SELECT: A NUMERICAL, ONE-DIMENSIONAL MODEL FOR SELECTIVE WITHDRAWAL

Final Report
Instruction Report E-87-2
March 1987

Instructions for Updating the SELECT Program and Its Documentation

1. Several improvements have been made and small errors corrected since the 1987 release of Version (Ver.) 1.0 of the SELECT program and documentation. The latest form of the program including these changes has been labelled Ver. 1.3. Ver. 1.1 and 1.2 were interim working versions of the program and therefore were not released or documented.

2. Documentation for Ver. 1.0 is found in the US Army Engineer Waterways Experiment Station Instruction Report E-87-2, entitled "SELECT: A Numerical One-Dimensional Model for Selective Withdrawal." To update this SELECT manual and make it current with the new program, you must

   a. Replace pages 13-14, 35-40, 71-72, and 89-94 in the main text with the corresponding pages in this enclosure.

   b. Replace Appendices A through E with their updated counterparts enclosed.

3. To update the program, a wholesale substitution should be made. That is, SELECT.FOR should be replaced with SELECT13.FOR, and SELECT.EXE with SELECT13.EXE. Input data files used with Ver. 1.0 should be compatible with Ver. 1.3 with one exception. Version 1.3 no longer expects to find the FILES command line in the input. The file assignments have been established as unit 05 for input and unit 06 for output. Removing the FILES command line from the Ver. 1.0 input files will make them usable with Ver. 1.3.

4. The programming errors corrected since Ver. 1.0 will not produce significantly different results for most SELECT applications. If an application you are running yields notably different answers with Ver. 1.3 than with Ver. 1.0, please contact us. A more detailed listing of the changes is given as comment within the code and appears on page 1 of Appendix E of the enclosure.

5. If placed in the manual, these pages can serve as an indication that the manual has been updated and when and how it was done. Any questions or comments regarding this update should be directed to either Mr. Stacy E. Howington (601-634-2939) or Mr. Steven C. Wilhelms (601-634-2475).

DVPLOT, and a tabular listing of profile data such as DO, normalized velocity, withdrawal, temperature, and other quality constituents is generated by XPRINT along with information about the outlet characteristics and withdrawal zone limits. Details of each of these subprograms are given in Part III.

Available Assistance

21. Assistance in understanding, setting up, or executing the SELECT program or in analyzing its results is available to CE Field Operating Agency users. Copies of the SELECT code are available for use on most mainframes, minicomputers, workstations, and personal computers. Thus far, the program has been executed on Control Data Corporation and CRAY mainframes; Digital Equipment Corporation (DEC) VAX minicomputers and workstations; and IBM, DEC, and Dell personal computers.

PART III: PROGRAM DESCRIPTION

22. The following sections give detailed descriptions of the equations and logic in SELECT and its subprograms. A written description of each subprogram is given along with a flowchart diagramming the operational sequence of the subprogram. Note that throughout the report, T and F signify true and false at decision points in the given flowcharts. Listings of the variables in each subprogram and their definitions are also given.

Main Program

23. The main program of SELECT is very small, with the bulk of the program being found in the functions and subroutines. The main program basically orders the calling sequence of the subprograms to perform input operations, calculations, and output operations (Figure 4). Table 1 lists the variables used in the main program.

24. The main program also performs other tasks that are very important to the operation of SELECT. The first is the generation of a density profile based on a user-input temperature profile. Generally, the user does not have density profile information on the impoundment being modeled but does have temperature data. SELECT will use an input temperature profile to generate densities for each discrete layer. The equation used to convert temperature to density is

$$\rho_I = 1 - \frac{\left(T_I - 3.9863\right)^2}{508{,}929.2} * \frac{\left(T_I + 288.9414\right)}{\left(T_I + 68.12963\right)} \quad (1)$$

where

ρ_I = density in grams per cubic centimeter for layer I

T_I = temperature in degrees Centigrade for layer I

I = index designating a specified layer

The main program also checks the stability of the density profile that was given or generated. The profile is stable if the density never decreases with increasing depth. If the profile is found unstable, the program will terminate execution and issue an error message.

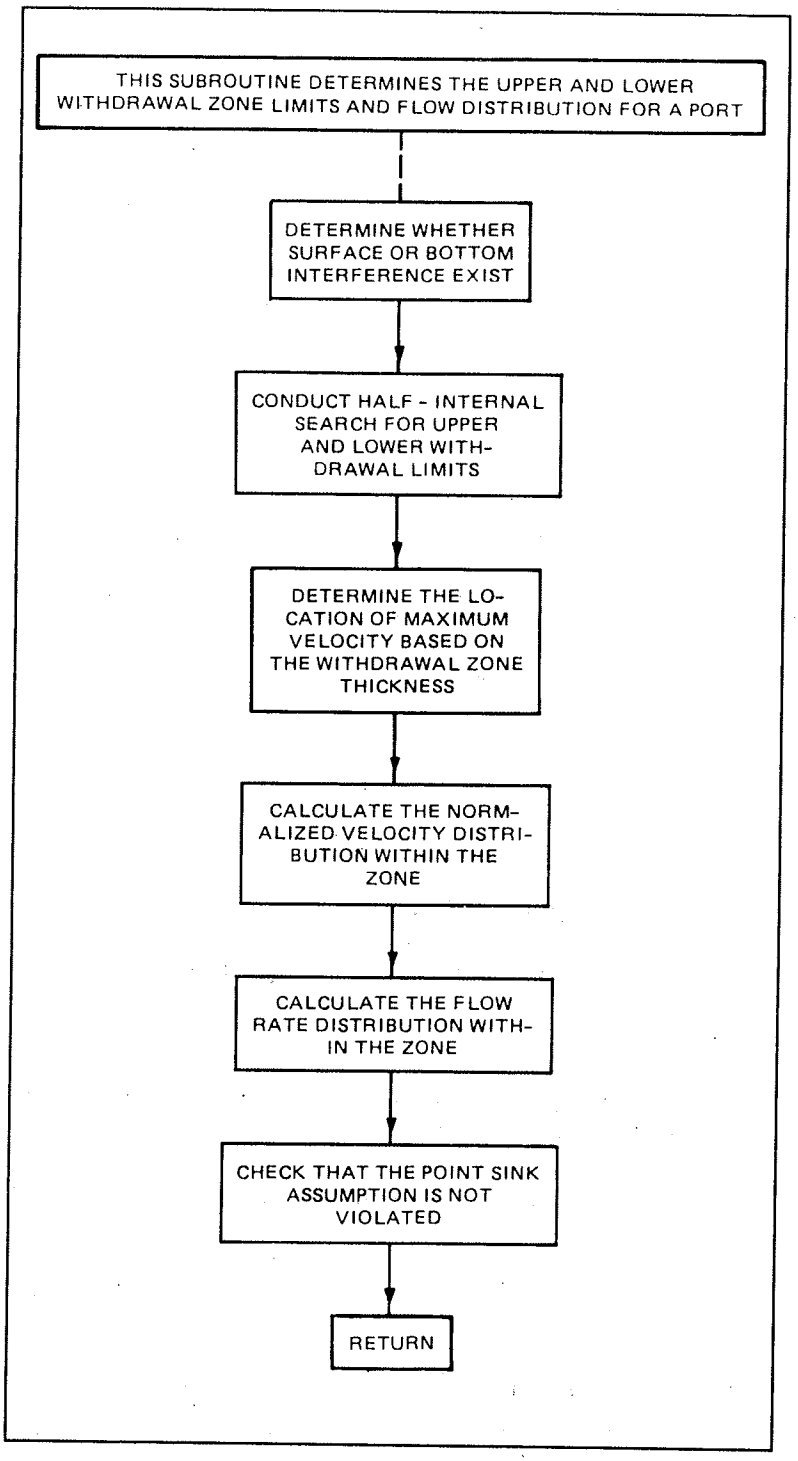

Figure 13. Flowchart for subroutine VPORT

Table 5

VPORT Variables

Variable	Definition
BONLIM	Assigned the value of zero for bottom interference or DEPTH for surface interference
C2	Assigned the value of WANGLE/II
DELDEN	Density difference from layer of maximum velocity to local elevation, g/cm^3
DELZ	Layer thickness
DEN(I)	Density of layer I, g/cm^3
DENBOT	Density at the bottom of the impoundment
DENDIF	Density difference between fluid at layer of maximum velocity and a particular withdrawal limit, g/cm^3
DENLIM	Assigned value of DENUPP for surface interference or DENBOT for bottom interference
DENLOW	Density at lower withdrawal limit, g/cm^3
DENPRT	Density at port center line, g/cm^3
DENTOP	Density at upper withdrawal limit, g/cm^3
DENUPP	Density at surface of the impoundment
DEPTH	Depth of pool
DRBLIM	Density difference between fluid at the port center line and fluid at the port bottom
DRPBOT	Density difference between fluid at the port center line and the port invert
DRPTOP	Density difference between fluid at the port center line and the port top
DRTLIM	Density difference between fluid at the port center line and fluid at the port top
DVMAX	Density at location of maximum velocity, g/cm^3
F1	Value of withdrawal limit function QBNG(X) evaluated at X1

(Continued)

Table 5 (Continued)

Variable	Definition
F2	Same as F1 evaluated at X2
F3	Same as F1 evaluated at X3
FLORAT	Flow rate through a port
G	Gravitational acceleration
H1	Value of function QSMITH(X) evaluated at X1
H2	Same as H1 evaluated at X2
H3	Same as H1 evaluated at X3
HGT(I)	Percentage of layer I that is filled with water
HGTLOW	Distance between pool bottom and lower withdrawal limit
HGTPRT	Distance between pool bottom and port center line
HGTTOP	Distance between pool bottom and upper withdrawal limit
ISURF	Total number of layers
LOWLIM	Layer of lower withdrawal limit
LVMAX	Layer of maximum velocity
MAX	Number of search iterations allowed to determine withdrawal limits
PHIFRAC	Fraction of flow within the truncated portion of the theoretical withdrawal zone
PI	Assigned the value of Π = 3.14159
PRTBOT	Height of the invert of port
PRTTOP	Height of the upper edge of port
QBLIM	Logical variable; true for bottom withdrawal interference; false for no interference from bottom
QSHIFT	Logical variable; true when VPORT is called from SHIFT; false when call is not from SHIFT

(Continued)

Table 5 (Continued)

Variable	Definition
QSINK1	Logical variable; true when point sink description is adequate for determination of lower withdrawal limit; false when the above is not true
QSINK2	Same as QSINK1, except check is for the upper withdrawal limit
QTLIM	Logical variable; true for surface withdrawal interference; false for no interference from surface
RATIO	Ratio of the product of distance and density difference between the point of maximum velocity and a local point to the product of distance and density difference between the point of maximum velocity and a given limit
SINK1	Empirical value used in determination of validity of point sink description for calculations of lower withdrawal limit
SINK2	Same as SINK1, except now pertaining to upper withdrawal limit
SMALL	Essentially zero; check for approximate equality between two values
SUBR	Subroutine name
SUM	Sum over layers in the withdrawal zone of the velocity values for each layer
TINY	Essentially zero; used in value comparisons
TOPLIM	Layer of upper limit
TRUNCZ	For surface interference, it is the distance between the port center line and the surface; for bottom interference, it is the distance between the bottom and the port center line
V(I)	Normalized velocity profile value at layer I for a given port
VDIM	Assigned as value of PVDIM(K) locally
VDIM2	One-half the vertical dimension of the port; VDIM/2.0
VD2	Equals VDIM2 or, if upper edge of port is above the pool surface, the distance between the surface and the port center line
VM	Scaling factor

(Continued)

Table 5 (Concluded)

Variable	Definition
VMAX	Maximum velocity in the normalized velocity profile; assigned as 1.0
WANGLE	Withdrawal angle; equals WTHETA(K) from subroutine OUTVEL
X1	Elevation of a search limit
X2	A second limit search elevation
X3	A third limit search elevation
X4	A fourth limit search elevation
XDUMY	Assigned 0.0; used in ERROR () argument list
XDUMY1	Same as XDUMY
XDUMY2	Same as XDUMY
XDUMY3	Same as XDUMY
XVMAX	Location of maximum velocity relative to the bottom
XXX	Used in label assignment statement
Y	Distance from elevation of maximum velocity to local elevation
YVMAX	Location of maximum velocity referenced to lower withdrawal limit
ZLOW	Distance between port center line and lower withdrawal limit
ZONE	Distance from lower withdrawal limit to upper withdrawal limit
ZONED	When surface or bottom interference exists (but not both), it equals the distance between the boundary of interference and the opposing withdrawal limit
ZTOP	Distance between port center line and upper limit

(Sheet 4 of 4)

the calculation of the velocities within the withdrawal zone.

42. The Bohan and Grace equation, modified to include the withdrawal angle, is

$$\frac{Q}{Z'^3 N} = \frac{\theta}{\Pi} \tag{5}$$

where

$$N = \frac{\Delta\rho}{\rho}\,\frac{g}{Z} \tag{6}$$

Q = flow rate

Z = distance between the port center line and the upper or lower withdrawal limit

θ = angle of withdrawal, in radians

Π = 3.14159 radians

$\Delta\rho$ = difference between the density at the upper or lower limit and the density at the port center line

ρ = density at the port center line

g = acceleration due to gravity

Figure 14 shows a schematic definition of these variables. Equation 5 is transcendental and cannot be solved directly since $\Delta\rho$ is a function of Z for the computation of N (Equation 6). Therefore, an iterative technique is needed to solve the equation for Z. Since Equation 5 and the Smith et al. (1987) equation, which follows, are transcendental and solved through iteration, a description of the iterative solution algorithm is withheld until after the Smith et al. equation is presented.

43. Smith et al. (1987) developed an equation that is an analytical extension of Equation 5 and is used to locate the limit that is free of interference when the other limit experiences boundary interference (Figure 15). The equation is

$$\frac{Q'}{D'^3 N} = \frac{0.125\phi}{\chi^3}\,\frac{\theta}{\Pi} \tag{7}$$

DVPLOT

70. Subroutine DVPLOT generates a line printer plot of elevation (and depth) versus density and velocity. This subroutine is called from subroutine XPRINT. Figure 24 and Table 9 show the algorithm flowchart for DVPLOT and a list of variable descriptions, respectively.

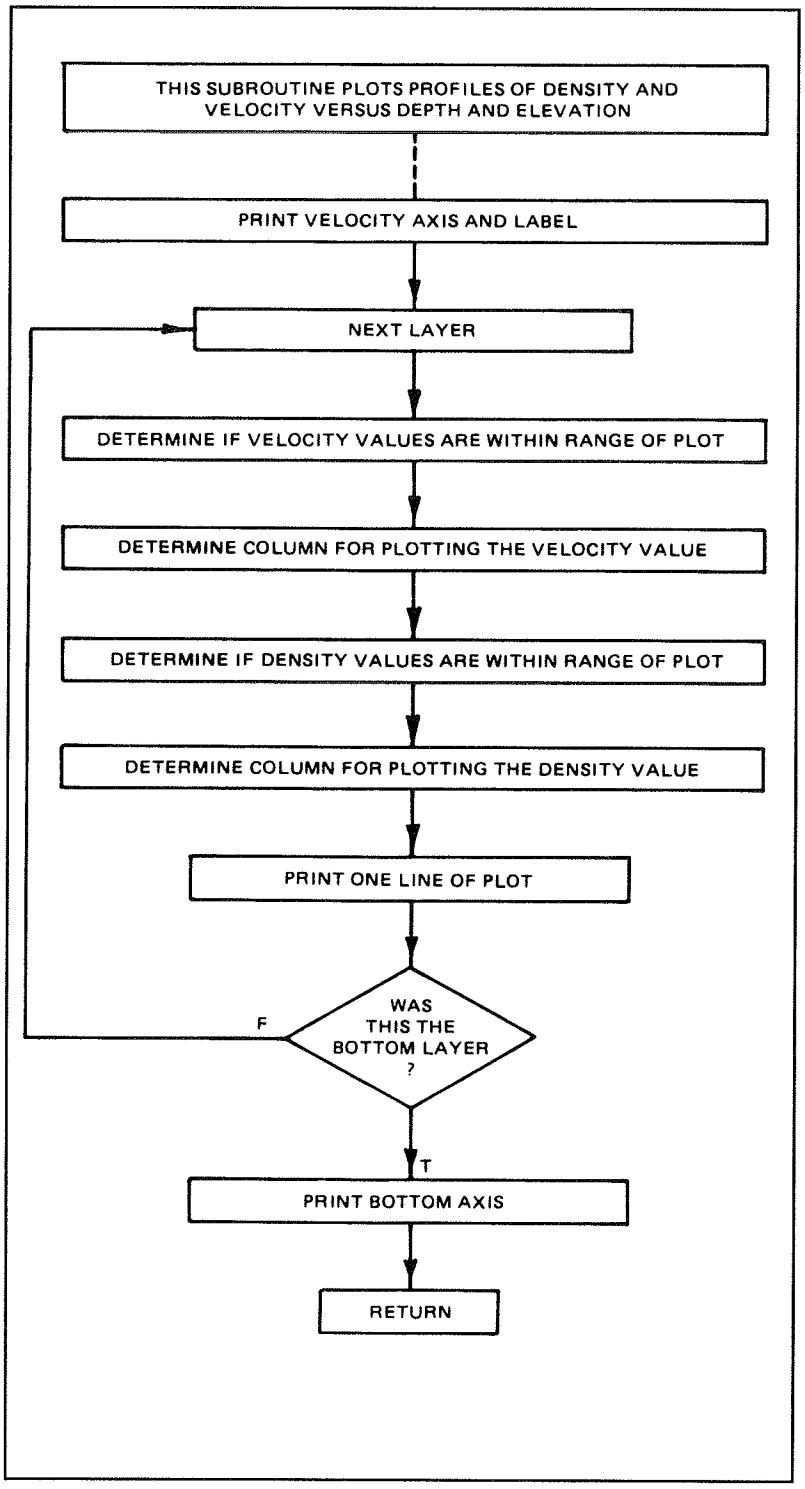

Figure 24. Flowchart for subroutine DVPLOT

Weir Crest Above Thermocline

83. The equations used in the calculation of withdrawal limits for flow over a weir assume that the weir crest is above the thermocline. If this assumption is violated, the results from the program may be erroneous.

Hydraulic Integrity

84. SELECT assumes that it is hydraulically possible to proportion flows between multiple ports as input by the user. SELECT makes no check, for example, to ensure that multiple ports in the same wet well are not used. SELECT users should be aware of their responsibility to input operational scenarios which are viable for water quality control.

Simultaneous Port-Weir Operation

85. A port and a weir can be operated simultaneously only if each is releasing flow under its own control. For example, a spillway (weir) could be operated simultaneously with a water quality intake (port). Prediction of the withdrawal zone formed by a cofferdam (weir) directly in front of an outlet works is beyond the scope of SELECT. Such an operation would require more sophisticated modeling.

PART V: INPUT DATA

Descriptions

86. The following descriptions are presented to define the data that are needed as input for SELECT. All are listed in the order as they should appear in an input file. Formal descriptions of the input formats are given in Appendix A; example input files are given in Appendix B.

a. TITLE - user-specified label to identify the global input file. The title should not exceed 80 characters in length (including spaces, numbers, and punctuation).

b. DATA SETS - each must contain a heading, all port and weir information, and all necessary and desired parameter profiles. The ability to model several data sets in one execution saves the user time. That is, if the user intends to analyze several data sets, they can all be run in one program loading rather than several.

c. PRINT INPUT - tells the program that the user desires an echo print (a copy of the input file) along with the output.

d. HEADING - similar to TITLE except that it labels a single data set in an input file. Each data set in an input file must have a heading. The heading may be up to 80 characters in length (including spaces, numbers, and punctuation).

e. METRIC OR ENGLISH - indicates which system of units to be used.

English (non-SI) Units	Metric (SI) Units
feet, seconds	meters, seconds

Note: Densities are assumed to be in grams per cubic centimeter. The program default is English (non-SI) units.

f. TABLES - the program accepts two different formats for table listings of any type of profile information. Whichever format is chosen, that format must be used for all tables in a single data set.

(1) Format 1 - indicated by following the word TABLES on the input line by the number 1. This tells the program that the user wishes to enter profile data as one value of elevation and the associated parameter value per line.

(2) Format 2 - indicated by following the word TABLES on the input line by any number other than 1. This tells the program that the user wishes to enter data in the following way the elevations will be listed eight values per line until all elevations are entered; then the associated parameter values will be listed eight values per line until all parameter values are entered. The positions of

the parameter values on a line must match the line positions of the associated elevations.

g. THICKNESS - indicates the user-desired thickness of each computational layer. It is suggested that the thickness not exceed 5 ft (or 1.5 m) in order to preserve definition of the input profiles. The computational layer has parameter values assigned to it, such as velocity, density, temperature, and water quality. Since the parameter value is taken as constant throughout the layer, any variation in the actual parameter value inside the layer is neglected. Thus, in order to prevent any gross errors from occurring due to the differences between the actual and discretized profiles, a layer thickness of no more than 5 ft should be used. The layer thickness limit may vary from project to project.

h. INTERVAL - determines how often computational layer parameter values are to be output--every layer, every other layer, etc. An interval of "1" will output values for every layer. An interval of "2" will output values for every second layer, and so on. An interval of "0" will not be accepted by the program.

i. SURFACE - the value of the surface elevation. This must be input as an elevation above the user-defined datum.

j. BOTTOM - the value of the bottom elevation. This must be input as an elevation above the user-defined datum.

k. PORTS - identifies the number of operating ports to be modeled by the program in a single data set. The number of operating ports is limited to five by the program dimensions. Multiple ports operating at the same elevation and within close lateral proximity should be combined into a single port for input. Otherwise, the extreme withdrawal zone interaction will likely result in underprediction of the withdrawal zone thickness by the program.

l. VDIM - the value of the vertical dimension of the port. If more than one port is being modeled, the vertical dimensions for all of the ports must be listed on one line. They may be listed from the bottom port to the top port, or vice versa.

m. HDIM - the value of the horizontal dimension of the port. If more than one port is modeled, the horizontal dimensions of all the ports must be listed on one line. They may be listed from the bottom port to the top port, or vice versa; however, the ordering must match the ordering of VDIM.

n. PORT ELEVATION - the vertical port positions in the impoundment may be given as elevation above a user-defined datum, as depth below the surface, or as height above the bottom. Elevation (or depth or height) values for multiple ports must be listed on one line. The ordering may be from the bottom port to the top port, or vice versa. Again, however, the ordering must match the ordering used for VDIM.

o. FLOW - the value of the flow rate through a port or over a weir. If multiple ports are modeled, the flow rates for all the ports must be listed on one line. The ordering of the values may be from the top port to the bottom port, or vice versa. This ordering must also match the ordering of VDIM.

p. WITHDRAWAL ANGLE - the effective angle of withdrawal in the horizontal plane of the port. The withdrawal angles for all ports must be entered on one line and may be ordered from bottom port to top port, or vice versa. The ordering must match that of VDIM.

q. WEIR - indicates that a weir is to be modeled by the program.

r. WEIR TYPE - indicates whether the weir is a free weir (discharge unaffected by downstream pool) or a submerged weir (discharge affected by downstream pool).

s. COEFFICIENT - the weir coefficient to be used if the weir is not considered submerged.

t. WEIR LENGTH - the length of the crest of the weir.

u. WEIR CREST ELEVATION - the elevation above the user-defined datum, depth below the surface, or height above the bottom of the weir crest.

v. TURBINE VENTING - indicates that the improvement in DO content due to turbine aeration should be taken into account. The improvement is based on a 30 percent decrease in the penstock DO deficit. A DO water quality profile must be part of the input file if this command is used.

w. GATED STRUCTURE - indicates that the change in DO content due to aeration through gated-conduit structures should be taken into account. The amount of change is approximated based on results of Wilhelms and Smith (1981). A DO water quality profile must be part of the input file if this command is used.

x. TAILWATER ELEVATION - indicates that the tailwater elevation is entered. The tailwater elevation must be used only if the GATED STRUCTURE command is used.

y. TAILWATER FUNCTION - often the tailwater cannot be given directly but is a function of the discharge. In that case, a function subprogram must be written and appended to the SELECT code. This command may be used only if the GATED STRUCTURE command is used. For assistance with this input, the user should contact personnel of the Reservoir Water Quality Branch of the WES Hydraulics Laboratory.

Profile Formats

87. Input profile formats for a single data set must match the format specified on the "TABLES" card.

a. DENSITY - density profile is necessary for the operation of SELECT. If a density profile is not available, a temperature profile must be input from which the program can generate densities.

b. OTHER PARAMETERS - water quality parameter profiles are necessary if release water quality predictions are desired. If the GATED STRUCTURE or TURBINE VENTING input commands are used, a DO profile must be the first water quality profile listed after the density and/or temperature profiles. If a density profile is input to define reservoir stratification (to account for suspended or dissolved solids) and release temperature is of interest, the temperature profile may be input as a water quality parameter. Up to four other water quality parameter profiles may be entered.

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APPENDIX A: INPUT FORMAT DESCRIPTION

Notes on Input Format

1. CARD refers to card image input if disc files or magnetic tapes are used as input devices.

2. The format code following the CARD number is the format by which the input line of data will be read. The input must match the fields of the appropriate format.

3. Following the CARD-FORMAT line is the list of variables used to store the input data. They are listed in the order by which they are entered. Following each variable name is the expected input for the first word(s) of the input line. When several expected input phrases are listed, only one is chosen.

4. Each time more than one card is required to input profile values, the remaining input cards will need to be renumbered to reflect the extra cards used. For example, when profile data are to be entered as one elevation value and one parameter value per line, such as CARD #24 when TABTYP = 1 , more than one profile data card will be required to define the profile. If, as a simple case, it is assumed four profile data input cards will be necessary, they would be numbered CARD #24, CARD #25, CARD #26, and CARD #27. The remaining input cards should be resequenced beginning with CARD #28.

5. Be sure that all input data units are consistent with the system of units specified on CARD #05. The exception to this is the units for density, which should always be entered as grams per cubic centimeter.

6. There must be a STOP statement at the end of each data set.

SELECT Program-Input Format Description

CARD #01 FORMAT (20A4)
1. TITLE - An arbitrary title not to exceed 80 characters in length

CARD #02 FORMAT (A4, 6X, 14I5)
1. CHECK - "DATA"
2. NSETS - Number of data sets in input file

CARD #03 FORMAT (20A4)
1. CHECK - A) "PRINT INPUT" - Echo print input
B) "(ANYTHING ELSE)" - No echo print

CARD #04 FORMAT (20A4)
1. HEADING - An arbitrary descriptive heading for the simulation, not to exceed 80 characters in length

CARD #05 FORMAT (20A4)
1. CHECK - A) "METRIC" - Input and output are in Metric (SI) units
B) "ENGLISH" - Input and output are in English (non-SI) units

CARD #06 FORMAT (A4, 6X, 14I5)
1. CHECK - "TABLES"
2. TABTYP - A) "1" - Program reads profile input data in a table of one value of elevation, depth below the surface, or height above the bottom, and a corresponding value of density, temperature, or quality per line.

