

Draft

**USER'S MANUAL
for
ENVIRONMENTAL FLUID DYNAMICS CODE**

**Hydro Version
(EFDC-Hydro)**

Release 1.00

for

U.S. Environmental Protection Agency
Region 4
Atlanta, GA

by

Tetra Tech, Inc.
10306 Eaton Place, Suite 340
Fairfax, Virginia 22030

August 1, 2002

Preface

This document comprises Volume I of the first release of a user's manual for the Environmental Fluid Dynamic Code, EFDC. A special version of named EFDC-Hydro has been developed for U.S. EPA Region 4. EFDC-Hydro contains only the hydrodynamic, temperature, dye, and sediment transport routines. In this manual, the terminology EFDC and EFDC-Hydro are considered synonymous. Volume I, comprised of 12 chapters and two appendices discusses the general structure of the EFDC model, grid generation and preprocessing, construction of input files, and post processing of output files. Volume II of the manual contains Appendix C, which is devoted to specific model applications. It is anticipated that the user's manual may be updated from time-to-time as significant features are added to the code. This manual will be released as an Adobe PDF electronic file.

Acknowledgments

The primary support for the initial development of the Environmental Fluid Dynamics Code was provided by the Commonwealth of Virginia by a special initiative appropriation to the Virginia Institute of Marine Science, The College of William and Mary. Prior to 1996, additional funding for the continued development of the EFDC model was provided by the U.S. Environmental Protection Agency, Exploratory Research Program through a grant to the Virginia Institute of Marine Science.

Subsequent to 1996, primary support for the development and maintenance of EFDC has been provided by various USEPA programs and by Tetra Tech, Inc. The development of EFDC Hydro and this user's manual was supported by the U.S. Environmental Protection Agency, Region 4, under contract 68-C-99-249.

Disclaimer

The EFDC model is capable of simulating a diverse range of environment flow and transport problems, often addressing critical questions related to both human health and safety and the health of natural ecosystems. However since the EFDC model is considered public domain and freely distributed, the author, the Virginia Institute of Marine Science, the College of William and Mary, the U.S. Environmental Protection Agency, and Tetra Tech, Inc., disclaim any and all liability which may be incurred by the use of the EFDC code for engineering, environmental assessment, and management purposes.

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1. Introduction

The EFDC (Environmental Fluid Dynamics Code) model was developed at the Virginia Institute of Marine Science (Hamrick, 1992a). The model has been applied to Virginia's James and York River estuaries (Hamrick, 1992b, 1995a) and the entire Chesapeake Bay estuarine system (Hamrick, 1994a). It is currently being used for a wide range of environmental studies in the Chesapeake Bay system including: simulations of pollutant and pathogenic organism transport and fate from point and nonpoint sources (Hamrick, 1991, 1992c), simulation of power plant cooling water discharges (Kuo and Hamrick, 1995), simulation of oyster and crab larvae transport, and evaluation of dredging and dredge spoil disposal alternatives (Hamrick, 1992b, 1994b, 1995b). The EFDC model has been used for a study of high fresh water inflow events in the northern portion of the Indian River Lagoon, Florida, (Moustafa and Hamrick, 1994, Moustafa, *et. al.*, 1995) and a flow through high vegetation density-controlled wetland systems in the Florida Everglades (Hamrick and Moustafa, 1995a,b; Moustafa and Hamrick, 1995).

The physics of the EFDC model and many aspects of the computational scheme are equivalent to the widely used Blumberg-Mellor model (Blumberg & Mellor, 1987) and U. S. Army Corps of Engineers' Chesapeake Bay model (Johnson, *et al*, 1993). The EFDC model solves the three-dimensional, vertically hydrostatic, free surface, turbulent averaged equations of motions for a variable density fluid. The model uses a stretched or sigma vertical coordinate and Cartesian or curvilinear, orthogonal horizontal coordinates. Dynamically coupled transport equations for turbulent kinetic energy, turbulent length scale, salinity and temperature are also solved. The two turbulence parameter transport equations implement the Mellor-Yamada level 2.5 turbulence closure scheme (Mellor & Yamada, 1982) as modified by Galperin *et al* (1988). An optional bottom boundary layer submodel allows for wave-current boundary layer interaction using an externally specified high frequency surface gravity wave field. The EFDC model also simultaneously solves an arbitrary number of Eulerian transport-transformation equations for dissolved and suspended materials. A complimentary Lagrangian particle transport-transformation scheme is also implemented in the model. The EFDC model also allows for drying and wetting in shallow areas by a mass conservative scheme. A number of alternatives are in place in the model to simulate general discharge control structures such as weirs, spillways and culverts. For nearshore surf zone simulation, the EFDC model can incorporate externally specified radiation stresses due to high frequency surface gravity waves. Externally specified wave dissipation due to

wave breaking and bottom friction can also be incorporated in the turbulence closure model as source terms. For the simulation of flow in vegetated environments, the EFDC model incorporates both two and three-dimensional vegetation resistance formulations (Hamrick and Moustafa, 1995a). The model provides output formatted to yield transport fields for water quality models, including WASP5 (Ambrose, *et. al.*, 1993) and CE-QUAL-IC (Cercio and Cole, 1993).

The numerical scheme employed in EFDC to solve the equations of motion uses second order accurate spatial finite difference on a staggered or C grid. The model's time integration employs a second order accurate three time level, finite difference scheme with an internal-external mode splitting procedure to separate the internal shear or baroclinic mode from the external free surface gravity wave or barotropic mode. The external mode solution is semi-implicit, and simultaneously computes the two-dimensional surface elevation field by a preconditioned conjugate gradient procedure. The external solution is completed by the calculation of the depth averaged barotropic velocities using the new surface elevation field. The model's semi-implicit external solution allows large time steps which are constrained only by the stability criteria of the explicit central difference or upwind advection scheme used for the nonlinear accelerations. Horizontal boundary conditions for the external mode solution include options for simultaneously specifying the surface elevation only, the characteristic of an incoming wave (Bennett & McIntosh, 1982), free radiation of an outgoing wave (Bennett, 1976; Blumberg & Kantha, 1985) or the normal volumetric flux on arbitrary portions of the boundary. The EFDC model's internal momentum equation solution, at the same time step as the external, is implicit with respect to vertical diffusion. The internal solution of the momentum equations is in terms of the vertical profile of shear stress and velocity shear, which results in the simplest and most accurate form of the baroclinic pressure gradients and eliminates the over determined character of alternate internal mode formulations. Time splitting inherent in the three time level scheme is controlled by periodic insertion of a second order accurate two time level trapezoidal step. The EFDC model is also readily configured as a two-dimensional model in either the horizontal or vertical planes.

The EFDC model implements a second order accurate in space and time, mass conservation fractional step solution scheme for the Eulerian transport equations at the same time step or twice the time step of the momentum equation solution (Smolarkiewicz and Margolin, 1993). The advective step of the transport solution uses either the central difference scheme used in the Blumberg-Mellor model or a hierarchy of positive definite upwind difference schemes. The highest accuracy upwind scheme, second order accurate in space and time, is based on a flux corrected transport version of Smolarkiewicz's

multidimensional positive definite advection transport algorithm (Smolarkiewicz, 1984; Smolarkiewicz & Clark, 1986; Smolarkiewicz & Grabowski, 1990) which is monotone and minimizes numerical diffusion. The horizontal diffusion step, if required, is explicit in time, while the vertical diffusion step is implicit. Horizontal boundary conditions include time variable material inflow concentrations, upwinded outflow, and a damping relaxation specification of climatological boundary concentration. For the heat transport equation, the NOAA Geophysical Fluid Dynamics Laboratory's atmospheric heat exchange model (Rosati & Miyakoda, 1988) is implemented. The Lagrangian particle transport-transformation scheme implemented in the model utilizes an implicit trilinear interpolation scheme (Bennett & Clites, 1987). To interface the Eulerian and Lagrangian transport-transformation equation solutions with near field plume dilution models, internal time varying volumetric and mass sources may be arbitrarily distributed over the depth in a specified horizontal grid cell. The EFDC model can be used to drive a number of external water quality models using internal linkage processing procedures described in Hamrick (1994a).

The EFDC model is implemented in a generic form requiring no internal source code modifications for application to specific study sites. The model includes a preprocessor system which generates a Cartesian or curvilinear-orthogonal grid (Mobley and Stewart, 1980; Ryskin & Leal, 1983), and interpolates bathymetry and initial salinity and temperature input fields from observed data. The model's input system features an interactive user's manual with extensive on-line documentation of input variables, files and formats. A menu driven, windows based, implementation of the input system is under development. The model produces a variety of real time messages and outputs for diagnostic and monitoring purposes as well as a restart file. For postprocessing, the model has the capability for in-place harmonic and time series analysis at user specified locations. A number of options exist for saving time series and creating time sequenced files for horizontal and vertical sliced contour, color shaded and vector plots. The model also outputs a variety of array file formats for three-dimensional vector and scalar field visualization and animation using a number of public and inexpensive private domain data visualization packages (Rennie and Hamrick, 1992). The EFDC model is coded in standard FORTRAN 77, and is designed to economize mass storage by storing only active water cell variables in memory. Particular attention has also been given to minimizing logical operations with the code being 99.8 per cent vectorizable for floating point operations and benchmarked at a sustained performance of 380 MFLOPS on a single Cray Y-MP C90 processor. The EFDC model is currently operational on VAX-VMS systems, Sun, HP-Apollo, Silicon Graphics, Convex, and Cray UNIX

systems, IBM PC compatible DOS systems (Lahey EM32 FORTRAN) and Macintosh 68K and Power PC systems (LSI and Absoft FORTRAN).

The theoretical and computational basis for the model is documented in Hamrick (1992a). Extensions to the model formulation for the simulation of vegetated wetlands are documented in Hamrick and Moustafa (1995a,b) and Hamrick and Moustafa and Hamrick (1995a). Model formulations for computation of Lagrangian particle trajectories and Lagrangian mean transport fields are described in Hamrick (1994a) and Hamrick and Yang (1995).

The general organization of this manual is as follows. Chapter 2 presents the general structure of the EFDC modeling system focusing on the structure of the EFDC code and the sequence of steps in setting up and executing the model and processing and interpreting the computational results. Chapters 3 through 10 essentially follow the sequence of steps in the application of the model to a specific environmental flow system. Chapter 3 describes the specification of the horizontal spatial configuration of the system being modeled using the GEFDC grid generating preprocessor code. Chapter 4 describes the configuration of the master input file *efdc.inp* which controls the overall execution of a model simulation. Chapter 5 documents additional input files necessary to specify the simulation. Guidelines for compiling and executing the model on UNIX workstations and super computers, IBM compatible PC systems and Macintosh systems are presented in Chapter 6. Chapter 7 describes options for diagnosing execution failures using EFDC's internal diagnostic options and a number of compiler option diagnostic tools. Chapter 8 describes time series output options and formats as well a number of generic and custom, application specific, time series analysis techniques. Two-dimensional horizontal and vertical plane graphics output and visualization options are presented in Chapter 9, while Chapter 10 presents similar material for three-dimensional graphics and visualization. Appendix A contain a list of the source code subroutines and their functions. Appendix B contains a number of example grids and input files for the *gefdc.f* grid generating preprocessor.

2. General Structure of the EFDC Modeling System

The primary component of the EFDC modeling system is the FORTRAN 77 source code *efdc.f* and two include files: *efdc.cmn*, which contains common block declarations and arrayed variable dimensions, and *efdc.par*, which contains a parameter statement specifying the dimensions of arrayed variables. The source code *efdc.f* and the common file, *efdc.cmn*, are universal for all model applications or configurations. The parameter file, *efdc.par*, is configured for a particular model application to minimize memory requirements during model execution. Details of configuring the parameter file, *efdc.par*, and compiling the source code *efdc.f* are presented in Chapter 6. The source code, *efdc.f*, is comprised of a main program and 136 subroutines. A list of the subroutines and a brief description of their functions is found in Appendix A.

Model configuration and environmental data for a particular application are provided in the following sequence of input files (in alphabetical order).

Table 1. Input files for the EFDC model.

<u>File Name</u>	<u>Type of Input Data</u>
aser.inp	Atmospheric forcing time series file.
cell.inp	Horizontal cell type identifier file.
celllt.inp	Horizontal cell type identifier file for saving mean mass transport.
depth.inp	File specifying depth, bottom elevation, and bottom roughness for Cartesian grids only.
dser.inp	Dye concentration time series file.

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dxdy.inp	File specifying horizontal grid spacing or metrics, depth, bottom elevation, bottom roughness and vegetation classes for either Cartesian or curvilinear-orthogonal horizontal grids.
dye.inp	File with initial dye distribution for cold start simulations.
efdc.inp	Master input file.
fldang.inp	File specifying the CCW angle to the flood axis of the local M2 tidal ellipses.
gcellmap.inp	File specifying a Cartesian grid overlay for a curvilinear-orthogonal grid.
gwater.inp	File specifying the characteristic of a simple soil moisture model.
lxly.inp	File specifying horizontal cell center coordinates and cell orientations for either Cartesian or curvilinear-orthogonal grids.
mappgns.inp	Specifies configuration of the model grid to represent a periodic region in the north-south or computational y direction.
mask.inp	File specifying thin barriers to block flow across specified cell faces.
modchan.inp	Subgrid scale channel model specification file.
modxdy.inp	File specifying modification to cell sizes (used primarily for calibration adjustment of subgrid scale channel widths)
pser.inp	Open boundary water surface elevation time series file.
qctl.inp	Hydraulic control structure characterization file.
qser.inp	Volumetric source-sink time series file.

restart.inp	File for restarting a simulation.
restran.inp	File with arbitrary time interval averaged transport fields used to drive mass transport only simulations.
salt.inp	File with initial salinity distribution for cold start, salinity stratified flow simulations.
sdser.inp	Suspended sediment concentration time series file.
show.inp	File controlling screen print of conditions in a specified cell during simulation runs.
sser.inp	Salinity time series file.
sfser.inp	Shellfish release time series file.
sfbser.inp	Shellfish behavior time series file.
tser.inp	Temperature time series file.
vege.inp	Vegetation resistance characterization file.
wave.inp	Specifies a high frequency surface gravity wave field require to activate the wave-current boundary layer model and/or wave induced current model.

The input files listed in Table 1 above can be classified in four groups as indicated in Table 2 below.

Table 2. Input files grouped by function.

(1) Horizontal grid specification files:

cell.inp	celllt.inp	depth.inp	dxdy.inp
gcellmap.inp	lxly.inp	mappgns.inp	mask.inp

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(2) General data and run control files:

efdc.inp show.inp

(3) Initialization and restart files:

salt.inp dye.inp restart.inp restran.inp

(4) Physical process specification files:

gwater.inp modchan.inp moddxdy.inp qctl.inp
vege.inp wave.inp

(5) Time series forcing and boundary condition files:

aser.inp dser.inp pser.inp qser.inp
sdser.inp sfser.inp sfbser.inp sser.inp
tser.inp

The recommended sequence for the construction of the input files for configuration of the model and set up for a simulation generally corresponds to the above file group classes. The files, *dxdy.inp* and *lxly.inp*, which specify the model grid geometry and topography or bathymetry, and the file, *gcellmap.inp*, which specifies an optional graphics overlay grid, can be automatically generated by an auxiliary grid generating preprocessor code GEFDC (FORTRAN 77 source file *gefdc.f*). The use of GEFDC is discussed in Chapter 3. The master input file, *efdc.inp*, is discussed in detail in Chapter 4, while the structure of the remaining input files are described in Chapter 5.

The EFDC modeling system produces five classes of output: 1) diagnostic output files; 2) restart and transport field files; 3) time series, point samples and least squares harmonic analysis output files; 4) two-dimensional graphics and visualization files; and 5) three-dimensional graphics and visualization files. The activation and control of these output classes is specified in the master input file *efdc.inp*, as will be discussed in Chapter 4. Guidance for activating and analyzing diagnostic output options is discussed in Chapter 7, while Chapters 8, 9, and 10 describe the formats and processing procedures for time series, two-dimensional and three-dimensional model outputs.

3. Grid Generation and Preprocessing

The first step in the setup or configuration of the EFDC modeling system is defining the horizontal plane domain of the region being modeled. The horizontal plane domain is approximated by a set of discrete quadrilateral and optional triangular cells. The terminology grid or grid lines refers to the lines defining the faces of the quadrilateral cells. (Triangular cells are defined by one of four possible regions resulting from diagonal division of a quadrilateral cell.) Since the EFDC model solves the hydrodynamic equations in a horizontal coordinate system that is curvilinear and orthogonal, the grid lines also correspond to lines having a constant value of one of the horizontal coordinates. In the following discussions, x and y , as well as I and J will be used to identify the two horizontal coordinate directions in the so-called computation domain. The terminology east and north, when associated with the curvilinear x and y coordinates respectively, will also be used to specify relative locations. The terminology true east and true north will be associated with a set of horizontal map coordinates, x^* and y^* , respectively, which may represent longitude-latitude, east and north state plane (SP) or universal transverse mercator (UTM) coordinates, or any local set of map coordinates defined by the user. Since the *efdc.f* code uses the MKS (meters, kilograms and seconds unit system internally), the writer tends to favor the use of localized UTM coordinates (true zonal UTM coordinates localized to an origin southwest of the region to be modeled).

The horizontal grid of cells is defined by a cell type array which is specified by the file *cell.inp*. To illustrate the definition of the horizontal model domain and the form of the *cell.inp* file, consider a simple circular basin with an entrance channel to the East, as shown in Figure 1. The region is coarsely approximated by 18 square cells and 4 right triangular cells as shown in Figure 1. The *cell.inp* file corresponding to the 22 water cell grid is shown in Figure 2. The *cell.inp* file has four header lines, followed by an image of the cell type array, $IJCT(I,J)$, where I and J are the cell indexes in the computational or curvilinear x and y directions respectively. In the lines following the header lines, the first three columns (I3 format) specify the value of J decreasing from a maximum of 6 to 1, followed by two blank spaces (2X format). The remaining columns across the row specify the cell type identification number entered in the array, $IJCT(I,J)$ for I increasing from 1 to 9. Seven identification numbers are used to define the cell type. They are as follows:

Table 3. Definition of cell types in the *cell.inp* file.

0	dry land cell not bordering a water cell on a side or corner
1	triangular water cell with land to the northeast
2	triangular water cell with land to the southeast
3	triangular water cell with land to the southwest
4	triangular water cell with land to the northwest
5	quadrilateral water cell
9	dry land cell bordering a water cell on a side or corner or a fictitious dry land cell bordering an open boundary water cell on a side or a corner.

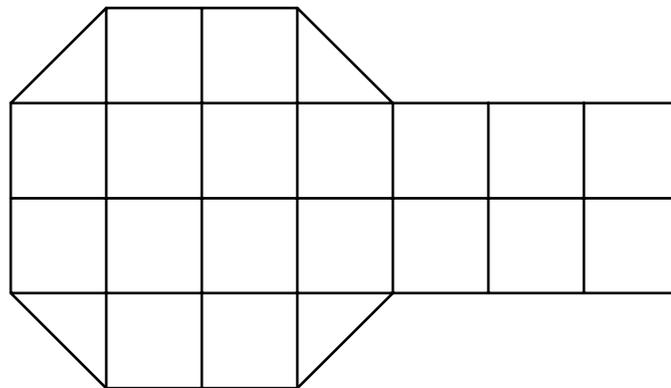


Figure 1. Representation of a circular basin and entrance channel by a 22 water cell grid.

```

C cell.inp file, i columns and j rows, for Figure 1
C   0       1
C  1234567890
C
C   6 999999000
C   5 945519999
C   4 955555559
C   3 955555559
C   2 935529999
C   1 999999000
C
C  1234567890
C   0       1

```

Figure 2. File *cell.inp* corresponding to the grid shown in Figure 1.

```

C celllt.inp file, i columns and j rows, for Figure 1
C   0       1
C  1234567890
C
C   6 999999000
C   5 945519900
C   4 955555900
C   3 955555900
C   2 935529900
C   1 999999000
C
C  1234567890
C   0       1

```

Figure 3. File *celllt.inp* corresponding to the grid shown in Figure 1, with four entry channel cells removed.

The type 9 dry land or fictitious dry land cell type is used in the specification of no flow boundary conditions and in graphics masking operations. For purposes of assigning adjacent type 9 cells, triangular water cells are treated identically to quadrilateral water cells. The file *celllt.inp* may be identical to the file *cell.inp* or specify a subset of the water cells in the *cell.inp* file. In specifying the subset, the following rules apply. Type 0 cells remain unchanged, type 9 cells may be changed only to type 0, and type 1-5 cells may be changed only to types 0 or 9. Figure 3 illustrates a *celllt.inp* file corresponding to the *cell.inp* file in Figure 2 with four of the entry channel cells removed.

To specify the horizontal geometric and topographic properties and other related characteristics of the region, the files *dxdy.inp* and *lxly.inp* are preferably used. (An older model option used the *depth.inp* file

for this purpose. However this is not recommended). For this simple grid, these files, shown in Figure 4 and 5, can be readily constructed by hand. Both files, which are read into the model execution in free format, begin with four header lines defining the columns. The file *dxdy.inp* provides the physical x and y dimensions of a cell, dx and dy , the initial water depth, the bottom elevation, and the roughness height (log law z_0). These quantities should generally be specified in meters, although units conversion options can be specified in the master input file, *efdc.inp*. The last column contains an integer vegetation type class identifier. This column is read only when the vegetation resistance option is activated in the master input file *efdc.inp*. The file *lxly.inp* provides cell center coordinates and the components of a rotation matrix. The cell center coordinates are used only in graphics output and can be specified in the most convenient units for graphical display such as decimal degrees, feet, miles, meters or kilometers. The rotation matrix is used to convert pseudo east and north (curvilinear x and y) horizontal velocities to true east and north for graphics vector plotting, according to:

$$\begin{Bmatrix} u_{te} \\ v_{tn} \end{Bmatrix} = \begin{bmatrix} C_{cue} & C_{cve} \\ C_{cun} & C_{cvn} \end{bmatrix} \begin{Bmatrix} u_{co} \\ v_{co} \end{Bmatrix} \quad (1)$$

where the subscripts te and tn denote true east and true north, while the subscripts co denote the curvilinear-orthogonal horizontal velocity components. The inverse of the rotation matrix is used to compute horizontal curvilinear components of the surface wind stress from true east and north components, according to:

$$\begin{Bmatrix} \tau_{x, co} \\ \tau_{y, co} \end{Bmatrix} = \begin{bmatrix} C_{cue} & C_{cve} \\ C_{cun} & C_{cvn} \end{bmatrix}^{-1} \begin{Bmatrix} \tau_{x, te} \\ \tau_{y, tn} \end{Bmatrix} \quad (2)$$

For the example shown in Figure 4, the horizontal grid is Cartesian and aligns with true east and north.

```

C dxdy.inp file, in free format across columns
C
C I J DX DY DEPTH BOTTOM ELEV ZROUGH VEG TYPE
C
  2 2 100.0 100.0 5.0 -5.0 0.02 0
  3 2 100.0 100.0 5.0 -5.0 0.02 0
  4 2 100.0 100.0 5.0 -5.0 0.02 0
  5 2 100.0 100.0 5.0 -5.0 0.02 0
  6 2 100.0 100.0 5.0 -5.0 0.02 0
  7 2 100.0 100.0 5.0 -5.0 0.02 0
  8 2 100.0 100.0 5.0 -5.0 0.02 0
  2 3 100.0 100.0 5.0 -5.0 0.02 0
  3 3 100.0 100.0 5.0 -5.0 0.02 0
  4 3 100.0 100.0 5.0 -5.0 0.02 0
  5 3 100.0 100.0 5.0 -5.0 0.02 0
  6 3 100.0 100.0 5.0 -5.0 0.02 0
  7 3 100.0 100.0 5.0 -5.0 0.02 0
  8 3 100.0 100.0 5.0 -5.0 0.02 0
  2 4 100.0 100.0 5.0 -5.0 0.02 0
  3 4 100.0 100.0 5.0 -5.0 0.02 0
  4 4 100.0 100.0 5.0 -5.0 0.02 0
  5 4 100.0 100.0 5.0 -5.0 0.02 0
  6 4 100.0 100.0 5.0 -5.0 0.02 0
  7 4 100.0 100.0 5.0 -5.0 0.02 0
  8 4 100.0 100.0 5.0 -5.0 0.02 0
  2 5 100.0 100.0 5.0 -5.0 0.02 0
  3 5 100.0 100.0 5.0 -5.0 0.02 0
  4 5 100.0 100.0 5.0 -5.0 0.02 0
  5 5 100.0 100.0 5.0 -5.0 0.02 0
  6 5 100.0 100.0 5.0 -5.0 0.02 0
  7 5 100.0 100.0 5.0 -5.0 0.02 0
  8 5 100.0 100.0 5.0 -5.0 0.02 0
C
C I ARRAY INDEX IN X DIRECTION
C J ARRAY INDEX IN Y DIRECTION
C DX CELL DIMENSION IN X DIRECTION, METERS
C DY CELL DIMENSION IN Y DIRECTION, METERS
C DEPTH INITIAL WATER DEPTH, METERS
C BOTTOM ELEV BOTTOM BED ELEVATION, METERS
C ZROUGH LOG LAW ROUGHNESS HEIGHT, ZO, METERS
C VEG TYPE VEGETATION TYPE CLASS, INTEGER VALUE
C

```

Figure 4. File *dxdy.inp* for grid shown in Figure 1.

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```

C lxly.inp file, in free format across columns
C
C   I   J   XLNUTME   YLTUTMN   CCUE   CCVE   CCUN   CCVN
C
  2   2   250.0     250.0     1.0   0.0   0.0   1.0
  3   2   350.0     250.0     1.0   0.0   0.0   1.0
  4   2   450.0     250.0     1.0   0.0   0.0   1.0
  5   2   550.0     250.0     1.0   0.0   0.0   1.0
  6   2   650.0     250.0     1.0   0.0   0.0   1.0
  7   2   750.0     250.0     1.0   0.0   0.0   1.0
  8   2   850.0     250.0     1.0   0.0   0.0   1.0
  2   3   250.0     350.0     1.0   0.0   0.0   1.0
  3   3   350.0     350.0     1.0   0.0   0.0   1.0
  4   3   450.0     350.0     1.0   0.0   0.0   1.0
  5   3   550.0     350.0     1.0   0.0   0.0   1.0
  6   3   650.0     350.0     1.0   0.0   0.0   1.0
  7   3   750.0     350.0     1.0   0.0   0.0   1.0
  8   3   850.0     350.0     1.0   0.0   0.0   1.0
  2   4   250.0     450.0     1.0   0.0   0.0   1.0
  3   4   350.0     450.0     1.0   0.0   0.0   1.0
  4   4   450.0     450.0     1.0   0.0   0.0   1.0
  5   4   550.0     450.0     1.0   0.0   0.0   1.0
  6   4   650.0     450.0     1.0   0.0   0.0   1.0
  7   4   750.0     450.0     1.0   0.0   0.0   1.0
  8   4   850.0     450.0     1.0   0.0   0.0   1.0
  2   5   250.0     550.0     1.0   0.0   0.0   1.0
  3   5   350.0     550.0     1.0   0.0   0.0   1.0
  4   5   450.0     550.0     1.0   0.0   0.0   1.0
  5   5   550.0     550.0     1.0   0.0   0.0   1.0
  6   5   650.0     550.0     1.0   0.0   0.0   1.0
  7   5   750.0     550.0     1.0   0.0   0.0   1.0
  8   5   850.0     550.0     1.0   0.0   0.0   1.0
C
C
C   I           ARRAY INDEX IN X DIRECTION
C   J           ARRAY INDEX IN Y DIRECTION
C XLNUTME      X CELL CENTER COORDINATE, LONGITUDE, METERS, OR KM
C YLTUTMN      Y CELL CENTER COORDINATE, LONGITUDE, METERS, OR KM
C CCUE         ROTATION MATRIX COMPONENT
C CCVE         ROTATION MATRIX COMPONENT
C CCUN         ROTATION MATRIX COMPONENT
C CCVN         ROTATION MATRIX COMPONENT
C

```

Figure 5. File *lxly.inp* for grid shown in Figure 1.

For realistic model applications, the grid generating preprocessor code, *gefdc.f*, is used to generate the horizontal grid and form the *dx dy.inp* and *lxly.inp* files. The *gefdc.f* code requires the input files listed in Table 4:

Table 4. Input files for the *gefdc.f* grid generating preprocessor.

<i>cell.inp</i>	Cell type file as shown in Figure 2.
<i>depdat.inp</i>	File specifying depth or bottom topography (optional if depth interpolation is not specified).
<i>gcell.inp</i>	Optional auxiliary file with <i>cell.inp</i> format which specifies an auxiliary square Cartesian grid for rectangular array graphics when the actual computational grid is curvilinear.
<i>gridext.inp</i>	File of water cell corner coordinates for used with NTYPE = 0 grid generation option.
<i>gefdc.inp</i>	Master input file for <i>gefdc.f</i> .
<i>vege.inp</i>	File specifying vegetation type classes.
<i>zrough.inp</i>	File specifying bottom roughness (log law z_0).

The format of the *cell.inp* file has already been discussed. The *depdat.inp* file is a three column ASCII text file with no header, as shown in Figure 6. The first two columns are true east and true north coordinates, in meters or kilometers, with the depth or bottom elevation given in the third column. The origin of the true east and north coordinates is arbitrary, but should generally be related to an accepted geographic coordinate system such as longitude-latitude, state plane, or universal transverse mercator. The optional file *gcell.inp* has the same format as the *cell.inp* file, but specifies an auxiliary, square cell, Cartesian grid corresponding to the curvilinear grid specified by the *cell.inp* file. When the option to process the *gcell.inp* file is activated in the *gefdc.inp* file, a correspondence table between the curvilinear grid and the auxiliary, square cell, Cartesian grid is generated. The correspondence table, output as file *gcellmap.inp*, is used by the *efdc.f* code to generate two and three-dimensional rectangular arrays of graphics visualization, as will be subsequently discussed. The file *gridext.inp* is used for generation of a grid constructed external to the *gefdc.f* code. This file is a four column free format ASCII text file with no header. The four columns correspond to the I indices, J indices, true east coordinates, and true north coordinates of the water cell corners. The lower left (pseudo southwest relative to the cell center) cell corners carry the same I and J indices as the cell. The *gridext.inp* file corresponding to the simple grid in Figure 1 is shown in Figure 7. Triangular cells must be specified as equivalent quadrilaterals in the

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gridext.inp file. The files *vege.inp* and *zrough.inp* have the same format as the *depdat.inp* file, with the exception that the third column of the *vege.inp* file has an integer value corresponding to a vegetation class. The third column of the *zrough.inp* file has values of the log law bottom roughness height, z_o , (preferably in meters, however unit conversion may be specified in the master input file *efdc.f*).

4.2798	6.9175	3.2309
4.2785	6.9175	3.2309
4.4509	6.7880	3.1090
4.4409	6.7927	3.1090
4.4222	6.7995	3.1090
4.4133	6.8028	3.1090

Figure 6. Format of the file *depdat.inp*.

2	2	200.	200.
3	2	300.	200.
4	2	400.	200.
5	2	500.	200.
6	2	600.	200.
2	3	200.	300.
3	3	300.	300.
4	3	400.	300.
5	3	500.	300.
6	3	600.	300.
7	3	700.	300.
8	3	800.	300.
9	3	900.	300.
2	4	200.	400.
3	4	300.	400.
4	4	400.	400.
5	4	500.	400.
6	4	600.	400.
7	4	700.	400.
8	4	800.	400.
9	4	900.	400.
2	5	200.	500.
3	5	300.	500.
4	5	400.	500.
5	5	500.	500.
6	5	600.	500.
7	5	700.	500.
8	5	800.	500.
9	5	900.	500.
2	6	200.	600.
3	6	300.	600.
4	6	400.	600.
5	6	500.	600.

Figure 7. File *gridext.inp* for grid shown in Figure 1.

```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
   'gefdc.inp corresponding to example in figure 1'
C2 INTEGER INPUT
C2 NTYPE  NBPP  IMIN  IMAX  JMIN  JMAX  IC  JC
   0      0    1    9    1    6    9  6
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
   0    0  0  0.  0.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
   0.    0.    0.    0.    0.    0.
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
   100    100    100    100    4000    1.0
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
   1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12 1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
   0.      0.      1.      1.      15.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI JSIRKI ISIHJHJ JSIHJHJ
   1      0      0      0
C9 NTYPE = 7 SPECIFID INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFID INPUT
C10 X  Y  IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
   0      0      2.  .5  2      4.0  0  0  0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT) Y(ILT,JLT)
   1  1  0.      0.
C13 BOUNDARY POINT INFORMATION
C13 I  J  X(I,J)  Y(I,J)

```

Figure 8. Example of the *gefdc.inp*, master input file for the *gefdc.f* code.

The execution of the *gefdc.f* code is controlled by its master input file, *gefdc.inp*. An example of the *gefdc.inp* file for the grid in Figure 1 is shown in Figure 8. The file is essentially a sequence of 'card images' or input lines. Each input line is preceded by card number lines beginning with 'C' followed by a number corresponding the card image or data input line and text defining the data type and the actual data parameters. To fully discuss the options in the execution of the *gefdc.f* code, it is useful to consider each 'card image' or input line sequence. The following discussion will sequentially present the header and data lines in Monaco text with definitions of data parameters following in Monaco text. Additional discussion

then follows in plain text. In the discussions, reference will be made to six grid generation examples in Appendix B, which illustrate specific options as well as showing the resulting grid.

Card Image 1

```
C1  TITLE
C1  (LIMITED TO 80 CHARACTERS)
    'ENR GRID'
```

This 80-character title simply serves to identify the particular application.

Card Image 2

```
C2  INTEGER INPUT
C2  NTYPE  NBPP    IMIN  IMAX  JMIN  JMAX  IC   JC
    0      0      1     50   1     55   50   55
```

Card Image 2 parameter definitions are as follows:

```
NTYPE = PROBLEM TYPE
0, READ IN FILE 'cell.inp' AND WATER GRID CELL CORNER
   COORDINATES FROM FILE 'gridext.inp' TO GENERATE
   INPUT FILES FOR AN EXTERNALLY GENERATED ORTHOGONAL GRID
1-5 GENERATE AN ORTHOGONAL GRID AND INPUT FILES USING
   THE METHOD OF RYSKIN AND LEAL, J. COMP. PHYS. V50,
   71-100 (1983) WITH SYMMETRIC REFLECTIONS AS SUGGESTED BY
   CHIKHLIWALA AND YORTSOS, J. COMP. PHYS. V57, 391-402 (1985).
1, RL-CY EAST REFLECTION
2, RL-CY NORTH REFLECTION
3, RL-CY WEST REFLECTION
4, RL-CY SOUTH REFLECTION
5, RL NO REFLECTION
6, GENERATE GRID AND INPUT FILES USING THE AREA-ORTHOGONALITY
   METHOD OF KNUPP, J. OF COMP PHYS. V100, 409-418 (1993)
   ORTHOGONALITY IS NOT GUARANTEED
7, GENERATE GRID ORTHOGONAL GRID AND INPUT FILES USING THE
   QUASI-CONFORMAL METHOD OF MOBLEY AND STEWART, J. OF COMP
   PHYS. V24, 124-135 (1980) REQUIRES USER SUPPLIED FUNCTION
   SUBROUTINES FIB,FIE,GJB,GJE
8, DEPTH INTERPOLATION TO CARTESIAN GRID SPECIFIED
   BY cell.inp AND GENERATE dxdy.inp AND lxly.inp FILES
9, DEPTH INTERPOLATION TO CARTESIAN GRID AS FOR 8
   CONVERTING INPUT COORDINATE SYSTEM FROM
   LONG,LAT TO UTMBAY (VIMS PHYS OCEAN CHES BAY REF)
NBPP = NUMBER OF INPUT BOUNDARY POINTS (NTYPE = 1-6)
IMIN,IMAX = RANGE OF I GRID INDICES
JMIN,JMAX = RANGE OF J GRID INDICES
IC = NUMBER OF CELLS IN I DIRECTION
JC = NUMBER OF CELLS IN J DIRECTION
```

The NTYPE parameter controls the type of grid generated by the *gefdc.f* code. NTYPE = 0 corresponds to an external specification of the grid by the *gridext.inp* file, see Figure 7, with *gefdc.f* only generating input files for the *efdc.f* code. Example of NTYPE = 0 grids are given in Appendices B.1, B.2, and B.4. The NTYPE options 1-5 generate curvilinear-orthogonal grids using the method of Ryskin and Leal (1983). NTYPE options 1-4 require that one of the boundaries of the grid to be a straight line and use reflection extensions of Ryskin and Leal's method proposed by Chikhliwala and Yortsos (1985). The NTYPE = 5 option is generally recommended. A simple NTYPE = 2 grid generation example is given in Appendix B.3. A more complicated composite grid composed of NTYPE 0 and 5 subgrids is discussed in Appendix B.4. The NTYPE = 7 option generates a quasi-conformal grid using the method of Mobley and Stewart (1980). When the NTYPE = 7 option is used, the computational domain must be rectangular (i.e. the physical domain is mapped into a rectangular region). An example of a NTYPE = 7 grid is presented in Appendix B.5. The NTYPE = 8 option generates a square cell Cartesian grid using only the *cell.inp* file and information on Card Image 4. The NTYPE = 9 option generates an approximately square cell Cartesian grid using the *cell.inp* file and information on Card Image 4. However, the coordinate information on Card Image 4 must correspond to longitude and latitude, which is internally converted to a universal transverse mercator (UTM) coordinate system localized to the Chesapeake Bay region. An example NTYPE = 9 grid is presented in Appendix B.6. The NTYPE = 6 option implements the area-orthogonal method of Knupp (1992). Since this method does not guarantee an orthogonal grid, it should be used with extreme care. For NTYPE = 1-6, NBPP coordinate pairs specifying the grid points (water cell corner points) around the boundary of the domain must be specified (see Card Images 12 and 13).

Card Image 3

```
C3  GRAPHICS GRID INFORMATION
C3  ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     0   0   1.    1.    1
```

Card Image 3 parameter definitions are as follows

```
ISGG = 1, READ IN gcell.inp WHICH DEFINES THE CARTESIAN OR
          GRAPHICS GRID OVERLAY
IGM    MAXIMUM X OR I CELLS IN CARTESIAN OR GRAPHICS GRID
JGM    MAXIMUM Y OF J CELLS IN CARTESIAN OR GRAPHICS GRID
DXCG   X GRID SIZE OF CARTESIAN OR GRAPHICS GRID
DYCG   Y GRID SIZE OF CARTESIAN OF GRAPHICS GRID
NWTGG  NUMBER OF WEIGHTED COMP CELLS USED TO INTERPOLATE
          TO THE GRAPHICS GRID (MUST EQUAL 1)
```

Activation of ISGG = 1, allows for a square cell Cartesian grid to be simultaneously generated when NTYPE = 1-7. This Cartesian grid is used by *efdc.f* to output the results of a 3D curvilinear coordinate computation in a 3D rectangular array for visualization and graphics. The relation between the I and J indices of the Cartesian grid, specified by *gcell.inp*, and the global coordinates (true east and true north) defining the curvilinear grid in physical space are defined by input on Card Image 4. The *gcell.inp* file has the same format as the *cell.inp* file. The *gefdc.inp* files shown in Figure B14 and B27 are examples where the ISGG = 1 option is activated.

Card Image 4

```
C4  CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4  CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
      -77.5   1.25   -0.625  36.7    1.0    -0.5
```

Card Image 4 parameter definitions are as follows:

```
CDLON1:  6  CONSTANTS TO GIVE CELL CENTER LAT AND LON OR OTHER
CDLON2:   COORDINATES FOR CARTESIAN GRIDS USING THE FORMULAE
CDLON3:   DLON (L) =CDLON1+ (CDLON2*FLOAT (I) +CDLON3) /60 .
CDLAT1:   DLAT (L) =CDLAT1+ (CDLAT2*FLOAT (J) +CDLAT3) /60 .
CDLAT2:
CDLAT3:
```

The information on this card image defines the global coordinates (true east and true north) of Cartesian cell centers corresponding to the I and J indices in the *gcell.inp* file for the Cartesian graphics grid overlay when NTYPE = 1-7 is specified (see *gefdc.inp* files in Figure B14 and B27). When NTYPE = 8 or 9 is specified, the information defines the cell center coordinates corresponding to I and J indices in the *cell.inp* file (see the *gefdc.inp* file in Figure B34). When NTYPE = 9, DLON and DLAT must correspond to longitude and latitude, otherwise DLON and DLAT can also correspond to a true east and true north coordinate system in meters or kilometers.

Card Image 5

```
C5  INTEGER INPUT
C5  ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
      500    500    500    500    4000    1.0
```

Card Image 5 parameter definitions are as follows:

```
ITRXM = MAXIMUM NUMBER OF X,Y SOLUTION ITERATIONS
ITRHM = MAXIMUM NUMBER OF HI,HJ SOLUTION ITERATIONS
ITRKM = MAXIMUM NUMBER OF KJ/KI SOLUTION ITERATIONS
ITRGM = MAXIMUM NUMBER OF GRID SOLUTION ITERATIONS
NDEPSM = NUMBER SMOOTHING PASSES TO FILL MISSING DEP DAT
DEPMIN = MINIMUM DEPTH PASSING DEP DAT.INP DATA
```

The first four parameters on Card Image 5 control the number of iterations for the various curvilinear grid generation schemes, based on successive over relaxation (SOR) solutions of elliptic equations, in *gefdc.f*. The value of 500 is recommended as a maximum for each of these parameters based on the writer's experience that if the successive over relaxation (SOR) solution schemes do not converge after 500 iterations they are not converging at all. The value of 4000 for NDEPSM is the recommended number of smoothing passes used to fill in missing depth or bottom elevation data when the ISIDEP = 1 option on Card Image 11 is activated.

Card Image 6

C6	REAL INPUT								
C6	RPX	RPK	RPH	RSQXM	RSQKM	RSQKIM	RSQHM	RSQHIM	RSQHJM
	1.8	1.8	1.8	1.E-12	1.E-12	1.E-12	1.E-12	1.E-12	1.E-12

Card Image 6 parameter definitions are as follows:

RPX, RPK, RPH = RELAXATION PARAMETERS FOR X, Y; KI/KJ; AND HI, HJ
SOR SOLUTIONS
RSQXM, RSQKM, RSQHM = MAXIMUM RESIDUAL SQUARED ERROR IN SOR
SOLUTION FOR X, Y; KJ/KI; AND HI, HJ
RSQKIM = CONVERGENCE CRITERIA BASED ON KI/KJ (NOT ACTIVE)
RSQHIM = CONVERGENCE CRITERIA BASED ON HI (NOT ACTIVE)
RSQHJM = CONVERGENCE CRITERIA BASED ON HJ (NOT ACTIVE)

The values of the first three parameters should not be changed, since they have been determined to be near optimum for the SOR solution schemes in *gefdc.f*. The remaining parameters are residual squared error criteria for stopping the SOR solutions. The values shown are rough estimates. For very large grids they can be decreased in magnitude to approximately 1.E-6.

Card Image 7

C7	COORDINATE SHIFT PARAMETERS AND ANGULAR ERROR				
C7	XSHIFT	YSHIFT	HSCALE	RKJDKI	ANGORO
	0.	0.	1000.	1.	5.0

Card Image 7 parameter definitions are as follows:

XSHIFT, YSHIFT = X, Y COORDINATE SHIFT X, Y=X, Y+XSHIFT, YSHIFT
HSCALE = SCALE FACTOR FOR HII AND HJJ WHEN PRINTED TO *dxdy.out*
RKJDKI = ANISOTROPIC STRETCHING OF J COORDINATE (USE 1.)
ANGORO = ANGULAR DEVIATION FROM ORTHOGONALITY IN DEG USED
AS CONVERGENCE CRITERIA

The first two parameters allow for a coordinate translation of input coordinate data, which is generally not recommended. The scale factor is used to convert the input coordinate units to meters. For example, if the input coordinates are in kilometers, 1000 is necessary for DX and DY in the *dxdy.inp*

file to be properly specified in meters. Note the cell center coordinates in the *lxly.inp* file will remain in the same units as the input coordinates. The final parameter, ANGORO, specifies the maximum deviation from orthogonal in the final grid. If the specified maximum deviation is not achieved, the generation procedure will execute the maximum number of iterations.

Card Image 8

```
C8 INTERPOLATION SWITCHES
C8 ISIRKI JSIRKI ISIHJHJ JSIHJHJ
   1      0      0      0
```

Card Image 8 parameter definitions are as follows:

```
ISIRKI = 1, SOLUTION BASED ON INTERPOLATION OF KJ/KI TO
          INTERIOR
JSIRKI = 1, INTERPOLATE KJ/KI TO INTERIOR WITH CONSTANT
          COEFFICIENT DIFFUSION EQUATION
ISIHJHJ =1, SOLUTION BASED ON INTERPOLATION OF HI AND HJ TO
          INTERIOR, AND THEN DETERMINING KJ/KI=HI/HJ
JSIHJHJ = 1, INTERPOLATE HI AND HJ TO INTERIOR WITH CONSTANT
          COEFFICIENT DIFFUSION EQUATION
```

The configuration shown above is recommended for Card Image 8.

Card Image 9

