



**User's Manual for
EFDC_Explorer8.1:
A Pre/Post Processor for the
Environmental Fluid Dynamics Code
Rev 00
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1 Introduction

EFDC_Explorer (Figure 1-1) is a Microsoft Windows™ based pre-processor and post-processor for the three-dimensional (3D) hydrodynamic model, Environmental Fluid Dynamics Code (EFDC), initially developed at the Virginia Institute of Marine Science (Hamrick, 1992 & 1996). The US Environmental Protection Agency (EPA) has continued to support its development. The EFDC code is public domain and part of a family of models recommended by EPA for environmental and regulatory applications (www.epa.gov/ceampubl/swater/efdc).



Figure 1-1 EFDC_Explorer Splash Screen.

EFDC is a general-purpose model for simulating three-dimensional (3-D) flow, transport, and biogeochemical processes in surface water systems including: rivers, lakes, estuaries, reservoirs, wetlands, and near-shore to shelf-scale coastal regions. EFDC is capable of simulating cohesive and non-cohesive sediment transport, near-field and far-field plume discharge from multiple sources, and the transport and fate of toxic contaminants in the water and sediment phases. A dissolved oxygen/nutrient process (i.e. eutrophication) sub-model (HEM-3D) was added later (Park, *et al.*, 2000). Special enhancements to the hydrodynamics of the code now include vegetation resistance, drying and wetting, hydraulic structure representation, wave-current boundary layer interaction and wave-induced currents. The EFDC code has been extensively tested and the code is currently used by many university, government, and engineering and environmental consulting organizations.

The EFDC model has been released in the past in various forms and versions. This user's manual focuses on only two versions, the 2010 GVC Version (EFDC_GVC) (Tetra Tech, 2007a, 2007b) and the EFDC_DSI Version 2013_06_07. The EFDC_GVC version has an implementation of the Generalized Vertical Coordinate (GVC) system (Stacey *et al.*, 1995; Adcroft and Campin, 2004, TetraTech, 2006) that is supported in the current version of EFDC_Explorer.

This latest version of EFDC_Explorer continues to load input and output files from older versions of the EFDC model. However, after loading an older project into EE, users are must save the project into a new folder before running the model. This is because the EFDC input files used by the latest EFDCPlus/EE is not always compatible with older versions of EFDC_DSI/GVC until EE updates them to the new format by saving the model. EFDCPlus has been updated and expanded with a number of enhancements and new features that required the input files to be modified. For this reason, the user should also ensure that EE is correctly linked to the corresponding version of EFDCPlus (see below).

This user's manual provides guidance in the use of EFDC_Explorer. This manual is NOT a user's manual for EFDC. It is assumed that the user is familiar with the types of data and information required by EFDC. *EFDC_Explorer is a tool to assist qualified engineers and scientists in the development, testing, calibration and interpretation/analysis of the model.*

1.1 EFDC Version Compatibility Summary

EFDC has been undergoing continuous updates and bug fixes since its earliest development in the 1990's. During that time the EFDC.INP file (i.e. the master control file for EFDC) as well as other input files, have undergone a range of changes and additions of card groups and parameters. EFDC_Explorer has been designed to completely load as many of these older models as possible. Table 1 summarizes the EFDC versions that EFDC_Explorer can successfully load.

Again, it should be noted that legacy models need to be loaded into EE8.1 and then saved prior to running to allow the models to be updated to the latest input file format.

Table 1-1 EFDC – EFDC_Explorer Compatibility Table.

Acronym	Description	Dates	Read	Write
EFDC_1D	A sub-model of EFDC that uses cross section data.		No	No
EFDC	The "Full" version of EFDC prior to the implementation of GVC.	2000 to 2007	Yes	No
EFDC_Hydro	Simplified version of EFDC with only hydrodynamics using the 3 time level solution. Intended for linkage to WASP.		Yes	No
EFDC_GVC	The "Full" version of EFDC with the GVC implementation. EPA released this version in 2008.	2007 to 2010	Yes	Yes 2010 Version
EFDC_DSI	The DS-INTL version of EFDC including dynamic memory allocation, particle tracking and internally generated wind waves.	2000 to 2015	Yes	No
EFDC_SGZ	Modified version of EFDC_DSI to handle Sigma Zed layer.	2014 to 2015	Yes	No
EFDC+ (EFDCPlus)	Includes EFDC_OMP and EFDC_SGZ as well as updates to EFDC_DSI	2016 forward	Yes	Yes

Beginning with EE7.1, when the user tries to start a new EFDC run, EE will check the EFDC_DSI executable version number to ensure that the correct version of EFDC_DSI is being used with the current version of EFDC_Explorer. If the user tries to run EFDC_DSI with an incorrect version, EE will report to the user that the versions are incompatible and will not allow the run to start. The EFDC_DSI executable file will have the same version number as that of EFDC_Explorer. For example EE8.1 will only run EFDCPlus_081_OMP_YYMMDD.exe. Where YYMMDD is the release date such 150601.

Likewise, if a user is still using EE6, then it must be linked to the corresponding release version of EFDC_DSI, but the user must keep track of which EFDC executable works with which version of EE. The EFDC_DSI executable release date allows the user to correctly match the software releases.

1.2 EFDC_Explorer Capabilities

1.2.1. Recent Enhancements to EFDCPlus/EFDC_Explorer Capabilities

- SEDZLJ Sediment sub-model implemented in EE for display of initial conditions and model results including Core Zone; Erosion Rate, Deposition Rate, Net Dep/Erosion Rate, Bedload Concentration, d50 (Active Layer) (EE8.1)
- Time series Line formatting drop down menus (EE8.1)
- Tabular management of time series extractions and plotting (EE8.1)
- Offline licensing support (EE8.1)
- Sigma Zed EFDC Model options
- OMP Model by default
- Enhanced hydraulic structures including culverts and bridges
- East-West connectors
- Map file enhancements
- Spatially variable background diffusivity (AHO)
- Licensing changes
- Import structures in 3D
- Time series plots for boundary conditions
- Improved drifters visualization for large number of drifters
- Use of pointers for water surface elevations (WSEL) to display larger models

1.2.2. Summary of Capabilities

The following lists provide a summary of the major features of EFDC_Explorer. The lists are grouped into three primary categories based on the general use of each feature. The first group contains general purpose features while the other two groups summarize the major pre- and post-processing features.

It is recognized that many more options and features could be added to EFDC_Explorer. It is anticipated that many new features will be added as resources are available.

General

- Graphical interface to most of the commonly used EFDC features.
- Graphical interface for EFDC (Sigma, GVC and SGZ versions) sub-models:
 - Hydrodynamics
 - Density dependent flow state variables: Salinity/Temperature
 - Tracer

- Sediment Transport
- Toxics
- Water Quality with Sediment Diagenesis
- Lagrangian Particle Tracking and Oil Spill
- Rooted Plant and Epiphyte Model
- Linkage of External Wave Model Results to EFDC
- Wind Generated Waves
- Ice formation and melt
- Extensive visualization and point and click inquiries of input and output data.
- Extensive use of popup tips to help the user select the proper inputs.
- Included EE User Manual Help file coupled to forms (F1).
- Extensive error and range checking for user inputs.
- Many functions work with Calendar date and/or Julian dates.
- Binary file access method to allow the access to files > 4.2 GB.
- Any number of snapshots that can be written by EFDC and managed/used by EFDC_Explorer.
- Output Plots and Tables in either Metric or English units.
- Ability to read, write and display ESRI® .SHP files.
- Ability to read, write and display Mapinfo® .tab files.
- Included EE User Manual Help file coupled to forms (F1).
- Ability to write KML files for grid and model 2D fields.
- Ability to user multiple processors (OMP) to significantly reduce run times.
- Double click to run a project (*.EE extension).
- SWAN control and linkage to EE system
- No need for template files for model setup
- Continuing support and development of the utility.

Pre-Processor-General

- Pre-Processor for the efdc+ & EFDC_GVC 2D-3D Versions.
- Import many previous versions of the main control file (i.e. EFDC.INP).
- Courant # and Courant-Fredrick-Levy calculator and display tools.
- Run logging.
- Status error window

Pre-Processor-Model Generation

- Build Cartesian or simple Curvilinear models.
- Cartesian models can use expanding grid spacing and grid rotations.
- Easily increase or decrease vertical layering.
- Import CVLGrid grids
- Import complex Curvilinear models generated by third party utilities:
 - Delft RGFGGrid formatted file (i.e. GRD file) ,
 - Grid95,
 - SEAGrid, and
 - Any generic cell based nodal coordinate file.
- Import grids from different hydrodynamic models:
 - CH3D-WES,
 - CH3D-IMS,
 - ECOMSED, and
 - Prior versions of EFDC.
- Import grids with multiple sub-domains

Pre-Processor-General Grid Tools

- Grid Orthogonality statistics and plots.
- Export any EFDC model grid as an RGFGGrid formatted GRD file.
- Export the model domain outline as a XY file (P2D format).
- Export the model cells as a XY file (P2D format).
- Transpose and/or flip the I and J indexes.
- Clean and repair any DX/DY and cell angle problems using a repair utility.
- Triangular Cells on Border toggle option
- Model Domain Rotation
- Connect sub-domains with N-S and/or E-W connectors

Pre-Processor-Initial Conditions

- Easy and fast plan views of the model domain with model option specific viewing options.
- Develop/Edit bathymetry from Digital Terrain Models (DTM's) or irregularly spaced elevation data.
- Build/Edit sediment beds with toxics.
- Set and edit cell properties by "point & click" on the model grid.
- User defined polygon cell selections for editing.
- Use simple operators to edit one or any number of cells.
- View/Set Vegetation mapping (if used).
 - Link Vegetation to Polygons for rapid vegetation assignments.
- View/Set Groundwater mapping (if used).
- Refine grid manually by activating/deactivating cells from the cell map.
- Rapid setting of the initial conditions water surface or depths.
- Use of 3D polylines to assist in setting initial conditions.
- Create/Read a compact binary "archive" file for a model run.
- Assign initial conditions using spatially varying vertical measured/estimated profiles.
- View/Assign/Edit roughness field.
- View Courant #/CFL map.
- View/Assign/Edit "Channel Modifier" information/configuration (if used).
- Set particle seeding and Lagrangian Particle Tracking control options.
- Base Date Updating
- Automated Atmospheric and Wind Series Weighting

Pre-Processor-Boundary Conditions

- Define/Edit/Plot flow, hydraulic structure, open and withdrawal/return type boundary condition groups based on flow series.
- Define hydraulic structures including culverts and bridges governed by equations
- Define tides with harmonic constants
- Set and edit boundary conditions by "point & click" on the model grid.
- Boundary conditions time series intelligent editor and one-button plotting.
- Use familiar names to identify and label boundary cells and input time series.
- Label boundary groups on 2D maps and/or export group labels to a file for more control over labeling of maps in EFDC_Explorer or GIS applications.
- HSPF model boundary condition interface to quickly import HSPF results to EFDC.
- Generate spatially interpolated time series for open boundary conditions.
- Use concentrations instead of mass loading (HEM3D default) for the water quality flow type BC groups.
- Updated EFDC_DSI to internally compute bed shear stress and currents due to wind generated waves.

- Updated EFDC_DSI to include recent EFDC enhancements by EFDC development partners including sediment transport, SEDZLJ and hydro-mechanical devices (HMK).
- Addition of Withdrawal/Return Boundary Condition for reversing flows (i.e. bi-directional flows)
- Updated Hydraulic Structures Boundary Condition (EFDC and EE)
- Jet Plume Boundary Condition Editor
- N-S and E-W connectors by groups

Pre-Processor-Mass Balance/Boundary Loadings

- Compute mass balance of various model constituents with plotting and tabular output of time series.
- Plot the boundary condition loadings for various model constituents or some derived parameters like Total Phosphorus, Total Nitrogen or Total Carbon.
- Compute average and cumulative loadings using the “Averaging” and “Integration” features of the time series plotting utility.
- Generate mass loading summary tables for each simulated parameter.
- Water Quality Boundary Conditions can be loaded as Concentrations rather than just Mass Loadings

Pre-Processor-Model to Model Comparisons

- Plan view plots of 2D model input fields compared by subtracting a “Comparison” model from the “Base” model.
- Compare water column initial conditions between models.
- Compare sediment bed conditions and bed elevations between models.
- Grids do not need to be identical; however, they do need to overlap horizontally.

Pre-Processor-Utilities

- Tracer configuration utility.
- A bitmap geo-referencing tool.
- Perform QA checks on input data prior to model runs.
- Merge multiple continuation runs into single data sets
- Create new model runs from any saved results from previous runs.
- Unix to Windows CR/LF conversion.
- Gradient fill as a display option for 2D plan view plots.
- Ability to Drag & Drop EFDC.INP files or Project Directories onto the Main EFDC_Explorer form to open a project.
- Ability to Drag & Drop model annotation files (overlays, labels and postings) while viewing the model

Post-Processor-General

- Post-Processor for the 3D Sigma Stretch, Sigma Zed and GVC versions of EFDC.
- Calendar day/Julian date labeling of plots and animations.
- EFDC output file management utility for resampling (i.e. reducing snapshot frequency) or merging continuation runs into a single output file.
- High Frequency Snapshot capability to insert high resolution results snapshots into the standard EFDC snapshot frequency.
- Optionally plot the color ramp in grey scale (for publications).
- Toggle on/off the display of titles on plots (for reports and publications).
- Ability to output sediment bed layer data to the EE_BED.OUT file with a skip frequency to save disk space.
- Automated statistics and plots at end of model run

- Automated folder structure for saving output files, plots etc.
- EFDC Restart Options Improvements (EFDC and EE) for Continuation Runs

Post-Processor-ViewPlan (2D Plan)

- View/label cell maps.
- Quickly animate many of the results to the screen or an AVI file.
- Export results to the commercial graphics package TECPlot® or Google Earth.
- Compute model results statistics for current view or by polygon.
- Compass (north arrow)
- Overlay the model with line drawings and labels.
- Export NetCDF Output
- Display one or more geo-referenced bitmaps as a background to the model grid.
 - Several views allow for transparent grid cells to view the background and model results.
- Capability to output bitmap images at user defined resolutions
- Display multiple “Timing Frames” to temporally reference results to model boundary conditions for the following types:
 - Open boundaries
 - Inflows/outflows
 - Withdrawal/Return
 - Winds
- Display spatial scales in various units.
- Generate a new model from the output of an existing model for any selected time,
- View water surface/depth maps, animations and time series.
 - Transparent Cells for water depths/elevations and other water column results.
 - Flood Inundation Mapping
 - Compute/Display areal extents based on specified a minimum depth and duration.
 - Compute/Display areal extents based on a Depth*Velocity Flood Hazard Factor.
 - Compare up to 3 models on the same plot showing Areal Extents.
 - Energy Mapping
 - Compute/Display total head (WS Elevation + $v^2/2g$).
 - Compute FEMA Overtopping parameter (depth + v^2).
 - Low Pass Filter for Model Analysis
- View Sediment/Bottom results for any time output or animation, (by layer or averaged/totalled over the number of sediment layers):
 - Bottom topography elevations,
 - Bottom scour/deposition,
 - Bottom grain size distributions,
 - Bottom sediment mass distributions (by layer or totalled over the total number of layers (i.e. KB),
 - Bottom sediment mass fractions (by layer or averaged over KB),
 - Bottom sediment porosity (by layer or averaged over KB),
 - Bed surface shear stress.
- View Velocity at multiple layers as magnitude or vector
 - Vector Plots – anchor point for vectors
 - Regular grid extraction for velocity plots
 - Downstream Projection
- View Water Column results for any time output or animations
 - Water Column reporting options
 - By layer or averaged/totalled over the number of water column layers
 - By specified depth or elevation

- Salinity,
- Temperature,
- Dye or a computed Age of Water (EFDC_DSI Only),
- Toxics,
 - By class or Totals
 - DOC Complexed
 - Dissolved, and
 - POC Adsorbed.
- Sediments (by class or totaled).
- Water quality parameters
 - 22 EFDC modeled constituents
 - Derived parameters like Chl-a, algal growth limiters, and TSI's.
- Anoxic volumes (User specified DO cutoff)
- Light penetration (Secchi Depth, Extinction Coefficients, % Irradiance).
- View boundary conditions map and view boundary condition time series.
 - View profiles of sediment bed and water column properties with time.
 - Store and quickly display time series calibration comparisons.
 - Compare velocity data to other model runs or field data (e.g. ADCP)
 - Compare model results from two different models to each other.
 - Plot time series plots for boundary conditions
- View Sediment Diagenesis concentrations and nutrient fluxes
 - View by class or total concentrations of PON, POP & POC
 - View concentrations by diagenesis layer or totals
 - View nutrient fluxes
- Model Metrics
 - Grid Orthogonality map & statistics,
 - Cell angle maps,
 - Courant Number,
 - Courant-Friedrichs-Levy (CFL) time step limits,
 - Froude Number,
 - Densimetric Froude Number,
 - Celerity, and
 - Richardson Number.
- View Longitudinal Profile plots
 - Generate longitudinal plots of water column and bottom sediments results.
 - User specified layer averaging (e.g. "1-3" will average the bottom three layers).
 - Water column or bottom sediment data can be overlaid with bottom topography and/or water surface elevation/depth results and/or bed shear.
 - Animations of the Longitudinal Profiles can be generated to the screen or AVI.
 - Display timing frame in Time Series and Profile Plotter
- Overlay plan view plots with the following Calibration Data/Information:
 - Station ID,
 - Date/Time coordinated data values,
 - Date/Time coordinated data residuals, and
 - Data values and residuals can use the same depth averaging or specified layer options specified for the model results.
- View plotting and animation of Lagrangian Particle Tracking and Oil Spill.
 - Ability to export one or more particle tracks to ASCII files for linkage to 3rd party applications.
 - Particles can be assigned to specific groups for separate treatment and display.
 - Particles can have an assigned settling rate or free floating.
 - Lagrangian Particle Tracking (LPT) by time release

- Group Method for LPT implemented
- External LPT module integrated into EE
- Group Method for LPT implemented.
- Oil evaporation and biodegradation
- View plotting and animation of the Rooted Plant and Epiphyte Model (RPEM).
 - Shoot carbon
 - Root carbon
 - Detritus carbon
 - Epiphyte carbon
- Save plot scales, positions for the model and annotation boxes for reuse later to allow plots to be formatted exactly the same from run to run.
- Specialty Analysis Tools including:
 - Habitat analysis based on water depth, temperature and other water column parameters.
 - Ability to compute the location of a “target concentration” of any water column constituent along a user specified polyline, .e.g. river mile location of 2 ppt salinity.
- Output time series at a specified depth.
- Contour lines
- Wind and Velocity Rose Plots
- Photo Viewers in Time Series Forms
- Annotated Plan View of Model Domain in Time Series Form
- Flight Path Animations

Post-Processor- View Profile (Horizontal Profiles)

- View Velocity at multiple layers as magnitude or vector
- View Water Column results for any time output or animations
- Contour lines
- View ice thickness

Post-Processor- Vertical Profiles

- View 2D vertical section plots along any I or J index or user defined polyline.
- For any vertical section view/animate:
 - Velocities,
 - Salinity,
 - Temperature,
 - Dye or a computed Age of Water (EFDC_DSI Only),
 - Toxics,
 - Sediments, and
 - Water quality parameters.

Post-Processor- View3D (3D Visualizations)

- View 2D vertical section plots along any I or J index or user defined polyline.
- For any vertical section view/animate:
- Velocity Banners
- Blanking and Clipping
- Background Images
- Sediment Bed Viewing
- Mouse Inquire Information
- Import COLLADA structures for display in 3D

Post-Processor-Miscellaneous

- Water flux calculator by layer or totaled for all layers.
- Mass flux of any water column constituent by layer or depth averaged.
- Ability to calculate current time or time series of Mass Fluxes across any user defined polyline(s).
- Sediment mass balance/sediment mass loadings.
- Single cell sediment/water column process plots and animations showing scour, deposition and consolidation.
- Output time series at a specified depth.
- High and Low Pass Filter for Time Series
- Mean Mass Transport - Averaging of 2D/3D fields
- Velocity Profiles

Post-Processor-Calibration Comparisons

- Time series comparisons for water column data of measured to modeled data for any layer, depth averaged and/or Min-Avg-Max model results.
- Vertical profile comparisons.
- Correlation Plots
- Produce report ready graphics.
- Calibration statistics using:
 - RMS Error,
 - Average Error,
 - Absolute Error,
 - Relative Error, and/or
 - Nash-Sutcliffe Efficiency Coefficient.
- Automatic generation of the calibration plots.
- Automatic generation of calibration statistics.
- Model Results Analysis Macro for consistent plots and tables.
- Cruise Plot Comparisons
- Forced evaporation analysis

Post-Processor-Model to Model Comparisons

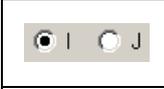
- 2D plan view plots of model results compared by subtracting a “Comparison” model from the “Base” model.
- Compare water column input and model results between models.
- Ability to compare sediment bed conditions, bed shear stress and scour/deposition between models.
- Compare computed layer or depth averaged velocities between models.
- Grids do not need to be identical; however, they do need to partially overlap horizontally.

1.3 Conventions

1.3.1. Windows Interface

While the general use of EFDC_Explorer is fairly standard with respect to a user interface for the Windows® operating system, some basic conventions will be explained here that should help the user.

Table 1-2 EFDC_Explorer user interface conventions.

	<p>A black box with green text provide information only, it cannot be edited from that location. The information/data may be modified elsewhere.</p>
	<p>A white box with black text is the primary data/text input interface.</p>
	<p>A radial button indicates a range of options. Only one can be selected for each operation requested.</p>
	<p>The “Browse” button is used extensively in the program to allow the user the ability to navigate to the requested/desired file(s) rather than typing in the adjacent text box.</p>

The user will notice several “grayed out” or disabled features in EFDC_Explorer. This indicates that a particular feature is not available for the currently applied version of EFDC or unavailable based on the user selected options. The “grayed out” options are not available to the user.

1.3.2. Message Boxes and the Clipboard

During the use of EFDC_Explorer various informational message boxes will be displayed, presenting the results of some calculation or other message. Most of these messages are also placed into the Windows clipboard for ease of transferring the information to some other applications. The data placed onto the clipboard are generally tab delimited.

1.3.3. Tooltips

When the cursor is passed over a button or field EFDC_Explorer will often show a tooltip that will help to explain the function of that button.

1.3.4. Operators

At several places in EFDC_Explorer the user has the option of entering a value to replace the current value of some input parameter (e.g., bottom elevation) or to use an “operator”. The latter is a simple mathematical function that will be applied to the current value of the parameter. A field that allows *operators* recognizes the inputs described in Table 1-3. Operators must be followed by a space then the value, unless it is a simple replacement value.

Table 1-3 Operator descriptions.

Input	Description	Example		
		Current Value	Input “Operator”	Result
A Number	Replacement value	300	310	310
+ Number	Additive Operation	300	+ 1	301
- Number	Subtraction Operation	300	- 20	280
* Number	Multiplication Operation	300	* 1.1	330
/ Number	Division Operation	300	/ 1.1	272.73

1.3.5. Units

EFDC uses the metric system to define the space and concentration variables. Meters are used for all of the length related parameters and g/m^3 are used for concentrations, with the exception of salinity (kg/m^3) and toxics. For toxics, the units must be consistent between concentrations and the water column and sediment bed sorption parameters. Generally, these are in mg/m^3 or g/m^3 .

The internal EFDC time units are in seconds. For EFDC, most of the input files can use any units along with a conversion factor to change the input units to seconds. EFDC_Explorer has fixed the user input units to days. All of the timing input should be in days and EFDC_Explorer generates the necessary conversion factors to seconds.

1.4 Terms & Abbreviations

The following is a description of common terms and abbreviations used in this report:

- LMC “Left Mouse Click”. On a standard mouse this refers to the left side button. Some Windows configurations can reverse the function of the left and right mouse buttons.
- RMC “Right Mouse Click”. On a standard mouse this refers to the right side button.
- Ctrl The “Control” key on the keyboard.
- Alt The “ALT” key on the Keyboard.

1.5 General Program Operation

Upon starting EFDC_Explorer the user will be presented with the form shown in Figure 1-2. This form is basically divided into three parts. At the top of the form, the main Toolbar is shown providing quick access to many of the primary EFDC_Explorer features and actions. Beneath this is some general information about the location of the model. The main section of the form presents the pre- and post-processor inputs and options.

The number and function of the tabs shown along the left column of the form are automatically updated based on the user selected computational options. The operation and further instructions for each of these groupings will be described in the following sections.

It is strongly recommended that the user keep a run log. EE provides a simple text interface to record changes to a run from a previous run and/or run notes.

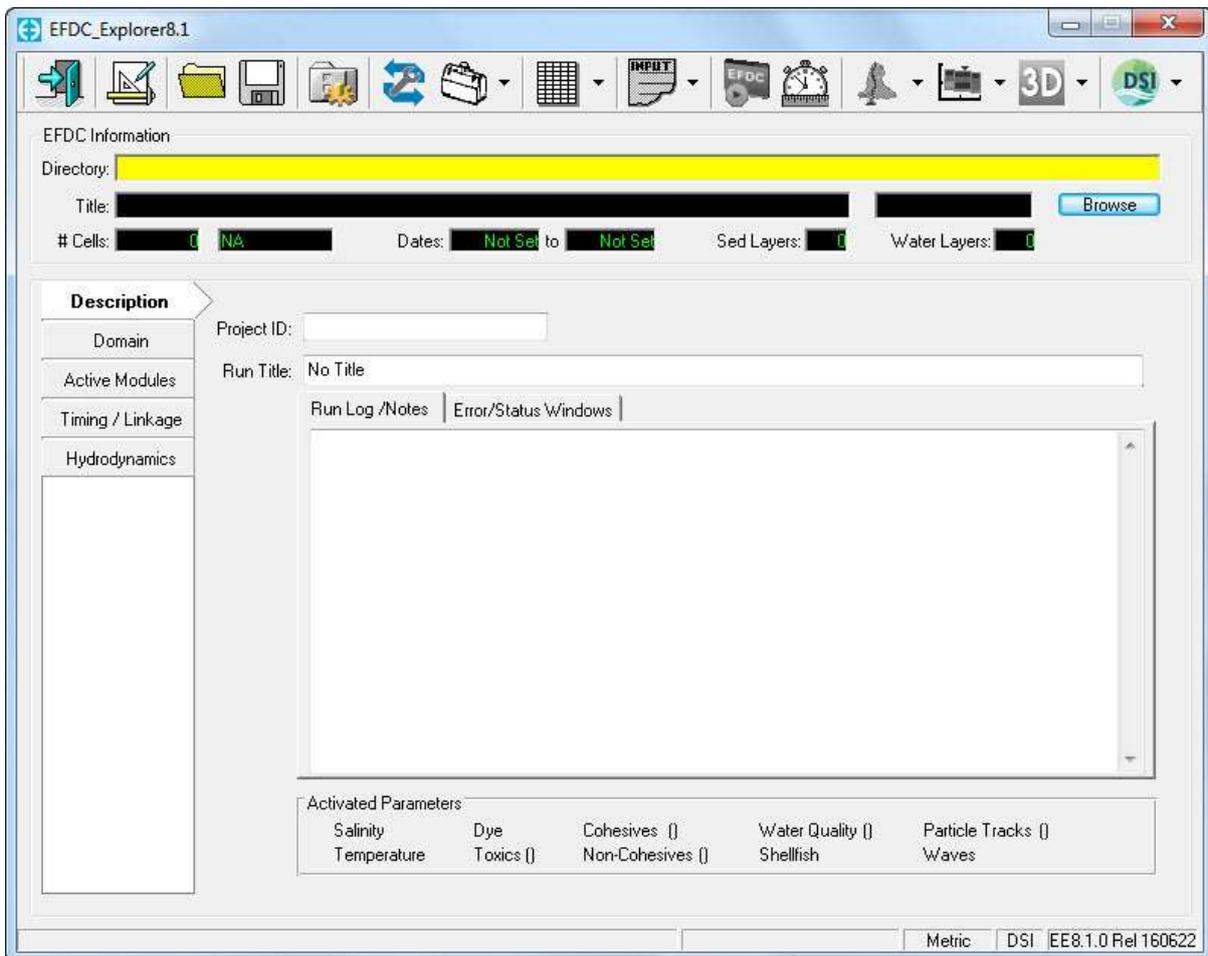


Figure 1-2 Main EFDC_Explorer form at startup.