B) "(ANY OTHER NUMBER)" - Program reads profile data as a table of all the values (eight per line) of elevation, depth below the surface, or height above the bottom followed by a table of all the values of the corresponding density, temperature, or quality.

CARD #07 FORMAT (A4, 6X (7F10.0))
1. CHECK - "THICKNESS"
2. DELZ - Thickness of each computational layer (feet or meters)

CARD #08 FORMAT (A4, 6X, 14I5)
1. CHECK - "INTERVAL"
2. INTER - The interval used to select layer information for printout

CARD #09 FORMAT (A4, 6X (7F10.0))
1. CHECK - "SURFACE"
2. SURFACE - Elevation of the water surface (feet or meters)

CARD #10 FORMAT (A4, 6X (7F10.0))
1. CHECK - "BOTTOM"
2. BOTTOM - Elevation of the lake bottom (feet or meters)

CARD #11 FORMAT (A4, 6X, 14I5)
1. CHECK - A) "PORT"
B) "WEIR"
2. NPORTS - Number of ports (not applicable if weir only)

If "WEIR" was specified on Card #11, go to Card #18; otherwise continue.

CARD #12 FORMAT (A4, 6X (7F10.0))
1. CHECK - "VDIM"
2. (PVDIM(K), K=1, NPORTS) - Vertical dimensions of the ports (feet or meters)

CARD #13 FORMAT (A4, 6X (7F10.0))
1. CHECK - "HDIM"
2. (PHDIM(K), K=1, NPORTS) - Horizontal dimensions of the ports (feet or meters)

CARD #14 FORMAT (A4, 6X (7F10.0))
1. CHECK - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"
2. (PHGT(K), K=1, NPORTS) - Center-line elevation, depth or height of the ports (feet or meters)

CARD #15 FORMAT (A4, 6X (7F10.0))
1. CHECK - "FLOW"
2. (FLOW(K), K=1, NPORTS) - Flow through each of the ports (cubic feet per second or cubic meters per second)

CARD #16 FORMAT (A4, 6X (7F10.0))
1. CHECK - "ANGLE"
2. (WTHETA(K), K=1, NPORTS) - The withdrawal angle for each port (radians)

If "PORTS" was specified on Card #11 and a weir is to be modeled also, used CARDS #17, #18, and #19; otherwise omit them.

CARD #17 FORMAT (A4, 6X, 14I5)
1. CHECK - "WEIR"

CARD #18 FORMAT (A4, 6X, 14I5)
1. CHECK - A) "FREE"
B) "SUBMERGED"

If "SUBMERGED" was specified on Card #18, omit Card #19; otherwise continue.

CARD #19 FORMAT (A4, 6X (7F10.0))
1. CHECK - "COEF"
2. COEF - Coefficient of discharge for free weir flow. These coefficients should be 3.0, 3.33, or 4.10.

CARD #20 FORMAT (A4, 6X (7F10.0))
1. CHECK - "LENGTH"
2. WRLNG - Length of the weir crest (feet or meters)

CARD #21 FORMAT (A4, 6X (7F10.0))
1. CHECK - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"
2. WRHGT - Elevation, depth, or height of the weir crest (feet per second or meters per second)

CARD #22 FORMAT (A4, 6X (7F10.0))
1. CHECK - "FLOW"
2. WRFLOW - Flow over the weir (cubic feet per second or cubic meters per second)

Optional CARD FORMAT (20A4)
1. CHECK - A) "TURBINE VENTING" - If turbine venting is to be modeled
B) "GATED STRUCTURE" - If aeration due to gated conduit is to be modeled

If "GATED STRUCTURE" is entered, so must the following optional card.

Optional CARD FORMAT (A4, 6X, A4 6X, (6F10.0))
1. CHECK1 - "TAILWATER"
2. CHECK2 - A) "ELEVATION" - If tailwater elevation
B) "FUNCTION" - If tailwater function
3. TWEL - Value of the tailwater elevation

CARD #23 FORMAT (A4, 6X, A4, 6X, 12I5)
1. CHECK1 - "NUMBER OF"
2. CHECK2 - A) "DENSITIES"
B) "TEMPS"
3. NUMD - A) Number of density values in profile, or
B) Number of temperature values in profile

If "TEMPS" was specified on Card #23, go to Card #29; otherwise continue.

If TABTYP EQ. 1 (Card #06)

CARD #24 FORMAT (A4, 6X, A4)
1. CHECK1 - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"
2. CHECK2 - "DENSITIES

CARD #25 FORMAT (2F10.0)
1. (YD(M), DEN(M), M=1, NUMD) - Values of elevation, depth, or height (feet or meters) and the corresponding values of density (grams per cubic centimeter)

CARD #26 and #27 not used

An adequate number of cards containing the profile elevation and density values using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

If TABTYP. NE. 1 (Card #06)

CARD #24 FORMAT (20A4)
CHECK - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"

CARD #25 FORMAT (8F10.0)
1. (YD(M), M=1, NUMD) - Values of elevation, depth, or height corresponding with density values to be input (feet or meters)

An adequate number of cards containing profile elevation values using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #26 FORMAT (A4, 6X, 14I5)
1. CHECK - "DENSITY"

CARD #27 FORMAT (8F10.0)
1. (DEN(M), M=1, NUMD) - Values of density corresponding to the data on Card #25 (grams per cubic centimeters)

An adequate number of cards containing profile density values using the above format are required at this point. The remaining input cards should be renumbered to continue in this sequence.

CARD #28 FORMAT (A4, 16X, 12I5)
1. CHECK - A) "NUMBER OF TEMPS"
B) "QUALITIES"
C) "STOP" - Read sequence stops
2. NUMT - Number of temperature if "NUMBER OF TEMPS" is entered

If "STOP" was specified on Card #28, go to last line of this description (page A8).

If "QUALITIES" was specified on Card #28, go to Card #35.

If "NUMBER OF TEMPS" was specified on Card #28, continue.

CARD #29 FORMAT (A4, 16X, A4)
1. CHECK - A) "TEMPERATURE DEGREES"
2. UNITS - A) "FAHRENHEIT"
B) "CENTIGRADE"

If TABTYP EQ. 1 (Card #06)

CARD #30 FORMAT (A4, 6X, A4)
1. CHECK1 - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"
2. CHECK2 - "TEMPERATURE"

CARD #31 FORMAT (2F10.0)
1. (YT(M), TEMP(M), M=1, NUMT) - Values of elevation, depth, or height (feet or meters) and the corresponding values of temperature (units specified on Card #29)

CARD #32 and #33 not used

An adequate number of cards containing the profile elevation and temperature values using the above format are required at this point. The remaining input cards should be renumbered to continue in this sequence.

If TABTYP NE. 1 (Card #06)

CARD #30 FORMAT (20A4)
1. CHECK - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"

CARD #31 FORMAT (8F10.0)
1. (TY(M), M=1, NUMT) - Values of elevation, depth, or height corresponding with temperature values to be input (feet or meters)

An adequate number of cards containing profile elevations using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #32 FORMAT (20A4)
1. CHECK - "TEMPERATURE"

CARD #33 FORMAT (8F10.0)
1. (TEMP(M), M=1, NUMT) - Values of temperature corresponding to the data on Card #31 (units specified on Card #30)

An adequate number of cards containing profile temperatures using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #34 FORMAT (A4, 6X, 14I5)
1. CHECK - A) "QUALITIES"
B) "STOP" - Read sequence stops
2. NQUAL - Number of quality parameters

If STOP was specified on CARD #34, go to last line of this description (page A8). If QUALITIES was specified on CARD #34, continue.

CARD #35 FORMAT (A4, 6X, 5A4, I5)
1. CHECK - "NUMBER OF"
2. (NAME(NM, I) NM=1,5) - Name of the I^{th} quality parameter (not to exceed 20 characters)
3. NUMQ(I) - Number of quality(I) values

If TABTYP EQ. 1 (Card #06)

CARD #36 FORMAT (A4, 6X, A4)
1. CHECK - A) "ELEVATION"
B) "DEPTH"
C) "HEIGHT"

CARD #37 FORMAT (2F10.0)
1. (YQ(I,M), QUAL(I,M), M=1, NUMQ(I)) - Values of elevation, depth, or height (feet or meters) and the corresponding values of the I^{th} quality parameter (appropriate units)

CARDS #38 and #39 not used

An adequate number of cards containing the profile elevation and quality values using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

If TABTYP NE. 1 (Card #06)

CARD #36 FORMAT (20A4)
1. CHECK - A) "ELEVATION
B) "DEPTH"
C) "HEIGHT"

CARD #37 FORMAT (8F10.0)
1. (YQ(I,M) M=1, NUMQ(I)) - Values of elevation, depth, or height corresponding with the I^{th} quality parameter values to be input (feet or meters)

An adequate number of cards containing the profile elevations using the above format are required at this point. The remaining input cards should be renumbered to continue in sequence.

CARD #38 FORMAT (20A4)
1. CHECK - Name of the I^{th} quality parameter

CARD #39 FORMAT (8F10.0)
1. (QUAL(I,M), M=1, NUMQ(I)) - Values of the I^{th} quality parameter corresponding to the data on Card #37 (appropriate units)

An adequate number of cards containing the profile qualities using the above format are required at this point. The remaining input card should be renumbered to continue in sequence.

If there are more water quality profiles, repeat CARDS #36-39 for each additional water quality parameter.

CARD #40 FORMAT (20A4)

1. CHECK - "STOP" - Stops read sequence

If there are more data sets, repeat CARDS #04-40 for each additional data set.

APPENDIX B: INPUT EXAMPLES

1. The following are examples of simple input files. They are presented to help clarify the structure of an input file.

2. The impoundment being modeled has a pool that is 100 ft deep, with the elevation of the bottom taken as zero or datum.

Example File 1

3. Example File 1 models a single 5- by 5-ft port whose center line is located 20 ft below the pool surface. The port has a withdrawal angle of 180 deg (3.14 rad) and releases a flow rate of 100 cfs.

4. The density profile needed to run SELECT will be generated by the program using the given temperature profile. The only water quality parameter modeled is temperature.

5. For the computations, the pool will be divided into layers 3 ft thick each. The printout interval for layer information will be at every layer (INTERVAL = 01).

```
ANONYMOUS LAKE EXAMPLE
DATA SETS    01
PRINT INPUT
EXAMPLE FOR INPUT/OUTPUT USING PORT
ENGLISH
TABLE        01
THICKNESS       3.0
INTERVAL     01
SURFACE       100.0
BOTTOM          0.0
PORT          1
VDIM            5.0
HDIM            5.0
DEPTH          20.0
FLOW          100.0
ANGLE          3.14
NUMBER OF TEMP         12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT    TEMP
     97.6      28.9
     90.0      28.2
     80.0      27.0
     69.8      26.0
     65.0      24.9
     60.0      23.0
     57.6      20.0
     53.9      18.5
     50.0      17.5
     40.0      16.7
     31.2      15.9
     20.0      15.0
STOP
```

Example File 2

6. Example File 2 models the same thing as Example File 1 with a few variations. One variation is that another port vertically separated from the first port is to be modeled. The two ports are considered to be operating simultaneously and independently. The second port is located 50 ft below the pool surface and has the same dimensions and withdrawal characteristics as the first port.

7. The presence of the dissolved oxygen (DO) profile following the temperature profile indicates that the user wishes to know the release DO concentration as well as temperature. The calculation of release DO will include DO uptake due to gated-conduit reaeration because the GATED STRUCTURE command is present following the port information in the input file.

```
ANONYMOUS LAKE EXAMPLE
DATA SETS    01
PRINT INPUT
EXAMPLE FOR INPUT/OUTPUT USING PORT
ENGLISH
TABLE        01
THICKNESS        3.0
INTERVAL     01
SURFACE        100.0
BOTTOM           0.0
PORT           2
VDIM             5.0      5.0
HDIM             5.0      5.0
DEPTH           50.0     20.0
FLOW           100.0    100.0
ANGLE           3.14     3.14
GATED STRUCTURE
TAILWATER ELEVATION      15.9
NUMBER OF TEMP         12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT    TEMP
      97.6      28.9
      90.0      28.2
      80.0      27.0
      69.8      26.0
      65.0      24.9
      60.0      23.0
      57.6      20.0
      53.9      18.5
      50.0      17.5
      40.8      16.7
      31.2      15.9
      20.0      15.0
QUALITIES    1
NUMBER OF DISSOLVED OXYGEN       13
HEIGHT    DISSOLVED OXYGEN
      95.6       3.2
      90.2       3.2
      84.9       3.1
      78.7       3.0
      73.4       2.1
      69.5       1.8
      61.0       1.3
      58.4       0.5
      50.3       0.3
      40.6       0.2
      30.0       0.2
      21.7       0.1
      15.4       0.0
STOP
```

Example File 3

8. Example File 3 models a weir. The weir is the submerged type with its crest 65 ft off the bottom. It is 100 ft in length and has a total flow rate of 200 cfs over its crest.

9. The input file dictates that the pool should be divided into layers that are 3 ft thick and that the output data be given at every layer (INTERVAL = 01). As in Example File 2, the temperature and DO concentration of the release are desired. There is no option for DO calculations based on reaeration through the outlet works for weir flow.

```
ANONYMOUS LAKE EXAMPLE
DATA SETS    01
PRINT INPUT
EXAMPLE FOR INPUT/OUTPUT USING WEIR
ENGLISH
TABLE        01
THICKNESS        3.0
INTERVAL     01
SURFACE        100.0
BOTTOM           0.0
WEIR
SUBMERGED
LENGTH          100.
HEIGHT           65.0
FLOW            200.0
NUMBER OF TEMP         12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT    TEMP
      97.6       28.9
      90.0       28.2
      80.0       27.0
      69.8       26.0
      65.0       24.9
      60.0       23.0
      57.6       20.0
      53.9       18.5
      50.0       17.5
      40.0       16.7
      31.2       15.9
      20.0       15.0
QUALITIES    1
NUMBER OF DISSOLVED OXYGEN       13
HEIGHT    DISSOLVED OXYGEN
      95.6        3.2
      90.2        3.2
      84.9        3.1
      78.7        3.0
      73.4        2.1
      69.5        1.8
      61.0        1.3
      58.4        0.5
      50.3        0.3
      40.6        0.2
      30.0        0.2
      21.7        0.1
      15.4        0.0
STOP
```

Example File 4

10. Example File 4 is an input file made up of Example Files 1 and 3. In other words, it is one input file containing two data sets. It is important to realize that this data file format will not cause the program to model the port and the weir simultaneously; rather, it will model the port only and produce output. Then it will model the weir only and produce output.

11. This technique of appending data sets saves time in loading and reloading the program for consecutive runs.

```
ANONYMOUS LAKE EXAMPLE
DATA SETS    02
PRINT INPUT
EXAMPLE FOR INPUT/OUTPUT USING PORT
ENGLISH
TABLE        01
THICKNESS        3.0
INTERVAL     01
SURFACE        100.0
BOTTOM           0.0
PORT          1
VDIM             5.0
HDIM             5.0
DEPTH           20.0
FLOW           100.0
ANGLE           3.14
NUMBER OF TEMP         12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT    TEMP
      97.6       28.9
      90.0       28.2
      80.0       27.0
      69.8       26.0
      65.0       24.9
      60.0       23.0
      57.6       20.0
      53.9       18.5
      50.0       17.5
      40.0       16.7
      31.2       15.9
      20.0       15.0
STOP
EXAMPLE FOR INPUT/OUTPUT USING WEIR
ENGLISH
TABLE        01
THICKNESS        3.0
INTERVAL     01
SURFACE        100.0
BOTTOM           0.0
WEIR
SUBMERGED
LENGTH          100.
HEIGHT           65.0
FLOW            100.0
NUMBER OF TEMP         12
TEMPERATURE DEGREES CENTIGRADE
HEIGHT    TEMP
      97.6       28.9
      90.0       28.2
      80.0       27.0
      69.8       26.0
      65.0       24.9
      60.0       23.0
      57.6       20.0
      53.9       18.5
      50.0       17.5
      40.0       16.7
      31.2       15.9
      20.0       15.0
QUALITIES    1
NUMBER OF DISSOLVED OXYGEN       13
HEIGHT    DISSOLVED OXYGEN
      95.6        3.2
      90.2        3.2
      84.9        3.1
      78.7        3.0
      73.4        2.1
      69.5        1.8
      61.0        1.3
      58.4        0.5
      50.3        0.3
      40.6        0.2
      30.0        0.2
      21.7        0.1
      15.4        0.0
STOP
```

APPENDIX C: OUTPUT EXAMPLE

1. This appendix presents SELECT output for the fourth example input file in Appendix B. This output is divided as follows:

   a. Listing of the input file. In this example, the PRINT INPUT command was included in the input file. If the command is omitted from the input file, no listing of the input file is given.

   b. Summary of the output results. The summary includes the title of the input file, the title of the data set to which the results pertain, the units used for computations, each outlet's dimensions and flow rate, the total flow rate from all outlets, the locations of the upper and lower withdrawal limits, and the total outflow concentration of all water quality parameters modeled.

   c. Tabular listing of flow rates, velocities, and water quality parameter concentrations, given at layer center-line elevations. The interval between the layers at which information is given depends on the INTERVAL command listed in the input file. An interval of "1" will list layer information at every layer, an interval of "2" will list layer information at every other layer, and so on.

   d. Line-printer plot of the velocity and density profile. The data points on the plot coincide with the data in each of the layers. All layers are included in this plot.

2. If the user chooses to use multiple data sets in one input file, as in this example, the results from each data set will be listed individually and output one after the other in the results.

```
1000        ***ANONYMOUS LAKE EXAMPLE
1010        ***DATA SETS    02
1020        ***PRINT INPUT
1030        ***EXAMPLE FOR INPUT/OUTPUT USING PORT
1040        ***ENGLISH
1050        ***TABLE        01
1060        ***THICKNESS        3.0
1070        ***INTERVAL     01
1080        ***SURFACE        100.0
1090        ***BOTTOM           0.0
1100        ***PORT           1
1110        ***VDIM             5.0
1120        ***HDIM             5.0
1130        ***DEPTH           20.0
1140        ***FLOW           100.0
1150        ***ANGLE           3.14
1160        ***NUMBER OF TEMP         12
1170        ***TEMPERATURE DEGREES CENTIGRADE
1180        ***HEIGHT    TEMP
1190        ***      97.6      28.9
1200        ***      90.0      28.2
1210        ***      80.0      27.0
1220        ***      69.8      26.0
1230        ***      65.0      24.9
1240        ***      60.0      23.0
1250        ***      57.6      20.0
1260        ***      53.9      18.5
1270        ***      50.0      17.5
1280        ***      40.8      16.7
1290        ***      31.2      15.9
1300        ***      20.0      15.0
1310        ***STOP
1320        ***EXAMPLE FOR INPUT/OUTPUT USING WEIR
1330        ***ENGLISH
1340        ***TABLE        01
1350        ***THICKNESS        3.0
1360        ***INTERVAL     01
1370        ***SURFACE        100.0
```

```
***BOTTOM            0.0
***WEIR
***SUBMERGED
***LENGTH           100.
***HEIGHT           65.0
***FLOW             100.0
***NUMBER OF TEMP          12
***TEMPERATURE DEGREES CENTIGRADE
***HEIGHT    TEMP
***       97.6       28.9
***       90.0       28.2
***       80.0       27.0
***       69.8       26.0
***       65.0       24.9
***       60.0       23.0
***       57.6       20.0
***       53.9       18.5
***       50.0       17.5
***       40.8       16.7
***       31.2       15.9
***       20.0       15.0
***QUALTITIES    1
***NUMBER OF DISSOLVED OXYGEN       13
***HEIGHT    DISSOLVED OXYGEN
***       95.6       3.2
***       90.2       3.2
***       84.9       3.1
***       78.7       3.0
***       73.4       2.1
***       69.5       1.8
***       61.0       1.3
***       58.4       0.5
***       50.3       0.3
***       40.6       0.2
***       30.0       0.2
***       21.7       0.1
***       15.4       0.0
***STOP
```

ANONYMOUS LAKE EXAMPLE

EXAMPLE FOR INPUT/OUTPUT USING PORT

UNITS ARE IN FEET

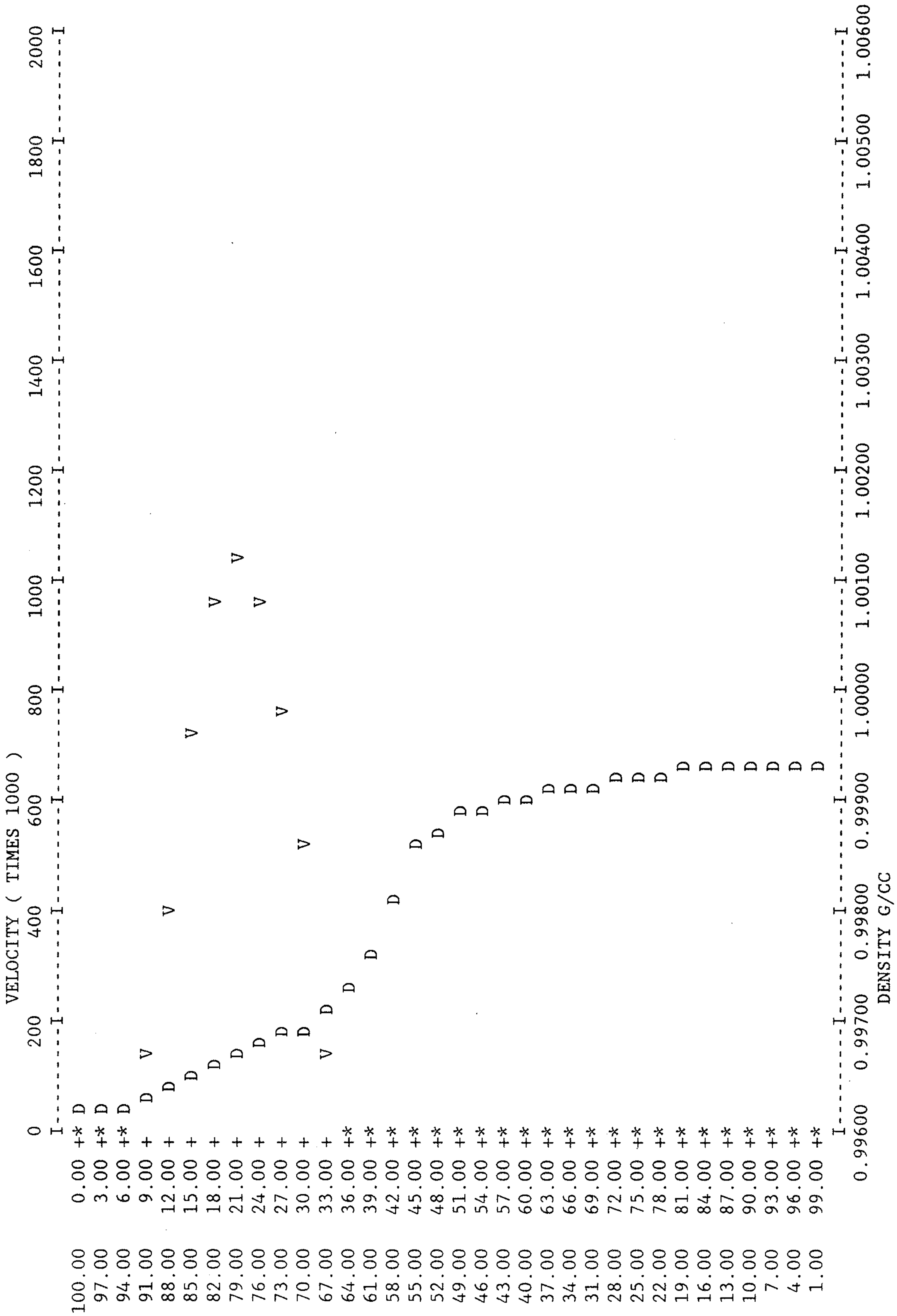
PORT ELEVATION 80.000
PORT VERTICAL DIMENSION 5.000
DISCHARGE, VOLUME FLOW PER SEC. 100.0000
WITHDRAWAL ANGLE, RAD 3.1400

TOTAL DISCHARGE, VOLUME PER SEC 100.0000

LOWER WITHDRAWAL LIMIT (ACTUAL) HEIGHT ABOVE BOTTOM	65.781	ELEVATION	65.781
LOWER WITHDRAWAL LIMIT (THEORETICAL) HEIGHT ABOVE BOTTOM	65.781	ELEVATION	65.781
UPPER WITHDRAWAL LIMIT (ACTUAL) HEIGHT ABOVE BOTTOM	94.531	ELEVATION	94.531
UPPER WITHDRAWAL LIMIT (THEORETICAL) HEIGHT ABOVE BOTTOM	94.531	ELEVATION	94.531

OUTFLOW DENSITY 0.99655 G/CC
OUTFLOW TEMPERATURE 26.96

ELEVATION	DEPTH	DENSITY	NORM. VEL.	FLOW	TEMPERATURE
99.500	0.50	0.99600	0.0000	0.0000	28.90
97.500	2.50	0.99601	0.0000	0.0000	28.89
94.500	5.50	0.99609	0.0000	0.0000	28.61
91.500	8.50	0.99617	0.1022	1.9055	28.34
88.500	11.50	0.99626	0.3755	7.0034	28.02
85.500	14.50	0.99636	0.6951	12.9650	27.66
82.500	17.50	0.99646	0.9260	17.2724	27.30
79.500	20.50	0.99656	1.0000	18.6533	26.95
76.500	23.50	0.99664	0.9259	17.2719	26.66
73.500	26.50	0.99672	0.7398	13.7991	26.36
70.500	29.50	0.99680	0.4823	8.9959	26.07
67.500	32.50	0.99695	0.1144	2.1336	25.47
64.500	35.50	0.99715	0.0000	0.0000	24.71
61.500	38.50	0.99743	0.0000	0.0000	23.57
58.500	41.50	0.99799	0.0000	0.0000	21.13
55.500	44.50	0.99841	0.0000	0.0000	19.15
52.500	47.50	0.99860	0.0000	0.0000	18.14
49.500	50.50	0.99872	0.0000	0.0000	17.46
46.500	53.50	0.99877	0.0000	0.0000	17.20
43.500	56.50	0.99882	0.0000	0.0000	16.93
40.500	59.50	0.99886	0.0000	0.0000	16.68
37.500	62.50	0.99890	0.0000	0.0000	16.43
34.500	65.50	0.99894	0.0000	0.0000	16.17
31.500	68.50	0.99898	0.0000	0.0000	15.92
28.500	71.50	0.99902	0.0000	0.0000	15.68
25.500	74.50	0.99906	0.0000	0.0000	15.44
22.500	77.50	0.99910	0.0000	0.0000	15.20
19.500	80.50	0.99913	0.0000	0.0000	15.00
16.500	83.50	0.99913	0.0000	0.0000	15.00
13.500	86.50	0.99913	0.0000	0.0000	15.00
10.500	89.50	0.99913	0.0000	0.0000	15.00
7.500	92.50	0.99913	0.0000	0.0000	15.00
4.500	95.50	0.99913	0.0000	0.0000	15.00
1.500	98.50	0.99913	0.0000	0.0000	15.00


