
132.20	494.00	12.04
132.20	502.58	13.41
132.20	511.16	13.11
132.20	519.74	13.72
132.20	528.32	13.72
132.20	536.90	14.33
132.20	545.48	14.63
132.20	554.06	14.78
132.20	562.60	14.02
132.20	573.51	14.17
132.20	584.42	13.72
132.20	595.33	12.19
132.20	606.24	10.67
132.20	617.15	10.36
132.20	628.06	12.80
132.20	638.97	13.87
132.20	649.88	13.87
132.20	660.79	13.41
132.20	671.70	11.58
132.20	682.61	9.14
132.20	693.52	10.21
132.20	704.43	12.19
132.20	715.34	12.80
132.20	726.25	15.24
132.20	737.16	16.76

132.20	748.00	17.22
190.70	748.00	9.14
190.70	738.73	8.99
190.70	729.46	9.14
190.70	720.19	9.45
190.70	710.92	9.45
190.70	701.65	9.14
190.70	692.38	8.99
190.70	683.11	9.75
190.70	673.84	10.06
190.70	664.57	9.91
190.70	655.30	9.60
190.70	646.03	9.75
190.70	636.76	9.45
190.70	627.49	10.21
190.70	618.22	10.97
190.70	608.95	11.89
190.70	599.68	12.50
190.70	590.41	12.80
190.70	581.14	13.56
190.70	571.87	13.56
190.70	562.60	13.72
190.70	557.32	13.72
190.70	552.04	14.17
190.70	546.76	14.02
190.70	541.48	14.02
190.70	536.20	14.17
190.70	530.92	14.17
190.70	525.64	14.33
190.70	520.36	14.17
190.70	515.08	13.41
190.70	509.80	13.41
190.70	504.52	13.41
190.70	499.24	13.41
190.70	494.00	13.26
190.70	488.64	13.41
190.70	483.28	13.72
190.70	477.92	14.17
190.70	472.56	14.17
190.70	467.20	14.33
190.70	461.84	14.63
190.70	456.48	14.92
190.70	451.12	15.09
190.70	445.76	15.24
190.70	440.40	15.54
190.70	435.04	16.15
190.70	429.68	17.37
190.70	424.32	17.68
190.70	418.96	17.53
190.70	413.60	17.53
190.70	408.24	17.53
190.70	402.88	17.68
190.70	397.50	17.37
190.70	393.39	17.07
190.70	389.28	16.76
190.70	385.17	16.46
190.70	381.06	16.00
190.70	376.95	15.54
190.70	372.84	15.09
190.70	368.73	14.15

190.70	364.62	13.72
190.70	360.51	13.11
190.70	356.40	12.80
190.70	352.29	11.89
190.70	348.18	11.28
190.70	344.07	10.52
190.70	339.96	7.16
190.70	335.85	7.46
190.70	331.74	8.23
190.70	327.63	9.45
190.70	323.52	10.67
190.70	319.41	11.28
190.70	315.30	12.50
190.70	311.20	12.50
190.70	304.38	12.50
190.70	297.56	12.50
190.70	290.74	13.11
190.70	283.92	14.63
190.70	277.10	16.15
190.70	270.28	16.76
190.70	263.46	17.07
190.70	256.64	17.07
190.70	249.82	16.76
190.70	243.00	16.61
190.70	236.18	16.15
190.70	229.36	15.85
190.70	222.54	15.39
190.70	215.72	15.09
190.70	208.90	14.78
190.70	202.08	14.63
190.70	195.26	14.33
190.70	188.44	14.02
190.70	181.62	13.72
190.70	174.80	13.41
190.70	167.98	12.50
190.70	161.16	11.43
190.70	154.34	10.36
190.70	147.52	8.84
190.70	140.70	8.84
190.70	133.88	9.30
190.70	127.06	9.45
190.70	120.24	8.69
190.70	113.42	7.92
190.70	106.70	7.16
190.70	101.08	6.10
190.70	95.46	5.94
190.70	89.84	5.94
190.70	84.22	5.94
190.70	78.60	5.79
190.70	72.98	5.79
190.70	67.36	5.79
190.70	61.74	5.64
190.70	56.12	5.49
190.70	50.50	5.33
190.70	44.88	5.18
190.70	39.26	5.18
190.70	33.64	4.88
190.70	28.02	4.88
190.70	22.40	4.57
190.70	16.78	4.57

190.70	11.16	4.57
190.70	5.54	4.27
190.70	0.00	4.11

APPENDIX D

Sample SYMAP data file. This file is not complete but does display the essential structure of each SYMAP package.

A sample of the SYMAP output is also displayed. This hardcopy is printed at the RJE10 line printer in Smith Hall every time SYMAP/DO is run. This output is for user information and preliminary analysis of the data matrix.