1.6 EFDC_Explorer Files

1.6.1. EE Project Files

The main control file for every EFDC application is the EFDC.INP file. EFDC.INP is an ASCII file structured into card groups that generally have the same basic objective, e.g. card group 8 (C8) contains the settings for the run time but it also contains other miscellaneous parameters. This file contains almost all of the computational options and data settings.

The EFDC model uses fixed file names (e.g. DXDY.INP) based on the type of information each file contains. The files that are required for a model application vary based on the computational and grid options selected. For example, if the ISVEG flag (C5) is >0 then the VEGE.INP file, which contains vegetation information to compute vegetation based flow resistance, must be supplied. EFDC_Explorer reads and writes these same files and reduces the need for the user to remember exactly which file and/or which card group has what flag or setting.

EFDC_Explorer requires additional information and data to perform its pre-processing and visualizations. When saving an existing or new project, EFDC_Explorer automatically generates these files based on the project's settings. The following provides a list of EFDC_Explorer specific files and their functions:

EFDC.EE	This is the main EFDC_Explorer project file. This file contains much of the labeling, formatting, boundary condition, and model-data linkage information. This file is REQUIRED for EFDC_Explorer to correctly manage boundary groups
CORNERS.INP	This file contains the corner coordinates for each cell. EFDC_Explorer computes these using the cell center coordinates, DX, DY and cell rotation. It then matches the cell corners and builds the nodal list. By default, EFDC_Explorer displays the 2D plan view cells using these corner coordinates. However, the user can choose to view the rectangular cells if desired.
EFDC_LOG.EE	This file contains the run log that is displayed in the main EFDC_Explorer form. This file is ASCII and can be viewed with any ASCII editor.
CalForm_TS.EE	This file contains formatting and labeling information for the time series calibration plots.
CalForm_VP.EE	This file contains formatting and labeling information for the vertical profile calibration plots.

EFDC_Explorer now use the “.EE” file extension rather than the old project file extension of “.DS”. EFDC_Explorer will still load .ds files but only .EE files can be double clicked to open the project. EFDC_Explorer will only update the files if the user saves the project, otherwise the old files will be kept.

1.6.2. EFDC – EFDC Explorer Linkage

In order for EFDC_Explorer to **post-process** the data the following files must be generated by EFDC:

EE_WS.OUT	Required. This file contains the water depths.
EE_VEL.OUT	Recommended. This file contains the 3D velocity field.
EE_WC.OUT	This file contains the water column results as well as the information for the top layer of the sediment bed.
EE_BED.OUT	This file contains the sediment bed data for each layer, including the toxics associated with each layer.
EE_ARRAYS.OUT	This is an optional file that the EEXPOUT subroutine in EFDC optionally generates. This file contains snapshots of almost any internal EFDC array desired. EFDC_Explorer automatically loads this file and provides visualization, if it exists. (See Appendix A for more details).
EE_WQ.OUT	This file contains the water column results for water quality constituents simulated.
EE_SD.OUT	This file contains the sediment diagenesis results if the full sediment diagenesis option is turned on.
EE_DRIFTER.OUT	This file contains the time history of the location of the particles from the Lagrangian particle tracking feature, if turned on.
EE_RPEM.OUT	This file contains the Rooted Plant and Epiphyte Model results.
EE_BC.OUT	This files contains flows for boundary conditions.

These files are created by EFDC_DSI and the version of EFDC_GVC that DS-INTL distributes on our web site. EFDC_Explorer allows the user to set the appropriate options to view EFDC output. EFDC_Explorer generates the EFDC input files needed when the project is saved. EFDC then reads the input files and writes the EFDC_Explorer linkage files.

The following **subroutines** are used by EFDC to write the EFDC_Explorer linkage files:

SURFPLT Writes the depths for each cell for each snapshot into the file EE_WS.OUT. Water surface elevations are computed by adding the bottom elevations of the cells at the same model snapshot time.

VELPLTH Writes the U & V velocities in IJ space to the file EE_VEL.OUT. This allows EE the use of velocities on U and V cell faces for flux calculations. For visualizations, EE transforms the velocities by computing a cell centroid U & V then rotating them to the XY space using the cell rotations.

EEXPOUT This is the main subroutine to write the linkage files for EE. Depending on the options selected, this routine will write the files, EE_WC.OUT, EE_BED.OUT, EE_ARRAYS.OUT, EE_WQ.OUT, EE_SD.OUT and EE_RPEM.OUT.

DRIFTER This is the Lagrangian Particle Tracking module. It writes the particle positions to the EE_DRIFTER.OUT at an independent snapshot frequency to the other output data.

1.7 EFDCPlus Project Folder Structure

From release of EFDC_Explorer7 there has been a pre-set folder structure for model outputs and EE generated files. All input files needed by EFDCPlus and EE are stored in the main project folder. This makes it easier to identify which files are needed by EFDC/EE and which ones are not. To send a colleague/regulator the required files the user only needs to copy all the files (not subdirectories) in the project folder. All other EFDCPlus and EE generated files are placed in a defined sub-folder. EFDC model output is contained in the #output folder with other folders being used to organize and manage EE user created files. These include:

- #output for all EFDC output files.
- #analysis for general EE plot files and EE exported data.
- #animations for all EE generated .AVI animations
- #calib_plots for all calibration plots.
- #calib_stats for the calibration statistic files.
- #calib_export for the EE exported files from the calibration plotting utility.

When the user requests some plot or data extraction EE will still bring up a file browsing dialog allowing the user to write the files to any location, however, the default locations will be those identified above.

2 Installation & License Management

2.1 Installation

- 1) If you received EFDC_Explorer in a zip file (EFDC_Explorer.ZIP), unzip the zip file into a *temporary directory* on your hard drive. To simplify the cleanup of files later it is recommended that the *temporary directory* be empty before unzipping.
- 2) You should use the the EFDC_Explorer Installation program to install EFDC_Explorer (EFDC_Explorer8.1_Setup_Ver160622). After opening the setup program the EE Install Wizard will run as shown in Figure 2-1 below.



Figure 2-1 Install Wizard for EFDC_Explorer

- 3) If you used a *temporary directory* you should delete the files that were unzipped. Keep a copy of the zip file in case you need to install the program again.
- 4) For Vista™ and Windows 7™ users, you may need to change the EFDC_Explorer8.1.exe to “Run as Administrator” before you can use EFDC_Explorer to run models.
- 5) As part of the conditions of use of EFDC_Explorer, the user must accept the License Agreement before installation.

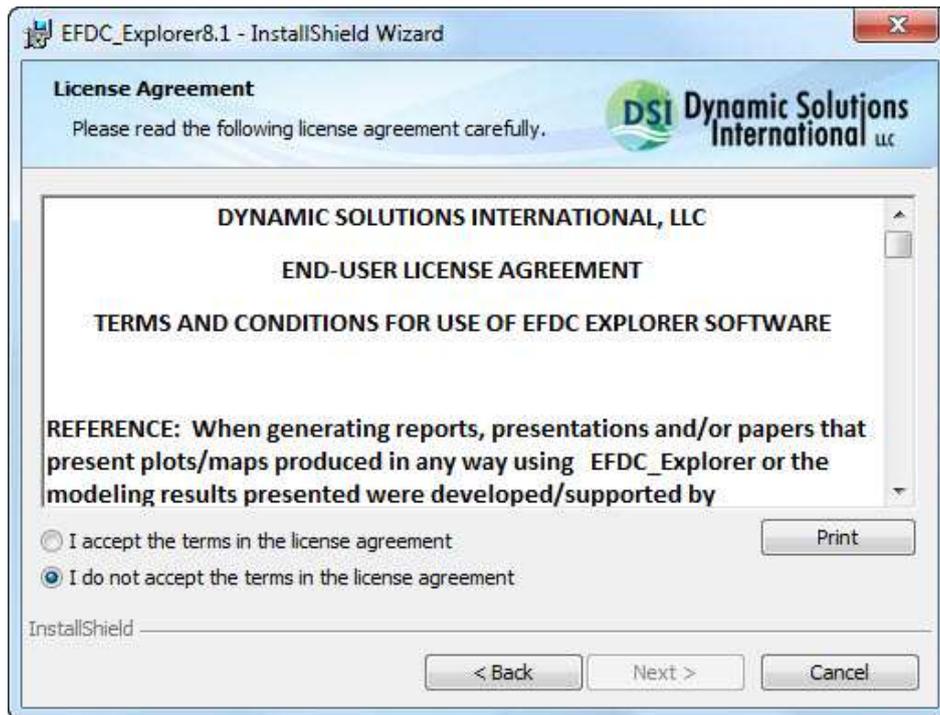


Figure 2-2 License Agreement Prompt

- 6) The user is then prompted for customer information. Please enter your User Name and Organization in the fields provided.
- 7) The user is then prompted for the Setup Option desired. A choice of “Complete” or “Custom” setup options are available. “Complete” means that all setup features will be installed, requiring more disc space. The “Custom” setup option allows the user to install just one or a combination of files, including EFDC_Explorer program file, Datafiles, Documents and Extra files.



Figure 2-3 EE Install Wizard – Custom Setup

- 8) If the “Custom” option is used a number of features may be selected to be installed at shown in are available . Here the user may also decide on the destination folder for the setup by selecting the “Change” button. The default folder is: C:\Program Files(x86)\DSI\EFDC_Explorer8.1\. An example test case will also be saved to C:\EE_EFDC\081.

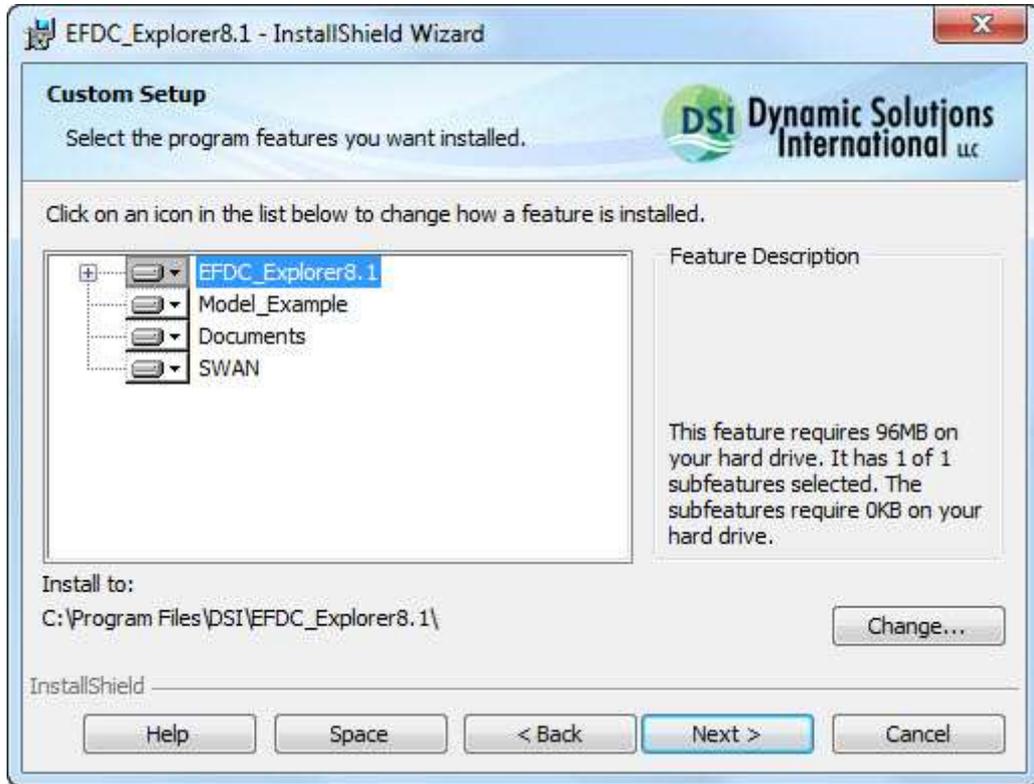


Figure 2-4 Destination folder for the setup

- 9) Upon completion of the Installation Wizard, the user is prompted with the message “Install Wizard Complete”. After selecting “Finish” the user is returned to the desktop.

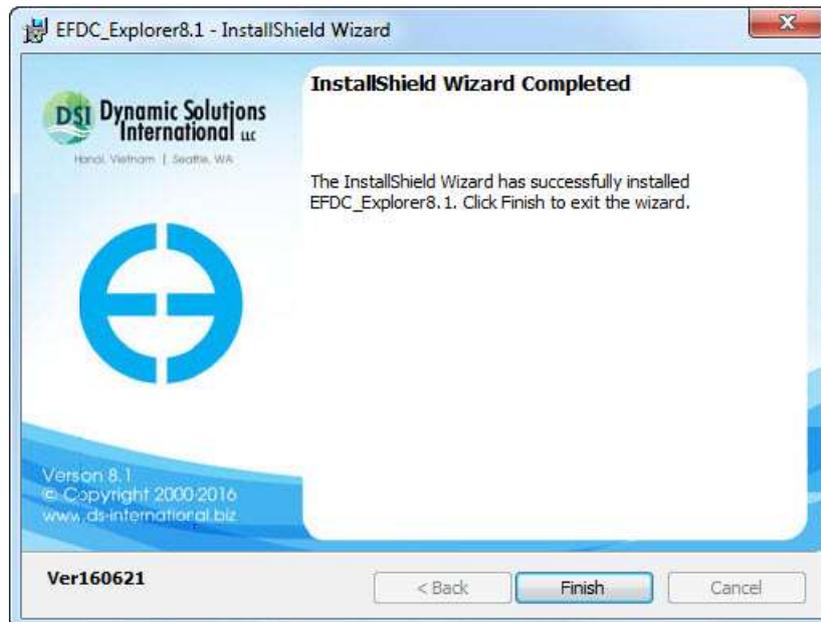


Figure 2-5 EE Installation Wizard Completion Screen.

2.2 License Models

EE8 utilizes a new licensing system. This system provides increased stability and ease of use for the users. Rental licenses are allowed and offline licenses may also be provided for users who don't connect their machines to the internet. The following license models are now supported by EE:

2.2.1. Trial License

Trial licenses are provided to people who want to assess the features of the EFDC_Explorer modeling system. The *Trial* license provides the full capability of EE without limitation. The only difference with the paid for version is that some images have a watermark in the background.

The *Trial* license is limited to 30 days duration after which the user must contact DSI to purchase a *Perpetual* license, or *Rental* license. The EE License Manager informs the user with the *Trial* license about the expiration as shown in Figure 2-6 . It should be noted that the *Trial* license cannot be transferred to another machine once the license has been activated.

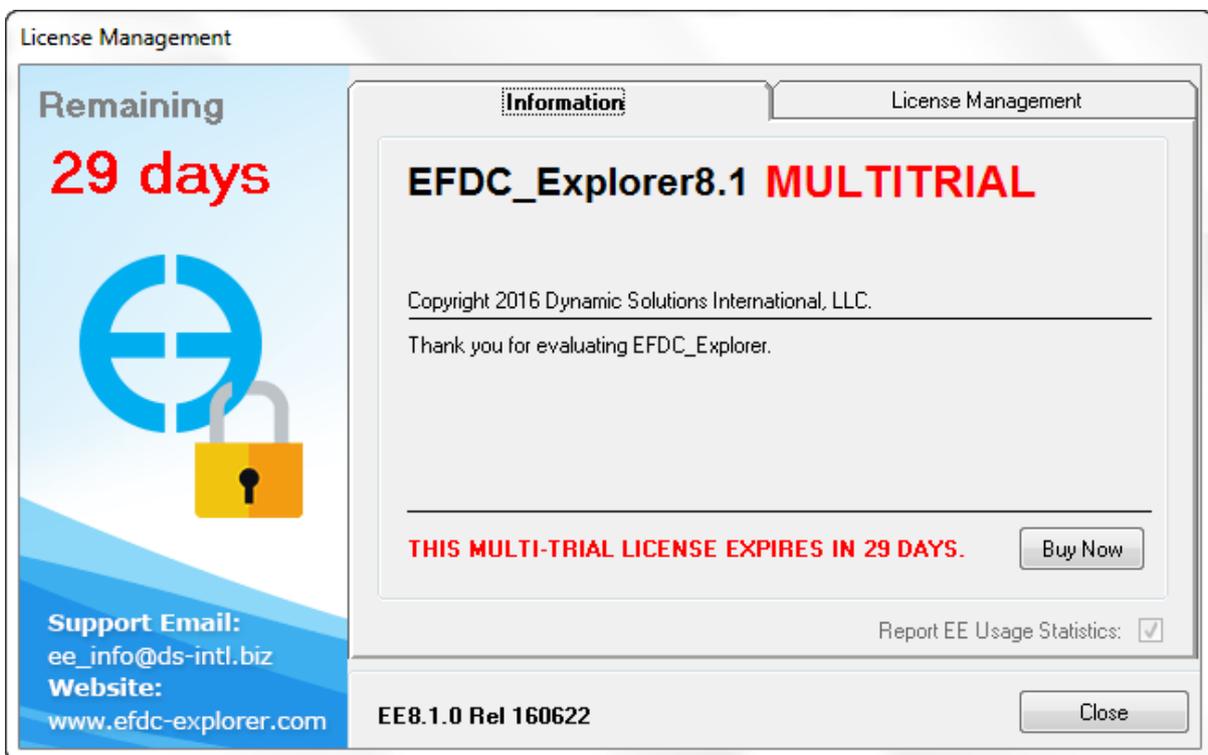


Figure 2-6 EE License Manager: Trial License.

2.2.2. Perpetual License

Perpetual licenses have no time limit in their use and provide the full capability of the EE modeling system without any kind of limitation. However, users will only be able to update their software to the latest version of EE within a certain time-frame agreed to in the sales arrangement. After that period of time, EE will still function normally but any bug fixes or new features which are added to EE after this date will not be accessible to the user. In order to access these updates the user will be required to have a valid maintenance contract with DSI. The *EE License Manager* will inform the user when this maintenance period is finished as shown in Figure 2-7. The user may then contact DSI to have their maintenance period extended if required.

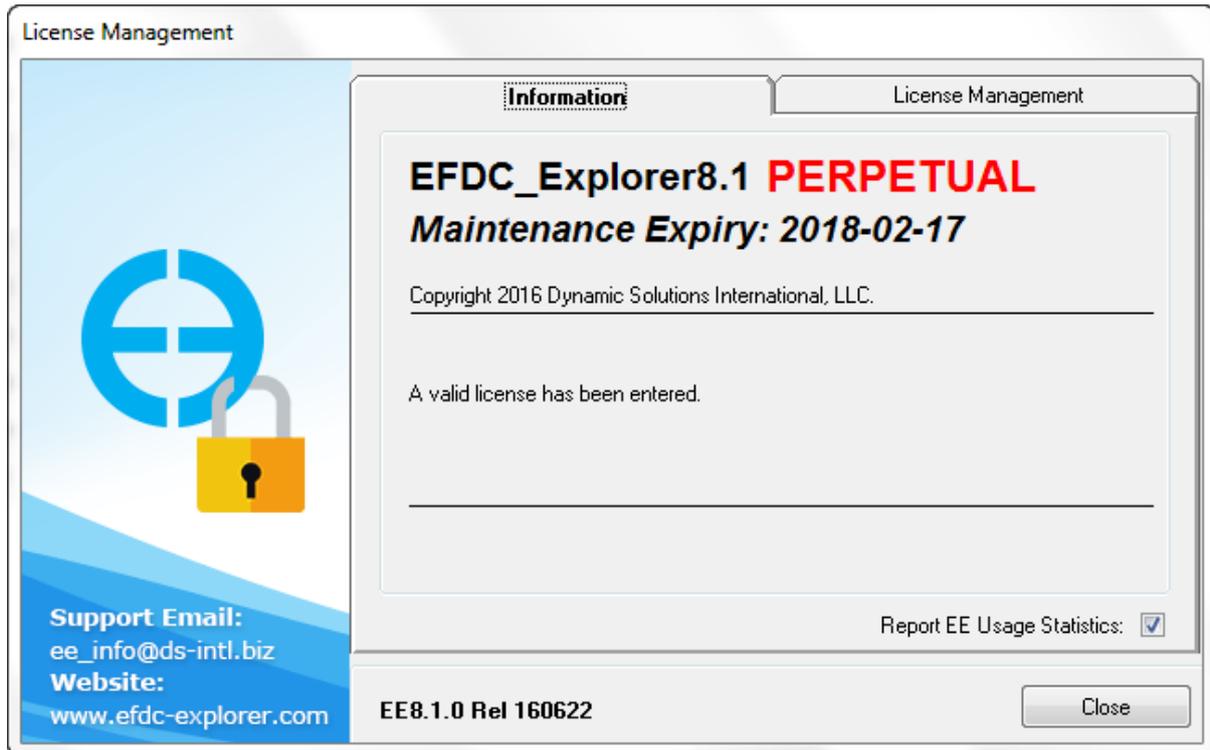


Figure 2-7 EE License Manager: Perpetual License.

2.2.3. Subscription License

A Subscription or Rental License provides the full capability of EE and efdc+ for a certain fixed period of time. Once this time has been exceeded the license will expire. The user may transfer the license to another machine by deactivating the license and then reactivating on the new machine. The EE License Manager form is shown in Figure 2-8.



Figure 2-8 EE License Manager: Rental License.

2.3 Online Activation Process

After installation, the user must activate the software before first use. Sometimes problems occur for users at the activation stage. Please note that to activate Perpetual, Rental and Trial versions of EE, the user **must be connected to the internet unless using offline activation**. If the user is not connected to the internet, or if there is a firewall on the network or installation computer, an error message may be given. In this case, please adjust your internet virus checker or firewall settings and try activating again. If this fails please contact support.

- 1) To activate EFDC_Explorer the user must start EE from the EE desktop icon or using the Start menu: "Start\All Programs\DSI\EFDC_Explorer8.1\EFDC_Explorer8.1".
- 2) The user should then review the "Terms and Conditions" associated with use of EFDC_Explorer software and then select "I Accept" option, if they do.
- 3) If this is the first time you have run EFDC_Explorer on your computer you will be see the EFDC_Explorer be prompted for your license name and license code, as shown in Figure 2-9. EE will automatically activate the Perpetual, Rental or Trial version based on your license code.



Figure 2-9 EE Version Options

- 4) Options for activating using a license file are provided on the EE website.
- 5) After activation of your software you will see the main EFDC_Explorer form, as shown in Figure 2-10.

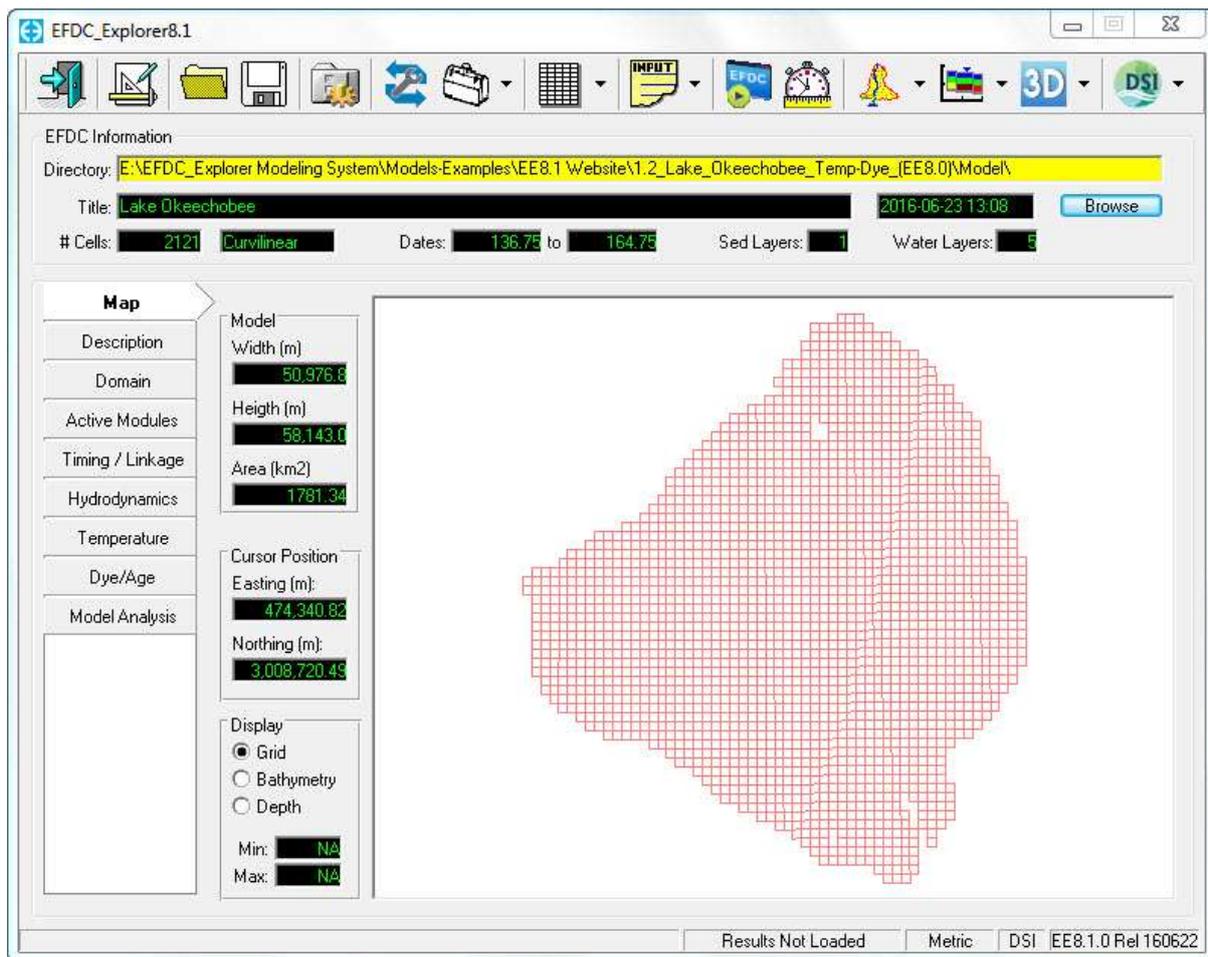


Figure 2-10 Main EFDC_Explorer form (with an EFDC project loaded).

2.4 Online Deactivation and License Management

Deactivation of EE is required when the user wishes to move their seat to a different computer, or plan to make some major changes to the hardware or operating system of their computer. Deactivation allows the seat to be retained and then reactivated on the same computer or a different computer later.

As for the activation process, deactivation of EE requires **connection to the internet unless using the offline license**. If the user is not connected to the internet, or if there is a firewall on the network or installation computer, an error message may be given. In this case, please adjust your internet virus checker or firewall settings and try activating again. If this fails please contact support.

- 1) To deactivate EFDC_Explorer the user must click on the DSI button on the top right of the user form to the drop-down menu and select *License Manager* as shown in Figure 2-11. The License Manager provides the user with basic license information, including the user of the total number of seats available, the number of allowed activations and deactivations remaining, license name and code.

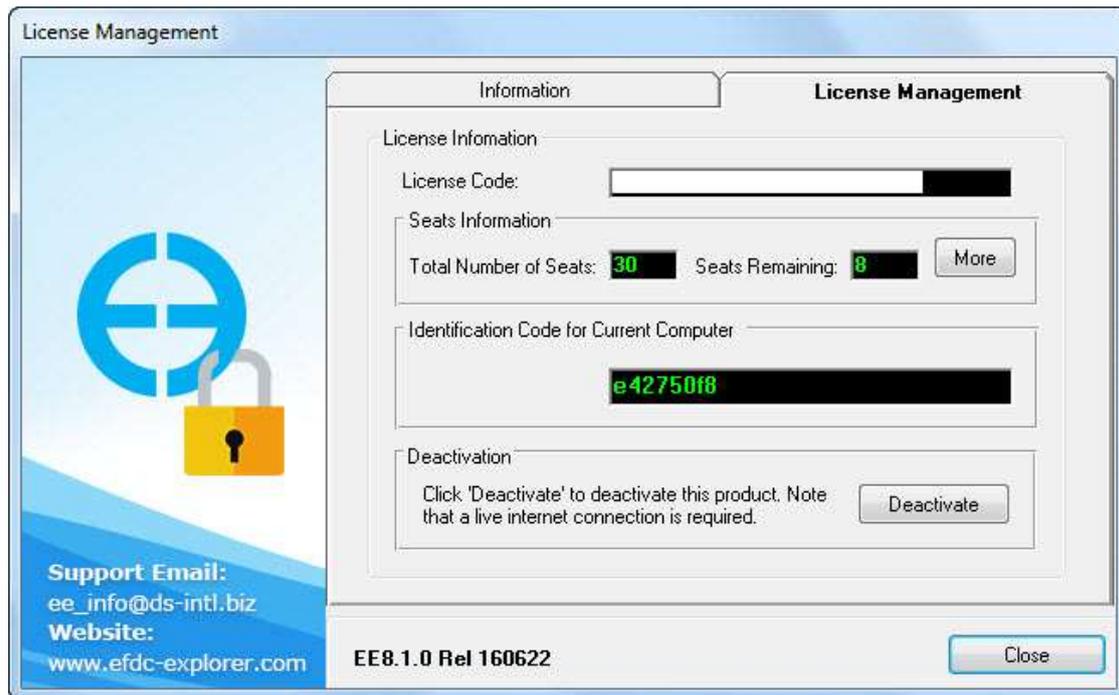


Figure 2-11 EE License Manager.