```
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB IE JB JE N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7 SERRMAX
```

Card Image 9 parameter definitions are as follows

```
IB      = BEGINNING I INDEX MS METHOD
IE      = ENDING I INDEX MS METHOD
JB      = BEGINNING J INDEX MS METHOD
JE      = ENDING J INDEX MS METHOD
N7RELAX= MAXIMUM RELAXATION PER INIT LOOP, NTYPE = 7
NXYIT  = NUMBER OF ITERS ON EACH X,Y SWEEP, NTYPE = 7
ITN7MAX= MAXIMUM GENERATION ITERS, NTYPE = 7
IJSMD  = 1, CALCULATE GLOBAL CONFORMAL MODULE
ISMD   = A VALUE IB.LE.ISMD.LE.IE, CALCULATE CONFORMAL
          MODULE ALONG LINE I=ISMD
JSMD   = A VALUE JB.LE.JSMD.LE.JE, CALCULATE CONFORMAL
          MODULE ALONG LINE J=JSMD
RP7    = SOR RELAXATION PARAMETER, NTYPE = 7
SERRMAX= MAXIMUM CONFORMAL MODULE ERROR, NTYPE = 7
```

Data is necessary for Card Image 9 only if NTYPE = 7. The indices IB and IE define the beginning and ending I grid lines of the rectangular (in the computational domain) grid generated by the quasi-

conformal mapping technique implemented for $NTYPE = 7$. The indices JB and JE likewise define the beginning and ending J indices. Recommended values for the remaining parameter in this card image are shown in Figure B27 in Appendix B.

Card Image 10

```
C10 NTYPE = 7 SPECIFIED INPUT
C10 X      Y      IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
```

Card Image 10 parameter definitions are as follows:

```
XIBJB, YIBJB = IB, JB COORDINATES
XIEJB, YIEJB = IE, JB COORDINATES
XIBJE, YIBJE = IB, JE COORDINATES
XIEJE, YIEJE = IE, JE COORDINATES
```

Data is necessary on this line only if $NTYPE = 7$, with the x and y coordinates specified corresponding to the true east and north physical domain coordinates of the four corners of the rectangular region in the computational domain.

Card Image 11

```
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
      1      11564      2.  .5      2      4.0      0      0      0
```

Card Image 11 parameter definitions are as follows:

```
ISIDEP      = 1, READ depdat.inp FILE AND INTERPOLATE DEPTH, BOTTOM
              ELEVATION AND BOTTOM ROUGHNESS DATA IN THE dx dy.inp FILE
NDEPDAT     = NUMBER OF X, Y, DEPTH FIELDS IN DEP DAT.INP FILE
CDEP        = WEIGHTING COEFFICIENT IN DEPTH INTERPOLATION SCHEME
RADM        = CONSTANT MULTIPLIER FOR DEPTH INTERPOLATION RADIUS
ISIDPTYP    = 1, ASSUMES DEP DAT.INP CONTAINS POSITIVE DEPTHS
              TO A BOTTOM BELOW A SEA LEVEL DATUM AND THE BOTTOM
              ELEVATION IS THE NEGATIVE OF THE DEPTH
              2, ASSUMES DEP DAT.INP CONTAINS POSITIVE BOTTOM ELEVATIONS,
              LOCAL INITIAL DEPTH IS THEN DETERMINED BY DEPTH=SURFELV-BELB
              3, ASSUMES DEP DAT.INP CONTAINS POSITIVE BOTTOM
              ELEVATIONS WHICH ARE CONVERTED TO NEGATIVE VALUES,
              LOCAL INITIAL DEPTH IS THEN DETERMINED BY DEPTH=SURFELV-BELB
SURFELV     = INITIALLY FLAT SURFACE ELEVATION FOR USE WHEN ISIDPTYP=2 OR 3
ISVEG       = 1, READ AND INTERPOLATE VEGETATION DATA
NVEGDAT     = NUMBER OF X, Y, VEGETATION CLASS DATA POINTS
NVEGTYP     = NUMBER OF VEGETATION TYPES OR CLASSES
```

Setting $ISIDEP = 1$ activates depth or bottom elevation interpolation to the grid using $NDEPDAT$ depth or bottom elevation data points. The depth or bottom elevation data within a radius of

RDM*Min(dx,dy) of a cell center to determine a weighted average cell center or cell mean depth using an inverse distance weighting if CDEP = 1 or an inverse square weighting is CDEP = 2. If no data is within RDM*Min(dx,dy) of the cell center, the cell is flagged as having missing depth or bottom elevation data. Missing depth or bottom elevation data is determined using a Laplace equation filling technique which preserves values of the depth and bottom elevation in the unflagged cells. Vegetation class interpolation is activated by ISVEG = 1. For vegetation class interpolation, the predominant class is selected if more than one vegetation class data point falls within a cell. Since there is no fill option for the vegetation class interpolation, cells not having vegetation data points within their boundaries are assigned the null class 0. The null class is then replaced by hand in the *dxdy.inp* file, using class information from surrounding cells.

Card Image 12

```
C12 LAST BOUNDARY POINT INFORMATION
C12  ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
      1    1    0.          0.
```

Card Image 12 parameter definitions are as follows:

LAST PAIR OF GRID COORDINATES ON BOUNDARY USED FOR NTYPE = 1 through 6

The last I,J index and true east and north coordinates X,Y for the last point in the clockwise sequence of grid points around the domain is specified. See the example in Appendix B.

Card Image 13

```
C13 BOUNDARY POINT INFORMATION
C13  I    J    X(I,J)  Y(I,J)
```

Card Image 13 parameter definitions are as follows:

SEQUENCE OF GRID COORDINATES CLOCKWISE AROUND THE BOUNDARY
USED FOR NTYPE = 1 THROUGH 6

The sequence of I,J index and true east and north coordinates X,Y clockwise around the domain is specified with one set of I,J,X,Y points per line, see the example in Appendix B. In the NTYPE = 1-4 options are specified, grid reflection occurs about the line joining the first and last points.

The *gefdc.f* code generates a number of output files, including the *dxdy.inp* and *lxly.inp* files for input into the *efdc.f* code. (These files are actually output as *dxdy.out* and *lxly.out* and must be renamed for use by *efdc.f*. The other output files and their purposes and content are defined in Table 5 below:

Table 5. Output files from the *gefdc.f* code.

<i>depint.log</i>	A file containing the I,J indices and true x,y coordinates of cells having no depth or bottom elevation data in their immediate vicinity (depths and bottom elevations are determined by a smoothing interpolation).
<i>dx dy.dia</i>	A file containing diagnostics for curvilinear-orthogonal grids. See following text and Figure 9.
<i>gefdc.log</i>	A file containing a log of the execution of the <i>gefdc.f</i> code. The contents of this file are also written to the screen during execution. See following text and Figure 10.
<i>gefdc.out</i>	This contain a listing of the <i>cell.inp</i> file, the KSGI array specifying interior grid points, the initial x,y grid coordinates, and the final x,y grid coordinates.
<i>grid.cor</i>	A file containing sequence of grid line coordinates with character variables separating sequences of constant I or J lines. Contents can be used for plotting grid.
<i>grid.dxf</i>	A dxf (CADD drawing exchange file) of the final grid which can be plotted with any CADD or graphics software capable of importing the dxf format.
<i>grid.ini</i>	A dxf (CADD drawing exchange file) of the initial grid which can be plotted with any CADD or graphics software capable of importing the dxf format.
<i>grid.ixy</i>	Similar to <i>grid.cord</i> , but contains only constant I lines
<i>grid.jxy</i>	Similar to <i>grid.cord</i> , but contains only constant J lines
<i>grid.mas</i>	A file containing a clockwise sequence of the true x,y coordinates of grid points along the land-water boundary. This file can be used in masking or defining the region for horizontal plane contour plotting by contouring software such as NCAR Graphic or Surfer.
<i>gridext.out</i>	A file containing the I,J indices and true x,y coordinates of all water cell grid points. This file can be renamed <i>gridext.inp</i> and used for NTYPE = 0 grid generation. A number of <i>gridext.out</i> files form subgrids that can be combined into a single <i>gridext.inp</i> to generate a composite grid. See example in Section B.4 of Appendix B.

3 - Grid Generation and Preprocessing

salt.inp This file is a template of the salt.inp input file for the *efdc.f* code. Salinity values are set to zero and may be filled with data (see Chapter 5).

I	J	HII	HJJ	HIHJJ	JACOBIAN	ANG ERROR
39	6	0.1968E+02	0.2962E+02	0.5827E+03	0.5827E+03	0.3120E+00
.
.
.
.
ASQRTG=	0.3305E+06	ASHIHJ=	0.3311E+06	AERR=	0.1973E-02	
NWCELLS=	325					

Figure 9. Sample output in the *dxdy.dia* file.

DIFF INITIAL X&Y, ITER = 100	RSX,RSY =	0.4439E-10	0.4383E-11
DIFFUSE RKI, ITERATION = 69	RSK =	0.9475E-12	
DIFF X & Y, ITER = 81	RSX,RSY =	0.9747E-12	0.8887E-12
GRID GENERATION LOOP ITERATION =		1	
GLOBAL RES SQ DIFF IN RKI=		0.3978E+00	
MIN AND MAX DEVIATION FROM ORTHO =		0.3837E-02	0.1008E+02
.	.	.	.
.	.	.	.
NWCELLS=	325		
N999 =	0		
DEPMAX =	0.30678E+01		

Figure 10. Sample output in the *gefdc.log* file.

The file *dxdy.dia*, Figure 9, contains the primary diagnostics of the curvilinear-orthogonal grid generation process. For each water cell, the file lists the computed orthogonal metric factors HI and HG (which are also dx and dy, the curvilinear cell dimensions). For true orthogonality, the product $HII*HJJ$ is the horizontal area of the cell. The actual area of the cell, which is also the Jacobian of the general curvilinear coordinate transformation, is also shown, and should agree with $HII*HJJ$ to within a few percent. The angular error for each cell is a measure of deviation from numerical orthogonality, and should be small. The orthogonality of the grid can be improved by identifying cells along the land water boundary with the largest angular errors and adjusting their land bounding grid corner coordinate points on Card Image 13 in the *gefdc.inp* file. At the end of the *dxdy.dia* file, the exact area of the grid, ASQRTG, is printed for comparison with the sum of the $HII*HJJ$ product for all water cells. The relative error between these two quantities, AERR, is also printed, as well as the total number of water cells in the grid. The *gefdc.log* file, shown in Figure 10, summarizes the computational steps in the grid generation. The initialization of the grid, referred to as diffuse x and y, since the generation scheme is similar to the solution of a steady state diffusion or elliptic equation, is followed by a summary of each grid generation iteration. The iteration involves diffusing the boundary metric ratios, RKI, to the interior and then the diffusion of the x and y coordinates to the interior. The residuals for these diffusion or elliptic equation solutions by successive over relaxation are the small quantities beginning with R. The minimum and maximum deviations from orthogonality, in degree, at the end of the iteration is then printed. After the grid generation has converged or executed the specified number of maximum iterations, the equivalent contents of the *dxdy.out* (inp) file is also written in *gefdc.log*. The file ends with a summary of the number of water cells, the number of cells where depth or bottom topography failed to be determined, and the maximum initial water depth in the grid.

4. EFDC Master Input File (*efdc.inp*)

This chapter describes the master input, *efdc.inp*, which contains 90 card images. The information in *efdc.inp* provides run control parameters, output control, and physical information describing the model domain and external forcing functions. The file is internally documented, in essence providing a template or menu for setting up a simulation. The file consists of card image sections, with each section having header lines which define the relevant input parameter in that section. The function of the various card image sections is best illustrated by a sequential discussion of each section. Card Image sections and input parameters which are judged to be clearly explained in the *efdc.inp* files internal documentation will not be discussed specifically. Before proceeding, a number of conventions should be discussed. Many options in the code are activated by integer switches (most beginning with either IS or JS). Unless otherwise noted, setting these switches to zero deactivates the option. Options are normally activated by specifying nonzero integer values. A number of options described in the file are classified as for research purposes. This classification indicates that the option may involve an experimental and not fully tested numerical scheme or that it involves rather complex internal analysis or flow field data extraction. **Note: A number of the card images are not functional in the EFDC-Hydro version of the model and are so noted below. However, it is important that the card images remain in the input file as space holders otherwise the model will encounter a read error during execution.**

Card Image 1

```
C01 TITLE FOR RUN
C
C   TITLE OR IDENTIFIER FOR THIS INPUT FILE AND RUN
C
C01 (LIMIT TO 80 CHARACTERS LENGTH)
   'Rectangular Basin - Test002'
```

This 80-character title simply serves to identify the particular application.

Card Image 2

```
C02 RESTART, GENERAL CONTROL AND AND DIAGNOSTIC SWITCHES
C
C   ISRESTI: 1 FOR READING INITIAL CONDITIONS FROM FILE restart.inp
C           -1 AS ABOVE BUT ADJUST FOR CHANGING BOTTOM ELEVATION
C           2 INITIALIZES A KC LAYER RUN FROM A KC/2 LAYER RUN FOR KC.GE.4
C           10 FOR READING IC'S FROM restart.inp WRITTEN BEFORE 8 SEPT 92
C   ISRESTO: -1 FOR WRITING RESTART FILE restart.out AT END OF RUN
C           N INTEGER.GE.0 FOR WRITING restart.out EVERY N REF TIME PERIODS
```

4 - EFDC Master Input File (*efdc.inp*)

```

C      ISRESTR: 1 FOR WRITING RESIDUAL TRANSPORT FILE restran.out
C      ISLOG:   1 FOR WRITING LOG FILE efdc.log
C      ISPAR:   0 FOR EXECUTION OF CODE ON A SINGLE PROCESSOR MACHINE
C              1 FOR PARALLEL EXECUTION, PARALLELIZING PRIMARILY OVER LAYERS
C              2 FOR PARALLEL EXECUTION, PARALLELIZING PRIMARILY OVER
C              NDM HORIZONTAL GRID SUBDOMAINS, SEE CARD CARD C9
C      ISDIVEX: 1 FOR WRITING EXTERNAL MODE DIVERGENCE TO SCREEN
C      ISNEGH:  1 FOR SEARCHING FOR NEGATIVE DEPTHS AND WRITING TO SCREEN
C      ISMMC:   1 FOR WRITING MIN AND MAX VALUES OF SALT AND DYE
C              CONCENTRATION TO SCREEN
C      ISBAL:   1 FOR ACTIVATING MASS, MOMENTUM AND ENERGY BALANCES AND
C              WRITING RESULTS TO FILE bal.out
C      ISHP:    1 FOR CALLING HP 9000 S700 VERSIONS OF CERTAIN SUBROUTINES
C      ISHOW:   1 TO SHOW RUN-TIME RESULTS ON SCREEN; 2=FORMATTED FOR MSDOS
C
C02 ISRESTI ISRESTO ISRESTR ISPAR ISLOG ISDIVEX ISNEGH ISMMC ISBAL ISHP ISHOW
      0         1         0         0         2         0         2         0         0         0         2

```

Card Image 2, specifies the mode of model startup, either a cold start, with the flow field initialized to zero, or a *restart.inp* using initial conditions corresponding to the conditions at the end of a previous simulation. The ISRESTO switch controls the frequency of outputting restart information to the file *restart.out* (which is renamed *restart.inp* to launch a run). The file *restran.out* contains the time averaged transport file, which may be used to execute the *efdc.f* code in a transport only mode. The switch ISPAR allows implementation of internal code options for execution on multiple processor or parallel machines. These options are currently supported on multiple vector processor Cray supercomputers, and on Silicon Graphic and Sparc (Sun and clones) based symmetric multiprocessor UNIX workstations. The choice of ISPAR equal to 1 or 2, depends on both the grid structure and the number of processors on which the code will execute. Portions of the code capable of being parallelized over vertical layers or horizontal grid subdomains are parallelized over vertical layers when ISPAR is set to 1. For layer parallelization, the number of layers must be an integer multiple of the number of processors on which the code will execute. For grids consistent with layer parallelization, portions of the code allowing either mode of parallelization are generally more efficient in the layer parallelization mode. Certain portions of the code may be parallelized only over horizontal subdomains, with this mode being active for ISPAR equal 1 or 2. For ISPAR = 2, all parallelization is over horizontal subdomains. See Card C9 and chapter 6 for additional details regarding parallel execution of EFDC. The switch ISLOG activates the creation of a log file (ISLOG=2, recommended) which is deleted and reopened after each reference time period. The contents and interpretation of the material in file *efdc.log* will be discussed in the diagnostics chapter. The switches, ISDIVEX, ISNEGH, and ISMMC, activate diagnostic checks on volume conservation, identify negative solution depths, and check mass conservation of transport materials, activation of these switches (IS=1)

produces identical output to the screen and efdc.log file. The use of these options for diagnostic purposes is discussed in the diagnostics chapter. The switch ISHP allows use of Hewlett-Packard 9000 series 700 vector libraries. The vector library calls are currently commented out with CDHP in the source code. The procedure for activating this option and accessing the HP vector library may be obtained from the writer. The switch ISBAL activates an internal volume, mass, momentum and energy balance procedure. The switch ISHOW activates a screen print of flow field conditions in a specified horizontal location during the run, with more details given with the description of the file show.inp in the next chapter.

Card Image 3

```

C03 EXTERNAL MODE SOLUTION OPTION PARAMETERS AND SWITCHES
C
C   RP:          OVER RELAXATION PARAMETER
C   RSQM:        TRAGET SQUARE RESIDUAL OF ITERATIVE SOLUTION SCHEME
C   ITERM:       MAXIMUN NUMBER OF ITERARTIONS
C   IRVEC:       0 STANDARD RED-BLACK SOR SOLUTION
C               1 MORE VECTORIZABLE RED-BLACK SOR (FOR RESEARCH PURPOSES)
C               2 RED-BLACK ORDERED CONJUGATE GRADIENT SOLUTION
C               3 REDUCED SYSTEM R-B CONJUGATE GRADIENT SOLUTION
C               9 NON-DRYING CON GRADIENT SOLUTION WITH MAXIMUM DIAGNOSTICS
C   RPADJ:       RELAXATION PARAMETER FOR AUXILLARY POTENTIAL ADJUSTME
C               OF THE MEAN MASS TRANSPORT ADVECTION FIELD
C               (FOR RESEARCH PURPOSES)
C   RSQMADJ:     TRAGET SQUARED RESIDUAL ERROR FOR ADJUSTMENT
C               (FOR RESEARCH PURPOSES)
C   ITRMADJ:     MAXIMUM ITERARTIONS FOR ADJUSTMENT(FOR RESEARCH PURPOSES)
C   ITERHPM:     MAXIMUM ITERATIONS FOR STRONGLY NONLINER DRYING AND WETTING
C               SCHEME (ISDRY=3 OR OR 4)  ITERHPM.LE.4
C   IDRYCK:      ITERATIONS PER DRYING CHECK (ISDRY.GE.1)  2.LE.IDRYCK.LE.20
C   ISDSOLV:    1 TO WRITE DIAGNOSTICS FILES FOR EXTERNAL MODE SOLVER
C   FILT:       FILTER COEFFICIENT FOR 3 TIME LEVEL EXPLICIT ( 0.0625 )
C               1.E-3
C03 RP   RSQM  ITERM IRVEC RPADJ RSQMADJ ITRMADJ ITERHPM IDRYCK ISDSOLV FILT
    1.8  1.E-8   200   9    1.8   1.E-16  1000   0     20    0     0.0625

```

The information input on Card Image 3 primarily controls the external or barotropic mode solution in *efdc.f*. The over-relaxation parameter of 1.8 should not be changed. The RSQM parameter is the residual squared error in the external mode solution. It is generally set between 1E-6 and 1E-15, with the small values corresponding several hundred cells and a small time step (10-100 seconds) and the larger value corresponding a large number of cells (1000-10,000) and a large time step (100-1000 seconds). If RSQM is set to a small value, a simulation may crash due to accumulated roundoff error. RSQM should be adjusted such that the number of iterations shown in the efdc.log file is between approximately 10 and 40. The maximum iteration count in the external solution ITERM is set such that execution stops if the

external solution does not converge in the maximum number of iterations. The parameter IRVEC controls the type of linear equation solver used in the external mode solution. The original successive over relaxation solver has been supplemented with two conjugate gradient solvers, a diagonally preconditioned solver, IRVEC = 2, and a red-black ordered, reduced system, conjugate gradient solver, IRVEC = 3. The options IRVEC = 0 or IRVEC = 3 is recommended if drying and wetting is not active, while the option, IRVEC = 2, is required when drying and wetting is activated. The remaining parameters are for research purposes, and generally not used in standard applications, or are self-explanatory.

Card Image 4

```

C04 LONGTERM MASS TRANSPORT INTEGRATION ONLY SWITCHES
C
C   ISLTMT:  1 FOR LONG-TERM MASS TRANSPORT ONLY (FOR RESEARCH PURPOSES)
C   ISSSMMT: 0 WRITES MEAN MASS TRANSPORT TO restran.out AFTER EACH
C             AVERAGING PERIOD (FOR RESEARCH PURPOSES)
C             1 WRITES MEAN MASS TRANSPORT TO restran.out AFTER LAST
C             AVERAGING PERIOD (FOR RESEARCH PURPOSES)
C   ISLTMTS: 0 ASSUMES LONG-TERM TRANSPORT SOLUTION IS TRANSIENT
C             (FOR RESEARCH PURPOSES)
C             1 ASSUMES LONG-TERM TRANSPORT SOLUTION IS ITERATED TOWARD
C             STEADY STATE (FOR RESEARCH PURPOSES)
C   ISIA:    1 FOR IMPLICIT LONG-TERM ADVECTION INTEGRATION FOR ZEBRA
C             VERTICAL LINE R-B SOR (FOR RESEARCH PURPOSES)
C   RPIA:    RELAXATION PARAMETER FOR ZEBRA SOR (FOR RESEARCH PURPOSES)
C   RSQMIA:  TRAGET RESIDUAL ERROR FOR ZEBRA SOR (FOR RESEARCH PURPOSES)
C   ITRMIA:  MAXIMUM ITERATIONS FOR ZEBRA SOR (FOR RESEARCH PURPOSES)
C
C04 ISLTMT  ISSSMMT  ISLTMTS  ISIA  RPIA  RSQMIA  ITRMIA
    0         1         0         0    1.8  1.E-10   100
  
```

The EFDC model has the capability to function in a transport only mode using advective and diffusive transport specified in the file *restran.inp*. The first parameter, ISLTMT, activates this mode. The second parameter ISSSMMT controls the creation of the *restran.inp* file, output as *restran.out*, during normal execution. The frequency of graphical output of residual fields is also controlled by this parameter. The third parameter determines whether the transport only mode will be integrated to steady state or integrated for a transient residual transport field. The remaining four parameters are for research purposes, however, ISIA should be set to zero.

Card Image 5

```

C05  MOMENTUM ADVEC AND HORIZ DIFF SWITCHES AND MISC SWITCHES
  
```

```

C
C   ISCDMA:  1  FOR CENTRAL DIFFERENCE MOMENTUM ADVECTION
C             0  FOR UPWIND DIFFERENCE MOMENTUM ADVECTION
C             2  FOR EXPERIMENTAL UPWIND DIFF MOM ADV (FOR RESEACH PURPOSES)
C   ISHDMF:  1  TO ACTIVE HORIZONTAL MOMENTUM DIFFUSION
C   ISDISP:  1  CALCULATE MEAN HORIZONTAL SHEAR DISPERSION TENSOR OVER LAST
C             MEAN MASS TRANSPORT AVERAGING PERIOD
C   ISWASP:  4  or 5 TO WRITE FILES FOR WASP4 or WASP5 MODEL LINKAGE
C   ISDRY:   GREATER THAN 0 TO ACTIVE WETTING & DRYING OF SHALLOW AREAS
C             1  CONSTANT WETTING DEPTH SPECIFIED BY HWET ON CARD 11
C             WITH NONLINEAR ITERATIONS SPECIFIED BY ITERHPM ON CARD C3
C             2  VARIABLE WETTING DEPTH CALCULATED INTERNALLY IN CODE
C             WITH NONLINEAR ITERATIONS SPECIFIED BY ITERHPM ON CARD C3
C             11 SAME AS 1, WITHOUT NONLINEAR ITERATION
C             12 SAME AS 2, WITHOUT NONLINEAR ITERATION
C             3  DIFFUSION WAVE APPROX, CONSTANT WETTING DEPTH (NOT ACTIVE)
C             4  DIFFUSION WAVE APPROX, VARIABLE WETTING DEPTH (NOT ACTIVE)
C   ISQQ:    1  TO USE STANDARD TURBULENT INTENSITY ADVECTION SCHEME
C   ISRLID:  1  TO RUN IN RIGID LID MODE (NO FREE SURFACE)
C   ISVEG:   1  TO IMPLEMENT VEGETATION RESISTANCE
C             2  IMPLEMENT WITH DIAGNOSTICS TO FILE cbot.log
C   ISVEGL:  1  TO INCLUDE LAMINAR FLOW OPTION IN VEGETATION RESISTANCE
C   ISITB:   1  FOR IMPLICIT BOTTOM & VEGETATION RESISTANCE IN EXTERNAL MODE
C             FOR SINGLE LAYER APPLICATIONS (KC=1) ONLY
C   ISEVER:  1  TO DEFAULT TO EVERGLADES HYDRO SOLUTION OPTIONS
C
C05  ISCDMA ISHDMF ISDISP ISWASP ISDRY ISQQ ISRLID ISVEG ISVEGL ISITB ISEVER
      0      0      0      0      0      1      0      0      0      0      0

```

This card image controls various options for integration of the advective and diffusive portions of the momentum equations as well as the activation of additional physical process representations and optional output processing. The parameter ISCDMA controls the finite difference representation of momentum advection, with the zero default value corresponding to upwind difference, and the values of 1 and 2 corresponding respectively to a central-difference and an experimental upwind-difference scheme. The central-difference option is generally recommended only for smooth or idealized bottom topography and lateral boundaries. The second parameter ISAHMF activates horizontal moment diffusion. It should be activated when using central difference advection or when simulating wave induced currents. For wave induced currents, the horizontal diffusion is specified in terms of the wave energy dissipation due to wave breaking in the surf zone. The options ISDISP and ISWASP respectively control the creation of shear dispersion coefficient file *disp.out* and a WASP water quality model transport files *waspX.out*. The parameter ISDRY activates drying and wetting and the value 11 is recommended. The parameter ISQQ should remain set to unity. The parameter ISRLID implements a rigid free surface simulation and is generally used only for research purposes. The next three parameters activate the vegetation resistance model. The last parameter ISITB should be activated only in single layer or depth integrated simulations.

The remaining parameter ISWAVE activates the wave-current boundary layer model and the wave induced current model, using an external specification of high frequency surface wave conditions in the input file wave.inp.

Card Image 6

```

C06 DISSOLVED AND SUSPENDED CONSTITUENT TRANSPORT SWITCHES
C   TURB INT=0 , SAL=1 , TEM=2 , DYE=3 , SFL=4 , TOX=5 , SED=6 , SND=7 , CWQ=8
C
C   ISTRAN:  1 OR GREATER TO ACTIVATE TRANSPORT
C   ISTOPT:   NONZERO FOR TRANSPORT OPTIONS,  SEE USERS MANUAL
C   ISCDCA:  0 FOR STANDARD DONOR CELL UPWIND DIFFERENCE ADVECTION
C             1 FOR CENTRAL DIFFERENCE ADVECTION FOR THREE TIME LEVEL STEPS
C             2 FOR EXPERIMENTAL UPWIND DIFFERENCE ADVECTION (FOR RESEARCH)
C   ISADAC:  1 TO ACTIVATE ANTI-NUMERICAL DIFFUSION CORRECTION TO
C             STANDARD DONOR CELL SCHEME
C   ISFCT:   1 TO ADD FLUX LIMITING TO ANTI-NUMERICAL DIFFUSION CORRECTION
C   ISPLIT:  1 TO OPERATOR SPLIT HORIZONTAL AND VERTICAL ADVECTION
C             (FOR RESEARCH PURPOSES)
C   ISADAH:  1 TO ACTIVATE ANTI-NUM DIFFUSION CORRECTION TO HORIZONTAL
C             SPLIT ADVECTION STANDARD DONOR CELL SCHEME (FOR RESEARCH)
C   ISADAV:  1 TO ACTIVATE ANTI-NUM DIFFUSION CORRECTION TO VERTICAL
C             SPLIT ADVECTION STANDARD DONOR CELL SCHEME (FOR RESEARCH)
C   ISCI:    1 TO READ CONCENTRATION FROM FILE restart.inp
C   ISCO:    1 TO WRITE CONCENTRATION TO FILE restart.out
C
C06 ISTRAN ISTOPT ISCDCA ISADAC ISFCT ISPLIT ISADAH ISADAV ISCI ISCO
    1      0      0      0      0      0      0      0      0      0      0      !turb 0
    0      1      0      1      1      0      0      0      1      1      1      !sal  1
    0      0      0      1      1      0      0      0      0      0      2      !tem  2
    0      0      0      1      1      0      0      0      1      1      3      !dye  3
    0      0      0      1      1      0      0      0      0      0      4      !sfl  4
    0      0      0      1      1      0      0      0      0      0      5      !tox  5
    0      0      0      1      1      0      0      0      0      0      6      !sed  6
    0      0      0      1      1      0      0      0      0      0      7      !snd  7
    0      0      0      1      1      0      0      0      0      0      8      !cwq  8

```

Card Image 6 controls the advective transport and source sink options for transported scalar fields. The seven lines of active input represent in order, turbulent intensity, salinity, temperature, a dye tracer, suspended sediment, shellfish larvae, and water quality variables. The first switch, ISTRAN activates advective transport and sources and sinks. On the first line, corresponding to the turbulence model, only ISTRAN should be set to unity with the remaining parameters set to zero. For water quality, ISTRAN=1, activates the embedded water quality model WQ3D (Park et al., 1995) which has additional input files not documented in this manual. The second parameter ISTOPT sets options for a number of the transport scalar fields. Current active options are:

Salinity

ISTOPT=1: Read initial salinity distribution from file *salt.inp* (ISRESTI=0, only)

Temperature

ISTOPT=1: Full surface and internal heat transfer calculation using data from file *aser.inp*.

ISTOPT=2: Transient equilibrium surface heat transfer calculation using external equilibrium temperature and heat transfer coefficient data from file *aser.inp*.

ISTOPT=3: Equilibrium surface heat transfer calculation using constant equilibrium temperature and heat transfer coefficient (HEQT) from Card Image 46. Initial isothermal temperature (TEMO) for cold starts (ISRESTI=0) is read on Card Image 46. See Cerco and Cole (1993) for a discussion of the equilibrium temperature surface heat transfer approach.

Dye Tracer

ISTOPT=1: Read initial dye tracer distribution from file *dye.inp* (ISRESTI=0, only). Linear or first order dye decay (RKDYE) specified on Card Image 46.

Suspended Sediment

ISTOPT=1: Suspended sediment is cohesive. Settling, deposition and resuspension calculated in subroutine CALSED

ISTOPT=2: Suspended sediment is cohesive. Settling, deposition and resuspension calculated in subroutine CALSED2

ISTOPT=3: Suspended sediment is noncohesive. Settling, deposition and resuspension calculated in subroutine CALSED3

ISTOPT=4: Suspended sediment is noncohesive. Settling, deposition and resuspension calculated in subroutine CALSED3 after wave wave-current boundary layer or wave induced forcing have been gradually introduced.

Sediment settling, resuspension, and deposition data is read on card images 39 and 41.

Shellfish Larvae [not active in EFDC-Hydro]

No options available

Water Quality Constituents [not active in EFDC-Hydro]

ISTOPT=1: Specifies 22 water column state variables.

ISTOPT=2: Specifies 14 water column state variables.

ISTOPT=3: Specifies 8 water column state variables.

The third parameter, ISCDCA, specifies the advection scheme with the zero default values corresponding to donor cell upwind difference. Values of 1 and 2 specify central difference (not recommended) and an experimental first order upwind difference scheme, respectively. The parameter ISADAC=1 activates an antidiffusion advective flux correction (Smolarkiewicz and Clark, 1986) for ISCDCA equals 0 or 1. The parameter ISFCT=1, implements the antidiffusion correction in the flux corrected transport form (Smolarkiewicz and Grabowski, 1990). The three parameters ISPLIT, ISADAH, and ISADAV activate an experimentally operated split antidiffusive upwind difference scheme and should remain set to 0. The parameters ISCI and ISCO when set to 1 read and write, respectively, the specified field from and to the files *restart.inp* and *restart.out*. Turbulence quantities are by default read from and written to the restart files.

Card Image 7

C07 TIME-RELATED INTEGER PARAMETERS

C
 C NTC: NUMBER OF REFERENCE TIME PERIODS IN RUN
 C NTSPTC: NUMBER OF TIME STEPS PER REFERENCE TIME PERIOD
 C NLTC: NUMBER OF LINEARIZED REFERENCE TIME PERIODS
 C NTTC: NUMBER OF TRANSITION REF TIME PERIODS TO FULLY NONLINEAR
 C NTCPP: NUMBER OF REFERENCE TIME PERIODS BETWEEN FULL PRINTED OUTPUT
 C TO FILE efdc.out
 C NTSTBC: NUMBER OF REFERENCE TIME PERIODS BETWEEN TWO TIME LEVEL
 C TRAPEZOIDAL CORRECTION TIME STEP
 C NTCNB: NUMBER OF REFERENCE TIME PERIODS WITH NO BUOYANCY FORCING
 C NTCVB: NUMBER OF REF TIME PERIODS WITH VARIABLE BUOYANCY FORCING
 C NTCMMT: NUMBER OF NUMBER OF REF TIME TO AVERAGE OVER TO OBTAIN
 C RESIDUAL OR MEAN MASS TRANSPORT VARIABLES
 C NFLTMT: USE 1 (FOR RESEARCH PURPOSES)
 C NDRYSTP: MIN NO. OF TIME STEPS A CELL REMAINS DRY AFTER INTIAL DYRING
 C

C07	NTC	NTSPTC	NLTC	NTTC	NTCPP	NTSTBC	NTCNB	NTCVB	NTSMMT	NFLTMT	NDRYSTP
35	1440	0	2	800	4	0	2	1	1	16	

Card Images 7 and 8 provide time controls for the simulation with card image 7 providing integer parameters. The EFDC code executes of a specified number of time cycles, NTC. The actual length of the time cycle in seconds is specified by TREF on card image 8. For example, a 35 day simulation would correspond to $NTC = 35$ and $TREF = 86400$ seconds. The time step is specified as the number of time steps per reference time period, NTSPTC. For the values shown, the actual time step is 60.0 seconds ($86400.0/1440$). The parameter NLTC allows for NLTC time periods with no nonlinear terms in the momentum equations, while NTTC allows for a gradual introduction of the nonlinear terms of NTC reference time periods. These two options may be useful for cold starts ($ISRESTI=0$) or diagnostic purposes. The NTCPP controls the frequency of printed output to *efdc.out*. The printed output is primarily in the form of line printer contour plots which may be useful in situations where graphics postprocessing capabilities are not readily available. Given the extensive options currently available in the code to generate graphical output, NTCPP is usually specified large enough such that the printed output is not generated. The parameter, NTSTBC is extremely important in that it specifies the frequency of insertion of a two time level trapezoidal correction step into the three-time level integration (see Hamrick, 1992a). Generally NTSTBC should be between 4 and 12, increasing if NTSPTC increases. The parameters NTCNB and NTCVB control the introduction of buoyancy forcing into the momentum equations in a similar manner as described for NLTC and NTTC. The parameter NTSMMT specifies the number of time steps for the calculation of time averaged or residual output variables and also the output frequency to the "r" class output files. If NTSMMT is greater than or equal to NTSPTC, the averaging includes calculation of the Lagrangian mean transport fields (Hamrick, 1994a). The parameter NFLTMT should remain set to 1. The parameter NDRYSTP specifies the number of time steps a cell must remain dry before wetting is allowed when the drying and wetting option is activated.

Card Image 8

```

C08 TIME-RELATED REAL PARAMETERS
C
C   TCON:      CONVERSION MULTIPLIER TO CHANGE TBEGIN TO SECONDS
C   TBEGIN:    TIME ORIGIN OF RUN
C   TREF:      REFERENCE TIME PERIOD IN SEC (ie 44714.16s or 86400s)
C   CORIOLIS:  CONSTANT CORIOLIS PARAMETER IN 1/SEC
C   ISCORV:    1 TO READ VARIABLE CORIOLIS COEFFICIENT FROM lxly.inp FILE
C   ISCCA:     WRITE DIAGNOSTICS FOR MAX CORIOLIS-CURV ACCEL TO FILEefdc.log
C   ISCFL:     1 WRITE DIAGNOSTICS OF MAX THEORETICAL TIME STEP TO cfl.out
C              GT 1 TIME STEP ONLY AT INTERVAL ISCFL FOR ENTIRE RUN
C   ISCFLM:    1 TO MAP LOCATIONS OF MAX TIME STEPS OVER ENTIRE RUN
C              0.0

```

4 - EFDC Master Input File (efdc.inp)

C08	TCON	TBEGIN	TREF	CORIOLIS	ISCORV	ISCCA	ISCFL	ISCFLM
	86400.	1.0	86400.	0.0000	0	0	0	0

This card image specifies a number of real time related parameters as well as activating timestep related diagnostics. TBEGIN specifies the start time of the runs in units of seconds, minutes, hours, or days, with TCON being the multiplier factor which would convert TBEGIN to seconds. The reference time period must always be specified in seconds. The EFDC model currently is based on an f -plane formulation for the Coriolis accelerations, with the variable CORIOLIS being the value of f in 1/seconds units. The maximum stable time step is constrained by the $0.5/f$ and the CFL criteria for advection (Hamrick, 1992a). Activation of ISDCCA causes the maximum effective Coriolis parameter to be printed to the log file *efdc.log* at each time step. Activation of ISCFL=1 writes the limiting time step, and the cell in which it occurs, based on the CFL condition to the file *cfl.out* at each time step. Since the CFL condition is based on linear stability analysis of a constant coefficient, three-dimensional advection equation, a good rule for real world applications with spatial and temporal varying advective fields is to use a time step on the order of 1/4 to 1/2 the limiting CFL time step written to *cfl.out*. Since both of the time step diagnostics involve logic searches, they should only be activated during the start up of a new model application.

Card Image 9

C09 SPACE-RELATED AND SMOOTHING PARAMETERS

```
C
C   KC:      NUMBER OF VERTICAL LAYER
C   IC:      NUMBER OF CELLS IN I DIRECTION
C   JC:      NUMBER OF CELLS IN J DIRECTION
C   LC:      NUMBER OF ACTIVE CELLS IN HORIZONTAL + 2
C   LVC:     NUMBER OF VARIABLE SIZE HORIZONTAL CELLS
C   ISCO:    1 FOR CURVILINEAR-ORTHOGONAL GRID (LVC=LC-2)
C   NDM:     NUMBER OF DOMAINS FOR HORIZONTAL DOMAIN DECOMPOSITION
C           ( NDM=1, FOR MODEL EXECUTION ON A SINGLE PROCESSOR SYSTEM OR
C             NDM=MM*NCPUS, WHERE MM IS AN INTEGER AND NCPUS IS THE NUMBER
C             OF AVAILABLE CPU'S FOR MODEL EXECUTION ON A PARALLEL
C             MULTIPLE PROCESSOR SYSTEM )
C   LDW:     NUMBER OF WATER CELLS PER DOMAIN
C           ( LDW=(LC-2)/NDM, FOR MULTIPLE VECTOR PROCESSORS, LDW MUST BE
C             AN INTEGER MULTIPLE OF THE VECTOR LENGTH OR STRIDE NVEC
C             THUS CONSTRAINING LC-2 TO BE AN INTEGER MULTIPLE OF NVEC )
C   ISMASK:  1 FOR MASKING WATER CELL TO LAND OR ADDING THIN BARRIERS
C             USING INFORMATION IN FILE mask.inp
C   ISPGNS:  1 FOR IMPLEMENTING A PERIODIC GRID IN COMP N-S DIRECTION OR
C             CONNECTING ARBITRARY CELLS USING INFO IN FILE mappgns.inp
C   NSHMAX:  NUMBER OF DEPTH SMOOTHING PASSES
C   NSBMAX:  NUMBER OF INITIAL SALINITY FIELD SMOOTHING PASSES
C   WSMH:    DEPTH SMOOTHING WEIGHT
```

```

C      WSMB:      SALINITY SMOOTHING WEIGHT
C
C09  KC  IC  JC    LC  LVC  ISCO  NDM  LDW  ISMASK  ISPGNS  NSHMX  NSBMX    WSMH    WSMB
      2  33  25  502  500  1    1   500  0      0      1    0    0.0625  0.0625

```

Card image 9 specifies the spatial structure of the model grid, with KC denoting the number of layers and IC and JC denoting the number of cells in the computational x and y directions as discussed in the previous chapter on grid generation. Internally, the EFDC code uses a single horizontal index, L, rather than the two indices I and J. The use of the single index L allows only for computation on and storage of only active water cells. The parameter LC is the number of active or water cells in the grid plus 2. The two additions to the L sequence at L=1 and L=LC are used for boundary condition implementation with computational loops ranging from L=2,LC-1. The parameter LVC is equal to LC-2 if the ISCLO switch is set to 1. The ISCLO switch is set to 1 for curvilinear grids, variable spaced Cartesian grids and Cartesian grids which are specified entirely by the *cell.inp*, *dxdy.inp* and *lxly.inp* files. The parameters NDM and LDM specify a domain decomposition of the horizontal grid for execution of EFDC on parallel or multiple processor systems. For parallel execution, NDM should equal the number of processors the code will execute on. For multiple processor systems, such as symmetric multiprocessor UNIX work stations, with no vector capability, LDM should be equal to the number of water cells in the grid, LC-2, divided by NDM, ensuring load balancing across the processors. The same rule should also be followed for parallel vector processors, however for optimum performance, LDM should also be an integer multiple of the vector stride (usually 64 or 128). This may require the additional cells to be added to the grid. The additional cells may be in the form of one-dimensional, in the horizontal, closed channels, which do not influence the solution of the actual problem. The input shown above could be modified for execution on a 4 processor system by setting NDM equal to 4 and LDM equal to 256, which is also an integer multiple of 64 and 128. The ISMASK switch activates the “curtain of no flow” barriers on cell faces specified in the file *mask.inp*. The switch ISPGNS configures all or portions of north and south open boundaries to represent periodic domains in the computational y direction, using information in the file *mappgns.inp*. This option is useful in shelf and near-shore applications. The parameter NSHMAX specifies the number of smoothing passes applied to the input depth and bottom elevation fields with WSMH being the smoothing parameter, which must be less than 0.25. The smoother has the form:

$$H_{new}(L) = H_{old}(L) + WSMH * \left(\begin{array}{l} H_{old}(LS) + H_{old}(LW) + H_{old}(LE) \\ + H_{old}(LN) - 4 * H_{old}(L) \end{array} \right) \quad (1)$$

Likewise the parameter NSBMAX specifies the number of smoothing passes to be applied to a salinity field initialized by the *salt.inp* file. The salinity smoother can also be used to interpolate sparse salinity data to create a smooth initial salinity field. In this case, the vertical salinity profiles in the *salt.inp* file must be set with zero values, except at locations where nonzero values are supplied. Setting NSBMAX to a large number, which must be greater than 10, and should usually be on the order of 2000, interpolates the salinity over the entire grid with the nonzero input data unmodified. In an estuary application, specifying small values at the limit of salinity intrusion will prevent the diffusive interpolation scheme from progressing upstream.

Card Image 10

```
C10 LAYER THICKNESS IN VERTICAL
C
C   THICKNESS OF EACH VERTICAL LAYER, 1 = BOTTOM
C   LAYER THICKNESS MUST SUM TO 1.0
C
C10 LAYER NUMBER    DIMENSIONLESS LAYER THICKNESS
      1              0.5
      2              0.5
```

This card specifies the dimensional thickness of the vertical layers, which do not have to be equal, but do need to sum to 1.0. Layer 1 is the bottom layer.

Card Image 11