VELOCITY (TIMES 1000)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
DENSITY G/CC
0.99600
0.99700
0.99800
0.99900
1.00000
1.00100
1.00200
1.00300
1.00400
1.00500
1.00600

ANONYMOUS LAKE EXAMPLE

EXAMPLE FOR INPUT/OUTPUT USING WEIR

UNITS ARE IN FEET

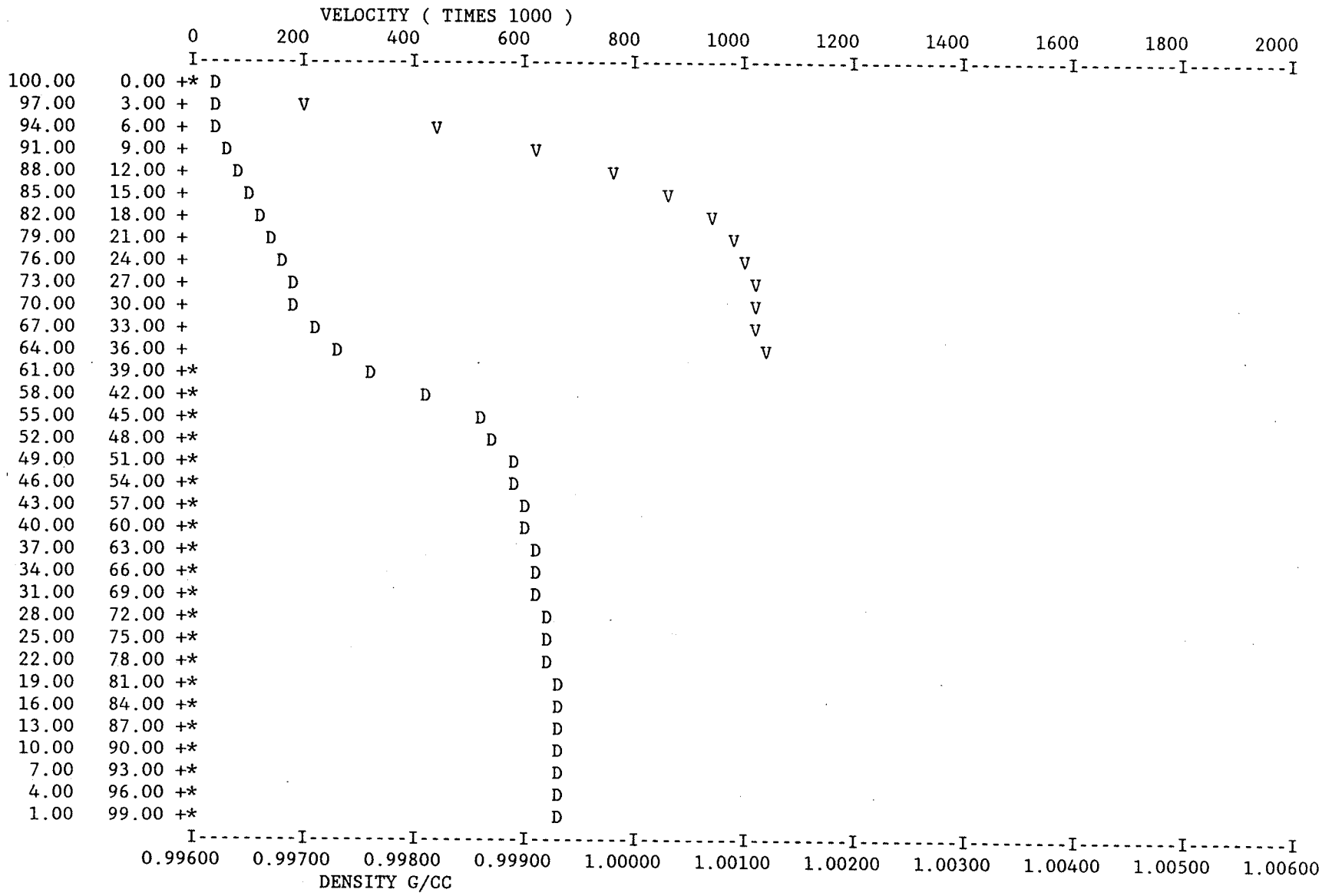
WEIR CREST ELEVATION 65.000
WEIR LENGHT 100.000
DISCHARGE, VOLUME FLOW PER SEC. 100.0000

TOTAL DISCHARGE, VOLUME PER SEC 100.0000

LOWER WITHDRAWAL LIMIT (ACTUAL) HEIGHT ABOVE BOTTOM	64.238	ELEVATION	64.238
LOWER WITHDRAWAL LIMIT (THEORETICAL) HEIGHT ABOVE BOTTOM	64.238	ELEVATION	64.238
UPPER WITHDRAWAL LIMIT (ACTUAL) HEIGHT ABOVE BOTTOM	100.000	ELEVATION	100.000
UPPER WITHDRAWAL LIMIT (THEORETICAL) HEIGHT ABOVE BOTTOM	100.000	ELEVATION	100.000

OUTFLOW DENSITY 0.99661 G/CC
OUTFLOW TEMPERATURE 26.74
OUTFLOW CONCENTRATION OF DISSOLVED OXYGEN 2.51

ELEVATION	DEPTH	DENSITY	NORM. VEL.	FLOW	TEMPERATURE	DISSOLVED OX
99.500	0.50	0.99600	0.0000	0.0000	28.90	3.20
97.500	2.50	0.99601	0.1636	1.7156	28.89	3.20
94.500	5.50	0.99609	0.4010	4.2055	28.61	3.20
91.500	8.50	0.99617	0.5837	6.1209	28.34	3.20
88.500	11.50	0.99626	0.7280	7.6343	28.02	3.17
85.500	14.50	0.99636	0.8356	8.7634	27.66	3.11
82.500	17.50	0.99646	0.9074	9.5159	27.30	3.06
79.500	20.50	0.99656	0.9520	9.9836	26.95	3.01
76.500	23.50	0.99664	0.9768	10.2439	26.66	2.63
73.500	26.50	0.99672	0.9906	10.3881	26.36	2.12
70.500	29.50	0.99680	0.9971	10.4571	26.07	1.88
67.500	32.50	0.99695	0.9998	10.4847	25.47	1.68
64.500	35.50	0.99715	1.0000	10.4872	24.71	1.51
61.500	38.50	0.99743	0.0000	0.0000	23.57	1.33
58.500	41.50	0.99799	0.0000	0.0000	21.13	0.53
55.500	44.50	0.99841	0.0000	0.0000	19.15	0.43
52.500	47.50	0.99860	0.0000	0.0000	18.14	0.35
49.500	50.50	0.99872	0.0000	0.0000	17.46	0.29
46.500	53.50	0.99877	0.0000	0.0000	17.20	0.26
43.500	56.50	0.99882	0.0000	0.0000	16.93	0.23
40.500	59.50	0.99886	0.0000	0.0000	16.68	0.20
37.500	62.50	0.99890	0.0000	0.0000	16.43	0.20
34.500	65.50	0.99894	0.0000	0.0000	16.17	0.20
31.500	68.50	0.99898	0.0000	0.0000	15.92	0.20
28.500	71.50	0.99902	0.0000	0.0000	15.68	0.18
25.500	74.50	0.99906	0.0000	0.0000	15.44	0.15
22.500	77.50	0.99910	0.0000	0.0000	15.20	0.11
19.500	80.50	0.99913	0.0000	0.0000	15.00	0.07
16.500	83.50	0.99913	0.0000	0.0000	15.00	0.02
13.500	86.50	0.99913	0.0000	0.0000	15.00	0.00
10.500	89.50	0.99913	0.0000	0.0000	15.00	0.00
7.500	92.50	0.99913	0.0000	0.0000	15.00	0.00
4.500	95.50	0.99913	0.0000	0.0000	15.00	0.00
1.500	98.50	0.99913	0.0000	0.0000	15.00	0.00


VELOCITY (TIMES 1000)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
100.00 0.00
97.00 3.00
94.00 6.00
91.00 9.00
88.00 12.00
85.00 15.00
82.00 18.00
79.00 21.00
76.00 24.00
73.00 27.00
70.00 30.00
67.00 33.00
64.00 36.00
61.00 39.00
58.00 42.00
55.00 45.00
52.00 48.00
49.00 51.00
46.00 54.00
43.00 57.00
40.00 60.00
37.00 63.00
34.00 66.00
31.00 69.00
28.00 72.00
25.00 75.00
22.00 78.00
19.00 81.00
16.00 84.00
13.00 87.00
10.00 90.00
7.00 93.00
4.00 96.00
1.00 99.00
0.99600
0.99700
0.99800
0.99900
1.00000
1.00100
1.00200
1.00300
1.00400
1.00500
1.00600
DENSITY G/CC

APPENDIX D: ERROR CODES

1. SELECT has various internal checks that test for errors in the input file data and format, and for errors in some of the program's internal computations. When a check is failed, the program prints an appropriate error message and terminates program execution.

2. The error message contains an error number, a subroutine name, and a statement regarding the type of error. With this information, the line at which the error occurred (and the cause) can often be easily determined by the user through the use of the program code. It is suggested that the user locate the subroutine in which the error occurred and then scan the CALL ERROR () statements therein for the error number. (The error number is the first number in the ERROR argument list.) The appropriate CALL ERROR () statement should be near the line(s) of code in which the failure occurred. NOTE: Most errors (error numbers 1010-1380 excluding 1080 and 1345) are due to input file format problems. If the user determines that the error is in the input file, check for missing lines, misplaced lines, misspelled words, etc., in the input file.

Error Number	Subroutine of Occurrence	Input Format Card	Explanation
1010	XREAD	02	"DATA" was expected as first four characters of input line.
1020	XREAD	05	"METR" or "ENGL" was expected as first four characters of input line.
1030	XREAD	06	"TABL" was expected as first four characters of input line.
1040	XREAD	07	"THIC" was expected as first four characters of input line.
1050	XREAD	08	"INTE" was expected as first four characters of input line.
1060	XREAD	09	"SURF" was expected as first four characters of input line.
1070	XREAD	10	"BOTT" was expected as first four characters of input line.
1080	XREAD	07	The number of computational layers dimensioned in the model has been exceeded. Probable solution is to increase the desired thickness of each layer.
1100	XREAD	11	"WEIR" or "PORT" was expected as first four characters of input line.
1110	XREAD	12	"VDIM" was expected as first four characters of input line.
1120	XREAD	13	"HDIM" was expected as first four characters of input line.

(Continued)

Error Number	Subroutine of Occurrence	Input Format Card	Explanation
1130	XREAD	14	"DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line.
1140	XREAD	15	"FLOW" was expected as first four characters of input line.
1150	XREAD	16	"ANGL" was expected as first four characters of input line.
1160	XREAD	17	"SUBM" or "FREE" was expected as first four characters of input line.
1170	XREAD	18	"COEF" was expected as first four characters of input line.
1180	XREAD	19	"LENG" was expected as first four characters of input line.
1200	XREAD	20	"DEPTH" or "ELEV" or "HEIG" was expected as first four characters of input line.
1210	XREAD	21	"FLOW" was expected as first four characters of input line.
1215	XREAD	22	"TAIL" was expected as first four characters of input line.
1220	XREAD	22	"NUMB" was expected as first four characters of input line.
1225	XREAD	22	"TEMP" or "DENS" was expected as first four characters of the second alphanumeric format field.

(Continued)

Error Number	Subroutine of Occurrence	Input Format Card	Explanation
1230	XREAD	23	"DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line. TABTYP not equal to 1.
1240	XREAD	25	"DENS" was expected as first four characters of input line. TABTYP not equal to 1.
1250	XREAD	23	"DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line. TABTYP not equal to 1.
1260	XREAD	23	"DENS" was expected as first four characters of the second alphanumeric format field. TABTYP not equal to 1.
1270	XREAD	27	"NUMB" or "QUAL" or "STOP" was expected as first four characters of input line.
1280	XREAD	28	"TEMP" or "STOP" was expected as first four characters of input line.
1290	XREAD	28	"FAHR" or "CENT" was expected as first four characters of the second alphanumeric format field.
1300	XREAD	29	"DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line. TABTYP not equal to 1.
1310	XREAD	31	"TEMP" was expected as first four characters of input line. TABTYP not equal to 1.
1320	XREAD	29	"DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line. TABTYP equal to 1.

(Continued)

Error Number	Subroutine of Occurrence	Input Format Card	Explanation
1330	XREAD	29	"TEMP" was expected as first four characters of the second alphanumeric format field. TABTYP equal to 1.
1340	XREAD	33	"QUAL" or "STOP" was expected as first four characters of input line.
1345	XREAD	--	Dissolved oxygen must be the first quality profile listed if aeration techniques are modeled.
1350	XREAD	34	"NUMB" was expected as first four characters of input line.
1360	XREAD	35	"DEPT" or "ELEV" or "HEIG" was expected as first four characters of input line. TABTYP not equal to 1.
1370	XREAD	35	"DEPT" or "ELEV" or "HELG" was expected as first four characters of input line. TABTYP equal to 1.
1380	XREAD	39	"STOP" was expected as first four characters of input line.
1400	OUTVEL	15	Flow rate entered for a port was less than or equal to zero. Flow rates must be greater than zero.
1410	OUTVEL	14	Center-line height of port exceeded depth of water.
1420	VPORT	21	Flow rate for weir found to be less than or equal to zero. Flow rate must be greater than zero.

(Continued)

Error Number	Subroutine of Occurrence	Input Format Card	Explanation
1500	VPORT	--	Convergence on the upper or lower withdrawal limit has not been reached.
1510	VPORT	--	Same as error number 1500.
1520	VPORT	--	Elevation of maximum velocity in withdrawal profile was found to be above the water surface or below the bottom.
1600	VWEIR	--	Internal computation check failure. Function FWEIR(X) must be positive at the crest elevation and negative at the bottom to allow convergence on the lower limit.
1610	VWEIR	--	Convergence on the lower withdrawal limit has not been reached.
1800	SHIFT	--	Number of iterations internally programmed for convergence on shifted limit is not sufficient.

APPENDIX E: PROGRAM LISTING

```
0001              PROGRAM SELECT
0002     ************************************************************************
0003     *                                                                      *
0004     *          P R O G R A M   S E L E C T                                 *
0005     *                                                                      *
0006     ************************************************************************
0007     *
0008     * ******************       ******************     ******************
0009     * *  VERSION 1.3  *       *  VERSION 1.3  *     *  VERSION 1.3  *
0010     * ******************       ******************     ******************
0011     *
0012     *
0013     *.... VERSION 1.0 ....
0014     *
0015     *.... COMPUTES THE LIMITS OF THE ZONE OF WITHDRAWAL
0016     *     AND THE DISTRIBUTION OF FLOW WITHIN THAT ZONE.  THE
0017     *     PROGRAM ALSO COMPUTES THE OUTFLOW DENSITY AND QUALITY FROM
0018     *     INPUT DENSITY AND QUALITY PROFILES.  VERSION 1.0 IS SUPPORTED
0019     *     BY THE WES EWQOS INSTRUCTION REPORT #E-87-2, "SELECT: A
0020     *     NUMERICAL MODEL FOR SELECTIVE WITHDRAWAL" BY
0021     *     JACK E. DAVIS ET AL. ....
0022     *
0023     *
0024     *.... VERSION 1.1 .... FEBRUARY 18, 1988 ....
0025     *
0026     *     THE INPUT AND OUTPUT FILE CODES WERE HARDWIRED IN PROGRAM.
0027     *     THE INPUT FILE IS 05 AND MUST BE CALLED SELECT.IN AND THE
0028     *     OUTPUT FILE IS 06 AND MUST BE CALLED SELECT.OUT ....
0029     *
0030     *
0031     *.... VERSION 1.2 .... JULY 20, 1990 ....
0032     *
0033     *     CORRECTED AN ERROR IN ROUTINE DENINT.  THE ROUTINE CAN NO
0034     *     LONGER SEARCH FOR DENSITIES OUTSIDE THE POOL WHEN A WEIR
0035     *     IS BEING MODELED ....
0036     *
0037     *
0038     *.... VERSION 1.3 .... JANUARY 6, 1992 ....
0039     *
0040     *     MADE SUPERFICIAL CHANGES TO THE CODE APPEARANCE TO IMPROVE
0041     *     READABILITY.  ALSO MADE INCONSEQUENTIAL CHANGES TO THE OUTPUT
0042     *     ROUTINE TO MAKE OUTPUT FILE MORE PC-PRINTER COMPATIBLE.  THE
0043     *     SUBROUTINES WERE REORDERED TO APPEAR ALPHABETICALLY.  FUNCTION
0044     *     NAMES IN VPORT WERE CHANGED TO MATCH THE VARIABLE NAMES IN THE
0045     *     DOCUMENTATION.
0046     *
0047     *     AN ERROR IN CONVERTING FAHRENHEIT TO CENTIGRADE WAS CORRECTED.
0048     *     DENINT WAS CORRECTED TO ACCOMMODATE POINT SINKS AT THE
0049     *     RESERVOIR BOTTOM.  THE SMITH ET AL. FORMULATION WAS
```

MAIN

```
0050    *     CORRECTED TO COMPUTE THE DENSITY GRADIENT FROM THE PORT
0051    *     CENTER LINE TO THE FREE LIMIT, RATHER THAN FROM THE BOUNDARY
0052    *     OF INTERFERENCE.  FOR ONE BOUNDARY OF INTERFERENCE, THE
0053    *     BOHAN AND GRACE CALCULATION OF THE THEORETICAL LIMIT NOW
0054    *     CORRECTLY USES A FRACTION MULTIPLIER FOR THE AMOUNT OF FLOW
0055    *     IN THE TRUNCATED WITHDRAWAL ZONE.  THE PORT ORDERING
0056    *     ROUTINE IN XREAD WAS CORRECTED TO INCLUDE FLOW AND ANGLE.
0057    *     (HOWINGTON)
0058    *
0059             COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0060             COMMON / BB / IFILE, KFILE
0061             COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0062             COMMON / DD / WTHETA (5), WANGLE
0063             COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0064             COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0065             COMMON / GG / COEF, QSUB, QQUAL
0066             COMMON / HH / WRLNG, WRHGT, WRFLOW
0067             COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0068             COMMON / JJ / NUMT, QCENT, TEMP (100), YT (100), QTEMP
0069             COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0070         &                 QUAL (4,100), YQ (4,100)
0071             COMMON / LL / ISURF, HGT(100), DEPTH, Y (100)
0072             COMMON / MM / SUMOUT, VEL(100), FLORAT
0073             COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0074         &                 QSINK2, QSHIFT
0075             COMMON / OO / LENGTH, CREST, HDIM
0076             COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0077             COMMON / QQ / VS (100, 6), NOUTS
0078             COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0079             COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0080             COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0081    *
0082             LOGICAL QDEN, QCENT
0083             LOGICAL QVENT, QAERA
0084    *
0085             DATA C1, C2 / -3.9863, 508929.2 /
0086             DATA C3, C4 / 288.9414, 68.12963 /
0087    *
0088    *.... DENSITIES FROM TEMPERATURES ....
0089    *
0090             DENFUN ( X ) = 1. - ( X + C1 ) ** 2 / C2
0091         &                  * ( X + C3 ) / ( X + C4 )
0092    *
0093    *....  FAHRENHEIT TO CENTIGRADE ....
0094    *
0095             TEMFUN ( T ) = ( 5. / 9. ) * ( T - 32. )
0096    *
0097    *.... READ CONTROL INFORMATION ....
0098    *
0099             IFILE = 5
```

MAIN

```
0100              KFILE = 6
0101    *
0102              OPEN ( 5, FILE = 'SELECT.IN'   , STATUS = 'OLD' )
0103              OPEN ( 6, FILE = 'SELECT.OUT' , STATUS = 'NEW' )
0104    *
0105              CALL XREAD
0106    *
0107    *.... INITIATE LOOP FOR THE NUMBER OF DATA SETS ....
0108    *
0109              DO 130 I = 1, NSETS
0110    *
0111    *.... READ INPUT DATA AND CONSTRUCT COMPLETE DATA TABLES ....
0112    *
0113              CALL XREAD
0114    *
0115    *.... DEVELOP DENSITY PROFILE IF NOT GIVEN ....
0116    *
0117              IF ( QDEN ) GO TO 110
0118              DO 100 J = 1, ISURF
0119                 IF ( .NOT. QCENT ) TEMP(J) = TEMFUN ( TEMP(J) )
0120                 DEN (J) = DENFUN ( TEMP(J) )
0121     100      CONTINUE
0122     110      CONTINUE
0123    *
0124    *.... CHECK FOR STABLE DENSITY PROFILE ....
0125    *
0126              DO 120 K = 2, ISURF
0127                 IF ( DEN (K - 1) .GE. DEN (K) ) GO TO 120
0128                 WRITE ( KFILE , 500 )
0129                 STOP
0130     120      CONTINUE
0131    *
0132    *.... COMPUTE SELECTIVE WITHDRAWAL LIMITS AND VELOCITIES AND
0133    *     RESULTANT OUTFLOW DENSITY AND QUALITIES ....
0134    *
0135              CALL OUTVEL
0136    *
0137    *.... MODIFY OUTFLOW D.O. IF GATED STRUCTURE
0138    *     AERATION IS USED. ....
0139    *
0140              IF ( QAERA ) CALL AERATE
0141    *
0142    *.... MODIFY OUTFLOW D.O. IF TURBINE VENTING IS USED ....
0143    *
0144              IF ( QVENT ) CALL VENTING
0145    *
0146    *.... PRINT RESULTS ....
0147    *
0148              CALL XPRINT
0149     130      CONTINUE
```

MAIN

```
0150              STOP
0151      500     FORMAT ( /// 10X, 27HDENSITY PROFILE UNSTABLE - ,
0152          &                     16HPROGRAM STOPPED )
0153              END
```

AERATE

```
0001              SUBROUTINE AERATE
0002    ***************************************************************
0003    *                                                             *
0004    *        S U B R O U T I N E   A E R A T E                    *
0005    *                                                             *
0006    ***************************************************************
0007    *
0008    *.... PREDICTS THE RELEASE D.O. (MG/L) THROUGH GATED CONDUIT OULET
0009    *     WORKS USING THE ENERGY DISSIPATION MODEL OUTLINED IN
0010    *     TR-E-81-5 BY WILHELMS AND SMITH ....
0011    *
0012              COMMON / AA / QMETR, NSETS, G, HEADING(18), TITLE(18)
0013              COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0014              COMMON / LL / ISURF, HGT(100), DEPTH, Y(100)
0015              COMMON / MM / SUMOUT, VEL(100), FLORAT
0016              COMMON / SS / WTHDRW(100), DENOUT, TEMOUT, QALOUT(4)
0017              COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0018    *
0019              LOGICAL QVENT, QAERA, QTWFUN
0020              LOGICAL QMETR
0021    *
0022    *.... FUNCTIONS FOR CALCULATIONS ADJUSTED ESCAPE COEFFICIENT ....
0023    *
0024              CT( X ) = C20 * 1.022 ** ( X - 20.0 )
0025    *
0026    *.... DISSOLVED OXYGEN SATURATION ....
0027    *
0028              DOSAT( X ) = 1 / ( 0.00209 * X + 0.06719 )
0029    *
0030    *.... ALTITUDE CORRECTION FACTOR ....
0031    *
0032              BARO( X ) = 1.0 - 3.224 E-5 * X
0033              C20 = 0.045
0034              IF ( QMETR ) C20 = 0.1476
0035    *
0036    *.... ADJUST ESCAPE COEFFICIENT ....
0037    *
0038              C = CT( TEMOUT )
0039    *
0040    *.... OXYGEN SATURATION CONCENTRATION ADJUSTED FOR ALTITUDE ....
0041    *
0042              ALT = BOTTOM
0043              IF ( QMETR ) ALT = BOTTOM * 3.28
0044              CSAT = DOSAT( TEMOUT ) * BARO( ALT )
0045    *
0046    *.... DELTA-H THROUGH STRUCTURE ....
0047    *
0048              DELH = DEPTH + BOTTOM - TWEL
0049    *
0050    *.... DISSOLVED OXYGEN DEFICIT ENTERING STRUCTURE ....
```

AERATE

```
0051    *
0052                DI = CSAT - QALOUT(1)
0053    *
0054    *.... REAERATE DISCHARGE ....
0055    *
0056                DF = DI * EXP( - C * DELH )
0057    *
0058    *.... RELEASE DISSOLVED OXYGEN ....
0059    *
0060              QALOUT(1) = CSAT - DF
0061              RETURN
0062              END
```

DENINT

```
0001            REAL FUNCTION DENINT ( X )
0002    ************************************************************************
0003    *                                                                      *
0004    *       R E A L   F U N C T I O N   D E N I N T                        *
0005    *                                                                      *
0006    ************************************************************************
0007    *
0008    *.... DETERMINE DENSITY AT ANY LOCATION ....
0009    *
0010            COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0011            COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0012            COMMON / II / NUMD, DEN(100), YD(100), QDEN, DENPRT
0013            COMMON / LL / ISURF, HGT(100), DEPTH, Y(100)
0014            COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM,
0015         &                QSINK1, QSINK2, QSHIFT
0016    *
0017            INTEGER SIGN
0018    *
0019            LOGICAL QDEN, QTLIM, QBLIM, QSINK1, QSINK2, QSHIFT, QWEIR
0020    *
0021            DATA SMALL / 1.E - 05 /
0022    *
0023            LAYER = 1. + X / DELZ
0024    *
0025    *.... IF WEIRS ARE BEING MODELED, CODE ONLY SEARCHES IN THE POOL
0026    *     FOR DENSITIES.  IF PORTS ARE BEING MODELED THE CODE SEARCHES
0027    *     BOTH IN AND OUTSIDE THE POOL FOR DENSITIES ....
0028    *
0029            IF ( QWEIR ) THEN
0030               IF ( LAYER .LE. 1 ) THEN
0031                  LAYER = 1
0032                  DENINT = DEN ( LAYER )
0033                  RETURN
0034               ELSE IF ( LAYER .GT. ISURF ) THEN
0035                  LAYER = ISURF
0036                  DENINT = DEN ( LAYER )
0037                  RETURN
0038               END IF
0039            END IF
0040    *
0041            IF ( X .GE. DEPTH .OR. X .LT. 0.0 ) GO TO 120
0042    *
0043    *.... IF THE LAYER IS OUTSIDE THE POOL, THE DENSITY IS
0044    *     EXTRAPOLATED BASED ON A LINEAR DENSITY GRADIENT EXTENDED
0045    *     FROM THE PORT CENTERLINE TO THE DESIRED BOUNDARY LAYER ....
0046    *
0047    *.... FIND THE DENSITY INSIDE THE POOL ....
0048    *
0049            ELMID = DELZ * ( FLOAT ( LAYER ) - 0.5 )
0050            DIFF = ABS ( ELMID - X )
```