- 2) At the bottom of the *License Manager Form* is the *Deactivation* button. Selecting this button will bring up the *Deactivation* form. Selecting *Next*, and selecting *OK* at the prompt will deactivate your current license seat, and the number of license seats available for activation will increase by one.

DSI usually provides the license code via email. The best way to enter the License Name and License Code is to copy and paste these from the DSI email (sometimes you may need to copy and paste into a text editor first). When pasting the license code, click on the 1st code field from the left and then paste the entire code. EE will parse the code into the appropriate blocks.

2.5 Offline Activation

Users who wish to have a license of EE without requiring a connection to the internet can do so with an Offline License. DSI will provide the user with a USB dongle which can be plugged into their computer to provide the license file required for operation. Offline licenses can be provided for both long term rentals as well as Perpetual Licenses. The steps for activation using a dongle are described below.

- 1) To use dongle, the Flexnet USB dongle driver may need to be installed for older versions of MS Windows. This will have been provided by email or can be found on the USB dongle. Plug the dongle into the USB port.
- 2) Open EE8.1 from shortcut on desktop or from the Start button then the Activation Wizard Form will appear as shown in Figure 2-12. The user should select the *Activation using a Dongle* option.



Figure 2-12 EE Activation Wizard Form for dongle

- 3) Select the Browse button to browse to license file (*.lic) in on the USB dongle drive as shown in Figure 2-13 and select *Open*.

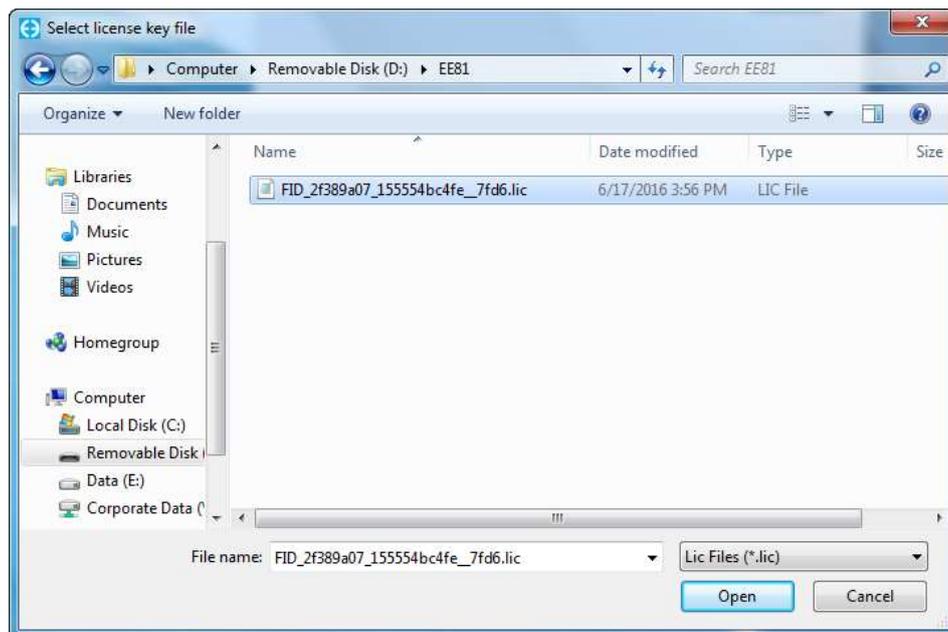


Figure 2-13 License File Selection Browse

- 4) Select the *Activate EE* button. The EFDC_Explorer Main form will then be opened.
- 5) If the user unplugs the USB dongle during use of EFDC_Explorer, a warning form will appear as shown in Figure 2-14. The user has two options: to save the current work and close EE or keep using EE by reinserting the dongle into the USB port.

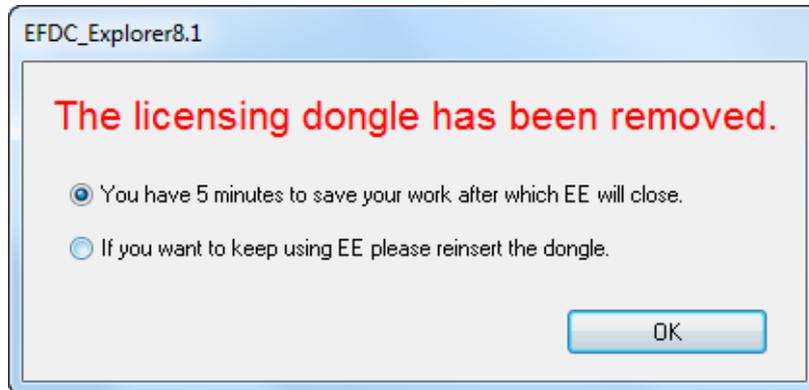


Figure 2-14 USB dongle license removed warning.

2.6 Offline Deactivation

To remove the Dongle key, the user must click on the DSI button on the top right of the EE main form. In the drop-down menu select *License Manager* to bring up the form shown in Figure 2-15. Select the *Remove* button. A confirmation form will be shown; select *Yes* to proceed. If the license has been removed successfully the EE Main Form will close immediately and user will need to reactivate.

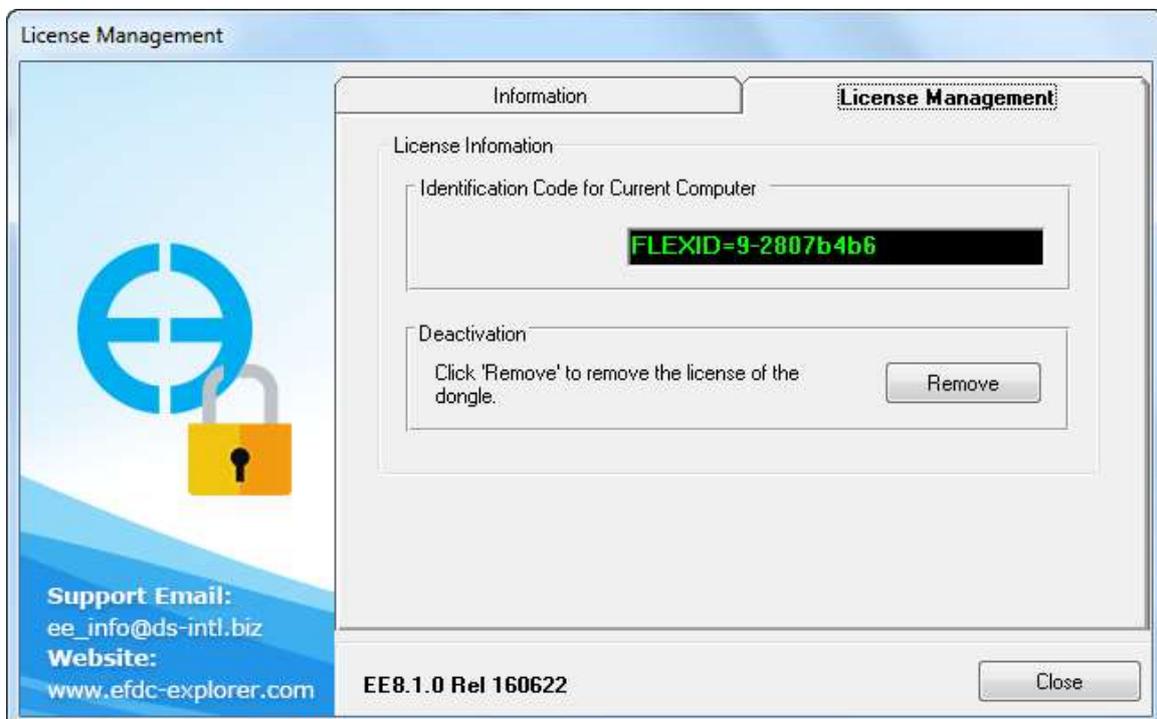


Figure 2-15 License Management Form

3 EFDC_Explorer Primary Toolbar

Upon starting EFDC_Explorer the user will be presented with the form shown in Figure 1-2. This form is basically divided into three parts. The middle section represents the pre-processor functions and the lower section provides access to some of the post-processor functions. Another major section of EFDC_Explorer is the toolbar located at the top of the form (Figure 3-1). This provides access to the program configuration options and the main model viewing functions. This section contains brief descriptions of several miscellaneous functions that are available from the main toolbar of EFDC_Explorer. Help files from the User Manual may be accessed at any time by pressing F1.



Figure 3-1 EFDC_Explorer main form toolbar.

3.1 EFDC Project Management

EFDC uses fixed file names for its input files; therefore each run/project should be stored in separate directories. EFDC_Explorer operates in the same manner. EFDC_Explorer reads and writes the files with the standard fixed file names to/from the specified subdirectory (called a “project” by EFDC_Explorer). Figure 3-2 shows the main file management toolbar and *Browse* buttons to access the opening and/or saving of a project. Table 3-1 provides a quick summary of each of the toolbar functions.

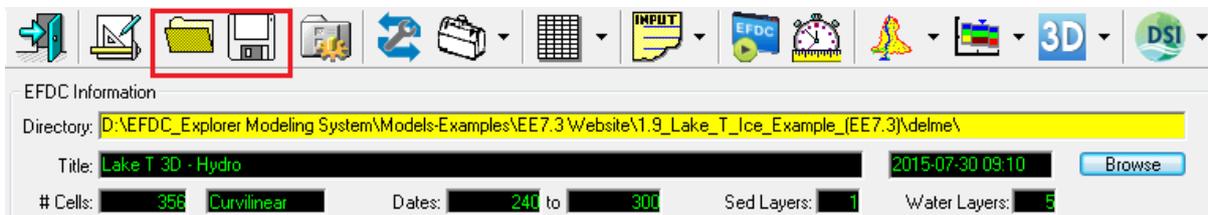


Figure 3-2 Project Open (Main Form).

Usage Tip

EFDC projects can be opened by **dragging and dropping** either the EFDC.INP file or the folder which contains the project on to either the **Directory** field or the **Title** field.

A project may also be opened by **double clicking** on the EFDC.EE file or any of the other *.EE extension files.

Table 3-1 Main toolbar summary of functions.

	Exit EFDC_Explorer. Does not save project, only Pre-/Post-processor settings.
	Generate an EFDC model using a template.
	Open/Read an EFDC model.
	Save current EFDC model into the same or new directory.
	Setup current printer.
	EFDC_Explorer configuration options, including where the EFDC executable files are located, one for the EPA version and one for the EFDC+ version.
	Convert between Julian days and Gregorian calendar dates
	Toolbox of miscellaneous features and utilities.
	View/Edit main EFDC.INP file for the current project.
	Various tools and utilities for analyzing and adjusting the grid.
	Run EFDC using the current project. Does not save the project first.
	Get runtime and other timing information for a completed model run.
	<i>ViewPlan</i> . Display the model in plan view. This is used for some pre-processing tasks (e.g. setting boundary conditions and modifying cell properties) and post-processing results. The dropdown menu allows the user to control whether the model results should be loaded and displayed or only initial conditions.
	<i>ViewProfile</i> . Display the model profile view along an I or J or a user defined section. This is used for post-processing results. The dropdown menu allows the user to control whether the model results should be loaded and displayed or only initial conditions.
	<i>View3D</i> : Display the model with 3D view. Viewing options include cut-aways (blanking), animations and light effects.
	Access Help files (User Manual); License Management

3.1.1. Open Operation

To open an existing project click on either on the toolbar folder button or the browse button highlighted. They accomplish identical tasks. The *Select Directory: Open Operation* form is then displayed. An example is shown in Figure 3-3. The directory displayed will be the last project directory opened. The last 20 projects are available in the dropdown list located near the bottom of the form. The panel on the right shows the files contained in the selected directory. For Open operations, the EFDC.INP file must exist in the directory.

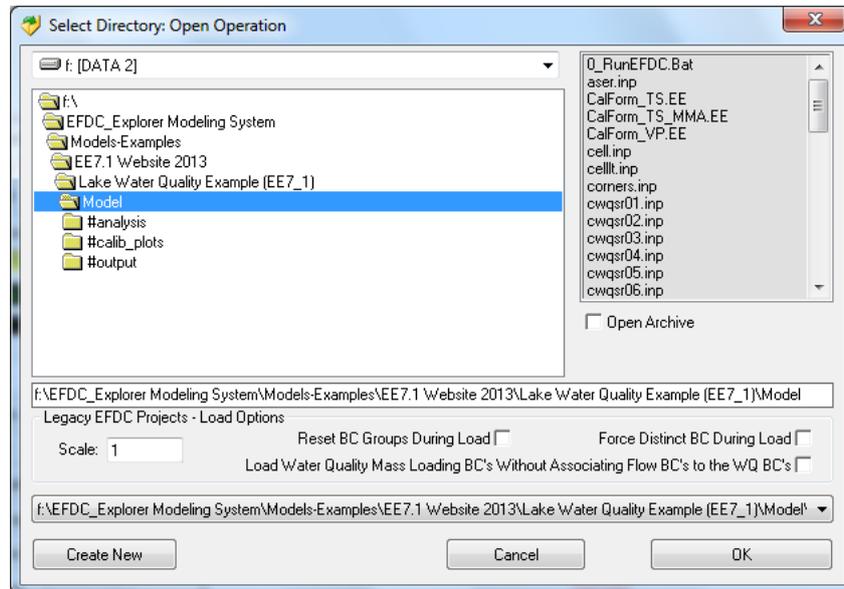


Figure 3-3 Select Directory: Open Operation.

An option to open a previously EFDC_Explorer saved archive file is given. These files all have an extension of “EFDC”, for example “CedarRiver.efdc”. When you select the *Open Archive* check box, the right panel only shows the available archive files in the selected directory.

3.1.1.1 Drag & Drop Method

If EE is already loaded, the user can load a new EFDC project using Windows Explorer. The user can browse to the project folder (or parent folder) and the click on one of the following and then drag the item to the yellow *Directory* box or the *Title* box. EE accepts:

- EFDC project folder
- EFDC.EE File
- EFDC.INP file

3.1.1.2 Double Click Method

During EE installation, the file extension “EE” was associated with the EFDC_Explorer application. Therefore, the user can start a new instance of EFDC_Explorer by double clicking on any file with the EE extension. EFDC_Explorer will start and then load the EFDC project contained in the same folder as the EE file double clicked on.

3.1.1.3 Legacy EFDC Loading Options

The options provided in the *Legacy EFDC Project – Load Options* frame can be used when loading old/legacy EFDC projects that were developed without EFDC_Explorer. Generally, these only need to be used the first time EE loads the project. When EE writes a project it saves the project out in the updated formats so these options do not need to be used but once for a legacy model application.

Historically, different versions of EFDC used different CELL.INP formats. EFDC_Explorer automatically handles the file format to correctly load the CELL.INP file. Similarly, the main EFDC.INP file and other input files have changed over the recent development history of EFDC. EFDC_Explorer attempts to correctly read most of the historical input files, while ensuring the latest version works and is the standard.

The “Scale” input box allows the user to apply a conversion factor to the centroid units used in the legacy LXLY file. The EFDC_Explorer default XY unit is in meters. Many applications use kilometers or miles as the units for the cell centroids provided in the LXLY file. For EE to correctly display the model these cell centroid coordinates must be converted to meters. EE can perform this function by entering the conversion factor in the “Scale” box when loading the model for the first time. Note: When a model is loaded and then viewed but looks like a bunch of large cells stacked on top of one another, it is likely to be a LXLY units conversion issue. Try reloading the model with an appropriate Scale factor.

The check boxes concerning resetting boundary condition groups apply to existing projects that have been managed by EFDC_Explorer. During the initial loading of a project, or if the *Reset* check box is selected, EFDC_Explorer tries to logically group boundary condition cells into groups by type and location. EFDC_Explorer then manages the boundary conditions using this group approach. If the user has modified the boundary conditions somehow and wants a different logical grouping, they should select one of these options. The *Load WQ Mass Loadings BC’s Without Associating Flow BC’s to the WQ BC’s* option is applicable when the user has no flow boundary condition assigned for a specific WQ mass loading boundary. Note that this is not recommended to be done in practice but has been seen in some models.

3.1.2. Write Operation

To save a currently opened project (i.e. Write Operation), click on the disk button highlighted on the toolbar shown in Figure 3-2.

The *Select Directory: Write Operation* form will be displayed (Figure 3-4). The user has the option to select which files are written by selecting the appropriate *Save Option* button. For a complete save of all the input files select the *Full Write* option. If you have only made changes to the formatting options in EFDC_Explorer and want those saved, select the *Save Profile* option. The profile is always saved for the other save options also.

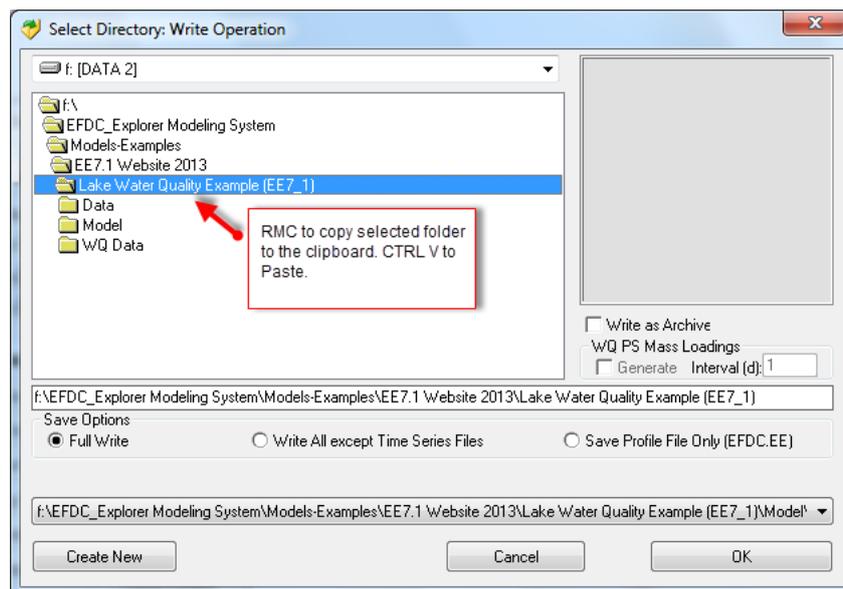


Figure 3-4 Select Directory: Write Operation.

If the user only has the “*.EFDC” archive file and wants to create a set of files that EFDC needs to run that project, the user must select the *Full Write* option to create all the input files required.

To create a new project using the existing project, use the *Create New* button to create a new subdirectory under the currently displayed directory. All the .INP files will be copied to the new directory after the user selects OK on the *Write Operation* form.

If the user wishes to save in the EPA GVC Model format rather than EFDC+ model format this should be selected in the *Active Modules* tab *Model Selection* frame on the main EFDC_Explorer form. This method allows quick reformatting of the EFDC.INP file for the different models. Care must be exercised to ensure that all the parameters have the desired values when switching models (see Section 5.4).

The project specific settings for information/data that the EFDC model does not use (i.e. labels, plot formatting, etc.) are saved in the EFDC.EE file, which is located in the project directory. If the user wants to **manually copy** a complete EFDC project data set (together with all the ASCII .INP files or the binary archive file) the user should also copy all of the *.EE files. However, the most important EE project file is the EFDC.EE file. The EFDC.EE file is an ASCII file that can be edited with any ASCII editor, though care should be taken not to corrupt the file.

Cross Platform Note

Many users may want to use EFDC on both a PC and a UNIX based computer. When transferring the input files from the UNIX machine to the PC, the carriage control MUST be reset to the Windows/DOS carriage control.

*EFDC_Explorer has the ability to convert non-Windows/DOS carriage control to Windows/DOS, via the **Toolbox** or when loading the UNIX project for the first time.*

Also, the user may use one of several ASCII editors that have this capability as well.

3.2 EFDC_Explorer Settings



This toolbar button allows the user to specify some installation specific parameters, like the location of the EFDC executable to use, as well as project specific settings like default precisions and some other miscellaneous settings. Figure 3-5 shows the settings form.

The settings for EFDC_Explorer are saved in the EFDC_EXPLORER.INI file that is located in the same directory as the EFDC_Explorer executable. This is an editable ASCII file, though care should be exercised to not corrupt the file. The file structure follows the Windows standard INI file using groups and tags.

The user must first specify the path to the *EFDC executables* before EE can be used to launch an EFDC run using the Run button. The *Browse* button is used to browse to the corresponding EFDC executable. If the EFDC executable selected does not exist, EE will change the associated path background to light red.

The *Default Precision for Write Operation* settings are for setting the output/display precisions for the indicated data types. The default settings shown are appropriate for most applications. However, for special cases (e.g. flume studies or other types of research applications) the user will likely have to make adjustments to the defaults. The settings are stored in the project specific EFDC.EE file.

Other miscellaneous settings include: *Secchi Conversion Factor* (to convert light extinction coefficients to a Secchi Depth in meters); the *Minimum Inorganic Sediment Thickness* allowable; *Carbon/Dry Weight Ratio* (ratio of mg of carbon to mg of dry weight to convert POC and Algae to a solids weight); and the *Maximum Number of Cells to Auto Refresh*.

The company/organization's name and address as well as the default fonts can be set by selected the *Edit* button in the *Company Data & Defaults* frame.

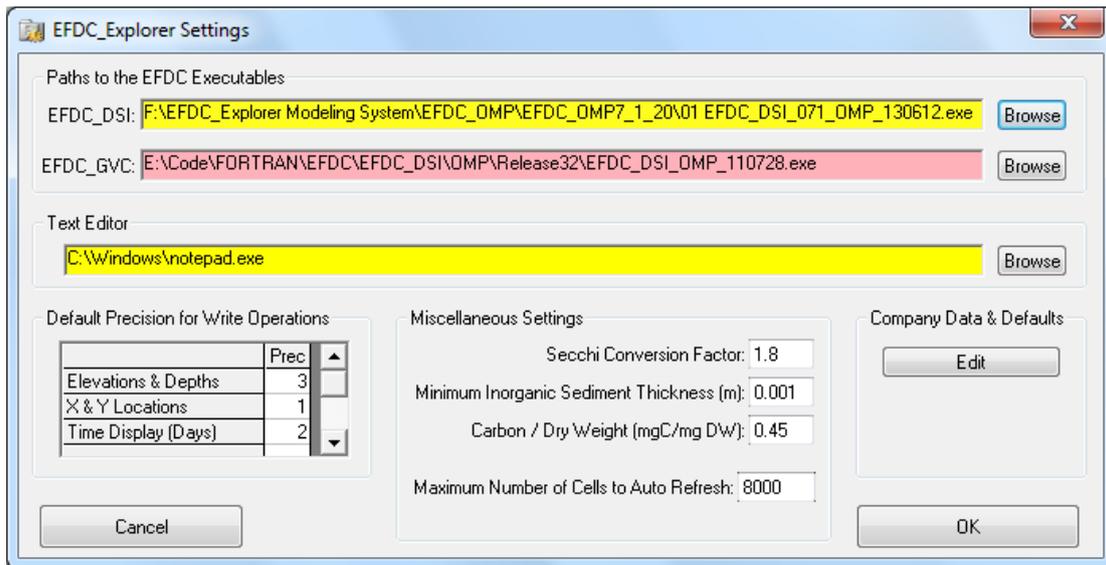
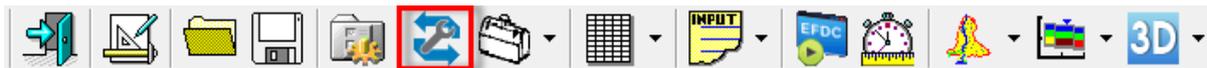


Figure 3-5 EFDC_Explorer settings form.

3.3 Date and Coordinate Conversion Tool



This toolbar button brings up a calendar and coordinate conversion tool. There are three tabs on this tool, *Date Conversion*, *IJ/XY Conversion*, and *UTM Conversion*. The first, shown in Figure 3-6 allows the number of days to be calculated from the time of a Base Date to the time of a specified (Gregorian) calendar date. If the calendar date entered is before the Base Date a negative number of Julian days is given. This tool can also be used to determine a Calendar Date, given any number of days before (<0) or after (>0) a given Base Date. The default Base Date is the Project's Base Date. However the user can change the Base Date in this utility without impacting the Project's Base Date.

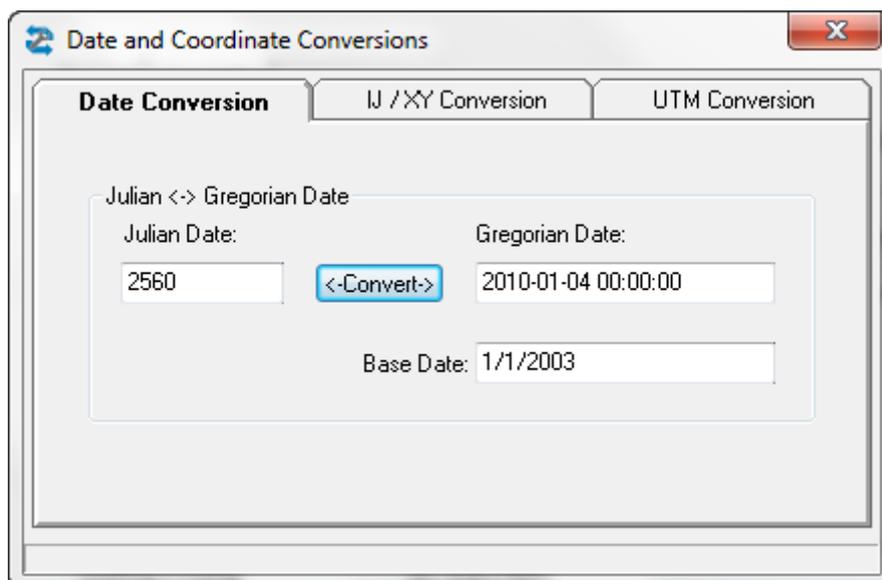


Figure 3-6 Julian to Calendar Date conversion.

The *UTM Conversion* tool is in the second tab is shown in Figure 3-7. An L index or IJ pair can be entered into the text box and EE will automatically display the corresponding L, IJ or model grid coordinates.

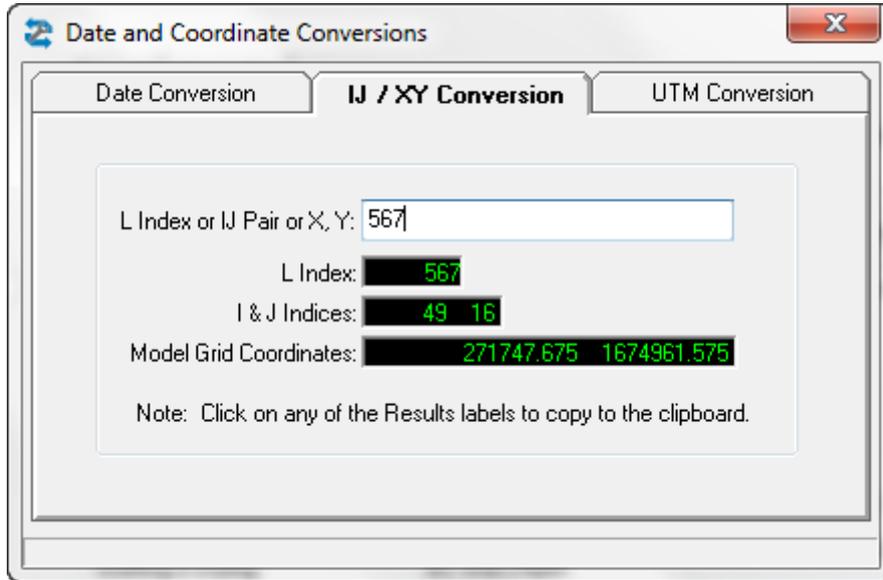


Figure 3-7 Date and Coordinate Conversions.