```
C11 GRID, ROUGHNESS AND DEPTH PARAMETERS
C
C   DX:          CARTESIAN CELL LENGTH IN X OR I DIRECTION
C   DY:          CARTESIAN CELL LENGTH IN Y OR J DIRECTION
C   DXYCVT:     MULTIPLY DX AND DY BY TO OBTAIN METERS
C   IMD:        GREATER THAN 0 TO READ MODDXDY.INP FILE
C   ZBRADJ:     LOG BDRY LAYER CONST OR VARIABLE ROUGH HEIGHT ADJ IN METERS
C   ZBRCVT:     LOG BDRY LAYER VARIABLE ROUGHNESS HEIGHT CONVERT TO METERS
C   HMIN:       MINIMUM DEPTH OF INPUTS DEPTHS IN METERS
C   HADJ:       ADJUSTMENT TO DEPTH FIELD IN METERS
C   HCVRT:      CONVERTS INPUT DEPTH FIELD TO METERS
C   HDRY:       DEPTH AT WHICH CELL OR FLOW FACE BECOMES DRY
C   HWET:       DEPTH AT WHICH CELL OR FLOW FACE BECOMES WET
C   BELADJ:     ADJUSTMENT TO BOTTOM BED ELEVATION FIELD IN METERS
C   BELCVRT:    CONVERTS INPUT BOTTOM BED ELEVATION FIELD TO METERS
C
C11 DX  DY  DXYCVT  IMD  ZBRADJ  ZBRCVT  HMIN  HADJ  HCVT  HDRY  HWET  BELADJ  BELCVT
      1.  1.  1.     0   0.05   0.0    0.5  0.0  1.0  0.11  0.16  0.0   1.00
```

Card image 11 specifies horizontal grid, bottom roughness and bathymetric parameters. The parameters DX and DY are used to specify constantly spaced Cartesian cell sizes for grids specified by the *cell.inp* and *depth.inp* files when ISCLO equals 0. The conversion factor DXYCVT can be used to convert the units of DX and DY in the *dxdy.inp* to the required internal unit of meters. The parameters ZBRADJ and ZBRCVT are used to adjust and convert the log law, z_0 , bottom roughness specified in either the *dxdy.inp* or *depth.inp* files. The conversion equation is of the form:

$$ZBR = ZBRADJ + ZBRCVT * ZBR$$

The parameter HMIN is used to specify a minimum depth, over-riding input values. The parameters HADJ and HCVRT and BEADJ and BECVRT provide for adjustments and conversions to the initial depth and bottom elevation inputs in the same format as that for bottom roughness. The parameter HDRY specifies the water depth at which a cell becomes dry, while HWET specifies the depth at which the cell become wet.

Card Image 12

C12 TURBULENT DIFFUSION PARAMETERS

```

C
C   AHO:      CONSTANT HORIZONTAL MOMENTUM AND MASS DIFFUSIVITY M*M/S
C   AHD:      DIMENSIONLESS HORIZONTAL MOMENTUM DIFFUSIVITY
C   AVO:      BACKGROUND, CONSTANT OR MOLECULAR KINEMATIC VISCOSITY M*M/S
C   ABO:      BACKGROUND, CONSTANT OR MOLECULAR DIFFUSIVITY M*M/S
C   AVMN:     MINIMUM KINEMATIC EDDY VISCOSITY M*M/S
C   ABMN:     MINIMUM EDDY DIFFUSIVITY M*M/S
C   AVBCON:   EQUALS ZERO FOR CONSTANT VERTICAL VISCOSITY AND DIFFUSIVITY
C             WHICH ARE SET EQUAL TO AVO AND ABO OTHERWISE SET TO 1.0
C   ISAVBMN:  SET TO 1 TO ACTIVATE MIN VIS AND DIFF OF AVMN AND ABMN
C   ISFAVB:   SET TO 1 OR 2 TO AVG OR SQRT FILTER AVV AND AVB
C   ISINWV:   SET TO 1 TO ACTIVATE PARAMETERIZATION OF INTERNAL WAVE
C             GENERATED TURBULENCE
C             1.E-6  1.E-9  1.E-6  1.E-9
C12  AHO  AHD  AVO  ABO  AVMN  ABMN  AVBCON  ISAVBMN  ISFAVB  ISINWV
      90.0  0.0  1.E-6  1.E-8  1.E-6  1.E-8  1.0    0        1        0

```

Card image 12 provides information for horizontal and vertical momentum and mass diffusion. A spatially constant horizontal diffusion is specified by a constant value AHO. A variable horizontal diffusion may be added to the constant value by specifying a non-zero value of AHD, which is the dimensionless constant in the Smagorinsky subgrid scale horizontal diffusion formulation (Smagorinsky, 1963). The background molecular kinematic viscosity and diffusivity are specified by AVO and ABO respectively. When

AVBCON is set to 0, the turbulence model is deactivated and the vertical viscosity and diffusivity are set to AVO and ABO respectively. Using this option and setting AVO and ABO to larger values representing turbulent flow readily allows model results to be compared with constant viscosity and diffusivity analytical solutions for vertical current structure. Setting the parameter ISFAVB to 1 activates a square root smoother for both the vertical turbulent viscosity and diffusivity of the form:

$$AVO(n+1) = \text{SQRT}(AVO(n+1) * AVO(n))$$

where n indicates the time step. The smoother is particularly useful for flows having strong surface wind stress forcing.

Card Image 13

```

C13 TURBULENCE CLOSURE PARAMETERS
C
C      VKC:      VON KARMAN CONSTANT
C      CTURB1:  TURBULENT CONSTANT (UNIVERSAL)
C      CTURB2:  TURBULENT CONSTANT (UNIVERSAL)
C      CTE1:    TURBULENT CONSTANT (UNIVERSAL)
C      CTE2:    TURBULENT CONSTANT (UNIVERSAL)
C      CTE3:    TURBULENT CONSTANT (UNIVERSAL)
C      QQMIN:   MINIMUM TURBULENT INTENSITY SQUARED
C      QQLMIN:  MINIMUM TURBULENT INTENSITY SQUARED TIME MACRO-SCALE
C      DMLMIN:  MINIMUM DIMENSIONLESS MACRO-SCALE
C
C13 VKC   CTURB1  CTURB2   CTE1   CTE2   CTE3   QQMIN   QQLMIN   DMLMIN
      0.4   16.6    10.1    1.8    1.33  0.53   1.E-8   1.E-12   1.E-4
    
```

The turbulence closure parameters on this line should not be modified without consulting the author.

Card Image 14

```

C14 TIDAL & ATMOSPHERIC FORCING, GROUND WATER AND SUBGRID CHANNEL PARAMETERS
C
C      MTIDE:   NUMBER OF PERIOD (TIDAL) FORCING CONSTITUENTS
C      NWSER:   NUMBER OF WIND TIME SERIES (0 SETS WIND TO ZERO)
C      NASER :  NUMBER OF ATMOSPHERIC CONDITION TIME SERIES (0 SETS ALL ZERO)
C      ISGWI:   1 TO ACTIVATE SOIL MOISTURE BALANCE WITH DRYING AND WETTING
C      ISCHAN:  1 ACTIVATE SUBGRID CHANNEL MODEL AND READ MODCHAN.INP
C      ISWAVE  1 FOR WAVE CURRENT BOUNDARY LAYER  REQUIRES FILE wave.inp
C              2 FOR WCBL AND WAVE INDUCED CURRENTS REQUIRES FILE wave.inp
C
C14 MTIDE  NWSER  NASER   ISGWI  ISCHAN  ISWAVE  ITIDASM
    
```

1 1 1 0 0 0 0

Card image 14 provides basic data for specifying periodic water surface elevation forcings on open boundaries as well as controlling the optional internal least squares harmonic analysis of modeling predictions. MTIDE specifies the number of periodic constituents. ISLSHA activates the least squares harmonic analysis at MLLSHA user specified horizontal locations over NTCLSHA reference time periods. The analysis assumes a steady component or a linear trend component if ISLSRT is set to 1. The switch ISHTA should only be activated if MTIDE is equal to 1, with a single period constituent least squares harmonic analysis activated for the entire free surface displacement and horizontal velocity field.

Card Image 15

```
C15 PERIODIC FORCING (TIDAL) CONSTITUENT SYMBOLS AND PERIODS
C
C     SYMBOL:  FORCING SYMBOL (CHARACTER VARIABLE) FOR TIDES, THE NOS SYMBOL
C     PERIOD:  FORCING PERIOD IN SECONDS
C
C15 SYMBOL      PERIOD
      'M2'      44714.1643936  1
```

Card image 15 specifies user defined symbols or standard NOAA tidal constituent symbols and forcing periods for the MTIDE constituents.

Card Image 16

```
C16 SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITION PARAMETERS
C
C     NPBS:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS
C           CELLS ON SOUTH OPEN BOUNDARIES
C     NPBW:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS
C           CELLS ON WEST OPEN BOUNDARIES
C     NPBE:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS
C           CELLS ON EAST OPEN BOUNDARIES
C     NPNB:  NUMBER OF SURFACE ELEVATION OR PRESSURE BOUNDARY CONDITIONS
C           CELLS ON NORTH OPEN BOUNDARIES
C     NPFOR: NUMBER OF HARMONIC FORCINGS
C     NPSE:  NUMBER OF TIME SERIES FORCINGS
C     PDGINIT: ADD THIS CONSTANT ADJUSTMENT GLOBALLY TO THE SURFACE ELEVATION
C
C16 NPBS NPBW NPBE NPNB NPFOR NPSE PDGINIT
      0   0   20   0   1   0   0.0
```

This card image specifies the number of open boundary cells on south, west, east and north open boundaries in the computational grid, as well as the number of periodic forcing functions, the number of surface elevation time series to be used for open boundary forcings and an initial adjustment to the water surface elevation. If NPSE is greater than zero, NPSE surface elevation time series are read from the *pser.inp* file. The adjustment factor should in general not be used without consultation with the writer. Note that south and north boundary cells paired to implement the periodic domain configuration in the computation y direction should not be included in the NPBS and NPBN counts.

Card Image 17

```

C17 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE BOUNDARY COND. FORCINGS
C
C      NPFOR:      FORCING NUMBER
C      SYMBOL:     FORCING SYMBOL (FOR REFERENCE HERE ONLY)
C      AMPLITUDE:  AMPLITUDE IN M (PRESSURE DIVIDED BY RHO*G)
C      PHASE:      FORCING PHASE RELATIVE TO TBEGIN IN SECONDS
C
C17 NPFOR      SYMBOL      AMPLITUDE      PHASE
      1          'M2'        0.5            0.0
    
```

Card image 17 specifies NPFOR forcing functions, each having MTIDE constituents, with the first column set to the forcing number for user reference. Constituents for each forcing should be in the order sequence defined on card image 15. The phase is specified in seconds consistent with the representation:

$$\zeta_{tot} = \sum_{n=1}^N \zeta_n \cos \left[\frac{2\pi}{T_n} (t - t_n) \right] + \zeta_{ser}(t) \quad (2)$$

where ζ and τ are the amplitude and phase of the n constituent and ζ_{ser} is an additive time series specification of the surface elevation. The time origin for the phase should be consistent with the time origin for the simulation. For example, TBEGIN on card image 8 is in Julian hours relative to midnight, January 1 of a given year. For this case, then the phase should also be relative to midnight January 1 of the same year. For the analysis of field records, to accomplish this synchronization, a stand alone least square harmonic analysis program *lsqhs.f* is available from the author. The null forcing function 2 might be used on an open boundary with only outgoing wave propagation, to be discussed below.

Card Image 18

```

C18 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON SOUTH OPEN BOUNDARIES
    
```

```

C
C   IPBS:      I CELL INDEX OF BOUNDARY CELL
C   JPBS:      J CELL INDEX OF BOUNDARY CELL
C   ISPBS:     1 FOR RADIATION-SEPARATION CONDITION
C               0 FOR ELEVATION SPECIFIED
C   NPFORS:    APPLY HARMONIC FORCING NUMBER NPFORS
C   NPSERS:    APPLY TIME SERIES FORCING NUMBER NPSERS
C
C18 IPBS      JPBS      ISPBS      NPFORS  NPSERS

```

See discussion following card image 21.

Card Image 19

```

C19 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON WEST OPEN BOUNDARIES
C
C   IPBW:      SEE CARD 19
C   JPBW:
C   ISPBW:
C   NPFORW:
C   NPSERW:
C
C19 IPBW      JPBW      ISPBW      NPFORW  NPSERW

```

See discussion following card image 21.

Card Image 20

```

C20 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON EAST OPEN BOUNDARIES
C
C   IPBE:      SEE CARD 19
C   JPBE:
C   ISPBE:
C   NPFORE:
C   NPSERE:
C
C20 IPBE      JPBE      ISPBE      NPFORE  NPSERE
    30         3         0         1        0
    30         4         0         1        0
    30         5         0         1        0
    30         6         0         1        0
    30         7         0         1        0
    30         8         0         1        0
    30         9         0         1        0

```

4 - EFDC Master Input File (efdc.inp)

30	10	0	1	0
30	11	0	1	0
30	12	0	1	0
30	13	0	1	0
30	14	0	1	0
30	15	0	1	0
30	16	0	1	0
30	17	0	1	0
30	18	0	1	0
30	19	0	1	0
30	20	0	1	0
30	21	0	1	0
30	22	0	1	0

See discussion following card image 21.

Card Image 21

```
C21 PERIODIC FORCING (TIDAL) SURF ELEV OR PRESSURE ON NORTH OPEN BOUNDARIES
C
C   IPBN:   SEE CARD 19
C   JPBN:
C   ISPBN:
C   NPFORN:
C   NPSERN:
C
C21 IPBN      JPBN      ISPBN      NPFORN      NPSERN
```

Card images 18 through 21 specify the open boundary conditions for the four directional faces of the horizontal computational domain. Because of the similarity of the four data sets, they will be discussed in a generic fashion. To provide background on the discussion of the model's operation at open boundaries, it is useful to summarize the treatment of open boundary conditions in the EFDC model. The EFDC model provides for two types of hydrodynamic open boundary conditions. The first type is the standard specification of water surface elevation using combinations of harmonic constituents and time series. The second type of open boundary conditions is referred to as a radiation-separation boundary condition in that the incoming wave at an open boundary is separated from the outgoing wave (Bennett and McIntosh, 1982). For outgoing waves the condition functions as a radiation condition with a phase speed equal to the square root of gh , where h is the mean or undisturbed depth along the open boundary. For incoming waves, $1/2$ of the characteristic of the incoming wave is specified. As an example, consider an east open boundary, with the model domain to the west in the negative x direction

and the unmodeled region to the east in the positive x direction. The incoming characteristic for the linear one-dimensional shallow water equation (Bennett, 1976), is:

$$\zeta - \frac{h\bar{u}}{\sqrt{gh}} \quad (3)$$

where ζ is the free surface displacement, h is the water depth and u is the x component of velocity, with the overbar denoting depth-averaged or external-mode velocity. For a purely progressive wave propagating in the negative x direction, incoming toward the east open boundary:

$$\zeta = \zeta \cos \left[\omega \left(\frac{x}{\sqrt{gh}} + t \right) \right] \quad (4)$$

$$\frac{h\bar{u}}{\sqrt{gh}} = -\zeta \cos \left[\omega \left(\frac{x}{\sqrt{gh}} + t \right) \right] \quad (5)$$

Inserting (6) and (7) into (5) gives

$$\zeta - \frac{h\bar{u}}{\sqrt{gh}} = 2\zeta \cos \left[\omega \left(\frac{x}{\sqrt{gh}} + t \right) \right] = 2\zeta \quad (6)$$

Thus 1/2 of the characteristic of the purely progressive incoming wave is the wave surface displacement.

Open boundary cells are defined by the type 5 cell type in the *cell.inp* file but are presumed to be external to the computation in that the continuity equation is not solved in the open boundary cell. Tangential velocities (i.e., the u or x velocity component in a south or north open boundary cell and the v or y velocity component in an east or west open boundary cell) are also not currently computed in open boundary cells. Due to the placement definition of u on west cell faces and v on south cell faces, the u is computed for east open boundary cells and v is computed for north open boundary cells. The first two parameters on each card image specify the I and J indices of the open boundary cells. The I and J indices sequence does not need to be continuous since a model domain may have multiple opening on either of the four directional face normals. The ISPBS (ISPBW, ISPBE, ISPBN) switch is

set to zero for direct specification of the open boundary cell surface elevation or to 1 for the implementation of a radiation-separation boundary condition. For ISPBS set to zero, the open boundary cell water surface elevation is directly specified by the sum of the periodic forcing function (NPFORS,W,E,N) and the surface elevation time series (NPSERS,W,E,N) where NPSER_ identifies one of the NPSER surface elevation time series in the *pser.inp* file. The radiation-separation boundary condition specifies the linear characteristic of an assumed normal incident incoming wave as twice the surface elevation specified by the sum of the periodic and time series forcing. By default, the outgoing characteristic is left undefined allowing waves generated interior to the model domain to pass outward across the boundary with no reflection. Since the normal incident criteria is somewhat idealized, care should be used in the use of the radiation separation boundary condition. A more sophisticated radiation-separation open boundary condition (relaxing the normal incident criteria the imposition of zero tangential velocity) is under development.

Card Image 22

```

C22 SPECIFY NUM OF SEDIMENT AMD TOXICS AND NUM OF CONCENTRATION TIME SERIES
C
C   NTOX:   NUMBER OF TOXIC CONTAMINANTS (DEFAULT = 1)
C   NSED:   NUMBER OF COHESIVE SEDIMENT SIZE CLASSES (DEFAULT = 1)
C   NSND:   NUMBER OF NON-COHESIVE SEDIMENT SIZE CLASSES (DEFAULT = 1)
C   NSSER:  NUMBER OF SALINITY TIME SERIES
C   NTSER:  NUMBER OF TEMPERATURE TIME SERIES
C   NDSER:  NUMBER OF DYE CONCENTRATION TIME SERIES
C   NSFSER: NUMBER OF SHELLFISH LARVAE CONCENTRATION TIME SERIES
C   NTXSER: NUMBER OF TOXIC CONTAMINANT CONCENTRATION TIME SERIES
C           EACH TIME SERIES MUST HAVE DATA FOR NTOX TOXICICANTS
C   NSDSER: NUMBER OF COHESIVE SEDIMENT CONCENTRATION TIME SERIES
C           EACH TIME SERIES MUST HAVE DATA FOR NSED COHESIVE SEDIMENTS
C   NSNSER: NUMBER OF NON-COHESIVE SEDIMENT CONCENTRATION TIME SERIES
C           EACH TIME SERIES MUST HAVE DATA FOR NSND NON-COHESIVE SEDIMENTS
C   ISDBAL: SET TO 1 FOR SEDIMENT MASS BALANCE
C
C22  NTOX  NSED  NSND  NSSER  NTSER  NDSER  NSFSER  NTXSER  NSDSER  NSNSER  ISSBAL
      1    1    1    0    0    0    0    0    0    0    0    0
    
```

Card Image 23

```

C23 VELOCITY, VOLUME SOURCE/SINK, FLOW CONTROL, AND WITHDRAWAL/RETURN DATA
C
C   NVBS:   NUMBER OF VELOCITY BC'S ON SOUTH OPEN BOUNDARIES
    
```

```

C   NUBW:   NUMBER OF VELOCITY BC'S ON WEST OPEN BOUNDARIES
C   NUBE:   NUMBER OF VELOCITY BC'S ON EAST OPEN BOUNDARIES
C   NVBN:   NUMBER OF VELOCITY BC'S ON NORTH OPEN BOUNDARIES
C   NQSIJ:  NUMBER OF CONSTANT AND/OR TIME SERIES SPECIFIED SOURCE/SINK
C           LOCATIONS (RIVER INFLOWS, ETC)
C   NQJPIJ: NUMBER OF CONSTANT AND/OR TIME SERIES SPECIFIED SOURCE
C           LOCATIONS TREATED AS JETS/PLUMES
C   NQSER:  NUMBER OF VOLUME SOURCE/SINK TIME SERIES
C   NQCTL:  NUMBER OF PRESSURE CONTROLLED WITHDRAWAL/RETURN PAIRS
C   NQCTLT: NUMBER OF PRESSURE CONTROLLED WITHDRAWAL/RETURN TABLES
C   NQWR:   NUMBER OF CONSTANT OR TIME SERIES SPECIFIED WITHDRAWAL/RETURN
C           PAIRS
C   NQWRSR: NUMBER OF TIME SERIES SPECIFYING WITHDRAWAL, RETURN AND
C           CONCENTRATION RISE SERIES
C   ISDIQ:  SET TO 1 TO WRITE DIAGNOSTIC FILE, diaq.out
C
C23 NVBS NUBW NUBE NVBN NQSIJ NQJPIJ NQSER NQCTL NQCTLT NQWR NQWRSR ISDIQ
    0    0    0    0    0    0    0    0    0    0    0    0    0

```

Card image 23 specifies basic information on volumetric sources and sinks. The first four parameters on this card are currently inactive. Volumetric source and sink representation in the EFDC model falls within three classes. The first class is constant or time varying volumetric sources and sinks at NQSIJ horizontal grid locations. The second class is pressure or surface elevation controlled hydraulic structures occurring as NQCTL source and sink pairs. The third class is constant or time variable flow withdrawal and return sources and sinks occurring as NQWR pairs. The sources and sinks associated with NQSIJ and NQWR may have constant flow rates, specified in this file or time variable flow rates as specified by one of NQSER flow time series read from the *qser.inp* file. For positive NQSIJ sources, inflow concentrations of the various transported scalar constituents may be associated with the flow. For negative NQSIJ sinks, mass loss of transport scalar constituents is accounted for. The withdrawal-return source sink class provides for a constant or time variable concentration rise between the withdrawal and return cells. The NQWR options is designed to power plant and industrial cooling systems. The final switch ISDIQ activates diagnostics of allowable classes of volumetric source and sink flows to be written to the file *diaq.out*. Since this file can become quite large, this option is recommended to be used only for debugging. Generally when activated, the model should be allowed to run only a few time steps, and then manually killed by the user.

Card Image 24

```

C24 VOLUMETRIC SOURCE/SINK LOCATIONS, MAGNITUDES, AND CONCENTRATION SERIES
C
C   IQS:     I CELL INDEX OF VOLUME SOURCE/SINK

```

4 - EFDC Master Input File (efdc.inp)

```
C      JQS:      J CELL INDEX OF VOLUME SOURCE/SINK
C      QSSE:    CONSTANT INFLOW/OUTFLOW RATE IN M*M*M/S
C      NQSMUL:  MULTIPLIER SWITCH FOR CONSTANT AND TIME SERIES VOL S/S
C              = 0  MULT BY 1. FOR NORMAL IN/OUTFLOW (L*L*L/T)
C              = 1  MULT BY DY FOR LATERAL IN/OUTFLOW (L*L/T) ON U FACE
C              = 2  MULT BY DX FOR LATERAL IN/OUTFLOW (L*L/T) ON V FACE
C              = 3  MULT BY DX+DY FOR LATERAL IN/OUTFLOW (L*L/T) ON U&V FACES
C      NQSMFF:  IF NON ZERO ACCOUNT FOR VOL S/S MOMENTUM FLUX
C              = 1  MOMENTUM FLUX ON NEG U FACE
C              = 2  MOMENTUM FLUX ON NEG V FACE
C              = 3  MOMENTUM FLUX ON POS U FACE
C              = 4  MOMENTUM FLUX ON POS V FACE
C      NQSERQ:  ID NUMBER OF ASSOCIATED VOLUMN FLOW TIME SERIES
C      NSSERQ:  ID NUMBER OF ASSOCIATED SALINITY TIME SERIES
C      NTSERQ:  ID NUMBER OF ASSOCIATED TEMPERATURE TIME SERIES
C      NDSERQ:  ID NUMBER OF ASSOCIATED DYE CONC TIME SERIES
C      NSFSERQ: ID NUMBER OF ASSOCIATED SHELL FISH LARVAE RELEASE TIME SERIES
C      NTXSERQ: ID NUMBER OF ASSOCIATED TOXIC CONTAMINANT CONC TIME SERIES
C      NSDSERQ: ID NUMBER OF ASSOCIATED COHEASIVE SEDIMENT CONC TIME SERIES
C      NSNSERQ: ID NUMBER OF ASSOCIATED NONCOHEASIVE SED CONC TIME SERIES
C
C24 IQS  JQS  QSSE  NQSMUL  NQSMFF  NQSERQ  NS-  NT-  ND-  NSF-  NTX-  NSD-  NSN-
```

Card image 24 provides information for the NQSIJ class of volumetric source sink flows, with the first two parameters specifying the location by I and J indices. The third parameter, QSSE is used to specify a time invariant inflow rate (outflows or sinks simply have negative signs) in either cubic meters per second or cubic meters per second per meter. The adjustment factor NQMUL specifies how volumetric flows per unit length are converted to true volumetric flows. The control parameter NQMF indicates if the volumetric source or sink is to have an associated momentum flux and which face of the source cell the momentum flux is assigned. Time variable flows are defined by entering a flow time series identifier number (less than or equal to NQSER) under NQSERQ. The remaining five columns allow the specification of a scalar constituent concentration time series associated with the flow time series only. Constant concentrations associated with the constant QSSE flows are defined on card image 25, below. The constant flowrate source and sinks are distributed uniformly over the vertical layers, while the time series specification of source and sink flows allows arbitrary distribution over the vertical layers.

Card Image 25

```
C25 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT VOLUMETRIC SOURCES
C
C      SAL:    SALT CONCENTRATION CORRESPONDING TO INFLOW ABOVE
C      TEM:    TEMPERATURE CORRESPONDING TO INFLOW ABOVE
C      DYE:    DYE CONCENTRATION CORRESPONDING TO INFLOW ABOVE
C      SFL:    SHELL FISH LARVAE CONCENTRATION CORRESPONDING TO INFLOW ABOVE
C      TOX:    NTOX TOXIC CONTAMINANT CONCENTRATIONS CORRESPONDING TO
```

```

C          INFLOW ABOVE WRITTEN AS TOXC(N) , N=1,NTOX A SINGLE DEFAULT
C          VALUE IS REQUIRED EVEN IF TOXIC TRANSPORT IS NOT ACTIVE
C
C25 SAL TEM DYE SFL TOX1-20

```

The time-constant inflow concentrations (salinity, temperature, dye, shellfish, and toxic) for the volumetric sources defined on card image 24 are specified here.

Card Image 26

```

C26 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT VOLUMETRIC SOURCES
C
C      SED:  NSED COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO
C            INFLOW ABOVE WRITTEN AS SEDC(N) , N=1,NSED. I.E., THE FIRST
C            NSED VALUES ARE COHESIVE A SINGLE DEFAULT VALUE IS REQUIRED
C            EVEN IF COHESIVE SEDIMENT TRANSPORT IS INACTIVE
C      SND:  NSND NON-COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO
C            INFLOW ABOVE WRITTEN AS SND(N) , N=1,NSND. I.E., THE LAST
C            NSND VALUES ARE NON-COHESIVE. A SINGLE DEFAULT VALUE IS
C            REQUIRED EVEN IF NON-COHESIVE SEDIMENT TRANSPORT IS INACTIVE
C
C26 SED1  SND1

```

The time-constant concentrations (cohesive and non-cohesive sediment) for the volumetric sources defined on card image 24 are specified here.

Card Image 27 [not active in EFDC-Hydro]

```

C27 JET/PLUME SOURCE LOCATIONS, GEOMETRY AND ENTRAINMENT PARAMETERS
C
C      ID:  ID COUNTER FOR JET/PLUME
C      ICAL: 1 ACTIVE, 0 BYPASS
C      IQJP: I CELL INDEX OF JET/PLUME
C      JQJP: J CELL INDEX OF JET/PLUME
C      KQJP: K CELL INDEX OF JET/PLUME (DEFAULT, QJET=0 OR JET COMP DIVERGES)
C      XJET: LOCAL EAST JET LOCATION RELATIVE TO DISCHARGE CELL CENTER (M)
C      YJET: LOCAL NORTH JET LOCATION RELATIVE TO DISCHARGE CELL CENTER (M)
C      ZJET: ELEVATION OF DISCHARGE (M)
C      PHJET: VERTICAL JET ANGLE POSITIVE FROM HORIZONTAL (DEGREES)
C      THJET: HORIZONTAL JET ANGLE POS COUNTER CLOCKWISE FROM EAST (DEGREES)
C      DJET: DIAMETER OF DISCHARGE PORT (M)
C      CFRD: ADJUSTMENT FACTOR FOR FROUDE NUMBER
C      DJPER: ENTRAINMENT ERROR CRITERIA
C

```

4 - EFDC Master Input File (efdc.inp)

C27 ID ICAL IQJP JQJP KQJP XJET YJET ZJET PHJET THJET DJET CFRD DJPER

The source locations for the jet-plume discharges are specified on this card image.

Card Image 28 [not active in EFDC-Hydro]

C28 JET/PLUME SOLUTION CONTROL AND OUTPUT CONTROL PARAMETERS
C
C ID: ID COUNTER FOR JET/PLUME
C NJEL: MAXIMUM NUMBER OF ELEMENTS ALONG JET/PLUME LENGTH
C NJPMX: MAXIMUM NUMBER OF ITERATIONS
C ISENT: 0 USE MAXIMUM OF SHEAR AND FORCED ENTRAINMENT
C 1 USE SUM OF SHEAR AND FORCED ENTRAINMENT
C ISTJP: 0 STOP AT SPECIFIED NUMBER OF ELEMENTS
C 1 STOP WHEN CENTERLINE PENETRATES BOTTOM OR SURFACE
C 2 STOP WITH BOUNDARY PENETRATES BOTTOM OR SURFACE
C NUDJP: FREQUENCY FOR UPDATING JET/PLUME (NUMBER OF TIME STEPS)
C IOJP: 1 FOR FULL ASCII, 2 FOR COMPACT ASCII OUTPUT AT EACH UPDATE
C 3 FOR FULL AND COMPACT ASCII OUTPUT, 4 FOR BINARY OUTPUT
C IPJP: NUMBER OF SPATIAL PRINT/SAVE POINT IN VERTICAL
C ISDJP: 1 WRITE DIAGNOSTIC TO jpllog__.out
C
C28 ID NJEL NJPMX ISENT ISTJP NUDJP IOJP IPJP ISDJP

The solution control and output control parameters for the jet-plume discharges are specified here.

Card Image 29 [not active in EFDC-Hydro]

C29 JET/PLUME SOURCE PARAMETERS AND DISCHARGE/CONCENTRATION SERIES IDS
C
C ID: ID COUNTER FOR JET/PLUME
C QQJP: CONSTANT JET/PLUME FLOW RATE IN M*M*M/S
C NQSERJP: ID NUMBER OF ASSOCIATED VOLUMN FLOW TIME SERIES
C NSSERJP: ID NUMBER OF ASSOCIATED SALINITY TIME SERIES
C NTSERJP: ID NUMBER OF ASSOCIATED TEMPERATURE TIME SERIES
C NDSERJP: ID NUMBER OF ASSOCIATED DYE CONC TIME SERIES
C NSFSERJP: ID NUMBER OF ASSOCIATED SHELL FISH LARVAE RELEASE TIME SERIES
C NTXSERJP: ID NUMBER OF ASSOCIATED TOXIC CONTAMINANT CONC TIME SERIES
C NSDSERJP: ID NUMBER OF ASSOCIATED COHESIVE SEDIMENT CONC TIME SERIES
C NSNSERJP: ID NUMBER OF ASSOCIATED NON-COHESIVE SED CONC TIME SERIES
C
C29 ID QQJP NQSERJP NS- NT- ND- NSF- NTX- NSD- NSN-

The source parameters and concentrations for the jet-plume discharges are specified here.

Card Image 30 [not active in EFDC-Hydro]

```

C30 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT JET/PLUME SOURCES
C
C   SAL:  SALT CONCENTRATION CORRESPONDING TO INFLOW ABOVE
C   TEM:  TEMPERATURE CORRESPONDING TO INFLOW ABOVE
C   DYE:  DYE CONCENTRATION CORRESPONDING TO INFLOW ABOVE
C   SFL:  SHELL FISH LARVAE CONCENTRATION CORRESPONDING TO INFLOW ABOVE
C   TOX:  NTOX TOXIC CONTAMINANT CONCENTRATIONS CORRESPONDING TO
C         INFLOW ABOVE WRITTEN AS TOXC(N), N=1,NTOX A SINGLE DEFAULT
C         VALUE IS REQUIRED EVEN IF TOXIC TRANSPORT IS NOT ACTIVE
C
C30 SAL TEM DYE SFL TOX1-20

```

The time constant inflow concentrations for salinity, temperature, dye, shellfish larvae, and toxicants for the jet-plume discharges are specified here.

Card Image 31 [not active in EFDC-Hydro]

```

C31 TIME CONSTANT INFLOW CONCENTRATIONS FOR TIME CONSTANT JET/PLUME SOURCES
C
C   SED:  NSED COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO
C         INFLOW ABOVE WRITTEN AS SEDC(N), N=1,NSED. I.E., THE FIRST
C         NSED VALUES ARE COHESIVE A SINGLE DEFAULT VALUE IS REQUIRED
C         EVEN IF COHESIVE SEDIMENT TRANSPORT IS INACTIVE
C   SND:  NSND NON-COHESIVE SEDIMENT CONCENTRATIONS CORRESPONDING TO
C         INFLOW ABOVE WRITTEN AS SND(N), N=1,NSND. I.E., THE LAST
C         NSND VALUES ARE NON-COHESIVE. A SINGLE DEFAULT VALUE IS
C         REQUIRED EVEN IF NON-COHESIVE SEDIMENT TRANSPORT IS INACTIVE
C
C31 SED1  SND1  SND2  SND3

```

The time constant inflow concentrations for the cohesive and non-cohesive sediment classes for the jet-plume discharges are specified here.

Card Image 32

```

C32 SURFACE ELEV OR PRESSURE DEPENDENT FLOW INFORMATION
C
C   IQCTLU:  I INDEX OF UPSTREAM OR WITHDRAWAL CELL
C   JQCTLU:  J INDEX OF UPSTREAM OR WITHDRAWAL CELL

```

4 - EFDC Master Input File (efdc.inp)

```
C      IQCTLD:  I INDEX OF DOWNSTREAM OR RETURN CELL
C      JQCTLD:  J INDEX OF DOWNSTREAM OR RETURN CELL
C      NQCTYP:  FLOW CONTROL TYPE
C              = 0  HYDRAULIC STRUCTURE: INSTANT FLOW DRIVEN BY ELEVATION
C                  OR PRESSURE DIFFERENCE TABLE
C              = 1  ACCELERATING FLOW THROUGH TIDAL INLET
C      NQCTLQ:  ID NUMBER OF CONTROL CHARACTERIZATION TABLE
C      NQCMUL:  MULTIPLIER SWITCH FOR FLOWS FROM UPSTREAM CELL
C              = 0  MULT BY 1. FOR CONTROL TABLE IN (L*L*L/T)
C              = 1  MULT BY DY FOR CONTROL TABLE IN (L*L/T) ON U FACE
C              = 2  MULT BY DX FOR CONTROL TABLE IN (L*L/T) ON V FACE
C              = 3  MULT BY DX+DY FOR CONTROL TABLE IN (L*L/T) ON U&V FACES
C      NQCMFU:  IF NON ZERO ACCOUNT FOR FLOW MOMENTUM FLUX IN UPSTREAM CELL
C              = 1  MOMENTUM FLUX ON NEG U FACE
C              = 2  MOMENTUM FLUX ON NEG V FACE
C              = 3  MOMENTUM FLUX ON POS U FACE
C              = 4  MOMENTUM FLUX ON POS V FACE
C      NQCMFD:  IF NON ZERO ACCOUNT FOR FLOW MOMENTUM FLUX IN DOWNSTREAM CELL
C              = 1  MOMENTUM FLUX ON NEG U FACE
C              = 2  MOMENTUM FLUX ON NEG V FACE
C              = 3  MOMENTUM FLUX ON POS U FACE
C              = 4  MOMENTUM FLUX ON POS V FACE
C      BQCMFU:  UPSTREAM MOMENTUM FLUX WIDTH (M)
C      BQCMFD:  DOWNSTREAM MOMENTUM FLUX WIDTH (M)
C
C32 IQCTLU JQCTLU IQCTLD JQCTLD NQCTYP NQCTLQ NQCMUL NQC_U NQC_D BQC_U BQC_D
```

This card image specifies the location and properties of source-sink pairs representing hydraulic control structures. The notation of upstream (sink) and downstream (source) is used for the hydraulic control structure pairs, which allow flow in only one direction. For structures such as culverts, which allow bi-directional flow, two control structure pairs are necessary to account for both flow directions. The first four parameters on this card image define the horizontal locations by the I and J indices of the upstream and downstream cells. Structures whose flow rates depend only on the surface elevation in the upstream cell (i.e., spillways and weirs) can discharge out of the computational domain by specifying the null indices 0,0 for the downstream cell. The parameter NQCTYP specifies the form of the flow dependence on the surface elevation difference between the upstream and downstream cell, (with only the 0 option currently active). The parameter NQCTLQ identifies control table number characterizing the structure. The control tables are input in the file *qctl.inp*.

Card Image 33

```
C33 FLOW WITHDRAWAL, HEAT OR MATERIAL ADDITION, AND RETURN DATA
C
```

```

C   IWRU:      I INDEX OF UPSTREAM OR WITHDRAWAL CELL
C   JWRU:      J INDEX OF UPSTREAM OR WITHDRAWAL CELL
C   KWRU:      K INDEX OF UPSTREAM OR WITHDRAWAL LAYER
C   IWRD:      I INDEX OF DOWNSTREAM OR RETURN CELL
C   JWRD:      J INDEX OF DOWNSTREAM OR RETURN CELL
C   KWRD:      J INDEX OF DOWNSTREAM OR RETURN LAYER
C   QWRE:      CONSTANT VOLUME FLOW RATE FROM WITHDRAWAL TO RETURN
C   NQWRSERQ:  ID NUMBER OF ASSOCIATED VOLUMN WITHDRAWAL-RETURN FLOW AND
C              CONCENTRATION RISE TIME SERIES
C   NQWRMFU:   IF NON ZERO ACCOUNT FOR WITHDRAWAL FLOW MOMENTUM FLUX
C              = 1  MOMENTUM FLUX ON NEG U FACE
C              = 2  MOMENTUM FLUX ON NEG V FACE
C              = 3  MOMENTUM FLUX ON POS U FACE
C              = 4  MOMENTUM FLUX ON POS V FACE
C   NQWRMFD:   IF NON ZERO ACCOUNT FOR RETURN FLOW MOMENTUM FLUX
C              = 1  MOMENTUM FLUX ON NEG U FACE
C              = 2  MOMENTUM FLUX ON NEG V FACE
C              = 3  MOMENTUM FLUX ON POS U FACE
C              = 4  MOMENTUM FLUX ON POS V FACE
C   BQWRMFU:   UPSTREAM MOMENTUM FLUX WIDTH (M)
C   BQWRMFD:   UPSTREAM MOMENTUM FLUX WIDTH (M)
C
C              23.1
C33 IWRU JWRU KWRU IWRD JCWRD KWRD  QWRE NQW_RQ NQWR_U NQWR_D BQWR_U BQWR_D

```

Card image 33 provides information for the NQWR volumetric source-sink class with the location of the upstream (withdrawal) and downstream (return) flow cell pairs specified by their I and J indices. The remaining parameters specify a constant flow rate and time series identified for variable flow rates and concentration rises. Time constant concentration rises associated with the constant flow rate are specified as shown below on card image 34.

Card Image 34

```

C34 TIME CONSTANT WITHDRAWAL AND RETURN CONCENTRATION RISES
C
C   SAL:      SALTINITY RISE
C   TEM:      TEMPERATURE RISE
C   DYE:      DYE CONCENTRATION RISE
C   SFL:      SHELLFISH LARVAE CONCENTRATION RISE
C   TOX#:     NTOX TOXIC CONTAMINANT CONCENTRATION RISES
C
C34 SALT  TEMP  DYEC  SFLC  TOX1

```

The time constant concentration rise for salinity, temperature, dye, shellfish larvae, and toxicants for the withdrawal and return flows are specified here.

Card Image 35

```
C35 TIME CONSTANT WITHDRAWAL AND RETURN CONCENTRATION RISES
C
C   SED#:   NSEDC COHESIVE SEDIMENT CONCENTRATION RISE
C   SND#:   NSEDN NONCOHESIVE SEDIMENT CONCENTRATION RISE
C
C35 SED1  SND1  SND2
```

The time constant concentration rise for cohesive and non-cohesive sediment for the withdrawal and return flows are specified here.

Card Image 36

```
C36 SEDIMENT INITIALIZATION AND WATER COLUMN/BED REPRESENTATION OPTIONS
C   DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) (CARD 6) ARE 0
C
C   ISEDINT: 0 FOR CONSTANT INITIAL CONDITIONS
C             1 FOR SPATIALLY VARIABLE WATER COLUMN INITIAL CONDITIONS
C             FROM sedw.inp AND sndw.inp
C             2 FOR SPATIALLY VARIABLE BED INITIAL CONDITIONS
C             FROM sedb.inp AND sndb.inp
C             3 FOR SPATIALLY VARIABLE WATER COL AND BED INITIAL CONDITIONS
C   ISEDBINT: 0 FOR SPATIALLY VARYING BED INITIAL CONDITIONS IN MASS/AREA
C             1 FOR SPATIALLY VARYING BED INITIAL CONDITIONS IN MASS FRACTION
C             OF TOTAL SEDIMENT MASS (REQUIRES BED LAYER THICKNESS
C             FILE bedlay.inp)
C   ISEDWC:  0 COHESIVE SED WC/BED EXCHANGE BASED ON BOTTOM LAYER CONDITIONS
C             1 COHESIVE SED WC/BED EXCHANGE BASED ON WAVE/CURRENT/SEDIMENT
C             BOUNDARY LAYERS EMBEDDED IN BOTTOM LAYER
C   ISMUD:   1 INCLUDE COHESIVE FLUID MUD VISCOUS EFFECTS USING EFDC
C             FUNCTION CSEDVIS(SED)
C   ISNDWC:  0 NONCOH SED WC/BED EXCHANGE BASED ON BOTTOM LAYER CONDITIONS
C             1 NONCOH SED WC/BED EXCHANGE BASED ON WAVE/CURRENT/SEDIMENT
C             BOUNDARY LAYERS EMBEDDED IN BOTTOM LAYER
C   ISEVDW:  0 FOR CONSTANT OR SIMPLE CONCENTRATION DEPENDENT
C             COHESIVE SEDIMENT SETTLING VELOCITY
C             >1 CONCENTRATION AND/OR SHEAR/TURBULENCE DEPENDENT COHESIVE
C             SEDIMENT SETTLING VELOCITY. VALUE INDICATES OPTION TO BE USED
C             IN EFDC FUNCTION CSEDSET(SED,SHEAR,ISEVDWC)
C             1 HUANG AND METHA - LAKE OKEECHOBEE
C             2 SHRESTA AND ORLOB - FOR KRONES SAN FRANCISCO BAY DATA
C             3 ZIEGLER AND NESBIT - FRESH WATER
```

```

C   ISNDVW: 0 USE CONSTANT SPECIFIED NONCOHESIVE SED SETTLING VELOCITIES
C           OR CALCULATE FOR CLASS DIAMETER IS SPECIFIED VALUE IS NEG
C           >1 FOLLOW OPTION 0 PROCEDURE BUT APPLY HINDERED SETTLING
C           CORRECTION. VALUE INDICATES OPTION TO BE USED WITH EFDC
C           FUNCTION CSNDSET(SND,SDEN,ISNDVW) VALUE OF ISNDVW INDICATES
C           EXPONENTIAL IN CORRECT (1-SDEN(NS))*SND(NS)**ISNDVW
C   KB:     MAXIMUM NUMBER OF BED LAYERS (EXCLUDING ACTIVE LAYER)
C   ISEDAL: 1 TO ACTIVATE STATIONARY COHESIVE MUD ACTIVE LAYER
C   ISNDAL: 1 TO ACTIVATE NONCOHESIVE ARMORING LAYER ACTIVE LAYER
C   3
C36 ISEDINT ISEDBINT ISEDWC ISMUD ISNDWC ISEDVW ISNDVW  KB ISEDAL ISNDAL
      0      0      0      0      0      5      0      1      0      0

```

This card image specifies parameters for sediment initialization as well as options for representing the water column and bed conditions.

Card Image 37

```

C37 BED MECHANICAL PROPERTIES PARAMETER SET 1
C   DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0
C
C   IBMECH: 0 TIME INVARIANT CONSTANT BED MECHANICAL PROPERTIES
C           1 SIMPLE CONSOLIDATION CALCULATION WITH CONSTANT COEFFICIENTS
C           2 SIMPLE CONSOLIDATION WITH VARIABLE COEFFICIENTS DETERMINED
C           EFDC FUNCTIONS CSEDCON1,2,3 (IBMECH)
C           3 COMPLEX CONSOLIDATION WITH VARIABLE COEFFICIENTS DETERMINED
C           EFDC FUNCTIONS CSEDCON1,2,3 (IBMECH). IBMECH > 0 SETS THE
C           C38 PARAMETER ISEDBINT=1 AND REQUIRES INITIAL CONDITIONS
C           FILES bedlay.inp, bedbdn.inp and bedddn.in
C   IMORPH: 0 CONSTANT BED MORPHOLOGY (IBMECH=0, ONLY)
C           1 ACTIVE BED MORPHOLOGY: NO WATER ENTRAIN/EXPULSION EFFECTS
C           2 ACTIVE BED MORPHOLOGY: WITH WATER ENTRAIN/EXPULSION EFFECTS
C   HBEDMAX: TOP BED LAYER THICKNESS (M) AT WHICH NEW LAYER IS ADDED OR IF
C           KBT(I,J)=KB, NEW LAYER ADDED AND LOWEST TWO LAYERS COMBINED
C   BEDPORC: CONSTANT BED POROSITY (IBMECH=0, OR NSED=0)
C           ALSO USED AS POROSITY OF DEPOSITIN NONCOHESIVE SEDIMENT
C   SEDDMX:  MAXIMUM FLUID MUD COHESIVE SEDIMENT CONCENTRATION (mg/l)
C   SEDMDN:  MINIMUM FLUID MUD COHESIVE SEDIMENT CONCENTRATION (mg/l)
C   SEDVDRD: VOID RATIO OF DEPOSITING COHESIVE SEDIMENT
C   SEDVDRM: MINIMUM COHESIVE SEDIMENT BED VOID RATIO (IBMECH > 0)
C   SEDVDRDRT: BED CONSOLIDATION RATED CONSTANT (1/SEC) (IBMECH = 1,2)
C
C37 IBMECH IMORPH  HBEDMAX  BEDPORC SEDDMX SEDMDN SEDVDRD SEDVDRM SEDVDRDRT
      0      0      2.0      0.5      1.1E5      4000.      20.      4.      1.E-5

```

The first set of bed mechanics properties are defined on this card image.

Card Image 38