DENINT

```
0051              IF ( DIFF .LT. SMALL ) THEN
0052                 DENINT = DEN ( LAYER )
0053                 RETURN
0054              ENDIF
0055     *
0056              IF ( LAYER .EQ. ISURF .AND. X .GE. ELMID ) THEN
0057                 SLOPE = ( DEN ( ISURF - 1 ) - DEN ( ISURF ) )
0058          &              / DELZ
0059                 DENINT = DEN ( LAYER ) - DIFF * SLOPE
0060                 RETURN
0061              ELSEIF ( LAYER .EQ. 1 .AND. X .LE. ELMID ) THEN
0062                 SLOPE = ( DEN ( 1 ) - DEN ( 2 ) ) / DELZ
0063                 DENINT = DEN ( LAYER ) + DIFF * SLOPE
0064                 RETURN
0065              ENDIF
0066     *
0067              SIGN = ( ELMID - X ) / ABS ( ELMID - X )
0068              IJK = - ( SIGN - 1 ) / 2
0069              IJ = LAYER + IJK
0070              JK = IJ - 1
0071              SLOPE = ( DEN ( IJ ) - DEN ( JK ) ) / DELZ
0072              ELTOP = DELZ * ( FLOAT ( IJ ) - 0.5 )
0073              DENINT = DEN ( IJ ) - ( ELTOP - X ) * SLOPE
0074              RETURN
0075      120     CONTINUE
0076     *
0077     *.... FIND THE DENSITY OUTSIDE THE POOL ....
0078     *
0079              IF ( HGTPRT .GE. DEPTH - 0.5 * DELZ ) THEN
0080                 DGRDT = ( DEN ( ISURF ) - DEN ( ISURF - 1 ) )
0081          &              / DELZ
0082              ELSE
0083                 DGRDT = ( DEN ( ISURF ) - DENPRT ) / ( DEPTH - HGTPRT )
0084              ENDIF
0085     *
0086              IF ( HGTPRT .LE. 0.5 * DELZ ) THEN
0087                 DGRDB = ( DEN ( 1 ) - DEN ( 2 ) ) / DELZ
0088              ELSE
0089                 DGRDB = ( DEN ( 1 ) - DENPRT ) / HGTPRT
0090              ENDIF
0091              IF ( LAYER .GE. ISURF ) DGRD = DGRDT
0092              IF ( LAYER .LE. 1 ) DGRD = DGRDB
0093              DENINT = DGRD * ABS ( HGTPRT - X ) + DENPRT
0094              RETURN
0095              END
```

DVPLOT

```
0001              SUBROUTINE DVPLOT
0002     ************************************************************************
0003     *                                                                      *
0004     *        S U B R O U T I N E   D V P L O T                             *
0005     *                                                                      *
0006     ************************************************************************
0007     *
0008     *.... THIS SUBROUTINE PLOTS PROFILES OF DENSITY AND VELOCITY
0009     *     VERSUS DEPTH ....
0010     *
0011              COMMON / BB / IFILE, KFILE
0012              COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013              COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0014              COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0015              COMMON / MM / SUMOUT,  VEL (100), FLORAT
0016     *
0017              CHARACTER*1 T, BLANK, PEGGED, FIRSTD, BOTH, COL1(100),
0018          *               V, D, LASTV, LASTD, COL2(100), FIRSTV
0019     *
0020              DIMENSION VSPACE(11), DSPACE(11)
0021     *
0022              CHARACTER*2 PLUS
0023              INTEGER VSPACE
0024              LOGICAL QRANGE, QDEN
0025     *
0026              DATA PEGGED, BLANK, V, D, PLUS / '*',' ','V','D',' +'/
0027              DATA VELMAX / 2.0 /
0028              DATA BOTH / 'B' /
0029     *
0030              WRITE ( KFILE, 500 )
0031     *
0032     *.... DETERMINE MAXIMUM VELOCITY ....
0033     *
0034              VMAX = VEL ( 1 )
0035              DO 100 I = 2, ISURF
0036                 IF ( VEL ( I ) .GT. VMAX ) VMAX = VEL ( I )
0037      100     CONTINUE
0038     *
0039     *.... DETERMINE VELOCITY AXIS SPACING ....
0040     *
0041              CHANGE = VELMAX * 100.
0042              VSPACE ( 1 ) = 0
0043              DO 110 K = 1 , 10
0044                 VSPACE( K + 1 ) = VSPACE ( K ) + INT ( CHANGE )
0045      110     CONTINUE
0046     *
0047     *.... DETERMINE MAXIMUM AND MINIMUM DENSITIES FOR AXIS SPACING ....
0048     *
0049              DMIN = DEN ( 1 )
0050              DMAX = DEN ( 1 )
```

DVPLOT

```
0051              DO 115 I = 2, ISURF
0052                 DMIN = AMIN1 ( DMIN, DEN ( I ) )
0053                 DMAX = AMAX1 ( DMAX, DEN ( I ) )
0054        115   CONTINUE
0055              DUM = DMIN * 1000.
0056              DMIN = FLOAT ( INT ( DUM ) )  / 1000.
0057              DDIF = DMAX - DMIN
0058              DMAX = DMIN + 0.01
0059              IF ( DDIF .GT. 0.01 ) DMAX = DMIN + 0.02
0060      *
0061      *.... DETERMINE DENSITY AXIS SPACING ....
0062      *
0063              DENDIF = DMAX - DMIN
0064              CHANGE2 = DENDIF / 10.
0065              DSPACE ( 1 ) = DMIN
0066              DO 120 J = 1, 10
0067                 DSPACE ( J + 1 ) = DSPACE ( J ) + CHANGE2
0068       120    CONTINUE
0069      *
0070      *.... PRINT VELOCITY AXIS AND LABEL ....
0071      *
0072              WRITE ( KFILE, 510 )
0073              WRITE ( KFILE, 520 ) ( VSPACE ( K ), K = 1, 11 )
0074              WRITE ( KFILE, 530 )
0075      *
0076      *.... BEGIN TO FILL IN COLUMN ARRAY ....
0077      *
0078              ELEV = BOTTOM + DEPTH + DELZ
0079              DEEP = - DELZ
0080              DO 170 I = 1, ISURF
0081                 K = ISURF - I + 1
0082                 DEEP = DEEP + DELZ
0083                 ELEV = ELEV - DELZ
0084      *
0085      *.... BLANK OUT VELOCITY COLUMN ARRAY ....
0086      *
0087                 FIRSTV = BLANK
0088                 LASTV = BLANK
0089                 DO 130 L = 1, 100
0090                    COL1 ( L ) = BLANK
0091       130       CONTINUE
0092      *
0093      *.... DETERMINE IF VELOCITY VALUES ARE WITHIN RANGE OF PLOT ....
0094      *
0095                 VL = VEL ( K )
0096                 IF ( VL .LE. 0.      ) FIRSTV = PEGGED
0097                 IF ( VL .GT. VELMAX ) LASTV = PEGGED
0098      *
0099      *.... DETERMINE COLUMN FOR PLOTTING EACH VELOCITY COMPONENT ....
0100      *
```

DVPLOT

```
0101                QRANGE = VL .GT. 0. .AND. VL .LE. VELMAX
0102                IRANGE = 0
0103                IF ( QRANGE ) IRANGE = 1
0104                IF ( .NOT. QRANGE ) GO TO 140
0105                IJK = INT ( ( VL / VELMAX ) * 100. )
0106                IJK = IJK + 1
0107                COL1 ( IJK ) = V
0108     140        CONTINUE
0109    *
0110    *.... BLANK OUT DENSITY COLUMN ARRAY ....
0111    *
0112                FIRSTD = BLANK
0113                LASTD = BLANK
0114                DO 150 L = 1, 100
0115                   COL2 ( L ) = BLANK
0116     150        CONTINUE
0117    *
0118    *.... DETERMINE IF DENSITY VALUES ARE WITHIN RANGE OF PLOT ....
0119    *
0120                DN = DEN(K)
0121                IF ( DN .LE. 0.    ) FIRSTD = PEGGED
0122                IF ( DN .GT. DMAX ) LASTD = PEGGED
0123    *
0124    *.... DETERMINE COLUMN FOR PLOTTING EACH DENSITY COMPONENT ....
0125    *
0126                QRANGE = DN .GT. 0. .AND. DN .LE. DMAX
0127                IRANGE = 0
0128                IF ( QRANGE ) IRANGE = 1
0129                IF ( .NOT. QRANGE ) GO TO 160
0130                IJK = INT ( 100. * ( DN - DMIN ) / DENDIF )
0131                IJK = IJK + 1
0132                COL2 ( IJK ) = D
0133     160        CONTINUE
0134                DO 165 L = 1, 100
0135                   IF ( COL1 ( L ) .EQ. V ) GO TO 162
0136                   COL1 ( L ) = COL2 ( L )
0137                   GO TO 165
0138     162           CONTINUE
0139                   IF ( COL2 ( L ) .NE. D ) GO TO 165
0140                   COL1 ( L ) = BOTH
0141     165           CONTINUE
0142    *
0143    *.... PRINT ONE LINE OF PLOT ....
0144    *
0145                   WRITE ( KFILE, 550 ) ELEV  , DEEP , PLUS  , FIRSTV ,
0146         &                                 FIRSTD, COL1 , LASTV , LASTD
0147     170     CONTINUE
0148    *
0149    *.... PRINT BOTTOM AXIS ....
0150    *
```

DVPLOT

```
0151              WRITE ( KFILE , 530 )
0152              WRITE ( KFILE , 570 ) ( DSPACE ( J ), J = 1, 11 )
0153              WRITE ( KFILE , 540 )
0154     *
0155     *.... QUIT ....
0156     *
0157              RETURN
0158     *
0159      500     FORMAT ( 1H1 , /// )
0160      510     FORMAT ( 30X , 23HVELOCITY ( TIMES 1000 ) )
0161      520     FORMAT ( 11X , 11I10 )
0162      530     FORMAT ( 20X , 10 ( 10HI--------- ), 1HI )
0163      540     FORMAT ( 30X , 12HDENSITY G/CC )
0164      550     FORMAT ( 1X  , F7.2, 1X, F7.2, A2, 104A1 )
0165      570     FORMAT ( 11X , 11F10.5 )
0166              END
```

ERROR

```
0001            SUBROUTINE ERROR ( ERR, SUBR, CHK, XCHK1, XCHK2, XCHK3 )
0002    ************************************************************************
0003    *                                                                      *
0004    *        S U B R O U T I N E   E R R O R                               *
0005    *                                                                      *
0006    ************************************************************************
0007    *
0008    *.... THERE ARE TWO TYPES OF ERROR CHECKS - ONE FOR INPUT
0009    *     FORMATTING AND ONE FOR PROGRAM COMPUTATIONS. FOR PROGRAM
0010    *     COMPUTATIONS, ONLY THE ERROR NUMBER AND THE SUBROUTINE-OF-
0011    *     OCCURRANCE NAME ARE PASSED TO THE ERROR SUBROUTINE.  THEN AN
0012    *     APPROPRIATE STATEMENT IS MATCHED WITH THE ERROR NUMBER AND
0013    *     PRINTED.  THE OTHER ARGUMENTS PASSED ARE EQUAL TO ZERO ....
0014    *
0015    *.... FOR FORMAT ERRORS, THE ERROR NUMBER, THE SUBROUTINE-OF-
0016    *     OCCURRANCE NAME, THE STRING IN ERROR, AND THE STRING(S)
0017    *     EXPECTED BY THE PROGRAM ARE PASSED.  UNUSED ARGUMENTS ARE
0018    *     PASSED AS ZERO ....
0019    *
0020            COMMON / BB / IFILE, KFILE
0021    *
0022            INTEGER ERR
0023    *
0024            CHARACTER*4 CHK, XCHK1, XCHK2, XCHK3
0025            CHARACTER*6 SUBR
0026    *
0027    *.... PRINT ERROR NUMBER AND SUBROUTINE-OF-OCCURRANCE ....
0028    *
0029            WRITE ( KFILE, 500 ) ERR, SUBR
0030    *
0031    *.... MATCH ERROR CODE WITH PROPER OUTPUT STATEMENT ....
0032    *
0033    *.... ERROR CODES FOR IMPROPER INPUT VALUES ....
0034    *
0035            IF ( ERR .EQ. 1400 ) WRITE ( KFILE, 510 )
0036            IF ( ERR .EQ. 1410 ) WRITE ( KFILE, 520 )
0037            IF ( ERR .EQ. 1420 ) WRITE ( KFILE, 530 )
0038    *
0039    *.... ERROR CODES FOR INTERNAL COMPUTATIONS ....
0040    *
0041            IF ( ERR .EQ. 2100 .OR. ERR .EQ. 2070 .OR.
0042         &        ERR .EQ. 2090 .OR. ERR .EQ. 2300 )
0043         &        WRITE ( KFILE, 540 )
0044            IF ( ERR .EQ. 2310 ) WRITE ( KFILE, 570 )
0045            IF ( ERR .EQ. 2320 ) WRITE ( KFILE, 580 )
0046    *
0047    *.... ERROR CODES FOR HALF INTERVAL SEARCH CONVERGENCE ERRORS ....
0048    *
0049            IF ( ERR .EQ. 2310 ) WRITE ( KFILE, 570 )
0050            IF ( ERR .EQ. 2080 .OR. ERR .EQ. 2110 )
```

ERROR

```
0051         &        WRITE ( KFILE, 590 )
0052              IF ( ERR .EQ. 1080 ) WRITE ( KFILE, 600 )
0053     *
0054     *.... IF THIS SUBROUTINE  USED ONE OF THE ABOVE 'IF' STATEMENTS
0055     *     THEN THE FOLLOWING IF STATEMENT IS USED TO EXIT PROGRAM ....
0056     *
0057              IF ( XCHK1 .EQ. '0   ' .AND. XCHK2 .EQ. '0   '
0058         &        .AND. XCHK3 .EQ. '0   ' ) GO TO 100
0059     *
0060     *.... ERROR CODES FOR INPUT FORMAT FAILURE CHECKS ....
0061     *
0062     *.... IF VARIABLE 'CHECK' WAS TESTED FOR ONLY ONE STRING VALUE
0063     *     DURING PROGRAM OPERATION ....
0064     *
0065              IF ( XCHK2 .EQ. '0   ' .AND. XCHK3 .EQ. '0   ' )
0066         &        WRITE ( KFILE, 610 ) CHK, XCHK1
0067     *
0068     *.... IF VARIABLE 'CHECK' WAS TESTED FOR ONE OF TWO STRING VALUES
0069     *     DURING PROGRAM OPERATION ....
0070     *
0071              IF ( XCHK2 .NE. '0   ' .AND. XCHK3 .EQ. '0   ' )
0072         &        WRITE ( KFILE, 620 ) CHK, XCHK1, XCHK2
0073     *
0074     *.... IF VARIABLE 'CHECK' WAS TESTED FOR ONE OF THREE STRING VALUES
0075     *     DURING PROGRAM OPERATION ....
0076     *
0077              IF ( XCHK2 .NE. '0   ' .AND. XCHK3 .NE. '0   ' )
0078         &        WRITE ( KFILE, 630 ) CHK, XCHK1, XCHK2, XCHK3
0079      100     STOP
0080     *
0081      500     FORMAT ( /,'ERROR NUMBER ',I4,
0082         &            ' OCCURRED IN SUBROUTINE' , A6 )
0083      510     FORMAT (/, 'FLOW RATE FOR A PORT WAS FOUND TO BE', /,
0084         &        'LESS THAN OR EQUAL TO ZERO.', /, 'ENTERED FLOWRATE',
0085
0086         &        ' MUST BE GREATER THAN  ZERO.')
0087      520     FORMAT ( /, 'CENTER LINE OF PORT WAS HIGHER ', /,
0088         &        'THAN THE WATER SURFACE.')
0089      530     FORMAT ( /, 'FLOW RATE FOR WEIR MUST BE > THAN ZERO' )
0090      540     FORMAT ( /,'*** COMPUTATIONAL ERROR IN PROGRAM ' )
0091      570     FORMAT ( /,'CONVERGENCE IN SUBROUTINE SHIFT FAILED.')
0092      580     FORMAT ( /, 'IN HALF INTERVAL SEARCH, CONVERGENCE ON THE',
0093         &            /, 'UPPER OR LOWER WITHDRAWAL LIMIT FAILED')
0094      590     FORMAT ( /, 'IN HALF INTERVAL SEARCH, CONVERGENCE ON ',/,
0095         &               'THE UPPER OR LOWER WITHDRAWAL LIMIT FAILED.')
0096
0097      600     FORMAT ( /,'NUMBER OF LAYERS DIMENSIONED WAS EXCEEDED')
0098      610     FORMAT ( /, 'INTERNAL CHECK WAS "',A4, '"', /,
0099         &            'PROGRAM EXPECTED "', A4,'" AS FIRST FOUR', /,
0100         &            'CHARACTERS OF INPUT LINE.')
```

ERROR

```
0101      620     FORMAT ( /,'INTERNAL CHECK WAS "', A4, '"', /,
0102          &            'PROGRAM EXPECTED "', A4, '" OR "', A4, '"', /,
0103          &            'AS FIRST FOUR CHARACTERS OF INPUT LINE.')
0104      630     FORMAT ( /, 'INTERNAL CHECK WAS "',A4, '"', /,
0105          &            'PROGRAM EXPECTED "', A4, '" OR "', A4, '"', /,
0106          &            'OR "', A4, '" AS FIRST FOUR CHARACTERS OF',
0107          &            ' INPUT LINE.')
0108              END
```

INTERP

```
0001              SUBROUTINE INTERP ( PQUAL, YV, NUMV )
0002     ********************************************************************
0003     *                                                                  *
0004     *        S U B R O U T I N E   I N T E R P                         *
0005     *                                                                  *
0006     ********************************************************************
0007     *
0008     *.... PROGRAM TO DEVELOP COMPLETE DATA TABLES OR PROFILES BY LINEAR
0009     *     INTERPOLATION OF INPUT DATA ....
0010     *
0011              COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0012              COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0013     *
0014              DIMENSION PQUAL (100), YV (100), PVALUE (100),
0015          &             DM (100), PM (100)
0016     *
0017              INTEGER SIGN1, SIGN2
0018     *
0019     *.... TOLERANCE, 0.01% OF LAYER THICKNESS ....
0020     *
0021              SMALL = 0.0001 * DELZ
0022     *
0023     *.... IF DATA IS ORDERED FROM TOP TO BOTTOM, IT MUST BE RESEQUENCED
0024     *     FROM BOTTOM TO TOP ....
0025     *
0026              IF ( YV(1) .LT. YV(2) ) GO TO 120
0027              NV = NUMV + 1
0028     *
0029     *.... RESEQUENCE ....
0030     *
0031              DO 100 I = 1, NUMV
0032                 DM(I) = YV(NV - I)
0033                 PM(I) = PQUAL(NV - I)
0034      100     CONTINUE
0035              DO 110 I = 1, NUMV
0036                 YV(I) = DM(I)
0037                 PQUAL(I) = PM(I)
0038      110     CONTINUE
0039      120     CONTINUE
0040     *
0041     *.... ASSIGN PARAMETER VALUE TO INTERP VARIABLE ....
0042     *
0043              DO 130 I = 1, NUMV
0044                 PVALUE(I) = PQUAL(I)
0045      130     CONTINUE
0046     *
0047     *.... START PROFILE DEVELOPMENT ....
0048     *
0049     *.... ANY CENTER LINE ELEVATION BELOW LOWEST PARAMETER POINT
0050     *     IS ASSIGNED THE VALUE OF THAT PARAMETER POINT ....
```

INTERP

```
0051    *
0052              DO 140 I = 1, ISURF
0053                 IF ( Y(I) .GT. YV(1) ) GO TO 150
0054                 PQUAL(I) = PVALUE(1)
0055     140      CONTINUE
0056     150      CONTINUE
0057              J = I
0058    *
0059    *.... ANY CENTER LINE ELEV. ABOVE HEIGHEST PARAMETER POINT IS
0060    *     ASSIGNED THAT PARAMETER VALUE ....
0061    *
0062              DO 160 I = 1, ISURF
0063                 L = ISURF + 1 - I
0064                 IF ( Y(L) .LT. YV(NUMV) ) GO TO 170
0065                 PQUAL(L) = PVALUE(NUMV)
0066     160      CONTINUE
0067     170      CONTINUE
0068    *
0069    *.... FIRST CENTER LINE BELOW HIGHEST PARAMETER POINT ....
0070    *
0071              K = L
0072    *
0073    *.... FIRST CENTER LINE ABOVE LOWEST PARAMETER POINT ....
0074    *
0075              I = J - 1
0076     180      CONTINUE
0077              I = I + 1
0078              IF ( I .GT. K ) GO TO 270
0079              NMINUS = NUMV - 1
0080    *
0081    *.... LOCATE DATA POINTS ABOVE AND BELOW THE LAYER CENTER LINE ....
0082    *
0083              DO 230 M = 1, NMINUS
0084                 DIFF1 = ABS ( YV(M) - Y(I) )
0085                 IF ( DIFF1 .LT. SMALL ) GO TO 190
0086    *
0087    *....  IF SIGN1 IS NEGATIVE, FIRST DATA POINT LIES BELOW CENTER
0088    *      LINE IF SIGN1 IS POSITIVE, POINT LIES ABOVE CENTER LINE ....
0089    *
0090                 SIGN1 = ( YV(M) - Y(I) ) / DIFF1 * 1.2
0091                 GO TO 200
0092     190         CONTINUE
0093                 SIGN1 = 0
0094     200         CONTINUE
0095                 DIFF2 = ABS ( YV(M+1) - Y(I) )
0096                 IF ( DIFF2 .LT. SMALL ) GO TO 210
0097    *
0098    *.... IF SIGN2 IS NEGATIVE, SECOND DATA POINT LIES BELOW CENTER
0099    *     LINE IF SIGN2 IS POSITIVE, POINT IS ABOVE CENTER LINE ....
0100    *
```

INTERP

```
0101                SIGN2 = ( YV ( M + 1 ) - Y ( I ) ) / DIFF2 * 1.2
0102                GO TO 220
0103     210        CONTINUE
0104                SIGN2 = 0
0105     220        CONTINUE
0106    *
0107    *.... IF BOTH DATA POINTS ARE BELOW CENTER LINE, LOOP AGAIN ....
0108    *
0109                IF ( SIGN1 .EQ. SIGN2 .AND. SIGN1 .EQ. -1 ) GO TO 230
0110                GO TO 240
0111     230      CONTINUE
0112     240      CONTINUE
0113    *
0114    *.... DOES CENTER LINE LIE VERY CLOSE TO DATA POINT ....
0115    *
0116              IF ( SIGN1 .EQ. 0 ) GO TO 250
0117              IF ( SIGN2 .EQ. 0 ) GO TO 260
0118    *
0119    *.... INTERPOLATE BETWEEN DATA POINTS FOR VALUE AT CENTER LINE ....
0120    *
0121              PQUAL(I) = ( ( PVALUE ( M + 1 ) - PVALUE ( M ) )
0122         &               * ( Y ( I ) - YV ( M ) ) /
0123         &               ( YV ( M + 1 ) - YV ( M ) ) ) + PVALUE ( M )
0124              GO TO 180
0125     250      CONTINUE
0126    *
0127    *.... ASSIGN LOWER DATA POINT VALUE TO CENTER LINE ....
0128    *
0129              PQUAL ( I ) = PVALUE ( M )
0130              GO TO 180
0131     260      CONTINUE
0132    *
0133    *.... ASSIGN UPPER DATA POINT VALUE TO CENTER LINE ....
0134    *
0135              PQUAL ( I ) = PVALUE ( M + 1 )
0136              GO TO 180
0137     270      CONTINUE
0138              RETURN
0139              END
```

OUTVEL

```
0001              SUBROUTINE OUTVEL
0002     ********************************************************************
0003     *                                                                  *
0004     *        S U B R O U T I N E   O U T V E L                         *
0005     *                                                                  *
0006     ********************************************************************
0007     *
0008     *.... THIS IS THE CONTROL MODULE FOR THE COMPUTATION PORTION OF
0009     *     THIS PROGRAM ....
0010     *
0011              COMMON / DD / WTHETA (5), WANGLE
0012              COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0013              COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0014              COMMON / GG / COEF, QSUB, QQUAL
0015              COMMON / HH / WRLNG, WRHGT, WRFLOW
0016              COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0017              COMMON / JJ / NUMT, QCENT, TEMP(100), YT (100), QTEMP
0018              COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0019             &              QUAL (4,100), YQ (4,100)
0020              COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0021              COMMON / MM / SUMOUT,  VEL (100), FLORAT
0022              COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0023             &              QSINK2, QSHIFT
0024              COMMON / OO / LENGTH, CREST, HDIM
0025              COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0026              COMMON / QQ / VS (100,6), NOUTS
0027              COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0028              COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0029              COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0030     *
0031              INTEGER TOPLIM
0032     *
0033              LOGICAL QPORT, QWEIR, QSUB, QTEMP, QPWEIR
0034     *
0035              REAL LENGTH
0036     *
0037              CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3, NAMEQ
0038              CHARACTER*6 SUBR
0039     *
0040              DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0   ' /
0041              DATA SUBR / 'OUTVEL' /
0042     *
0043              LAYER ( X ) = 1. + X / DELZ
0044              NOUTS = NPORTS
0045              IF ( QWEIR ) NOUTS = NOUTS + 1
0046     *
0047     *.... INITIALIZE THE TOTAL OUTFLOW FLOW RATE PROFILE ....
0048     *
0049              DO 100 I = 1, ISURF
0050                 VEL (I) = 0.0
```