The user may also select the *UTM Conversion* tab to convert from longitude and latitude coordinates to UTM or vice versa. The user should enter the coordinates in the text box and ENTER keystroke for this conversion to take place as shown in Figure 3-8. The user may also copy this information to the clipboard with the *Copy to Clipboard* button. A file containing coordinates may also be converted using the *Convert File* button and browsing to the file to be converted.

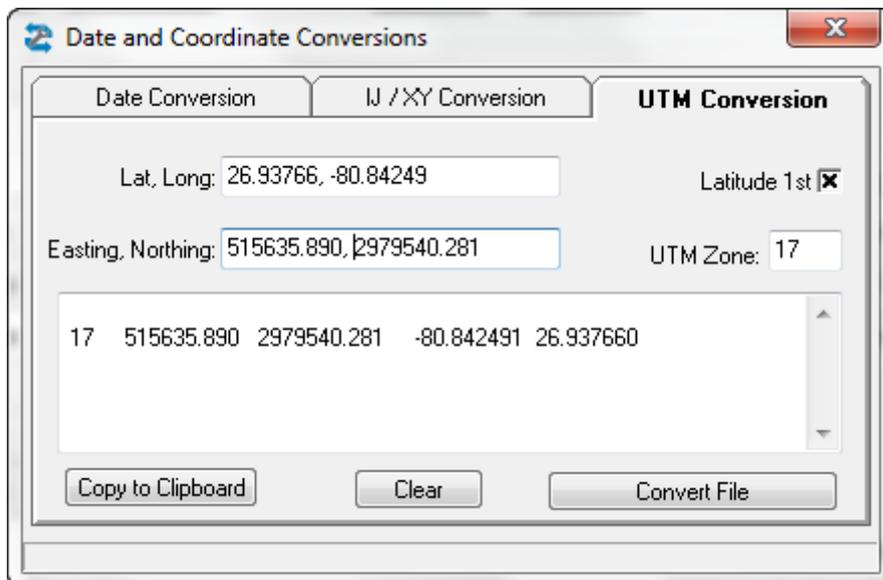


Figure 3-8 Date and Coordinate Conversions.

3.4 Toolbag: General Utilities



The *Toolbag* function provides access to a range of general utilities that support the modeling process but may not be directly related to the EFDC model. Figure 3-9 shows a screen capture of the current functions available under the *Toolbag*. The following list provides a summary of these functions.

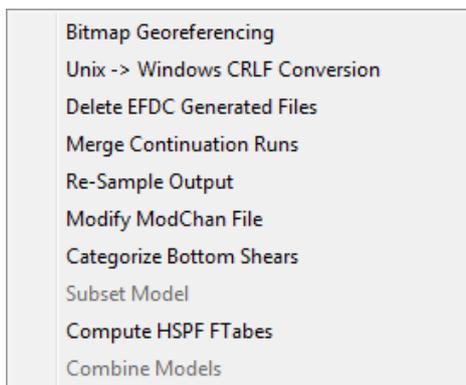


Figure 3-9 Toolbar functions.

Bitmap Georeferencing: This utility can be used to create or edit the configuration file that EFDC_Explorer uses to provide bitmap images and maps as a background for the display of models in *ViewPlan*. To use bitmaps you must first create a “geo” file. This is an ASCII file with the extension “geo” that contains the pixel and project coordinate information. It is very similar to MapInfo’s TAB format. One “geo” file can reference multiple bitmaps to build mosaics, if needed. When this function is selected a form is displayed with the bitmap filenames and coordinate information. Any changes must be saved into the same or new “geo” file for later use in *ViewPlan*.

Unix -> Windows CRLF Conversion: This utility scans a specified directory and determines if any of the files contained in the directory do not use the Windows CRLF standard. The user then has the option of automatically converting all non-Windows CRLF files to the Windows standard. EFDC_Explorer uses the Windows CRLF convention, so files created or edited on a Unix platform need to be converted to Windows before use by EFDC_Explorer.

Delete EFDC Generated Files: This utility allows the user to specify certain groups of output files from EFDC to be deleted. The main purpose of this function is to clean up all the project directories and save disk space by deleting all the files in a project directory that are not needed by EFDC or EFDC_Explorer. This utility works on the specified directory and ALL subdirectories under the top level directory specified. The utility scans the directory structure and then lists all the files that may be deleted if the user presses the *Delete Matched Files* button. If a few files are listed that the user doesn’t want deleted the user can delete their file names from the list. This will keep them from being deleted as the utility uses the files in the list to delete.

Merge Continuation Runs: This utility merges EFDC_Explorer specific output files from two EFDC runs into a single output file. Multiple runs can be merged by starting with the earliest runs and sequentially appending each subsequent run. At the end of each merge process, the EE_WS, EE_Vel, EE_WC, EE_WQ and EE_Bed from the base run will be saved in the base run project directory, but with an “.org” extension. The

newly merged files will have the “.out” extension and can be used by EFDC_Explorer. The models/projects must be of the same model domain and discretization.

Re-sample Output: Allows the user to reduce the number of saved output snapshots in the EFDC_Explorer output files (i.e. the EE_WS.OUT, EE_VEL.OUT, EE_WC.OUT, EE_WQ.OUT and EE_BED.OUT). At the end of the resampling process, the original output files will have been saved in the project directory but with an “.org” extension. The newly resampled files will have the “.out” extension and can be used by EFDC_Explorer. To resample the output the user runs this utility and enters a snapshot skip interval. Once the user verifies that the resampling produced the desired results, the user may want to delete the *.ORG files to save disk space. This function can also be used to delete all the model results after a specified time (i.e. truncate).

Modify ModChan File: This option provides access to a channel modifier global editor that recalculates channel lengths, change orientation from U to V and vice-a-versa. It also has a Q/A function to ensure all the upstream and downstream I & J's point to valid cells. The *ViewPlan* function allows the user a graphical point and click approach to create and edit these “pipes”.

Categorize Bottom Shears: This utility scans the EE_WC.OUT file for the entire simulation period and builds a list of categorized shears into predetermined bins. The results are displayed in a message box and placed onto the clipboard for pasting into Excel® or some other display/plotting package.

Compute HSPF FTables: This utility computes the data necessary for creating an FTable for the HSPF model. It assumes that the current project has been designed to be able to generate the necessary information for the FTable. This type of project is simply the base model, but without the actual inflows into the domain. Instead, all the flow boundaries have a step flow to allow the system to achieve steady state at that flow, and then all the flows must be stepped up again to the appropriate level. Generally, this can be done with just one upstream flow BC, but each case needs to be evaluated. After the run is complete the EFDC results should be a series of steady state flow regimes throughout the model domain. This utility then uses these results along with the reach polygons to build the FTable.

3.5 Grid Tools and Utilities



The *Grid Tools* function on the toolbar contains a range of different functions and utilities that have been needed. Figure 3-10 shows a screen capture of the current functions available under the *Grid Tools* button.

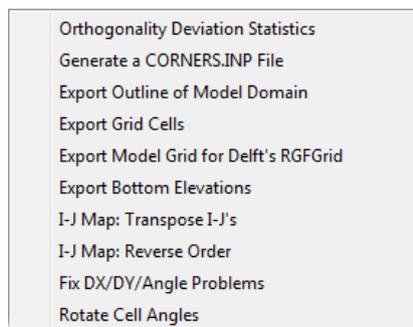


Figure 3-10 Grid Tools functions.

Orthogonality Deviation Statistics: This utility provides summary statistics on the orthogonality of the grid. A perfectly orthogonal grid will have a zero deviation angle at every grid intersection. The goal during the gridding process is to produce a representative and computationally efficient grid of the model domain with as low as practical deviation angles (e.g. < 3 degrees). The user can view a map of the deviation angles using the ViewPlan function.

Generate a CORNERS.INP File: This utility allows the user to generate a CORNERS.INP file. This is which is in the DRIFTER module, and determines the centroid of a cell from the coordinates of the four cell corners. This file is generated automatically by EE when a new model is built, but this tool allows the user to force EE to recompute the cell corners, if needed

Export Outline of Model Domain: Use this function to output a bounding polygon in the coordinate system used by the model. The output file format is P2D. This file can be used as an overlay in ViewPlan or imported into GIS systems.

Export Grid Cells: Use this function to export the cells by cell polygons in the coordinate system used by the model. The output file format is P2D. This file can be used as an overlay in ViewPlan or imported into GIS systems.

Export Model Grid for Delft's RGFGGrid: Use this function to export the currently loaded EFDC model grid out to a Delft RGFGGrid formatted GRD file. This file can then be directly loaded into RGFGGrid for editing. RGFGGrid edited grids can be imported into EFDC_Explorer by selecting “Generate New Model | Import Grid | Delft RGFGGrid”.

Export Bottom Elevations: Use this function to export an XYZ data file at the cell center coordinates of the bottom elevations.

I-J Map: Transpose I-J's: These *I-J Map* functions are used during the grid generation-importing process to correct any model I-J orientation issues. This function switches I to J and J to I. If boundary conditions are already assigned, the IJ mapping is remapped to the new IJ space.

I-J Map: Reverse Order: These *I-J Map* functions are used during the grid generation-importing process to correct any model I-J orientation issues. This function flips the numbering direction for either the I or the J index. If boundary conditions are already assigned, the IJ mapping is remapped to the new IJ space.

Fix DX/DY/Angle Problems: This routine attempts to correct DX, DY and Cell Angle problems before computing cell metrics. EE picks a South cell face for cell L=2 then assigns DX/DY/Angles. The user may enter a face shift of n, where n=0 (the default) means no shift but correct the angles (if needed), and n can vary from -2 to +2. Entering a -1 EE reorients the IJ map and corresponding DX/DY -90 degrees.

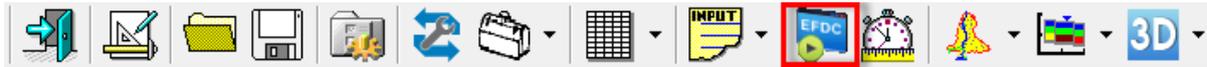
Rotate Cell Angles: This function applies a rotation to the cell rotation angles. It does not rotate the actual cell. If using the CORNERS.INP file it just applies a user specified rotation to the cell rotation matrix. In EFDC the cell's rotation matrix is used for velocity plots and interaction with the wind field.

3.6 Text Editor



This button on the toolbar starts the ASCII editor (configured in *EFDC_Explorer Settings*, see Section 3.3) and directly loads certain input files for the current project. From the drop down window the user can directly access the input files: EFDC.INP, DXDY.INP, LXLX.INP, CELL.INP, WQ3DWC.INP, WQPSL.INP or WQ3DSD.INP. In addition, the user can select "Other INP" to access any of the input files in the current project.

3.7 Run Model



This is the function that actually runs an EFDC project/model. It does not first save to disk the currently loaded EFDC project prior to running. Therefore, if the user has made changes that they desire the run to reflect, the user must first save the project.

Figure 3-11 shows the options box for the *Run Option*. The *EFDC Run* form provides quick access to the most pertinent run time settings for the EFDC simulation. Some of these data have already been set in the main form but EE allows the user to review and update these data as needed just prior to running the model. EE will save the EFDC input files automatically, if changes are made.

3.7.1. General

If the user selects the *Overwrite?* check box then existing EFDC+ model results files will be overwritten. If model results exist in the project folder, EE will not start a new run unless this checkbox has been checked. If the user does not want to overwrite the results, then save the project out to a new folder then run the model.

The user should ensure that the correct EFDC executable has been selected in the EFDC_Explorer Settings in the main form (see Section 3.2). The run option builds a batch file, saves it in the EFDC project directory, and then launches the batch file. The file name is 0_RunEFDC.Bat. This DOS batch file launches the EFDC executable EFDCPlus or EFDC_GVC as a DOS window with the current project directory in the Title bar.

The screenshot shows the 'EFDC_DS Run Options' dialog box with the 'General' tab selected. The dialog has three sub-tabs: 'General', 'Model Timing', and 'Run Time Diagnostics'. The 'General' tab contains the following settings:

- Run Time Options:**
 - Enter the number of OMP Threads to use for the EFDC_DSI_OMP run: 2 (Max: 4)
 - KMP Offset: 0
 - There are existing EFDC_DSI model results files in the current project folder: Overwrite?
- Run Time Status:**
 - Type: 819
 - I: 4
 - J: 4
 - Print Interval: 500
- EFDC_Explorer Post Processing Linkage:**
 - Use
 - Linkage Freq: 60 (min)
 - Do not pause at the end of the run:
 - Generate Calibration Plots & Statistics:

At the bottom of the dialog are two buttons: 'Cancel' and 'Run EFDC_DSI'.

Figure 3-11 EFDCPlus Model Run Option Form: General.

Run Time Status frame contains the settings for feedback to EFDC's runtime screen during the model run. The user can simply type in the desired I and J or the user can set them using the mouse. To set using the mouse, select *ViewPlan | Cell Map* or *ViewPlan | Bottom Elev* views, then right mouse click on the desired cell and select *Set as Show I J*. The data displayed on the screen depends on the *Type*, whose options are: 0-TSS, 1-Salinity, 2-Temp, 3-Dye, 5XX-Toxic, 6XX-Seds, 7XX-Snds, 8XX-WQ Var, where XX refers to a specific constituent in the sub-model group.

For more information on EFDC_DSI_OMP, setting the KMP offset, and selecting the number of threads for multithreading, please see Section 11, Open Multi-Processing Functionality.

When EFDCPlus finishes execution, the model waits for the user to press a key to continue/exit. If the user does not want the pause function, they make check the box *Do not pause at the end of the run*.

EE now has the option of automatically generating calibration plots and statistics. In order to do this the file "Orun" is created as a flag which is tells EE that the model is still running or has crashed. When this is not the case EE will automatically generate the plots and statistics. If the user opens a new EFDC model with the same instance of EE while the EFDCPlus model is running, the automatic plot/statistics generation function is aborted. A new EE window should be opened if the user needs to open another EFDC model.

3.7.2. Model Timing

Model Timing options may also be set by the user with the *Run Options* form as shown in Figure 3-12. These options are also available within the *Timing* tab further described in Section 5.5.

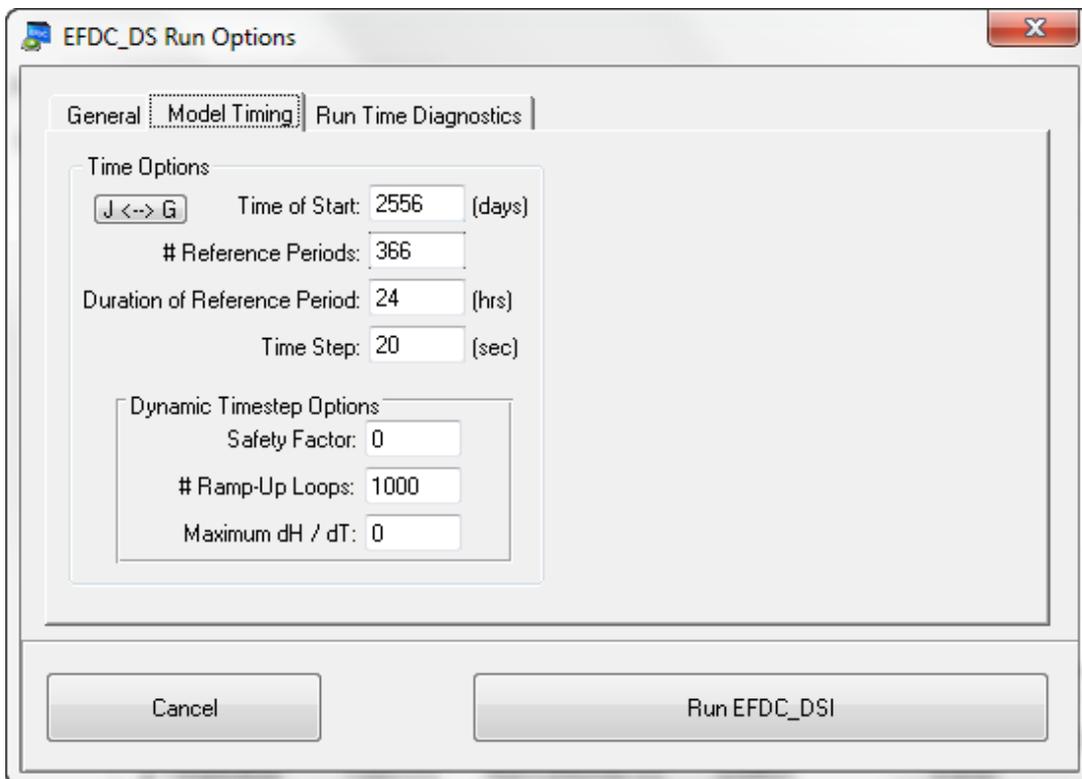


Figure 3-12 EFDCPlus Model Run Option Form: Model Timing.

3.7.3. Run Time Diagnostics and Mass Balance Reporting Options

Figure 3-13 shows the *Run Logging Options* frame with various check box options to aid error diagnosis. Checking the *Enable Diagnostics* causes EFDC to produce many extra output files but will add to runtime. The diagnostic files depend on the EFDC options, and the source code needs to be consulted to determine the content of the diagnostic files. The diagnostic files can usually be turned off after initial model testing. Other options include the ability to write Negative Depth and Courant diagnostics; and to write the optional EE_ARRAYS.OUT file, which contains data from the arrays in the EEXPOUT.FOR subroutine.

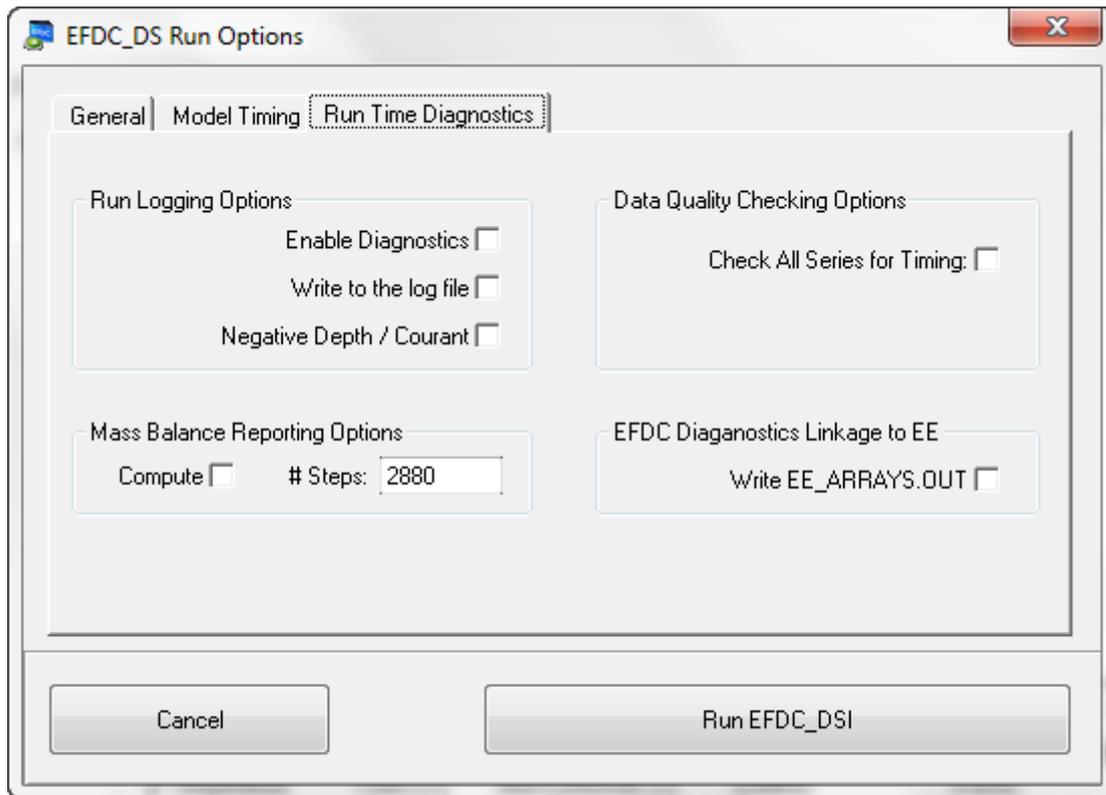


Figure 3-13 EFDCPlus Model Run Option Form: Run Time Diagnostics.

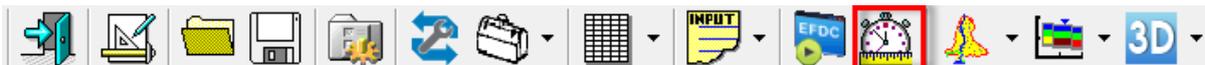
The *Mass Balance Reporting Options* frame enables mass balance checking and reporting for EFDC. The number of steps relates to the number of time steps accumulated between reporting. Consistent with the fixed naming convention, the mass balance file written by EFDC is BAL.OUT for the 3 time level solution and BAL2T.OUT for the 2 time level solution. The user must refer to the FORTRAN code to interpret these outputs.

In the *Data Quality Checking Options* frame, the *Check All Series for Timing* frame will run a check on the EFDC input files to ensure that all of the boundary condition time series files start and end times fit within the model run time, even if they are not used by a boundary condition. EFDC_Explorer ALWAYS checks for boundary condition timing for time series used by the model. However, if the user is running the model in DEBUG model (e.g. VS2010 debug mode), the model will report an out of array bounds error for any time series that starts late or ends too soon. This option helps the user either fix the error or delete the series, since it is not being used.

3.7.4. EFDCPlus Runtime Pause/Resume

The EFDCPlus model allows the user to *pause* and *resume* the EFDC model during a run by pressing any key when the model's DOS window has focus. This is often used to check the model performance during a run. The user can pause the model, load the results, perform any level of review including calibration statistics and plots, and then resume the model. This can be repeated as many times as desired during an EFDCPlus run. Note that pressing the same key that was used to pause the run will exit the run. Pressing any other key will resume the model run.

3.8 Run Times



The *Show Runtime Output Summary* (Clock) button provides a summary of the project's run times in hours. As EFDC runs it keeps track of its run time, and when the run finishes it writes the information to the file TIME.LOG. When this button is pressed, EFDC_Explorer reads the TIME.LOG file and provides a summary of the information. Figure 3-14 shows an example timing output. This function is operational only for the EFDCPlus version. The summary may be copied for pasting into another application with the *Clipboard* button.

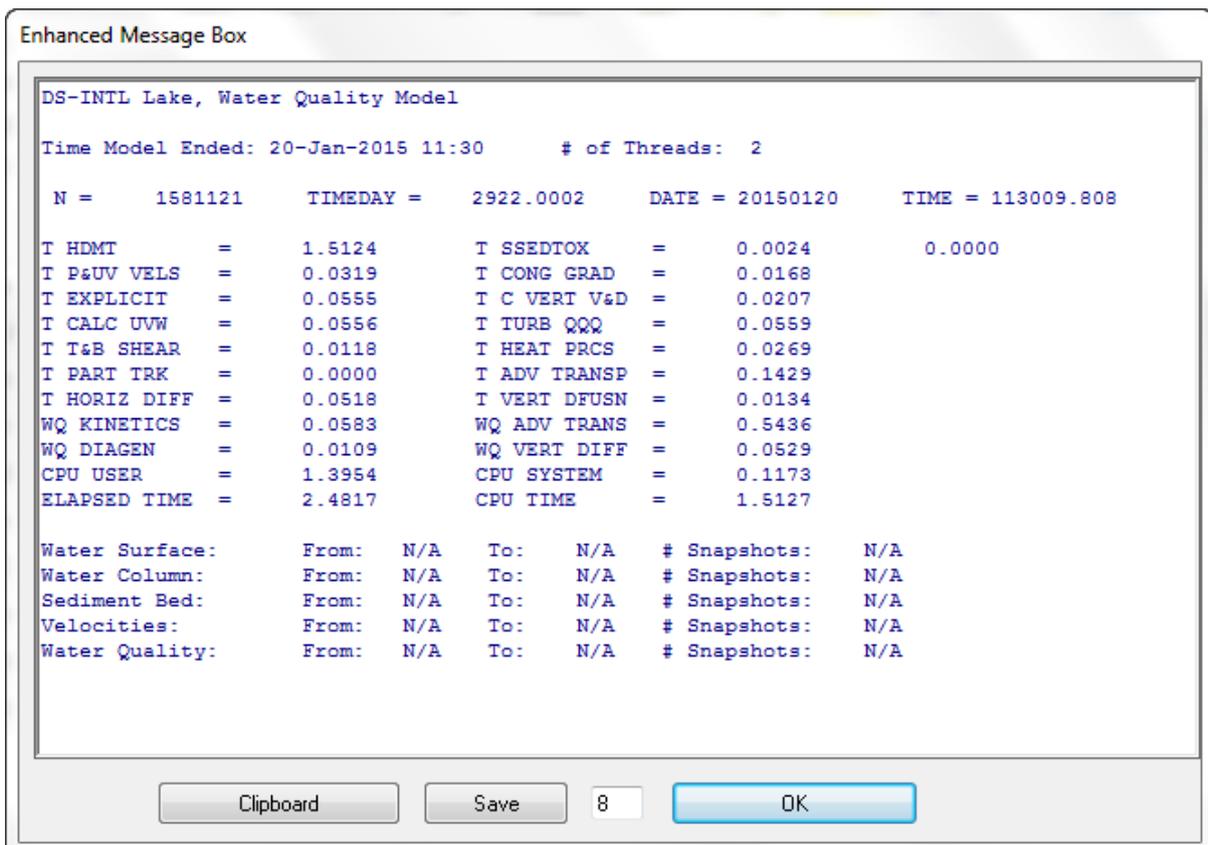
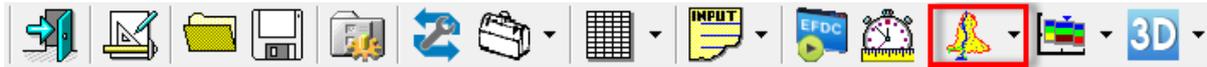


Figure 3-14 Example of the model run times.

3.9 ViewPlan Viewer



The *ViewPlan* button of the main toolbar provides access to the utility for viewing two dimensional (2D) plan views of the model. This function is used for pre-processing visualization and editing of the grid, initial conditions and boundary conditions. Once the model has been run and output files generated (see Section 7.1). *ViewPlan* can be used to view 2D plots, extract model cell time series and vertical profiles and other post-processing visualizations and analyses. Section 7 contains a more complete description of the features and use of *ViewPlan*.

ViewPlan has many options and features for displaying background maps (geo-referenced bitmaps), line features (e.g. shorelines), ESRI® .SHP files, labels, measured data, model-data residuals and many more. An example plot is shown in Figure 3-15 of Perdido Bay's bathymetry with the 250K scale USGS topo map in the background, a timing frame showing the Gulf of Mexico tide level at the date/time indicated in legend and the location/ID of the defined calibration stations.