```
C38 BED MECHANICAL PROPERTIES PARAMETER SET 2
C DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0
C
C BMECH1: BED MECHANICS FUNCTION COEFFICIENT
C BMECH2: BED MECHANICS FUNCTION COEFFICIENT
C BMECH3: BED MECHANICS FUNCTION COEFFICIENT
C BMECH4: BED MECHANICS FUNCTION COEFFICIENT
C BMECH5: BED MECHANICS FUNCTION COEFFICIENT
C BMECH6: BED MECHANICS FUNCTION COEFFICIENT
C
C38 BMECH1 BMECH2 BMECH3 BMECH4 BMECH5 BMECH6
0.0 0. 0. 0. 0. 0.
```

The second set of bed mechanics properties are defined on this card image.

Card Image 39

```
C39 COHESIVE SEDIMENT PARAMETER SET 1 REPEAT DATA LINE NSED TIMES
C DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0
C
C SEDO: CONSTANT INITIAL COHESIVE SEDIMENT CONC IN WATER COLUMN
C (mg/liter=gm/m**3)
C SEDBO: CONSTANT INITIAL COHESIVE SEDIMENT IN BED PER UNIT AREA
C (gm/sq meter) IE 1CM THICKNESS BED WITH SSG=2.5 AND
C N=.6,.5 GIVES SEDBO 1.E4, 1.25E4
C SDEN: SEDIMENT SPEC VOLUME (IE 1/2.25E6 m**3/gm)
C SSG: SEDIMENT SPECIFIC GRAVITY
C WSEDO: CONSTANT OR REFERENCE SEDIMENT SETTLING VELOCITY
C IN FORMULA WSED=WSEDO*( (SED/SEDSN)**SEXP )
C SEDSN: NORMALIZING SEDIMENT CONC (COHESIVE SED TRANSPORT) (gm/m**3)
C SEXP: EXPONENTIAL (COHESIVE SED TRANSPORT)
C TAUD: BOUNDARY STRESS BELOW WHICH DEPOSITION TAKES PLACE ACCORDING
C TO (TAUD-TAU)/TAUD
C ISEDSOR: 1 TO CORRECT BOTTOM LAYER CONCENTRATION TO NEAR BED CONC
C
C39 SEDO SEDBO SDEN SSG WSEDO SEDSN SEXP TAUD ISEDSOR
65.0 1.0E4 4.4E-7 2.25 1.E-4 1.0 0. 1.E-6 0
```

See discussion following card image 42a.

Card Image 40

```
C40 COHESIVE SEDIMENT PARAMETER SET 2 REPEAT DATA LINE NSED TIMES
C DATA REQUIRED EVEN IT ISTRAN(6) AND ISTRAN(7) ARE 0
C
C IWRSP: 0 USE RESUSPENSION RATE AND CRITICAL STRESS BASED ON PARAMETERS
```

```

C           ON THIS DATA LINE
C       >1 USE BED PROPERTIES DEPENDEDNT RESUSPENSION RATE AND CRITICAL
C           STRESS GIVEN BY EFDC FUNCTIONS CSEDRESS,CSEDTAUS,CSEDTAUB
C           FUNCTION ARGUMENSTS ARE (BDENBED,IWRSP)
C       1 HWANG AND METHA - LAKE OKEECHOBEE
C   WRSPO:  REF SURFACE EROSION  RATE IN FORMULA
C           WRSP=WRSPO*( ((TAU-TAUR)/TAUN)**TEX ) (gm/m**2-sec)
C   TAUR:   BOUNDARY STRESS ABOVE WHICH SURFACE EROSION OCCURS (m/s)**2
C   TAUN:   NORMALIZING STRESS (EQUAL TO TAUR FOR COHESIVE SED TRANS)
C   TEXP:   EXPONENTIAL (COH SED)
C
C40  IWRSP  WRSPO    TAUR    TAUN    TEXP
      0     0.005   2.75E-4  2.75E-4  1.

```

See discussion following card image 42a.

Card Image 41

```

C41 NON-COHESIVE SEDIMENT PARAMETER SET 1 REPEAT DATA LINE NSND TIMES
C   DATA REQUIRED EVEN IT ISTRAN(6) AND ISTRAN(7) ARE 0
C
C   SNDO:   CONSTANT INITIAL NON-COHESIVE SEDIMENT CONC IN WATER COLUMN
C           (mg/liter=gm/m**3)
C   SNDBO:  CONSTANT INITIAL NON-COHESIVE SEDIMENT IN BED PER UNIT AREA
C           (gm/sq meter)  IE 1CM THICKNESS BED WITH SSG=2.5 AND
C           N=.6,.5 GIVES SNDBO 1.E4, 1.25E4
C   SDEN:   SEDIMENT SPEC VOLUME (IE 1/2.65E6 m**3/gm)
C   SSG:    SEDIMENT SPECIFIC GRAVITY
C   SNDDIA: REPRESENTATIVE DIAMETER OF SEDIMENT CLASS
C   WSNDO:  CONSTANT OR REFERENCE SEDIMENT SETTLING VELOCITY
C           IF WSNDO < 0, SETTLING VELOCITY INTERNALLY COMPUTED
C   SNDN:   MAX MASS/TOT VOLUME IN BED (NON-COHESIVE SED TRANS) (gm/m**3)
C   SEXP:   DIMENSIONLESS RESUSPENSION PARAMETER GAMMA ZERO
C   TAUD:   DUNE BREAK POINT STRESS (m/s)**2
C   ISNDSCOR: 1 TO CORRECT BOTTOM LAYER CONCENTRATION TO NEAR BED CONC
C
C41 SNDO  SNDBO  SDEN    SSG  SNDDIA  WSNDO  SNDN  SEXP  TAUD  ISNDSCOR
      1.0   1.E4   3.8E-7  2.65  1.8E-4  0.01  1.E6  1.E-3  7.E-5  0

```

See discussion following card image 42a.

Card Image 42

```

C42 NONCOHESIVE SEDIMENT PARAMETER SET 2 REPEAT DATA LINES NSND TIMES
C   DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0
C
C   ISNDEQ: >1 CALCULATE ABOVE BED REFERENCE NONCHOHESIVE SEDIMENT

```

4 - EFDC Master Input File (efdc.inp)

```
C          EQUILIBRIUM CONCENTRATION USING EFDC FUNCTION
C          CSNDEQC (SNDDIA, SSG, WS, TAUR, TAUB, SIGPHI, SNDDMX, IOTP)
C          WHICH IMPLEMENT FORMULATIONS OF
C          1 GRACIA AND PARKER
C          2 SMITH AND MCLEAN
C          3 VAN RIJN
C  ISBDLD:  0 BED LOAD PHI FUNCTION IS CONSTANT, SBDLDP
C          1 VAN RIJN PHI FUNCTION
C          2 OHTER PHI FUNCTION
C          3 OHTER PHI FUNCTION
C  ISBDLD:  0 BED LOAD PHI FUNCTION IS CONSTANT
C  TAUR:    CRITICAL SHIELDS STRESS IN (m/s)**2   (ISNDEQ=2)
C          NOTE: IF TAUR < 0, THEN TAUR, TAUN, AND TEXP ARE INTERNALLY
C          COMPUTED USING VAN RIJN'S FORMULAS
C  TAUN:    EQUAL TO TAUR FOR NONCOHESIVE SED TRANS (ISNDEQ=2)
C  TEXP:    CRITICAL SHIELDS PARAMETER (ISNDEQ=2)
C
C42  ISNDEQ  ISBDLD  TAUR      TAUN      TEXP
      1      0      -1.E+6   -1.E+6   -0.2
```

See discussion following card image 42a.

Card Image 42a

```
C42a NONCOHESIVE SEDIMENT PARAMETER SET 3 (BED LOAD FORMULA PARAMETERS)
C  DATA REQUIRED EVEN IF ISTRAN(6) AND ISTRAN(7) ARE 0
C
C  SBDLDA:  ALPHA EXPONENTIAL FOR BED LOAD FORMULA
C  SBDLDB:  BETA EXPONENTIAL FOR BED LOAD FORMULA
C  SBDLDG:  GAMMA CONSTANT FOR BED LOAD FORMULA
C  SBDLDP:  CONSTANT PHI FOR BED LOAD FORMULA
C
C42a SBDLDA  SBDLDB  SBDLDG  SBDLDP
      2.1    0.      0.      0.
```

Card images 39 and 40 specify information for the transport of suspended cohesive sediment, and Card images 41-42a specify information for the transport of non-cohesive suspended sediment. The EFDC model allows for the transport of multiple sediment classes with the information of this card image repeated for each class (NSED classes). The various parameters on these card image have different meanings for cohesive and non-cohesive sediment. For both types of sediment, the units are chosen such that sediment concentrations in the water column will have units of mg per liter and the mass per unit area of sediment on the bed will be grams per square meter. These units remain consistent if velocities are specified in meters per second and stresses are expressed in kinematic units of square meters per square seconds (i.e., stresses are squared shear velocities). On card images 39 and 41, the

first two parameters for both sediment types are the initial sediment concentration in the water column and the initial mass of sediment per unit area on the bed which are used to initialize the entire model domain for cold starts or when restarting with no sediment information in the *restart.inp* file for cold starts. The third parameter is the sediment specific volume and is used only to introduce the effect of suspended sediment into the buoyancy distribution by:

$$B(L, K) = B(L, K) * (1. - SDEN * SED(L, K)) + (SSG - 1.) * SDEN * SED(L, K)$$

where B is the buoyancy ((mixture density-ref water density)/ref water density) and SED is the sediment concentration in mg/l. The parameter SSG is the sediment specific gravity. For noncohesive sediment, WSEDO represents a constant settling velocity in m/s. For cohesive sediment, a concentration dependent settling velocity of the form:

$$WSED = WSEDO * ((SED/SEDN) **SEXP)$$

where SEDN is a reference or normalizing sediment concentration and SEXP is a dimensionless quantity. For non-cohesive sediment SEDN is the maximum sediment concentration defined as the sediment mass per unit total volume in the bed (sediment density in mg/l times the bed porosity). For non-cohesive sediment, SEXP is a dimensionless coefficient in an empirical formula for the reference near bed sediment concentration. For cohesive sediment, TAUD is a probability of deposition stress in the depositional flux expression:

$$\begin{aligned} \text{FLUXD} &= \text{WSED} * \text{SED} * (\text{TAUD} - \text{TAU}) / \text{TAUD} : & \text{TAU} < \text{TAUD} \\ \text{FLUXD} &= 0 : & \text{TAU} \geq \text{TAUD} \end{aligned}$$

where TAU is the magnitude of the bottom boundary or bed stress. For non-cohesive sediment, TAUD is the bottom boundary stress at which ripples or dunes begin to decay and is determined from a Shields' parameter ratio according to Grant and Madsen (1982) (also see Glenn and Grant, 1987). The parameter WRSPO is used only for cohesive sediment transport to specify the sediment resuspension rate according to:

$$\begin{aligned} \text{WRSP} &= \text{WRSPO} * (((\text{TAU} - \text{TAUR}) / \text{TAUN}) ** \text{TEXP}) : & \text{TAU} > \text{TAUR} \\ \text{WRSP} &= 0 : & \text{TAU} \leq \text{TAUR} \end{aligned}$$

The units of WRSPO are (m/s)*(mg/liter). For cohesive sediment transport, the next three parameters are as defined in the above resuspension formula. For non-cohesive sediment, TAUR and TAUN are both equal to the critical stress for incipient sediment motion and are determined from the critical Shields' parameter. For non-cohesive sediment transport, TEXP is the critical Shields' parameter. For both sediment classes, the parameter SDBLV is used to determine bottom bed elevation changes in response to deposition and resuspension according to:

$$BELV(N+1) = BELV(N) - DT * SDBLV * SEDF(L, 0)$$

where BELV is the bed elevation at time level N+1 or N and SEDF is the bed flux defined as positive for resuspension. For fine sand, SDBLV=0.58E-6 in units such that BELV is in meters, DT is in seconds, and SEDF is in (m/s)*(mg/liter).

Card Image 43

```

C43 TOXIC CONTAMINANT INITIAL CONDITIONS AND PARAMETERS
C   USER MAY CHANGE UNITS OF WATER AND SED PHASE TOX CONCENTRATION
C   AND PARTITION COEFFICIENT ON C44 - C46 BUT CONSISTENT UNITS MUST
C   MUST BE USED FOR MEANINGFUL RESULTS
C   DATA REQUIRED EVEN IT ISTRAN(5) IS 0
C
C   NTOXN:   TOXIC CONTAMINANT NUMBER ID (1 LINE OF DATA BY DEFAULT)
C   ITXINT:   0 FOR SPATIALLY CONSTANT WATER COL AND BED INITIAL CONDITIONS
C             1 FOR SPATIALLY VARIABLE WATER COLUMN INITIAL CONDITIONS
C             2 FOR SPATIALLY VARIABLE BED INITIAL CONDITIONS
C             3 FOR SPATIALLY VARIABLE WATER COL AND BED INITIAL CONDITION
C   ITXBDUT:  SET TO 0 FOR CONST INITIAL BED GIVEN BY TOTAL TOX (ug/liter)
C             SET TO 1 FOR CONST INITIAL BED GIVEN BY
C             SORBED MASS TOX/MASS SED(mg/kg)
C   TOXINTW:  INIT WATER COLUMN TOT TOXIC VARIABLE CONCENTRATION (ug/liter)
C   TOXINTB:  INIT SED BED TOXIC CONC SEE ITXBDUT
C   RKTOXW:   FIRST ORDER WATER COL DECAY RATE FOR TOX VARIABLE IN 1/SEC
C   TKTOXW:   REF TEMP FOR 1ST ORDER WATER COL DECAY DEG C
C   RKTOXB:   FIRST ORDER SED BED DECAY RATE FOR TOX VARIABLE IN 1/SEC
C   TKTOXB:   REF TEMP FOR 1ST ORDER SED BED DECAY DEG C
C
C           ck blw kevin uses 6.0
C43 NTOXN ITXINT ITXBDUT TOXINTW TOXINTB RKTOXW TKTOXW RKTOXB TRTOXB COMMENTS
      1      0      0      1.      1.      0.      0.      0.      0.      DUMMY
    
```

Toxic contaminant parameters are specified here.

Card Image 44

```

C44 ADDITIONAL TOXIC CONTAMINANT PARAMETERS
C   DATA REQUIRED EVEN IT ISTRAN(5) IS 0
C
C   NTOXN:   TOXIC CONTAMINANT NUMBER ID (1 LINE OF DATA BY DEFAULT)
C   VOLTOX:  WATER SURFACE VOLITALIZATION RATE MULTIPLIER (0. OR 1.)
C   RMOLTX:  MOLECULAR WEIGHT FOR DETERMINING VOLATILIZATION RATE
C   RKTOXP:  REFERENCE PHOTOLYSIS DECAY RATE 1/SEC
C   SKTOXP:  REFERENCE SOLAR RADIATION FOR PHOTOLYSIS (WATTS/M**2)
C   DIFTOX:  DIFFUSION COEFF FOR TOXICANT IN SED BED PORE WATER (M**2/S)
C
C44  NTOXN VOLTOX RMOLTX RKTOXP SKTOXP DIFTOX  COMMENTS
      1      0.      0.      0.      0.      1.E-9  DUMMY

```

Additional toxic contaminant parameters are specified here.

Card Image 45

```

C45 TOXIC CONTAMINANT SEDIMENT INTERACTION PARAMETERS
C   2 LINES OF DATA REQUIRED EVEN IT ISTRAN(5) IS 0
C
C   NTOXC: TOXIC CONTAMINANT NUMBER ID.  NSEDC+NSEDN LINES OF DATA
C           FOR EACH TOXIC CONTAMINANT (DEFAULT = 2)
C   NSEDN/NSNDN: FIRST NSED LINES COHESIVE, NEXT NSND LINES NON-COHESIVE.
C                 REPEATED FOR EACH CONTAMINANT
C   ITXPARW: EQUAL 1 FOR SOLIDS DEPENDENT PARTITIONING (WC) GIVEN BY
C             TOXPARG=PARO*(CSED**CONPAR)
C   TOXPARG: WATER COLUMN PARO (ITXPARW=1) OR EQUIL TOX CON PART COEFF BETWEEN
C             EACH TOXIC IN WATER AND ASSOCIATED SEDIMENT PHASES (liters/mg)
C   CONPARW: EXPONENT IN TOXPARG=PARO*(CSED**CONPARW) IF ITXPARW=1
C   ITXPARG: EQUAL 1 FOR SOLIDS DEPENDENT PARTITIONING (BED)
C   TOXPARG: SEDIMENT BED PARO (ITXPARG=1) OR EQUIL TOX CON PART COEFF BETWEEN
C             EACH TOXIC IN WATER AND ASSOCIATED SEDIMENT PHASES (liters/mg)
C   CONPARG: EXPONENT IN TOXPARG=PARO*(CSED**CONPARG) IF ITXPARG=1
C           1           0.8770  -0.943           0.025
C45  NTOXN NSEDN ITXPARG TOXPARG CONPARW ITXPARG TOXPARG CONPARG  COMMENTS
      1      1      0          1.          0.          0          1.          0.  DUMMY FOR NSED=1
      1      2      0          1.          0.          0          1.          0.  DUMMY FOR NSND=1

```

Toxic contaminant sediment interaction parameters are specified here.

Card Image 46

```

C46 BUOYANCY, TEMPERATURE, DYE DATA AND CONCENTRATION BC DATA
C
C   BSC:     BUOYANCY INFLUENCE COEFFICIENT 0 TO 1, BSC=1. FOR REAL PHYSICS

```

4 - EFDC Master Input File (efdc.inp)

```
C      TEMO:  REFERENCE, INITIAL, EQUILIBRUM AND/OR ISOTHERMAL TEMP IN DEG C
C      HEQT:  EQUILIBRUM TEMPERTURE TRANSFER COEFFICIENT M/SEC
C      RKDYE: FIRST ORDER DECAY RATE FOR DYE VARIABLE IN 1/SEC
C      NCBS:  NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON SOUTH OPEN
C           BOUNDARIES
C      NCBW:  NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON WEST OPEN
C           BOUNDARIES
C      NCBE:  NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON EAST OPEN
C           BOUNDARIES
C      NCBN:  NUMBER OF CONCENTRATION BOUNDARY CONDITIONS ON NORTH OPEN
C           BOUNDARIES
C
C46   BSC  TEMO  HEQT  RKDYE  NCBS  NCBW  NCBE  NCBN
      1.0  25.0  0.E-6  0.     0     0     0     0
```

This card image is used to specify scalar constituent concentration informative on open boundaries as well as to provide additional scalar variable information. The parameter BSC controls the buoyancy forcing in the momentum equations. The temperature TEMO (in degrees C) is used as the initial temperature for cold starts or the isothermal temperature. When the temperature transport option ISTOPT on card image 6 is specified as 3, TEMO is the time invariant equilibrium temperature. The parameter HEQT is the equilibrium surface heat transfer coefficient, in square meters per second, and is used only when the temperature option ISTOPT=3 on card image 6. The parameter RKDYE is a first order decay rate of the dye tracer variable and must have units of 1/seconds. The last four parameters (NCBS, NCBW, NCBE, and NCBN) specify the number of concentration open boundary cells on the South, West, East, and North computational grid direction faces, and should be identical to the values of the first four parameters on card image 16.

Card Image 47

```
C47   LOCATION OF CONC BC'S ON SOUTH BOUNDARIES
C
C      ICBS:  I CELL INDEX
C      JCBS:  J CELL INDEX
C      NTSCRS: NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE
C           TO INFLOW FROM OUTFLOW
C      NSSERS: SOUTH BOUNDARY CELL SALINITY TIME SERIES ID NUMBER
C      NTSERS: SOUTH BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER
C      NDSERS: SOUTH BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER
C      NSFERS: SOUTH BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER
C      NTXSERS: SOUTH BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM.
C      NSDSERS: SOUTH BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER
C      NSNSERS: SOUTH BOUNDARY CELL NONCOHESIVE SED CONC TIME SERIES ID NUMBER
C
C47   IBBS  JBBS  NTSCRS  NSSERS  NTSERS  NDSERS  NSFERS  NTXSERS  NSDSERS  NSNSERS
```

See description following card image 66.

Card Image 48

```

C48 TIME CONSTANT BOTTOM CONC ON SOUTH CONC BOUNDARIES
C
C   SAL:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY
C   TEM:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
C   DYE:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
C   SFL:  ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRAION
C   TOX:  NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT
C         CONCENTRATIONS NTOX VALUES TOX(N) , N=1,NTOX
C
C48 SAL   TEM   DYE   SFL   TOX1

```

See description following card image 66.

Card Image 49

```

C49 TIME CONSTANT BOTTOM CONC ON SOUTH CONC BOUNDARIES
C
C   SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT
C         CONCENTRAIONS  FIRST NSED VALUES SED(N) , N=1,NSND
C   SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NONCOHESIVE SEDIMENT
C         CONCENTRATIONS LAST NSND VALUES SND(N) , N=1,NSND
C
C49 SED1  SND1  SND2  SND3

```

See description following card image 66.

Card Image 50

```

C50 TIME CONSTANT SURFACE CONC ON SOUTH CONC BOUNDARIES
C
C   SAL:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
C   TEM:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
C   DYE:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
C   SFL:  ULTIMATE INFLOWING SURFACE LAYER SHELLFISH LARVAE CONCENTRATION
C   TOX:  NTOX ULTIMATE INFLOWING SURFACE LAYER TOXIC CONTAMINANT
C         CONCENTRATIONS NTOX VALUES TOX(N) , N=1,NTOX

```

4 - EFDC Master Input File (efdc.inp)

C
C50 SAL TEM DYE SFL TOX1

See description following card image 66.

Card Image 51

C51 TIME CONSTANT SURFACE CONC ON SOUTH CONC BOUNDARIES
C
C SED: NSED ULTIMATE INFLOWING SURFAC LAYER COHESIVE SEDIMENT
C CONCENTRAIONS FIRST NSED VALUES SED(N), N=1,NSND
C SND: NSND ULTIMATE INFLOWING SURFAC LAYER NONCOHESIVE SEDIMENT
C CONCENTRATIONS LAST NSND VALUES SND(N), N=1,NSND
C
C51 SED1 SND1 SND2 SND3

See description following card image 66.

Card Image 52

C52 LOCATION OF CONC BC'S ON WEST BOUNDARIES AND SERIES IDENTIFIERS
C
C ICBW: I CELL INDEX
C JCBW: J CELL INDEX
C NTSCRW: NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE
C TO INFLOW FROM OUTFLOW
C NSSERW: WEST BOUNDARY CELL SALINITY TIME SERIES ID NUMBER
C NTSERW: WEST BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER
C NDSERW: WEST BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER
C NSFSERW: WEST BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER
C NTXSERW: WEST BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM.
C NSDSERW: WEST BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER
C NSNSERW: WEST BOUNDARY CELL NON-COHESIVE SED CONC TIME SERIES ID NUMBER
C
C52 IBBW JBBW NTSCRW NSSERW NTSERW NDSERW NSFSERW NTXSERW NSDSERW NSNSERW

See description following card image 66.

Card Image 53

```

C53 TIME CONSTANT BOTTOM CONC ON WEST CONC BOUNDARIES
C
C   SAL:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY
C   TEM:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
C   DYE:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
C   SFL:  ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRATION
C   TOX:  NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT
C         CONCENTRATIONS NTOX VALUES TOX(N) , N=1,NTOX
C
C53 SAL   TEM   DYE   SFL   TOX1

```

See description following card image 66.

Card Image 54

```

C54 TIME CONSTANT BOTTOM CONC ON WEST CONC BOUNDARIES
C
C   SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT
C         CONCENTRAIONS  FIRST NSED VALUES SED(N) , N=1,NSND
C   SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NONCOHESIVE SEDIMENT
C         CONCENTRATIONS LAST NSND VALUES SND(N) , N=1,NSND
C
C54 SED1  SND1

```

See description following card image 66.

Card Image 55

```

C55 TIME CONSTANT SURFACE CONC ON WEST CONC BOUNDARIES
C
C   SAL:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
C   TEM:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
C   DYE:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
C   SFL:  ULTIMATE INFLOWING SURFACE LAYER SHELLFISH LARVAE CONCENTRATION
C   TOX:  NTOX ULTIMATE INFLOWING SURFACE LAYER TOXIC CONTAMINANT
C         CONCENTRATIONS NTOX VALUES TOX(N) , N=1,NTOX
C
C55 SAL   TEM   DYE   SFL   TOX1

```

See description following card image 66.

Card Image 56

```
C56 TIME CONSTANT SURFACE CONC ON WEST CONC BOUNDARIES
C
C   SED:  NSED ULTIMATE INFLOWING SURFACE LAYER COHESIVE SEDIMENT
C         CONCENTRATIONS  FIRST NSED VALUES SED(N) , N=1,NSND
C   SND:  NSND ULTIMATE INFLOWING SURFACE LAYER NON-COHESIVE SEDIMENT
C         CONCENTRATIONS  LAST NSND VALUES SND(N) , N=1,NSND
C
C56  SED1  SND1
```

See description following card image 66.

Card Image 57

```
C57 LOCATION OF CONC BC'S ON EAST BOUNDARIES AND SERIES IDENTIFIERS
C
C   ICBE:   I CELL INDEX
C   JCBE:   J CELL INDEX
C   NTSCRE: NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE
C           TO INFLOW FROM OUTFLOW
C   NSSERE: EAST BOUNDARY CELL SALINITY TIME SERIES ID NUMBER
C   NTSERE: EAST BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER
C   NDSERE: EAST BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER
C   NSFSERE: EAST BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER
C   NTXSERE: EAST BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM.
C   NSDSERE: EAST BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER
C   NSNSERE: EAST BOUNDARY CELL NON-COHESIVE SED CONC TIME SERIES ID NUMBER
C
C57  IBBE  JBBE  NTSCRE  NSSERE  NTSERE  NDSERE  NSFSERE  NTXSERE  NSDSERE  NSNSERE
```

See description following card image 66.

Card Image 58

```
C58 TIME CONSTANT BOTTOM CONC ON EAST CONC BOUNDARIES
C
C   SAL:  ULTIMATE INFLOWING BOTTOM LAYER SALINITY
C   TEM:  ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
C   DYE:  ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
C   SFL:  ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRTAION
C   TOX:  NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT
C         CONCENTRATIONS  NTOX VALUES TOX(N) , N=1,NTOX
C
C58  SAL  TEM  DYE  SFL  TOX1
```

See description following card image 66.

Card Image 59

```

C59 TIME CONSTANT BOTTOM CONC ON EAST CONC BOUNDARIES
C
C   SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT
C         CONCENTRATIONS  FIRST NSED VALUES SED(N) , N=1,NSND
C   SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NON-COHESIVE SEDIMENT
C         CONCENTRATIONS  LAST NSND VALUES SND(N) , N=1,NSND
C
C59  SED1  SND1

```

See description following card image 66.

Card Image 60

```

C60 TIME CONSTANT SURFACE CONC ON EAST CONC BOUNDARIES
C
C   SAL:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
C   TEM:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
C   DYE:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
C   SFL:  ULTIMATE INFLOWING SURFACE LAYER SHELLFISH LARVAE CONCENTRATION
C   TOX:  NTOX ULTIMATE INFLOWING SURFACE LAYER TOXIC CONTAMINANT
C         CONCENTRATIONS  NTOX VALUES TOX(N) , N=1,NTOX
C
C60 SAL  TEM  DYE  SFL  TOX1

```

See description following card image 66.

Card Image 61

```

C61 TIME CONSTANT SURFACE CONC ON EAST CONC BOUNDARIES
C
C   SED:  NSED ULTIMATE INFLOWING SURFACE LAYER COHESIVE SEDIMENT
C         CONCENTRATIONS  FIRST NSED VALUES SED(N) , N=1,NSND
C   SND:  NSND ULTIMATE INFLOWING SURFACE LAYER NON-COHESIVE SEDIMENT
C         CONCENTRATIONS  LAST NSND VALUES SND(N) , N=1,NSND
C
C61  SED1  SND1

```

See description following card image 66.

Card Image 62

```
C62 LOCATION OF CONC BC'S ON NORTH BOUNDARIES AND SERIES IDENTIFIERS
C
C   ICBN:   I CELL INDEX
C   JCBN:   J CELL INDEX
C   NTSCRN: NUMBER OF TIME STEPS TO RECOVER SPECIFIED VALUES ON CHANGE
C           TO INFLOW FROM OUTFLOW
C   NSSERN: NORTH BOUNDARY CELL SALINITY TIME SERIES ID NUMBER
C   NTSERN: NORTH BOUNDARY CELL TEMPERATURE TIME SERIES ID NUMBER
C   NDSERN: NORTH BOUNDARY CELL DYE CONC TIME SERIES ID NUMBER
C   NSFERN: NORTH BOUNDARY CELL SHELLFISH LARVAE TIME SERIES ID NUMBER
C   NTXSERN: NORTH BOUNDARY CELL TOXIC CONTAMINANT CONC TIME SERIES ID NUM.
C   NSDSERN: NORTH BOUNDARY CELL COHESIVE SED CONC TIME SERIES ID NUMBER
C   NSNSERN: NORTH BOUNDARY CELL NON-COHESIVE SED CONC TIME SERIES ID NUMBER
C
C62 IBBN  JBBN  NTSCRN NSSERN NTSERN NDSERN NSFERN NTXSERN NSDSERN NSNSERN
```

See description following card image 66.

Card Image 63

```
C63 TIME CONSTANT BOTTOM CONC ON NORTH CONC BOUNDARIES
C
C   SAL:   ULTIMATE INFLOWING BOTTOM LAYER SALINITY
C   TEM:   ULTIMATE INFLOWING BOTTOM LAYER TEMPERATURE
C   DYE:   ULTIMATE INFLOWING BOTTOM LAYER DYE CONCENTRATION
C   SFL:   ULTIMATE INFLOWING BOTTOM LAYER SHELLFISH LARVAE CONCENTRATION
C   TOX:   NTOX ULTIMATE INFLOWING BOTTOM LAYER TOXIC CONTAMINANT
C           CONCENTRATIONS NTOX VALUES TOX(N) , N=1,NTOX
C
C63 SAL  TEM  DYE SFL TOX1-20
```

See description following card image 66.

Card Image 64

```
C64 TIME CONSTANT BOTTOM CONC ON NORTH CONC BOUNDARIES
C
```

```

C      SED:  NSED ULTIMATE INFLOWING BOTTOM LAYER COHESIVE SEDIMENT
C            CONCENTRATIONS  FIRST NSED VALUES SED(N) , N=1,NSND
C      SND:  NSND ULTIMATE INFLOWING BOTTOM LAYER NON-COHESIVE SEDIMENT
C            CONCENTRATIONS  LAST NSND VALUES SND(N) , N=1,NSND
C
C64  SED1  SED2  SND1  SND2  SND3

```

See description following card image 66.

Card Image 65

```

C65 TIME CONSTANT SURFACE CONC ON NORTH CONC BOUNDARIES
C
C      SAL:  ULTIMATE INFLOWING SURFACE LAYER SALINITY
C      TEM:  ULTIMATE INFLOWING SURFACE LAYER TEMPERATURE
C      DYE:  ULTIMATE INFLOWING SURFACE LAYER DYE CONCENTRATION
C      SFL:  ULTIMATE INFLOWING SURFACE LAYER SHELLFISH LARVAE CONCENTRATION
C      TOX:  NTOX ULTIMATE INFLOWING SURFACE LAYER TOXIC CONTAMINANT
C            CONCENTRATIONS  NTOX VALUES TOX(N) , N=1,NTOX
C
C65 SAL  TEM  DYE SFL TOX1-20

```

See description following card image 66.

Card Image 66

```

C66 TIME CONSTANT SURFACE CONC ON NORTH CONC BOUNDARIES
C
C      SED:  NSED ULTIMATE INFLOWING SURFACE LAYER COHESIVE SEDIMENT
C            CONCENTRATIONS  FIRST NSED VALUES SED(N) , N=1,NSND
C      SND:  NSND ULTIMATE INFLOWING SURFACE LAYER NON-COHESIVE SEDIMENT
C            CONCENTRATIONS  LAST NSND VALUES SND(N) , N=1,NSND
C
C66  SED1  SED2  SND1  SND2  SND3

```

Card images 47 through 66 specify scalar inflowing concentrations on South, West, East, and North open boundaries. The open boundary condition for salinity, temperature and other transported constituents is based on the specification of inflowing values. The inflowing values may be specified as depth dependent and either time constant or time variable, if concentration time series are available at open boundaries. Outflowing values are calculated using upwinded values immediately inside the open boundary. When the

flow at the open boundary changes from outflow to inflow, the model provides for a linear interpolation of inflowing concentration, over a user specified number of timesteps, (NTSCRx on card images 47, 52, 57, and 62) between the last outflowing value and the ultimate inflowing value of concentration, which allows for a smooth transition of concentration values at the open boundary. The ultimate inflowing concentration is the sum of a time constant value and a time series specified inflowing concentration value (either of which may be zero). Card images 47, 52, 57, and 62 define the location of open boundary cells by the indices ICBx and JCBx. The next parameter on these four card images, NTSCRx, defines the number of time steps to recover the specified boundary concentration value after the change from outflow to inflow. For tidal flows, NTSCRx might typically be the number of time steps corresponding to one hour. Alternately NTSCRx can be adjusted during model calibration. The remaining five parameters on these four cards specify scalar concentration time series identifier numbers if the inflow concentrations are to be specified by time series. The time series specification of inflowing concentrations allows a unique concentration in each layer of the boundary cell. When the open boundary inflow concentrations are specified by constant values, bottom layer values on the four computational domain face directions are specified on card images 48-49, 53-54, 58-59, and 63-64, while surface layer values are specified on card images 50-51, 56-57, 60-61, and 65-66. If the number of layers exceeds two, values for the interior layers are linearly interpolated between the bottom and surface layer values.

Card Image 66a

```
C66a CONCENTRATION DATA ASSIMILATION
C
C   NLCDA:  NUMBER OF HORIZONTAL LOCATIONS FOR DATA ASSIMILATION
C   TSCDA:  WEIGHTING FACTOR, 0.-1., 1. = FULL ASSIMILATION
C   ISCDA:  1 FOR CONCENTRATION DATA ASSIMILATION (NC=1,7 VALUES)
C
C66a  NLCDA  TSCDA  ISCDA
      0      0.5    0    0    0    0    0    0    0
```

Concentration data assimilation parameters are specified here.

Card Image 66b

```
C66b CONCENTRATION DATA ASSIMILATION
C
C   ICDA:  1 FOR CONCENTRATION DATA ASSIMILATION
C   JCDA:  NUMBER OF HORIZONTAL LOCATIONS FOR DATA ASSIMILATION
```

```

C      NS:    WEIGHTING FACTOR, 0.-1., 1. = FULL ASSIMILATION
C
C66b  ICDA  JCDA   NS  NT  ND  NSF  NTX  NSD  NSN

```

Concentration data assimilation parameters are specified here.

Card Image 67 [not active in EFDC-Hydro]

```

C67 DRIFTER DATA (FIRST 4 PARAMETER FOR SUB DRIFER, SECOND 6 FOR SUB LAGRES)
C
C      ISPD:   1 TO ACTIVE SIMULTANEOUS RELEASE AND LAGRANGIAN TRANSPORT OF
C              NEUTRALLY BUOYANT PARTICLE DRIFTERS AT LOCATIONS INPUT ON C44
C      NPD:    NUMBER OF PARTICLE DIRIFERS
C      NPDRT:  TIME STEP AT WHICH PARTICLES ARE RELEASED
C      NRPD:   NUMBER OF TIME STEPS BETWEEN WRITING TO TRACKING FILE
C              drifter.out
C      ISLRPD: 1 TO ACTIVATE CALCULATION OF LAGRANGIAN MEAN VELOCITY OVER TIME
C              INTERVAL TREF AND SPATIAL INTERVAL ILRPD1<I<ILRPD2,
C              JLRPD1<J<JLRPD2, 1<K<KC, WITH MLRPDRT RELEASES. ANY AVERGE
C              OVER ALL RELEASE TIMES IS ALSO CALCULATED
C              2 SAME BUT USES A HIGER ORDER TRAJECTORY INTEGRATION
C      ILRPD1  WEST BOUNDARY OF REGION
C      ILRPD2  EAST BOUNDARY OF REGION
C      JLRPD1  NORTH BOUNDARY OF REGION
C      JLRPD2  SOUTH BOUNDARY OF REGION
C      MLRPDRT NUMBER OF RELEASE TIMES
C      IPLRPD  1,2,3 WRITE FILES TO PLOT ALL,EVEN,ODD HORIZ LAG VEL VECTORS
C
C67 ISPD NPD NPDRT NRPD ISLRPD ILRPD1 ILRPD2 JLRPD1 JLRPD2 MLRPDRT IPLRPD
      0    0    0    12    0     6     47     6     17     12     1

```

This card image activates and controls two types of Lagrangian particle trajectory calculations, which may be activated simultaneously. The first Lagrangian trajectory calculation, activated by setting ISPD=1, releases NPD particles at time step NPDRT. The released particles are then tracked for the remainder of the model simulation, with the nearest cell center positions (I,J,K) written to the file *drifter.out* every NRPD time steps. The initial position of the NPD particles is specified on card image 68, shown below. The second Lagrangian trajectory calculation, activated by ISLRD greater than zero, releases particles at active water cell centers for all vertical layers, in the region of the computational grid bound in the x or I direction by (ILRD1 .LE. I .LE. ILRD2), and in the y or J direction by (JLRD1 .LE. J .LE. JLRD2). MLRPDRT releases, evenly spaced in the reference time period (card image 8), occur during the next to last reference time period of the model simulation (i.e., NTC .GE. 2). Each group of particles is tracked for one reference time period and their net vector displacements from their release positions are

determined. The net vector displacements are then divided by the reference time period to give Lagrangian mean velocity vectors (Hamrick, 1994a), which are written to the file *lmvvech.out*. The average Lagrangian mean of the MLRPDRT release times is also calculated and written to the file *almvvech.out*. For ISLRD equal to 1 or 2, the Lagrangian mean velocity vectors are associated with their release positions for plotting. For ISLRD equal to 3 or 4, the Lagrangian mean velocity vectors are associated with the mean position of the corresponding particle during its trajectory. To assure a uniform distribution of vectors for plotting, the trajectory centroid located vectors are interpolated back to the cell centers and the results written to the file *lmvech.out* for the MLRPDRT releases with the average of the releases written to the file *almvech.out*. Values of 1 or 3 for ISLRD implement first order explicit forward Euler integrator for the trajectory calculation, while values of 2 and 4 implement a second order implicit trapezoidal integrator (Bennett and Clites, 1987) incurring increased computational time. If the trajectory calculation is executed over the entire grid for 10 to 12 release times, the computational effort for the last two time cycles is increased by approximately 20 to 40 percent.

Card Image 68 [not active in EFDC-Hydro]

```
C68 INITIAL DRIFTER POSITIONS (FOR USE WITH SUB DRIFTER)
C
C      RI:  I CELL INDEX IN WHICH PARTICLE IS RELEASED IN
C      RJ:  J CELL INDEX IN WHICH PARTICLE IS RELEASED IN
C      RK:  K CELL INDEX IN WHICH PARTICLE IS RELEASED IN
C
C68  RI   RJ   RK
```

Initial drifter I, J, and K indices are specified on this card for NPD locations.

Card Image 69

```
C69 CONSTANTS FOR CARTESION GRID CELL CENTER LONGITUDE AND LATITUDE
C
C      CDLON1:  6 CONSTANTS TO GIVE CELL CENTER LAT AND LON OR OTHER
C      CDLON2:  COORDINATES FOR CARTESIAN GRIDS USING THE FORMULAS
C      CDLON3:  DLON (L) =CDLON1+ (CDLON2*FLOAT (I) +CDLON3) /60 .
C      CDLAT1:  DLAT (L) =CDLAT1+ (CDLAT2*FLOAT (J) +CDLAT3) /60 .
C      CDLAT2:
C      CDLAT3:
C
C69 CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
      0.0    0.0    0.0    0.0    0.0    0.0
```

This card image allows cell center coordinates for graphics output files to be generated for Cartesian grids where the grid, bathymetric and roughness are specified in the *cell.inp* and *depth.inp* files.

Card Image 70 [not active in EFDC-Hydro]

```

C70 CONTROLS FOR WRITING ASCII OR BINARY DUMP FILES
C
C   ISDUMP: GREATER THAN 0 TO ACTIVATE
C       1 SCALED ASCII INTEGER (0<VAL<65535)
C       2 SCALED 16BIT BINARY INTEGER (0<VAL<65535) OR (-32768<VAL<32767)
C       3 UNSCALED ASCII FLOATING POINT
C       4 UNSCALED BINARY FLOATING POINT
C   ISADMP: GREATER THAN 0 TO APPEND EXISTING DUMP FILES
C   NSDUMP: NUMBER OF TIME STEPS BETWEEN DUMPS
C   TSDUMP: STARTING TIME FOR DUMPS (NO DUMPS BEFORE THIS TIME)
C   TEDUMP: ENDING TIME FOR DUMPS (NO DUMPS AFTER THIS TIME)
C   ISDMPP: GREATER THAN 0 FOR WATER SURFACE ELEVATION DUMP
C   ISDMPU: GREATER THAN 0 FOR HORIZONTAL VELOCITY DUMP
C   ISDMPW: GREATER THAN 0 FOR VERTICAL VELOCITY DUMP
C   ISDMPT: GREATER THAN 0 FOR TRANSPORTED VARIABLE DUMPS
C   IADJDMP: 0 FOR SCALED BINARY INTEGERS (0<VAL<65535)
C           -32768 FOR SCALED BINARY INTEGERS (-32768<VAL<32767)
C
C70 ISDUMP ISADMP NSDUMP TSDUMP TEDUMP ISDMPP ISDMPU ISDMPW ISDMPT IADJDMP
      0      0      864    0.    731.    0      0      0      1    -32768

```

Controls for writing ASCII or binary dump files are specified here.

Card Image 71 [not active in EFDC-Hydro]

```

C71 CONTROLS FOR HORIZONTAL PLANE SCALAR FIELD CONTOURING
C
C   ISSPH: 1 TO WRITE FILE FOR SCALAR FIELD CONTOURING IN HORIZONTAL PLANE
C   NPSPH: NUMBER OF WRITES PER REFERENCE TIME PERIOD
C   ISRSPH: 1 TO WRITE FILE FOR RESIDUAL SALINITY PLOTTING IN
C           HORIZONTAL
C   ISPHXY: 0 DOES NOT WRITE I,J,X,Y IN ***cnh.out and r***cnh.out FILES
C           1 WRITES I,J ONLY IN ***cnh.out and r***cnh.out FILES
C           2 WRITES I,J,X,Y IN ***cnh.out and r***cnh.out FILES
C   DATA LINE REPEATS 7 TIMES FOR SAL, TEM, DYE, SFL, TOX, SED, SND
C
C71 ISSPH  NPSPH  ISRSPH  ISPHXY
      0      12      0        1      !SAL
      0       6      0        1      !TEM
      0      12      0        1      !DYE
      0       6      0        1      !SFL

```

4 - EFDC Master Input File (efdc.inp)

0	6	0	1	!TOX
0	6	0	1	!SED
0	6	0	1	!SND

This card image activates the creation of output files xxxconh.out and rxxxconh.out (where xxx is sal, tem, dye, sfl, sed, snd, or tox) for horizontal plane contour plotting of surface and bottom layer scalar field distributions. For sediment (sed and snd) and shellfish larvae (sfl) bottom bed concentrations are also output. The switch ISSPH generated the non-r-prefixed files for transport scalar fields at NPSPH times during the last time cycle of the model run. The switch ISRSPH activates the output of time averaged or residual fields representing an average over NTSMMT time steps (see card image 7). If ISSSMMT=0 on card image 4, residual fields are written for each averaging period in the model run, while a value of ISSSMMT=1 results in writing the results of only the last averaging period.

Card Image 72 [not active in EFDC-Hydro]

```
C72 CONTROLS FOR HORIZONTAL SURFACE ELEVATION OR PRESSURE CONTOURING
C
C   ISPPH:  1 TO WRITE FILE FOR SURFACE ELEVATION OR PRESSURE CONTOURING
C           IN HORIZONTAL PLANE
C   NPPPH:   NUMBER OF WRITES PER REFERENCE TIME PERIOD
C   ISRPPH:  1 TO WRITE FILE FOR RESIDUAL SURFACE ELEVATION CONTOURNG IN
C           HORIZONTAL PLANE
C
C72 ISPPH   NPPPH   ISRPPH
    0       6       0
```

This card image controls output for contour plotting instantaneous and residual or averaged water surface elevation fields to files *surfconh.out* and *rsurfconh.out*. The control switches have similar definitions as those for card image 73.

Card Image 73 [not active in EFDC-Hydro]