OUTVEL

```
0051     100     CONTINUE
0052             SUMOUT = 0.0
0053     *
0054     *.... DETERMINE TYPE OF WITHDRAWAL ....
0055     *
0056             IF ( QPORT ) GO TO 110
0057             IF ( QWEIR ) GO TO 140
0058     *
0059     *.... SELECTIVE WITHDRAWAL FOR ORIFICE FLOW ....
0060     *
0061     110     CONTINUE
0062             DO 130 K = 1, NPORTS
0063     *
0064     *.... VARIABLE ASSIGNMENTS ....
0065     *
0066                 QPWEIR = .FALSE.
0067                 FLORAT= FLOW(K)
0068                 IF ( FLORAT .LE. 0. )
0069          &           CALL ERROR ( 1400   , SUBR, XDUMY, XDUMY1, XDUMY2,
0070          &                        XDUMY3 )
0071                 SUMOUT = SUMOUT + FLORAT
0072                 VDIM = PVDIM(K)
0073                 HDIM = PHDIM(K)
0074                 HGTPRT = PHGT(K)
0075                 IF ( HGTPRT .GE. DEPTH )
0076          &           CALL ERROR ( 1410   , SUBR, XDUMY, XDUMY1, XDUMY2,
0077          &                        XDUMY3 )
0078                 DENPRT = DENINT ( HGTPRT )
0079                 WANGLE = WTHETA ( K )
0080     *
0081     *.... CHECK FOR PARTIALLY SUBMERGED PORT ....
0082     *
0083                 FLODEP = DEPTH - HGTPRT + VDIM/2.
0084                 IF ( VDIM .LE. FLODEP ) GO TO 115
0085                 VW = FLORAT / ( FLODEP * HDIM )
0086                 VHL = ( VW * FLODEP ** .5 ) / HDIM
0087                 IF ( VHL .GT. 0.5 ) GO TO 115
0088     *
0089     *.... PARTIALLY SUBMERGED PORT - TREAT AS A WEIR ....
0090     *
0091                 QPWEIR = .TRUE.
0092                 QSUB = .TRUE.
0093                 LENGTH = HDIM
0094                 CREST = HGTPRT - VDIM/2.
0095     *
0096                 CALL VWEIR
0097     *
0098                 GO TO 116
0099     115         CONTINUE
0100     *
```

OUTVEL

```
*.... FULLY SUBMERGED PORT ....
*
             CALL VPORT
*
 116         CONTINUE
*
*.... ASSIGN FLOW RATE PROFILE VALUES CALCULATED IN VPORT
*     OR VWEIR TO AN ARRAY ....
*
             DO 120 I = 1, ISURF
                VS(I,K) = V(I)
 120         CONTINUE
*
*.... ASSIGN WITHDRAWAL LIMIT VALUES TO AN ARRAY ....
*
             ZUP  ( K ) = HGTTOP
             ZDN  ( K ) = HGTLOW
             LTOP ( K ) = TOPLIM
             LLOW ( K ) = LOWLIM
 130     CONTINUE
 140     CONTINUE
         IF ( .NOT. QWEIR ) GO TO 160
*
*.... SELECTIVE WITHDRAWAL FOR WEIR FLOW ....
*
          FLORAT = WRFLOW
          SUMOUT = SUMOUT + FLORAT
          IF ( FLORAT .LE. 0.)
     &       CALL ERROR ( 1420   , SUBR, XDUMY, XDUMY1, XDUMY2,
     &                            XDUMY3 )
          LENGTH = WRLNG
          CREST  = WRHGT
*
*.... DETERMINE WITHDRAWAL LIMITS AND FLOW RATE PROFILES ....
*
          CALL VWEIR
*
*.... ASSIGN FLOW RATE PROFILE VALUES CALCULATED IN VWEIR TO AN
*     ARRAY ....
*
          DO 150 I = 1, ISURF
             VS(I,NOUTS) = V(I)
 150     CONTINUE
*
*.... ASSIGN WITHDRAWAL LIMIT VALUES TO ARRAY ....
*
          ZUP  ( NOUTS ) = HGTTOP
          ZDN  ( NOUTS ) = HGTLOW
          LTOP ( NOUTS ) = TOPLIM
          LLOW ( NOUTS ) = LOWLIM
```

OUTVEL

```
0151     160     CONTINUE
0152    *
0153    *.... IF MUTIPLE OUTLETS CALL SHIFT ....
0154    *
0155            IF ( NOUTS .GT. 1 ) CALL SHIFT
0156    *
0157    *.... DETERMINE TOTAL OUTFLOW FLOW RATE DISTRIBUTION ....
0158    *
0159            DO 180 I = 1, ISURF
0160            DO 170 J = 1, NOUTS
0161               VEL ( I ) = VEL ( I ) + VS ( I , J )
0162     170    CONTINUE
0163     180    CONTINUE
0164    *
0165    *.... FIND MAXIMUM LAYER FLOW RATE ....
0166    *
0167            VMAX = VEL ( LOWLIM )
0168            DO 185 I = 1, ISURF
0169               VMAX = AMAX1 ( VMAX, VEL ( I ) )
0170     185    CONTINUE
0171    *
0172    *.... ASSIGN LAYER FLOW RATES TO WTHDRW(I) ....
0173    *
0174            DO 190 I = 1, ISURF
0175               WTHDRW ( I ) = VEL ( I ) * HGT ( I )
0176     190    CONTINUE
0177            DO 200 I = 1, ISURF
0178               VEL ( I ) = VEL ( I ) / VMAX
0179     200    CONTINUE
0180    *
0181    *.... COMPUTE THE RELEASE DENSITY ....
0182    *
0183            SUMDF = 0.
0184            DO 210 I = 1, ISURF
0185               SUMDF = SUMDF + DEN ( I ) * WTHDRW ( I )
0186     210    CONTINUE
0187            DENOUT = SUMDF / SUMOUT
0188    *
0189    *.... COMPUTE RELEASE TEMPERATURE ....
0190    *
0191            IF ( .NOT. QTEMP ) GO TO 230
0192            SUMTF = 0.
0193            DO 220 I = 1, ISURF
0194               SUMTF = SUMTF + TEMP ( I ) * WTHDRW ( I )
0195     220    CONTINUE
0196            TEMOUT = SUMTF / SUMOUT
0197     230    CONTINUE
0198    *
0199    *.... COMPUTE RELEASE QUALITIES ....
0200    *
```

OUTVEL

```
0201              IF ( NQUAL .EQ. 0 ) GO TO 260
0202              DO 250 J = 1, NQUAL
0203                 SUMQF = 0.
0204                 DO 240 I = 1, ISURF
0205                    SUMQF = SUMQF + QUAL(J,I) * WTHDRW ( I )
0206        240      CONTINUE
0207                 QALOUT ( J ) = SUMQF / SUMOUT
0208        250      CONTINUE
0209        260      CONTINUE
0210              RETURN
0211              END
```

SHIFT

```
0001              SUBROUTINE SHIFT
0002     ******************************************************************
0003     *                                                                *
0004     *        S U B R O U T I N E   S H I F T                         *
0005     *                                                                *
0006     ******************************************************************
0007     *
0008     *.... THIS SUBROUTINE SHIFTS THE INNER WITHDRAWAL LIMITS WHEN TWO
0009     *     WITHDRAWAL ZONES OVERLAP ....
0010     *
0011              COMMON / AA / QMETR, NSETS, G, HEADING(18), TITLE(18)
0012              COMMON / BB / IFILE, KFILE
0013              COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0014              COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0015              COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0016              COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0017              COMMON / HH / WRLNG, WRHGT, WRFLOW
0018              COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0019              COMMON / MM / SUMOUT, VEL(100), FLORAT
0020              COMMON / NN / HGTPRT, VDIM  , QTLIM, QBLIM, QSINK1,
0021         &                  QSINK2, QSHIFT
0022              COMMON / OO / LENGTH, CREST, HDIM
0023              COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0024              COMMON / QQ / VS (100,6), NOUTS
0025              COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0026     *
0027              LOGICAL QPORT , QWEIR , QSBLIM, QSTLIM, QBLIM,
0028         &            Q1    , Q2    , QTLIM
0029              LOGICAL QPRINT, QSINK1, QSINK2, QSHIFT
0030     *
0031              INTEGER TOPLIM, XXX
0032     *
0033              CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3
0034              CHARACTER*6 SUBR
0035     *
0036              DATA MAX                              / 10       /
0037              DATA TINY                             / 1.E-07   /
0038              DATA QPRINT                           / .TRUE.   /
0039              DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4*'0   ' /
0040              DATA SUBR                             / 'SHIFT'  /
0041     *
0042     *.... LAYER NO. LOCATION OF X ....
0043     *
0044              LAYER ( X ) = 1. + X / DELZ
0045              FROUD ( X, D, ZL ) = SQRT ( G * ABS ( 1. -
0046         &                    DENINT ( X ) / D ) * ABS ( X - ZL ) )
0047     *
0048     *.... BASED ON BOHAN AND GRACE ....
0049     *
0050              FSHIFT ( VH, X, D, ZL ) = VH - HTEST * FROUD ( X, D, ZL)
```

SHIFT

```
0051    *
0052    *.... TOLERANCE, 10% OF THE LAYER THICKNESS ....
0053    *
0054              SMALL = .10 * DELZ
0055    *
0056    *.... INITIALIZE LOGICAL VARIABLE ....
0057    *
0058              QSTLIM = .FALSE.
0059              QSBLIM = .FALSE.
0060              QBLIM  = .FALSE.
0061              QTLIM  = .FALSE.
0062              QSHIFT = .FALSE.
0063    *
0064    *.... CHECK FOR OVERLAP OF WITHDRAWAL ZONES. IS LOWER LIMIT OF
0065    *     UPPER PORT BELOW UPPER LIMIT OF LOWER PORT ....
0066    *
0067              NMINUS = NOUTS - 1
0068              DO 260 K = 1, NMINUS
0069              H = ZDN ( K + 1 ) - ZUP ( K )
0070              IF ( H .GE. 0. ) GO TO 260
0071    *
0072    *.... SET UP PARAMETERS FOR SHIFTING LIMITS ....
0073    *
0074              H  = ABS ( H )
0075              IF ( QWEIR .AND. K .EQ. NOUTS - 1 ) GO TO 100
0076              HO = PHGT ( K + 1 ) - PHGT ( K )
0077              GO TO 110
0078     100      CONTINUE
0079    *
0080    *.... ZONES FROM WEIR AND A PORT OVERLAP ....
0081    *
0082              HO    = CREST - PHGT(K)
0083     110      CONTINUE
0084              HTEST = .7 * ( H / HO ) ** 1.25
0085              VH1   = 0.
0086              VH2   = 0.
0087    *
0088    *.... K + 1 IS THE UPPER PORT, K IS THE LOWER PORT ....
0089    *
0090              L1 = LLOW ( K + 1 )
0091              L2 = LTOP ( K     )
0092    *
0093    *.... NUMBER OF LAYERS BETWEEN OVERLAPPING LIMITS, INCLUSIVE ....
0094    *
0095              LAY = L2 - L1 + 1
0096              DO 120 I = L1, L2
0097    *
0098    *.... DETERMINE AVERAGE VELOCITY IN OVERLAPPING REGION ....
0099    *
0100              VH1 = VH1 + VS ( I , K     )
```

SHIFT

```
0101              VH2 = VH2 + VS ( I , K + 1 )
0102      120     CONTINUE
0103              VH1 = VH1 / LAY
0104              VH2 = VH2 / LAY
0105     *
0106     *.... CALCULATE DENSITIES AT LIMITS ....
0107     *
0108              DENS2 = DENINT ( ZUP ( K     ) )
0109              DENS1 = DENINT ( ZDN ( K + 1 ) )
0110     *
0111     *.... LIMIT VARIABLES REASSIGNED ....
0112     *
0113              ZL2 = ZUP ( K     )
0114              ZL1 = ZDN ( K + 1 )
0115     *
0116     *.... CHECK FOR INTERFERENCE FROM SURFACE OR BOTTOM ....
0117     *
0118              QSTLIM = FSHIFT ( VH1, DEPTH, DENS2, ZL2 ) .GE. 0.
0119              QSBLIM = FSHIFT ( VH2, 0., DENS1, ZL1 ) .GE. 0.
0120              IF ( .NOT. QSTLIM ) GO TO 125
0121     *
0122     *.... SOLVE FOR THE SHIFTED LIMIT ....
0123     *
0124     *.... CHECK FIRST FOR DENSITY DIFFERENCE
0125     *     BETWEEN THE PORT AND THE SURFACE ....
0126     *
0127              IF ( ABS ( DEN ( ISURF ) - DENINT ( PHGT ( K ) ) ) .GT.
0128          &               TINY ) GO TO 125
0129              ZUP ( K ) = DEPTH
0130              GO TO 175
0131      125     CONTINUE
0132     *
0133     *.... DETERMINE FUNCTION SIGN AT EACH SEARCH LIMIT AND ORIGINAL
0134     *     UPPER LIMIT OF LOWER PROFILE IF THE FUNCTION SIGN IS
0135     *     POSITIVE , ASSUMED AMOUNT OF SHIFT IS LESS THAN ACTUAL
0136     *     AMOUNT OF SHIFT; IF FUNCTION SIGN IS NEGATIVE, ASSUMED AMOUNT
0137     *     OF SHIFT IS GREATER THAN ACTUAL AMOUNT OF SHIFT ....
0138     *
0139              KOUNT = 0
0140              X1 = DEPTH
0141      130     CONTINUE
0142              KOUNT = KOUNT + 1
0143              IF ( KOUNT .GE. 5 ) GO TO 135
0144              X2 = ZUP ( K )
0145              F2 = FSHIFT ( VH1, X2, DENS2, ZL2 )
0146              Q2 = F2 .GT. 0.
0147              X1 = X1 * 2.0
0148              F1 = FSHIFT ( VH1, X1, DENS2, ZL2 )
0149              Q1 = F1 .GE. 0.
0150              X3 = -2. * SMALL
```

SHIFT

```
0151    *
0152    *.... FUNCTION SIGN MUST BE POSITIVE AT THE ORIGINAL LIMIT AND
0153    *     NEGATIVE AT THE NEW LIMIT, ELSE CHOOSE NEW LIMIT, X1,
0154    *     2 TIMES GREATER ....
0155    *
0156             IF ( Q1 .OR. .NOT. Q2 ) GO TO 130
0157             ASSIGN 170 TO XXX
0158             GO TO 140
0159     135     CONTINUE
0160    *
0161    *.... IF THEORETICAL SHIFTED UPPER LIMIT IS NOT FOUND, IT IS
0162    *     ASSIGNED TO 2 * DEPTH AND NOTED IN THE OUTPUT ....
0163    *
0164             IF ( QPRINT ) WRITE ( KFILE, 500 )
0165             QPRINT= .FALSE.
0166             WRITE ( KFILE, 505 ) K
0167             WRITE ( KFILE, 510 )
0168             X3 = 2 * DEPTH
0169             GO TO 170
0170     140     CONTINUE
0171    *
0172    *.... INITIATE ITERATION PROCESS ....
0173    *
0174             DO 160 I = 1, MAX
0175    *
0176    *.... ESTABLISH A THIRD POINT BETWEEN TWO EXISTING POINTS ....
0177    *
0178             X4 = X3
0179             X3 = ( X1 + X2 ) / 2.
0180    *
0181    *.... CALCULATE FUNCTION SIGN AT NEW ELEVATION ....
0182    *
0183             F3 = FSHIFT ( VH1, X3, DENS2, ZL2 )
0184    *
0185    *.... IF NEW POINT IS THE SAME AS THE PREVIOUS POINT, THEN SEARCH
0186    *     IS COMPLETE ....
0187    *
0188             IF ( ABS ( X4 - X3 ) .LT. SMALL ) GO TO XXX, ( 170, 200 )
0189    *
0190    *.... USE AS NEW SEARCH LIMITS THE MOST RECENTLY COMPUTED POINT
0191    *     AND THE REMAINING POINT OF OPPOSITE SIGN ....
0192    *
0193             IF ( F1 * F3 .GT. 0. ) GO TO 150
0194             X2 = X3
0195             F2 = F3
0196             GO TO 160
0197     150     CONTINUE
0198             X1 = X3
0199             F1 = F3
0200     160     CONTINUE
```

SHIFT

```
0201    *
0202    *.... CONVERGENCE HAS NOT BEEN REACHED ....
0203    *
0204              CALL ERROR ( 1800, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3 )
0205     170      CONTINUE
0206    *
0207    *.... SET UP SHIFTED UPPER LIMIT OF LOWER PROFILE ....
0208    *
0209              ZUP ( K ) = X3
0210     175      CONTINUE
0211              IF ( .NOT. QSBLIM ) GO TO 180
0212    *
0213    *.... CHECK DENSITY STRUCTURE FOR LOWER LIMIT OF UPPER PORT ....
0214    *
0215              IF ( ABS ( DEN ( 1 ) - DENINT ( PHGT ( K + 1 ) ) )
0216         &                .GT. TINY ) GO TO 180
0217              ZDN( K + 1 ) = 0.
0218              GO TO 210
0219     180      CONTINUE
0220    *
0221    *.... DETERMINE FUNCTION SIGN AT SEARCH LIMITS (1) BOTTOM
0222    *     (2) ORIGINAL LOWER LIMIT OF UPPER PROFILE ....
0223    *
0224              X1 = - DEPTH / 2.
0225              KOUNT = 0
0226     185      CONTINUE
0227              KOUNT = KOUNT + 1
0228              IF ( KOUNT .GE. 5 ) GO TO 190
0229              X1 = X1 * 2.0
0230              F1 = FSHIFT ( VH2, X1, DENS1, ZL1 )
0231              Q1 = F1 .GE. 0.
0232              X2 = ZDN(K + 1)
0233              F2 = FSHIFT ( VH2, X2, DENS1, ZL1 )
0234              Q2 = F2 .GT. 0.
0235    *
0236    *.... FUNCTION VALUE MUST BE NEGATIVE AT BOTTOM AND POSITIVE AT
0237    *     ORIGINAL LIMIT ....
0238    *
0239              IF ( Q1 .OR. .NOT. Q2 ) GO TO 185
0240    *
0241    *.... IF LIMIT IS IN POOL, USE PRIOR SEARCH PROCEDURE ....
0242    *
0243              ASSIGN 200 TO XXX
0244              GO TO 140
0245     190      CONTINUE
0246    *
0247    *.... IF LIMIT IS OUTSIDE THE POOL, ASSIGN IT TO DEPTH ....
0248    *
0249              WRITE ( KFILE, 520 )
0250              X3 = - DEPTH
```

SHIFT

```
0251     200     CONTINUE
0252    *
0253    *.... SET SHIFTED LOWER LIMIT OF UPPER PROFILE ....
0254    *
0255            ZDN ( K + 1 ) = X3
0256     210    CONTINUE
0257    *
0258    *.... COMPUTE NEW NORMALIZED VELOCITIES AND LAYER FLOW RATES FOR
0259    *     LOWER HALF OF PROFILE ....
0260    *
0261    *.... ASSIGN LIMITS TO VARIABLES ....
0262    *
0263            HGTLOW = ZDN   ( K      )
0264            LOWLIM = LAYER ( HGTLOW )
0265            HGTTOP = ZUP   ( K      )
0266            TOPLIM = LAYER ( HGTTOP )
0267            HGTPRT = PHGT  ( K      )
0268            FLORAT = FLOW  ( K      )
0269            QBLIM  = ZDN   ( K      ) .LE. 0.
0270            IF ( QSTLIM ) QTLIM = .TRUE.
0271    *
0272    *.... CALL VPORT TO RECALCULATE VELOCITIES ....
0273    *
0274            QSHIFT = .TRUE.
0275            CALL VPORT
0276    *
0277            QSHIFT   = .FALSE.
0278            DO 220 I = 1, ISURF
0279            VS ( I , K ) = V ( I )
0280     220    CONTINUE
0281    *
0282    *.... COMPUTE NEW NORMALIZED VELOCITIES AND LAYER FLOW RATES FOR
0283    *     THE UPPER HALF OF THE PROFILE ....
0284    *
0285    *.... ASSIGN LIMITS TO VARIABLES ....
0286    *
0287            HGTLOW = ZDN   ( K + 1  )
0288            LOWLIM = LAYER ( HGTLOW )
0289            HGTTOP = ZUP   ( K + 1  )
0290            TOPLIM = LAYER ( HGTTOP )
0291            IF ( QWEIR .AND. K .EQ. NOUTS - 1 ) GO TO 230
0292            HGTPRT = PHGT  ( K + 1  )
0293            FLORAT = FLOW  ( K + 1  )
0294            QTLIM  = ZUP   ( K + 1  ) .GE. DEPTH
0295            IF ( QSBLIM ) QBLIM = .TRUE.
0296            QSHIFT = .TRUE.
0297    *
0298    *.... CALL VPORT TO RECALCULATE VELOCITIES ....
0299    *
0300            CALL VPORT
```

SHIFT

```
0301    *
0302              QSHIFT = .FALSE.
0303              GO TO 240
0304     230      CONTINUE
0305    *
0306    *.... ASSIGN WEIR INFO TO VARIABLES ....
0307    *
0308              CREST  = WRHGT
0309              LENGTH = WRLNG
0310              FLORAT = WRFLOW
0311              QTLIM  = .TRUE.
0312              IF ( QSBLIM ) QBLIM = .TRUE.
0313              QSHIFT = .TRUE.
0314    *
0315    *.... CALL VWEIR TO CALCULATE VELOCITIES ....
0316    *
0317    *.... CALL VWEIR ....
0318    *
0319              QSHIFT = .FALSE.
0320     240      CONTINUE
0321              DO 250 I = 1, ISURF
0322                 VS ( I , K + 1 ) = V ( I )
0323     250      CONTINUE
0324     260      CONTINUE
0325     500      FORMAT ( 1H1 )
0326     510      FORMAT ( // , 5X, 29H*** THEORITICAL SHIFTED UPPER,
0327         &             43H LIMIT NOT FOUND. ASSIGNED TO 2 * DEPTH ***)
0328     520      FORMAT ( // , 5X, 29H*** THEORETICAL SHIFTED LOWER,
0329         &                 41H LIMIT NOT FOUND. ASSIGNED TO - DEPTH ***)
0330     505      FORMAT ( // , 5X, 35H*** LOWER PORT FOR THIS CASE IS NO.,
0331         &              I5, 5H  ***)
0332              RETURN
0333              END
```

VENTING

```
0001              SUBROUTINE VENTING
0002     ********************************************************************
0003     *                                                                  *
0004     *         S U B R O U T I N E    V E N T I N G                     *
0005     *                                                                  *
0006     ********************************************************************
0007     *
0008     *....  PREDICTS RESEASE D.O. BASED ON A MAXIMUM 30% REDUCTION
0009     *      IN D.O. DEFICIT ....
0010     *
0011               COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0012               COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0013               COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0014     *
0015               LOGICAL QVENT, QAERA, QTWFUN
0016     *
0017     *....  D.O. SATURATION ....
0018     *
0019               DOSAT ( X ) = 1 / ( 0.00209 * X + 0.06719 )
0020     *
0021     *....  ALTITUDE CORRECTION FACTOR ....
0022     *
0023               BARO( X ) = 1.0 - 3.224 E-5 * X
0024     *
0025     *....  OXYGEN SATURATION CONCENTRATION ADJUSTED FOR ALTITUDE ....
0026     *
0027               ALT = BOTTOM
0028               CSAT = DOSAT ( TEMOUT ) * BARO ( ALT )
0029     *
0030     *....  DEFICIT CALCULATIONS; DI = INITIAL DEFICIT,
0031     *      DF = FINAL DEFICIT ....
0032     *
0033               DI = CSAT - QALOUT ( 1 )
0034               DF = 0.70 * DI
0035               QALOUT ( 1 ) = CSAT - DF
0036               RETURN
0037               END
```

VPORT

```
0001              SUBROUTINE VPORT
0002    ***********************************************************************
0003    *                                                                     *
0004    *        S U B R O U T I N E   V P O R T                              *
0005    *                                                                     *
0006    ***********************************************************************
0007    *
0008    *.... CALCULATE WITHDRAWAL LIMITS AND VELOCITY PROFILE FOR
0009    *     AN ORIFICE ....
0010    *
0011              COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0012              COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013              COMMON / DD / WTHETA (5), WANGLE
0014              COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0015              COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0016              COMMON / MM / SUMOUT, VEL (100), FLORAT
0017              COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0018         &                  QSINK2, QSHIFT
0019              COMMON / OO / LENGTH, CREST, HDIM
0020              COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0021    *
0022              LOGICAL  QBLIM, QTLIM, QMETR, QSINK1, QSINK2, QSHIFT
0023    *
0024              INTEGER XXX , TOPLIM
0025    *
0026              CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3
0027              CHARACTER*6 SUBR
0028    *
0029              DATA  MAX, VMAX, TINY               / 10, 1., 1.0E-08 /
0030              DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0   '       /
0031              DATA SUBR                           / 'VPORT'         /
0032    *
0033    *.... FUNCTION STATEMENTS TO SOLVE FOR ORIFICE WITHDRAWAL LIMITS
0034    *     FOR INTERMEDIATE FLOW CONDITIONS ....
0035    *
0036              LAYER    ( X ) = 1. + X / DELZ
0037              ZEE      ( X ) = ABS ( HGTPRT - X )
0038              FROUD    ( X ) = SQRT ( G * ABS ( 1. - DENINT ( X )
0039         &                     / DENPRT ) )
0040    *
0041    *.... COMPUTE THE DIFFERENCE BETWEEN THE FLOW 'ENERGY' AND THE
0042    *     ENERGY EXPENDED BASED ON BOHAN AND GRACE (1969), MODIFIED
0043    *     TO INCLUDE WITHDRAWAL ANGLE CONCEPTS ....
0044    *
0045              QBNG     ( X ) = FLORAT / PHIFRAC - C2 * FROUD ( X )
0046         &                     * ZEE ( X ) ** 2.5
0047    *
0048    *.... FUNCTION STATEMENTS TO SOLVE FOR THE UNBOUNDED WITHDRAWAL
0049    *     LIMIT WHEN THERE IS BOTTOM OR SURFACE INTERFERENCE ....
0050    *
```