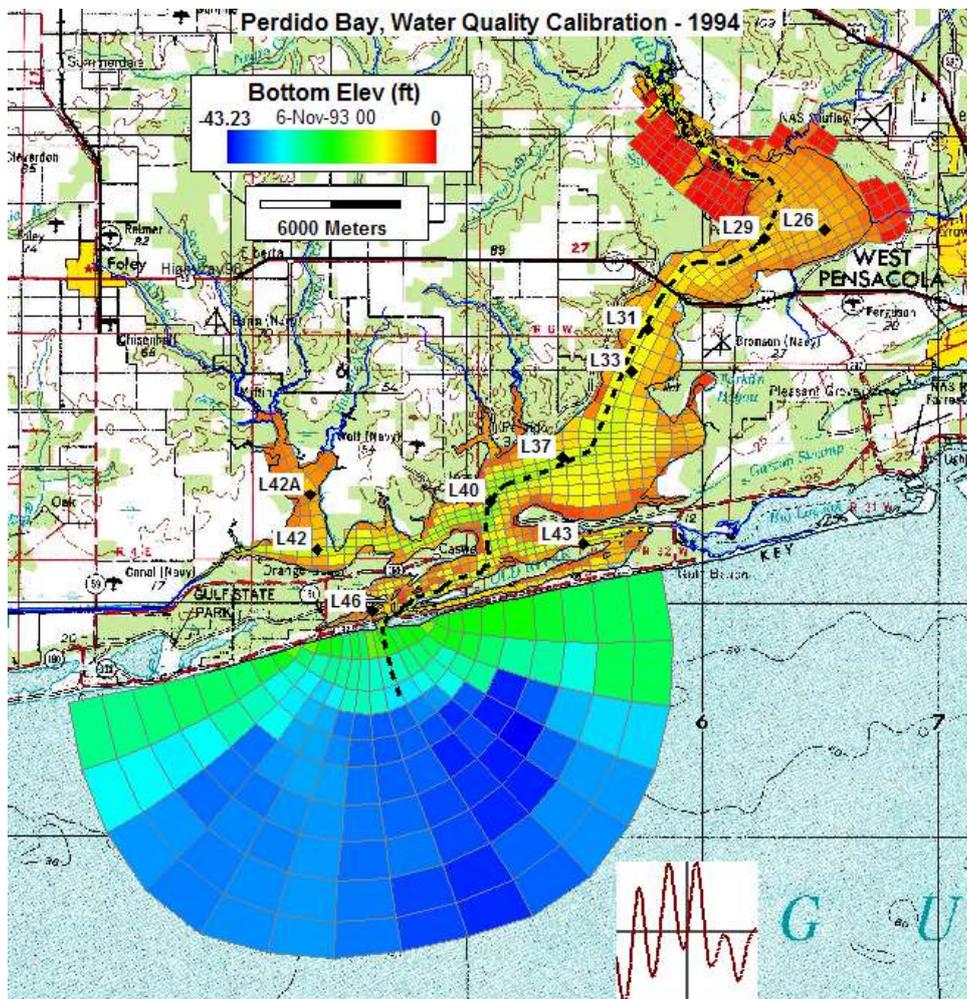


Figure 3-15 Example of ViewPlan output for the Perdido Bay water quality model.

ViewPlan provides the user with a dropdown menu comprising the following options:

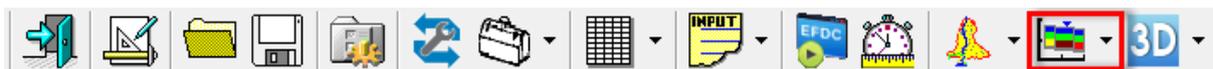
View Initial Conditions: This option may be used when the user is setting up the model or wants to view only the IC's, even if model output has already been loaded.

View Model Results: This option is used after the model has been run and the user wishes to analyze the model results. This is the default action if the user clicks on the *ViewPlan* button and not the dropdown arrow.

View Model Results (Re-scan Output): This option should be used if the user has paused an EFDC model run, viewed the results then resumed the model run. EE will only have the data from the originally paused run loaded. To later view the complete model run results, the user would then use this option to reload the model results.

Drag & drop files such as ArcView polylines or ASCII data posting files to provide quick annotations on the model.

3.10 ViewProfile Viewer



The *ViewProfile* button of the main toolbar provides access to the visualization of the 2D vertical section post-processing utility of EFDC_Explorer. An example of the type of plot available is shown in Figure 3-16. This plot shows a 2D profile of dissolved oxygen along the user defined transect shown previously in Figure 3-15 (see the black dotted line) for Perdido Bay. Section 8 contains a more complete description of the features and use of *ViewProfile*.

The *ViewProfile* button also provides the user with a dropdown menu with functions identical to those described above for the *ViewPlan* button.

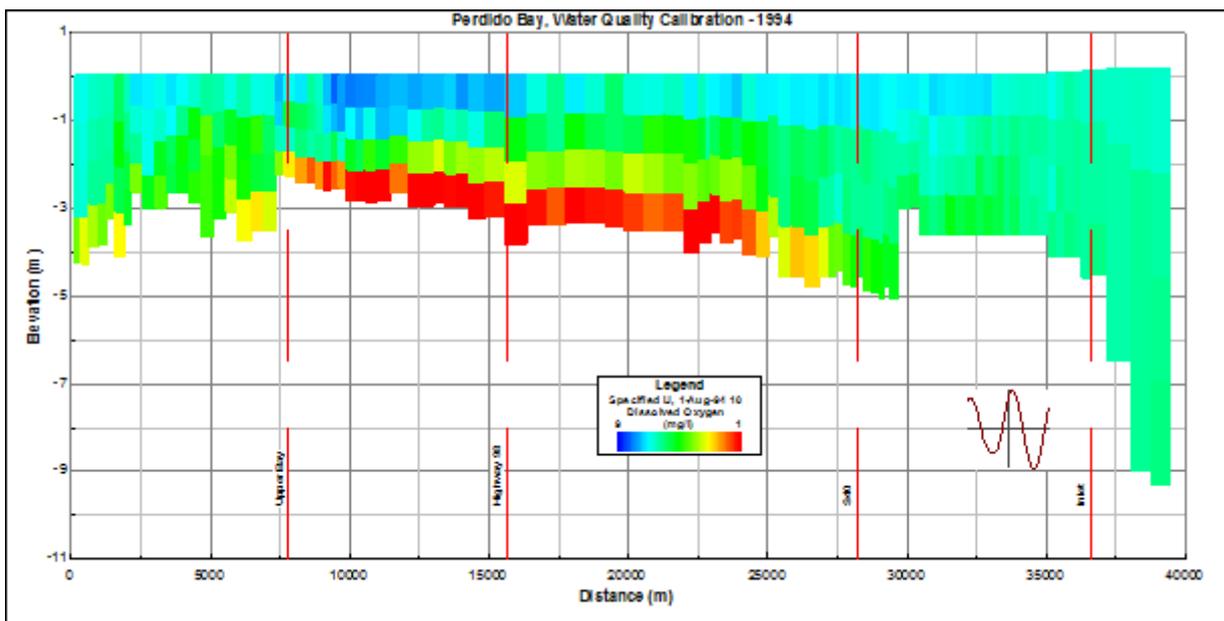


Figure 3-16 Example of ViewProfile for dissolved oxygen for WQ model.

4 Generate New Model



EFDC_Explorer can generate a new grid and write to disk the essential EFDC model files to begin building an application. Figure 4-1 shows an example model generation options form.

There are many settings that need to be assigned when building a new model. The approach taken by EFDC_Explorer is to use a master input file for EFDC which is stored in a non-editable database. EFDC_Explorer automatically updates the EFDC default initial conditions from this MS Access file (EFDC.MDB) for the following files:

- EFDC.INP
- WQ3DWC.INP
- WQ3DSD.INP
- WQRPEM.INP

From EE7.3 onward this method supersedes the use of the EFDC.INP file which had been used to update the basic features the user required such as computation options, hydrodynamic settings, and a range of miscellaneous settings. Formerly a valid EFDC.INP had to be selected prior to being able to generate a new model.

EFDC_Explorer can quickly generate simple to complex Cartesian grids. These grids can be uniform or expanding, rotated and trimmed to match the physical domain. For more complex grids, EFDC_Explorer can import grids generated with many tools or other models as described further below. In addition to these grid generation/import options, EFDC_Explorer can import a generic set of nodal points.

Generate EFDC Model

Grid Type

- Cartesian
- CVLGrid
- Import Grid

Grid/Element Generation Options

- Uniform Grid
- Expanding Grid
- Rotation Angle: 15

Uniform Grid

Lower Left		Upper Right	
Easting:	373610	Easting:	375410
Northing:	3103260	Northing:	3106060
Delta:	100	Delta:	100
nX:	18	nY:	28

Buttons: Update, Set to Data

Active Cell Polygon: e:\EFDC_Explorer Modeling System\Training Courses\2014-08 Edmonds\Distribution\2DLake\Mc [Browse]

Channel Polygon: E:\EFDC_Explorer Modeling System\Training Courses\2014-08 Edmonds\Distribution\2DLake\Dε [Browse]

Global Options

Roughness

Channel: 0.04

FloodPlain: 0.01

Water Surface: 0

of Water Layers: 5

Note

All model settings can be adjusted after initial model build using the functions available in EFDC_Explorer.

Inside Polygon Test Option

Number of Corners Inside Polygon(s) to Count Cell as "Inside": 0

Bathymetry Assignment Options

- Flat Bottom
- Bottom Slope - I Direction
- Bottom Slope - J Direction

Bottom Elev (m): -1

Slope: 0

- Average all Elevations in a Cell

Buttons: Cancel, Keep Titles , Generate

Figure 4-1 Generate new model options form, with Cartesian uniform grid option.

4.1 Grid Type

The *Grid Type* frame contains the primary selection of grid generation function. The contents of the center frame, *Grid/Element Generation Options*, will vary depending on the option selected. Shown in Figure 4-1 is the frame contents Cartesian grid type described below.

4.1.1. Cartesian Grid

There are two options for generation of Cartesian grids, uniform grid spacing and variable grid spacing. The user selects the desired option and then fills in the appropriate settings as outlined below.

The coordinate system used in the topographic file, if used, boundary polygons and specified in the various required coordinate parameters must be the same.

Typically the user is not building a rectangular model domain. Therefore the user has the option of entering a polygon file that specifies the outline of the model domain. Any cells that are inside the polygon will be set as active for the model. The *Cell Test* frame allows the user to set the inside polygon test options to determine if the cell is inside the model domain or not. An option value of "0" will cause the inside cell test to use the cell centroid only. If the *# Corners* is between 1 and 4, the inside cell test will require the specified number of cell corners to be inside the polygon to be considered "inside" and therefore an active cell.

If the user is modeling a riverine system with overbank/floodplains, the user may provide a *Channel Polygon* file. This file assigns all cells outside this polygon but inside the model domain as floodplain cells (Cell type = 7). Those cells inside the polygon receive a standard computational cell type (Cell type = 5). This allows some of the tools in EFDC_Explorer to be quickly applied, e.g. Roughness Options.

The *Rotation Angle* can be entered to rotate a Cartesian grid about its centroid. If a grid is to be rotated, the coordinates entered in the following sections are based on the unrotated grid. However, the application of the *Active Cell Polygon* and *Channel Polygon* are applied after the cell rotation.

4.1.1.1 *Uniform Grid*

For the Cartesian grid option, the user must specify the model corner coordinates and spacing. Several utilities have been provided to speed up this process. The *Set to Data* button simply copies the data from the topographic data corners to the grid corners. The user can edit them afterwards as desired. Secondly, the *Update* button computes empty fields. For example, if the user enters the lower left (LL) corner, the DX, DY and NX (IC-2) and NY (JC-2) then presses the *Update* button, the upper right (UR) coordinates are set. Likewise, if the LL and UR coordinates are set and the NX and NY values are set the DX and DY are computed.

If the user has specified 3 of the 4 entries per dimension, pressing the Ctrl-U key in the field needed will cause EFDC_Explorer to compute the required entry.

4.1.1.2 Expanding Grid

An expanding grid is simply a variable spaced Cartesian grid that expands in all directions from a focal point. The form shown in Figure 4-2 shows the parameters needed for developing an expanding grid. The user must specify the coordinates of the focal point, the initial (smallest) delta X and delta Y's, the rate at which the user wants them to expand at and the maximum cell sizes. Specify an *Active Cell Polygon* to trim the cells to the desired model domain. The spatial limits of the grid are set either by the topographic data or the active cell polygon.

Figure 4-2 Cartesian gridding: Expanding & rotated grid.

Figure 4-3 shows an example of the expanding grid developed for the San Francisco Bay. The focal point is just offshore from Hunters Point.

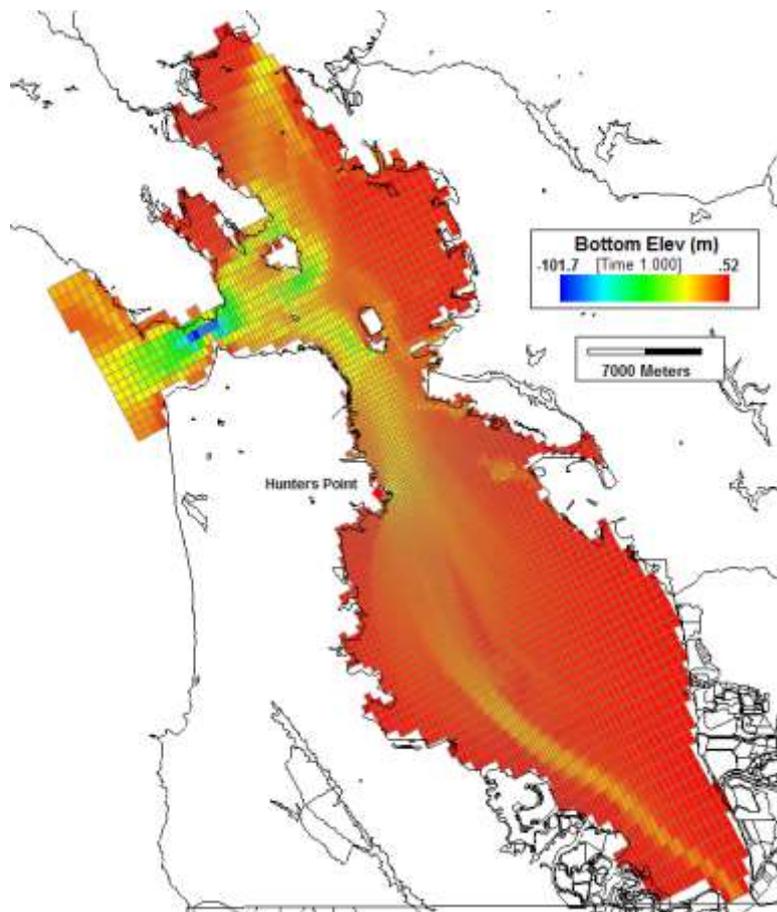


Figure 4-3 Expanding Cartesian grid example of San Francisco Bay.

4.1.2. Import Grid

This feature allows the user to import an existing model grid from another hydrodynamic model or a grid generated using a supported third party grid generator. The types of third party grids that can be imported are:

- CVLGrid (DSI, curvilinear grid generator)
- Delft RGFGGrid (Delft 2006),
- Grid95, or
- SEAGRID (Signell, 2007).

EFDC_Explorer can also import the grids from the following models:

- GEFDC (Hamrick, 2007)
- CH3D (WES version and University of Florida version), and
- ECOMSED.

In the *Grid Type* frame the user should select the *Import Grid* option. The dropdown list below the option is then enabled. The user then needs to select the appropriate import type. Import type dependent options will then be displayed. The user should specify the files and enter any options required. The import file(s) which are optional are labeled as such. Figure 4-4 shows an example of the import form with the Delft RGFGGrid option. Generally, it is recommended to use CVLGrid to develop grids best suited to use with EFDC and edit at a later time if required.

For an existing model grid import, the topographic data does not need to be separately processed as the cell bottom data should already exist in the model grid files.

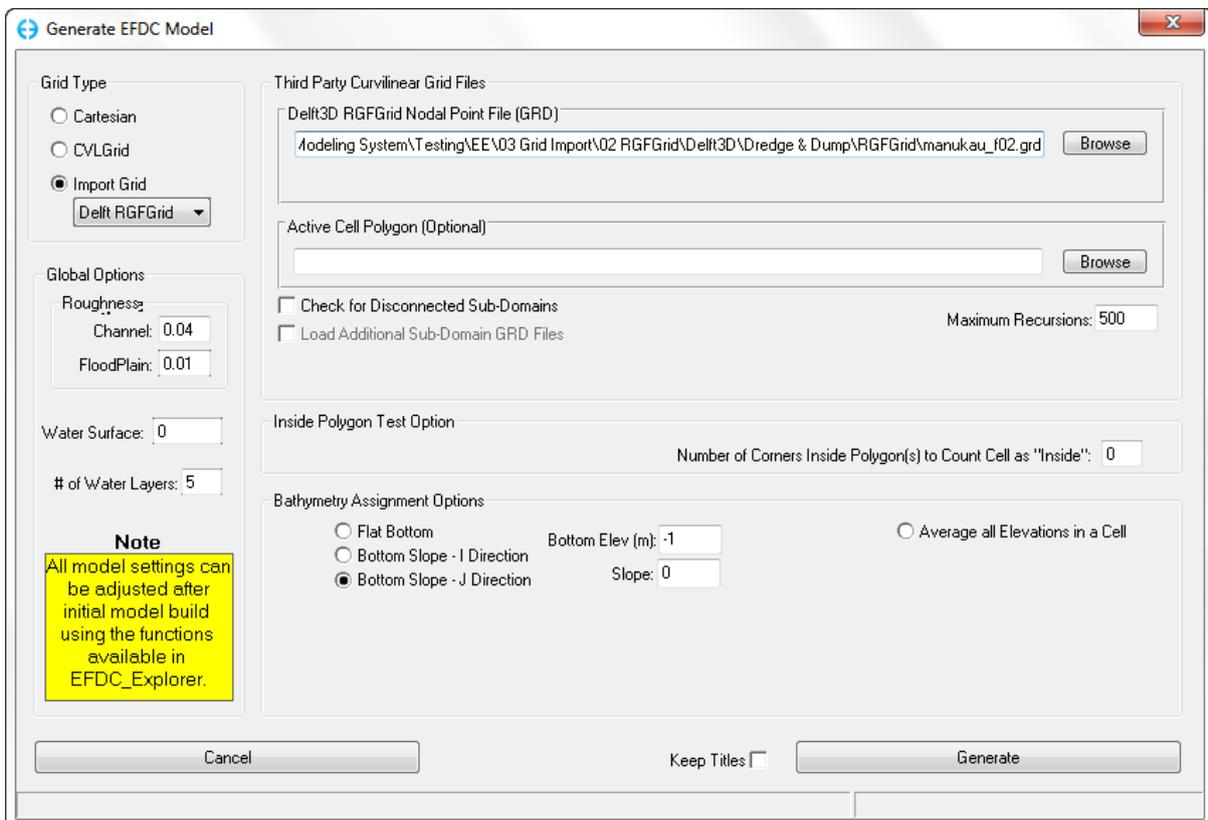


Figure 4-4 Grid generation: Import Delft’s RGFGGrid.

4.1.2.1 Importing Disconnected Sub-domains

EE has the ability to import grids with multiple sub-domains. When the user checks the box labeled *Check for Disconnected Sub-Domains* the MAPGNS file will store the various sub-domains. The user is then able to post-process the grid to allow non-adjoining cells to connect. This is useful when importing complex grid systems.

To import multiple subdomains the user should first browse to load one subdomain. After this they may select the *Check for Disconnected Sub-Domains* checkbox as well as the *Load Additional Sub-Domains CVL/GRD File* as shown in Figure 4-5. The user may then select the *Generate* button. Only after selecting the *Generate* button will EE allow the user to navigate to the other subdomains. The remaining subdomains should all be selected at the same time by combination of *Ctrl* key and *LMC* then select the *Open* button. In this way several unconnected sub-domains can be loaded into EE.

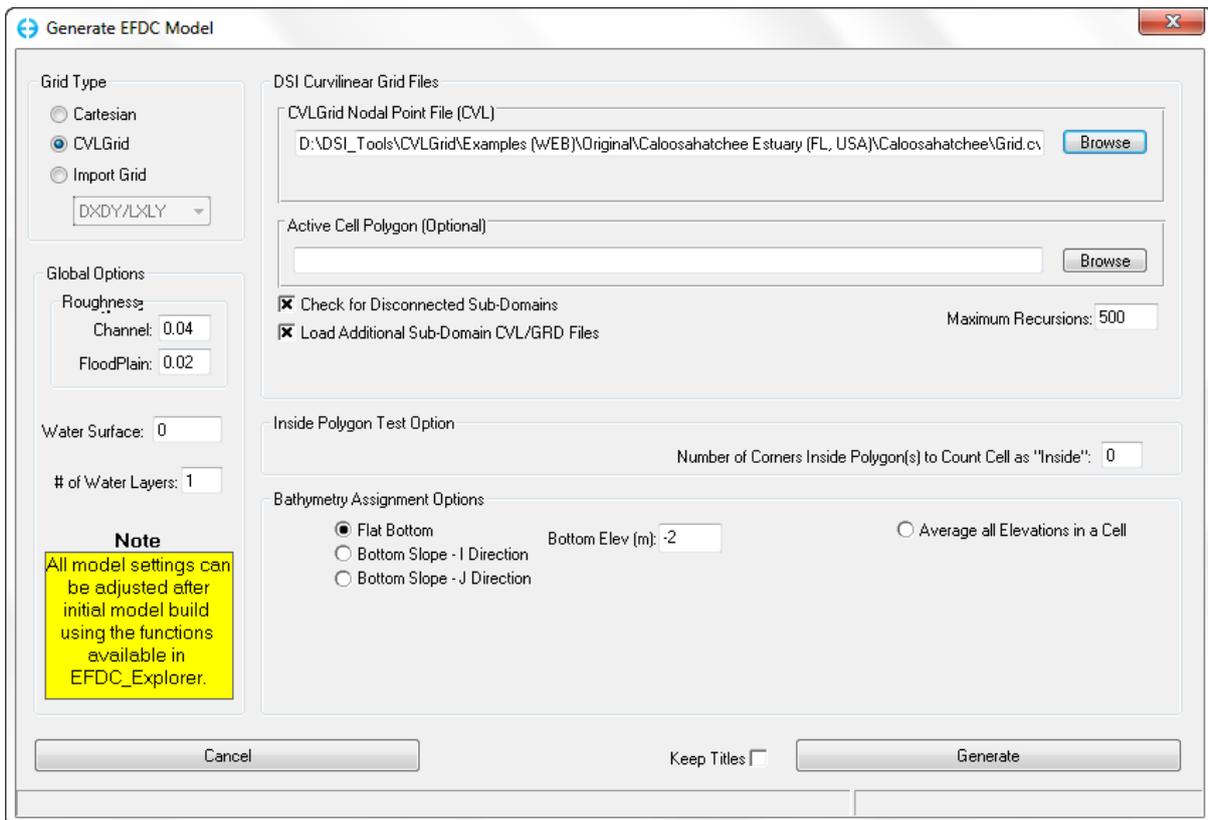


Figure 4-5 Generate Model: Loading multiple sub-domains

See section 7.6.6.1 on how to connect the sub-domains in *ViewPlan*. An example of the MAPPGEW.INP file that EFDC uses to map the connectors is provided in the appendix for the user's reference.

4.1.3. Triangular Cells on Border

EFDC has long had the capability to simulate triangular cells on the boundary of the domain. However, previously the editing and display of these cells was not supported by EE. From release of EE7.2 triangular cells are allowed on the border.

In the CELL.INP file, active cells are designated as 5, and border cells as 9 and inactive cells as 0. Triangular cells are 1 or 2 on the western face and 3 or 4 on the eastern face of the grid. The user may set all border cells as triangular by select ALT-T from the *ViewPlan | Viewing Options | Bottom Elevations*. The user will be prompted to *Convert the staggered border cells to triangular cells*. Selecting “Yes” will automatically place triangular cells on corner cells. To change individual cells the user should then *Enable Edit* from the *Viewing Options* frame and RMC on a cell. Selecting *Edit* allows the user to alter the cell as shown in Figure 4-6 with options *Quad* or *Triangular: NE*.

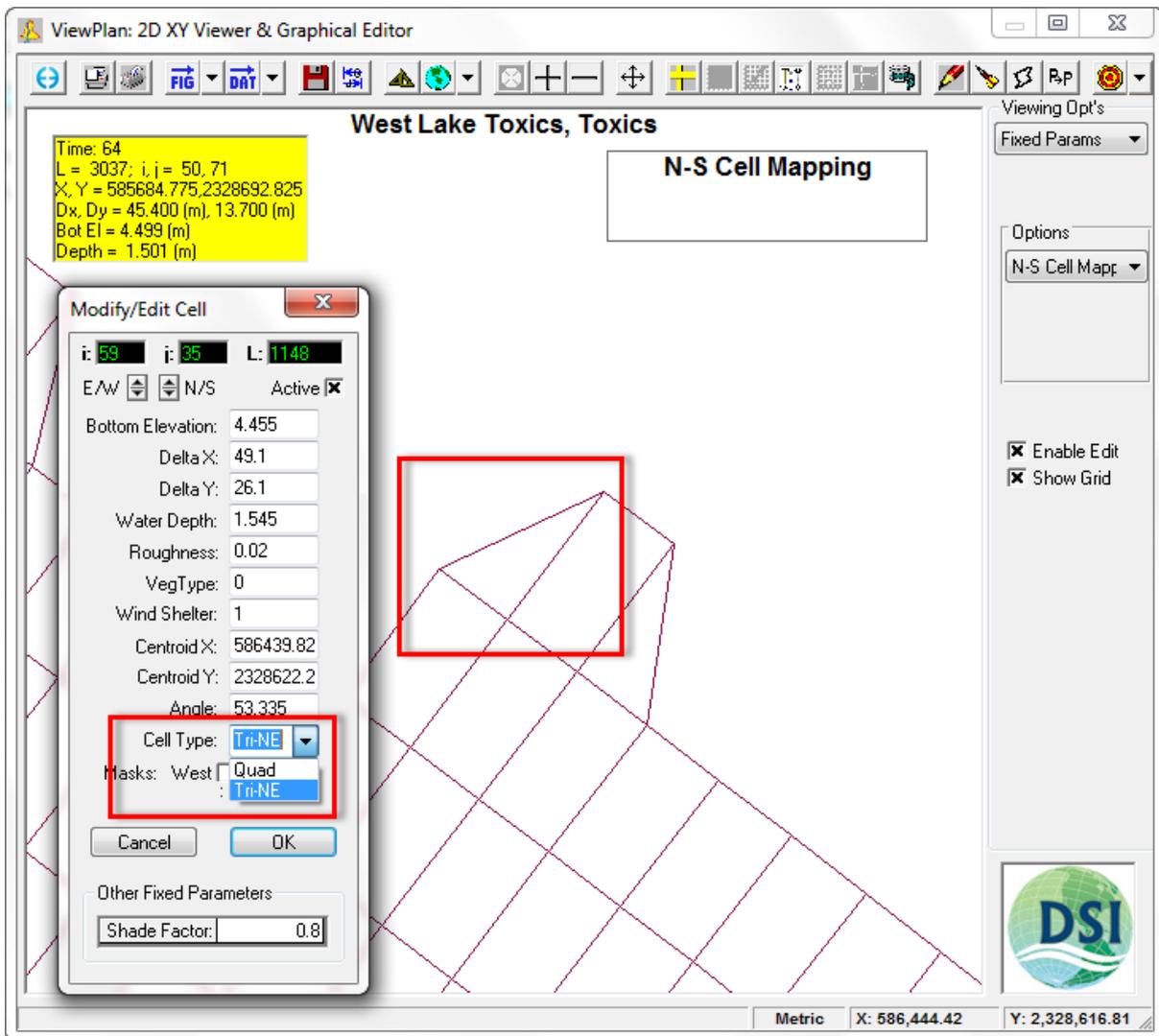


Figure 4-6 ViewPlan: Triangular Boundary Cells.

The triangular edge is also displayed with exporting /graphic images such as shapefiles and Google KML files as shown in Figure 4-7.