```
C73 CONTROLS FOR HORIZONTAL PLANE VELOCITY VECTOR PLOTTING
C
C   ISVPH:  1 TO WRITE FILE FOR VELOCITY PLOTTING IN HORIZONTAL PLANE
C   NPVPH:   NUMBER OF WRITES PER REFERENCE TIME PERIOD
C   ISRVPH:  1 TO WRITE FILE FOR RESIDUAL VELOCITY PLOTTING IN
C           HORIZONTAL PLANE
C
C73 ISVPH   NPVPH   ISRVPH
    0       12      0
```

This card image activates the creation of the output file *velvech.out*, containing instantaneous surface and bottom horizontal velocity vectors for ISVPH = 1, 2, or 3 at NPVPH times during the last reference time period for vector plotting. The switch ISRVPH = 1, 2, or 3 activates the creation of three files, *xvelconh.out* (where x is r, p, or m) containing surface and bottom layer residual velocity vectors corresponding to the Eulerian mean transport velocity (r prefix), the nondivergent component of the Stokes' drift (p prefix) and the first order Lagrangian mean or mean mass transport velocity (m prefix) for horizontal plane vector plotting. If ISSSMMT=0 on card image 4, residual fields are written for each averaging period in the model run, while a value of 1 results in writing the results of only the last averaging period. The choice of 1, 2, or 3 for ISVPH and ISRVPH writes all cell vectors, (I+J) is even vectors, or (I+J) is odd vectors. For grids with a large number of cells, the 2 or 3 options often result plots that are less dense and more pleasing to the eye.

Card Image 74 [not active in EFDC-Hydro]

```

C74 CONTROLS FOR VERTICAL PLANE SCALAR FIELD CONTOURING
C
C   ISECSVP:  N AN INTEGER NUMBER OF VERTICAL SECTIONS (N.LE.9) TO WRITE
C             N FILES FOR SCALAR FIELD CONTOURING
C   NPSPV:    NUMBER OF WRITES PER REFERENCE TIME PERIOD
C   ISSPV:    1 TO ACTIVATE INSTANTANEOUS SCALAR FIELDS
C   ISRSPV:   1 TO ACTIVATE FOR RESIDUAL SCALAR FIELDS
C   ISHPLTV:  1 FOR VERTICAL PLANE PLOTTING FOR MSL DATUMS, ZERO OTHERWISE
C   DATA LINE REPEATS 7 TIMES FOR SAL, TEM, DYE, SFL, TOX, SED, SND
C   ISECSVP IS DETERMINED FOR ALL 7 VARIABLES BY VALUE ON FIRST DATA LINE
C
C74 ISECSVP  NPSPV  ISSPV  ISRSPV  ISHPLTV
    1         6     0     0         1          !SAL
    1         6     0     0         1          !TEM
    1         6     0     0         1          !DYE
    1         6     0     0         1          !SFL
    1         6     0     0         1          !TOX
    1         6     0     0         1          !SED
    1         6     0     0         1          !SND

```

This card image activates output of information for vertical plane scalar field contouring for ISCESPV vertical sections or transects. The switch ISSPV activates output of instantaneous values NPSPV times during the last reference time period to the files xxxcnvN.out (xxx equals sal, tem, dye, sed, or sfl, and N represents the section number currently limited to a maximum of 9). The switch ISRSPV activates output of time-averaged or residual variables to similar r-prefixed files after each averaging period (ISSSMMT

= 0) or only the last averaging period (ISSMMT = 1) with the time steps in the averaging period defined by NTSMMT on card image 7. The last parameter configures the plotting information for tidal or other datums. Additional information is specified on card images 75 and 76.

Card Image 75 [not active in EFDC-Hydro]

```
C75 MORE CONTROLS FOR VERTICAL PLANE SCALAR FIELD CONTOURING
C
C   ISECSPV:  SECTION NUMBER
C   NIJSPV:   NUMBER OF CELLS OR I,J PAIRS IN SECTION
C   SEC ID:   CHARACTER FORMAT SECTION TITLE
C
C75 ISECSPV NIJSPV  SEC ID
      0         0      ' 0 '
```

This card image provides information to define the vertical plane transects. A line of data is required for each vertical section. The maximum number of vertical sections is currently limited to 9. The first parameter identifies the section number, the second parameter specifies the number of cells comprising the section, and the last character string provides an identifier which is also written to the output files.

Card Image 76 [not active in EFDC-Hydro]

```
C76 I,J LOCATIONS FOR VERTICAL PLANE SCALAR FIELD CONTOURING
C
C   ISECSPV:  SECTION NUMBER
C   ISPV:     I CELL
C   JSPV:     J CELL
C
C76 ISECSPV ISPV   JSPV
```

This card image defines the sequence of cells comprising the section, with the first parameter being for user identification. The other two parameters define the section sequenced by I and J cell indices. It is noted that cells in the sequence do not need to be adjacent, nor do they need to follow a straight line. For example, they may represent instrument locations, longitudinal moving survey locations, or interesting cross sections of the flow field or a typical longitudinal section up an estuary.

Card Image 77 [not active in EFDC-Hydro]

```

C77 CONTROLS FOR VERTICAL PLANE VELOCITY VECTOR PLOTTING
C
C   ISECVPV:  N AN INTEGER NUMBER (N.LE.9) OF VERTICAL SECTIONS
C             TO WRITE N FILES FOR VELOCITY PLOTTING
C   NPVPV:    NUMBER OF WRITES PER REFERENCE TIME PERIOD
C   ISVPV:    1 TO ACTIVATE INSTANTANEOUS VELOCITY
C   ISRSPV:   1 TO ACTIVATE FOR RESIDUAL VELOCITY
C
C77 ISECVPV  NPVPV  ISVPV  ISRSPV
      0        6      0      0

```

This card image activates output of information for three types of vector plotting in ISECVPV (currently limited to 9) vertical planes. The switch ISVPV activates output of instantaneous data at NPVPV times during the reference time period, while ISRSPV activates output of time averaged or residual data after each averaging period (ISSMMT = 0), defined by NTSMMT on card image 7, or the last averaging period (ISSMMT = 1). The first class of output files provides data for plotting vectors tangential to the vertical plane. Instantaneous data are written to the files velvcvN.out, while residual data are written to the files rvelvcvN.out, pvelvcvN.out, mvelvcvN.out, lmvvcvN.out, and almvvcvN.out, where N indicates the second number. The last two files are written only if ISLRD is not zero. The second class of output files provides data for contour plotting the component of the horizontal velocity normal to the vertical planes. Instantaneous data are written to the files velcnvN.out, while residual data are written to the files rvelcnvN.out, pvelcnvN.out, mvelcnvN.out, lmvcnvN.out, and almvcnvN.out. The last two files are written only if ISLRD is not zero. The final class of output files provides data for contour plotting the component of the horizontal residual velocities tangential to the vertical plane. Time-averaged or residual data are written to the files rvelcvtN.out, pvelcvtN.out, mvelcvtN.out, lmvcvtN.out, and almvcvtN.out, again with the last two files written to as ISLRD is not zero.

Card Image 78 [not active in EFDC-Hydro]

```

C78 MORE CONTROLS FOR VERTICAL PLANE VELOCITY VECTOR PLOTTING
C
C   ISCEVPV:  SECTION NUMBER
C   NIJVPV:   NUMBER IS CELLS OR I,J PAIRS IN SECTION
C   ANGVPV:   CCW POSITIVE ANGLE FROM EAST TO SECTION NORMAL
C   SEC ID:   CHARACTER FORMAT SECTION TITLE
C
C78 ISECVPV  NIJVPV  ANGVPV  SEC ID

```

This card image provides additional information to specify the vertical planes for plotting velocity vectors and contours, with the first parameter identifying the section number and the second parameter specifying the number of horizontal cells defining the section. The third parameter, ANGVVPV defines the angle counterclockwise from east to the section normal. For meaningful results, the sequence of cells defining the vertical plane should approximate a straight line. For a section oriented at 45 degrees CC from east, the normal angle could be defined as 135 degrees or -45 degrees. For these two choices, the definitions of the positive normal and tangential directions are reversed. The remaining character parameter defines a title to be written on the output file headers.

Card Image 79 [not active in EFDC-Hydro]

```
C79 CONTROLS FOR VERTICAL PLANE VELOCITY PLOTTING
C
C   ISECVPV:  SECTION NUMBER (REFERENCE USE HERE)
C   IVPV:     I CELL INDEX
C   JVPV:     J CELL INDEX
C
C79 ISECVPV IVPV   JVPV
```

This card image specifies the I and J indices defining the vertical plane sections selected by the user for plotting.

Card Image 80 [not active in EFDC-Hydro]

```
C80 CONTROLS FOR 3D FIELD OUTPUT
C
C   IS3DO:  1 TO WRITE TO 3D ASCI INTEGER FORMAT FILES, JS3Dvar.LE.2   SEE
C           1 TO WRITE TO 3D ASCI FLOAT POINT FORMAT FILES, JS3Dvar.EQ.3 C57
C           2 TO WRITE TO 3D CHARACTER ARRAY FORMAT FILES (NOT ACTIVE)
C           3 TO WRITE TO 3D HDF IMAGE FORMAT FILES (NOT ACTIVE)
C           4 TO WRITE TO 3D HDF FLOATING POINT FORMAT FILES (NOT ACTIVE)
C   ISR3DO:  SAME AS IS3DO EXCEPT FOR RESIDUAL VARIABLES
C   NP3DO:   NUMBER OF WRITES PER LAST REF TIME PERIOD FOR INST VARIABLES
C   KPC:     NUMBER OF UNSTRETCHED PHYSICAL VERTICAL LAYERS
C   NWGG:    IF NWGG IS GREATER THAN ZERO, NWGG DEFINES THE NUMBER OF 12877
C           WATER CELLS IN CARTESIAN 3D GRAPHICS GRID OVERLAY OF THE
C           CURVILINEAR GRID. FOR NWGG>0 AND EFDC RUNS ON A CURVILINEAR
C           GRID, I3DMI,I3DMA,J3DMI,J3DMA REFER TO CELL INDICES ON THE
C           ON THE CARTESIAN GRAPHICS GRID OVERLAY DEFINED BY FILE
C           gcell.inp. THE FILE gcell.inp IS NOT USED BY EFDC, BUT BY
```

```

C          THE COMPANION GRID GENERATION CODE GEFDC.F.  INFORMATION
C          DEFINING THE OVERLAY IS READ BY EFDC.F FROM THE FILE
C          gcellmp.inp. IF NWGG EQUALS 0, I3DMI,I3DMA,J3DMI,J3DMA REFER
C          TO INDICES ON THE EFDC GRID DEFINED BY cell.inp.
C          ACTIVATION OF THE REWRITE OPTION I3DRW=1 WRITES TO THE FULL
C          GRID DEFINED BY cell.inp AS IF cell.inp DEFINES A CARTESIAN
C          GRID.  IF NWGG EQ 0 AND THE EFDC COMP GRID IS CO, THE REWRITE
C          OPTION IS NOT RECOMMENDED AND A POST PROCESSOR SHOULD BE USED
C          TO TRANSFER THE SHORT FORM, I3DRW=0, OUTPUT TO AN APPROPRIATE
C          FORMAT FOR VISUALIZATION. CONTACT DEVELOPER FOR MORE DETAILS
C          I3DMI:  MINIMUM OR BEGINNING I INDEX FOR 3D ARRAY OUTPUT
C          I3DMA:  MAXIMUM OR ENDING I INDEX FOR 3D ARRAY OUTPUT
C          J3DMI:  MINIMUM OR BEGINNING J INDEX FOR 3D ARRAY OUTPUT
C          J3DMA:  MAXIMUM OR ENDING J INDEX FOR 3D ARRAY OUTPUT
C          I3DRW:  0 FILES WRITTEN FOR ACTIVE CO WATER CELLS ONLY
C                   1 REWRITE FILES TO CORRECT ORIENTATION DEFINED BY gcell.inp
C                   AND gcellmp.inp FOR CO WITH NWGG.GT.0 OR BY cell.inp IF THE
C                   COMPUTATIONAL GRID IS CARTESIAN AND NWGG.EQ.0
C          SELVMAX: MAXIMUM SURFACE ELEVATION FOR UNSTRETCHING (ABOVE MAX SELV )
C          BELVMIN: MINIMUM BOTTOM ELEVATION FOR UNSTRETCHING (BELOW MIN BELV)
C
C80 IS3DO ISR3DO NP3DO KPC NWGG I3DMI I3DMA J3DMI J3DMA I3DRW SELVMAX BELVMIN
      0      0      0      1      0      1      42      1      132      0      15.0      -315.

```

This card image controls the output of three-dimensional data for graphics and visualization. The switches IS3D and ISR3D activate output of instantaneous data at NP3D times during the last reference time period and time averaged or residual data respectively. The residual data is output after each averaging period (ISSMMT = 0), defined by NTSMMT on card image 7, or only the last averaging period (ISSMMT = 1). However, the current configuration allows only 24 averaged output files, and if the number of averaging periods for a run exceeds 24, only the last 24 periods are output. The only currently active option (IS3D=1 and ISR3D=1) writes output as eight bit ASCII integers (0 to 255). This choice was made for flexibility and the minimization of disk storage. A post processor is available via ftp to translate the 8-bit ASCII integer data to a number of alternate forms including 8 bit ASCII character data, 8-bit binary, and HDF image or floating point format for compatibility with various visualization software. Although the 8-bit three-dimensional integer array files may be very large, they can be efficiently compressed on most systems. On UNIX systems, the UNIX .Z compressed version of the output files may be up to a factor 10 times smaller.

The output format is a three-dimensional array which can be conceptualized as a stack of KPC layers, of equal thickness, which slice the model domain at constant elevation plane, progressing from above the maximum water surface elevation to below the minimum bottom elevation. Each layer (or plane) comprises a two-dimensional array with a true east-north alignment. The most rapid variation in the two-dimensional

plane is from west to east analogous to the columns of a spread sheet. The sequence of columns is written from north to south analogous to the rows of a spread sheet. Thus if a layer of the 3 matrix is viewed in a spread sheet type form, it will have the proper geographic orientation. The KPC constant elevation slices are generated by constant elevation interpolation equivalent to an unstretching of the model's internal stretched or sigma coordinate system. The upper bounding elevation of the first layer is specified by elevation SELVMAX, which should be slightly larger than the maximum water surface elevation during the entire data sampling period. The lower bounding elevation of the last layer is specified by BELVMIN, which should correspond to an elevation slightly below the bottom of the deepest cell in the model domain. The values SELVMAX and BELVMIN shown in the example data line above are referenced to a sea level datum, hence the negative value of BELVMIN. For constant spacing Cartesian grids, the rectangular two-dimensional arrays or matrices corresponding to the constant elevation layers directly coincide with the model grid.

For curvilinear, or variable-spacing, Cartesian grids, a Cartesian graphics grid overlay, which can be generated by the preprocessor code GEFDC, and is input into EFDC by the file gcellmap.inp and is used to define the horizontal layers. The parameter NWGG defines the number of water cells in the Cartesian graphic grid. If NWGG is zero, the computation grid is assumed to be Cartesian, while a nonzero value indicates an overlay and activates the reading of the file gcellmap.inp. The input file gcellmap.inp includes information from interpolating the curvilinear grid data to the Cartesian graphic grid. The extent of the horizontal region over which three-dimensional data is to be extracted is defined by I3DMI<IG< I3DMA, and J3DMI<JG< J3DMA, where IG and JG are east and north indices in the Cartesian graphics grid overlay or the I and J indices of an equal spacing Cartesian computational grid. The parameter I3DRW allows the three-dimensional output to be written in a temporary compressed form. If I3DRW is set to 1, the output files are in the three-dimensional array structure described above. However, from many model applications to irregular regions, a large percent of the three-dimensional output matrix represents dry land. Setting I3DRW to zero results in output of information for active water cells in either the graphics overlay or computation grid. This output can later be expanded into the aforementioned fully three-dimensional format by a post processing utility, available via ftp.

Card Image 81 [not active in EFDC-Hydro]

```
C81 OUTPUT ACTIVATION AND SCALES FOR 3D FIELD OUTPUT
C
C      VARIABLE:          DUMMY VARIABLE ID (DO NOT CHANGE ORDER)
```

```

C      IS3 (VARID) : 1 TO ACTIVATE THIS VARIABLES
C      JS3 (VARID) : 0 FOR NO SCALING OF THIS VARIABLE
C
C      1 FOR AUTO SCALING OF THIS VARIABLE OVER RANGE 0<VAL<255
C      AUTO SCALES FOR EACH FRAME OUTPUT IN FILES out3d.dia AND
C      rout3d.dia OUTPUT IN I4 FORMAT
C
C      2 FOR SCALING SPECIFIED IN NEXT TWO COLUMNS WITH OUTPUT
C      DEFINED OVER RANGE 0<VAL<255 AND WRITTEN IN I4 FORMAT
C
C      3 FOR MULTIPLIER SCALING BY MAX SCALE VALUE WITH OUTPUT
C      WRITTEN IN F7.1 FORMAT (IS3DO AND ISR3DO MUST BE 1)
C
C81 VARIABLE      IS3D (VARID)  JS3D (VARID)  MAX SCALE VALUE  MIN SCALE VALUE
'U VEL'          0              3              100.0            -1.0
'V VEL'          0              3              100.0            -1.0
'W VEL'          0              0              1000.0           -1.0E-3
'SALINITY'       0              3              1.0              0.0
'TEMP'           0              3              1.0              10.0
'DYE'            0              0              1000.0           0.0
'COH SED'        0              3              1000.0           0.0
'NCH SED'        0              3              1000.0           0.0
'TOX CON'        0              3              1000.0           0.0

```

This card image controls the fields for three-dimensional data output. Current fields for output, corresponding to the data lines above include the true east and north horizontal velocity vectors, the physical vertical velocity vector, (as opposed to the internally used stretched coordinate vertical velocity), and the salinity, temperature, dye tracer, cohesive sediment concentration, non-cohesive sediment concentration, and toxic concentration scalar fields. The switch IS3D activates the output of the particular variable, while the switch JS3D defines its conversion to 8-bit integer form. If the option JS3D equals 2, then the minimum and maximum values correspond to 1 and 255 (recommended). Dry land positions in the three-dimensional array are by default set to 0. The output filenames corresponding to the data lines on this card image are:

Output Variable	Instantaneous	Residual
U VEL	uuu3dNN.asc	ruuu3dNN.asc
V VEL	vvv3dNN.asc	rvvv3dNN.asc
W VEL	www3dNN.asc	rwww3dNN.asc
SALINITY	sal3dNN.asc	rsal3dNN.asc
TEMP	tem3dNN.asc	rtem3dNN.asc
DYE	dye3dNN.asc	rdye3dNN.asc
SEDIMENT COHESIVE	sed3dNN.asc	rsed3dNN.asc

4 - EFDC Master Input File (efdc.inp)

```
SEDIMENT NON-COHESIVE   snd3dNN.asc           rsnd3dNN.asc
TOXIC                    tox3dNN.asc           rtox3dNN.asc
```

where NN represents a two digit time sequence identified between 1 and 24. Two additional files, out3d.dia and rout3d.dia, provide summary information including the actual minimum and maximum values of each variable for the output files.

Card Image 82 [not active in EFDC-Hydro]

```
C82 INPLACE HARMONIC ANALYSIS PARAMETERS
C
C   ISLSHA:  1 FOR IN PLACE LEAST SQUARES HARMONIC ANALYSIS
C   MLLSHA:  NUMBER OF LOCATIONS FOR LSHA
C   NTCLSHA: LENGTH OF LSHA IN INTEGER NUMBER OF REFERENCE TIME PERIODS
C   ISLSTR:  1 FOR TREND REMOVAL
C   ISHTA :  1 FOR SINGLE TREF PERIOD SURFACE ELEV ANALYSIS
C
C                                     90
C82 ISLSHA  MLLSHA  NTCLSHA  ISLSTR  ISHTA
C      0      0      7      0      0
```

This card in conjunction with Card Image 83 provides the controls for an in place least squares harmonic analysis procedure.

Card Image 83 [not active in EFDC-Hydro]

```
C83 HARMONIC ANALYSIS LOCATIONS AND SWITCHES
C
C   ILLSHA:  I CELL INDEX
C   JLLSHA:  J CELL INDEX
C   LSHAP:  1 FOR ANALYSIS OF SURFACE ELEVATION
C   LSHAB:  1 FOR ANALYSIS OF SALINITY
C   LSHAUE: 1 FOR ANALYSIS OF EXTERNAL MODE HORIZONTAL VELOCITY
C   LSHAU:  1 FOR ANALYSIS OF HORIZONTAL VELOCITY IN EVERY LAYER
C   CLSL:   LOCATION AS A CHARACTER VARIABLE
C
C83 ILLSHA  JLLSHA  LSHAP  LSHAB  LSHAUE  LSHAU  CLSL
```

This card image specifies the I and J cell indices at which multiple constituent least squares harmonic analysis is to be performed. The following four switches activate the analysis for surface elevation, salinity,

the barotropic or depth integrated horizontal velocity and the horizontal velocity in each layers. The character string identifies the analysis location in the output file *lsha.out*.

Card Image 84

```

C84 CONTROLS FOR WRITING TO TIME SERIES FILES
C
C   ISTMSR:  1 OR 2 TO WRITE TIME SERIES OF SURF ELEV, VELOCITY, NET
C             INTERNAL AND EXTERNAL MODE VOLUME SOURCE-SINKS, AND
C             CONCENTRATION VARIABLES,  2 APPENDS EXISTING TIME SERIES FILES
C   MLTMSR:  NUMBER HORIZONTAL LOCATIONS TO WRITE TIME SERIES OF SURF ELEV,
C             VELOCITY, AND CONCENTRATION VARIABLES,  MAXIMUM LOCATIONS = 9
C   NBTMSR:  TIME STEP TO BEGIN WRITING TO TIME SERIES FILES
C   NSTMSR:  TIME STEP TO STOP WRITING TO TIME SERIES FILES
C   NWTMSR:  WRITE INTERVAL FOR WRITING TO TIME SERIES FILES
C   NTSSTSP: NUMBER OF TIME SERIES START-STOP SCENARIOS,  1 OR GREATER
C   TCTMSR:  UNIT CONVERSION FOR TIME SERIES TIME.  FOR SECONDS, MINUTES,
C             HOURS,DAYS USE 1.0, 60.0, 3600.0, 86400.0 RESPECTIVELY
C   IDUM:    2 DUMMY INTEGER VARIABLES REQUIRED, BOTH = 0
C
C84  ISTMSR  MLTMSR  NBTMSR  NSTMSR  NWTMSR  NTSSTSP  TCTMSR  IDUM  IDUM
      1         9        1    2000000    60         1    86400.    0    0

```

Card image 84 activates and controls the writing of time series files. The parameter $ISTMSR = 1$ activates the creation of new time series files, while $ISTMSR = 2$ writes to the end of existing time series files and is useful in certain cases where the model is restarted to continue a long simulation. Instantaneous data for various model variables may be output at $MLTMSR$ locations (the current limit is 99 locations). The parameters $NBTMSR$ and $NSTMSR$ specify the beginning and ending time steps of a time interval where data is output at every $NWTMSR$ time steps. The conversion factor $TCTMSR$ specifies the time units for the time column in the time series output files. The parameter $NTSSTSP$ defines the number of start-stop scenarios, in other words, the time-series data can be written to the output files for a specified period, then the writing can be stopped for another period, and resumed again, etc. The start and stop times are controlled in Card Images 85 and 86.

Card Image 85

```

C85 CONTROLS FOR WRITING TO TIME SERIES FILES
C
C   ITSSS:   START-STOP SCENARIO NUMBER 1.GE.ISSS.LE.NTSSTSP
C   MTSSSTSP: NUMBER OF STOP-START PAIRS FOR SCENARIO ISSS
C

```

4 - EFDC Master Input File (efdc.inp)

```
C85 ITSSS MTSSTSP
    1      1      !FULL SAVE
```

Start-stop controls for writing to time series files are specified here.

Card Image 86

```
C86 CONTROLS FOR WRITING TO TIME SERIES FILES
C
C   ITSSS:   START-STOP SCENARIO NUMBER 1.GE.ISSS.LE.NTSSTSP
C   MTSSS:   NUMBER OF STOP-START PAIRS FOR SCENARIO ISSS
C   TSSTRT:  STARTING TIME FOR SCENARIO ITSSS, SAVE INTERVAL MTSSS
C   TSSTOP:  STOPING TIME FOR SCENARIO ITSSS, SAVE INTERVAL MTSSS
C
C86 ISSS    MTSSS    TSSTRT    TSSTOP    USER COMMENT
    1      1      -1000.    10000.    ! FULL SAVE
```

Start-stop controls for writing to time series files are specified here.

Card Image 87

```
C87 CONTROLS FOR WRITING TO TIME SERIES FILES
C
C   ILTS:    I CELL INDEX
C   JLTS:    J CELL INDEX
C   NTSSSS:  WRITE SCENARIO FOR THIS LOCATION
C   MTSP:    1 FOR TIME SERIES OF SURFACE ELEVATION
C   MTSC:    1 FOR TIME SERIES OF TRANSPORTED CONCENTRATION VARIABLES
C   MTSA:    1 FOR TIME SERIES OF EDDY VISCOSITY AND DIFFUSIVITY
C   MTSUE:   1 FOR TIME SERIES OF EXTERNAL MODE HORIZONTAL VELOCITY
C   MTSUT:   1 FOR TIME SERIES OF EXTERNAL MODE HORIZONTAL TRANSPORT
C   MTSU:    1 FOR TIME SERIES OF HORIZONTAL VELOCITY IN EVERY LAYER
C   MTSQE:   1 FOR TIME SERIES OF NET EXTERNAL MODE VOLUME SOURCE/SINK
C   MTSQ:    1 FOR TIME SERIES OF NET EXTERNAL MODE VOLUME SOURCE/SINK
C   CLTS:    LOCATION AS A CHARACTER VARIALBLE
C
C87 ILTS JLTS NTSSSS MTSP MTSC MTSA MTSUE MTSUT MTSU MTSQE MTSQ CLTS
    7    3    1     1     0     0     0     0     1     0     0 'station 1'
   16    3    1     1     0     0     0     0     1     0     0 'station 2'
   23    3    1     1     0     0     0     0     1     0     0 'station 3'
    7   12    1     1     0     0     0     0     1     0     0 'station 4'
   16   12    1     1     0     0     0     0     1     0     0 'station 5'
   23   12    1     1     0     0     0     0     1     0     0 'station 6'
    7   20    1     1     0     0     0     0     1     0     0 'station 7'
   16   20    1     1     0     0     0     0     1     0     0 'station 8'
   23   20    1     1     0     0     0     0     1     0     0 'station 9'
```

Card image 87 specifies the I and J indices of horizontal locations for writing time series data and the class of data. The generic file names created by the activation of the output switches are:

Switch	File Name
MTSP	seltmsrNN.out
MTSC	saltmsrNN.out temtmsrNN.out dyetmsrNN.out sedtmsrNN.out sfltmsrNN.out
MTSA	avvtmsrNN.out avbtmsrNN.out
MTSUE	uvetmsrNN.out
MTSUT	uvttmsrNN.out
MTSU	u3dtmsrNN.out v3dtmsrNN.out
MTSQE	qgetmsrNN.out
MTSQ	q3dtmsrNN.out

with NN, between 01 and 99, indicating the location. The last column (CLTS) provides a character string identifier for the location, which is written to the output file header.

Card Image 88 [not active in EFDC-Hydro]

```

C88 CONTROLS FOR EXTRACTING INSTANTANEOUS VERTICAL SCALAR FIELD PROFILES
C
C   ISVSFP: 1 FOR EXTRACTING INSTANTANEOUS VERTICAL FIELD PROFILES
C   MDVSFP:  MAXIMUM NUMBER OF DEPTHS FOR SAMPLING VALUES
C   MLVSFP:  NUMBER OF HORIZONTAL SPACE-TIME LOCATION PAIRS TO BE SAMPLED
C   TMVSFP:  MULTIPLIER TO CONVERT SAMPLING TIMES TO SECONDS
C   TAVSFP:  ADDITIVE ADJUSTMENT TO SAMPLING TIME BEFORE CONVERSION TO SEC
C           200max   1600max
C88 ISVSFP MDVSFP MLVSFP TMVSFP TAVSFP
      0       0       0       86400.  0.0

```

Card image 88 provides for the extraction of instantaneous vertical scalar field profiles at specified times and locations. This option is designed to mimic field sampling surveys and produce a smaller volume of output data than the time series output option. The switch ISVSFP = 1 activates the option. The

parameter MDVSFP specifies the maximum number of depths (measured downward from the instantaneous free surface for sampling, while MLVSFP specifies the number of discrete time and space locations for sampling. The parameter TMVSFP converts the sampling times specified on card image 89 to seconds. The time origin for specifying sampling should be consistent with information specified on card image 8. The parameter TAVSFP is an additive adjustment to the sampling times on card image 90, and is useful for dealing with sampling times recorded during daylight savings conditions. Output for this option is written to the file *vsfp.out*.

Card Image 89 [not active in EFDC-Hydro]

```
C89 SAMPLING DEPTHS FOR EXTRACTING INST VERTICAL SCALAR FIELD PROFILES
C
C   MMDVSFP:  Mth SAMPLING DEPTH
C   DMSFP:    SAMPLING DEPTH BELOW SURFACE, IN METERS
C
C89 MMDVSFP  DMVSFP
```

Card image 89 specifies the MDVSFP sampling depths below the water surface at the specified times and locations. If the local depth to the bottom is less than a sample depth, output data is not written for that depth.

Card Image 90 [not active in EFDC-Hydro]

```
C90 HORIZONTAL SPACE-TIME LOCATIONS FOR SAMPLING
C
C   MMLVSFP:  Mth SPACE TIME SAMPLING LOCATION
C   TIMVSFP:  SAMPLING TIME
C   IVSFP:    I HORIZONTAL LOCATION INDEX
C   JVSFP:    J HORIZONTAL LOCATION INDEX
C
C90 MMLVSFP  TIMVSFP  IVSFP  JVSFP
```

Card image 90 specifies the times and I and J cell indices for sampling.

5. Additional Input Files

This chapter describes additional input files required to run the EFDC model. Before describing the various files, it is useful to summarize them, noting the conditions and model options under which the model will need the file to execute.

File Name	Comments
aser.inp	Atmospheric time-series data. Required for all model runs for which atmospheric conditions are needed (i.e., when NASER=1 on card image 14)..
cell.inp	Required for all model runs
cellt.inp	Required for all model runs
depth.inp	Note: this file is no longer used by EFDC. The cell depths are now contained in the dxdy.inp file.
dser.inp	Required if NDSER .GE. 1 on card image 22 of file efdc.inp
dxdy.inp	Required if ISCLO=1 or if ISCLO=0 and (LC-LVC) .GT. 2 on card image 9 of file efdc.inp
dye.inp	Required if ISTOPT=1 on line 4, card image 6 of file efdc.inp
efdc.inp	Required for all model runs
efdc.wsp	Required if ISWASP .GE.1 on card image 5 of file efdc.inp
fldang.inp	Required if ISSFLFE=1 on file sfbser.inp; reads in the counter-clockwise angle from east specifying the principal flood flow direction for shellfish larvae simulations.
gcellmap.inp	Not Required if ISCLO=0 on card image 9, or if NWGG=0 on card image 80 of file efdc.inp
gwater.inp	Required for all model runs if ISGWI .GT. 0 on card image 14 of file efdc.inp..
lxly.inp	Required if ISCLO=1 or if ISCLO=0 and (LC-LVC) .GT. 2 on card image 9 of file efdc.inp

5 - Additional Input Files

mappns.inp	Required if ISPGNS=1 on card image 9 of file efdc.inp
mask.inp	Required if ISMASK=1 on card image 9 of file efdc.inp
modchan.inp	Required if ISCHAN=1 on card image 14 of file efdc.inp
moddxdy.inp	Required if IMD=1 on card image 11 of file efdc.inp
pser.inp	Required if NPSER .GE.1 on card image 16 of file efdc.inp
qctl.inp	Required if NQCTL .GE.1 on card image 23 of file efdc.inp
qser.inp	Required if NQSER .GE.1 on card image 23 of file efdc.inp
restart.inp	Required if ISRESTI =1 on card image 2 of file efdc.inp
restran.inp	Required if ISLTMT = 1 on card image 4 of file efdc.inp
salt.inp	Required if ISTOPT = 1 on line 2, card image 6 of file efdc.inp
sdser.inp	Required if NSDSER .GE.1 on card image 22 of file efdc.inp
show.inp	Required if ISHOW > 1 on card image 2 of file efdc.inp
sser.inp	Required if NSSER .GE.1 on card image 22 of file efdc.inp
sfser.inp	Required if NSFSER .GE.1 on card image 22 of file efdc.inp
sfbser.inp	Required if ISTRAN .EQ. 1 on data line 6, card image 6 of file efdc.inp
tser.inp	Required if NTSER .GE.1 on card image 22 of file efdc.inp
vege.inp	Required if ISVEG .GE.1 on card image 5 of file efdc.inp
wave.inp	Required if ISWAVE .GE.1 on card image 14 of file efdc.inp

The files *cell.inp*, *celllt.inp*, *dxdy.inp* and *lxly.inp* have been discussed and illustrated in Chapter 2, and the reader should refer to that chapter. The field *depth.inp* was used in early versions of the model and its functions has been superseded by the *dxdy.inp*; therefore it will not be discussed. Examples of the remaining input files will now be presented and discussed in alphabetical order.

5.1 Input file aser.inp

The input file aser.inp specifies atmospheric, wind and thermal forcings as well as precipitation and evapotranspiration. For ISTOPT = 1 on line 3 of card image 6, the full set of environmental parameters for an internal-to-the-model calculation of thermal sources and sinks is specified in the file. An example of the aser.inp file for this case is:

```
# ASER.INP: Mashapaug Pond, 01/01/2001 - 12/31/2001 (hourly data)
# solar radiation based on 1960-91 observations at Providence, RI (WBAN14765)
#   SRadj = SRmin + (SRmax - SRmin)*(1.0-CL)   where CL=cloud cover (0-1)
# ATMOSPHERIC FORCING FILE, USE WITH 28 JULY 96 AND LATER VERSIONS OF EFDC
# MASER      =NUMBER OF TIME DATA POINTS
# TCASER     =DATA TIME UNIT CONVERSION TO SECONDS
# TAASER     =ADDITIVE ADJUSTMENT OF TIME VALUES SAME UNITS AS INPUT TIMES
# IRELH      =0 VALUE TWET COLUMN VALUE IS TWET, =1 VALUE IS RELATIVE HUMIDITY
# RAINCVT    =CONVERTS RAIN TO M/SEC, inch/day=0.00254/86400=2.94E-7m/d=7.0556E-6m/h
# EVAPCVT    =CONVERTS EVAP TO UNITS OF M/SEC, IF EVAPCVT<0 EVAP IS INTERNALLY COMPUTED
# SOLRCVT    =CONVERTS SOLAR SW RADIATION TO JOULES/SQ METER
# CLDCVT     =MULTIPLIER FOR ADJUSTING CLOUD COVER
# IASWRAD    =0 DISTRIBUTE SW SOL RAD OVER WATER COL AND INTO BED, =1 ALL TO SURF LAYER
# REVC       =1000*EVAPORATIVE TRANSFER COEF, REVC<0 USE WIND SPD DEPD DRAG COEF
# RCHC       =1000*CONVECTIVE HEAT TRANSFER COEF, REVC<0 USE WIND SPD DEPD DRAG COEF
# SWRATNF    =FAST SCALE SOLAR SW RADIATION ATTENUATION COEFFICIENT 1./METERS
# SWRATNS    =SLOW SCALE SOLAR SW RADIATION ATTENUATION COEFFICIENT 1./METERS
# FSWRATF    =FRACTION OF SOLSR SW RADIATION ATTENUATED FAST  0<FSWRATF<1
# DABEDT     =DEPTH OR THICKNESS OF ACTIVE BED TEMPERATURE LAYER, METERS
# TBEDIT     =INITIAL BED TEMPERATURE
# HTBED1     =CONVECTIVE HT COEFFICIENT BETWEEN BED AND BOTTOM WATER LAYER  NO DIM
# HTBED2     =HEAT TRANS COEFFICIENT BETWEEN BED AND BOTTOM WATER LAYER  M/SEC
# PATM       =ATM PRESS MILLIBAR
# TDRY/TEQ   =DRY ATM TEMP ISOPT(2)=1 OR EQUIL TEMP ISOPT(2)=2
# TWET/RELH  =WET BULB ATM TEMP IRELH=0, RELATIVE HUMIDITY IRELH=1
# RAIN       =RAIN FALL RATE LENGTH/TIME
# EVAP       =EVAPORATION RATE IF EVAPCVT>0.
# SOLSWR     =SOLAR SHORT WAVE RADIATION AT WATER SURFACE  ENERGY FLUX/UNIT AREA
# CLOUD      =FRACTIONAL CLOUD COVER
#
#   MASER   TCASER   TAASER   IRELH     RAINCVT   EVAPCVT   SOLRCVT   CLDCVT
#
# IASWRAD  REVC     RCHC     SWRATNF  SWRATNS  FSWRATF  DABEDT   TBEDIT   HTBED1   HTBED2
#
# TASER(M)  PATM(M)   TDRY(M)  TWET(M)  RAIN(M)  EVAP(M)  SOLSWR(M)  CLOUD(M)
#           /TEQ     /RELH
#   8761   86400.  0.       1        7.05556E-06  -1.     1.0       1.00
#   2      1.5    1.5     1.0     0.0      1.0     10000.0   2.0     0.000    2.0E-6
# 0.00000  1007.79  0.30    0.68    0.000    0.000    0.0       0.25
# 1.03542  1007.79  0.30    0.68    0.000    0.000    0.0       0.25
# 1.07708  1008.80  0.30    0.68    0.000    0.000    0.0       0.05
# 1.11875  1009.82  0.30    0.71    0.000    0.000    0.0       0.05
# ...etc.
```

5 - Additional Input Files

Parameters on the first data line specify the number of time points (MASER), a factor to convert the time units to seconds (TCASER), a constant time to be added before unit conversion (TAASER), a factor to convert wind speed to meters/second (WINDSCT), and factors to convert rainfall and evapotranspiration rates to meters per second (RAINCVT, EVAPCVT). Each time lines data has in order: time (TASER), wind speed (WINDS), wind direction (WINDD) in bearing angle to the direction the wind is blowing (oceanographic as opposed to meteorological convention), atmospheric pressure (PATM) in millibars, dry and wet bulb temperature (TDRY, TWET) in degrees C, rainfall rate (RAIN), evapotranspiration rate (EVAP) and incident solar short-wave radiation (SOLSWR) in Joules per second per square meter. For ISTOPT = 2 on line 3 of card image 6, a time variable equilibrium temperature surface heat exchange formulation is implemented in the model. The form of the *aser.inp* file for this case is identical to that above, except that now the equilibrium temperature (degrees C) is entered under the TDRY column and the net surface heat exchange coefficient in square meters per second is entered under the SOLSWR column. Data entered under PATM and TWET are not used for this case. For ISTOPT=3 on line 3 of card image 6, a time-invariant equilibrium temperature surface heat exchange formulation is implemented with a constant equilibrium temperature and heat exchange coefficient provided on card image 46 of the file *efdc.inp*. In this case, wind speed and direction data and rainfall and evapotranspiration data form the *aser.inp* file used by the model.

5.2 Input Files *dser.inp*, *sser.inp*, *sdser.inp*, *sfser.inp*, and *tser.inp*

The scalar constituent time series files have identical formats, and thus it suffices to discuss them in a generic sense. An example of the *sser.inp* time series file containing one time series is shown below.

```

C sser.inp file, salt is nc=1 conc, in free format across line,
C repeats ncser(1) times, test case
C
C ISTYP MCSER(NS,1) TCCSER(NS,1) TACSER(NS,1) RMULADJ(NS,1) ADDADJ(NS,1)
C
C if istyp.eq.1 then read depth weights and single value of CSER
C
C (WKQ(K),K=1,KC)
C
C TCCSER(M,NS,1) CSER(M,NS,1) !(mcser(ns,1) sets ns=1,ncser(1) series)
C
C else read a value of qser for each layer
C
C TCCSER(M,NS,1) (CSER(M,K,NS,1),K=1,KC) !(mcser(ns,1) pairs)
C
0      7      86400.      0.0      1.0      0.0
35.791668  29.57  29.57  29.57  29.57  29.57  29.57  29.57  29.57
35.833336  29.93  29.93  29.93  29.93  29.93  29.93  29.93  29.93
35.875000  29.88  29.88  29.88  29.88  29.88  29.88  29.88  29.88
35.916668  30.89  30.89  30.89  30.89  30.89  30.89  30.89  30.89
35.958336  31.24  31.24  31.24  31.24  31.24  31.24  31.24  31.24
36.000000  31.12  31.12  31.12  31.12  31.12  31.12  31.12  31.12
36.041668  31.28  31.28  31.28  31.28  31.28  31.28  31.28  31.28

```

A concentration time series input file may contain multiple time series. Each time series set begins with the single data line specifying ISTYP (the time series format identifier), MCSER (the number of time data points), TCCSER (a multiplying conversion factor changing the input time units to seconds), TACSER (an additive time adjustment, applied before unit conversion), RMULADJ (a multiplying conversion for the concentration), and ADDADJ (an additive conversion for concentration, applied before the multiplier). If the ISTYP parameter is 0, the MCSER time data points must have a concentration value for each layer. If ISTYP=1, an additional line of data providing interpolating factors is read, and the time data lines should have only one concentration value. An example of an ISTYP=1 file is the dye time-series, *dser.inp*, shown below in which the dye is added only to the surface layer of a 6-layer system:

```

C dser.inp file, dye is nc=3 conc, in free format across line,
C repeats ncser(3) times, test case
C
C ISTYP MCSER(NS,3) TCCSER(NS,3) TACSER(NS,3) RMULADJ(NS,3) ADDADJ(NS,3)
C

```

5 - Additional Input Files

```
C if istyp.eq.1 then read depth weights and single value of CSER
C
C (WKQ(K),K=1,KC)
C
C TCSER(M,NS,3) CSER(M,NS,3) !(mcser(ns,3) sets ns=3,ncser(3) serseries)
C
C else read a value of dser for each layer
C
C TCSER(M,NS,3) (CSER(M,K,NS,3),K=1,KC) !(mcser(ns,3) pairs)
C
  1    10    3600.0    0.    1.    0.
    0.0    0.00    0.00    0.00    0.00    1.00
-200.00          0.00
  713.39          0.00
  713.41    2263374.5
  726.89    2263374.5
  726.91          0.00
  7076.49         0.00
  7076.51    2657004.85
  7087.99    2657004.85
  7088.01          0.00
 10000.00         0.00
```

This example specifies 6 weights (for a 6 layer model) on the second data line, which is read when `ISTYP=1`. The weights are read from the bottom (left) to the top layer (right). For the example shown above, the dye is being released into the surface layer (see the *qser.inp* file below for the corresponding dye release flow rate formulation).

5.3 Input Files *dye.inp* and *salt.inp*

The input files *dye.inp* and *salt.inp* are used to initialize the dye and salinity fields for cold start runs if an appropriate ISTOPT switch is set on card image 6 of the *efdc.inp* file. An example of a portion of the *salt.inp* field is shown below.

```
C salt.inp file, in free format across line, for IRLTC Final Grid
C first data line ISALTYP =0 no L,I,J =1 read L,I,J
C L=2,LA rows of SALINIT(L,K),K=1,KC across columns
C
  1
  1  40   2  30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
  2  41   2  30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
  3  42   2  30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
  4  43   2  30.62  30.62  30.62  30.62  30.62  30.62  30.62  30.62
  5  40   3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  6  41   3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  7  42   3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  8  43   3   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

The file has four header lines, followed by a line specifying the format type switch, ISALTYP. If ISALTYP is equal to 1, LC-2 data lines follow in the order L=2,LA, which is the single index sequence of active water cells. For ISALTYP=1, the first three columns give L (the single horizontal internal cell index), and I and J (the two external indices). These are then followed by KC (the number of model layers) values of salinity read from the bottom to the surface. For ISALTYP=0, the L, I, and J indices are absent from the data lines. A template for the *salt.inp* file, of ISALTYP=1 form, is generated by GEFDC. However, the four header lines and ISALTYP=1 must be manually added. The ISALTYP=0 format is carried over from older versions of the model. To allow conversion from older versions, the EFDC model outputs a file, *newsalt.inp*, of the ISALTYP=1, form.