VPORT

```
0051              DPRIME  ( X ) = ABS ( BONLIM - X )
0052              BDRATIO ( X ) = SMALLB / DPRIME ( X ) /
0053         &                    ( 1 - SMALLB / DPRIME ( X ) )
0054              FROUDE  ( X ) = SQRT ( G * ABS ( 1. - DENINT ( X )
0055         &                    / DENPRT ) / ZEE ( X ) )
0056              CHI     ( X ) = 1. / 2. * ( 1. + BDRATIO ( X ) )
0057              PHI     ( X ) = 1. / 2. * ( 1 + 1 / PI
0058         &                    * SIN ( BDRATIO ( X ) * PI ) +
0059         &                    BDRATIO ( X ) )
0060     *
0061     *.... COMPUTE THE DIFFERENCE BETWEEN THE FLOW 'ENERGY' AND THE
0062     *     'ENERGY' EXPENDED BASED ON SMITH, ET AL (1985), EQN 36 ....
0063     *
0064              QSMITH  ( X ) = FLORAT - C2 *  FROUDE ( X ) * PHI ( X )
0065         &                    / ( 2.0 * CHI ( X ) ) ** 3
0066         &                    * DPRIME ( X ) ** 3
0067     *
0068     *.... TOLERANCE, 10% OF LAYER THICKNESS ....
0069     *
0070              SMALL = .10 * DELZ
0071     *
0072     *....  INITIALIZE LOGICAL VARIABLES ....
0073     *
0074              QSINK1 = .TRUE.
0075              QSINK2 = .TRUE.
0076              QSHIFT = .FALSE.
0077     *
0078     *....  SET THE VALUE  OF THE ANGLE OF WITHDRAWAL COEFFICIENT
0079     *      FOR THE BOUNDARY INTERFERENCE EQUATION ....
0080     *
0081     *.... CHECK TO SEE IF ENTERING FROM SUBROUTINE SHIFT ....
0082     *
0083              IF ( QSHIFT ) GO TO 185
0084              PI      = 3.14159
0085              C2      = WANGLE / PI
0086              PHIFRAC = 1.0
0087     *
0088     *.... CHECK FOR BOUNDARY INTERFERENCE FROM SURFACE OR BOTTOM
0089     *     USING INTERMEDIATE FLOW EQUATION ....
0090     *
0091              DENBOT = DENINT ( 0.    )
0092              DENUPP = DENINT ( DEPTH )
0093              IF ( HGTPRT .GT. 0.0 ) THEN
0094                   QBLIM  = QBNG   ( 0.    ) .GE. 0.
0095              ELSE
0096                   QBLIM  = .TRUE.
0097              ENDIF
0098              QTLIM  = QBNG   ( DEPTH ) .GE. 0.
0099     *
0100     *.... DIRECT COMPUTATIONS BASED ON INTERFERENCE
```

VPORT

```
0101    *     CHARACTERISTICS ....
0102    *
0103             IF ( QTLIM .AND. QBLIM             ) GO TO 540
0104             IF ( QTLIM                         ) GO TO 500
0105             IF ( QBLIM                         ) GO TO 510
0106             IF ( .NOT. QTLIM .AND. .NOT. QBLIM ) GO TO 540
0107     500     CONTINUE
0108    *
0109    *....  IF ONLY ONE  BOUNDARY EXPERIENCES INTERFERENCE, FIND THE
0110    *      HEIGHT OF WITHDRAWAL USING SMITH, 1987 ....
0111    *
0112    *.... DETERMINE THE HEIGHT OF THE TRUNCATED PORTION, THE BOUNDARY
0113    *     LIMIT, THE SEARCH INTERVAL LIMITS, AND THE FUNCTION SIGN AT
0114    *     THE SEARCH LIMITS ....
0115    *
0116    *.... SURFACE INTERFERENCE ....
0117    *
0118             SMALLB = DEPTH - HGTPRT
0119             DENLIM = DENUPP
0120             BONLIM = DEPTH
0121             X1     = 0.
0122             X2     = DEPTH
0123             H1     = QSMITH ( X1 )
0124             GO TO 530
0125     510     CONTINUE
0126    *
0127    *.... BOTTOM INTERFERENCE ....
0128    *
0129             SMALLB = HGTPRT
0130             DENLIM = DENBOT
0131             BONLIM = 0.
0132             X1     = 0.
0133             X2     = DEPTH
0134             H1     = 1.
0135     530     CONTINUE
0136    *
0137    *.... FIND THE LIMIT USING A HALF-INTERVAL SEARCH ....
0138    *
0139    *.... INITIALIZE X3 ....
0140    *
0141             X3 = SMALL
0142    *
0143    *.... BEGIN ITERATION ....
0144    *
0145             DO 560 I = 1, 2 * MAX
0146                X4 = X3
0147    *
0148    *.... ESTABLISH A THIRD POINT BETWEEN TWO EXISTING POINTS ....
0149    *
0150                X3 = ( X1 + X2 ) / 2.0
```

VPORT

```
0151    *
0152    *.... CALCULATE FUNCTION SIGN AT NEW POINT ....
0153    *
0154                H3 = QSMITH ( X3 )
0155                ZONED = ABS ( BONLIM - X3 )
0156    *
0157    *.... IF NEW POINT IS SAME AS PREVIOUS POINT (WITHIN TOLERANCE),
0158    *     ITERATION IS COMPLETE ....
0159    *
0160                IF ( ABS ( X4 - X3 ) .LT. SMALL ) GO TO 570
0161    *
0162    *.... USE AS NEW SEARCH LIMITS THE MOST RECENT POINT AND THE
0163    *     REMAINING POINT OF OPPOSITE FUNCTION SIGN ....
0164    *
0165                IF ( H1 * H3  .LT. 0. ) GO TO 535
0166                X1 = X3
0167                H1 = H3
0168                GO TO 560
0169     535        CONTINUE
0170                X2 = X3
0171     560      CONTINUE
0172    *
0173    *.... CONVERGENCE WAS NOT REACHED ....
0174    *
0175              CALL ERROR ( 1500, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3 )
0176     570      CONTINUE
0177              PHIFRAC = PHI ( X3 )
0178    *
0179    *....  CALCULATE WITHDRAWAL LIMIT ....
0180    *
0181              IF ( QTLIM .AND. .NOT. QBLIM ) HGTLOW = DEPTH - ZONED
0182              IF ( QBLIM .AND. .NOT. QTLIM ) HGTTOP = ZONED
0183     540    CONTINUE
0184    *
0185    *.... USAGE FOR THE BOHAN AND GRACE EQUATION
0186    *     1. NO BOUNDARY INTERFERENCE
0187    *     2. BOTH BOUNDARIES INTERFERE WITH WITHDRAWAL ZONE
0188    *     3. SINGLE BOUNDARY INTERFERENCE.  THEORETICAL LIMIT
0189    *        OF ONE INTERFERED WITH MUST BE DETERMINED
0190    *        (FREE LIMIT IS DETERMINED ABOVE WITH SMITH EQUATION) ....
0191    *
0192              IF ( QTLIM .AND. .NOT. QBLIM  ) GO TO 150
0193    *
0194    *.... EMBARK ON DETERMINATION OF LOWER WITHDRAWAL LIMIT ....
0195    *
0196    *
0197    *.... IF LOWER LIMIT IS WITHIN THE POOL THEN FIND IT WITH A
0198    *     HALF-INTERVAL SEARCH ....
0199    *
0200    *.... INITIAL SEARCH LIMITS ARE X1 =0 AND X2 = HGTPRT ....
```

```
0201    *
0202              X1 = 0.0
0203    *
0204    *.... IF BOTTOM BOUNDARY INTERFERENCE EXISTS (LOWER LIMIT OUTSIDE
0205    *     POOL), THEN X1 = - DEPTH ....
0206    *
0207              IF ( QBLIM ) X1 = - DEPTH
0208              F1 = QBNG ( X1 )
0209              DENLIM = DENBOT
0210              X2 = HGTPRT
0211              X3 = -2. * SMALL
0212              ASSIGN 140 TO XXX
0213     110      CONTINUE
0214    *
0215    *.... INITIATE ITERATION PROCESS ....
0216    *
0217              DO 130 I = 1, MAX
0218    *
0219    *.... ESTABLISH A THIRD POINT BETWEEN THE TWO EXISTING POINTS ....
0220    *
0221                 X4 = X3
0222                 X3 = ( X1 + X2 ) / 2.
0223    *
0224    *.... CALCULATE FUNCTION SIGN AT NEW ELEVATION ....
0225    *
0226                 DENLIM = DENINT ( X3 )
0227                 IF (  DENLIM .EQ. DENPRT ) GO TO XXX
0228                 F3 = QBNG ( X3 )
0229    *
0230    *....  IF NEW POINT IS SAME AS PREVIOUS POINT (WITHIN TOLERANCE)
0231    *      THEN SEARCH IS COMPLETE ....
0232    *
0233                 IF ( ABS ( X4 - X3 ) .LT. SMALL )
0234         &            GO TO XXX, ( 140, 170 )
0235    *
0236    *.... USE AS NEW SEARCH LIMITS THE MOST RECENTLY COMPUTED POINT AND
0237    *     THE REMAINING POINT OF OPPOSITE SIGN
0238    *
0239                 IF ( F1 * F3 .GT. 0. ) GO TO 120
0240                 X2 = X3
0241                 GO TO 130
0242     120         CONTINUE
0243                 X1 = X3
0244                 F1 = F3
0245     130      CONTINUE
0246    *
0247    *.... CONVERGENCE HAS NOT BEEN REACHED ....
0248    *
0249              CALL ERROR ( 1510, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3 )
0250     140      CONTINUE
```

VPORT

```
0251    *
0252    *.... SET LOWER LIMIT ELEVATION ....
0253    *
0254              HGTLOW = X3
0255     150      CONTINUE
0256              IF ( QBLIM .AND. .NOT. QTLIM ) GO TO 180
0257    *
0258    *.... APPLY SAME PROCEDURE FOR DETERMINING UPPER WITHDRAWAL LIMIT
0259    *     FOR ORIFICE
0260    *
0261    *.... DETERMINE ELEVATION, LAYER AND FUNCTION SIGN AT SEARCH
0262    *     LIMITS.  IF NIETHER LIMIT EXPERIENCES INTERFERENCE THE THE
0263    *     INITIAL SEARCH LIMITS ARE X1 = HGTPRT AND X2 = DEPTH.
0264    *     HOWEVER, IF SURFACE INTERFERENCE EXISTS ( UPPER LIMIT OUTSIDE
0265    *     POOL ), THEN X2 = 2. * DEPTH ....
0266    *
0267              X1 = HGTPRT
0268              X2 = DEPTH
0269              IF ( QTLIM )  X2 = 2 * DEPTH
0270              F1 = QBNG ( X1 )
0271    *
0272    *.... USE THE PRIOR SEARCH PROCEDURE ....
0273    *
0274              ASSIGN 170 TO XXX
0275              DENLIM = DENUPP
0276              GO TO 110
0277     170      CONTINUE
0278              HGTTOP = X3
0279     180      CONTINUE
0280    *
0281    *.... CALCULATE LOCATION OF MAXIMUM VELOCITY AND THICKNESS OF
0282    *     WITHDRAWAL LIMITS ....
0283    *
0284     185      CONTINUE
0285              ZONE = HGTTOP - HGTLOW
0286              ZTOP = HGTTOP - HGTPRT
0287              ZLOW = HGTPRT - HGTLOW
0288    *
0289    *.... BASED ON BOHAN AND GRACE
0290    *
0291              YVMAX = ZONE * ( SIN ( 1.57 * ZLOW / ZONE ) ) ** 2
0292    *          YVMAX = HGTPRT
0293    *
0294    *.... HEIGHT ABOVE BOTTOM.  HARDWIRE TO PREVENT MAX VELOCITY
0295    *     OUTSIDE THE POOL (HOWINGTON 9-25-91) ....
0296    *
0297              XVMAX = YVMAX + HGTLOW
0298              IF ( XVMAX .LT. 0.0    ) XVMAX = 0.0
0299              IF ( XVMAX .GT. DEPTH ) XVMAX = DEPTH
0300              LVMAX = LAYER ( XVMAX )
```

VPORT

```
0301    *
0302    *.... MAXIMUM VELOCITY OUTSIDE THE POOL ....
0303    *
0304              IF ( ( XVMAX .LT. 0. ) .OR. ( XVMAX .GT. DEPTH ) )
0305         &        CALL ERROR ( 1520  , SUBR, XDUMY, XDUMY1, XDUMY2,
0306         &                     XDUMY3 )
0307    *
0308    *.... ASSIGN DENSITIES AT LIMITS AND MAXIMUM VELOCITY ....
0309    *
0310              DVMAX  = DENINT ( XVMAX  )
0311              DENLOW = DENINT ( HGTLOW )
0312              DENTOP = DENINT ( HGTTOP )
0313    *
0314    *.... WITHDRAWAL LAYER LIMITS ....
0315    *
0316              IF ( HGTLOW .LT. 0.    ) LOWLIM = LAYER ( 0.     )
0317              IF ( HGTLOW .GE. 0.    ) LOWLIM = LAYER ( HGTLOW )
0318              IF ( HGTTOP .GE. DEPTH ) TOPLIM = ISURF
0319              IF ( HGTTOP .LT. DEPTH ) TOPLIM = LAYER ( HGTTOP )
0320    *
0321    *.... ZERO THE VELOCITY PROFILE FOR THE CURRENT PORT ....
0322    *
0323              DO 190 I = 1, ISURF
0324                 V ( I ) = 0.
0325     190      CONTINUE
0326    *
0327    *.... IF LOWER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0328    *     ASSIGN CONSTANT VELOCITY TO EACH LAYER ....
0329    *
0330              DENDIF = DENLOW - DVMAX
0331              IF ( DENDIF .GT. 0. ) GO TO 210
0332              DO 200 I = LOWLIM, LVMAX
0333                 V ( I ) = VMAX
0334     200      CONTINUE
0335              GO TO 240
0336     210      CONTINUE
0337    *
0338    *.... CALCULATE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0339    *     TO LOWER LIMIT ....
0340    *
0341              IF ( LOWLIM .EQ. LVMAX ) GO TO 240
0342              DO 230 I = LOWLIM, LVMAX
0343                 Y1 = DELZ * ( LVMAX - I )
0344                 DELDEN = DEN ( I ) - DVMAX
0345    *
0346    *.... BASED ON BOHAN AND GRACE ....
0347    *
0348                 RATIO = Y1 * DELDEN / ( ZLOW * DENDIF )
0349                 RATIO = AMIN1 ( 1., RATIO )
0350                 V(I) = VMAX * ( 1. - RATIO ) ** 2.0
```

VPORT

```
0351     230     CONTINUE
0352     240     CONTINUE
0353    *
0354    *.... IF UPPER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0355    *     ASSIGN CONSTANT VELOCITY TO EACH LAYER ....
0356    *
0357            DENDIF = DVMAX - DENTOP
0358            IF ( DENDIF .GT. 0. ) GO TO 260
0359            DO 250 I = LVMAX, TOPLIM
0360               V ( I ) = VMAX
0361     250    CONTINUE
0362            GO TO 290
0363     260    CONTINUE
0364    *
0365    *.... DETERMINE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0366    *     TO UPPER LIMIT ....
0367    *
0368            IF ( LVMAX .EQ. TOPLIM ) GO TO 290
0369            DO 280 I = LVMAX, TOPLIM
0370               Y1 = DELZ * ( I - LVMAX )
0371               DELDEN = DVMAX - DEN ( I )
0372    *
0373    *.... BASED ON BOHAN AND GRACE ....
0374    *
0375               RATIO = Y1 * DELDEN / ( ZTOP * DENDIF )
0376               RATIO = AMIN1 ( 1., RATIO )
0377               V(I) = VMAX * ( 1. - RATIO ) ** 2.0
0378     280    CONTINUE
0379     290    CONTINUE
0380    *
0381    *.... CONVERT NORMALIZED VELOCITIES TO FLOW RATES, I.E., DETERMINE
0382    *     THE WITHDRAWAL FROM EACH LAYER ....
0383    *
0384            SUM = 0.0
0385            DO 310 I = LOWLIM, TOPLIM
0386               SUM = SUM + V ( I ) *  HGT ( I )
0387     310    CONTINUE
0388            VM = FLORAT / SUM
0389            DO 320 I = LOWLIM, TOPLIM
0390               V ( I ) = V ( I ) * VM
0391     320    CONTINUE
0392    *
0393    *.... CHECK FOR POINT SINK DESCRIPTION ....
0394    *
0395            VDIM2 = VDIM / 2.
0396            PRTTOP = HGTPRT + VDIM2
0397            VD2 = VDIM2
0398            IF ( PRTTOP .GT. DEPTH ) VD2 = DEPTH - HGTPRT
0399            IF ( PRTTOP .GT. DEPTH ) PRTTOP = DEPTH
0400            PRTBOT = HGTPRT - VDIM2
```

VPORT

```
0401              IF ( PRTBOT .LT. 0. .AND. PRTBOT .GT. -.1 ) PRTBOT = 0.
0402              DRPTOP = DENPRT - DENINT ( PRTTOP )
0403              DRPBOT = DENINT ( PRTBOT ) - DENPRT
0404     *
0405              DRTLIM = DENPRT - DENTOP
0406              DRBLIM = DENLOW - DENPRT
0407     *
0408              IF ( DRPBOT .LT. TINY ) DRPBOT = TINY
0409              IF ( DRPTOP .LT. TINY ) DRPTOP = TINY
0410              IF ( DRBLIM .LT. TINY ) DRBLIM = TINY
0411              IF ( DRTLIM .LT. TINY ) DRTLIM = TINY
0412              IF ( VDIM2  .LT. TINY ) VDIM2  = TINY
0413              IF ( VD2    .LT. TINY ) VD2    = TINY
0414     *
0415     *.... EMPIRICAL EQUATIONS FOR POINT SINK VERIFICATION ....
0416     *
0417              SINK1  = ( DRBLIM ) * ZLOW / ( DRPBOT * VDIM2 )
0418              SINK2  = ( DRTLIM ) * ZTOP / ( DRPTOP * VD2 )
0419              QSINK1 = SINK1 .GT. 3.0
0420              QSINK2 = SINK2 .GT. 3.0
0421              RETURN
0422              END
```

VWEIR

```
0001              SUBROUTINE VWEIR
0002     ************************************************************************
0003     *                                                                      *
0004     *        S U B R O U T I N E   V W E I R                               *
0005     *                                                                      *
0006     ************************************************************************
0007     *
0008     *.... CALCULATE WITHDRAWAL LIMITS AND VELOCITY PROFILE FOR
0009     *     WEIR FLOW ....
0010     *
0011              COMMON / AA / QMETER, NSETS, G, HEADING(18), TITLE(18)
0012              COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013              COMMON / DD / WTHETA (5), WANGLE
0014              COMMON / GG / COEF, QSUB, QQUAL
0015              COMMON / II / NUMD, DEN (100), YD(100), QDEN, DENPRT
0016              COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0017              COMMON / MM / SUMOUT, VEL (100), FLORAT
0018              COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1, QSINK2,
0019         &                  QSHIFT
0020              COMMON / OO / LENGTH, CREST, HDIM
0021              COMMON / PP / LOWLIM, TOPLIM, HGTLOW, HGTTOP, V (100), VM
0022     *
0023              LOGICAL QSUB, QMETER, QSHIFT, QBLIM, QTLIM, Q1, Q2, QZ
0024     *
0025              REAL LENGTH
0026              INTEGER TOPLIM
0027     *
0028              CHARACTER*4 XDUMY, XDUMY1, XDUMY2, XDUMY3
0029              CHARACTER*6 SUBR
0030     *
0031              DATA A, B                              / 4.35 , -1.04 /
0032              DATA VMAX, ITMAX                       / 1.   , 10    /
0033              DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0   '   /
0034              DATA SUBR                              / 'VWEIR'      /
0035     *
0036              LAYER ( X ) = 1. + X/DELZ
0037     *
0038     *.... FUNCTION STATEMENTS TO SOLVE FOR LOWER WITHDRAWAL LIMITS ....
0039
0040     *
0041              SIZE   ( X ) = ABS  ( CREST - X )
0042              RWEIR  ( Z ) = SQRT ( Z + HEAD  ) * ( 1. + Z / HEAD )
0043              R2WEIR ( Z ) = SQRT ( Z + HEAD  )
0044     *
0045     *.... BASED ON DORTCH AND WILHELMS ....
0046     *
0047              FWEIR ( X ) = AVGVEL - C * RWEIR ( SIZE ( X ) ) *
0048         &                  SQRT ( G * ABS ( 1. - DENINT (X) / WRDEN ))
0049         &                  + D * R2WEIR ( SIZE(X) ) *
0050         &                  SQRT ( G * ABS ( 1. - DENINT(X) / WRDEN ) )
```

VWEIR

```
0051    *
0052    *.... TOLERANCE, 10% OF THE LAYER THICKNESS ....
0053    *
0054              SMALL = 0.10 * DELZ
0055    *
0056    *.... CHECK TO SEE IF ENTERING VWEIR FROM SUBROUTINE SHIFT ....
0057    *
0058              IF ( QSHIFT ) GO TO 145
0059              IF ( QSUB   ) GO TO 85
0060    *
0061    *.... CALCULATE EXPONENT FOR USE WITH FREE WEIR ....
0062    *
0063              EXPNT = A + B * COEF
0064              IF ( ABS ( COEF - 3.00 ) .LT. .01 ) EXPNT = 1.5
0065              IF ( ABS ( COEF - 3.33 ) .LT. .01 ) EXPNT = 0.5
0066              IF ( ABS ( COEF - 4.10 ) .LT. .01 ) EXPNT = 0.2
0067     85       CONTINUE
0068              C = .54
0069              D = 0.
0070              QZ = .FALSE.
0071    *
0072    *.... CALCULATE AVERAGE VELOCITY OVER THE WEIR IN FT/SEC ....
0073    *
0074              VMAX = 1.
0075              HEAD = DEPTH - CREST
0076              AVGVEL = FLORAT / ( HEAD * LENGTH )
0077    *
0078    *.... CHECK FOR INTERFERENCE FROM BOTTOM. ASSUMED SURFACE
0079    *     INTERFERENCE ....
0080    *
0081       90     CONTINUE
0082              WRDEN = DENINT ( CREST )
0083              QBLIM = FWEIR  ( 0.    ) .GE. 0.
0084              QTLIM = .TRUE.
0085    *
0086    *.... EMBARK ON DETERMINATION OF LOWER WITHDRAWAL LIMIT ....
0087    *
0088              IF ( .NOT. QBLIM ) GO TO 100
0089    *
0090    *.... IF BOTTOM INTERFERENCE EXISTS THEN SET LOWER LIMIT
0091    *     AT THE BOTTOM ....
0092    *
0093              HGTLOW = 0.
0094              LOWLIM = 1
0095              GO TO 140
0096     100      CONTINUE
0097    *
0098    *.... IF LOWER LIMIT IS WITHIN THE POOL THEN FIND IT WITH A
0099    *     HALF-INTERVAL SEARCH ....
0100    *
```

VWEIR

```
0101    *.... DETERMINE ELEVATION, LAYER, FUNCTION VALUE, AND FUNCTION SIGN
0102    *     AT EACH SEARCH LIMIT X1 POOL BOTTOM AND X2 WEIR CREST ....
0103    *
0104             X1 = 0.
0105             F1 = FWEIR ( X1 )
0106             Q1 = F1 .GT. 0.
0107             X2 = CREST
0108             F2 = AVGVEL
0109             Q2 = F2 .GT. 0.
0110             X3 = - 2. * SMALL
0111    *
0112    *.... FUNCTION MUST BE POSITIVE AT THE WEIR LEVEL AND NEGATIVE
0113    *     AT THE BOTTOM ....
0114    *
0115             IF ( Q1 .OR. .NOT. Q2 )
0116         &        CALL ERROR ( 1600  , SUBR, XDUMY, XDUMY1, XDUMY2,
0117         &                     XDUMY3 )
0118    *
0119    *.... INITIATE ITERATION PROCESS ....
0120    *
0121             DO 120 I = 1, ITMAX
0122    *
0123    *.... ESTABLISH A THIRD POINT BETWEEN THE TWO EXISTING POINTS ....
0124    *
0125             X4 = X3
0126             X3 = ( X1 + X2 ) / 2.
0127    *
0128    *.... CALCULATE FUNCTION SIGN AT NEW ELEVATION ....
0129    *
0130             F3 = FWEIR ( X3 )
0131    *
0132    *.... IF NEW POINT IS SAME AS PREVIOUS POINT (WITHIN TOLERANCE)
0133    *     THEN SEARCH IS COMPLETE ....
0134    *
0135             IF ( ABS ( X4 - X3 ) .LT. SMALL ) GO TO 130
0136    *
0137    *.... USE AS NEW SEARCH LIMITS THE MOST RECENTLY COMPUTED POINT
0138    *     AND THE REMAINING POINT OF OPPOSITE SIGN ....
0139    *
0140             IF ( F1 * F3 .GT. 0. ) GO TO 110
0141             X2 = X3
0142             F2 = F3
0143             GO TO 120
0144     110     CONTINUE
0145             X1 = X3
0146             F1 = F3
0147     120     CONTINUE
0148    *
0149    *.... CONVERGENCE HAS NOT BEEN REACHED ....
0150    *
```

VWEIR

```
0151              CALL ERROR ( 1610, SUBR, XDUMY, XDUMY1, XDUMY2, XDUMY3 )
0152     130      CONTINUE
0153    *
0154    *.... CHECK FOR ( Z + H ) / H LESS THAN 2.0.  IF TRUE, REASSIGN
0155    *     COEFFICIENTS C AND D AND REPEAT ITERATION PROCESS ....
0156    *
0157              IF ( QZ ) GO TO 136
0158              ZLOW = CREST - X3
0159              XCHECK = ( ZLOW + HEAD ) / HEAD
0160              IF ( XCHECK .GE. 2.0 ) GO TO 135
0161              C  = .78
0162              D  = .70
0163              QZ = .TRUE.
0164              GO TO 90
0165     135      CONTINUE
0166     136      CONTINUE
0167    *
0168    *.... SET LOWER LIMIT ELEVATION AND LAYER ....
0169    *
0170              HGTLOW = X3
0171              LOWLIM = LAYER ( X3 )
0172     140      CONTINUE
0173    *
0174    *.... SET UPPER LIMIT AT SURFACE ....
0175    *
0176     145      CONTINUE
0177              HGTTOP = DEPTH
0178              TOPLIM = ISURF
0179    *
0180    *.... CALCULATE LOCATION OF MAXIMUM VELOCITY ....
0181    *
0182              ZONE = HGTTOP - HGTLOW
0183              ZLOW = CREST  - HGTLOW
0184    *
0185    *.... IF WEIR IS FREE, MAXIMUM VELOCITY IS AT THE SURFACE ....
0186    *
0187              IF ( .NOT. QSUB ) YVMAX = ZONE
0188    *
0189    *.... BASED ON BOHAN AND GRACE ....
0190    *
0191              IF ( QSUB ) YVMAX = ZONE * SIN ( 1.57 * ZLOW / ZONE ) **2
0192    *
0193    *.... COMPUTE THICKNESS OF WITHDRAWAL ZONE ....
0194    *
0195    *.... HEIGHT OF MAX. VELOCITY ABOVE THE BOTTOM ....
0196    *
0197              XVMAX = YVMAX + HGTLOW
0198    *
0199    *.... LAYER NO. LOCATION OF MAX VELOCITY ....
0200    *
```