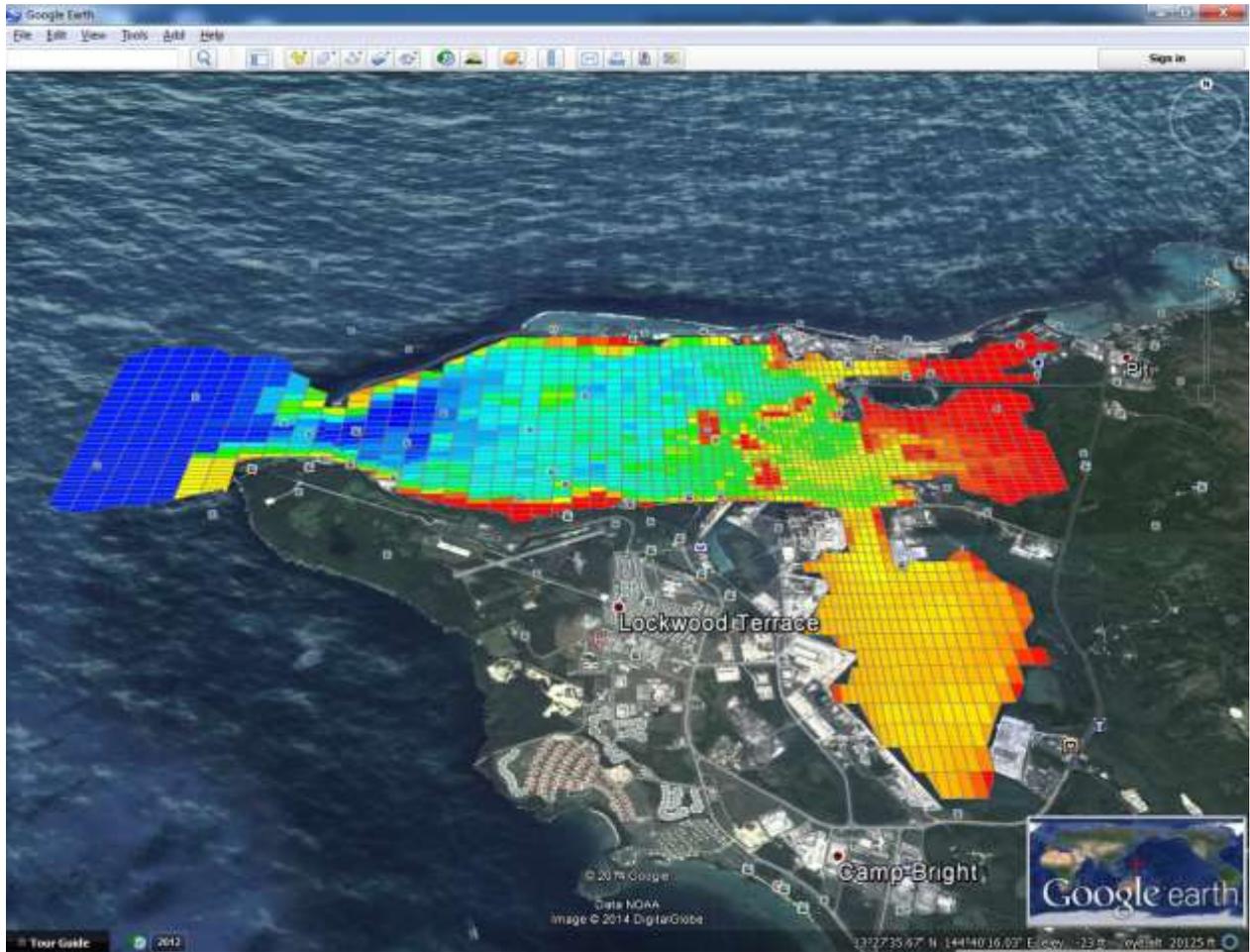


Figure 4-7 Triangular Edge Cells in KML Plot.

4.2 Elevation Options

EFDC_Explorer provides the user with several methods of generating the cell bottom elevations from the input topographic data. The following discussion addresses each option.

The following three options do not require a topographic data file. They can be used for quicker model generation or building test or evaluation models.

Flat Bottom: Applies the specified constant bottom elevation to all cells. Due to the iterative nature of grid generation, this is the recommended option. Actual Model bathymetry can be applied once grid generation is complete.

Bottom Slope – I Direction: Applies a constant bed slope to the cells in the I direction, starting with a specified initial bottom elevation. If the entered slope is positive the bottom elevations will decrease with higher I's. The inverse is true if the entered slope is negative.

Bottom Slope - J Direction: Applies a constant bed slope to the cells in the J direction, starting with a specified initial bottom elevation. If the entered slope is positive the bottom elevations will decrease with higher J's. The inverse is true if the entered slope is negative.

The following three options do require a topographic data file to be specified.

Average all Z's in Cell Use this option if the topographic data is very dense, relative to the grid.

Use Minimum Z This option scans the data and applies the lowest elevation for any point located inside the model cell.

Use Z at Cell Centroid: Use this option if the topographic data is relatively sparse as compared to the grid. This approach uses the inverse distance interpolation scheme to compute the elevation at the X and Y of the cell centroids.

4.2.1. Topographic Information File

Fundamental to any model is an understanding of the topography/bathymetry of the region. If bathymetry is to be applied at this phase, a file must be selected that contains topographic data over the region to be modeled. The formats of this type of file are provided in Appendix B and listed in Section 4.2.2. Once selected, EFDC_Explorer loads the file and displays the corner coordinates in the *Upper Right* and *Lower Left* frames. The units displayed are assumed to be in meters with direct correspondence to the coordinates to be used for the LXL file. An example digital topographic data file using colors to represent the elevation range is displayed in Figure 4-8.

The user should note that this file is not necessary to generate a new model. EFDC_Explorer provides the user the ability to reapply revised or new topographic information to an existing model using the *Assign* button on the *Domain* tab, *Initial Conditions and Bottom Roughness* Tab in the *Bathymetry* frame.

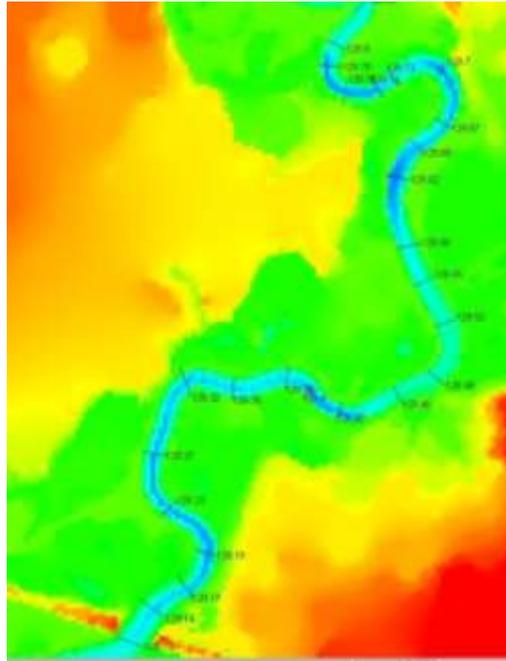


Figure 4-8 Example digital topographic data.

4.2.2. File Formats

Some of the data file formats that EFDC_Explorer currently reads include:

<i>DAT/TXT</i>	ASCII XYZ files with space, comma or tab delimited (Appendix B)
<i>TB2/TP2</i>	ASCII regular grid file (Appendix B)
<i>P2D</i>	ASCII XYZ files grouped into polylines. Space, comma or tab delimited (see Appendix B)
<i>2DM/3DM</i>	Surface Water Modeling System (SMS) mesh geometry file
<i>PLT</i>	TecPlot formatted file
<i>E00</i>	ArInfo Coverage Export file
<i>BIL/DEM</i>	USGS BIL format for Digital Elevation Model (DEM)
<i>GRD/ASC</i>	ArInfo ASCII grid file

Furthermore, some of EFDC_Explorer polygon/polyline formats supported include:

<i>P2D</i>	ASCII XY or XYZ files grouped into polylines. Space, comma or tab delimited (see Appendix B)
<i>DAT, TXT, XYZ, OUT, ASC</i>	ASCII XYZ files with space, comma or tab delimited (see Appendix B)
<i>2DM/3DM</i>	Surface Water Modeling System (SMS) mesh geometry file
<i>PLT</i>	TecPlot formatted file
<i>E00</i>	ArcInfo Coverage Export file
<i>GRD/ASC</i>	ArcInfo ASCII grid file
<i>KML</i>	Google Earth formatted file. Model units must be in UTM WGS84
<i>SDF</i>	HEC-RAS GeoRas File
<i>G0</i>	HEC-RAS Geometry File
<i>DXF</i>	AutoCad drawing exchange format
<i>SHP</i>	ESRI ArcView Shapefile (units must be in model units or Lat/Long)
<i>TAB</i>	Mapinfo (units must be in model units or Lat/Long)
<i>LDB, SPL</i>	Delft land boundary or spline format
<i>DLG, OPT</i>	USGS Digital Line Graphs

4.3 Model Generation Process

The model generation process is:

1. Locate a template EFDC.INP file that EFDC_Explorer will use to set many of the standard coefficients and parameters. The user can change any of these later in the model generation process. An EFDC.INP template file is required. A simple EFDC.INP was supplied in the original EFDC_Explorer setup package (C:\EE_EFDC\072\).
2. Bathymetry is required for the model generation process, but not required for the gridding process. Because the grid generation process is often iterative, it is recommended to skip specifying the *Topographic Information File* and, instead, use the flat bottom option in the *Elevation Options* frame.
3. Select the file containing polygons to trim the model cells (optional). The first polygon in the file should be the main model domain outline. Subsequent polygons in the file are interpreted as cutouts/islands.
4. Set the number of layers.
5. Set the initial water surface elevation. Should be above the flat bottom elevation
6. Set the default bottom roughness height.

7. Select the gridding approach and import or generate a grid.
8. At this point the *Generate* button should be enabled. If it is still grayed out then there is still an essential piece of information that has not been set. The required inputs vary depending on the gridding option selected. Press the *Generate* button to create a new EFDC model using the options specified. Even though a project directory is requested, this process does not write the files, only creates the model in memory.
9. When the model generation process is complete, EFDC_Explorer pops up a message informing the user as to how many active cells were created and what the maximum I and J were.
10. The last pop up displayed informs the user to review the model and make sure the I and J orientations are reasonable. For some convoluted grids, the L=2 lower left cell may not be correctly assigned. After reviewing the grid in *ViewPlan* and determining that the IJ mapping needs to be adjusted, the user can use the IJ mapping tools from the main EFDC_Explorer form to flip either I or J and/or transpose the I and J mapping.
11. Review the generated grid in *ViewPlan*. Load background images and/or polyline overlays to visually check the grid. View and check grid orthogonality.
12. If the grid is acceptable, then apply the bathymetry to this new grid using the *Bottom Elevations* button on the *Initial* conditions tab on the main EFDC_Explorer form.
13. Review the model grid with bathymetry added to make sure important bathymetric features are properly represented. Check the reasonableness of the CFL time step.
14. Repeat these steps as necessary to obtain the proper balance of grid resolution, computational speed and other project specific factors.

5 Pre-Processor Form Operations

In the pre-processor section of the main form, EFDC_Explorer provides a simple user interface to most of the commonly used options in EFDC that are stored in EFDC.INP. Some parameters and settings are adjustable directly from this form while some others, usually some specific subgroup, are available from buttons located on the main form.

Many of the input boxes have tips/values that pop up as the user holds the mouse pointer over the input box. In addition, many of the input boxes have internal range checks, but as they are so broad as to cover a large range of applications they should not be relied upon in any way to validate user inputs. For further user help, F1 will display the EE User Manual linked to the currently displayed form. F2 will generally display the short-cut keys associated with the particular function being viewed at that time.

The *ViewPlan* function also provides some pre-processing features and functions that will be described later in Section 7.

5.1 Map Tab

The *Map* tab is shown in Figure 5-1 and provides the user with basic model grid information such as width and height of the grid as well as a simple display. The user may select from grid, bathymetry and depth display. For display and editing of the detailed grid and most pre-processing related to the model the user should use the *ViewPlan* mode (available by RMC on the Map view).



Figure 5-1 Map Tab

The user can drag and drop an EFDC project to the map the same way they drag and drop a folder to the yellow *Directory* bar on the main form.

5.2 Description Tab

The *Description* tab is shown in Figure 5-2. Here the *Project ID* and the *Run Title* are optional labels that will be displayed on plots and tables. Many of the EFDC input files will be stamped with the Project ID and Run Title and the date/time of the file creation.

The *Run Log/Notes* text box provides a readily accessible free form notepad to record changes and notes concerning each run. If used, this can provide a complete run history during a calibration process. For each run, it is recommended to note which prior run you are using for the current run. For example “Run012 Based on Run011” provides a clear run path. After that entry the user should then note any changes made to the current run. These data are stored in an ASCII text file in each run directory called “EFDC_LOG.EE”.

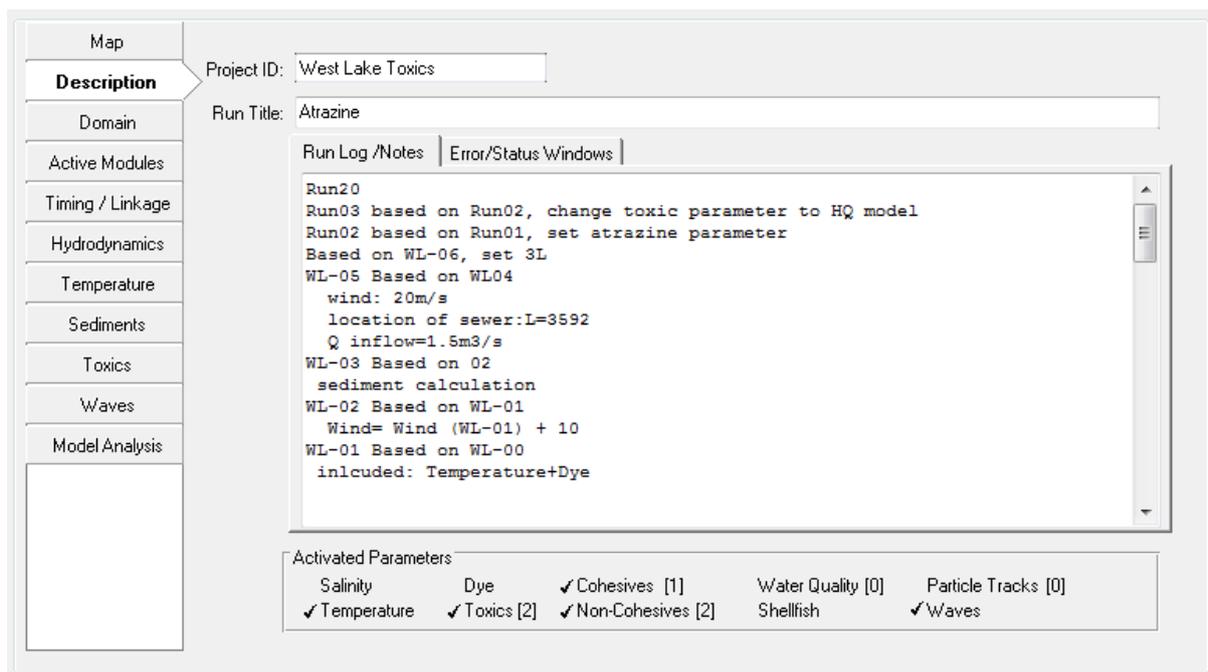


Figure 5-2 Description Tab: Run/Log Notes

The *Activated Parameters* form indicates with a check mark which parameters have been activated in the current model. This may be changed in the *Active Modules* tab (Section 5.4).

The *Error/Status Windows* features is new with EE7.1. This function has been included for the purpose of recording any error or warning messages found by EE when loading a model and it is shown on the Main EE Form in Figure 5-3. Any error or warning messages are displayed in red.

The *Show Dialog* box is off by default. If *Show Dialog* is on it serves the function of recording each error or warning message as a comprehensive list which is then displayed in its entirety each time a new warning is given. If the *Show Dialog* is off the typical error message is shown instead of the full list of errors.

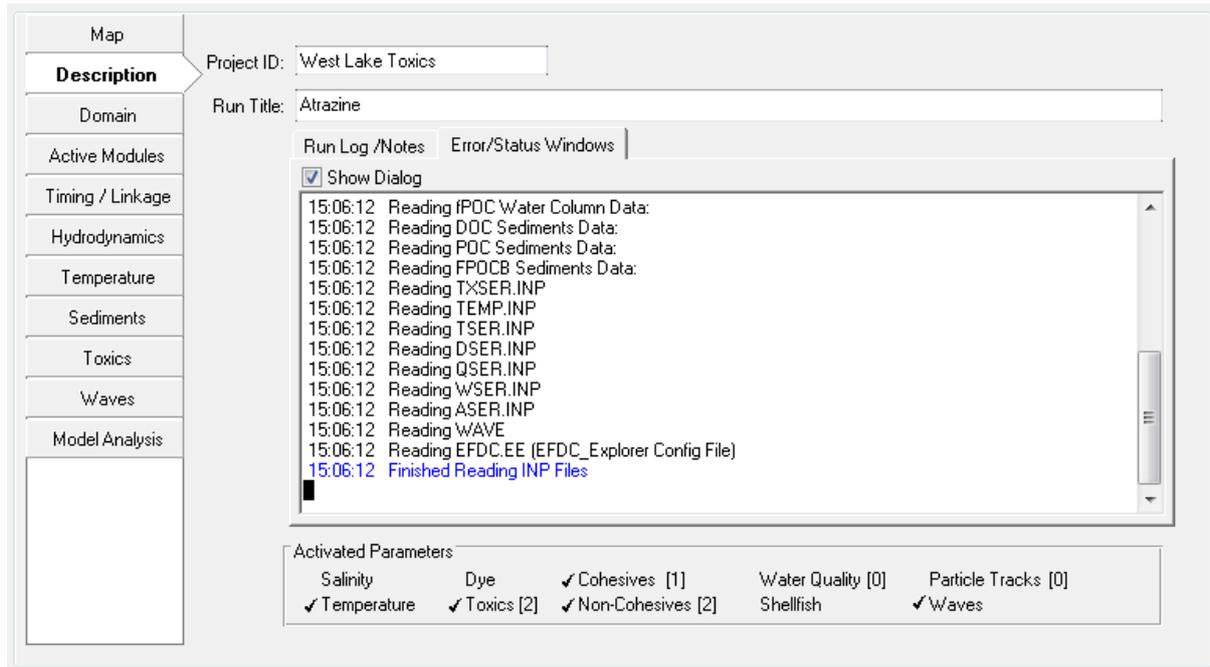


Figure 5-3 Description tab: Error/Status Window.

5.3 Domain Tab

The *Domain* tab shown in Figure 5-4 contains three sub-tabs: *Grid*; *Initial Conditions and Bottom Roughness*; and *Boundary Conditions*, each of which is described below.

5.3.1. Grid Tab

The *Grid* tab provides the options by which the user may set the vertical layering system as well as modify the horizontal grid as shown in Figure 5-4. The Sigma Zed (SGZ) vertical layering option is implemented with efdc+ alongside the previous option of Standard Sigma grid (SIG). A dropdown option for the *Water Layers* is provided and each option described below.

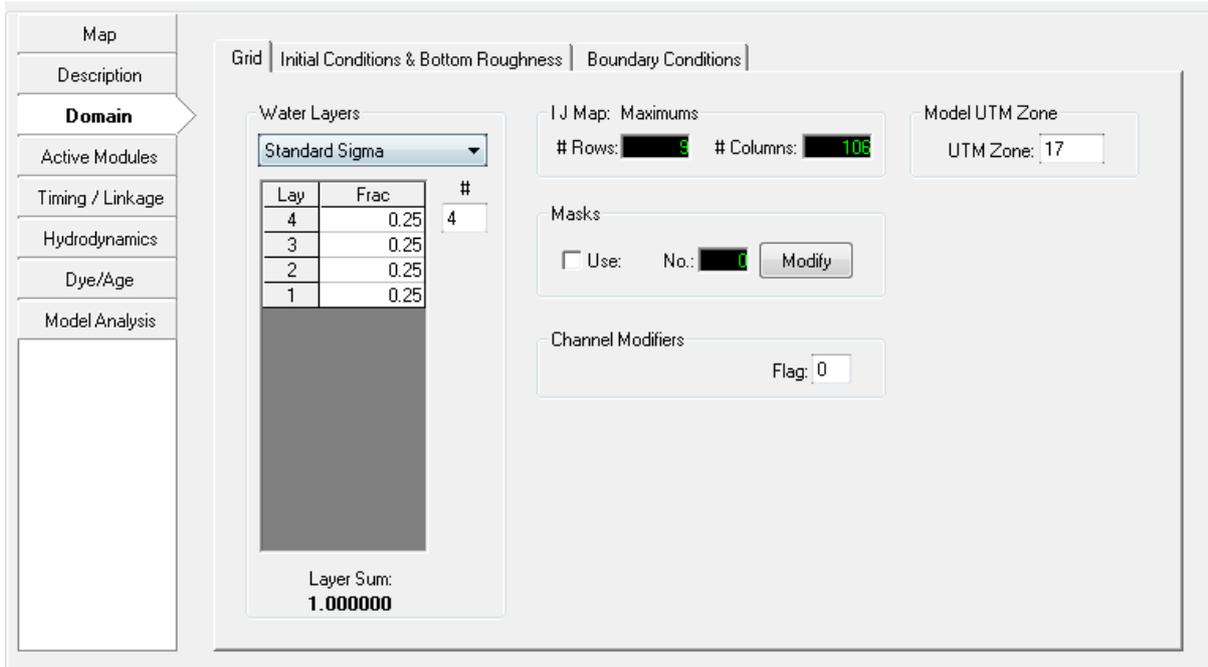


Figure 5-4 Domain Tab: Grid

5.3.1.1 Standard Sigma Stretch Grid

The *Standard Sigma* option for *Water Layers* is the previous option provided in all versions of EFDC+. When this is selected the SGZ options are not displayed.

The table in the *Water Layers* frame shows the primary water layer settings (KC = number of water layers) and the distribution of the relative layer thicknesses.

The relative thicknesses must add to 1 (or very close). EFDC_Explorer checks this for the user. EFDC_Explorer will automatically divide the water layers into equal fractions based on the number of layers specified by the user. Note that layer 1 is the bottom most layer and that the highest layer number is the surface layer (i.e. KC).

A feature here that is very useful during preliminary testing of a model application is the rapid adjustment of layering simply by changing the number of layers. EFDC_Explorer simply reallocates the layering based on the new KC and then adjusts all the boundary conditions to reflect this change. Use this feature with care, but it has been used on many applications and found to work well.

The *I J Map: Maximums* frame display the maximum number of rows and columns in the I J map.

5.3.1.2 Sigma Zed Vertical Layering

EFDC_Explorer8.1 now implements DSI's improved version of the EFDC code, the EFDCPlus_SGZ. DSI has developed this version to deal with pressure gradient errors that occur in models that have steep changes in bed elevation. This new version of the code is called the Sigma Zed code, or EFDC_SGZ. This version contrasts with the conventional sigma stretch version (SIG) of the EFDC code in terms of vertical layering in the model. SIG uses a sigma coordinate transformation in the vertical direction and uses the same number of layers for all cells in the domain. To accommodate the varying depths over the model domain in the SIG approach, the thickness of the layers vary from cell to cell but the number of layers and fraction of depth for each layer are constant. SIG approach introduces a well-known error in the density gradient terms, otherwise known as the pressure gradient error (Mellor, et. al. 1994). These errors are most pronounced in regions with steeply varying bathymetry.

The new vertical layering approach (SGZ approach) developed and applied to the EFDC model is computationally efficient and significantly reduces pressure gradient errors. In the EFDC_SGZ model, the vertical layering scheme has been modified to allow for the number of layers to vary over the model domain. Each cell can use a different number of layers, though the number of layers for each cell is constant in time. As with the Sigma Stretch approach, the thickness of each layer varies in time to accommodate the time varying depths. The z coordinate system varies for each cell face, matching the number of active layers to the adjacent cells. The new version is computationally more efficient than a similarly configured Sigma Stretch grid, thus making models with 20 to 50 layers or more practical for typical projects.

A comparison of SIG and SGZ grids is shown in Figure 5-5.

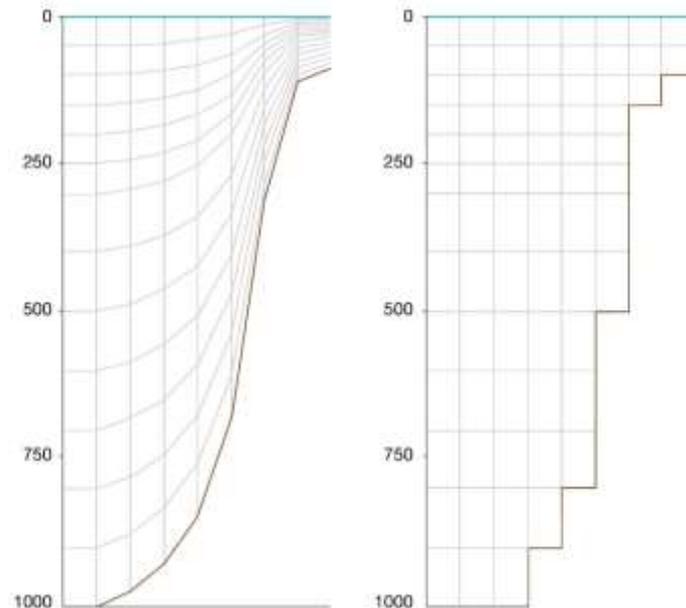


Figure 5-5 Vertical grids for Sigma stretch (left) and Sigma Z (right).

The model grid specification as SIG or SGZ can be made in the main form of EE from the *Domain tab | Grid sub-tab* as shown in Figure 5-6 The first option *Standard Sigma* is the conventional gridding scheme of EFDC model.

The two options for implementing SGZ option in EE8 are a) Specified Bottom Layer and b) Uniform Layer Thickness. The second two options i.e., *SGZ Specified Bottom Layer* and *SGZ Uniform Layer Thickness* are both SGZ model options with the following attributes.

(1) Specified Bottom Layer:

In *Specified bottom layer*, the layer thickness of the adjacent cells in the vertical do not align in the same plane. Maximum depth in the model is first calculated and the maximum layer thicknesses are determined based on maximum depth. Zonation can be applied using this option. This is the robust option and can be applied on any type of systems such as stratified systems, systems with rapidly changing bed elevation.

(2) Uniform Layer Thickness:

Layer thickness of the cell is mostly of the same size as the neighboring cell. The bottom layer thickness can be from 20-120% of the overlying layer. The maximum thickness is first calculated throughout the domain. Thickness at each layer for the cell with maximum depth is then calculated by multiplying DZCK with maximum thickness. Zonation cannot be applied in *Uniform Layer Thickness* option. *Uniform Layer Thickness* is suitable in quiescent systems where there are very little external flow influence.

When computing buoyancy integrals in the model, there are differences between layer thickness and difference between elevation. Using the uniform layer thickness, the differences between layer thicknesses is very small except for the regions with minimum sigma layers.

The *SIGMA ZED Layering Options* form provides the user with the option of specifying maximum and minimum layers to be used in the model. After selecting *Set SGZ Layering* and *OK*, the layers are all automatically updated to the Sigma Stretch layering.

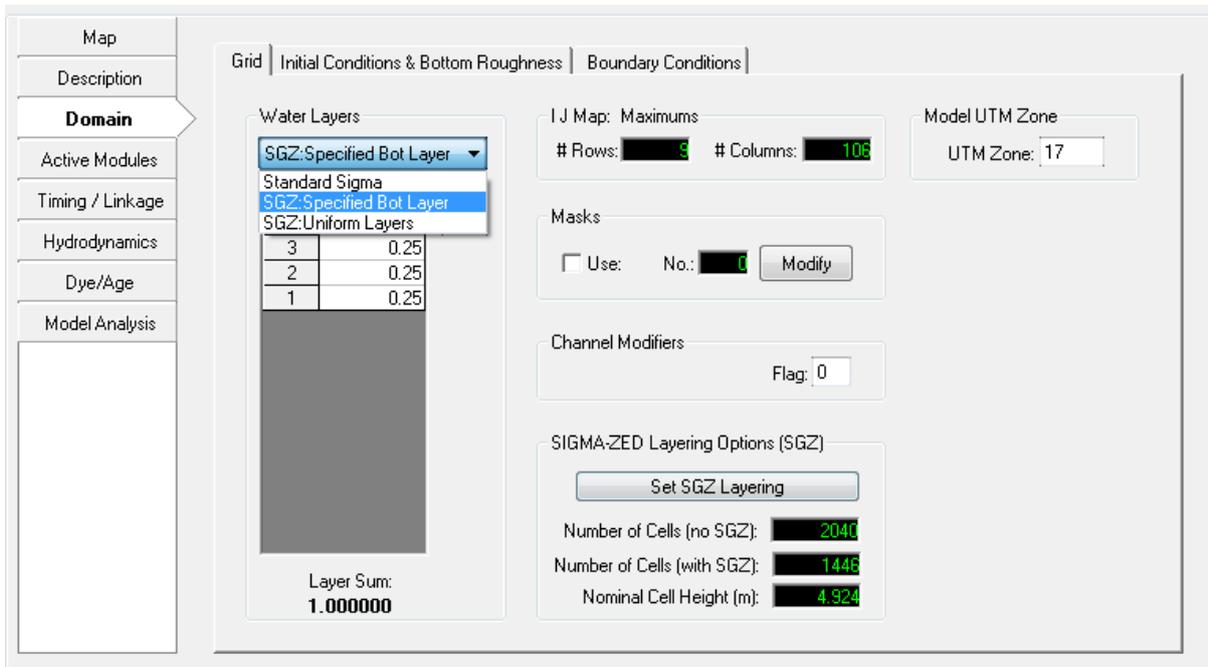


Figure 5-6 Domain Tab: Layering Options (SIG & SGZ)

5.3.1.3 Masks

In the *Masks* frame the *Use* check box enables the user to enable masks (zero thickness flow barriers) in EFDC. The MASK.INP file will then be required by EFDC. EFDC_Explorer can generate and modify masks using the *Modify* button as shown in Figure 5-7. The *Create Masks* utility does not automatically turn on the mask computation, it just generates the masks and writes the MASK.INP file. The user must manually click the mouse cursor inside the *Use Masks* check box to use the masks generated.