5.4 Input File *efdc.wsp*

The file *efdc.wsp* provides data for controlling the linkage of EFDC and the WASP water quality model (Ambrose, *et. al.* 1993) writing WASP format input files specifying cell volumes, flow and diffusion linkages and flow files in either generic or DYNHYD format. An example of the *efdc.wsp* input file is shown below.

```

C1  CELL VOLUME PARAMETERS for WASP-EFDC Linkage
C1  IVOPT IBDEV SCALV CONVV VMULT VEXP DMULT DEXP
    2    0    1.0  1.0  1.0  0.  1.0  0.
C2  DIFFUSION AND DISPERSION PARAMETERS
C2  NRFLD SCALR CONVR ISNKH
    2    1.0  1.0  1
C3  ADVECTION PARAMETERS (iqopt=3 ASCII HYD, =4 for binary HYD file)
C3  IQOPT NFIELD SCALQ CONVQ HYDFIL          ISWASPD  ISDHD
    3    5        1.0  1.0  'NORWALK.HYD'    0          0
C4  DEPTH OF SEDIMENT LAYER (METERS)
C4  DEPSED  TDINTS  SEDIFF          WSS1          WSS2          WSS3
    0.1     366     2.315E-09      0.05         0.10         0.15

```

The parameters on card images 1 and 2 are identical to those defined in the WASP user's manuals. Card images 3 and 4 provide information for the flow and diffusive transport fields and the sediment submodel. EFDC users considering activating the WASP linkage option should contact the author for further information and guidance.

5.5 Input File fldang.inp

The file *fldang.inp* is used to specify the direction of tidal flood flow and is used in shellfish larvae transport simulations (see file *sfbser.inp*) to cue larvae swimming behavior. It is a headerless file with LC-2 lines of data. The first few lines of an example are shown below.

98	3	131.46	133.67
99	3	166.15	165.82
100	3	173.50	175.51
101	3	210.48	211.48
96	4	148.08	144.86
97	4	166.50	161.98
98	4	149.75	145.43
99	4	169.05	167.36

The data on each line correspond to the I and J horizontal cell indices, followed by a bottom and surface layer flood direction angle. The angles, measured counter clockwise (CCW) from east specify the maximum tidal flood flow direction determined by an analysis of bottom and surface layer tidal velocity ellipses for a single dominant tidal constituent (usually M2 on the U. S. east coast). Tidal ellipse directions are obtained from the output files *tidelkb.out* and *tidelkc.out* generated by a preliminary model run. Contact the author for software to generate the *fldang.inp* file from the *tidelkb.out* and *tidelkc.out* files.

5.6 Input File gcellmap.inp

The input file *gcellmap.inp* is read if NWGG on card image 56 of the *efdc.inp* file is greater than zero. The *gcellmap.inp* file specifies a square cell Cartesian graphic grid overlay of a horizontal curvilinear grid. The file is used in the generation of three-dimensional graphics and visualization output in 3D array form. The file is optionally generated by GEFDC (also see *efdc.inp* file, card image 56 description). The file has four header lines, followed by a single data line specifying IG and JG, the number of I and J cells in the Cartesian graphics grid. This line is then followed by NWGG lines of data specifying the water cell indices IGRAPHIC and JGRAPHIC, in the graphics grid and the corresponding indices ICOMP and JCOMP in the curvilinear computational grid. An example of a portion of the *gcellmap.inp* file is shown below.

```

C gcellmap.inp file, in free format across columns
C
C IGRAPHIC  JGRAPHIC      ICOMP      JCOMP
C
          50          92
          40           3          16          2
          41           3          17          2
          39           4          16          2
          40           4          16          2
          41           4          17          2
          42           4          18          2
          43           4          19          2

```

5.7 Input File `gwater.inp`

A simple soil moisture model (Hamrick and Moustafa, 1995a) is activated by the input file `gwater.inp`, shown below.

```

C gwater.inp file, in free format across columns
C   ISGWIE
C   gt.1 for on
C   DAGWZ      RNPOR      RIFTRM
C dep act gw  eff porosity  max infilt rate
C
C   1
C   0.4      0.3      0.0001

```

The soil moisture model is generally implemented for wetland simulations (Moustafa and Hamrick, 1995). The switch `ISGWIE` activates a simple soil moisture mass balance, which does not include horizontal flow. The soil moisture mass balance is calculated in an active zone which extends to a depth `DAGWZ` (in meters) below the bottom of each horizontal cell. The maximum available soil water, in volume of soil water per unit total volume is specified by the effective porosity, `RNPOR`, which is the physical porosity reduced by a factor accounting for capillary retention under unsaturated conditions. If the overlying water cell is wet, and the soil moisture is less than its maximum available value, infiltration occurs at a maximum rate `RIFTRM` (in meters per second). If the overlying water cell is dry, and soil moisture is available, the soil moisture is reduced at each time step by evapotranspiration. For a cold start run, the soil moisture is set to its maximum available value below wet cells. Below dry cells, an initial value is set using the mean of the water surface elevation in the wet cells of the simulated region.

5.8 Input File *mappgns.inp*

The input file *mappgns.inp* is used to configure the EFDC model for the simulations of regions presumed to be periodic or infinite in the computational y or north-south direction, the prime example being an infinite continental shelf or near-shore region, or the same region under the assumption of spatially periodic forcing. An example of a portion of the file is shown below.

```

C  ISPNS,JSPNS =  I,J INDICES OF A SOUTH CELL
C  INPNS,JNPNS =  I,J INDICES OF A CORRESPONDING NORTH CELL
C  NPNSBP
C  ISPNS      JSPNS      INPNS      JNPNS      (REPEATED NPNSBP TIMES)
C
    4
      2          2          2          126
      3          2          3          126
      4          2          4          126
      5          2          5          126

```

The parameter NPNSBP specifies the number of north-south pairs. This is followed by NPNSBP pairs of south and north I and J indices. North and south open boundary conditions must not be specified for these cell pairs in the *efdc.inp* file.

5.9 Input File mask.inp

The file *mask.inp* is used to insert thin barriers, which block flow across specified cell faces. This option is useful to simulate structural obstacles such as breakwaters and causeways locally aligning with the model grid, but have widths much less than the cell size or grid spacing in one direction. An example of the *mask.inp* file is shown below.

```

C mask.inp file, in free format across line, MMASK LINES
C
C MMASK
C
C I      J      MTYPE
C
      3
53      5      1  ! Block flow across west ( u face )
38      28     2  ! Block flow across south ( v face )
36      56     3  ! Block flow across all four cell faces

```

The parameter *MMASK* identifies the number of data lines. Each data line consists of the *I* and *J* indices of the cell to be masked, while the parameter *MTYPE* identifies the face to be blocked. The mask option can be activated on both cold starts and restarts (with no previous masking).

5.10 Input File `modchan.inp`

The input file `modchan.inp` is used to activate and specify data for a subgrid scale channel model. The subgrid scale channel model (Hamrick and Moustafa, 1995a,b; Moustafa and Hamrick, 1995) allows narrow channels (one-dimensional in the horizontal plane) to pass through larger scale cells (two-dimensional in the horizontal) referred to as host cells. Up to two subgrid channels at arbitrary orientations may pass through a host cell. The two channels are referred to as u and v channel (the u and v notation is arbitrary and does not define the alignment of the subgrid channels in an arbitrary direction). The subgrid scale channels interact with the host cells through an exchange flow. If the host cell is wet, the exchange flows are determined such that the water surface elevations in the host cell and the channel cells are identical. If the host cell becomes dry, flow is allowed to continue in the subgrid scale channels. An example of the `modchan.inp` file is shown below for 4 channel sections passing through 4 host cells.

```

C modchan.inp file, in free format across columns
C # host cells MDCHHD=1 wet host from chan MDCHHD2=1 dry ck first
C MDCHH MDCHHD MDCHHD2
C max iters MDCHHQ=1 int Q=0 QCHERR= abs error for flow cms
C MDCITM MDCHHQ QCHERR
C type i host j host i uchan j uchan i vchan j vchan
C MDCHTYP IMDCHH JMDCHH IMDCHU JMDCHU IMDCHV JMDCHH
C
  4          1          1
 40          2          0.001
  1         2         4         6         31         1         1
  1         3         4         7         31         1         1
  1         4         4         8         31         1         1
  1         5         4         9         31         1         1

```

The parameter `MDCHH` specifies the number of host cells, `MDCHHD` switches on wetting of a dry host cell when the water surface elevation in the channel exceeds the bottom elevation in the host. `MDCHHD2` specifies a drying iteration before the solution for the exchange flows. The maximum number of iterations allowed in the solution for the exchange flows is specified by `MDCITM`. `MDCHHQ = 0` initializes the iterative exchange flow with its value at the previous time step, while `MDCHHQ = 1` initializes the iteration with zero values for the exchange flows. `QCHERR` is the convergence criteria for determining the exchange flows. The two lines of control parameters are followed by `MDCHH` lines of data defining the host cell and subgrid channel linkage mapping. The first parameter `MDCHTYP` equals 1, 2, or 3 for a single u orientation channel, a single v orientation channel, or two channels. `IMDCHH` and `JMDCHH` are

the I and J indices of the host cell. IMDCHU and JMDCHU are the I and J indices of the u -type channel. IMDCHV and JMDCHV are the I and J indices of the v -type channel. For MDCHTYP equals 1 or 2, the indices 1,1 specified either null u or v type channels. The flow example data lines show a set of host cells running for I equals 2 to 5 at a constant J of 4. These cells host a u type channel running from I equal 6 to 9 at a constant J equal to 31. The u -type subgrid channels are generally located along a constant J index line in the computational grid, while the v -type channels are located along a constant I index line in the computation grid.

5.11 Input File moddxdy.inp

The file *moddxdy.inp* allows for quick modification of cell sizes, specified as dx and dy in the *dxdy.inp* file. Its primary use is for the quick adjustment of subgrid channel sections lengths and widths. The example below is self-explanatory.

```

C moddxdy.inp file, in free format across columns
C NMDXDY = # of cells for DX(I,J)=RMDX*DX(I,J) & DY(I,J)=RMDY*DX(I,J)
C   I   J   RMDX   RMDY
C
C   4
C   6   31   1.0   2.5
C   7   31   1.0   2.5
C   8   31   1.0   2.5
C   9   31   1.0   2.5

```

5.12 Input File *pser.inp*

The input file *pser.inp* is used to specify surface elevation time series primarily for use at open boundaries. The file may contain multiple time series, each having a single control and conversion data line followed by a sequence of MPSEER time data lines. An example is shown below.

```

C  pser.inp file, in free format across line, repeats npser times
C
C  MPSEER(NS)    TCPSEER(NS)    TAPSEER(NS)    RMULADJ(NS)    ADDADJ(NS)
C
C  TPSEER(M,NS)  PSEER(M,NS)    !(mpser(ns) pairs for ns=1,npser series)
C
      4          86400.         0.             1.0            0.0
      265.00     4.90
      270.00     4.90
      273.00     4.90
      275.00     2.06

```

The parameter MPSEER specifies the number of time data lines. TCPSEER and TAPSEER provide for adjustment and conversion of the time data units to seconds. RMULADJ and ADDADJ provide for conversion and adjustment of the elevation data to meters.

5.13 Input File qctl.inp

The input file *qctl.inp* specifies data to implement flow between pairs of cells controlled by hydraulic structures or rating curves. The flow is unidirectional between an upstream and downstream cell. Bi-directional flow is implemented by a control structure for each direction. An example of the file, which contains data sequences for an arbitrary number of structures is shown below:

```

C qctl.inp file, in free format across line, repeats nqctl times
C
C  ISTYP MQCTL(NS) HCTLUA HCTLUM HCTLDA HCTLDM RMULADJ ADDADJ
C
C if istyp.eq.1 then read depth weights and single value of QCTL
C
C (WKQ(K),K=1,KC)
C
C HDIFCTL(M,NS) QCTL(M,1,NS) !(mqctl(ns) pairs for ns=1,nqser series)
C
C else read a value of qser for each layer
C
C HDIFCTL(M,NS) (QCTL(M,K,NS),K=1,KC) !(mqctl(ns) pairs)
C
1      5      0.0      1.0      0.0      1.0      1.76E-05      0.0
1.0
0.0      0.0
0.0001      2.0
5.0      12.485
5.0001      0.0
1.E+12      0.0

```

The parameter *ISTYPE* is either zero or one, corresponding to a flow for each model layer or a set of layer weights used to distribute a single flow over the layers. *MQCTL* specifies the number of data point in the control table, which is essentially a flow versus head difference rating curve. *HCTLUA* and *HCTLDA* are additive adjustments to the surface elevation in the upstream and downstream cells respectively. *HCTLUM* and *HCTLDM* are multiplying factors applied to the adjusted upstream and downstream water surface elevations respectively. *ADDADJ* and *RMULADJ* are additive and multiplier conversions applied directly to the flow data and are useful for unit conversion. *MQCTL* data lines follow the one or two control data lines. The data pairs are elevation difference and flow. The data in the above example implements the formula:

$$\text{HDIFCTL} = \text{HCTLUM} \times (\text{SELU} + \text{HCTLUA}) - \text{HCTLDM} \times (\text{SELD} + \text{HCTLDA})$$

where SELU and SELD are the water surface elevations upstream and downstream of the control structure. For example, a rating curve for flow over a spillway has only upstream control, and therefore, HCTLDM would be set to zero. For a culvert, HCTLUM and HCTLDM would be set to one or a unit conversion factor, if required. For a rating curve in terms of the flow depth, the HCTLUA adjustment would be set to the negative of the channel bottom elevation. Likewise, for a spillway rating curve based on upstream head above the spillway crest, HCTLUA would be set to the negative elevation of the spillway crest elevation.

To illustrate the capabilities of the surface elevation or pressure flow control option it is convenient to summarize the sequence of steps involved in calculating the flow between the upstream and downstream cells. The FORTRAN statement sequence involves looping over all control structure pairs, NQCTL, and is shown in Figure 5-1. The flow from the upstream cell to the downstream cell is determined by the difference, DELH, between the upstream pressure plus elevation head, HUP relative to -HCTLUA, adjusted by multiplying by HCTLUM, and the downstream pressure plus elevation head, HDW relative to -HCTLDA, adjusted by multiplying by HCTLDM. For flows controlled entirely by surface elevation differences, HCTLUA and HCTLDA would both be zero. For a spillway or weir, -HCTLUA would be the spillway or weir crest elevation. For upstream only control, HCTLDM would be set to zero. Given the adjusted head difference, DELH, which must be greater than zero, the discharge or discharge per unit width, QCTLT, is determined from an interpolation table. A final multiplying adjustment, by RQCMUL, is applied to convert discharge per unit width to discharge if required. The hydraulic control structure option is also suitable for simulating water surface elevation controlled pump station operation.

```

DO NCTL=1,NQCTL
RQDW=1.
IU=IQCTLU(NCTL)           ! I CELL INDEX UPSTREAM
JU=JQCTLU(NCTL)           ! J CELL INDEX UPSTREAM
LU=LIJ(IU,JU)             ! L CELL INDEX UPSTREAM
HUP=HP(LU)+BELV(LU)+HCTLUA(NCTL) ! UPSTREAM SUF ELEV + HCTLUA
ID=IQCTLD(NCTL)           ! I CELL INDEX DOWNSTREAM
JD=JQCTLD(NCTL)           ! J CELL INDEX DOWNSTREAM
IF (ID.EQ.0.AND.JD.EQ.0) THEN
  LD=LC                     ! FLOW OUT OF MODEL DOMAIN
  HDW=0.                    ! WITH UPSTREAM FLOW
  RQDW=0.                   ! CONTROL
ELSE
  LD=LIJ(ID,JD)             ! L CELL INDEX DOWNSTREAM
  HDW=HP(LD)+BELV(LD)+HCTLDA(NCTL) ! UPSTREAM SUF ELEV + HCTLDA
END IF
DELH=HCTLUM(NCTL)*HUP-HCTLDM(NCTL)*HDW ! ADJUSTED DIFFERENCE
IF (DELH.LE.0.) THEN       ! NO FLOW
  DO K=1,KC
    QCTLT(K,NCTL)=0.
  END DO
ELSE                         ! ENTER INTERPOLATION TABLE
  M1=0                       ! TO DETERMINE FLOW IN
  M2=1                       ! EACH LAYER AS A FUNCTION
500  M1=M1+1                   ! OF DELH
  M2=M2+1
  IF (DELH.GE.HDIFCTL(M1,NCTL).AND.DELH.LE.HDIFCTL(M2,NCTL)) THEN
    TDIFF=HDIFCTL(M2,NCTL)-HDIFCTL(M1,NCTL)
    WTM1=(HDIFCTL(M2,NCTL)-DELH)/TDIFF
    WTM2=(DELH-HDIFCTL(M1,NCTL))/TDIFF
    DO K=1,KC
      QCTLT(K,NCTL)=WTM1*QCTL(M1,K,NCTL)+WTM2*QCTL(M2,K,NCTL)
    END DO                    ! FLOW ASSIGNED TO LAYERS,K
  ELSE
    GO TO 500
  END IF
END IF
DO K=1,KC                   ! ADD CONTROL FLOW TO OTHERS
  QSUM(LU,K)=QSUM(LU,K)-RQCMUL(NCTL)*QCTLT(K,NCTL)
  QSUM(LD,K)=QSUM(LD,K)+RQCMUL(NCTL)*RQDW*QCTLT(K,NCTL)
END DO
END DO

```

C

```

HP( ): CELL CENTER DEPTH
BELV( ): CELL CENTER BOTTOM ELEVATION
NQCTL: NUMBER OF CONTROLLED FLOW SETS
MQCTL: NUMBER OF DEPTH FLOW PAIRS IN SET NS
HCTLUA: CONSTANT ADDED TO UPSTREAM ELEVATION
HCTLUM: UPSTREAM MULTIPLIER
HCTLDA: CONSTANT ADDED TO UPSTREAM ELEVATION
HCTLDM: DOWNSTREAM MULTIPLIER
HDIFCTL: DEPTH AND
QCTL: VOLUMETRIC FLOW PAIRS

```

Figure 6. FORTRAN implementation of control structures.

5.14 Input File qser.inp

An example of the *qser.inp* file is shown below. The flows of the first time series correspond to the surface dye release shown previously in the *dser.inp* file.

```

C qser.inp file, in free format across line, repeats nqser times
C
C  ISTYP  MQSER(NS)  TCQSER(NS)  TAQSER(NS)  RMULADJ(NS)  ADDADJ(NS)
C
C  if istyp.eq.1 then read depth weights and single value of QSER
C
C  (WKQ(K),K=1,KC)
C
C  TQSER(M,NS)  QSER(M,1,NS)  !(mqser(ns) pairs for ns=1,nqser series)
C
C  else read a value of qser for each layer
C
C  TQSER(M,NS)  (QSER(M,K,NS),K=1,KC) !(mqser(ns) pairs)
C
  1    10    3600.0    0.    1.    0.    0
    0.000  0.000  0.000  0.000  0.000  1.000
-200.00    0.00
  713.39    0.00
  713.41    0.001
  726.89    0.001
  726.91    0.00
 7076.49    0.00
 7076.51    0.001
 7087.99    0.001
 7088.01    0.00
10000.00    0.00
  1    11    3600.0    0.0  1.0  0.  0
    0.166  0.167  0.167  0.167  0.167  0.166
-200.0    260.3
  708.0    260.3
  732.0    243.3
  756.0    230.2
  780.0    215.9
  804.0    202.3
  828.0    192.9
  852.0    181.1
  876.0    182.9
  900.0    173.5
10000.0    173,5

```

5.15 Input File restart.inp

The file *restart.inp* is used to specify initial conditions for running the EFDC model in the restart mode (i.e., ISRESTI=1 on card image 2 of file *efdc.inp*). The file is obtained by renaming the *restart.out* file.

5.16 Input File restran.inp

The file *restran.inp* is used to specify advective and diffusive transport files when the EFDC model is executed in the transport only mode. The file is obtained by renaming the *restran.out* file.

5.17 Input File *show.inp*

The file *show.inp*, shown below, is used to control screen writing of information at the horizontal location specified by the horizontal cell indices *ISHOWC* and *JSHOWC*. The variable *ISHOW* on card image 2 of file *efdc.inp* controls whether *show.inp* is read. If *ISHOW*=0, then *show.inp* is not read and no information is displayed on the user's screen. For MacIntosh, Unix, or other systems having column widths greater than 80 characters, the user can set *ISHOW*=1. For users running the model in an 80-character DOS window, setting *ISHOW*=2 will provide a more pleasing formatted screen display. The parameter *NSTYPE* determines the type of screen display. For *NSTYPE*=1, the screen display emulates a strip chart recording of water surface elevation and surface and bottom salinity. In this mode, and lower and upper scale for the surface elevation, *ZSSMIN* and *ZSSMAX* and an upper scale for salinity, *SSALMAX* must be specified on the third data line. A header is written to the screen every *NSHOWR* time steps. Between re-writes of the header information, the *show.inp* file be edited if the user wishes to revise the *ISHOWC* and *JSHOWC* output locations or the *NSTYPE* of display. For *NSTYPE* equal 2, 3, or 4, column-format data of time or time step, surface and bottom layer velocity, salinity or sediment concentration, and vertical diffusion coefficients are displayed. *NSTYPE* = 2 displays timestep and salinity. *NSTYPE* = 3 displays time in days and salinity. *NSTYPE* = 4 displays timestep and sediment concentration. Activating this option is generally recommended for diagnostics of new applications and may result in noticeable decreases in model execution speeds on systems with slow I/O capabilities. The variable *NSHFREQ* controls the frequency (in time steps) at which the model results are written to the screen. The use of a large value of *NSHFREQ* is recommended to speed up execution speed on systems with slow I/O throughput.

```

C  show.inp file, in free format across line
C
C  NSTYPE      NSHOWR      ISHOWC      JSHOWC      NSHFREQ
C
C  ZSSMIN      ZSSMAX      SSALMAX
C
C      3          22          10          12          60
C  -500.       500.       35.

```

5.18 Input File *sfbser.inp*

The file *sfbser.inp* specifies behavioral information for shellfish larvae when the shellfish larvae transport is activated. The header lines explain the meaning to the various time dependent behavior control information.

```

C  sfbser.inp file, shellfish larvae behavior time series in free format
C  MSFSER=no of time data points.  TCSFSER=converts time values to sec
C  TASFSEr=additive adjustment to time values
C  TSRSF,TSSSF=times of sunrise and sun set as a fraction of 24 hours
C  ISSFLDN=1 to activate daylight,darkness dependent behavior
C  ISSFLFE=1 to activate flood,ebb dependent behavior
C  TSFSER=time of data  RKDSFL=first order decay rate in 1/sec
C  WSFLST=settling velocity in m/s  WSFLSM=vert swim velocity in m/s
C  DSFLMN=minimum depth below surface in daylight, meters
C  DSFLMX=maximum depth below surface in daylight, meters
C  SFNTBE=restricts advection in bottom layer during ebb
C           0. equals full restriction, 1. equals no restriction
C  SFATBT=1. allows larvae to settle to bottom and attach
C
C  MSFSER   TCSFSER   TASFSEr   TSRSF   TSSSF   ISSFLDN   ISSFLFE
C
C  TSFSER RKDSFL WSFLST WSFLSM DSFLMN DSFLMX SFNTBE SFATBT
C
C   4           86400.    0.        0.25   0.84    1         1
-10000.  0.        0.        0.        0.        0.        0.        0.
  0.      0.        0.        0.        0.        0.        0.        0.
  0.01   0.        0.        0.        0.        0.        0.        0.
 10000.  0.        0.        0.        0.        0.        0.        0.

```

5.19 Input File *vege.inp*

The input file *vege.inp* specifies information on vegetation resistance. An example is shown below.

```

C  vege.inp file, in free format across line,  WCA2A
C
C  MVEGTYP(# vege classes) MVEGOW(open water class) UVEGSCL(vel scale)
C
C  after reading MVEGTYP, MVEGOW and UVEGSCL read MVEGTYP lines of vars
C
C      M      RDLPSQ      BPVEG      HPVEG      ALPVEG      BETVEG      GAMVEG      SCVEG
C  typ#  1/m**2      meters      meters      no dim      no dim      no dim      nodim
C
      20      17          0.01
      1      32.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      2      18.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      3       8.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      4      26.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      5      12.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      6      32.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      7      32.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      8      18.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
      9      12.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     10      32.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     11      18.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     12       8.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     13      26.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     14      18.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     15      26.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     16      32.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     17      0.25      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     18      32.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     19      32.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50
     20       8.0      0.1E-0      2.5      0.7854      1.0      0.0      0.50

```

The parameter MVEGTYP specifies the number of vegetation types. The vegetation is represented as cylindrical elements of height HPVEG and width or diameter BPVEG having a spatial density of RDLPSQ resistance elements per square meter. The parameter ALPVEG, BETVEG, GAMVEG, and SCVEG are dimensionless shape factors (see Hamrick and Moustafa, 1995a) with the values shown being typical of cattail and sawgrass.

5.20 Input File wave.inp

The file *wave.inp* is used to specify forcings for modeling wave induced currents and wave-current boundary layers. The definitions on the header lines define and explain the various data types. A preprocessor is available from the author to generate the two layer data sets required in this file using the output of various wave prediction and transformation models.

```

c file wave.inp to specify information for wave-current boundary layer
c and wave induced flow
c
c *first line data
c NWVDAT=number of cells receiving wave data
c WVPRD=wave period in secs
c CVTWHM=mult convert wave height to amplitude in m
c ISWCBL=1 activates wave current boundary layer model
c ISWRSR=1 activates inclusion of rotational component of rad stress
c ISWRSI=1 activates inclusion of irrotational component of rad stress
c NWUPDT=number of time steps between updating wave forcing
c NTSWV=number of time steps for gradual introduction of wave forcing
c WVDISV=fraction of wave dissipation as source in vertical TKE closure
c WVDISH=fraction of wave dissipation as source in horiz SSG closure
c WVLSH=weight for depth as the horiz SSG eddy viscosity length scale
c WVLSX=weight for sqrt(dx dy) as the horiz SSG eddy vis length scale
c ISWVSD=1, include nondiverg wave stokes drift in mass transport
c ISDZBR=1, write diagnos for effect wave current bndry layer roughness
c
c *second NWVDAT lines data
c I,J cell indices
c HMP,HMC cell center & corner depths for consistent disper evaluation
c WVENE wave energy 0.5*g*abs(amp)*abs(amp)
c SXX rotational depth integrated wave radiation stress <huu>
c SYX rotational depth integrated wave radiation stress <hvv>
c SXY rotational depth integrated wave radiation stress <huv>
c WVDISP wave energy dissipation in (m/s)**3
c
c *third NWVDAT lines data
c I,J cell indices
c HMU,HMV cell u and v face depths for consistent disper evaluation
c UWVRE real part of u component of wave orbital velocity magnitude
c UWVIM imag part of u component of wave orbital velocity magnitude
c VWVRE real part of v component of wave orbital velocity magnitude
c VWVIM imag part of v component of wave orbital velocity magnitude
c
c NWVDAT WVPRD CVTWHM ISWCBL ISWRSR ISWRSI NWUPDT NTSWV WVDISV WVDISH
continuation of first head (not sep line)\ WVLSH WVLSX ISWVSD ISDZBR
c I J HMP HMC WVENE SXX SYX SXY WVDISP
c I J HMU HMV UWVRE UWVIM VWVRE VWVIM
c
5500 10.9 1.0 1 1 1 1000000 120 1.0 1.0
2 2 .001 .001 .5845E-05 .0000E+00 .1288E-09 .0000E+00 .0000E+00
3 2 .001 .001 .2276E-04 .1472E-04 .9844E-09 .8752E-07 .0000E+00

```

6. Compiling and Executing the Code

To compile the EFDC model, the FORTRAN 77 source code *efdc.f* and the include files *efdc.cmn*, which contains global common blocks, and *efdc.par*, which contains a global parameter statement are necessary and should reside in the same directory. Extensive efforts have been made to ensure cross-platform compatibility of the EFDC model, however, a number of minor modifications are required for various platforms. The source code *efdc.f* contains calls to the VMS time utility *secnds*. For compilers which support the *secnds* function through systems libraries, (DEC and Hewlett-Packard UNIX systems and Absoft and LSI Macintosh FORTRAN compilers), no modifications to the standard source *efdc.f* are required if appropriate compiler options are specified. (To determine if your compiler supports the *secnds* functions, look for *secnds* or VMS compatibility in the compiler reference manuals.) For compilers which do not support the *secnds* function, (Cray cf77, Sun UNIX) the real function subroutine *secnds.f* should be appended to the end of the standard source code. A somewhat less desirable fix is to comment out calls to the *secnds* function. Many of the IO operations in the *efdc.f* source code use the open file statement form:

```
OPEN(1, FILE=' fname' , STATUS=' UNKNOWN' , ACCESS=' APPEND' )
```

To the author's knowledge, the only systems which do not support the ACCESS='APPEND' modifier are Cray and IBM Risc6000 UNIX Systems. For Cray compilation, the ACCESS='APPEND' should be globally replaced by POSITION='APPEND'. A Cray-compatible version of the source, *cefdc.f* is continually maintained and available by *ftp* as described in the foreword of this report.

Except for the optional function subroutine *secnds.f*, the source code consisting of approximately 112 subroutines at last count is maintained as a single text file, *efdc.f* or *cefdc.f*. A number of compilers, including the Cray and Silicon Graphics UNIX compilers and the Lahey Intel based PC compiler, are able to produce optimized executable code by operating on the entire source using, for example, the Cray and SGI commands:

```
cf77 -Zv cefdc.f
```

```
f77 -O3 efdc.f
```

which produce the executable *a.out*. (Note the option *-Zv* for the Cray compilation produces optimum vectorization, using *-Zp* would produce both optimum vectorization and autotasking). Other compilers, such as the HP and SUN UNIX compilers and the Absoft and LSI Macintosh compilers, are capable of producing only nonoptimized executables working with the entire source code. An example command line for the HP is:

```
f77 -K +E1 -C -o hpefdcnopt efdc.f
```

which produces the nonoptimized executable *hpefdcnopt*. The options *-K +E1* invoke support of the *secnds* function, while *-C* implements array range checking. To produce optimized code on these systems, recourse to makefiles or batch command files which compile each subroutine separately is necessary. Batch command files for HP and SUN UNIX compilers and Makefiles for Absoft and LSI Macintosh compilers are available via *ftp*.

To achieve minimum memory requirements for running a specific application, it is recommended that the parameter file be customized for that application. The parameter file *efdc.par* is of the form:

```
C*****C
C
C ** EFDC PARAMETER FILE
C ** FOR USE WITH 31 August 2001 EFDC HYDRO CODE RELEASE
C
C ** THIS FILE IS CONFIGURED FOR
C Lake Tenkiller (MRM 02/27/2002)
C*****C
C ** RELDATE = release date
C COMPDATE = compile date
C COMPDESC = compile description, i.e., application notes
C
C CHARACTER*30 RELDATE, COMPDATE, COMPDESC
C
C 1 2 3
C '123456789012345678901234567890'
C PARAMETER (RELDATE = '31-AUG-2001 (Hydro version) ')
C PARAMETER (COMPDATE = '28-FEB-2002 ')
C PARAMETER (COMPDESC = 'Lake Tenkiller, Oklahoma ')
C
C ** HYDRODYNAMIC AND TRANSPORT PARAMETER BLOCK
C
C PARAMETER (KSM=10,KCM=11,KGM=11,KBM=11, LCM=200, ICM=30, JCM=50,
```

```

$      IGM=31,   JGM=51,   KPCM=10,   NWGGM=200,NTSM=86400,  NPDm=1,
$      NPBSM=4,  NPBWM=4,  NPBEM=4,  NPBNM=4,  NPFORM=38,
$      NBBSM=4,  NBBWM=4,  NBBEM=4,  NBBNM=4,  NLDAM=12,
$      NVBSM=1,  NVBNM=1,  NUBWM=1,  NUBEM=1,
$      NGLM=2,   LCGLM=2,  LCMW=200,  NPSERM=2,  NDP SER=184,
$      NQSIJM=50,  NQSERM=366,  NDQSER=1400,  NQINFLM=66,
$      NQCTLM=10,  NQCTTM=10,  NDQCLT=45,  NDQCLT2=45,
$      NQWRM=30,  NQWRSRM=30,  NDQWRSR=1400,  NVEGTPM=1,  NCHANM=1,
$      NCSERM=20,  NDCSER=1400,  NASERM=2,  NDASER=10400,
$      NWSERM=1,  NDWSER=10400,NQJPM=1,  NJPSM=1,
$      NJUNXM=1,  NJUNYM=1,  NXYSDATM=2,
$      MTM=11,   MLM=12,   MGM=22,   MLTMSRM=60,
$      NTSSTSPM=99,MTSSTSPM=32,  MDVSM=10,  MTVSM=10,
$      NSCM=1,   NSNM=1,   NSTM=2,   NTXM=5,   NSTVM=12)
C
C ** NSTVM=5+NSCM+NSNM+NTXM
C
C*****C
C
C ** WATER QUALITY/EUTROPHICATION PARMETER BLOCK
C
C ** USE PARAMETER STATEMENT BELOW FOR INACTIVE WATER QUALITY
C
PARAMETER (NWQVM=22,NWQZM=2,NWQPSM=2,NWQTDm=2,NWQTSM=2,
$  NTSWQVM=22,LCMWQ=2,NSMGM=2,NSMZM=2,NTSSMVM=2,NSMTSM=2,
$  NWQCSRm=2,NDWQCSR=2,NWQPSRM=2,NDWQPSR=2)
C
C
C ** USE PARAMETER STATEMENT BELOW FOR ACTIVE WATER QUALITY
C
PARAMETER (NWQVM=22,NWQZM=2,NWQPSM=2,NWQTDm=2,NWQTSM=2,
$  NTSWQVM=22,LCMWQ=2,NSMGM=3,NSMZM=2,NTSSMVM=2NSMTSM=2,
$  NWQCSRm=4,NDWQCSR=2,NWQPSRM=2,NDWQPSR=2)
C
C*****C
C
C      ICM= MAXIMUM X OR I CELL INDEX TO SPECIFIC GRID IN FILE cell.inp
C      IGM= ICM+1
C      JCM= MAXIMUM Y OR J CELL INDEX TO SPECIFIC GRID IN
C           FILE cell.inp
C      JGM= JCM+1
C      KBM= MAXIMUM NUMBER OF BED LAYERS, MAX LOOP INDEX KB
C      KCM= MAXIMUM NUMBER OF LAYERS, MAX LOOP INDEX KC
C      KGM= KCM
C      KSM= KCM-1
C      KPCM= MAXIMUM NUMBER OF CONSTANT ELEVATION LEVELS FOR
C           THREE-DIMENSIONAL GRAPHIC OUTPUT
C      LCM= MAXIMUM NUMBER OF WATER CELLS + 2
C           OR 1 + THE MAX LOOP INDEX LA
C      LCMW= SET TO LCM IF ISWAVE.GE.1 OTHERWISE =2
C      LCGLM= SET TO LCM IF ISLRD.GE.1 OTHERWISE =2
C      LCMWQ= SET TO LCM IF WATER QUALITY TRANSPORT ISTRAN(8).EQ.1
C      MDVSM= MAXIMUM DEPTHS FOR VERTICAL SCALAR PROFILE SAMPLING
C      MTVSM= MAXIMUM NUMBER OF SPACE-TIME LOCATIONS FOR VERTICAL SCALAR
C           FIELD PROFILING
C      MGM= 2*MTM

```

6 - Compiling and Executing the Code

```
C      MLM= MAXIMUM NUMBER OF HARMONIC ANALYSIS LOCATION
C      MTM= MAXIMUM NUMBER OF PERIODIC FORCING CONSTITUENTS
C      MLTMSRM= MAXIMUM NUMBER OF TIME SERIES SAVE LOCATIONS
C      MTSSTSPM= MAX NUMBER OF TIMES SERIES START-STOP TIME PAIRS
C      NASERM= MAX NUMBER OF ATMOSPHERIC DATA TIME SERIES
C      NBBEM= NPBEM
C      NBBNM= NPBNM
C      NBBSM= NPBSM
C      NBBWM= NPBWM
C      NCSERM= MAXIMUM NUMBER OF CONCENTRATION TIME SERIES FOR
C              ANY CONCENTRATION VARIABLE
C      NCHANM= MAXIMUM NUMBER OF HEC-TYPE 1D CHANNEL CELLS
C      NDASER= MAX NUMBER OF TIME DATA PTS IN ATMOSPHERIC TIME SERIES
C      NDQSER= MAXIMUM NUMBER OF TIME POINTS IN THE LONGEST TIME SERIES
C      NDQCLT= MAXIMUM NUMBER OF DATA PAIRS IN FLOW CONTROL TABLE
C      NDQCLT2= MAXIMUM NUMBER OF 2ND DATA PAIRS IN FLOW CONTROL TABLE
C      NDQWRSR= MAX NUMBER OF TIME DATA PTS IN WITH-RETURN TIME SERIES
C      NDWQCSR= MAX NUMBER OF TIME DATA PTS IN WQ CONCENTRATION SERIES
C      NDWQPSR= MAX NUMBER OF TIME DATA PTS IN WQ PSL TIME SERIES
C      NDWSER= MAX NUMBER OF TIME DATA PTS IN WIND TIME SERIES
C      NGLM= NUMBER OF ISLRD PARTICLE RELEASE TIMES
C      NJUNXM= MAX NUMBER OF X DIR 1D CHANNEL JUNCTIONS
C      NJUNYM= MAX NUMBER OF Y DIR 1D CHANNEL JUNCTIONS
C      NLDAM= MAXIMUM NUMBER OF LOCATIONS FOR CONCENTRATION DATA
C              ASSIMILATION
C      NPBEM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
C      NPBNM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
C      NPBSM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
C      NPBWM= MAXIMUM NUMBER OF EAST OPEN SURFACE ELEV BOUNDARIES
C      NPDM= MAXIMUM NUMBER OF ISPD TYPE PARTICLE DRIFTERS
C      NPFORM= MAXIMUM NUMBER OF PERIODIC FORCING FUNCTIONS
C      NPSERM= MAXIMUM NUMBER OF SURFACE ELEVATION TIME SERIES
C      NQCTLM= MAXIMUM NUMBER OF FLOW CONTROL STRUCTURE LOCATION
C      NQCTTM= MAXIMUM NUMBER OF FLOW CONTROL STRUCTURE TABLES
C      NQSERM= MAXIMUM NUMBER OF FLOW TIME SERIES
C      NQSIJM= MAXIMUM NUMBER OF NQSIJ VOLUMETRIC SOURCE-SINKS
C      NQJPM= MAXIMUM NUMBER OF JET/PLUME VOLUME AND MASS SOURCES
C      NJPSM= MAXIMUM NUMBER OF JET/PLUME SAVE POSITIONS
C      NQWRM= MAXIMUM NUMBER OF FLOW WITH-RETURN PAIRS
C      NQWRSRM= MAXIMUM NUMBER OF FLOW WITH-RETURN TIME SERIES
C      NSMGM=
C      NSMTSM= MAX SED DIAGENSIS MODEL TIME SERIES OUTPUT LOCATIONS
C      NSMZM= MAXIMUM NUMBER OF SEDIMENT DIAGENSIS MODEL ZONES
C      NTSM= MAXIMUM NUMBER OF TIME STEP PER REFERENCE TIME PERIOD
C      NTSSMVM=
C      NTSWQVM= MAX NUMBER OF WATER QUALITY TIME SERIES OUTPUT VARIABLES
C      NTSSTSPM= MAXIMUM NUMBER OF TIME SERIES START-STOP SCEARIOS
C      NUBEM= 1
C      NUBWM= 1
C      NVBNM= 1
C      NVBSM= 1
C      NSCM = MAXIMUM NUMBER OF COHESIVE SEDIMENT SIZE CLASSES
C      NSNM = MAXIMUM NUMBER OF NON-COHESIVE SEDIMENT SIZE CLASSES
C      NSCM = TOTAL NUMBER OF SEDIMENT SIZE CLASSES NSCM+NSNM
C      NTOXM= MAXIMUM NUMBER OF TOXIC CONTAMINANTS
C      NVEGTPM= MAXIMUM NUMBER OF VEGETATION TYPE CLASSES
```

```

C   NWGGM= NUMBER OF WATER CELLS IN CARTESIAN GRAPHIC OVERLAY
C   GRID, EQUAL TO LCM-2 FOR CARTESIAN GRIDS
C   NWQCSR= MAX NUMBER OF WQ STATE VARIABLE TIME SERIES
C   NWQPSM= MAX NUMBER OF WQ POINT SOURCES
C   NWQPSRM= MAX NUMBER OF WQ POINT SOURCE LOAD TIME SERIES
C   NWQTDM= MAX NUMBER OF PTS IN WQ MODEL TEMPERATURE FUNCTION TABLES
C   NWQTSM= MAX NUMBER OF WQ MODEL TIME SERIES OUTPUT LOCATIONS
C   NWQVM= MAXIMUM NUMBER OF WQ VARIABLES
C   NWQZM= MAXIMUM NUMBER OF SURFACE WATER QUALITY ZONES
C   NWSERM= MAX NUMBER OF WIND TIME SERIES
C   NXYSDATM= MAXIMUM NUMBER OF DATA POINTS DEFINING HEC TYPE 1D
C   CHANNEL CROSS SECTION PROPERTIES
C
C*****C

```

For a given model application, the parameters, which dimension arrays in *efdc.cmn*, should be set to the lowest value that accommodates the grid and data for the application. When starting to run a new application, it is recommended to use a nonoptimized executable compiled with the range checking option (usually `-C` on UNIX compilers) to determine if arrayed variables are within the range specified by the parameter dimensioned arrays. After it has been determined that the input files are configured properly, then the model can be compiled without the range-checking option activated to improve execution speed.

7. Diagnostic Options and Output Files

File	Description
adjmmt.dia	
bal.out	
balo.out	
bale.out	
buoy.dia	
disdia.out	
modchan.dia	
rbcn.dia	
sinval.out	
efdc.log	Errors encountered when reading the <i>efdc.inp</i> file are recorded in this file.
time.log	The execution clock time is recorded in this file at the end of each NTC interval.
drywet.log	Diagnostics for grid cell wetting and drying processes are written to this file.
lijmap.out	This is a file that maps the L-vector index to the cell I,J indices.
zvolbal.out	
cfl.out	Diagnostics of the maximum time step for each grid cell are written to this file.
eqcoef.out	
eqterm.out	
fp.out	

7 - Diagnostic Options and Output

eqcoef1.out

diag.out

8. Time-Series Output and Analysis Files

File	Description
lsha.out	Least squares harmonic analysis output file.
saltmsr01.out	Salinity time-series output file for a single grid cell location.
temtmsr01.out	Temperature time-series output file for a single grid cell location.
dyetmsr01.out	Dye concentration time-series output file for a single grid cell location.
sedtmsr01.out	Cohesive sediment concentration time-series output file for a single grid cell location.
sndtmsr01.out	Non-cohesive sediment concentration time-series output file for a single grid cell location.
sfltmsr01.out	Shellfish larvae time-series output file for a single grid cell location.
avvtmsr01.out	
avbtmsr01.out	
uvetmsr01.out	
uvttmsr01.out	
u3dtmsr01.out	
v3dtmsr01.out	
qqetmsr01.out	
q3dtmsr01.out	
vsfp.out	Vertical scalar field profiles output file (see example below).

INSTANTANEOUS VERTICAL SCALAR FIELD PROFILES

TIME = 3221.6001 N = 1665 I,J = 151 42
 DEPTH BELOW SURFACE MODEL SALINITY
 1.00 16.70

8 - Time-Series Output and Analysis

3.00	17.27
5.00	17.79
7.00	18.09
9.00	18.21
11.00	18.24
13.00	18.25

TIME = 3222.0000 N = 1679 I,J = 140 46
DEPTH BELOW SURFACE MODEL SALINITY

1.00	17.36
3.00	17.37
5.00	17.37
7.00	17.37
9.00	17.39
11.00	17.42
13.00	17.43
15.00	17.44
17.00	17.44
19.00	17.45

TIME = 3222.3999 N = 1693 I,J = 124 59
DEPTH BELOW SURFACE MODEL SALINITY

1.00	13.51
3.00	13.51
5.00	14.53
7.00	14.93
9.00	14.93

9. Two-Dimensional Graphics Output and Visualization

9.1 Two-Dimensional Horizontal Plane Scalar Format

File	Description
belvcon.out	Bottom elevation contour output file.
wcustrh.out	Wave current shear velocity
ccustrh.out	Current shear velocity
zbreffh.out	
surfamp.out	
surfpha.out	
majaxis.out	
majapha.out	
salconh.out	Salinity instantaneous horizontal contour output file.
temconh.out	Temperature instantaneous horizontal contour output file.
dyeconh.out	Dye instantaneous horizontal contour output file.
sedconh.out	Cohesive sediment instantaneous horizontal contour output file.
sflconh.out	Shellfish larvae instantaneous horizontal contour output file.
rsalconh.out	Residual salinity horizontal contour output file.
rtemconh.out	Residual temperature horizontal contour output file.
rdyeconh.out	Residual dye horizontal contour output file.
rsedconh.out	Residual cohesive sediment horizontal contour output file.
rsflconh.out	Residual shellfish larvae horizontal contour output file.

9 - Two-Dimensional Graphics Output and Visualization

surfcon.out Water surface elevation instantaneous contour output file.

rsurfcon.out Residual water surface elevation contour output file.