VWEIR

```
0201              LVMAX = LAYER ( XVMAX )
0202     *
0203     *.... DENSITY AT LAYER OF MAX. VELOCITY ....
0204     *
0205              DVMAX = DENINT ( XVMAX )
0206     *
0207     *.... DETERMINE DISTANCE BETWEEN PORT ELEVATION AND LOWER AND
0208     *     UPPER LIMITS RESPECTIVELY ....
0209     *
0210              YLOW = DELZ * ( LVMAX - LOWLIM )
0211              YTOP = DELZ * ( TOPLIM - LVMAX )
0212     *
0213     *.... DETERMINE DENSITY AT LIMITS ....
0214     *
0215              DENLOW = DENINT ( HGTLOW )
0216              DENTOP = DENINT ( HGTTOP )
0217     *
0218     *.... CALCULATE MAXIMUM VELOCITY ....
0219     *
0220              VMAX = 1.
0221     *
0222     *.... ZERO THE VELOCITY PROFILE ....
0223     *
0224              DO 150 I = 1, ISURF
0225                 V ( I ) = 0.
0226      150     CONTINUE
0227     *
0228     *.... IF LOWER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0229     *     ASSIGN CONSTANT VELOCITY TO EACH LAYER ....
0230     *
0231              IF ( LVMAX .EQ. LOWLIM ) GO TO 200
0232              DENDIF = DENLOW - DVMAX
0233              IF ( DENDIF .GT. 0. ) GO TO 170
0234              DO 160 I = LOWLIM, LVMAX
0235                 V ( I ) = VMAX
0236      160     CONTINUE
0237              GO TO 200
0238      170     CONTINUE
0239     *
0240     *.... CALCULATE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0241     *     TO LOWER LIMIT ....
0242     *
0243              DO 190 I = LOWLIM, LVMAX
0244              Y1 = DELZ * ( LVMAX - I )
0245              DELDEN = DEN ( I ) - DVMAX
0246              RATIO = Y1 * DELDEN / ( YLOW * DENDIF )
0247              RATIO = AMIN1 ( 1., RATIO )
0248              IF ( QBLIM ) GO TO 180
0249              P = 3.0
0250     *
```

VWEIR

```
0251    *.... IF WEIR IS SUBMERGED ....
0252    *
0253              IF ( QSUB ) V ( I ) = VMAX * ( 1. - RATIO ) ** P
0254    *
0255    *.... IF WEIR IS FREE ....
0256    *
0257              IF ( .NOT. QSUB ) V ( I ) = VMAX *
0258         &                                ( 1. - RATIO ** EXPNT )
0259              GO TO 190
0260     180      CONTINUE
0261    *
0262    *.... IF BOTTOM INTERFERENCE ....
0263    *
0264              V ( I ) = VMAX * ( 1. - RATIO ** 2 )
0265     190      CONTINUE
0266     200      CONTINUE
0267    *
0268    *.... IF FREE WEIR, GO TO 260 ....
0269    *
0270              IF ( .NOT. QSUB ) GO TO 260
0271    *
0272    *.... IF UPPER WITHDRAWAL LAYERS ARE OF CONSTANT DENSITY THEN
0273    *     ASSIGN CONSTANT VELOCITY TO EACH LAYER ....
0274    *
0275              IF ( LVMAX .EQ. TOPLIM ) GO TO 260
0276              DENDIF = DVMAX - DENTOP
0277              IF ( DENDIF .GT. 0. ) GO TO 220
0278              DO 210 I = LVMAX, TOPLIM
0279                 V ( I ) = VMAX
0280     210      CONTINUE
0281              GO TO 250
0282     220      CONTINUE
0283    *
0284    *.... DETERMINE VELOCITY PROFILE FROM LAYER OF MAXIMUM VELOCITY
0285    *     TO UPPER LIMIT ....
0286    *
0287              DO 240 I = LVMAX, TOPLIM
0288                 Y1      = DELZ * ( I - LVMAX )
0289                 DELDEN  = DVMAX - DEN ( I )
0290                 RATIO   = Y1 * DELDEN / ( YTOP * DENDIF )
0291                 RATIO   = AMIN1 ( 1., RATIO )
0292                 V ( I ) = VMAX * ( 1. - RATIO ** 2 )
0293     240      CONTINUE
0294     250      CONTINUE
0295     260      CONTINUE
0296    *
0297    *.... CONVERT NORMALIZED VELOCITIES TO FLOW RATES, I.E.,
0298    *     DETERMINE WITHDRAWAL FROM EACH LAYER ....
0299    *
0300              SUM = 0.0
```

VWEIR

```
0301              DO 270 I = LOWLIM, TOPLIM
0302                 SUM = SUM + V ( I ) * HGT ( I )
0303        270   CONTINUE
0304              VM = FLORAT / SUM
0305              DO 280 I = LOWLIM, TOPLIM
0306                 V ( I ) = V ( I ) * VM
0307        280   CONTINUE
0308              RETURN
0309              END
```

XPRINT

```
0001              SUBROUTINE XPRINT
0002     ********************************************************************
0003     *                                                                  *
0004     *        S U B R O U T I N E   X P R I N T                         *
0005     *                                                                  *
0006     ********************************************************************
0007     *
0008     *.... PRINTS OUTPUT INFORMATION ....
0009     *
0010              COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0011              COMMON / BB / IFILE, KFILE
0012              COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0013              COMMON / DD / WTHETA (5), WANGLE
0014              COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0015              COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0016              COMMON / HH / WRLNG, WRHGT, WRFLOW
0017              COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0018              COMMON / JJ / NUMT, QCENT, TEMP (100), YT (100), QTEMP
0019              COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0020             &                  QUAL (4, 100), YQ (4, 100)
0021              COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0022              COMMON / MM / SUMOUT, VEL (100), FLORAT
0023              COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0024             &                  QSINK2, QSHIFT
0025              COMMON / QQ / VS (100, 6), NOUTS
0026              COMMON / RR / ZUP (6), ZDN (6), LTOP (6), LLOW (6)
0027              COMMON / SS / WTHDRW (100), DENOUT, TEMOUT, QALOUT (4)
0028     *
0029              CHARACTER*4 HEADING, TITLE, NAMEQ
0030     *
0031              LOGICAL QMETR, QPORT, QWEIR, QCENT, QTEMP, QPLOT
0032              LOGICAL QSINK1, QSINK2, QPWEIR
0033     *
0034              CHARACTER*6 XMETERS, DIST
0035              CHARACTER*4 XFEET
0036     *
0037              DATA XFEET, XMETERS / 'FEET', 'METERS' /
0038     *
0039              TEMFUN ( T ) = 9. / 5. * T + 32.
0040     *
0041     *.... PRINT HEADINGS AND SUMMARY INFORMATION ....
0042     *
0043              WRITE ( KFILE, 510 ) TITLE
0044              WRITE ( KFILE, 520 ) HEADING
0045     *
0046     *.... UNITS ....
0047     *
0048              DIST = XFEET
0049              IF ( QMETR ) DIST = XMETERS
0050              WRITE ( KFILE, 500 ) DIST
```

XPRINT

```
0051              IF ( .NOT. QPORT ) GO TO 110
0052     *
0053     *.... PORT INFORMATION ....
0054     *
0055              DO 100 L = 1, NPORTS
0056                 PELEV = PHGT(L) + BOTTOM
0057                 WRITE ( KFILE, 530 ) PELEV, PVDIM ( L ), FLOW ( L ),
0058          &                               WTHETA ( L )
0059       100    CONTINUE
0060       110    CONTINUE
0061     *
0062     *.... WEIR INFORMATION ....
0063     *
0064              IF ( QWEIR ) WELE = WRHGT + BOTTOM
0065              IF ( QWEIR ) WRITE ( KFILE, 540 ) WELE, WRLNG, WRFLOW
0066     *
0067     *.... FLOW RATE INFORMATION ....
0068     *
0069              WRITE ( KFILE, 550 ) SUMOUT
0070     *
0071     *.... WITHDRAWAL LIMIT INFORMATION ....
0072     *
0073     *.... THEORETICAL LIMITS ....
0074     *
0075              ZUPEL = ZUP ( NOUTS ) + BOTTOM
0076              ZDNEL = ZDN (     1 ) + BOTTOM
0077     *
0078     *.... ACTUAL LIMITS ....
0079     *
0080              AWLUPP = AMIN1 ( DEPTH, ZUP ( NOUTS ) )
0081              AWLBOT = AMAX1 ( 0.0  , ZDN ( 1     ) )
0082              AZUPEL = AWLUPP + BOTTOM
0083              AZDNEL = AWLBOT + BOTTOM
0084              WRITE ( KFILE, 555 ) AWLBOT       , AZDNEL
0085              WRITE ( KFILE, 560 ) ZDN ( 1     ), ZDNEL
0086              WRITE ( KFILE, 565 ) AWLUPP       , AZUPEL
0087              WRITE ( KFILE, 570 ) ZUP ( NOUTS ), ZUPEL
0088     *
0089     *.... RELEASE DENSITY ....
0090     *
0091              WRITE ( KFILE, 580 ) DENOUT
0092              IF ( .NOT. QTEMP ) GO TO 120
0093     *
0094     *.... RELEASE TEMPERATURE ....
0095     *
0096              IF ( .NOT. QCENT ) TEMOUT = TEMFUN ( TEMOUT )
0097              WRITE ( KFILE, 590 ) TEMOUT
0098       120    CONTINUE
0099              IF ( NQUAL .EQ. 0 ) GO TO 130
0100     *
```

XPRINT

```
0101    *.... RELEASE QUALITY PARAMETER VALUE ....
0102    *
0103             WRITE( KFILE, 600 ) ( ( NAMEQ ( NM, J ), NM = 1, 5 ),
0104         &                           QALOUT ( J ), J = 1, NQUAL )
0105     130     CONTINUE
0106    *
0107    *.... PORT MODELED AS WEIR ....
0108    *
0109             IF ( QPWEIR ) WRITE ( KFILE, 607 )
0110    *
0111    *.... POINT SINK VERIFICATION INFORMATION ....
0112    *
0113             IF ( .NOT. QSINK1 ) WRITE ( KFILE, 605 )
0114             IF ( .NOT. QSINK2 ) WRITE ( KFILE, 606 )
0115    *
0116    *.... PRINT TABULAR INFORMATION ....
0117    *
0118                IF ( .NOT. QTEMP .AND. NQUAL .EQ. 0 ) THEN
0119                   WRITE ( KFILE, 610 )
0120                ELSEIF ( QTEMP .AND. NQUAL .EQ. 0 ) THEN
0121                   WRITE ( KFILE, 620 )
0122                ELSEIF ( .NOT. QTEMP .AND. NQUAL .GT. 0 ) THEN
0123                   WRITE ( KFILE, 630 ) ( ( NAMEQ ( NM , J ), NM = 1, 3 ),
0124         &                                J = 1, NQUAL )
0125                ELSE
0126                   WRITE ( KFILE, 635 ) ( ( NAMEQ ( NM , J ), NM = 1, 3 ),
0127         &                                J = 1, NQUAL )
0128                ENDIF
0129    *
0130             DO 170 I = 1, ISURF, INTER
0131                K = ISURF - I + 1
0132                ELEV = Y ( K ) + BOTTOM
0133                DEEP = SURFACE - ELEV
0134    *
0135    *.... ELEVATION, DENSITIES, NORMALIZED VELOCITY, AND
0136    *     LAYER WITHDRAWAL ....
0137    *
0138                IF ( .NOT. QTEMP .AND. NQUAL .EQ. 0 ) THEN
0139                   WRITE ( KFILE, 640 ) ELEV, DEEP, DEN ( K ),
0140         &                VEL ( K ), WTHDRW ( K )
0141                ELSEIF ( QTEMP .AND. NQUAL .EQ. 0 ) THEN
0142                   IF ( .NOT. QCENT ) TEMP ( K ) = TEMFUN ( TEMP ( K ) )
0143                   WRITE ( KFILE, 650 ) ELEV, DEEP, DEN ( K ),
0144         &                VEL ( K ), WTHDRW ( K ), TEMP ( K )
0145                ELSEIF ( .NOT. QTEMP .AND. NQUAL .GT. 0 ) THEN
0146                   WRITE ( KFILE, 660 ) ELEV, DEEP, DEN ( K ),
0147         &                VEL ( K ), WTHDRW ( K ),
0148         &                ( QUAL ( J , K ), J = 1, NQUAL )
0149                ELSE
0150                   WRITE ( KFILE, 670 ) ELEV, DEEP, DEN ( K ),
```

XPRINT

```
0151          &                VEL ( K ), WTHDRW ( K ), TEMP ( K ) ,
0152          &                ( QUAL ( J , K ), J = 1, NQUAL )
0153                 ENDIF
0154      170    CONTINUE
0155     *
0156     *.... PLOT DENSITY AND VELOCITY PROFILES ....
0157     *
0158            CALL DVPLOT
0159     *
0160            RETURN
0161      500   FORMAT ( // 20X, 12HUNITS ARE IN, 1X, A6 )
0162      510   FORMAT ( 1H1 // 8X, 18A4 )
0163      520   FORMAT ( //// 8X, 18A4 )
0164      530   FORMAT ( // 20X, 14HPORT ELEVATION, 2X, F9.3 / 20X,
0165          &          23HPORT VERTICAL DIMENSION, 2X, F10.3 / 20X,
0166          &          31HDISCHARGE, VOLUME FLOW PER SEC., 2X, F11.4
0167          &          / 20X, 21HWITHDRAWAL ANGLE, RAD, 2X , F6.4 )
0168      540   FORMAT ( // 20X, 20HWEIR CREST ELEVATION, 2X, F9.3 /
0169          &          20X, 11HWEIR LENGHT, 2X, F10.3 / 20X,
0170          &          31HDISCHARGE, VOLUME FLOW PER SEC., 2X, F11.4 )
0171      550   FORMAT ( /// 20X, 31HTOTAL DISCHARGE, VOLUME PER SEC,
0172          &          2X, F11.4 )
0173      555   FORMAT ( // 20X, 33HLOWER WITHDRAWAL LIMIT ( ACTUAL ),
0174          &          20H HEIGHT ABOVE BOTTOM, 7X, F9.3, 4X,
0175          &          9HELEVATION, 2X, F9.3 )
0176      560   FORMAT ( 20X, 38HLOWER WITHDRAWAL LIMIT ( THEORETICAL ),
0177          &          20H HEIGHT ABOVE BOTTOM, 2X, F9.3, 4X,
0178          &          9HELEVATION, 2X, F9.3 )
0179      565   FORMAT ( 20X, 33HUPPER WITHDRAWAL LIMIT ( ACTUAL ),
0180          &          20H HEIGHT ABOVE BOTTOM, 7X, F9.3, 4X,
0181          &          9HELEVATION, 2X, F9.3 )
0182      570   FORMAT ( 20X, 38HUPPER WITHDRAWAL LIMIT ( THEORETICAL ),
0183          &          20H HEIGHT ABOVE BOTTOM, 2X, F9.3, 4X,
0184          &          9HELEVATION, 2X, F9.3 )
0185      580   FORMAT ( 20X, 15HOUTFLOW DENSITY, 2X, F7.5, 2X, 4HG/CC )
0186      590   FORMAT ( 20X, 19HOUTFLOW TEMPERATURE, 2X, F6.2 )
0187      600   FORMAT ( 20X, 24HOUTFLOW CONCENTRATION OF, 1X, 5A4,
0188          &          2X, F8.2 )
0189      605   FORMAT ( /, 20X, 10H**********, 5X, 18HWARNING-POINT SINK,
0190          &          41HDESCRIPTION NOT ADEQUATE FOR LOWER LIMIT, 5X,
0191          &          10H********** )
0192      606   FORMAT ( /, 20X, 10H**********, 5X, 18HWARNING-POINT SINK,
0193          &          41H DESCRIPTION NOT ADEQUATE FOR UPPER LIMIT, 5X,
0194          &          10H********** )
0195      607   FORMAT ( /, 20X, 5H*****, 3X, 'PARTIALLY SUBMERGED',
0196          &          ' PORT RESPONDED AS A WEIR FOR THIS CONDITION',
0197          &          ' SO VWEIR WAS USED' )
0198      610   FORMAT ( 1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,
0199          &          7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW )
0200      620   FORMAT ( 1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,
```

XPRINT

```
0201          &             7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW,
0202          &             13X, 11HTEMPERATURE )
0203      630     FORMAT ( 1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,
0204          &             7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW,
0205          &             24X, 4( 2X, 3A4 ) )
0206      635     FORMAT ( 1H1 // 2X, 9HELEVATION, 3X, 5HDEPTH, 4X,
0207          &             7HDENSITY, 3X, 10HNORM. VEL., 4X, 4HFLOW,
0208          &             13X, 11HTEMPERATURE, 4( 2X, 3A4 ) )
0209      640     FORMAT ( 2X, F9.3, 4X, F6.2,  4X,   F7.5,
0210          &             5X, F6.4, 3X, F9.4 )
0211      650     FORMAT ( 2X, F9.3, 4X, F6.2,  4X,   F7.5,
0212          &             5X, F6.4, 3X, F9.4, 15X,   F5.2 )
0213      660     FORMAT ( 2X, F9.3, 4X, F6.2,  4X,   F7.5,
0214          &             5X, F6.4, 3X, F9.4, 20X, 4F13.2 )
0215      670     FORMAT ( 2X, F9.3, 4X, F6.2,  4X,   F7.5,
0216          &             5X, F6.4, 3X, F9.4, 15X,   F5.2, 4F13.2 )
0217              END
```

XREAD

```
0001            SUBROUTINE XREAD
0002    ************************************************************************
0003    *                                                                      *
0004    *       S U B R O U T I N E   X R E A D                                *
0005    *                                                                      *
0006    ************************************************************************
0007    *
0008    *.... THIS SUBROUTINE READS ALL INPUT DATA AND CONSTRUCTS
0009    *     FULL TABLES ....
0010    *
0011            COMMON / AA / QMETR, NSETS, G, HEADING (18), TITLE (18)
0012            COMMON / BB / IFILE, KFILE
0013            COMMON / CC / DELZ, INTER, SURFACE, BOTTOM
0014            COMMON / DD / WTHETA (5), WANGLE
0015            COMMON / EE / NPORTS, QPORT, QWEIR, QPLOT, QPWEIR
0016            COMMON / FF / PVDIM (5), PHGT (5), FLOW (5), PHDIM (5)
0017            COMMON / GG / COEF, QSUB, QQUAL
0018            COMMON / HH / WRLNG, WRHGT, WRFLOW
0019            COMMON / II / NUMD, DEN (100), YD (100), QDEN, DENPRT
0020            COMMON / JJ / NUMT, QCENT, TEMP (100), YT (100), QTEMP
0021            COMMON / KK / NQUAL, NUMQ (4), NAMEQ (5,4),
0022        &                 QUAL (4,100), YQ (4,100)
0023            COMMON / LL / ISURF, HGT (100), DEPTH, Y (100)
0024            COMMON / NN / HGTPRT, VDIM, QTLIM, QBLIM, QSINK1,
0025        &                 QSINK2, QSHIFT
0026            COMMON / TT / QVENT, QAERA, QTWFUN, TWEL
0027    *
0028            DIMENSION DUMMY (20)
0029            DIMENSION DUMQUAL (100), DUMYQ (100)
0030    *
0031            INTEGER     TABTYP
0032    *
0033            CHARACTER*4 CHECK, CHECK1, CHECK2,
0034        &               HEADING, TITLE, NAMEQ,
0035        &               XDATA, XPRIN, XENGL, XMETR, XELEV, XDEPT,
0036        &               XHEIG, XTHIC, XINTE, XSURF, XBOTT,
0037        &               XNUMB, XPORT, XWEIR, XVDIM, XFLOW,
0038        &               XFREE, XSUBM, XCOEF, XLENG, XDENS, XTEMP,
0039        &               XQUAL, XFAHR, XCENT, XTABL, XSTOP, XHDIM,
0040        &               XTURB, XGATE, XFUNC, XTAIL, XDISS,
0041        &               DUMMY, UNITS, XANGL
0042            CHARACTER*6 SUBR
0043    *
0044            LOGICAL QECHO , QMETR, QPORT , QWEIR , QSUB  , QPLOT,
0045        &           QPWEIR, QDEN , QCENT , QTAB1 , QTEMP , QQUAL
0046            LOGICAL QVENT , QAERA, QTWFUN, QFIRST, QSINK1, QSINK2
0047    *
0048            DATA XDATA, XPRIN, XENGL / 'DATA', 'PRIN', 'ENGL' /
0049            DATA XMETR, XELEV, XDEPT / 'METR', 'ELEV', 'DEPT' /
0050            DATA XHEIG, XTHIC        / 'HEIG', 'THIC'         /
```

XREAD

```
0051            DATA XINTE, XSURF, XBOTT / 'INTE', 'SURF', 'BOTT' /
0052            DATA XNUMB, XPORT, XGATE / 'NUMB', 'PORT', 'GATE' /
0053            DATA XWEIR, XVDIM, XFLOW / 'WEIR', 'VDIM', 'FLOW' /
0054            DATA XFREE, XSUBM, XCOEF / 'FREE', 'SUBM', 'COEF' /
0055            DATA XLENG, XDENS, XTEMP / 'LENG', 'DENS', 'TEMP' /
0056            DATA XQUAL, XFAHR, XCENT / 'QUAL', 'FAHR', 'CENT' /
0057            DATA XTABL, XSTOP, XANGL / 'TABL', 'STOP', 'ANGL' /
0058            DATA XHDIM, XDISS        / 'HDIM', 'DISS'         /
0059            DATA XTURB, XTAIL, XFUNC / 'TURB', 'TAIL', 'FUNC' /
0060            DATA QFIRST              / .FALSE.                /
0061            DATA XDUMY, XDUMY1, XDUMY2, XDUMY3 / 4 * '0   '   /
0062            DATA SUBR                / 'XREAD'                /
0063    *
0064    *....  PROGRAM CONTROL PARAMETERS ....
0065    *
0066            IF ( QFIRST ) GO TO 145
0067            QFIRST = .TRUE.
0068    *
0069    *....  INPUT FILE TITLE ....
0070    *
0071            READ ( IFILE, 610 ) TITLE
0072    *
0073    *....  NUMBER OF DATA SETS ....
0074    *
0075            READ ( IFILE, 620 ) CHECK, NSETS
0076            IF ( CHECK .NE. XDATA )
0077         &      CALL ERROR ( 1010  , SUBR, CHECK, XDATA , XDUMY2,
0078         &                   XDUMY3 )
0079    *
0080    *....  ECHO PRINT ....
0081    *
0082            QECHO = .FALSE.
0083            READ ( IFILE, 610 ) CHECK
0084            QECHO = CHECK .EQ. XPRIN
0085            IF ( .NOT. QECHO ) GO TO 140
0086            QECHO = .FALSE.
0087            MFILE = IFILE
0088            REWIND MFILE
0089            WRITE ( KFILE, 600 )
0090    *
0091    *....  INITIALIZE LINE NUMBERS.  ECHO PRINT FILE ....
0092    *
0093            LINE = 1000
0094     100    CONTINUE
0095    *
0096    *....  PRINT LINE OF INPUT TO OUTPUT WITH EACH LOOP ....
0097    *
0098            READ ( MFILE, 610, END = 110 ) DUMMY
0099            WRITE ( KFILE, 630 ) LINE, DUMMY
0100    *
```

XREAD

```
0101    *....  INCREMENT LINE NUMBER ....
0102    *
0103             LINE = LINE + 10
0104             GO TO 100
0105     110     CONTINUE
0106    *
0107             REWIND MFILE
0108    *
0109     120     CONTINUE
0110    *
0111    *....  INCREMENT FILE POINTER TO PRIOR INPUT LINE ....
0112    *
0113             IK = 3
0114             DO 130 I = 1, IK
0115                READ ( IFILE, 610 ) DUMMY
0116     130     CONTINUE
0117     140     CONTINUE
0118             RETURN
0119    *
0120    *....  ENTRY POINT TO READ THE INDIVIDUAL DATA SETS ....
0121    *
0122     145     CONTINUE
0123    *
0124    *....  INITIALIZE VARIABLES ....
0125    *
0126             QSINK1 = .TRUE.
0127             QSINK2 = .TRUE.
0128             QPWEIR = .FALSE.
0129             QMETR  = .FALSE.
0130             QPORT  = .FALSE.
0131             QWEIR  = .FALSE.
0132             QTEMP  = .FALSE.
0133             QSUB   = .FALSE.
0134             QDEN   = .FALSE.
0135             QCENT  = .FALSE.
0136             QTAB1  = .FALSE.
0137             QVENT  = .FALSE.
0138             QAERA  = .FALSE.
0139             QTWFUN = .FALSE.
0140             NPORTS = 0
0141             NQUAL  = 0
0142             G      = 32.18
0143    *
0144    *....  DATA SET HEADING ....
0145    *
0146              READ ( IFILE, 610 ) HEADING
0147    *
0148    *....  METRIC OR ENGLISH UNITS
0149    *
0150              READ ( IFILE, 610 ) CHECK
```

XREAD

```
0151              IF ( CHECK .NE. XMETR .AND.
0152         &         CHECK .NE. XENGL )
0153         &         CALL ERROR ( 1020   , SUBR, CHECK, XENGL, XMETR,
0154         &                      XDUMY3 )
0155              QMETR = CHECK .EQ. XMETR
0156              IF ( QMETR ) G = 9.807
0157     *
0158     *....  FORM OF INPUT TABLES ....
0159     *
0160              READ ( IFILE, 620 ) CHECK, TABTYP
0161              IF ( CHECK .NE. XTABL )
0162         &         CALL ERROR ( 1030   , SUBR, CHECK, XTABL, XDUMY2,
0163         &                      XDUMY3 )
0164              QTAB1 = TABTYP .EQ. 1
0165     *
0166     *....  LAYER THICKNESS ....
0167     *
0168              READ ( IFILE, 650 ) CHECK, DELZ
0169              IF ( CHECK .NE. XTHIC )
0170         &         CALL ERROR ( 1040   , SUBR, CHECK, XTHIC, XDUMY2,
0171         &                      XDUMY3 )
0172     *
0173     *....  LAYER INTERVALS FOR WHICH OUTPUT INFO IS DESIRED ....
0174     *
0175              READ ( IFILE, 620 ) CHECK, INTER
0176              IF ( CHECK .NE. XINTE )
0177         &         CALL ERROR ( 1050   , SUBR, CHECK, XINTE, XDUMY2,
0178         &                      XDUMY3 )
0179     *
0180     *....  SURFACE ELEVATION ....
0181     *
0182              READ ( IFILE, 650 ) CHECK, SURFACE
0183              IF ( CHECK .NE. XSURF )
0184         &         CALL ERROR ( 1060   , SUBR, CHECK, XSURF, XDUMY2,
0185         &                      XDUMY3 )
0186     *
0187     *....  BOTTOM ELEVATION ....
0188     *
0189              READ ( IFILE, 650 ) CHECK, BOTTOM
0190              IF ( CHECK .NE. XBOTT )
0191         &         CALL ERROR ( 1070   , SUBR, CHECK, XBOTT, XDUMY2,
0192         &                      XDUMY3 )
0193     *
0194     *....  CONSTRUCT LAYERS ....
0195     *
0196              DEPTH = SURFACE - BOTTOM
0197     *
0198     *....  CALCULATE NUMBER OF LAYERS ....
0199     *
0200              ISURF = ( DEPTH / DELZ ) + .999
```