PARTIAL SYMAP DATA FILE

(all necessary packages are shown)

```
A-OUTLINE
          814.43      0.00
          701.04      7.32
          643.13     60.96
          505.97     59.74
          454.15    110.34
           12.19    107.90
            0.00    246.28
          454.76    248.11
          513.89    296.88
          671.17    295.05
          695.55    319.43
          722.38    346.86
          719.94    358.44
          766.88    368.81
          811.99    362.10
99999
B-DATA POINTS
         1021.00      0.00
         1021.00      8.28
         1021.00     16.56
         1021.00     24.84
         1021.00     33.12
         1021.00     41.40
         1021.00     49.68
         1021.00     57.96
         1021.00     66.24
         1021.00     74.52
         1021.00     82.80
         1021.00     91.08
         1021.00     99.36
         1021.00    107.64
         1021.00    115.92
         1021.00    124.20
         1021.00    132.48
         1021.00    140.76
         1021.00    149.04
         1021.00    157.32
         1021.00    165.60
         1021.00    173.88
         1021.00    182.16
         1021.00    190.44
         1021.00    198.72
         1021.00    207.00
         1021.00    215.28
         1021.00    223.56
         1021.00    231.84
         1021.00    240.12
         1021.00    248.40
         1021.00    256.68
         1021.00    264.96
         1021.00    273.24
         1021.00    281.52
         1021.00    289.80
         1021.00    298.08
         1021.00    306.36
         1021.00    314.64
         1021.00    322.92
         1021.00    331.20
         1021.00    339.48
```

907.58	190.70
914.30	190.70
919.92	190.70
925.54	190.70
931.16	190.70
936.78	190.70
942.40	190.70
948.02	190.70
953.64	190.70
959.26	190.70
964.88	190.70
970.50	190.70
976.12	190.70
981.74	190.70
987.36	190.70
992.98	190.70
998.60	190.70
1004.22	190.70
1009.84	190.70
1015.46	190.70
1021.00	190.70

99999
E-VALUES

6.71
6.55
6.71
6.55
6.40
6.40
6.40
6.40
6.40
5.79
5.33
5.18
5.18
4.88
4.72
4.57
4.27
4.11
3.96
4.11
4.27
4.72
5.03
5.49
5.79
6.40
6.86
6.71
7.16
7.62
7.62
7.92
7.16
6.55
6.10
5.94
6.10

```
                8.84
                8.84
                9.30
                9.45
                8.69
                7.92
                7.16
                6.10
                5.94
                5.94
                5.94
                5.79
                5.79
                5.79
                5.64
                5.49
                5.33
                5.18
                5.18
                4.88
                4.88
                4.57
                4.57
                4.57
                4.27
                4.11
99999
F-MAP
                   SYMAP TEST
                   BATHYGRAPH TEST
                   FLETCHER/PETIT DE MANGE
    1       8.0         10.0
    9
   15         6.0        10.0
   17
   21
99999
999999
```