9.2 Two-Dimensional Horizontal Plane Vector Format

File	Description
-------------	--------------------

tstvech.out	
-------------	--

stvech.out	
------------	--

tauvech.out	
-------------	--

tidelkc.out	
-------------	--

tidelkb.out	
-------------	--

velvech.out	
-------------	--

rvelvech.out	
--------------	--

pvelvech.out	
--------------	--

mvelvech.out	
--------------	--

lmvvech.out	
-------------	--

almvvech.out	
--------------	--

9.3 Two-Dimensional Vertical Plane Scalar Format

File	Description
-------------	--------------------

salcnv1.out	
-------------	--

temcnv1.out	
-------------	--

dyecnv1.out	
-------------	--

sedcnv1.out	
-------------	--

sflcnv1.out	
-------------	--

rsalcnv1.out	
--------------	--

rviscnv1.out	
--------------	--

rvefcnv1.out	
--------------	--

rsflcnv1.out	
--------------	--

velcnv1.out	
-------------	--

rvelcnv1.out	
--------------	--

pvelcnv1.out	
--------------	--

mvelcnv1.out	
--------------	--

lmcnv1.out	
------------	--

almvcnv1.out	
--------------	--

rvelcvt1.out	
--------------	--

pvelcvt1.out	
--------------	--

mvelcvt1.out	
--------------	--

lmcvt1.out	
------------	--

almvcvt1.out	
--------------	--

9.4 Two-Dimensional Vertical Plane Vector Format

File	Description
-------------	--------------------

velvcv1.out	
-------------	--

rvelvcv1.out	
--------------	--

pvelvcv1.out	
--------------	--

mvelvcv1.out	
--------------	--

lmvvcv1.out	
-------------	--

almvvcv1.out	
--------------	--

10. Three-Dimensional Graphics Output and Visualization

File	Description
sal3d01.asc	Instantaneous salinity (up to 24 files)
tem3d01.asc	Instantaneous temperature
dye3d01.asc	Instantaneous dye
sed3d01.asc	Instantaneous cohesive sediment
uuu3d01.asc	Instantaneous velocity (u-direction)
vvv3d01.asc	Instantaneous velocity (v-direction)
www3d01.asc	Instantaneous velocity (w-direction)
out3d.dia	Diagnostics for instantaneous 3D output.
rsal3d01.asc	Residual salinity (up to 24 files)
rtem3d01.asc	Residual temperature
rdye3d01.asc	Residual dye
rzed3d01.asc	Residual cohesive sediment
ruuu3d01.asc	Residual velocity (u-direction)
rvvv3d01.asc	Residual velocity (v-direction)
rwww3d01.asc	Residual velocity (w-direction)
rou3d.dia	Diagnostics for residual 3D output.

11. Miscellaneous Output Files

File	Description
efdc.out	This is an echo of the <i>efdc.inp</i> file
avsel.out	
gwelv.out	
cell9.out	File containing grid cell mapping information
drifter.out	Lagrangian drifter output file
restran.out	Residual transport output file
restart.out	Restart file written at the end of each NTC interval or at end of model run.
waspp.out	WASP horizontal position and layer information file
waspb.out	WASP data group B
waspb.mrm	WASP data group B (use this for Tetra Tech's version of WASP5)
waspc.out	WASP data group C
waspd.out	WASP data group D
waspd.mrm	WASP data group D (use this for Tetra Tech's version of WASP5)
waspdhd.out	WASP hydrodynamic diagnostic file (ASCII format)
waspdh.out	WASP external hydrodynamic file
waspdhu.out	WASP external hydrodynamic file (unformatted binary)
advmod.wsp	
disten.out	
uvtsc.out	

11 - Miscellaneous Output Files

uvern.out

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Appendix A. EFDC Source Code Subroutines and Functions

Subroutine	Purpose
ADJMMT.f	Adjust mean transport field for transport only simulations
AINIT.f	Initializes Variables
ASOLVE.f	Utility solver for bi-conjugate gradient solver
ATIMES.f	Utility sparse matrix multiplier for bi-conjugate gradient solver
CALAVB.f	Calculates vertical turbulent viscosity and diffusivity
CALBAL1.f	Calculates mass, momentum and energy balances
CALBAL2.f	Calculates mass, momentum and energy balances
CALBAL3.f	Calculates mass, momentum and energy balances
CALBAL4.f	Calculates mass, momentum and energy balances
CALBAL5.f	Calculates mass, momentum and energy balances
CALBUOY.f	Calculates buoyancy or density anomaly using UNESCO equation of state
CALCONC.f	Calculates scalar field (concentration) transport
CALCSER.f	Concentration time series processor
CALDIFF.f	Calculates horizontal diffusion of scalar fields
CALDISP2.f	Calculates time average horizontal shear dispersion tensor
CALDISP3.f	Calculates time average horizontal shear dispersion tensor
CALEBI.f	Calculates buoyancy integral in external mode equations
CALEXP.f	Calculates explicit terms in momentum equations
CALFQC.f	Calculates mass (scalar concentration field) sources and sinks
CALHDMF.f	Calculates horizontal diffusion in momentum equations

CALHEAT.f	Calculates surface and internal heat sources and sinks
CALHTA.f	Performs harmonic analysis for single frequency periodically forced flow
CALMMT.f	Calculates time mean mass transport field including Stokes' drift
CALPSER.f	Processes surface elevation time series
CALPUV.f	External mode solver for rigid lid or small surface displacement flows
CALPUV2.f	External mode solver for larger surface displacements, but no drying or wetting
CALPUV5.f	External mode solver for flows with drying and wetting and subgrid scale channels
CALPUV7.f	External mode solver for kinematic wave approximation
CALQQ1.f	Calculates transport of turbulent kinetic energy and length scale
CALQQ2.f	Calculates transport of turbulent kinetic energy and length scale (research version)
CALQVS.f	Processes volumetric source and sink time series
CALSED.f	Calculates cohesive sediment settling, deposition and resuspension
CALSED2.f	Calculates cohesive sediment settling, deposition and resuspension
CALSED3.f	Calculates noncohesive sediment settling, deposition and resuspension
CALSFT.f	Calculates diffusion, sources and sinks and vertical migration of shellfish larvae.
CALTBXY.f	Calculates bottom drag coefficients for bottom stress calculation and calculates certain vegetation resistance parameters.
CALTRAN.f	Calculates explicitly advective transport of scalar field concentration) variables
CALTRANI.f	Calculates implicit advective transport of scalar field concentration) variables
CALTRANQ.f	Calculates advective transport of turbulent kinetic energy and length scale
CALTRWQ.f	Calculates explicit advection of water quality variables

CALTSXY.f	Processes wind and atmospheric condition time series and calculates surface wind stress.
CALUVW.f	Solves the internal mode momentum equations and continuity equation
CALWQC.f	Calculates diffusion and sources and sinks of water quality variables
CBALEV1.f	Calculates mass, momentum and energy balances for even time steps
CBALEV2.f	Calculates mass, momentum and energy balances for even time steps
CBALEV3.f	Calculates mass, momentum and energy balances for even time steps
CBALEV4.f	Calculates mass, momentum and energy balances for even time steps
CBALEV5.f	Calculates mass, momentum and energy balances for even time steps
CBALOD1.f	Calculates mass, momentum and energy balances for odd time steps
CBALOD2.f	Calculates mass, momentum and energy balances for odd time steps
CBALOD3.f	Calculates mass, momentum and energy balances for odd time steps
CBALOD4.f	Calculates mass, momentum and energy balances for odd time steps
CBALOD5.f	Calculates mass, momentum and energy balances for odd time steps
CELLMAP.f	Maps I,J horizontal indexes to single L index
CELLMASK.f	Inserts barriers across cell flow faces
CGRS.f	Red-Black reduced system conjugated gradient solver for two-dimensional Helmholtz equation
CONGRAD.f	Diagonally preconditioned conjugated gradient solver for two-dimensional Helmholtz equation
DEPPLT.f	Generates file for bathymetry contouring in ASCII column format
DEPSMTH.f	Smooths bottom elevation and initial depth fields
DRIFTER.f	Releases and tracks Lagrangian drifters at specified times and locations
EFDC.f	Main program
FILTRAN.f	Performs vertical filtering of mean mass transport field

GLMRES.f	Calculates generalized Lagrangian mean velocities
HDMT.f	Controls hydrodynamic and mass transport solution
INPUT.f	Processes input files
LAGRES.f	Calculates Lagrangian mean velocities by forward trajectories
LINBCG.f	Bi-conjugate gradient linear equation solver
LSQHARM.f	Performs least squares harmonic analysis
LTMT.f	Controls mass transport only solution
LUBKSB.f	Back substitution utility for LU decomposition equation solver
LUDCMP.f	LU decomposition equation solver
LVELPLTH.f	Writes ASCII column files for visualization of Lagrangian mean velocity field in horizontal stretched layer
LVELPLTV.f	Writes ASCII column files for visualization of Lagrangian mean velocity field in vertical transects
OUT3D.f	Writes files for two-dimensional slice and three-dimensional volume visualization of vector and scalar fields in 8 bit ASCII integer format or 8 bit HDF integer format
OUTPUT1.f	Writes printer output files in crude printer character contouring form
OUTPUT2.f	Writes printer output files in crude printer character contouring form
PLOT.f	Processes printer character contour plots
REDKC.f	Reduces layers by 1/2 in mass transport only simulations (not active)
RELAX.f	Solve two-dimensional Helmholtz equation by Red-Black SOR (successive over relaxation)
RELAXV.f	A more vectorizable version of RELAX.f
RESTIN1.f	Reads restart.inp file for restarting a run
RESTIN10.f	Reads older versions of restart.inp
RESTIN2.f	Reads a K layer restart.inp file to initialize a 2*K layer simulation

RESTMOD.f	Reads restart.inp field and deactivates specified horizontal cell
RESTOUT.f	Writes restart file restart.out
RESTRAN.f	Reads transport file restran.inp for transport only simulations
ROUT3D.f	Writes files for two-dimensional slice and three-dimensional volume visualization of time mean vector and scalar fields in 8 bit ASCII integer format or 8 bit HDF integer format
RSALPLTH.f	Writes ASCII column files for time means scalar field visualization in horizontal stretched layers
RSALPLTV.f	Writes ASCII column files for time mean scalar field visualization in vertical transects
RSURFPLT.f	Writes ASCII column file for visualization of time mean surface displacement field
RVELPLTH.f	Writes ASCII column files for visualization of time mean velocity field in horizontal stretched layers
RVELPLTV.f	Writes ASCII column files for visualization of time mean velocity field in vertical transects
SALPLTH.f	Writes ASCII column files for instantaneous scalar field visualization in horizontal stretched layers
SALPLTV.f	Writes ASCII column files for instantaneous scalar field visualization in vertical transects
SALTSMTH.f	Smooths or interpolates an initial salinity field for cold start runs
SECNDS.f	Emulates VMS library function secnds on compilers not supporting this function. This is the only optional subroutine in the code and is normally appended to the end of the efdc.f file for compilation on certain UNIX and Intel based PC compilers.
SETBCS.f	Set horizontal boundary conditions
SHOWVAL.f	Writes screen display of instantaneous conditions at a specified horizontal location
SNRM.f	Computes error norm for bi-conjugate gradient equation solver
SURFPLT.f	Writes ASCII column files for instantaneous surface displacement

	visualization
SVBKSB.f	Back substitution utility of SVD equation solver
SVDCMP.f	SVD (Singular value decomposition) linear equation solver
TMSR.f	Writes time series files
VALKH.f	Real function subroutine to solve high frequency surface gravity wave dispersion relationship for kh.
VELPLTH.f	Writes ASCII column files for visualization of instantaneous velocity field in horizontal stretched layer
VELPLTV.f	Writes ASCII column files for visualization of instantaneous velocity field in vertical transects
VMSLIB.f	Library of VMS system subroutines for the function SECNDS (required for compiling code on Power Macintosh Systems using Absoft FORTRAN compiler)
VSFP.f	Extracts and writes files of vertical scalar field profiles at specified times and locations to mimic field sampling
WASP4.f	Writes grid and transport files to drive the WASP4 water quality simulation model
WASP5.f	Writes grid and transport files to drive the WASP5 water quality simulation model
WASP6.f	Writes grid and transport files to drive the WASP5 water quality simulation model as modified by Tetra Tech, Inc. Fairfax, VA.
WAVE.f	Processes input high frequency surface gravity field specified in file wave.inp for calculating near bottom wave velocities for the wave-current bottom boundary layer formulation and/or calculating the three-dimensional wave Reynolds' stress and wave Stokes' drift for wave induced current simulation.

Appendix B. EFDC Grid Generation Examples

This appendix contains a number of example grids generated by the *gefdc.f* grid generating preprocessor code. Each sub section contains a plot of the grid in physical space and images of the *cell.inp* and *gefdc.inp* files.

B.1 Lake Okeechobee, Florida

This section describes a 1 kilometer square cell Cartesian grid of Lake Okeechobee, Florida. The physical domain grid is shown in Figure B1, the *cell.inp* file in Figure B2, and the *gefdc.inp* file in Figure B3. The grid was generated with the $NTYPE = 0$, option by *gefdc.f*. A FORTRAN program for the generation of the *gridext.inp* file is shown in Figure B4. It is noted that for square cell grids, the physical and computational domains are geometrically identical and differ by a scale factor equal to the cell side length, which in this case is 1 kilometer.

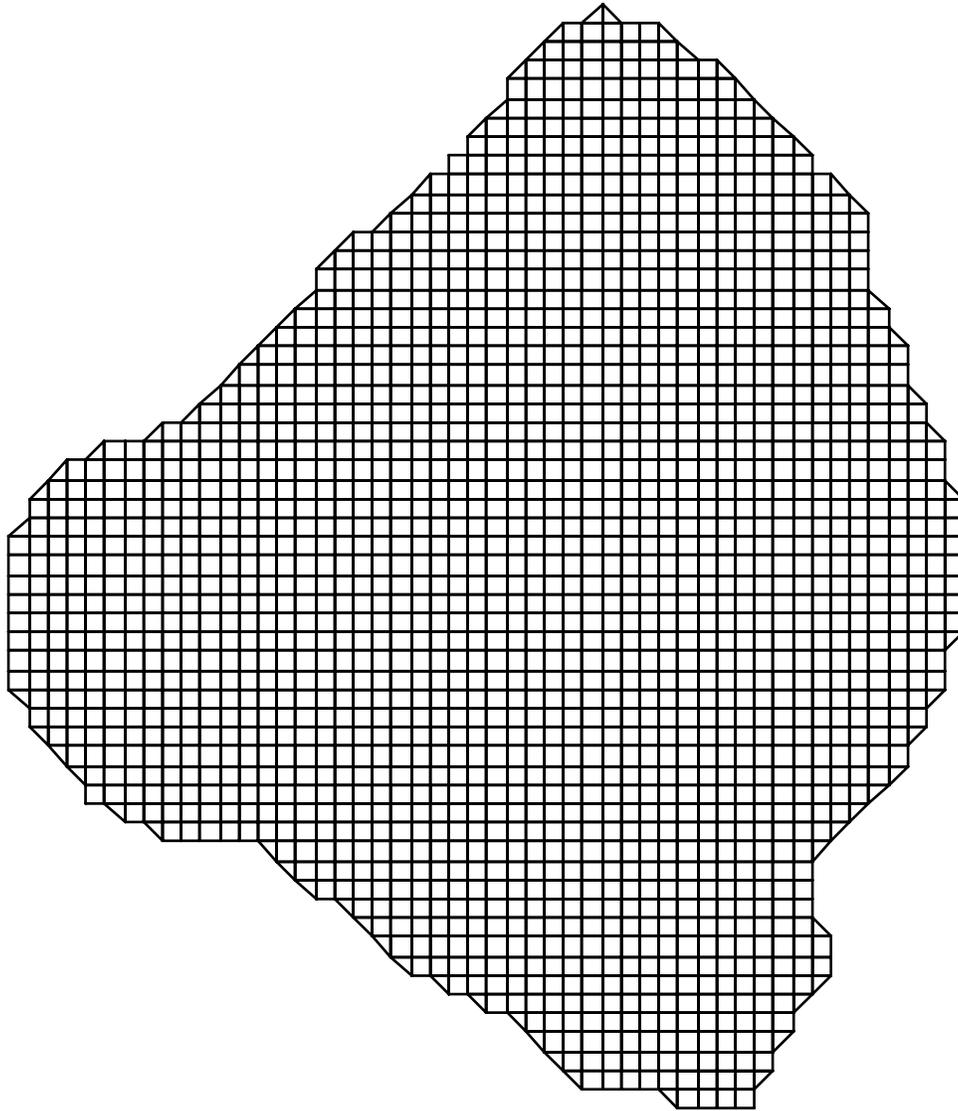


Figure B1. Physical and computational domain grid of Lake Okeechobee, Florida. Grid spacing is 1000 meters.


```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    lake okeechobee
C2 INTEGER INPUT
C2 NTYPE NBPP IMIN IMAX JMIN JMAX IC JC
    0      0      1    54    1    62   54  62
C3 GRAPHICS GRID INFORMATION
C3 ISGG IGM JGM DXCG DYCG NWTGG
    0     96  180 1850. 1850.  1
C4 CARTESION AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
    -77.5  1.25   -0.625 36.7   1.0   -0.5
C5 INTEGER INPUT
C5 ITRXM ITRHM ITRKM ITRGM NDEPSM DEPMIN
    100    100    100    100   4000   1.0
C6 REAL INPUT
C6 RPX RPK RPH RSQXM RSQKM RSQKIM RSQHM RSQHIM RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12  1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT YSHIFT HSCALE RKJDKI ANGORO
    0.      0.      1000.  1.      15.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI JSIRKI ISIHJHJ JSIHJHJ
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB IE JB JE N7RLX NXYIT ITN7M IJSMD ISMD JSMD RP7 SERRMAX
C10 NTYPE = 7 SPECIFID INPUT
C10 X Y IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP RADM ISIDPTYP SURFELV ISVEG NVEGDAT NVEGTYP
    1      1799   2.  .5    2      5.0    0    0    0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT JLT X(ILT,JLT) Y(ILT,JLT)
    0  0  0.0    0.0
C13 BOUNDARY POINT INFORMATION
C13 I J X(I,J) Y(I,J)

```

Figure B3. File gefdc.inp for Lake Okeechobee.

```
PROGRAM GENGRID
OPEN(1,FILE='gridext.inp',STATUS='UNKNOWN')
DO J=1,62
DO I=1,54
X=FLOAT(I-1)
Y=FLOAT(J-1)
WRITE(1,100) I, J, X, Y
END DO
END DO
100 FORMAT(2I5,2(2X,F12.3))
CLOSE(1)
STOP
END
```

Figure B4. FORTRAN program for generation of the gridext.inp file for the Lake Okeechobee grid shown in Figure B1.

B.2 Kings Creek and Cherry Stone Inlet, Virginia

This section describes a rectangular Cartesian grid of Kings Creek and Cherry Stone Inlet, located on the Eastern Shore of the Chesapeake Bay, north of Cape Charles, Virginia. The physical domain grid is shown in Figure B5, the cell.inp file in Figure B6, and the gefdc.inp file, Figure B7. The grid was generated with the NTYPE = 0, option by gefdc.f. The FORTRAN program for generation of the gridext.inp file is shown in Figure B8.

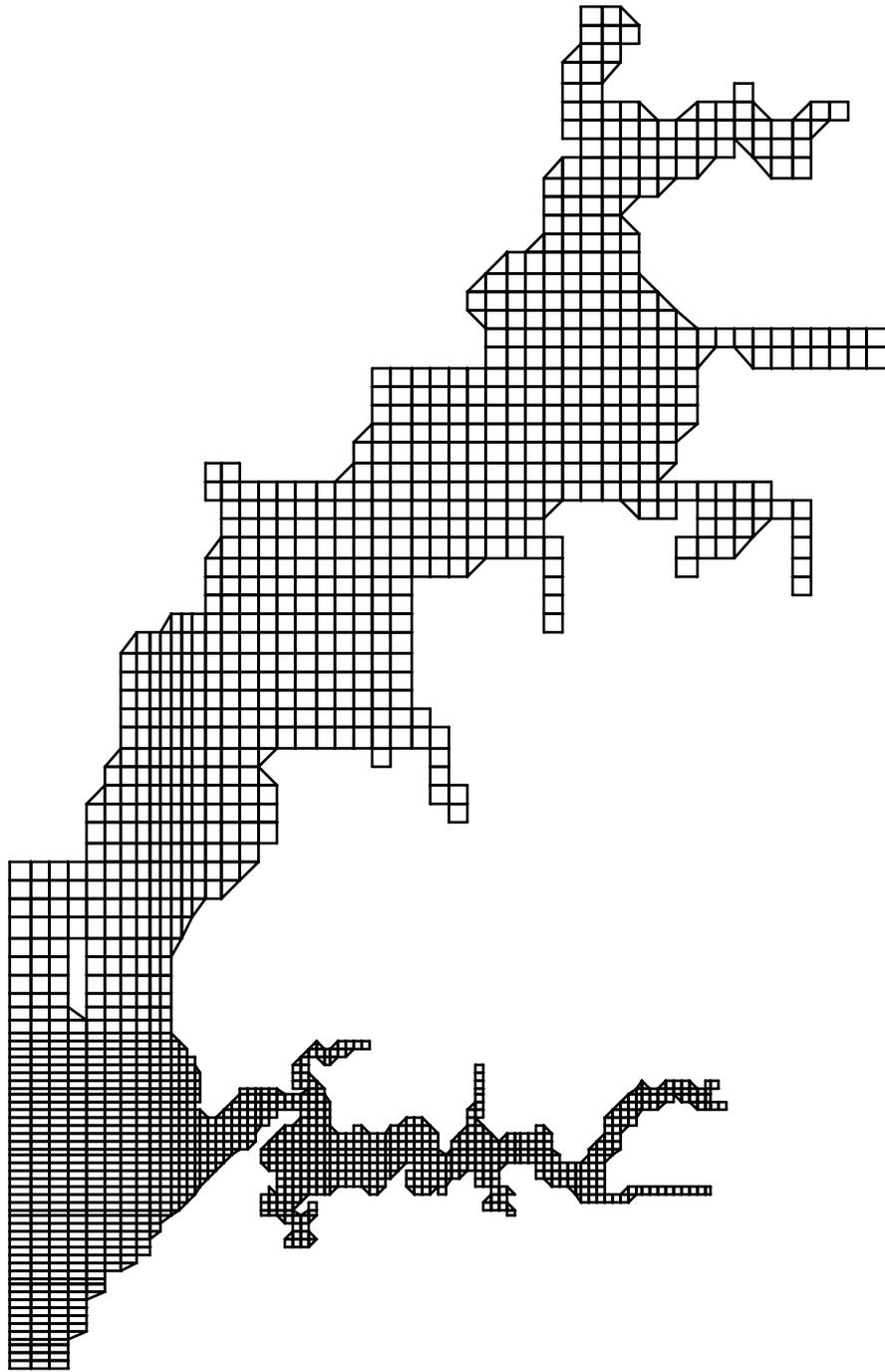


Figure B5. Physical domain grid of Kings Creek and Cherry Stone Inlet, Virginia. Grid spacing ranges from 40 to 100 Meters.

```

C cell.inp file, i columns and j rows, for Kings Creek and Cherry Stone Inlet
C          1          2          3          4          5          6          7          7          9
C 123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123
C
109 00000000000000000000000000000000000000000000099999000000000000000000000000000000000000000000000
108 00000000000000000000000000000000000000000000095519000000000000000000000000000000000000000000000
107 00000000000000000000000000000000000000000000099555900000000000000000000000000000000000000000000
106 00000000000000000000000000000000000000000000094555900000000000000000000000000000000000000000000
105 00000000000000000000000000000000000000000000095529000099900000000000000000000000000000000000000
104 00000000000000000000000000000000000000000000095599999959999900000000000000000000000000000000000
103 00000000000000000000000000000000000000000000095551945551945590000000000000000000000000000000000
102 00000000000000000000000000000000000000000000095555555555529900000000000000000000000000000000000
101 00000000000000000000000000000000000000000000099955555555559900000000000000000000000000000000000
100 00000000000000000000000000000000000000000000094555555529935590000000000000000000000000000000000
 99 00000000000000000000000000000000000000000000095555552999999900000000000000000000000000000000000
 98 00000000000000000000000000000000000000000000095555299900000000000000000000000000000000000000000
 97 00000000000000000000000000000000000000000000099555190000000000000000000000000000000000000000000
 96 00000000000000000000000000000000000000000000099945555900000000000000000000000000000000000000000
 95 00000000000000000000000000000000000000000000099455555990000000000000000000000000000000000000000
 94 00000000000000000000000000000000000000000000094555555199000000000000000000000000000000000000000
 93 00000000000000000000000000000000000000000000095555555519900000000000000000000000000000000000000
 92 00000000000000000000000000000000000000000000093555555551999999999900000000000000000000000000000
 91 00000000000000000000000000000000000000000000099555555555555555900000000000000000000000000000000
 90 0000000000000000000000000000000000000000000009999999555555555293555559000000000000000000000000000
 89 0000000000000000000000000000000000000000000009555555555555559999999999000000000000000000000000000
 88 00000000000000000000000000000000000000000000095555555555555590000000000000000000000000000000000
 87 00000000000000000000000000000000000000000000099555555555555900000000000000000000000000000000000
 86 00000000000000000000000000000000000000000000094555555555555529000000000000000000000000000000000
 85 00000000000000000000009999009955555555555555990000000000000000000000000000000000000000000000000
 84 00000000000000000000095599994555555555555555299999900000000000000000000000000000000000000000000
 83 00000000000000000955555555555555555555555599000000000000000000000000000000000000000000000000000
 82 00000000000000000995555555555555552999355955559000000000000000000000000000000000000000000000000
 81 00000000000000000995555555555555599099999552959000000000000000000000000000000000000000000000000
 80 00000000000000000945555555555555900095529959000000000000000000000000000000000000000000000000000
 79 00000000000000000955555555555552999590009599999990000000000000000000000000000000000000000000000
 78 00000000000000000955555555559999095900099900959000000000000000000000000000000000000000000000000
 77 00000000000009999955555555590000959000000000000000000000000099900000000000000000000000000000000
 76 00000000000999945555555555900009590000000000000000000000000000000000000000000000000000000000000
 75 00000000000945555555555555900009990000000000000000000000000000000000000000000000000000000000000
 74 00000000000955555555555559000000000000000000000000000000000000000000000000000000000000000000000
 73 00000000000955555555555559000000000000000000000000000000000000000000000000000000000000000000000
 72 00000000000955555555555559900000000000000000000000000000000000000000000000000000000000000000000
 71 00000000000955555555555559900000000000000000000000000000000000000000000000000000000000000000000
 70 00000000000995555555555559000000000000000000000000000000000000000000000000000000000000000000000
 69 00000000000945555555552999995995900000000000000000000000000000000000000000000000000000000000000
 68 00000000000995555555519009999599000000000000000000000000000000000000000000000000000000000000000
 67 00000000000945555555559000095590000000000000000000000000000000000000000000000000000000000000000
 66 00000000000955555555590000995900000000000000000000000000000000000000000000000000000000000000000
 65 00000000000955555555590000099900000000000000000000000000000000000000000000000000000000000000000
 64 00099999999555555559900000000000000000000000000000000000000000000000000000000000000000000000000
 63 00095555555555552900000000000000000000000000000000000000000000000000000000000000000000000000000
 62 00095555555555552990000000000000000000000000000000000000000000000000000000000000000000000000000
 61 00095555555555552999000000000000000000000000000000000000000000000000000000000000000000000000000
 60 00095555555555552990000000000000000000000000000000000000000000000000000000000000000000000000000
 59 00095555595555299000000000000000000000000000000000000000000000000000000000000000000000000000000
 58 00095555955559900000000000000000000000000000000000000000000000000000000000000000000000000000000
 57 00095555955559000000000000000000000000000000000000000000000000000000000000000000000000000000000
 56 00095555955559000000000000000000000000000000000000000000000000000000000000000000000000000000000
 55 00095555155559000000000000000000000000000000000000000000000000000000000000000000000000000000000

```

Figure B6a. File cell.inp for Kings Creek and Cherry Stone Inlet.


```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    Kings Creek and Cherry Stone Inlet
C2 INTEGER INPUT
C2 NTYPE  NBPP    IMIN  IMAX  JMIN  JMAX  IC   JC
    0      0      1     93   1     109  93  109
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     50  92  250.  250.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
    1.875  15.0    0.0     17.875  15.0    0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
    100    100    100    100    4000    0.2
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
    0.      0.      1000.  1.      5.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X   Y   IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
    1      545     2.  .5    1          0.0     0     0     0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
    1   1   0.0          0.0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)

```

Figure B7. File gefdc.inp for Kings Creek and Cherry Stone Inlet.

```

PROGRAM GVARCGRID
C
DIMENSION X(93,109),Y(93,109)
C
DO J=1,53
DO I=1,93
Y(I,J)=40.*FLOAT(J)+630.
END DO
END DO
C
DO I=1,93
Y(I,54)=2800.
Y(I,55)=2860.
Y(I,56)=2930.
Y(I,57)=3010.
END DO
C
DO J=58,109
DO I=1,93
Y(I,J)=100.*FLOAT(J-58)+3100.
END DO
END DO
C
DO J=1,109
DO I=1,14
X(I,J)=100.*FLOAT(I)
END DO
X(15,J)=1490.
X(16,J)=1580.
X(17,J)=1660.
X(18,J)=1730.
X(19,J)=1790.
X(20,J)=1840.
END DO
C
DO J=1,54
DO I=21,93
X(I,J)=40.*FLOAT(I-21)+1880.
END DO
END DO
C
DO J=55,109
X(21,J)=1890.
X(22,J)=1950.
X(23,J)=2020.
DO I=24,93
X(I,J)=100.*FLOAT(I-24)+2100.
END DO
END DO

```

Figure B8a. FORTRAN program for generation of gridext.inp file.

```

C
OPEN (1,FILE='gridext.inp',STATUS='UNKNOWN')
DO J=1,109
DO I=1,93
X(I,J)=(X(I,J)/1000.)+408.
Y(I,J)=(Y(I,J)/1000.)+124.
WRITE(1,20)I,J,X(I,J),Y(I,J)
END DO
END DO
CLOSE(1)

C
OPEN (1,FILE='maskij.dat',STATUS='UNKNOWN')
OPEN (2,FILE='shoremask',STATUS='UNKNOWN')
OPEN (3,FILE='shoredep',STATUS='UNKNOWN')
DEP=0.1
DO N=1,337
READ(1,*)J,I
WRITE(2,2000)X(I,J),Y(I,J)
IF(I.NE.6.OR.J.NE.10) THEN
WRITE(3,3000)X(I,J),Y(I,J),DEP
XTMP=X(I,J)+.01
YTMP=Y(I,J)+.01
WRITE(3,3000)X(I,J),YTMP,DEP
WRITE(3,3000)XTMP,Y(I,J),DEP
XTMP=X(I,J)-.01
YTMP=Y(I,J)-.01
WRITE(3,3000)X(I,J),YTMP,DEP
WRITE(3,3000)XTMP,Y(I,J),DEP
END IF
END DO
CLOSE(1)
CLOSE(2)
CLOSE(3)

C
20 FORMAT(2I5,2X,F12.6,2X,F12.6)
2000 FORMAT(2X,F12.6,2X,F12.6)
3000 FORMAT(2X,F12.6,2X,F12.6,2X,F6.2)

C
STOP
END

C

```

Figure B8b. Continuation of FORTRAN program for generation of gridext.inp file.

B.3 Rose Bay, Florida

This section describes a curvilinear orthogonal grid of Rose Bay, on the Halifax River, near New Smyrna Beach, Florida. The physical domain grid is shown in Figure B9, the cell.inp file in Figure B10, and the gefdc.inp file in Figure B11. The grid was generated with the NTYPE = 5, option by gefdc.f.

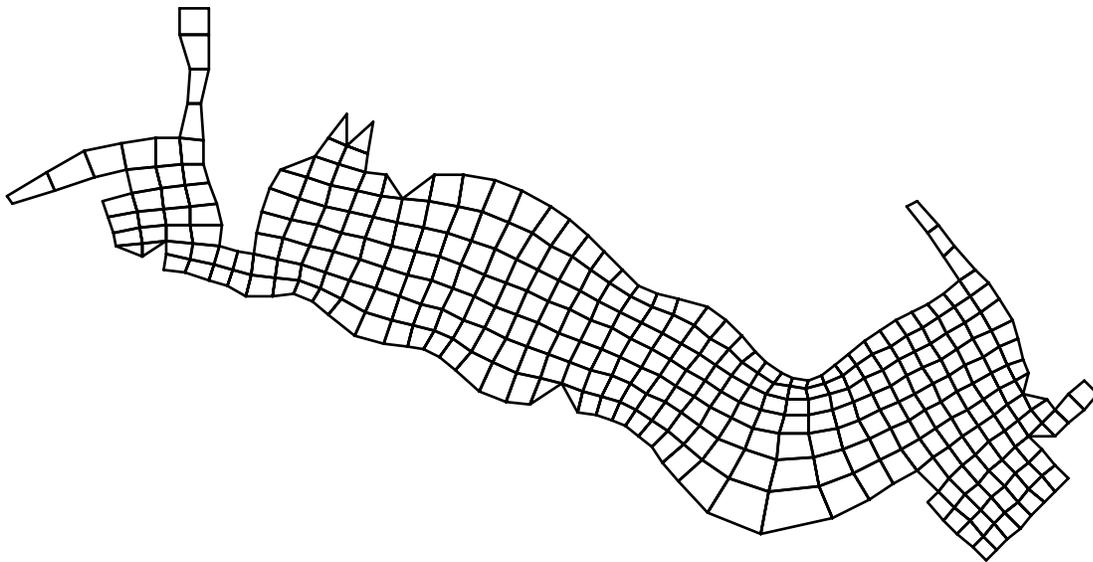


Figure B9. Physical domain grid of Rose Bay, Florida. Grid spacing ranges between approximately 20 and 90 meters.


```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    rose bay
C2 INTEGER INPUT
C2 NTYPE  NBPP  IMIN  IMAX  JMIN  JMAX  IC  JC
    5      148   1     50   1     25   50  25
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     96  180  1850. 1850. 1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
    -77.5  1.25  -0.625 36.7   1.0   -0.5
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM  DEPMIN
    100    100    100    100    1000    1.0
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12 1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
    0.      0.      1.      1.      9.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y    IN ORDER (IB,JB) (IE,JE) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
    1      62      2.  .5   1      5.0    0    0    0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
    40    6      1456.    16.
C13 BOUNDARY POINT INFORMATION
C13 I    J    X(I,J)    Y(I,J)
    39    6      1440.000    0.000
    39    7      1420.000    20.000
    39    8      1400.000    40.000
    39    9      1380.000    60.000
    39   10      1356.000    84.000
    40   10      1372.000   100.000
    40   11      1340.000   132.000
    39   11      1308.480   112.080
    38   11      1270.640    89.200
    37   11      1218.480    60.400

```

Figure B11a. File gefdc.inp for Rose Bay.

36	11	1116.000	40.000
35	11	1038.720	67.680
34	11	995.840	114.320
33	11	976.240	143.280
32	11	957.520	165.680
31	11	942.080	182.160
30	11	920.000	196.320
29	11	901.760	203.600
28	11	877.920	209.440
27	11	850.480	216.640
26	11	818.080	220.400
25	11	784.960	226.800
24	11	750.480	228.480
23	11	712.080	244.160
22	11	677.040	276.400
21	11	654.320	293.520
20	11	631.200	304.720
19	11	607.600	309.200
18	11	575.040	315.600
17	11	532.160	326.640
16	11	494.080	356.960
15	11	468.960	376.400
14	11	444.720	385.040
13	11	413.680	384.320
12	11	375.920	384.240
11	11	348.020	397.000
10	11	320.160	406.240
9	11	288.800	416.480
8	11	256.480	421.120
8	12	259.440	442.720
7	12	226.720	440.400
6	12	192.400	434.160
6	13	187.760	453.920
6	14	182.080	476.000
6	15	178.080	497.040
6	16	169.360	520.080
7	16	212.240	530.880
7	17	203.360	566.720
6	17	156.000	556.000
5	17	100.000	536.000
4	17	40.000	516.000
4	18	32.000	528.000
5	18	87.000	562.000
6	18	142.000	594.000
7	18	194.320	605.600
8	18	243.520	611.000

Figure B11b. Continuation of file gefdc.inp for Rose Bay.

9	18	280.000	611.000
9	19	290.000	660.000
9	20	294.000	710.000
9	21	280.000	760.000
9	22	280.000	800.000
10	22	320.000	800.000
10	21	320.000	760.000
10	20	320.000	710.000
10	19	310.000	660.000
10	18	312.000	610.000
10	17	315.440	573.680
10	16	321.840	547.200
10	15	331.440	516.880
10	14	338.800	487.040
10	13	336.480	456.960
11	13	362.960	447.280
12	13	384.560	442.880
12	14	389.120	473.280
12	15	396.720	504.720
12	16	408.320	538.480
12	17	423.920	567.040
12	18	441.600	598.960
13	18	475.000	585.000
13	19	492.000	612.000
13	20	520.000	647.000
14	20	540.000	640.000
15	20	560.000	633.000
15	19	552.000	590.000
15	18	547.000	564.000
16	18	575.920	559.360
17	18	605.520	558.400
18	18	644.800	557.360
19	18	689.200	558.000
20	18	734.800	551.120
21	18	773.280	536.080
22	18	812.560	512.800
23	18	840.080	493.440
24	18	866.880	470.800
25	18	891.920	447.920
26	18	915.920	422.080
27	18	941.200	399.840
28	18	967.200	386.160
29	18	998.400	378.960
30	18	1038.000	366.880
31	18	1066.320	348.640
32	18	1088.480	326.880

Figure B11c. Continuation of file gefdc.inp for Rose Bay.

33	18	1107.040	302.640
34	18	1124.320	285.680
35	18	1144.560	272.320
36	18	1162.480	264.800
37	18	1182.800	260.560
38	18	1204.640	266.640
39	18	1224.720	284.400
40	18	1240.640	298.880
41	18	1265.440	316.240
42	18	1289.040	333.440
43	18	1311.280	348.960
44	18	1332.960	360.480
45	18	1356.800	372.560
46	18	1379.280	388.240
47	18	1403.000	404.000
47	19	1380.000	440.000
47	20	1355.000	475.000
47	21	1326.000	512.000
48	21	1340.000	520.000
48	20	1370.000	485.000
48	19	1395.000	455.000
48	18	1425.920	422.800
48	17	1444.000	401.120
48	16	1460.880	379.840
48	15	1477.200	349.440
48	14	1488.240	320.480
48	13	1494.800	293.040
48	12	1501.680	272.640
48	11	1512.560	253.920
48	10	1528.400	235.040
48	9	1540.000	220.000
49	9	1560.000	240.000
50	9	1580.000	260.000
50	8	1600.000	240.000
49	8	1580.000	220.000
48	8	1560.000	200.000
47	8	1540.000	180.000
46	8	1520.000	160.000
46	7	1540.000	140.000
46	6	1560.000	120.000
45	6	1541.000	101.000
44	6	1523.000	83.000
43	6	1505.500	65.500
42	6	1488.500	48.500
41	6	1470.000	32.000
40	6	1456.000	16.000

Figure B11d. Continuation of file gefdc.inp for Rose Bay.

B.4 Indian River Lagoon, Florida

This section describes the construction of a composite grid of a section of the Indian River Lagoon, near Melbourne, Florida, from five subgrids. Figures B 12-B14 show the composite grid, and the corresponding cell.inp and gefdc.inp files. The composite grid was generated with the NTYPE = 0 option by gefdc.f. The input file, gridext.inp, specifying the composite grid was formed by combining the five gridext.out files generated for the five subgrid regions. Figure B15&B16, B17&B18, B19&B20, B21&B22, and B23&B24 show the subgrids and the corresponding gefdc.inp files. The cell.inp file for each sub grid is similar to the cell.inp file shown in Figure B13, with only the water cells in the particular subgrid activated. The first subgrid, Figures B15&B16, and the fourth subgrid, Figure B21&B22, were generated with the NTYPE = 0 option. The remaining subgrids are curvilinear-orthogonal and were generated with the NTYPE = 5 option.

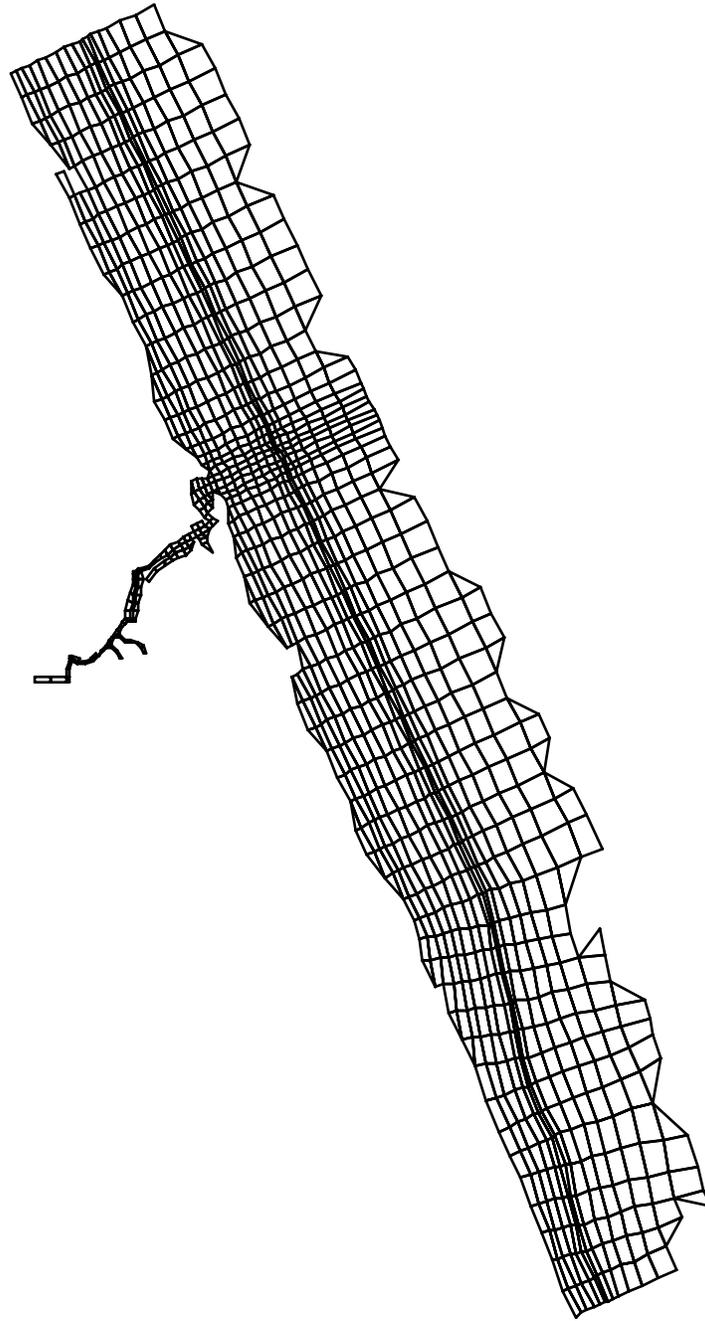


Figure B12. Grid of a section of the Indian River Lagoon near Melbourne, FL. Grid is a composite of five subgrids.


```
20 00000000009990000000000000000000095555555555555555529
19 00000000000000000000000000000000093555555555555555519
18 0000000000000000000000000000000009935555555555555559
17 000000000000000000000000000000000995555555555555559
16 0000000000000000000000000000000009555555555555555299
15 0000000000000000000000000000000009555555555555555990
14 0000000000000000000000000000000009355555555555555490
13 0000000000000000000000000000000009995555555555555599
12 000000000000000000000000000000000935555555555555519
11 00000000000000000000000000000000099355555555555559
10 00000000000000000000000000000000099955555555555559
9 0000000000000000000000000000000009555555555555559
8 0000000000000000000000000000000009555555555555529
7 0000000000000000000000000000000009555555555555519
6 000000000000000000000000000000000955555555555559
5 000000000000000000000000000000000955555555555559
4 0000000000000000000000000000000009555555555555539
3 0000000000000000000000000000000009555555555555299
2 0000000000000000000000000000000009555555555555990
1 0000000000000000000000000000000009999999999999900
```

Figure B13b. Continuation of File cell.inp for the Indian River Lagoon grid shown in Figure B12.

```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    Indian River Lagoon
C2 INTEGER INPUT
C2 NTYPE  NBPP  IMIN  IMAX  JMIN  JMAX  IC  JC
    0      0     1    54   1    60   54  60
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    1    50  92  250.  250.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
    1.875  15.0  0.0    17.875  15.0  0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
    100    100    100    100    1000
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
    0.      0.      1000.  1.      5.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJH  JSIHJH
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X  Y  IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
    1      995     2.  .5    3          0.3517  0      0      0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
    1  1  0      0
C13 BOUNDARY POINT INFORMATION
C13 I  J  X(I,J)  Y(I,J)

```

Figure B14. File gefdc.inp for the Indian River Lagoon grid shown in Figure B12.