XREAD

```
0201            IF ( ISURF .GT. 100 )
0202           &     CALL ERROR ( 1080   , SUBR, XDUMY, XDUMY1, XDUMY2,
0203           &                  XDUMY3 )
0204     *
0205     *....  PERCENTAGE OF LAYER FILLED WITH WATER ....
0206     *
0207            DO 150 I = 1, ISURF
0208               HGT ( I ) = 1.0
0209               Y   ( I ) = ( DELZ * FLOAT ( I ) ) - ( .5 * DELZ )
0210      150   CONTINUE
0211            HGT ( ISURF ) = ( DEPTH - ( DELZ * ( ISURF - 1 ) ) )
0212          &                 / DELZ
0213     *
0214     *....  TOP LAYER MAY NOT BE DELZ THICK ....
0215     *
0216            Y ( ISURF ) = DEPTH - ( HGT ( ISURF ) * DELZ / 2.0 )
0217     *
0218     *....  DESCRIPTION OF WITHDRAWAL DEVICES ....
0219     *
0220     *....  PORT (AND TOTAL NUMBER THEREOF) OR WEIR ....
0221     *
0222            READ ( IFILE, 620 ) CHECK, NPORTS
0223            IF ( CHECK .NE. XPORT .AND.
0224           &     CHECK .NE. XWEIR )
0225           &     CALL ERROR ( 1100   , SUBR, CHECK, XWEIR, XPORT,
0226           &                  XDUMY3 )
0227     *
0228     *....  DETERMINE TYPE OF WITHDRAWAL DEVICE ....
0229     *
0230            QPORT = CHECK .EQ. XPORT
0231            QWEIR = CHECK .EQ. XWEIR
0232            IF ( QPORT ) GO TO 220
0233            IF ( QWEIR ) GO TO 300
0234      220   CONTINUE
0235     *
0236     *....  PORT CHARACTERISTICS ....
0237     *
0238     *....  PORT VERTICAL DIMENSIONS ....
0239     *
0240            READ ( IFILE, 650 ) CHECK, ( PVDIM ( K ), K = 1, NPORTS )
0241            IF ( CHECK .NE. XVDIM )
0242           &     CALL ERROR ( 1110   , SUBR, CHECK, XVDIM, XDUMY2,
0243           &                  XDUMY3 )
0244     *
0245     *....  PORT HORIZONTAL DIMENSIONS ....
0246     *
0247            READ ( IFILE, 650 ) CHECK, ( PHDIM ( K ), K = 1, NPORTS )
0248            IF ( CHECK .NE. XHDIM )
0249           &     CALL ERROR ( 1120   , SUBR, CHECK, XHDIM, XDUMY2,
0250           &                  XDUMY3 )
```

XREAD

```
0251    *
0252    *....  PORT ELEVATIONS ....
0253    *
0254             READ ( IFILE, 650 ) CHECK, ( PHGT ( K ), K = 1, NPORTS )
0255             IF ( CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0256         &        CHECK .NE. XDEPT )
0257         &        CALL ERROR ( 1130 , SUBR, CHECK, XDEPT, XHEIG,
0258         &                     XELEV )
0259    *
0260    *....  CONVERT ELEVATION TO HEIGHT ABOVE BOTTOM ....
0261    *
0262             IF ( CHECK .EQ. XHEIG ) GO TO 260
0263             IF ( CHECK .EQ. XDEPT ) GO TO 240
0264    *
0265    *....  ELEVATION TO HEIGHT ....
0266    *
0267             DO 230 K = 1, NPORTS
0268                PHGT ( K ) = PHGT ( K ) - BOTTOM
0269     230     CONTINUE
0270             GO TO 260
0271     240     CONTINUE
0272    *
0273    *....  DEPTHS TO HEIGHTS ....
0274    *
0275             DO 250 K = 1, NPORTS
0276                PHGT ( K ) = SURFACE - PHGT ( K ) - BOTTOM
0277     250     CONTINUE
0278     260     CONTINUE
0279    *
0280    *....  PORT FLOW RATES ....
0281    *
0282             READ ( IFILE, 650 ) CHECK, ( FLOW ( K ), K=1, NPORTS )
0283             IF ( CHECK .NE. XFLOW )
0284         &        CALL ERROR ( 1140  , SUBR, CHECK, XFLOW, XDUMY2,
0285         &                     XDUMY3 )
0286    *
0287    *....  WITHDRAWAL ANGLE ....
0288    *
0289             READ ( IFILE, 650 ) CHECK, ( WTHETA ( K ), K=1, NPORTS )
0290             IF ( CHECK .NE. XANGL )
0291         &        CALL ERROR ( 1150  , SUBR, CHECK, XANGL, XDUMY2,
0292         &                     XDUMY3 )
0293             IF ( NPORTS .EQ. 1 ) GO TO 290
0294    *
0295    *....  ORDER PORTS FROM BOTTOM TO TOP ....
0296    *
0297             NP = NPORTS - 1
0298             DO 280 I = 1, NP
0299                K = I + 1
0300                DO 270 J = K, NPORTS
```

XREAD

```
0301                    IF ( PHGT ( I ) .LT. PHGT ( J ) ) GO TO 270
0302     *
0303     *....  ASSIGN CHARACTERISTICS OF LOWER SUBSCRIPTED PORTS
0304     *      TO DUMMY VARIABLES ....
0305     *
0306                    HGTDUM  = PHGT   ( I )
0307                    VDUM    = PVDIM  ( I )
0308                    HDUM    = PHDIM  ( I )
0309                    FLOWDUM = FLOW   ( I )
0310                    ANGDUM  = WTHETA ( I )
0311     *
0312     *....  ASSIGN CHARACTERISTICS OF HIGHER SUBSCRIPTED PORTS
0313     *      TO LOWER SUBSCRIPT ....
0314     *
0315                    PHGT   ( I ) = PHGT   ( J )
0316                    PVDIM  ( I ) = PVDIM  ( J )
0317                    PHDIM  ( I ) = PHDIM  ( J )
0318                    FLOW   ( I ) = FLOW   ( J )
0319                    WTHETA ( I ) = WTHETA ( J )
0320     *
0321     *....  ASSIGN DUMMY VARIABLE VALUES TO HIGHER SUBSCRIPTED PORT ....
0322     *
0323                    PHGT   ( J ) = HGTDUM
0324                    PVDIM  ( J ) = VDUM
0325                    PHDIM  ( J ) = HDUM
0326                    FLOW   ( J ) = FLOWDUM
0327                    WTHETA ( J ) = ANGDUM
0328       270        CONTINUE
0329       280      CONTINUE
0330       290      CONTINUE
0331     *
0332     *....  CHECK FOR WEIR INPUT ....
0333     *
0334               READ ( IFILE, 620 ) CHECK
0335               QWEIR = CHECK .EQ. XWEIR
0336               IF ( QWEIR ) GO TO 300
0337               BACKSPACE IFILE
0338               GO TO 340
0339      300      CONTINUE
0340     *
0341     *....  WEIR CHARACTERISTICS ....
0342     *
0343     *....  SUBMERGED OR FREE ....
0344     *
0345               READ ( IFILE, 620 ) CHECK
0346               IF ( CHECK .NE. XFREE .AND.
0347          &         CHECK .NE. XSUBM )
0348          &         CALL ERROR ( 1160   , SUBR, CHECK, XSUBM, XFREE,
0349          &                      XDUMY3 )
0350               QSUB = CHECK .EQ. XSUBM
```

XREAD

```
0351              IF ( QSUB ) GO TO 310
0352     *
0353     *....  FREE WEIR COEFFICIENT ....
0354     *
0355              READ ( IFILE, 650 ) CHECK, COEF
0356              IF ( CHECK .NE. XCOEF )
0357          &        CALL ERROR ( 1170  , SUBR, CHECK, XCOEF, XDUMY2,
0358          &                     XDUMY3 )
0359      310     CONTINUE
0360     *
0361     *....  WEIR LENGTH ....
0362     *
0363              READ ( IFILE, 650 ) CHECK, WRLNG
0364              IF ( CHECK .NE. XLENG )
0365          &        CALL ERROR ( 1180  , SUBR, CHECK, XLENG, XDUMY2,
0366          &                     XDUMY3 )
0367     *
0368     *....  WEIR HEIGHT ....
0369     *
0370              READ ( IFILE, 650 ) CHECK, WRHGT
0371              IF ( CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0372          &        CHECK .NE. XDEPT )
0373          &        CALL ERROR ( 1200  , SUBR, CHECK, XDEPT, XELEV,
0374          &                     XHEIG )
0375     *
0376     *....  CONVERT DEPTH OR ELEV TO HEIGHT ABOVE BOTTOM ....
0377     *
0378              IF ( CHECK .EQ. XHEIG ) GO TO 330
0379              IF ( CHECK .EQ. XDEPT ) GO TO 320
0380     *
0381     *....  ELEVATION TO HEIGHT ....
0382     *
0383              WRHGT = WRHGT - BOTTOM
0384              GO TO 330
0385      320     CONTINUE
0386     *
0387     *....  DEPTH TO HEIGHT ....
0388     *
0389              WRHGT = SURFACE - WRHGT - BOTTOM
0390      330     CONTINUE
0391     *
0392     *....  FLOW RATE OVER WEIR ....
0393     *
0394              READ ( IFILE, 650 ) CHECK, WRFLOW
0395              IF ( CHECK .NE. XFLOW )
0396          &        CALL ERROR ( 1210  , SUBR, CHECK, XFLOW, XDUMY2,
0397          &                     XDUMY3 )
0398      340     CONTINUE
0399     *
0400     *....  TURBINE VENTING OR CONDUIT AERATION ....
```

XREAD

```
0401    *
0402              READ( IFILE, 610 ) CHECK
0403              QVENT = CHECK .EQ. XTURB
0404              QAERA = CHECK .EQ. XGATE
0405              IF( .NOT. QVENT .AND. .NOT. QAERA ) BACKSPACE IFILE
0406    *
0407    *....  TAILWATER FUNCTION OR SINGLE ELEVATION.
0408    *      NEEDED WHEN QAERA =.TRUE. ....
0409    *
0410              IF ( .NOT. QAERA ) GO TO 345
0411              READ ( IFILE, 635 ) CHECK1, CHECK2, TWEL
0412              IF ( CHECK1 .NE. XTAIL )
0413         &         CALL ERROR( 1215   , SUBR, CHECK1, XTAIL, XDUMY2,
0414         &                     XDUMY3 )
0415              QTWFUN = CHECK2 .EQ. XFUNC
0416     345      CONTINUE
0417    *
0418    *....  INFORMATION FOR DENSITY OR TEMP PROFILE INCLUDING
0419    *      NUMBER OF DATA ....
0420    *
0421              READ ( IFILE, 640 ) CHECK1, CHECK2, NUMD
0422              IF ( CHECK1 .NE. XNUMB )
0423         &         CALL ERROR ( 1220   , SUBR, CHECK1, XNUMB, XDUMY2,
0424         &                      XDUMY3 )
0425              IF( CHECK2 .NE. XDENS .AND. CHECK2 .NE. XTEMP )
0426         &         CALL ERROR ( 1225   , SUBR, CHECK2, XDENS, XTEMP,
0427         &                      XDUMY3 )
0428    *
0429              QDEN = CHECK2 .EQ. XDENS
0430              IF ( QDEN ) GO TO 350
0431              NUMT = NUMD
0432              GO TO 420
0433     350      CONTINUE
0434    *
0435    *....  DENSITY ....
0436    *
0437              IF ( QTAB1 ) GO TO 360
0438    *
0439    *....  ELEVATION AND DENSITY VALUES LISTED IN SEPERATE TABLES ....
0440    *
0441              READ ( IFILE, 610 ) CHECK
0442    *
0443    *....  ELEVATIONS ....
0444    *
0445              IF ( CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0446         &         CHECK .NE. XDEPT )
0447         &         CALL ERROR ( 1230 , SUBR, CHECK, XDEPT, XHEIG,
0448         &                      XELEV )
0449              READ ( IFILE, 660 ) ( YD ( M ), M = 1, NUMD )
0450    *
```

XREAD

```
0451     *....  DENSITIES ....
0452     *
0453               READ ( IFILE, 620 ) CHECK
0454               IF ( CHECK .NE. XDENS )
0455          &        CALL ERROR ( 1240   , SUBR, CHECK, XDENS, XDUMY2,
0456          &                     XDUMY3 )
0457               READ ( IFILE, 660 ) ( DEN ( M ), M = 1, NUMD )
0458               GO TO 370
0459      360      CONTINUE
0460     *
0461     *....  ELEVATION AND DENSITY VALUES LISTED IN ONE TABLE ....
0462     *
0463               READ ( IFILE, 670 ) CHECK1, CHECK2
0464               IF ( CHECK1 .NE. XDEPT .AND. CHECK1 .NE. XHEIG
0465          &        .AND. CHECK1 .NE. XELEV )
0466          &        CALL ERROR ( 1250   , SUBR, CHECK1, XDEPT, XELEV,
0467          &                     XHEIG )
0468               IF ( CHECK2 .NE. XDENS )
0469          &        CALL ERROR ( 1260   , SUBR, CHECK2, XDENS, XDUMY2,
0470          &                     XDUMY3 )
0471               READ ( IFILE, 680 ) ( YD ( M ), DEN ( M ), M = 1, NUMD )
0472               CHECK = CHECK1
0473      370      CONTINUE
0474     *
0475     *....  CONVERT DEPTH OR ELEVATION TO HEIGHT ABOVE THE BOTTOM ....
0476     *
0477               IF ( CHECK .EQ. XHEIG ) GO TO 410
0478               IF ( CHECK .EQ. XDEPT ) GO TO 390
0479     *
0480     *....  ELEVATION TO HEIGHT ....
0481     *
0482               DO 380 M = 1, NUMD
0483                  YD ( M ) = YD ( M ) - BOTTOM
0484      380      CONTINUE
0485               GO TO 410
0486      390      CONTINUE
0487     *
0488     *....  DEPTH TO HEIGHT ....
0489     *
0490               DO 400 M = 1, NUMD
0491                  YD ( M ) = SURFACE - YD ( M ) - BOTTOM
0492      400      CONTINUE
0493      410      CONTINUE
0494     *
0495     *....  GENERATE COMPUTATIONAL DENSITY PROFILE ....
0496     *
0497               CALL INTERP ( DEN, YD, NUMD )
0498     *
0499     *....  CHECK FOR TEMPERATURE OR QUALITY PROFILE
0500     *      (AND NUMBER OF DATA) OR A STOP COMMAND ....
```

XREAD

```
0501    *
0502              READ ( IFILE, 700 ) CHECK, NUMT
0503              IF ( CHECK .NE. XNUMB .AND. CHECK .NE. XQUAL .AND.
0504           &        CHECK .NE. XSTOP )
0505           &        CALL ERROR ( 1270  , SUBR, CHECK, XNUMB, XQUAL,
0506           &                     XSTOP )
0507              IF ( CHECK .EQ. XSTOP ) RETURN
0508              IF ( CHECK .EQ. XQUAL ) GO TO 490
0509    *
0510    *....  TEMPERATURE ....
0511    *
0512     420      CONTINUE
0513    *
0514    *....  FAHRENHEIT OR CENTIGRADE ....
0515    *
0516              READ ( IFILE, 690 ) CHECK, UNITS
0517              IF ( CHECK .NE. XTEMP .AND. CHECK .NE. XSTOP )
0518           &        CALL ERROR ( 1280  , SUBR, CHECK, XTEMP, XSTOP,
0519           &                     XDUMY3 )
0520    *
0521              IF ( CHECK .EQ. XSTOP ) RETURN
0522              IF ( UNITS .NE. XFAHR .AND. UNITS .NE. XCENT )
0523           &       CALL ERROR ( 1290  , SUBR, UNITS, XFAHR, XCENT,
0524           &                    XDUMY3 )
0525    *
0526              QCENT = UNITS .EQ. XCENT
0527              QTEMP = .TRUE.
0528              IF ( QTAB1 ) GO TO 430
0529    *
0530    *....  ELEVATION AND TEMPERATURE LISTED IN SEPERATE TABLES ....
0531    *
0532              READ ( IFILE, 610 ) CHECK
0533    *
0534    *....  ELEVATION TABLE
0535    *
0536              IF ( CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0537           &        CHECK .NE. XDEPT )
0538           &        CALL ERROR ( 1300  , SUBR, CHECK, XHEIG, XELEV,
0539           &                     XDEPT )
0540              READ ( IFILE, 660 ) ( YT ( M ), M = 1, NUMT )
0541    *
0542    *....  TEMPERATURE TABLE ....
0543    *
0544              READ ( IFILE, 610 ) CHECK
0545              IF ( CHECK .NE. XTEMP )
0546           &       CALL ERROR ( 1310  , SUBR, CHECK, XTEMP, XDUMY2,
0547           &                    XDUMY3 )
0548              READ ( IFILE, 660 ) ( TEMP ( M ), M = 1, NUMT )
0549              GO TO 440
0550     430      CONTINUE
```

XREAD

```
0551    *
0552    *....  ELEVATION AND TEMP LISTED IN ONE TABLE ....
0553    *
0554             READ ( IFILE, 670 ) CHECK1, CHECK2
0555             IF ( CHECK1 .NE. XELEV .AND. CHECK1 .NE. XHEIG
0556          &       .AND. CHECK1 .NE. XDEPT )
0557          &       CALL ERROR ( 1320 , SUBR, CHECK1, XDEPT, XELEV,
0558          &                    XHEIG )
0559             IF ( CHECK2 .NE. XTEMP )
0560          &       CALL ERROR ( 1330  , SUBR, CHECK2, XTEMP, XDUMY2,
0561          &                    XDUMY3 )
0562             READ ( IFILE, 680 ) ( YT ( M ), TEMP ( M ), M = 1, NUMT )
0563             CHECK = CHECK1
0564     440     CONTINUE
0565    *
0566    *....  CONVERT ELEVATION OR DEPTH TO HEIGHT ABOVE BOTTOM ....
0567    *
0568             IF ( CHECK .EQ. XHEIG ) GO TO 480
0569             IF ( CHECK .EQ. XDEPT ) GO TO 460
0570    *
0571    *....  ELEVATION TO HEIGHT ....
0572    *
0573             DO 450 M = 1, NUMT
0574                YT ( M ) = YT ( M ) - BOTTOM
0575     450     CONTINUE
0576    *
0577             GO TO 480
0578     460     CONTINUE
0579    *
0580    *....  DEPTH TO HEIGHT ....
0581    *
0582             DO 470 M = 1, NUMT
0583                YT ( M ) = SURFACE - YT ( M ) - BOTTOM
0584     470     CONTINUE
0585     480     CONTINUE
0586    *
0587    *....  GENERATE COMPUTATIONAL PROFILE ....
0588    *
0589             CALL INTERP ( TEMP, YT, NUMT )
0590    *
0591             GO TO 500
0592    *
0593    *....  QUALITIES ....
0594    *
0595     490     CONTINUE
0596             BACKSPACE IFILE
0597     500     CONTINUE
0598    *
0599    *....  CHECK FOR QUALITY PROFILE ( AND NUMBER OF DATA)
0600    *       OR A STOP COMMAND ....
```

XREAD

```
0601    *
0602              READ ( IFILE, 620 ) CHECK, NQUAL
0603              QQUAL = CHECK .EQ. XQUAL
0604              IF ( CHECK .NE. XQUAL .AND.
0605           &       CHECK .NE. XSTOP )
0606           &       CALL ERROR ( 1340   , SUBR, CHECK, XQUAL, XSTOP,
0607           &                    XDUMY3 )
0608              IF ( CHECK .EQ. XSTOP ) RETURN
0609              DO 590 I = 1, NQUAL
0610              READ ( IFILE, 710 ) CHECK, ( NAMEQ ( NM, I ),
0611           &                      NM = 1, 5 ), NUMQ ( I )
0612              IF ( CHECK .NE. XNUMB )
0613           &       CALL ERROR ( 1350   , SUBR, CHECK, XNUMB, XDUMY2,
0614           &                    XDUMY3 )
0615    *
0616    *....  CHECK THAT THE FIRST QUALITY PROFILE IS DISSOLVED OXYGEN
0617    *      WHEN AERATE OR VENTING SUBROUTINES ARE TO BE USED ....
0618    *
0619              IF( QVENT .OR. QAERA .AND. NAMEQ ( 1 , 1 ) .NE. XDISS )
0620           &       CALL ERROR ( 1345   , SUBR, XDUMY, XDUMY1, XDUMY2,
0621           &                    XDUMY3 )
0622              NUMBER = NUMQ ( I )
0623              IF ( QTAB1 ) GO TO 510
0624    *
0625    *....  ELEVATION AND QUALITY LISTED IN SEPERATE TABLES ....
0626    *
0627              READ ( IFILE, 610 ) CHECK
0628    *
0629    *....  ELEVATION TABLE ....
0630    *
0631              IF ( CHECK .NE. XELEV .AND. CHECK .NE. XHEIG .AND.
0632           &       CHECK .NE. XDEPT )
0633           &       CALL ERROR ( 1360, SUBR, CHECK, XDEPT, XHEIG,
0634           &                    XELEV )
0635              READ ( IFILE, 660 ) ( YQ ( I , M ), M = 1, NUMBER )
0636    *
0637    *....  QUALITY PARAMETERS ....
0638    *
0639              READ ( IFILE, 610 ) CHECK
0640              READ ( IFILE, 660 ) ( QUAL ( I , M ), M = 1, NUMBER )
0641              GO TO 520
0642     510      CONTINUE
0643    *
0644    *....  ELEVATION AND QUALITY LISTED IN ONE TABLE ....
0645    *
0646              READ ( IFILE, 670 ) CHECK
0647              IF ( CHECK .NE. XELEV .AND. CHECK .NE. XHEIG
0648           &       .AND. CHECK .NE. XDEPT )
0649           &       CALL ERROR ( 1370 , SUBR, CHECK, XDEPT, XHEIG,
0650           &                    XELEV )
```

XREAD

```
0651            READ ( IFILE, 680 ) ( YQ ( I , M ), QUAL ( I , M ),
0652         &                          M = 1, NUMBER)
0653
0654     520    CONTINUE
0655    *
0656    *....  CONVERT ELEVATION OR DEPTH TO HEIGHT ABOVE THE BOTTOM ....
0657    *
0658            IF ( CHECK .EQ. XHEIG ) GO TO 560
0659            IF ( CHECK .EQ. XDEPT ) GO TO 540
0660    *
0661    *....  ELEVATION TO HEIGHT ....
0662    *
0663            DO 530 M = 1, NUMBER
0664               YQ ( I , M ) = YQ ( I , M ) - BOTTOM
0665     530    CONTINUE
0666            GO TO 560
0667     540    CONTINUE
0668    *
0669    *....  DEPTH TO HEIGHT ....
0670    *
0671            DO 550 M = 1, NUMBER
0672               YQ ( I , M ) = SURFACE - YQ ( I , M ) - BOTTOM
0673     550    CONTINUE
0674     560    CONTINUE
0675    *
0676    *....  ASSIGN QUALITY VALUES TO DUMMY VARIABLES TO BE PASSED
0677    *      TO ROUTINE INTERP ....
0678    *
0679            NQ = NUMQ ( I )
0680            DO 570 K = 1 , NUMBER
0681               DUMQUAL ( K ) = QUAL ( I , K )
0682               DUMYQ   ( K ) = YQ   ( I , K )
0683     570    CONTINUE
0684    *
0685    *....  GENERATE COMPUTATIONAL PROFILE ....
0686    *
0687            CALL INTERP ( DUMQUAL, DUMYQ, NQ )
0688    *
0689    *....  ASSIGN ROUTINE INTERP OUTPUT TO ARRAY ....
0690    *
0691            DO 580 K = 1, ISURF
0692               QUAL ( I , K ) = DUMQUAL ( K )
0693     580    CONTINUE
0694     590    CONTINUE
0695    *
0696    *.... STOP COMMAND ....
0697    *
0698            READ ( IFILE, 610 ) CHECK
0699            IF ( CHECK .NE. XSTOP )
0700         &       CALL ERROR ( 1380  , SUBR, CHECK, XSTOP, XDUMY2,
```

XREAD

```
0701          &                        XDUMY3 )
0702      600      FORMAT ( 1H1 )
0703      610      FORMAT ( 20A4 )
0704      620      FORMAT ( A4, 6X, 14I5 )
0705      630      FORMAT ( 10X, I6, 7X, 3H***, 20A4 )
0706      635      FORMAT( A4, 6X, A4,  6X, 6F10.0 )
0707      640      FORMAT ( A4, 6X, A4, 6X, 12I5 )
0708      650      FORMAT ( A4, 6X, ( 7F10.0 ) )
0709      660      FORMAT ( 8F10.0 )
0710      670      FORMAT ( A4, 6X, A4 )
0711      680      FORMAT ( 2F10.0 )
0712      690      FORMAT ( A4, 16X, A4 )
0713      700      FORMAT ( A4, 16X, 12I5 )
0714      710      FORMAT ( A4, 6X, 5A4, I5 )
0715               RETURN
0716               END
```

XREAD

```
0701          &                        XDUMY3 )
0702      600      FORMAT ( 1H1 )
0703      610      FORMAT ( 20A4 )
0704      620      FORMAT ( A4, 6X, 14I5 )
0705      630      FORMAT ( 10X, I6, 7X, 3H***, 20A4 )
0706      635      FORMAT( A4, 6X, A4,  6X, 6F10.0 )
0707      640      FORMAT ( A4, 6X, A4, 6X, 12I5 )
0708      650      FORMAT ( A4, 6X, ( 7F10.0 ) )
0709      660      FORMAT ( 8F10.0 )
0710      670      FORMAT ( A4, 6X, A4 )
0711      680      FORMAT ( 2F10.0 )
0712      690      FORMAT ( A4, 16X, A4 )
0713      700      FORMAT ( A4, 16X, 12I5 )
0714      710      FORMAT ( A4, 6X, 5A4, I5 )
0715               RETURN
0716               END
```