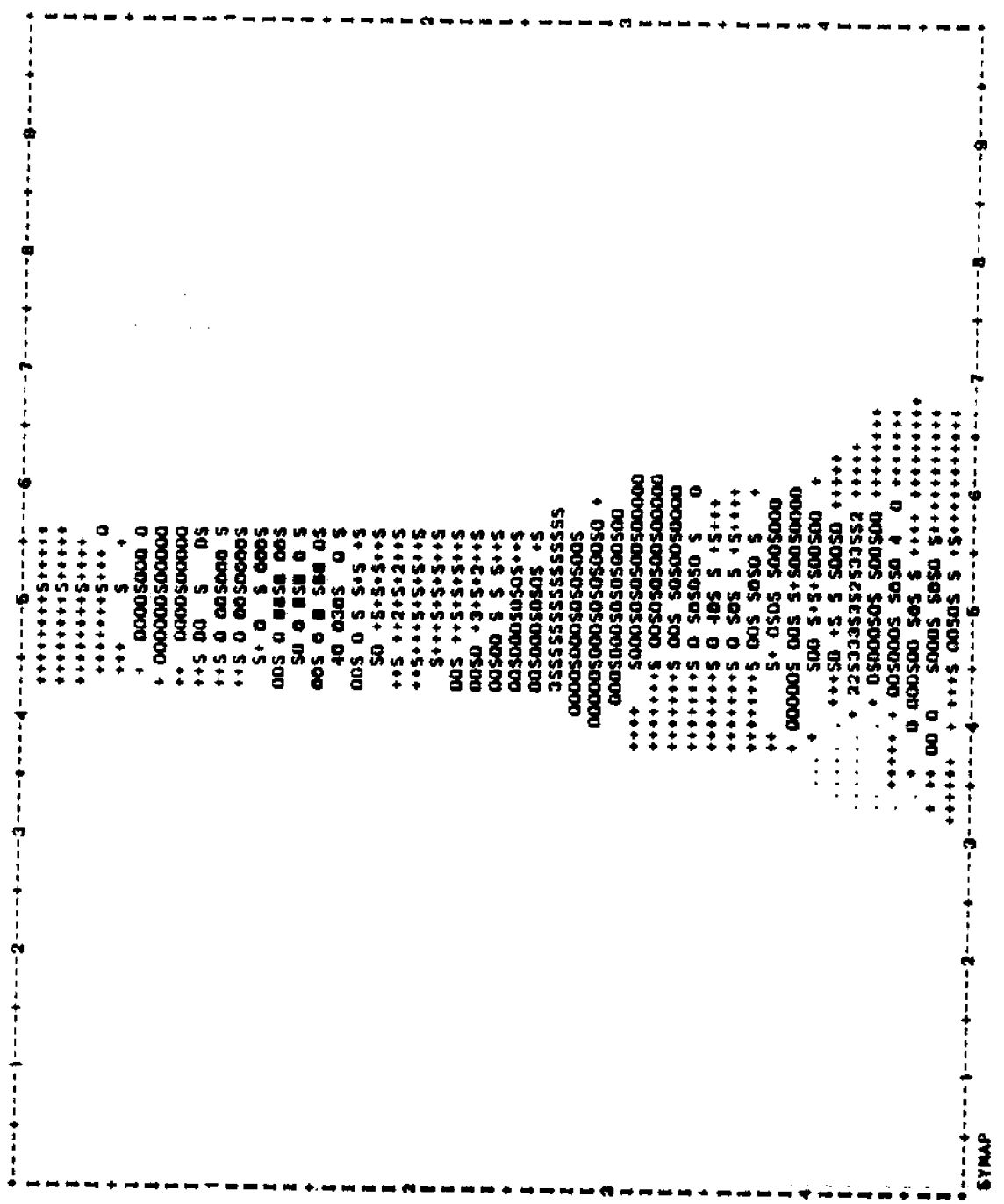
PARTIAL SYMAP OUTPUT

Automatically created at RJE10 printer
(Smith Hall) whenever SYMAP/DO is run.

ELECTIVE IDENTIFICATION

```
F-MAP
-----

        SYMAP TEST

          BATHYGRAPH TEST

            FLETCHER/PETIT DE MANGE

ELECTIVE

   1 MAP DIMENSIONS ARE   8.00 INCHES LONG BY  10.00 INCHES WIDE
   9 SUPPRESSION OF HISTOGRAM
  15 NUMBER OF CHARACTERS PER INCH IS  6.0 DOWN AND 10.0 ACROSS
  17 SUPPRESSION OF TABULAR OUTPUT DATA
  21 SYMVU TAPE CREATED

 0.4 MINUTES ELAPSED TIME FOR INPUT
 0.1 MINUTES TOTAL PROCESSOR TIME
 0.1 MINUTES TOTAL IO TIME

TIME OF DAY = 15:30
```

SAMPLE CHOROPLETH MAP



```
MAP    1
-------

                    SYMAP TEST
                    BATHYGRAPH TEST
                    FLETCHER/PETIT DE MANGE



MAP WINDOW DISPLAYED IS
          (     0.000,   -324.614)  (TOP-LEFT CORNER)
          (   814.430,    693.424)  (BOTTOM-RIGHT CORNER)

MAP SCALE =      0.0098 (INCHES ON OUTPUT MAP)/(UNITS ON SOURCE MAP)

MAP SHOULD BE PRINTED AT   6.0 ROWS PER INCH AND  10.0 COLUMNS PER INCH

TRANSFORMATION FROM SOURCE COORDINATES TO PRINT CHARACTER LOCATION IS
ROW    = DOWN    COORDINATE *      0.0589
COLUMN = (ACROSS COORDINATE -     -324.61) *      0.0982


THERE ARE  963 VALID DATA VALUES

MINIMUM AND MAXIMUM VALID DATA VALUES ARE      3.660 AND     24.380

MEAN OF VALID DATA IS                    11.271

STANDARD DEVIATION OF VALID DATA IS      3.894

STANDARD SEARCH RADIUS IS         31.7830

   0.3 MINUTES ELAPSED TIME FOR INITIAL CALCULATIONS
   0.2 MINUTES TOTAL PROCESSOR TIME
   0.1 MINUTES TOTAL IO TIME

TIME OF DAY = 15:31
```

SYMAP TEST

BATHYGRAPH TEST

FLETCHER/PETIT DE MANGE

DATA VALUE EXTREMES ARE 3.66 24.38

TOTAL SUPERIMPOSED DATA POINTS IS 827. THESE OCCUR IN 100 LOCATIONS.

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

MINIMUM	3.66	7.80	11.95	16.09	20.24
MAXIMUM	7.80	11.95	16.09	20.24	24.38

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

	20.00	20.00	20.00	20.00	20.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL

LEVEL	1	2	3	4	5
	.....	+++++++++	000000000	000000000	#########
	.....	+++++++++	000000000	000000000	#########
SYMBOLS	....1....	++++2++++	000030000	000040000	####5####
	.....	+++++++++	000000000	000000000	#########
	.....	+++++++++	000000000	000000000	#########
FREQ.	217	305	339	93	9

0.1 MINUTES ELAPSED TIME FOR HISTOGRAM
0.5 MINUTES TOTAL PROCESSOR TIME
0.1 MINUTES TOTAL IO TIME

TIME OF DAY = 15:32