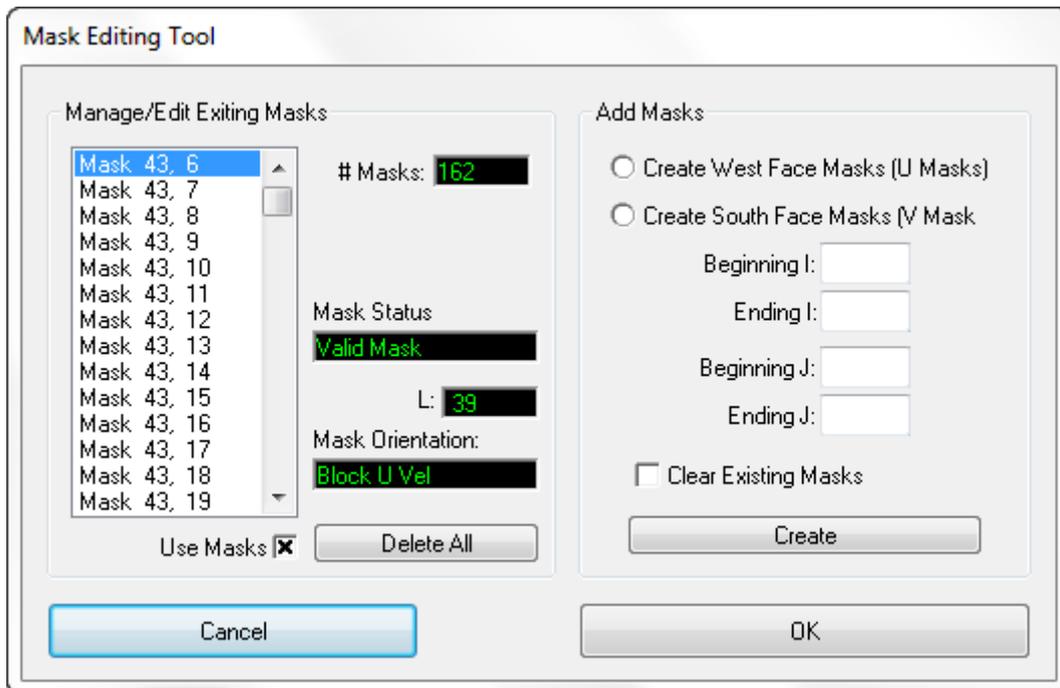


Figure 5-7 Mask Editing Tool.

Masks can be viewed, added and deleted in the *ViewPlan* function. When viewing the *Bottom Elevations*, RMC on a cell (*Enable Editing* must be checked first) and the cell properties are displayed, along with the mask options.

The *Channel Modifiers* frame allows the user to select the use of EFDC channel modifiers. These are like *pipes* that connect two cells. The *Channel Modifier Flag* option box is used to enable the use of the channel modifiers capability of EFDC. The normal “on” option is when this flag is set to 2. If set, EFDC requires the MODCHAN.INP file to be input.

The most flexible approach to create and edit channel modifiers is to:

1. turn on this option (i.e. ISCHAN=2),
2. enter the *ViewPlan*,
3. select *Modchannel*,
4. enable edit, and
5. use the right mouse click to add, delete or modify channel modifiers (i.e. “pipes”).

Care should be exercised in using channel modifiers as model instability is sometimes increased and mass balance errors can occur.

5.3.2. Initial Conditions and Bottom Roughness Tab

Figure 5-8 shows the *Initial Conditions* frame tab that contains access to the functions that assign initial conditions (IC's) that may be applied for bottom elevations, water depths, and bottom roughness. This is done through the use of the *Assign* button in the pertinent frame.

Other water column parameters, sediment transport bed, salinity and bed thermal sub-model use a common approach to interpolate data onto the model grid. This approach is discussed in the following section.

Note that each input parameter also has *Legacy* setting frames. These are ways of making global adjustments to the data sets, through addition or multiplication of all the data. These are no longer required as EFDC_Explorer provides more capability through the *Assign* button. However, they are included in the EE interface so the user can make sure how they are being used in legacy models.

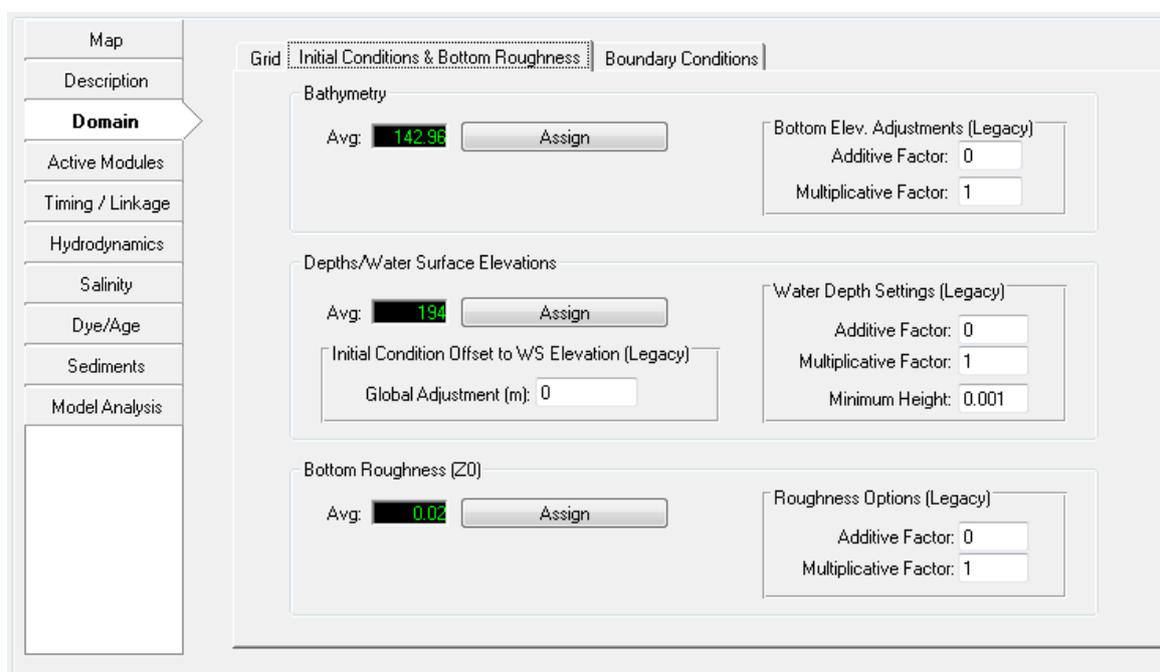


Figure 5-8 Domain Tab: Initial Conditions and Bottom Roughness

5.3.2.1 *Apply Cell Properties via Polygons*

EFDC_Explorer often needs to assign constant or spatially varying values across the entire model domain or within subsets for a variety of water column, sediment and other spatially variable parameters and concentrations. The *Initial Conditions* frames in the *Domain* tab: (Bathymetry; Depths/WS Elevation; Bottom Roughness) use the same process as the *Salinity*, *Temperature*, *Dye/Age*, *Toxics*, *Sediment* and *Water Quality* tabs, each containing an *Assign* button for: Surface Elevation, Salinity, Temperature, Dye, Bottom Elevations, Thermal Depth and Bed Temperature. Selecting any of these buttons will bring up the form *Apply Cell Properties via Polygons*. As shown in Figure 5-9. This form provides the general purpose horizontal spatial assignment function needed. However, this utility is context/parameter sensitive and displays different options and features, based on what the user requested and/or specified for data. Figure 5-9 shows an example of this utility for bottom elevation.

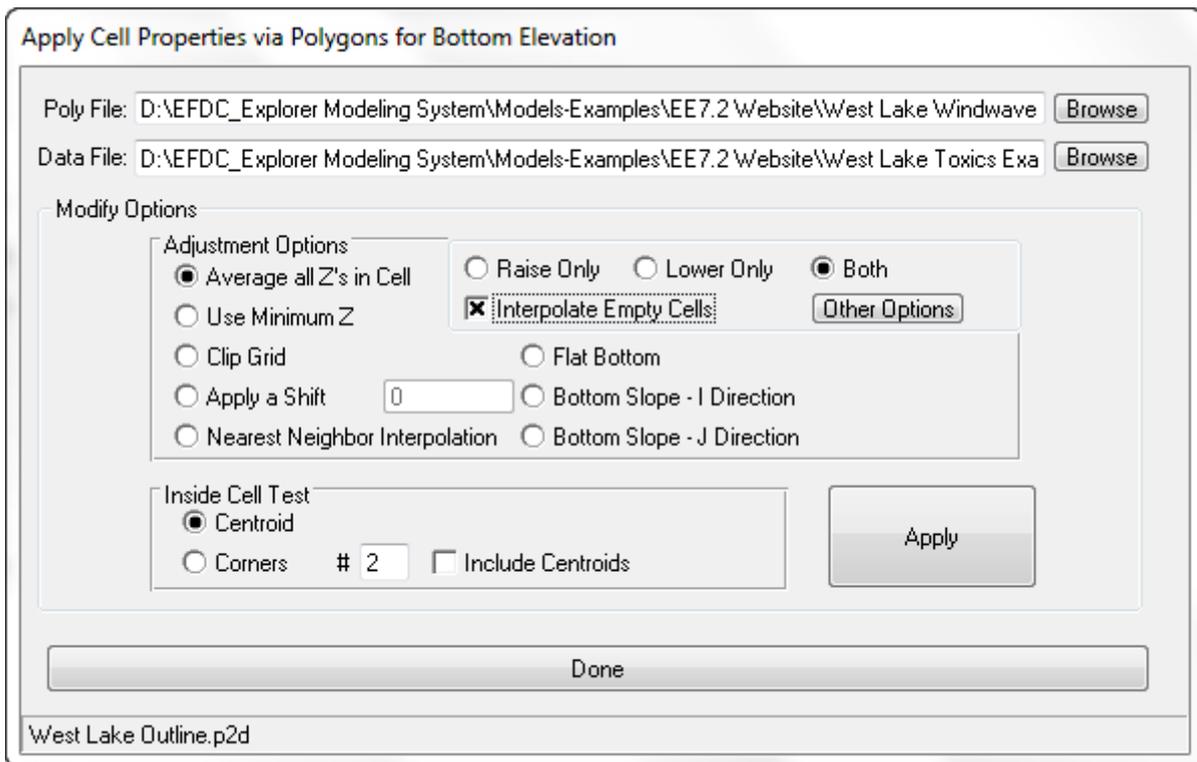


Figure 5-9 Apply Cell Properties via Polygons.

The *Poly File* field is an optional field used to specify a polygon file (in P2D or DAT formats) that contains one or more polygons. Cells that are inside the polygon(s), using the *Inside Cell Test* options, will be adjusted according to the options specified in the *Modify Options* frame. If the *Poly File* is missing, EFDC_Explorer will use all of the cells in the model.

The *XYZ File* is an optional file that identifies the measured or otherwise determined data that the user wants to assign to the EFDC cells. Generally, this file is required unless the user is simply applying a constant to the cells or is applying an operator.

Under the *Modify Options* frame various functions and features will be displayed, based on what parameter or process the user is assigning or modifying. In this case (Figure 5-9), bathymetry is being assigned. The user can select either to apply an operator to the currently defined field or interpolate the data in the *XYZ File* to the selected cells (via the Poly File). Nearest neighbor approach is used to interpolate the horizontal spatial data onto the grid. If it is for the water column, the user must specify which layer this assignment is for, one layer or all the layers.

If data is sparse the user is recommended to select the *Interpolate Empty Cells* option so that bathymetry for the whole domain is generated from interpolated data. The *Other Options* or *Options* button brings up a form allowing the user to change the interpolation options. Depending on whether bathymetry or wave parameters are being set the *Option* button also allows the user to define raw data zonation options. The zonation option simply automatically divides the raw data into a specified number of X and Y zones (with overlap to handle zone edges) before applying the requested interpolation process. This significantly speeds up many applications with no loss in accuracy. Zonation is recommended if the raw data has a large number of points. EFDC_Explorer informs the user of the range in number of data points in each zone before conducting the actual assignment.

For bathymetry and wave data the user has two choices for cell assignment, spatial interpolation via nearest neighbor or averaging data into each cell. If the XYZ data is very dense, relative to the model cell size, then the best approach will be to use cell averaging. However, if the XYZ data is not dense enough to completely assign at least one value for every applicable model cell, then the nearest neighbor interpolation option is better.

Pressing the *Apply* button causes EFDC_Explorer to perform the requested operations. You can perform a series of operations, one after the other by changing the options and pressing *Apply*. For example, you can set the water surface elevation from a data file with units in centimeters then change the *Constant* options and change the *Operator* to “/ 100” to convert the elevations to meters. Once assigning/editing the current parameter is complete, pressing the *Done* button returns to the main EFDC_Explorer form. The *Done* button does not do anything except return the user to the main EFDC_Explorer form.

(1) Example Problem

The user has generated a poly line, and now wants to set a constant bottom elevation to all the cells inside the poly line.

1. Go to the *Domain/Initial and Boundary Conditions* tab.
2. Click on the *Assign* button for bathymetry. From the bathymetry assignment form, type in or browse to the polyline file.
3. Select the *Flat Bottom* option and enter the elevation in the text box
4. Click *Apply*. If the polyline is not closed, EE will ask you if you want to treat it as open or closed. Open polylines select cells along the line. Closed polylines select all the cells whose corners/centroids are inside the polygon, based on the *Inside Cell Test* options.
5. EE will build a list of the cells and apply the specified flat bottom to those cells and report how many cells were modified.

5.3.2.2 Set Initial Conditions – Water Column

This section contains methods to assist the user to assign the initial conditions for the water column parameters. The check boxes next to each parameter set the flags for EFDC to read and use these initial condition fields. When an *Assign* button is pressed for a parameter (e.g. *Bathymetry*), the *Apply Cell Properties via Polygons* form is displayed with appropriate options for that parameter (e.g. Figure 5-9). Depending on the options selected on the spatial assignment form, the IC's can be initialized or modified, in one or more operations. Each water layer must be specified or the user can select the *Set for All Layers* to assign vertically uniform ICs.

The *Assign Value Using Vertical Profiles* option on the *Apply Cell Properties via Polygons* form allows the user to specify a data file with vertical profiles (data format in Appendix B) of the water quality parameter being assigned. In this case, the *XYZ File* will be the file that contains the vertical profile data. When the *Apply* button is pressed, EFDC_Explorer interpolates this data onto the water column initial conditions horizontally and vertically (all active layers).

5.3.2.3 Initial Condition to Offsets

The *Initial Condition Offset to WS Elevation* frame contains an input box that allows the user to apply a global offset to the Water Surface elevation that will be applied during the initialization.

5.3.2.4 Roughness Options

Under *Bottom Roughness*, other than the standard additive and multiplicative factors that EFDC will apply to whatever z_0 's are input in the DXDY.INP file, EFDC_Explorer has several methods to set and/or modify the z_0 's that will be written in the DXDY file.

Floodplain Z_0 's and Channel z_0 's: If the model was constructed with channel and floodplain cell ID's (i.e. 5 for channels and 7 for the floodplain in the cell map file, i.e., CELL.INP) then the user can set each one quickly using these buttons.

Polygon Set: The user can employ a user defined polygon to modify/set the z_0 's. This tool may be applied as many times as needed anytime during the model construction and calibration process.

5.3.2.5 Legacy Options

EFDC_Explorer allows the user to make changes to older (legacy) models whose functions have been superseded by changes in the EFDC_Explorer/EFDCPlus modeling system. It is not recommended users edit these fields unless the user wants to maintain consistency with some legacy model.

5.3.3. Boundary Conditions Tab

Figure 5-10 shows an example of the *Boundary Conditions* tab that contains boundary condition information and editing features. The *Number of Boundary Groups* frame provides the user with a summary of the current assigned boundary groups. The user can also view, create and edit boundary conditions from the *ViewPlan | Boundary Conditions* feature (Section 7.6.5).

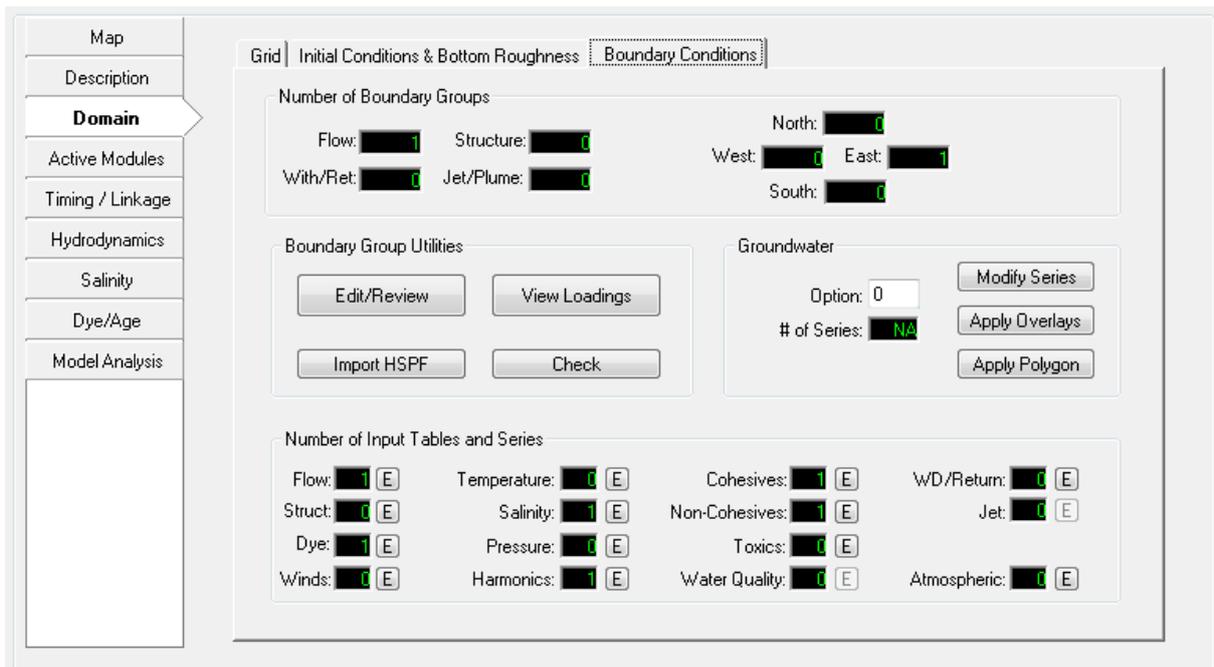


Figure 5-10 Domain Tab: Boundary Conditions.

EFDC applies the boundary conditions in a cell by cell manner. However, EFDC_Explorer takes a more physically based approach to handle boundary conditions. It groups boundary cells into logical groupings, e.g., a river inflow, a tributary or an open boundary along one face. Ideally, the user will create the group, name it something meaningful to the project, assign all the cells included in that group to the group (this can be done manually or via polylines/polygons), and then set the boundary condition. The boundary group information is stored in the EFDC.EE project file located in the project directory. However, if there are no current groupings when EFDC_Explorer loads a project (which is the case for existing EFDC models not managed with EFDC_Explorer), it groups the existing boundary cells into groups based on the type of boundary condition and their locations. Within a group, the flow, head and pressure settings can vary from cell to cell but the water quality parameters must be the same. This limits the complete specification of each cell that EFDC provides, but gives a much more logical way to manage the boundary conditions. If the user needs to specify the water column parameters on a cell by cell basis the EFDC_Explorer user needs to manage each cell as a separate group.

The boundary condition time series available in EFDC are displayed in the *Number of Input Tables and Series* frame (see Figure 5-10). The number of currently defined tables and series are displayed alongside the button labeled “E”. A time series boundary condition editor is displayed if the user clicks the “E” button. Jet type boundary condition uses a flow series. Once the user has created a Jet type boundary conditions from *ViewPlan | Boundary Conditions*, the GUI is accessed from the *Edit/Review* button in *Boundary Group Utilities* .

5.3.3.1 Edit/Review Boundary Conditions

The *Edit/Review* button provides access to the general *Boundary Conditions Definitions/Groups* group form shown in Figure 5-11. This form provides a listing of all the defined boundary groups by group ID. The list of boundary groups can be sorted by ID or listed in the order they are defined in the EFDC.INP file. In the top frame, *Number of Boundary Groups*, the number of the currently defined boundary groups, by type, are displayed. For details on how boundary groups work see Section 5.3.4.

A method to quickly define one or more boundary groups (where boundary condition details are to be added later) is available using the *Batch Define* button. This approach uses a P2D file with one or more polylines/polygons in a single file. If a polyline is open (i.e. the 1st and last point are not the same) EFDC_Explorer will select all of the cells the line intersects as one group. If the polyline is closed (i.e. the 1st and last point are the same) EFDC_Explorer will select all of the cells whose centroids are inside the polygon as one group.

As the user selects a boundary group from the list, summary information about the boundary group and its linkages to various boundary forcings is displayed. To edit a boundary group the user can double click on the group ID or press the *Edit* button. RMC'ing on a group ID pops up a menu that allows the user to *Insert* (add a new boundary group), *Delete* (delete the currently selected group) or *View* (plot the time series of the primary forcing).

When using the time series plotting function from this tool, the model simulation start and end times define the minimum and maximum date range. If the time series is longer, the entire time series can be viewed from the Time Series editor.

The *Momentum Corrector for BC Cells Located on the Model Edge* is used to set the appropriate model response for the EFDC_DSI or EFDC_GVC models. It should be 0 for the former and 1 for the latter, but may be set to some number between 0 and 1.

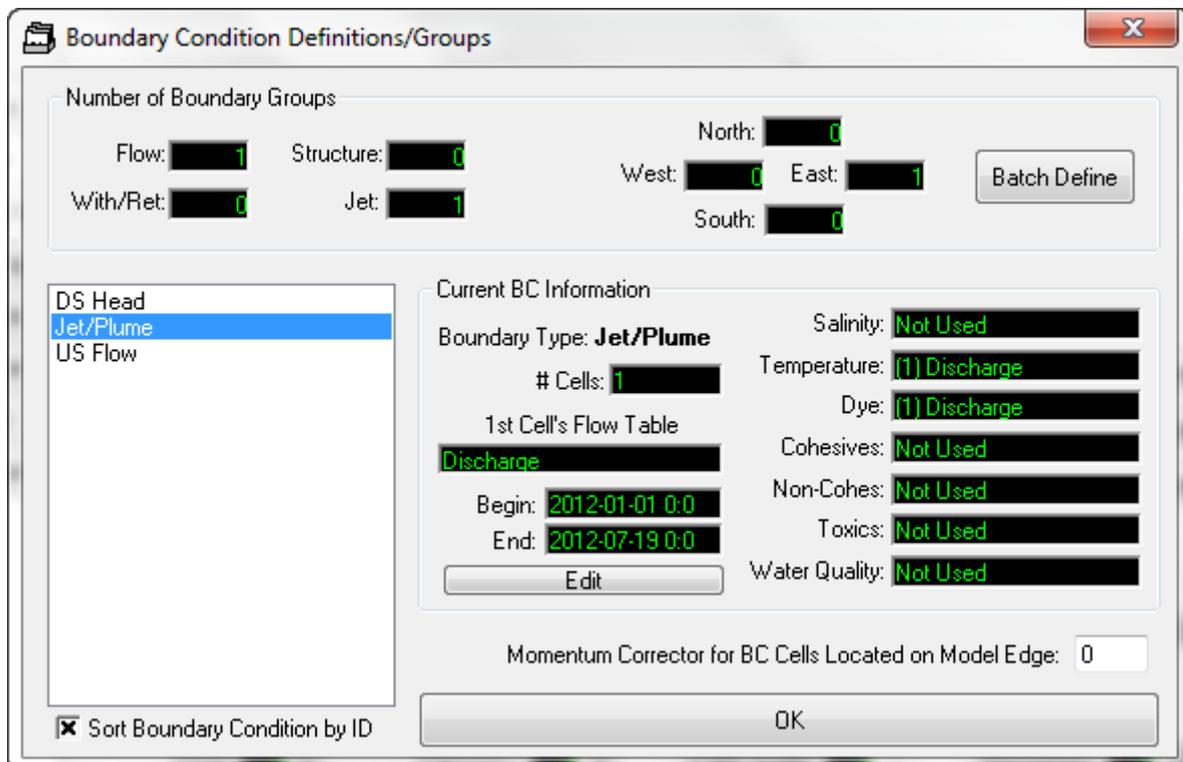


Figure 5-11 Boundary Condition Definitions/Groups.

5.3.3.2 Import HSPF Data

The *Import HSPF* button provides access to the import function for the Hydrologic Simulation Program in Fortran (HSPF) (Bicknell et al., 2001). This is a hydrologic watershed modeling tool that is commonly used to predict flows and some water quality parameters. If this tool is used to predict the flows in a basin/watershed in which the EFDC model is being applied, then these results can be imported as boundary conditions for EFDC.

In addition to HSPF results, the *Import HSPF* tool can import any time series data whose flow and or water quality parameters are contained in columns (i.e. Excel™ type csv or tab delimited data). The dates can be Julian or Gregorian calendar dates. If Julian dates, the Base Date used for the imported time series should be the same as that used in the EFDC project.

The import tool, shown in Figure 5-12, works by linking the time series/HSPF files to specific boundary groups. The only groups that can have HSPF data linked to them are flow boundaries. Each group can have its own HSPF file and import options. Flow, temperature, solids and water quality are optionally selected in the Import Parameters Frame.

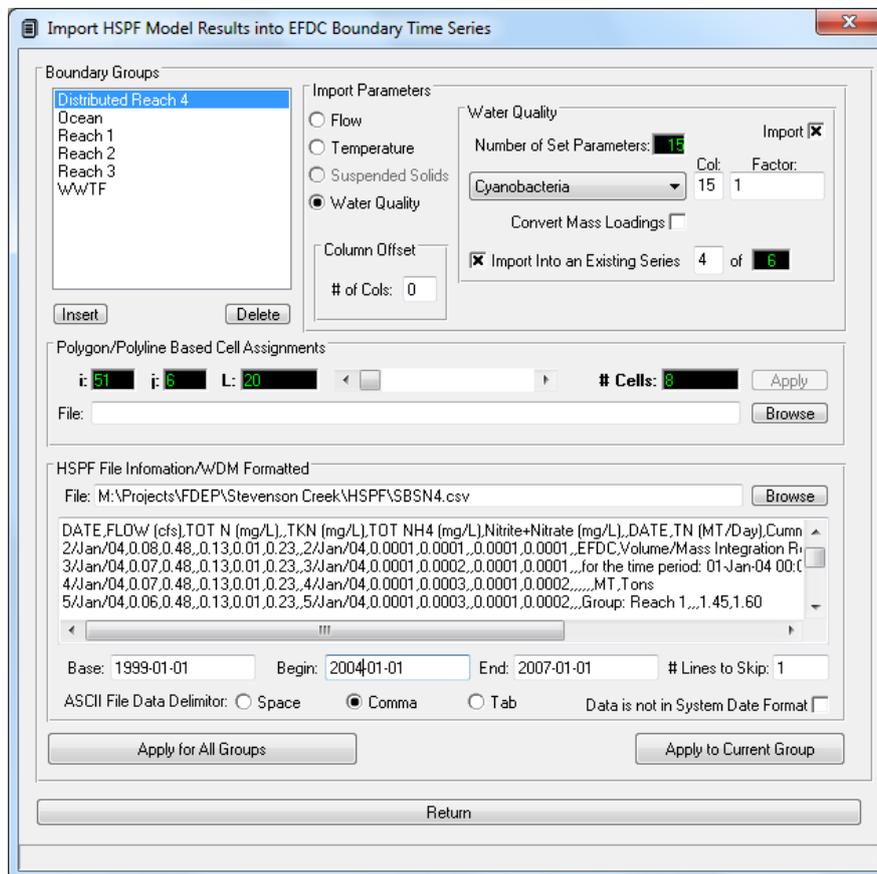


Figure 5-12 HSPF model results import utility.