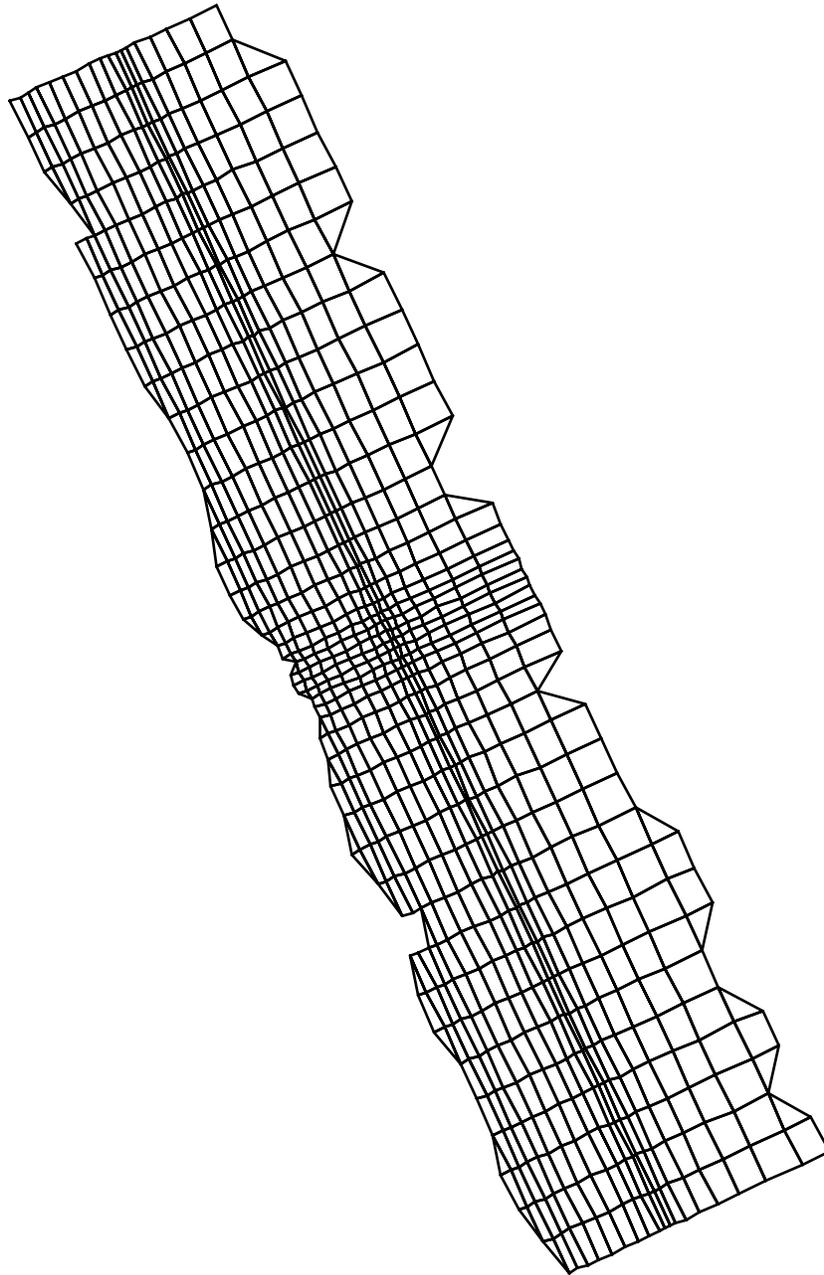


Figure B15. Subgrid 1 of the Indian River Lagoon grid shown in Figure B12. This grid is a variable spacing Cartesian grid generated with $NTYPE = 0$, option by gefdc.f.

```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
   Indian River Lagoon, sub grid 1
C2 INTEGER INPUT
C2 NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
   0      146    1     54   1     60   54   60
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
   0     50   92  250.  250.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
   1.875  15.0   0.0    17.875  15.0   0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
   100    100    100    100    1000
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
   1.8  1.8  1.8  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
   0.       0.       1000.   1.       1.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
   0       0       1       0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X   Y   IN ORDER (IB,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
   0       896     2.   .5    3         0.35    0     0         0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
   0    0    0.0         0.0
C13 BOUNDARY POINT INFORMATION
C13 I   J   X(I,J)  Y(I,J)

```

Figure B16. File gefdc.inp for subgrid 1, shown in Figure B15.

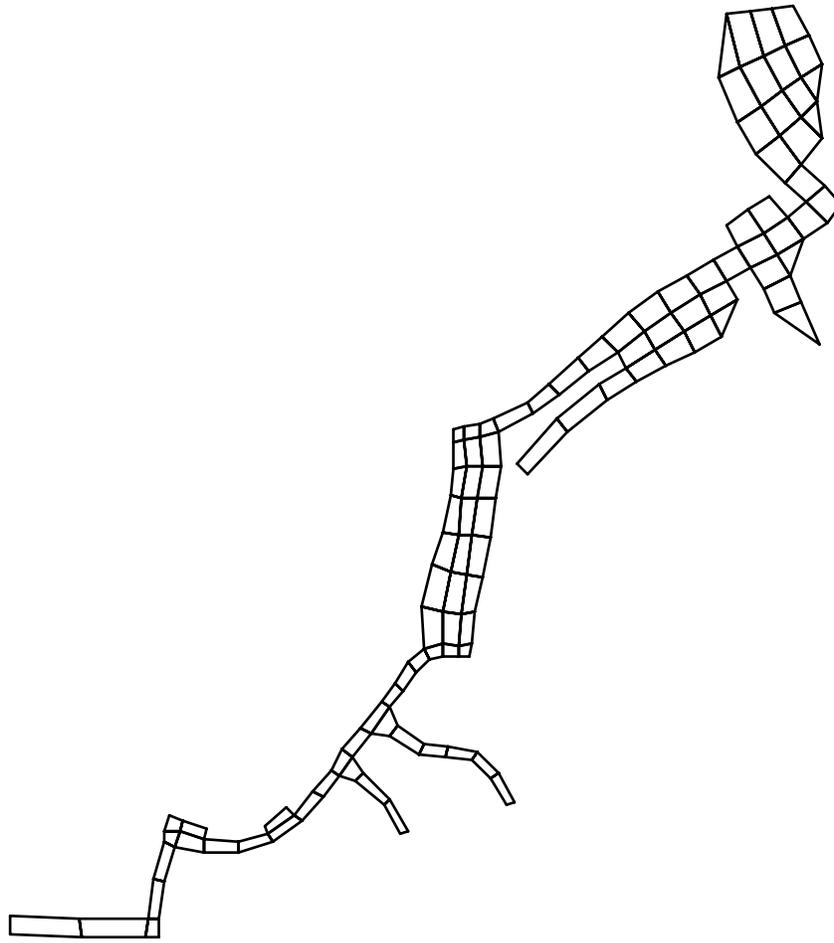


Figure B17. Subgrid 2 of the Indian River Lagoon grid shown in Figure B10. This grid is a curvilinear-orthogonal grid generated with $N_{TYPE} = 5$.

```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    Indian River Lagoon, Subgrid 2
C2 INTEGER INPUT
C2 NTYPE  NBPP  IMIN  IMAX  JMIN  JMAX  IC  JC
    5      140   1    54   1    60   54  60
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0    50   92  250.  250.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
    1.875  15.0   0.0   17.875  15.0   0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
    100    100    100    100    1000
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
    0.      0.      1000.   1.      10.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y    IN ORDER (IB,JB) (IE,JE) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
    0      1054    2.  .5    3      0.167  0    0    0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
    36  39  5.416584  32.868687
C13 BOUNDARY POINT INFORMATION
C13 I    J    X(I,J)  Y(I,J)
    36  38  5.458846  32.778057
    36  37  5.501108  32.687428
    35  37  5.446730  32.662067
    35  36  5.514679  32.611004
    34  36  5.459079  32.540939
    33  36  5.396529  32.462120
    33  35  5.468399  32.390812
    33  34  5.520639  32.337936
    32  34  5.476520  32.278748

```

Figure B18a. File gefdc.inp for subgrid 2, shown in Figure B17.

31	34	5.403405	32.222584
31	33	5.452924	32.151886
30	33	5.364405	32.105095
30	32	5.395795	32.025944
30	31	5.452544	31.892416
29	31	5.370976	31.854382
29	32	5.312114	31.992439
29	33	5.276192	32.069473
29	34	5.239964	32.135338
28	34	5.165042	32.094883
28	33	5.199157	32.033554
28	32	5.235079	31.956518
27	32	5.148980	31.916368
26	32	5.060462	31.869576
25	32	4.971944	31.822783
24	32	4.878895	31.773876
23	32	4.790073	31.715906
22	32	4.664386	31.618679
21	32	4.537784	31.487925
21	33	4.500639	31.520256
22	33	4.625128	31.655542
23	33	4.762297	31.763639
24	33	4.846588	31.819498
24	34	4.818812	31.867229
23	34	4.725458	31.807148
22	34	4.636329	31.738003
21	34	4.549620	31.675501
20	34	4.440557	31.613609
20	33	4.451099	31.508188
20	32	4.437174	31.407907
20	31	4.415995	31.287693
20	30	4.396928	31.162949
20	29	4.373633	31.047266
20	28	4.360015	30.948162
20	27	4.355037	30.905406
19	27	4.318927	30.908500
18	27	4.269384	30.905899
17	27	4.226488	30.901413
16	27	4.189625	30.862158
15	27	4.145506	30.802967
14	27	4.103806	30.750420
14	26	4.131277	30.691509
14	25	4.207983	30.633492
14	24	4.287153	30.627129
14	23	4.375015	30.606558

Figure B18b. Continuation of file gefdc.inp for subgrid 2, shown in Figure B17.

14	22	4.447190	30.546427
14	21	4.496096	30.453379
13	21	4.473438	30.442812
13	22	4.424227	30.524685
13	23	4.358696	30.582397
13	24	4.280768	30.595711
13	25	4.198070	30.602991
13	26	4.103477	30.656477
13	27	4.043370	30.667067
12	27	3.989883	30.592476
12	26	4.019771	30.540209
12	25	4.100399	30.461952
12	24	4.158063	30.361954
11	24	4.135406	30.351387
11	25	4.086499	30.444435
11	26	3.996809	30.518467
11	27	3.945765	30.533283
10	27	3.894697	30.465336
9	27	3.830034	30.391047
8	27	3.734261	30.324322
7	27	3.626115	30.295958
6	27	3.518578	30.289949
5	27	3.425249	30.312630
5	26	3.393198	30.203899
5	25	3.376549	30.085796
5	24	3.377136	30.025385
4	24	3.339077	30.024187
3	24	3.133373	30.027571
2	24	2.909850	30.033678
2	25	2.909263	30.094091
3	25	3.128256	30.085871
4	25	3.345134	30.082182
4	26	3.362088	30.211458
4	27	3.392026	30.324722
4	28	3.397473	30.360365
4	29	3.414402	30.406878
5	29	3.451852	30.390721
6	29	3.531892	30.367876
6	28	3.521913	30.330122
7	28	3.629143	30.324955
8	28	3.723696	30.346979
8	29	3.711017	30.374166
9	29	3.775374	30.437279
9	28	3.805872	30.407366
10	28	3.863892	30.484074
11	28	3.919492	30.554134

Figure B18c. Continuation of file gefdc.inp for subgrid 2, shown in Figure B17.

12	28	3.956964	30.615744
13	28	4.008034	30.683691
14	28	4.077534	30.771271
15	28	4.117120	30.828348
16	28	4.159126	30.892069
17	28	4.209583	30.937666
17	29	4.204185	31.067553
17	30	4.236845	31.198639
17	31	4.273123	31.298307
17	32	4.296415	31.413992
17	33	4.300971	31.498867
17	34	4.302171	31.581327
17	35	4.301000	31.623074
18	35	4.338164	31.632065
19	35	4.384400	31.645300
20	35	4.430603	31.658621
21	35	4.532715	31.711754
22	35	4.605831	31.767914
23	35	4.695264	31.848236
24	35	4.773217	31.917688
25	35	4.855700	31.989252
26	35	4.944829	32.058399
27	35	5.035765	32.111835
28	35	5.124283	32.158630
29	35	5.199204	32.199085
29	36	5.160864	32.269474
30	36	5.227030	32.316879
31	36	5.295308	32.359753
31	35	5.356001	32.288750
32	35	5.408877	32.340988
32	36	5.347880	32.400818
32	37	5.254269	32.495087
32	38	5.196604	32.595085
32	39	5.135629	32.737679
32	40	5.082215	32.911377
33	40	5.163478	32.938236
34	40	5.232954	32.943050
35	40	5.306961	32.949978
36	40	5.374322	32.959320
36	39	5.416584	32.868687

Figure B18d. Continuation of file gefdc.inp for subgrid 2, shown in Figure B17.

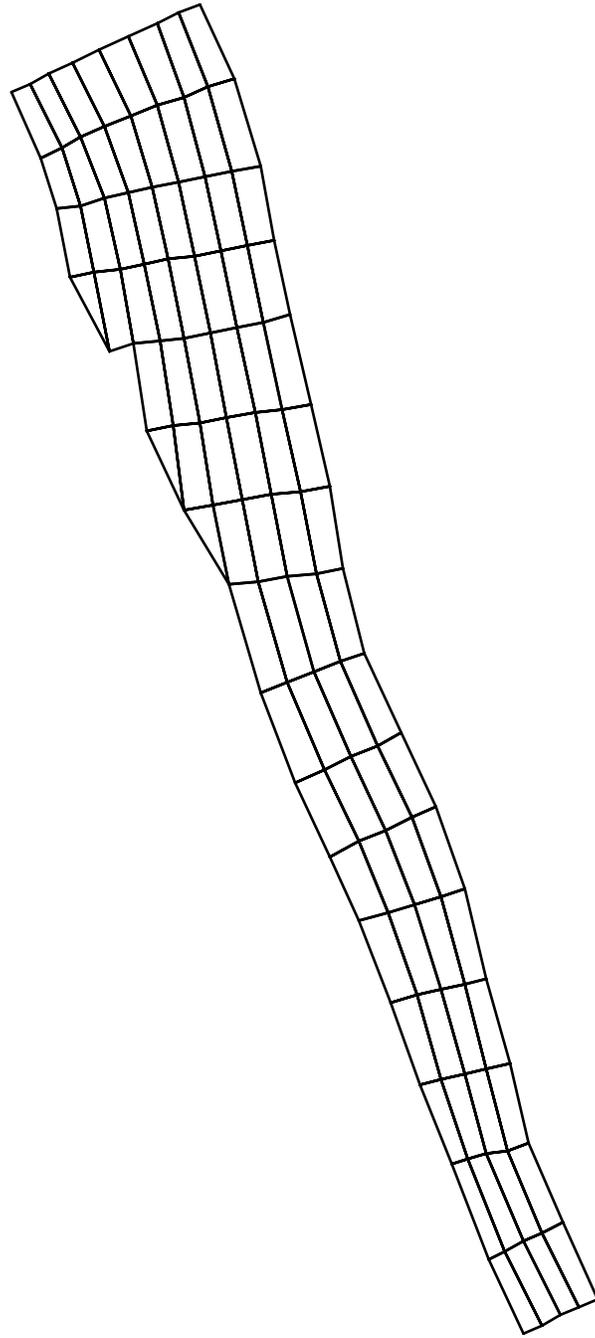


Figure B19. Subgrid 3 of the Indian River Lagoon grid shown in Figure B12. This grid is a curvilinear-orthogonal grid generated with $N_{TYPE} = 5$.

```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    Indian River Lagoon, Sub Grid 3
C2 INTEGER INPUT
C2 NTYPE  NBPP  IMIN  IMAX  JMIN  JMAX  IC  JC
    5      48    1     54    1     60   54  60
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     50   92  250.  250.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
    1.875  15.0   0.0    17.875  15.0   0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
    200    200    200    200    1000
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12 1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
    0.      0.      1000.   1.      5.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X  Y  IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
    0      896      2.  .5   3          0.167  0      0      0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
    41   2   10.771623   20.911531
C13 BOUNDARY POINT INFORMATION
C13 I  J  X(I,J)  Y(I,J)
    40  2   10.680992   20.869270
    40  3   10.511944   21.231794
    40  4   10.332051   21.688562
    40  5   10.185966   22.072828
    40  6   10.044719   22.470383
    40  7    9.894407   22.863710
    40  8    9.746491   23.180916
    40  9    9.581670   23.534378
    40 10    9.410230   23.973021
    40 11    9.254519   24.496237

```

Figure B20a. File gefdc.inp for subgrid 3, shown in Figure B19.

39	11	9.088380	24.473932
39	12	9.040770	24.859980
38	12	8.901817	24.850355
38	13	8.859043	25.249693
38	14	8.798752	25.662931
37	14	8.681543	25.630342
36	14	8.573397	25.601980
36	15	8.490144	25.993475
36	16	8.427410	26.317305
36	17	8.353781	26.569849
36	18	8.205865	26.887056
37	18	8.296495	26.929317
38	18	8.387127	26.971581
39	18	8.500415	27.024408
40	18	8.636361	27.087799
41	18	8.772307	27.151192
42	18	8.908255	27.214586
43	18	9.021543	27.267414
44	18	9.112172	27.309675
44	17	9.281219	26.947151
44	16	9.412794	26.523020
44	15	9.479142	26.167774
44	14	9.558780	25.807695
44	13	9.654101	25.366657
44	12	9.746417	24.979389
44	11	9.811546	24.579441
44	10	9.916542	24.164982
44	9	10.098267	23.775270
44	8	10.263088	23.421810
44	7	10.404335	23.024256
44	6	10.508718	22.587444
44	5	10.613714	22.172985
44	4	10.706031	21.785717
44	3	10.874467	21.400841
44	2	11.043514	21.038317
43	2	10.952884	20.996056
42	2	10.862254	20.953794
41	2	10.771623	20.911531

Figure B20b. Continuation of file gefdc.inp for sub grid 3, shown in Figure B19.

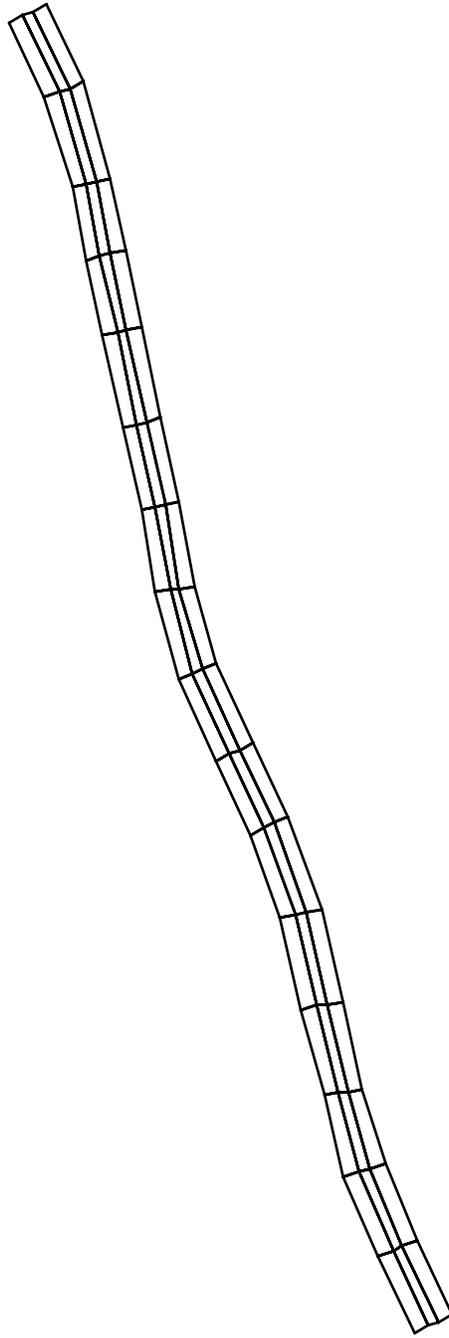


Figure B21. Subgrid 4 of the Indian River Lagoon grid shown in Figure B12. This grid is a curvilinear-orthogonal grid generated with $N_{TYPE} = 0$.

```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    Indian River Lagoon, Subgrid 4
C2 INTEGER INPUT
C2 NTYPE  NBPP  IMIN  IMAX  JMIN  JMAX  IC  JC
    0      0    1     54   1     60   54  60
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0    50   92  250.  250.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
    1.875  15.0   0.0    17.875  15.0   0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
    100    100    100    100    1000
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12 1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
    0.      0.      1000.   1.      7.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X  Y  IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
    0      1054    2.  .5    3          0.167  0    0    0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
    1    1    0.0        0.0
C13 BOUNDARY POINT INFORMATION
C13 I  J  X(I,J)  Y(I,J)

```

Figure B22. File gefdc.inp for subgrid 4, shown in Figure B21, generated with NTYPE = 0.

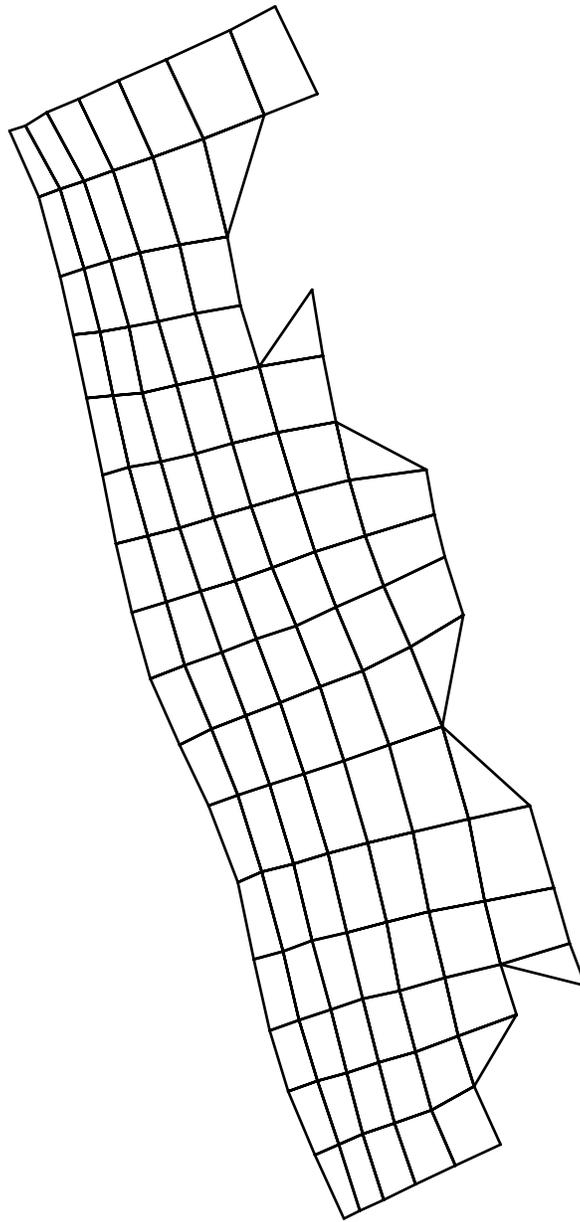


Figure B23. Subgrid 5 of the Indian River Lagoon grid shown in Figure B12. This grid is a curvilinear-orthogonal grid generated with $N_{TYPE} = 5$.

```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
    Indian River Lagoon, Subgrid 5
C2 INTEGER INPUT
C2 NTYPE  NBPP  IMIN  IMAX  JMIN  JMAX  IC  JC
    5      50   1     54   1     60   54  60
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
    0     50   92  250.  250.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1  CDLON2  CDLON3  CDLAT1  CDLAT2  CDLAT3
    1.875  15.0    0.0     17.875  15.0    0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
    100    100    100    100    1000
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
    1.8  1.8  1.8  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12  1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
    0.      0.      1000.  1.      5.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
    1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X  Y  IN ORDER (IB,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
    0      1054    2.  .5  3      0.167  0  0  0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
    48   2  11.315408  21.165104
C13 BOUNDARY POINT INFORMATION
C13 I  J  X(I,J)  Y(I,J)
    47  2  11.224776  21.122841
    47  3  11.055729  21.485365
    47  4  10.909035  21.847277
    47  5  10.797980  22.203743
    47  6  10.702049  22.622427
    47  7  10.606728  23.063465
    47  8  10.444349  23.506332
    47  9  10.279528  23.859795
    47 10  10.102028  24.240444

```

Figure B24a. File gefdc.inp for subgrid 5, shown in Figure B23, generated with NTYPE = 5.

47	11	9.995811	24.610197
47	12	9.917395	25.014980
47	13	9.829916	25.415539
47	14	9.738821	25.847515
47	15	9.664020	26.220884
47	16	9.592834	26.562840
47	17	9.466708	27.022612
47	18	9.293435	27.394197
48	18	9.384066	27.436460
49	18	9.520012	27.499853
50	18	9.701274	27.584377
51	18	9.927851	27.690031
52	18	10.199742	27.816816
53	18	10.562265	27.985865
54	18	10.834159	28.112650
54	17	11.070825	27.605118
53	17	10.763290	27.483780
53	16	10.961871	26.892284
52	16	10.556476	26.791515
52	15	10.621604	26.391569
53	15	11.044516	26.478437
53	14	11.101190	26.096615
54	14	11.559133	26.155685
54	13	11.637548	25.750900
54	12	11.696055	25.436136
54	11	11.747332	25.184202
54	10	11.807670	24.936493
54	9	11.919335	24.602381
54	8	12.111296	24.096069
54	7	12.300815	23.500349
54	6	12.431167	23.031511
54	5	12.529542	22.702236
54	4	12.621296	22.458145
53	4	12.223131	22.294544
53	3	12.324560	22.077030
52	3	11.974715	21.880795
52	2	12.131084	21.545460
51	2	11.859191	21.418674
50	2	11.632614	21.313019
49	2	11.451354	21.228497
48	2	11.315408	21.165104

Figure B24b. Continuation of file gefdc.inp for subgrid 5, shown in Figure B23, generated with NTYPE = 5.

B.5 SFWMD Water Conservation Area 2A, Florida

This section describes a curvilinear-orthogonal grid of the South Florida Water Management District's Water Conservation Area 2A southwest of West Palm Beach, Florida. The physical domain grid is shown in Figure B25, the cell.inp file in Figure B26, and the gefdc.inp file in Figure B27. The Cartesian graphic grid overlay file, gcell.inp, is shown in Figure B28, and its equivalent square cell Cartesian grid is shown in Figure B29. The main portion of the curvilinear grid, excluding the lower four cells is based on a quasi-conformal mapping using the $NTYPE = 7$, option by gefdc.f. The four lower cells were then appended to the grid by hand. The four boundary function subroutines required by the $NTYPE = 7$, option are shown in Figure B30-B33.

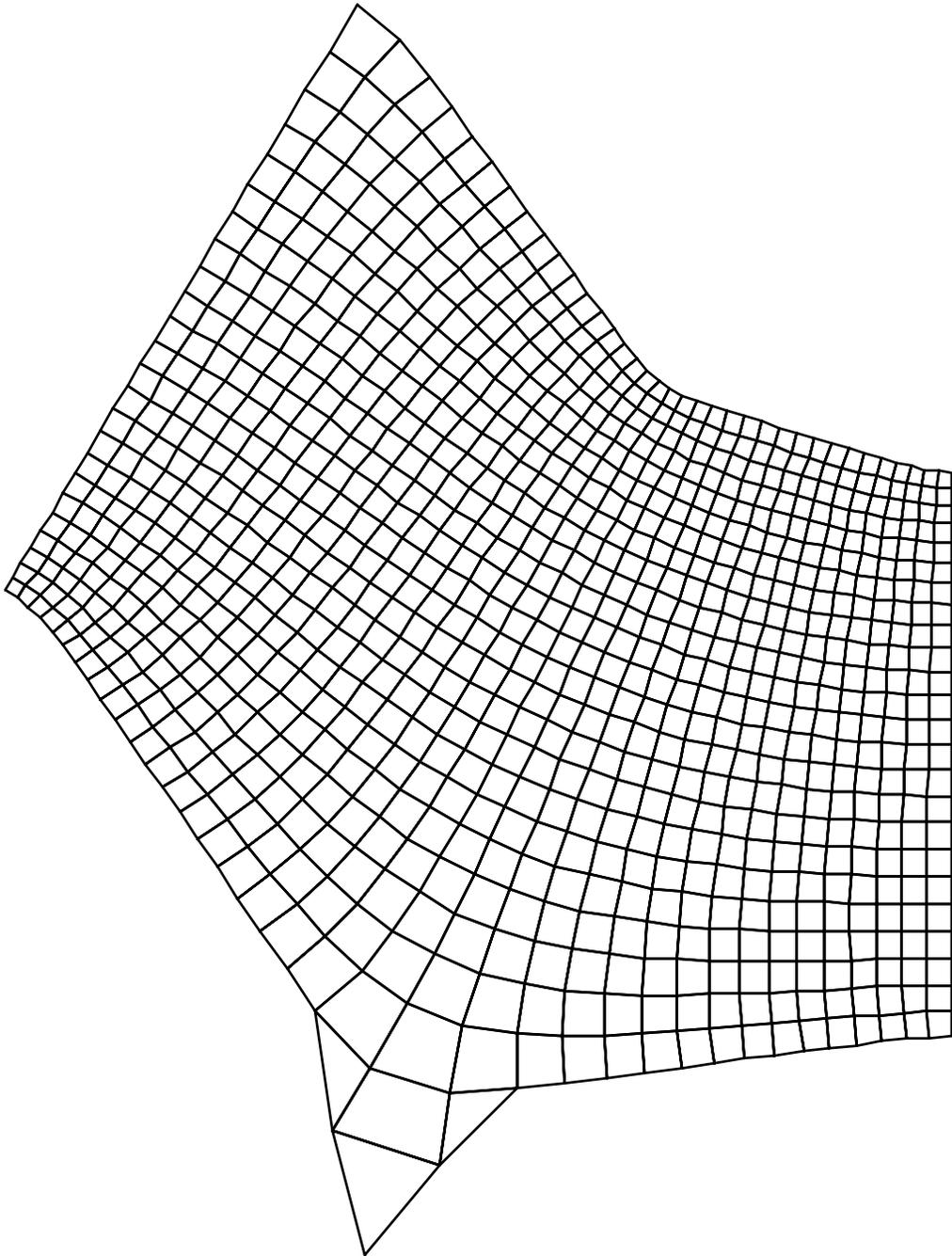


Figure B25. Physical domain grid of SFWMD's Water Conservation Area 2A. Grid spacing ranges from approximately 400 to 2500 meters.


```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
   SWFWMD WCA2A
C2 INTEGER INPUT
C2 NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
   7      106   1     38   1     28   38   28
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  NWTGG
   1     44  55  600.  600.  1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
   5.1    36.0   0.0    3.9    36.0   0.0
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM  NDEPSM
   100    100   100    100   1000
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
   1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12 1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
   0.       0.       1000.   1.       5.04
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
   0        0        1        0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  N7RLX  NXYIT  ITN7M  IJSMD  ISMD  JSMD  RP7  SERRMAX
   2  38  4  28  1000  1      500   0     0    26  1.0  1.E-8
C10 NTYPE = 7 SPECIFIED INPUT
C10 X    Y    IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
   6.76  20.6
   31.   9.1
   31.  23.6
  15.76 35.6
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP NDEPDAT CDEP  RADM  ISIDPTYP  SURFELV  ISVEG  NVEGDAT  NVEGTYP
   1      783    2.   .5   2          4.00    1     10710   12
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
   1    1  0.0          0.0
C13 BOUNDARY POINT INFORMATION
C13 I    J    X(I,J)    Y(I,J)

```

Figure B27. File gefdc.inp for WCA2A Grid Shown in Figure B25.

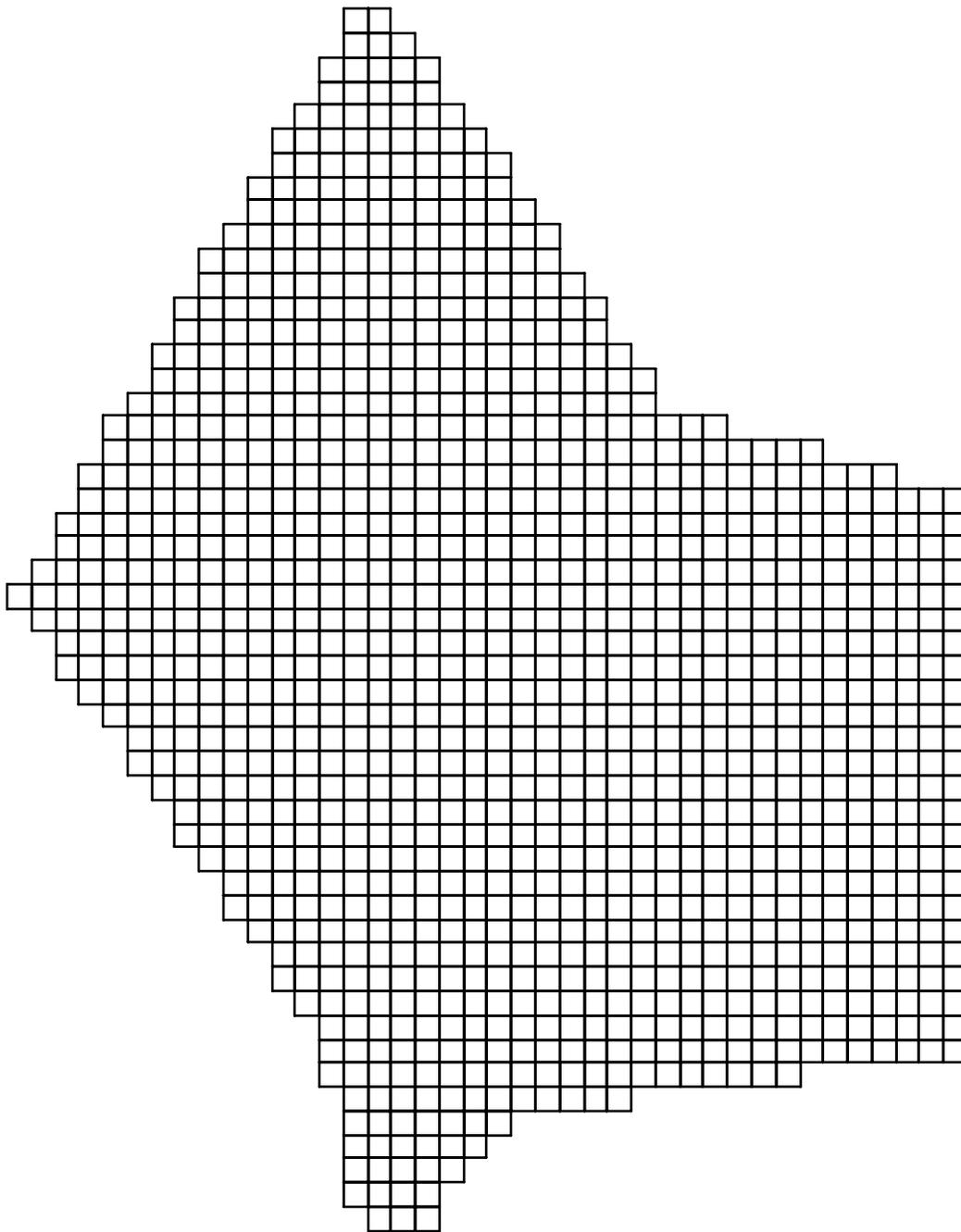


Figure B29. Square cell Cartesian grid representing same region as shown in Figure B25. This grid corresponds to the file gcell.inp in Figure B28.

```

C
REAL*8 FUNCTION FIB (YY,J)
IMPLICIT REAL*8 (A-H,O-Z)
REAL*8 YY
C
IF (YY.GE.20.6.AND.YY.LE.35.6) THEN
  FIB=9.*(YY-21.)/15. + 7.
  RETURN
END IF
C
WRITE(6,601) YY,J
601 FORMAT(' FUNCTION FIB OUT OF BOUNDS YY,J = ',F10.4,I8/)
C
RETURN
END
C

```

Figure B30. FORTRAN function subroutine for physical domain true east or X coordinate (FIB), along beginning I boundary as a function of physical domain true north or Y coordinate (YY) on that boundary.

```

C
REAL*8 FUNCTION FIE (YY,J)
IMPLICIT REAL*8 (A-H,O-Z)
REAL*8 YY
C
IF (YY.GE.9.1.AND.YY.LE.23.6) THEN
  FIE=31.
  RETURN
END IF
C
WRITE(6,601) YY,J
601 FORMAT(' FUNCTION FIE OUT OF BOUNDS YY,J = ',F10.4,I8/)
C
RETURN
END
C

```

Figure B31. FORTRAN function subroutine for physical domain true east or X coordinate (FIE), along ending I boundary as a function of physical domain true north or Y coordinate (YY) on that boundary.

```

C
REAL*8 FUNCTION GJB (XX, I)
IMPLICIT REAL*8 (A-H, O-Z)
REAL*8 XX
C
IF (XX.GE.6.76.AND.XX.LT.8.76) THEN
  X=XX-6.76
  GJB=20.6-0.6*X- (2.254-0.203*X) *X*X/7.7
  RETURN
END IF
C
IF (XX.GE.8.76.AND.XX.LT.14.7) THEN
  GJB=-11.2*(XX-7.)/7.7 + 21.
  RETURN
END IF
C
IF (XX.GE.14.7.AND.XX.LT.19.4) THEN
C
  GJB=-2.1*(XX-14.7)/4.7 + 9.8
  X=XX-14.7
  CTMP=6.764968/(4.7*4.7)
  DTMP=-2.028605/(4.7*4.7*4.7)
  GJB=9.8-11.2*X/7.7+(CTMP+DTMP*X) *X*X
  RETURN
END IF
C
IF (XX.GE.19.4.AND.XX.LE.29.0) THEN
  GJB=1.5*(XX-19.4)/11.6 + 7.7
  RETURN
END IF
C
IF (XX.GE.29.0.AND.XX.LE.31.) THEN
  X=XX-31.
  GJB=9.1-(0.63+0.085*X) *X*X/11.6
  RETURN
END IF
C
WRITE (6, 601) XX, I
601 FORMAT (' FUNCTION GJB OUT OF BOUNDS XX, I = ', F10.4, I8/)
C
RETURN
END
C

```

Figure B32. FORTRAN function subroutine for physical domain true north or Y coordinate (GJB), along beginning J boundary as a function of physical domain true east or X coordinate (XX) on that boundary.

```

C
REAL*8 FUNCTION GJE (XX, I)
IMPLICIT REAL*8 (A-H,O-Z)
REAL*8 XX
C
IF (XX.GE.15.76.AND.XX.LT.17.76) THEN
X=XX-15.76
GJE=35.6-0.6*X-(1.696-0.082*X)*X*X/7.5
RETURN
END IF
C
IF (XX.GE.17.76.AND.XX.LT.22.5) THEN
GJE=-10.3*(XX-16.)/7.5 + 36.
RETURN
END IF
C
IF (XX.GE.22.5.AND.XX.LT.24.5) THEN
X=XX-22.5
GJE=(203.05-10.3*X+2.*X*X)/7.5
RETURN
END IF
C
IF (XX.GE.24.5.AND.XX.LT.29.0) THEN
GJE=-2.3*(XX-23.5)/7.5 + 25.7
RETURN
END IF
C
IF (XX.GE.29.0.AND.XX.LE.31.0) THEN
X=XX-31.
GJE=23.6+(1.175+0.2*X)*X*X/7.5
RETURN
END IF
C
WRITE (6,601) XX,I
601 FORMAT(' FUNCTION GJE OUT OF BOUNDS XX,I = ',F10.4,I8/)
C
C
RETURN
END
C

```

Figure B33. FORTRAN function subroutine for physical domain true north or Y coordinate (GJE), along ending J boundary as a function of physical domain true east or X coordinate (XX) on that boundary.

B.6 Chesapeake Bay

This section describes a square cell Cartesian grid of the Chesapeake Bay. The physical domain grid is shown in Figure B34, the cell.inp file, Figure B35, and the gefdc.inp file, Figure B36. The grid was generated with the `NTYPE = 9`, option by `gefdc.f`.

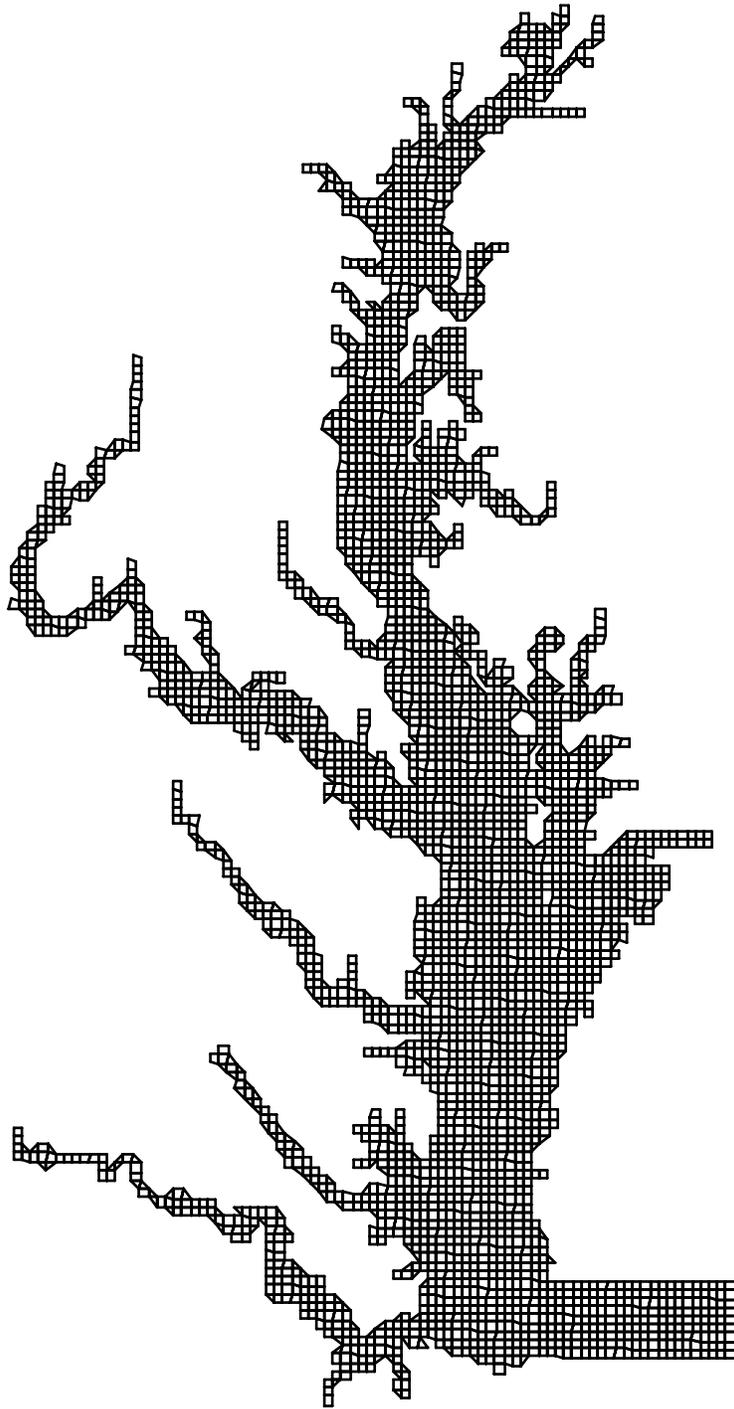


Figure B34. Physical and computational domain grid of the Chesapeake Bay. Grid spacing is approximately 1850 meters.


```

C1 TITLE
C1 (LIMITED TO 80 CHARACTERS)
   chesapeake bay cartesian, ll input, utm output
C2 INTEGER INPUT
C2 NTYPE  NBPP   IMIN  IMAX  JMIN  JMAX  IC   JC
   9      0     1     97   1     181  96   180
C3 GRAPHICS GRID INFORMATION
C3 ISGG  IGM  JGM  DXCG  DYCG  nwtgg
   1     96  180  1850. 1850. 1
C4 CARTESIAN AND GRAPHICS GRID COORDINATE DATA
C4 CDLON1 CDLON2 CDLON3 CDLAT1 CDLAT2 CDLAT3
   -77.5  1.25  -0.625  36.7   1.0   -0.5
C5 INTEGER INPUT
C5 ITRXM  ITRHM  ITRKM  ITRGM
   100    100    100    100    4000  1.0
C6 REAL INPUT
C6 RPX  RPK  RPH  RSQXM  RSQKM  RSQKIM  RSQHM  RSQHIM  RSQHJM
   1.8  1.8  1.8  1.E-12 1.E-12 1.E-12  1.E-12 1.E-12 1.E-12
C7 COORDINATE SHIFT PARAMETERS
C7 XSHIFT  YSHIFT  HSCALE  RKJDKI  ANGORO
   0.      0.      1000.   1.      7.0
C8 INTERPOLATION SWITCHES
C8 ISIRKI  JSIRKI  ISIHJHJ  JSIHJHJ
   1      0      0      0
C9 NTYPE = 7 SPECIFIED INPUT
C9 IB  IE  JB  JE  NINITM  N7RELAX  ITN7MAX  SERRMAX
C10 NTYPE = 7 SPECIFIED INPUT
C10 X  Y  IN ORDER (IB,JB) (IE,JB) (IE,JE) (IB,JE)
C11 DEPTH INTERPOLATION SWITCHES
C11 ISIDEP  NDEPDAT  CDEP  RADM  isidptyp  surfelv
   0      79431     2.   1.  1      0.      0      0      0
C12 LAST BOUNDARY POINT INFORMATION
C12 ILT  JLT  X(ILT,JLT)  Y(ILT,JLT)
   1  1  1      1
C13 BOUNDARY POINT INFORMATION
C13 I  J  X(I,J)  Y(I,J)

```

Figure B36. File gefdc.inp for Chesapeake Bay Grid Shown in Figure B34.