To view each parameter's options, select the corresponding radial option in the *Import Parameters* frame. When the parameter is selected, the options frame is shown to allow the user to:

- Select whether to import that parameter for the current group using the *Import* check box. To activate all the groups for the current parameter, press Ctrl-A.

- Set the column which contains the data. Column 1 is the 1st column after the column offset.
- Define a conversion factor to convert whatever units are in the file to the appropriate units for EFDC (i.e. m³/s for flow, °C for temperature and mg/l for solids, mg/l for water quality and MPN/100 ml for fecal Coliform). In addition, the conversion factor can be used to split a single number into its sub-components. For example, total organic nitrogen from and HSPF run can be split into the dissolved and particular (refractory and labile) nitrogen components.
- Select which time series number to import the series into. The first time the user imports an HSPF file, the *Import into Existing* checkbox should not be checked. EFDC_Explorer will import the series and add a new series ID and assign it to the appropriate boundary group. However, if the HSPF results are being re-imported or updated based on new HSPF results then the user will want to import the data into an existing EFDC series. EFDC_Explorer uses the current boundary information to assign the series number to import to, but the user can change it if needed. When the *Import to Existing* checkbox has focus, pressing Ctrl-A will cause the all of the boundary groups to use the same option as the current group. Importing into an existing series does not overwrite the entire series, rather it inserts into the specified series between the *Begin* and *End* dates.
- The *# of Cols* in the *Column Offset* frame provides a global column offset. This may be needed if there is an “E” in column 1 (some HSPF export series use this) or some other information in columns before the date column. EFDC_Explorer uses the date/time columns as the 1st columns from the left, after accounting for the column offset.

The solids are a special case. Along the rows the solids classes for HSPF are displayed. In the 1st grid column (“Col”) the user specifies the data column number that contains the clay, silt and sand. Then the user assigns weights or factors to each grain size class modeled in EFDC to the data columns. In this manner the user may combine HSPF sizes into whatever EFDC class they desire. If the class weights totaled for each row add up to 1, then the same mass that is predicted by HSPF will be input to EFDC. It is possible to assign more of any HSPF size class to EFDC than HSPF computed by using weights that add up to more than one. This same approach is true in reverse as well.

The period of extraction from the HSPF files is controlled by the *Begin* and *End* dates specified in the input boxes located at the bottom of the HSPF preview pane.

The HSPF File preview pane shows the some of the data from the HSPF File for the user’s reference. It can be seen in this example that the flow is contained in column 2 (0.01 cfs) and dissolved oxygen is contained in column 7 (5.58 mg/l).

EFDC_Explorer interprets a calendar date using the Windows date settings. This is important if files are processed on different computers with different date settings (i.e. files from Asia being processed on computers in America). The issue here is if the dates are ambiguously formatted as MM-DD-YYYY or DD-MM-YYYY. A date of “01-02-2008” can be interpreted as 01-Feb-2008 or 02-Jan-2008, depending on the windows date format. To correct a date interpretation problem between windows configurations, check the *Data is not in System Date Format* checkbox. This simply reverses the order of the first two date fields.

The delimiter must be specified as space, tab or comma. The correct delimiter must be selected before processing the linkage.

The time series/HSPF File that will be linked to the current boundary group is shown in the *HSPF File Information/WDM Formatted* frame. The user should *Browse* to the file. If the

same file will be used for all boundary groups the user may press Ctrl-A when the HSPF File field has focus to assign the same file for all the groups.

To actually link the HSPF data to the EFDC boundary condition group(s) the user must press one of the following:

- *Apply to Current Group:* This button processes all the parameters designated for import for the currently selected boundary group only. Only those parameters selected for import are processed.
- *Apply for All Groups:* This button processes all the parameters designated for import for every flow type boundary group. All the options defined for each boundary group are used.

Groups are added and deleted by setting the focus to the group list and then pressing “INS” or “DEL” as is appropriate. If deleting a group, make sure the correct group is selected.

5.3.3.3 Check Boundary Conditions

The *Check* button runs a series of checks all the currently defined boundary conditions. Some of the validation checks include:

- I & J cell indexes point to active cells
- Table series are valid
- Matching head/concentration cells for open boundaries,
- Etc.

If errors are found they are reported and can be copied to the clipboard for pasting into other reports.

5.3.3.4 View Loadings

The *View Loadings* button brings up the loadings option form shown in Figure 5-13. This form shows the valid model timing (based on the model start and end times) and allows the user to select a date range to process within the model dates. The parameter to view is also shown. This list varies, depending on the computational options.

When the *View* button is selected, EFDC_Explorer computes the mass loadings time series for all of the flow type boundary groups selected and displays them in a plot. The units displayed will vary, depending on whether the user is configured to display metric (metric tons (MT) per day) or English (tons (2000 lbs.) per day). Figure 5-14 shows an example of mass loading (by group) for Total Phosphorus. To then compute the *total mass loading* for the time period displayed on the plot, press Ctrl-I to integrate the series (see Section 9.2 for more details). Since the time units are days and the mass loading is MT/day, entering a 1 for the conversion factor results in the mass loading being reported in metric tons. Note that the user is now able to use concentration loadings rather than mass loadings as discussed in Section 5.15.5.

Constituent Boundary Loadings

Mass Balance Computation Options

	From	To	
Model Range:	1.00	1461.00	
View Range:	1.00	1461.00	J <---> G
Parameter:	Water Quality		
Sub-Parameter:	Tot P		

Total Load Summary

BC Group: View Table

Return View

Figure 5-13 View loadings options form.

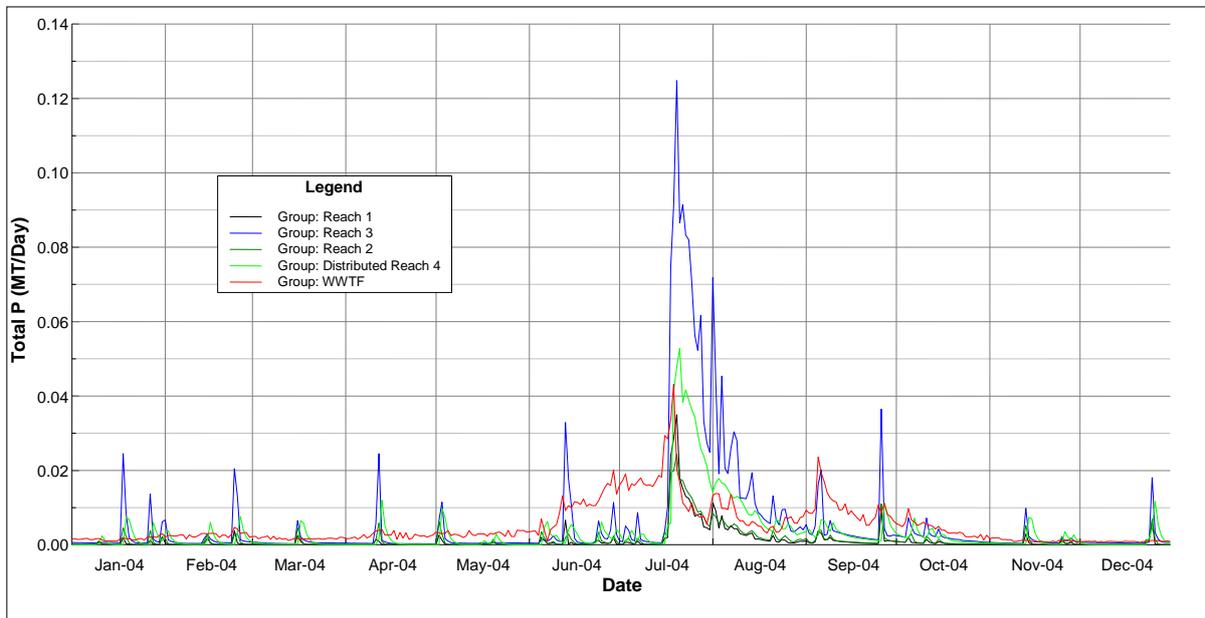


Figure 5-14 Example of mass loading plot for Total Phosphorus (TP).

5.3.4. Boundary Condition Group Editing Form

The editing of boundary condition groups were formerly all handled by one *Modify/Edit BC Properties* form. From release of EE7.2 onward each BC has its own specific form which is accessed by the *Edit* button shown in Figure 5-11 . The individual boundary condition types are explored in the sections following. However, two frames are generic across all the BC types, the *Current Boundary Group Information* and *Setting for Current Boundary Cell* as shown in Figure 5-15.

The top frame, *Current Boundary Group Information*, contains general information on the total number of BC groups, the number of groups for this BC, the current group number and number of series for this BC. The next frame, *Setting for Current Boundary Cell*, contains the cell specific information for the current group. The user may add a cell or remove a cell from a boundary group using the scroll bar to select the *Current Cell* or set the cell location. The user may also use *Add by Polygon* option to select a polygon or polyline to assign the cells that are to be included in the group.

Modify/Edit Flow BC Properties

Current Boundary Group Information

Number of BC Groups: 3 ID: US Flow
 # Flow Groups: 1
 Current Group: 1

Available Flow Series

Number of Flow Series: 1

Setting for Current Boundary Cell

Current Cell: 1 Number of Cells: 9
 Add Cell Remove Cell Remove All Add by Polygon

Cell Location

L: 618 I: 3 J: 11
 Initial Water Surface Elevation: 100
 Initial Depth: 5
 Bot Elev: 95

Flow Assignment

Flow Table: None Edit All
 Factor: 0.1209 Dist Factors
 Constant Flow: 0.024186 Dist Flow
 Apply Flow Files

Boundary Condition Group

Constant Concentrations (Used with Constant Flow)

Constituent	Conc
Salinity (ppt)	0
Temperature (°C)	10
Dye (mg/l)	0
	0

Concentration Tables (Used with Time Variable Flows)

Salinity: None E Toxics: None E
 Temperature: None E Cohesives: None E
 Dye: None E Non-Cohesives: None E
 Shell Fish: None E Water Quality: None E

Flow Multiplier Switch: Normal Inflow/Outflow [L*L*L/T]

Cancel OK

Figure 5-15 Boundary Condition Settings – Flow Boundary.

5.3.5. Flow Boundary Condition Editor

For flow BC's the *Flow Assignment* frame has several useful functions. The *Edit* button to allow the user to edit the associated time series. The *All* buttons next to the fields in this subframe allow the user to quickly assign all the boundary cells in the current group to the parameter specified in the adjacent field. For example, pressing the *All* next to the *Flow Table* field shown in Figure 5-15 would set the flow series number for all cells in the *US Flow* flow group to the current *Flood Flow* table settings. If the user has an input flow series for a river that requires distributing the river flow across several cells, the single time series of flow can be specified in the *Flow Table* and the *Factor* can be set to split the flow appropriately among the cells. The *Dist Factors* button sets the *Factor* based on cell volumes. A constant inflow can also be distributed in a similar manner by using the *Dist Flow* button next to the *Constant Flow* field.

The *Flow Assignment* frame also provides the *Apply Flow Files* button, allowing the user to import flow with the flow files to build a cell by cell variable inflow series. This feature is predominantly used in wetting and drying models.

The user interface for boundary conditions has a uniquely designed editor with drop down menus for concentration table assignment to flow tables. When the user selects *Flow Table* as shown in Figure 5-15, they can use drop down menu items to link flow tables with concentration tables. As with earlier versions of EFDC_Explorer, the concentrations specified in the *Constant Concentrations* frame are only used with constant flows. Specifying a constant salinity concentration of 5 ppt in the *Constant Concentrations* frame but with zero constant flow, even if the boundary has flows assigned via a time series, the salinity input to the model will be zero. If using a time series for flows, the user must use a time series to assign salinities, even if they are constant. Note that the water column concentration settings, for both time series and constant, are fixed for all cells for the same group.

The *Flow Multiplier Switch* subframe provides a drop down box with a number of options, from normal inflow to various lateral inflow/outflow options. Constant concentrations and time variable Concentration Tables may also be edited from this frame.

5.3.6. Withdrawal/Return BC Editor

EFDC_Explorer fully supports the withdrawal/return flow boundary condition of EFDC. The user interface for the withdrawal return boundary condition editor is shown in Figure 5-16. The user may specify the location of the withdrawal and return cells directly for each cell in the group.

In the past EFDC did not allow the specification of the rise/fall for the water quality constituents. A “0” rise was always assumed. EFDCPlus was modified to allow the rise/fall for each water quality constituent to be specified, if using the time series option (i.e. QWRS.INP file). The constant rise/fall feature is only available for the original set of EFDC parameters of salinity, temperature, dye, toxics and sediments. These may be set in the *W/R Flow and Concentration Rise/Fall Settings* frame.

The user may also specify the momentum options for the withdrawal and return cells in the bottom frame. Use the drop down menu to select momentum flux to be ignored, or positive or negative in the U and V faces. The user may also set the momentum width for both withdrawal and return flows. In the case of the return flow the user may also set *Return Flow Horizontal Angle*.

Figure 5-16 Boundary Condition Settings – Withdrawal Return.

5.3.7. Hydraulic Structures Boundary Condition Editor – Flow Derived

The form for setting the hydraulic control structure boundary condition is shown in Figure 5-17. The hydraulic structure boundary condition uses a head lookup table to describe the relationship between head and flow for that cell and is set with the *Flow Control Type* menu. Several options are available for the flow control type including:

- Flow derived from Upstream Depth
- Flow derived from Elevation Difference
- Flow derived from Elevation Difference with Flow Accelerations
- Flow derived from Upstream and Downstream Elevations
- Flow derived from Upstream Depth with Low Chord
- Flow derived from Elevation Difference with Low Chord

Using the flow acceleration parameter flows are now squared and multiplied by an acceleration factor when passing through an inlet.

Figure 5-17 Hydraulic Structure Boundary Conditions: Low Chord Option.

With *Cell Options*, the *Rating Table/Flow Lookup Table* frame allows the user to set the head for each table. After the user has selected the table number, the *All* button applies the current flow table setting for cells in the current group. The user may also enter an *Offset* which will apply an offset to the result of HP + BELV to obtain the H to look up from the H vs Q table.

The *Shift All* button prompts the user for an offset, after which a uniform shift is applied to all the offsets in the group.

The rating curve may also be generated within the *Generate Rating Curve from a Power Series* frame.

The user sets the hydraulic structure options in the *Boundary Condition Group* frame. The dropdown menu allows selection from the following equations for the boundary flow multiplier, where $q(h)$ are unit discharges and need to be multiplied by a dimension:

Equation	Units for q^1
$Q = q(h)$	L^3/T
$Q = q(h)DY$	L^2/T
$Q = q(h)DX$	L^2/T
$Q = q(h)(DX + DY)$	L^2/T

¹ Where L is length and T is time

The user may also input the cell downstream from hydraulic structure in the *Downstream I and J* boxes. The length “L”, bottom elevation and initial depth are all displayed for the downstream cell.

Two examples of how different uses of flow control types are described below:

5.3.7.1 Flow derived from Elevation Difference with Low Chord

One use of hydraulic structures is to simulate a low chord, i.e. the bottom of a bridge. In this case, when flows are below the bridge deck they may be bi-directional, i.e. flows can be going upstream or downstream. However once the bridge is overtopped flow is only upstream to downstream.

EFDC uses the total flow rate for the flow calculations, therefore it requires the flow to be at the actual time when the cell reaches the low chord elevation. The elevation is then subtracted from the value obtained from the rating curve as this curve defines the relationship for the total flow around the bridge for the whole range of depths. It is necessary to subtract the actual flows from the curve to prevent a large jump in flow. To prevent instability at the transition the minimum number of time steps above the low chord may be provided by the user. An example of how this is setup is shown in Figure 5-17.

In the equations for the head look up tables (Figure 5-17), HQCTLU is set on a cell by cell basis. HCTLUA comes from cell options offset.

The table for CTRL_1 is defined by the user as shown in Figure 5-18.

This boundary condition needs to be turned on for each cell. However, to enter one value for all the cells in a group the user may select all (CTRL A) and then apply to all the cells in that

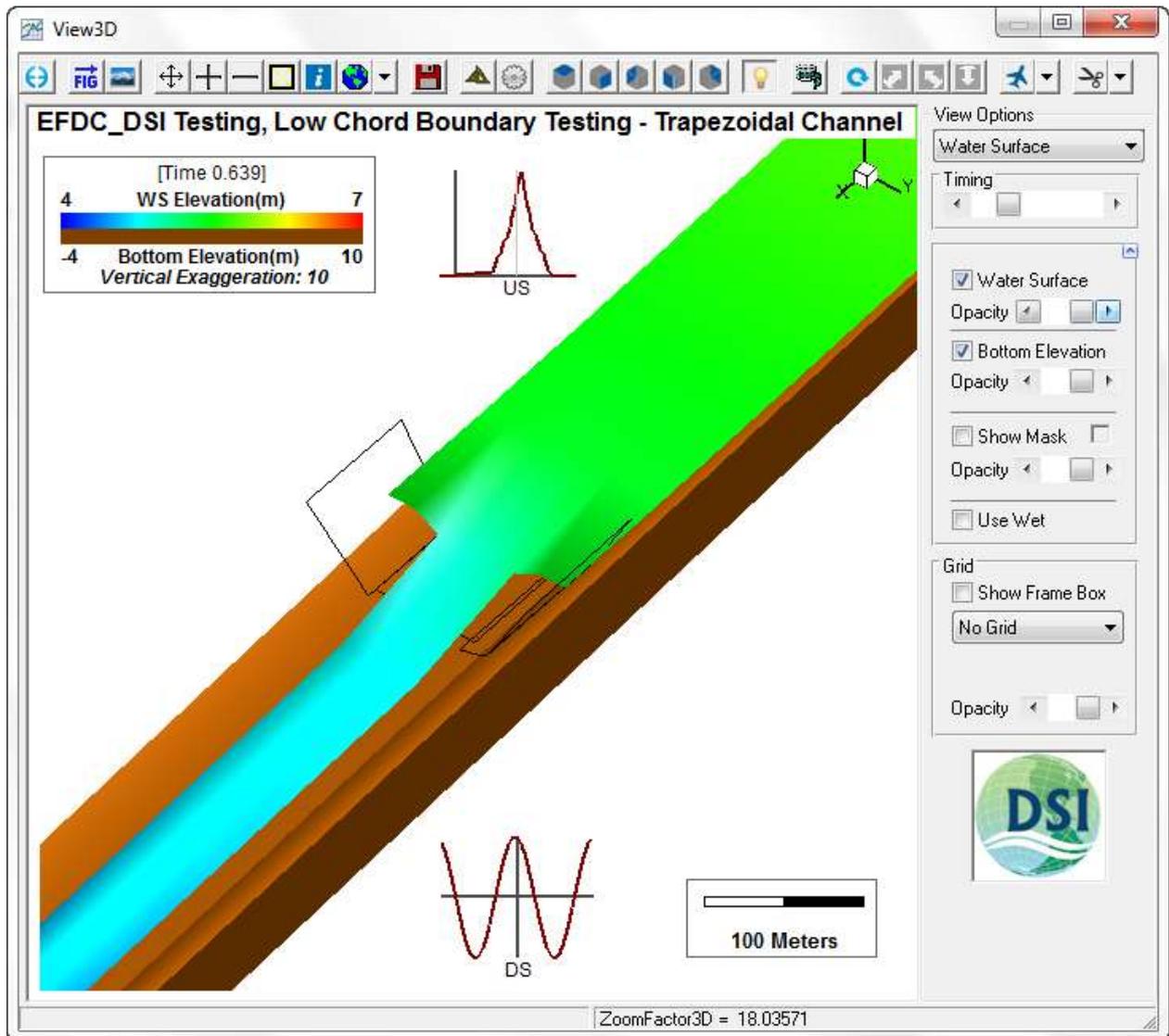


Figure 5-19 Bridge (Low Chord) Hydraulic Structure in View3D.

5.3.7.2 Flow Derived from Upstream and Downstream Elevations

In another example, P Outlet uses a control type with flow derived from both upstream and downstream elevations as shown in Figure 5-20. In this case it is necessary to have a matrix to describe the relationship between head and flow as shown in Figure 5-21. Most data tables, such as those by the US Corp of Engineers, use the same downstream and upstream head. Therefore, if the user wants to change the table, they should select *Edit Heads*, and add a new table. When *Accept Heads* is selected a new row and column will be created.

Figure 5-20 Structure Boundary Conditions: Flow from US and DS Elevations.

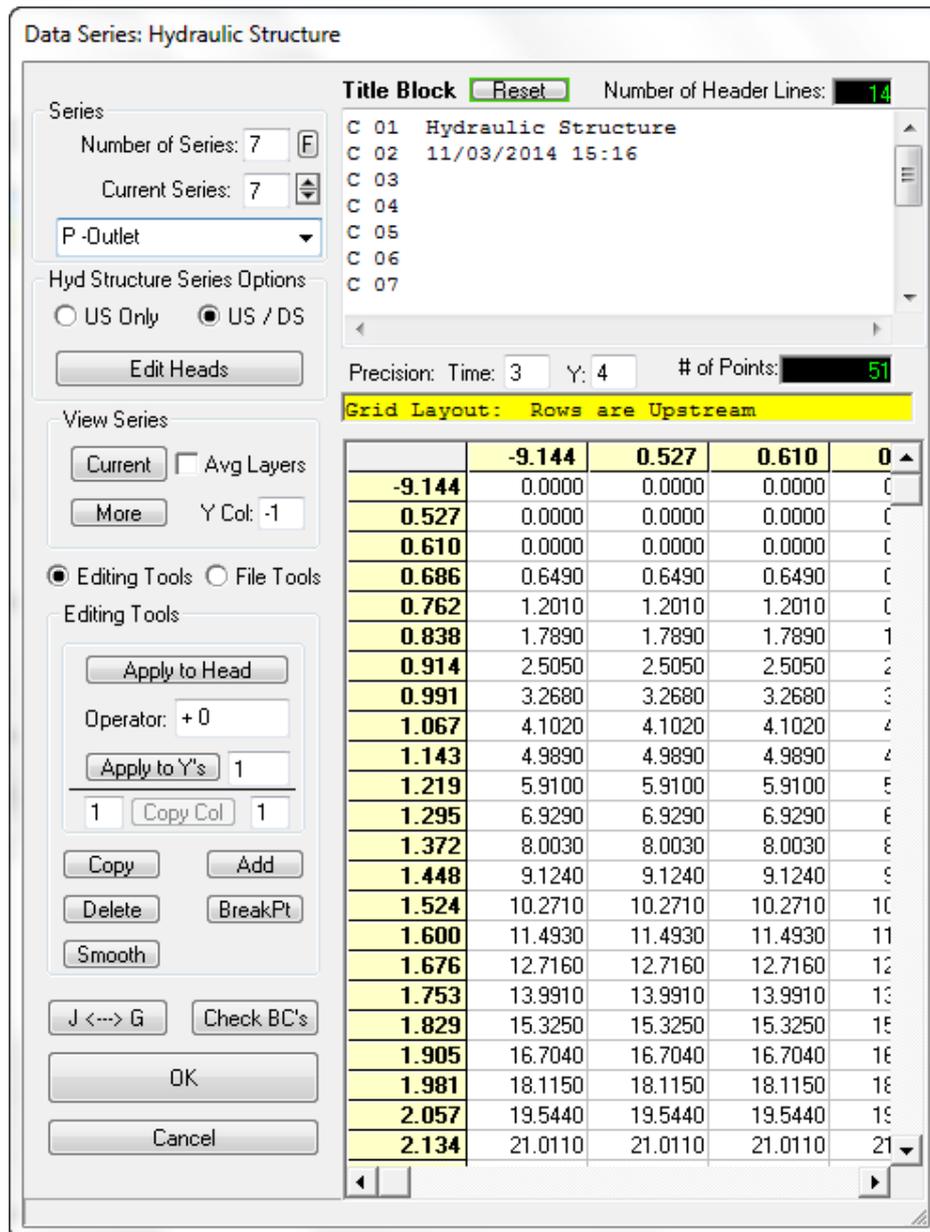


Figure 5-21 Hydraulic Structure BC Editing: Flow from US and DS Elevations.

This matrix may be plotted by selecting the *View Series / Current* option. This displays the graph as shown in Figure 5-22. As there are often too many series to plot, the user is prompted for a skip interval so that some lines are not displayed. The user may also select a specific upstream head to plot.

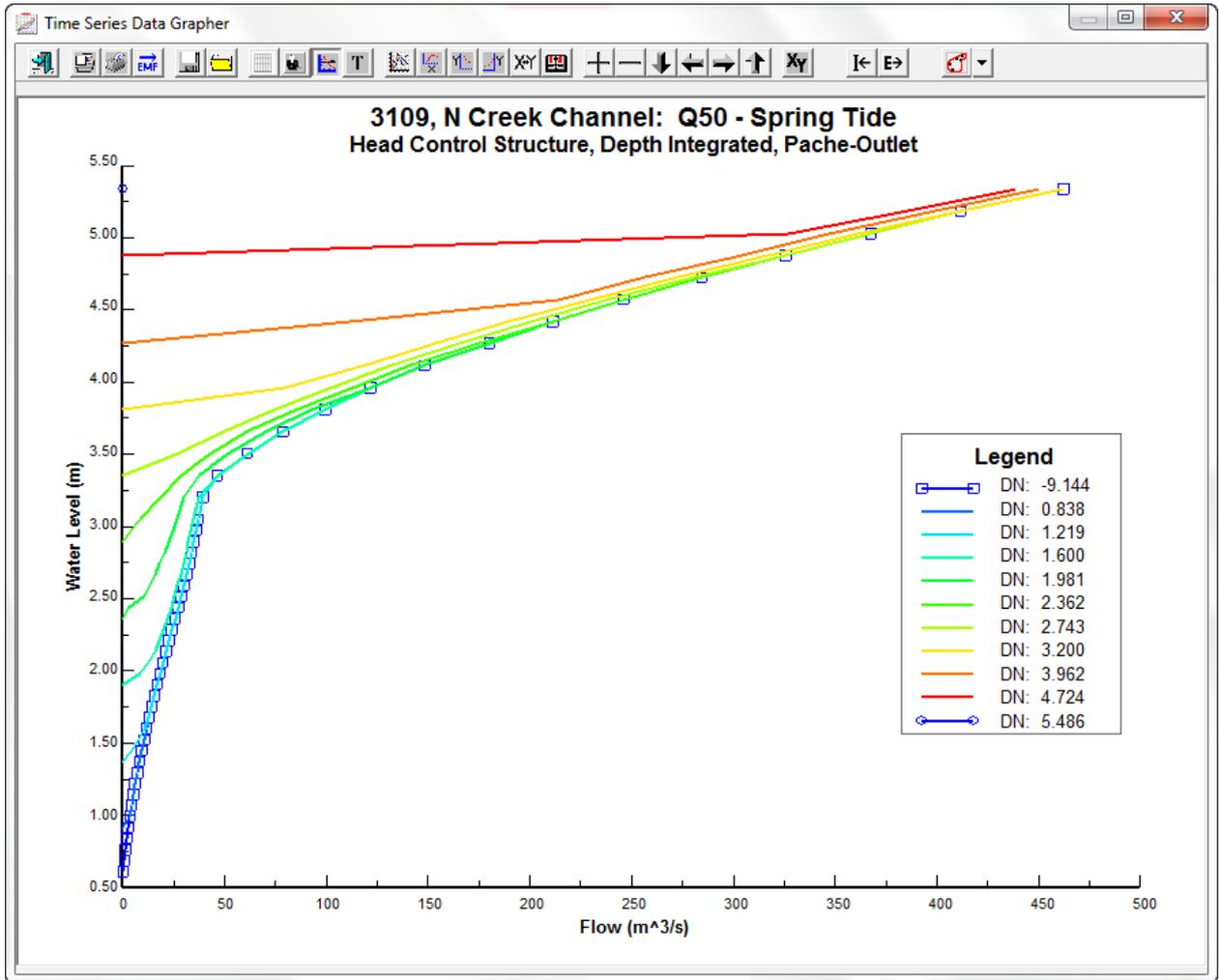


Figure 5-22 Flow from US and DS Elevations.

5.3.8. Hydraulic Structures Boundary Condition Editor - Equation Based

EE8 and efdc+ can simply and quickly setup up hydraulic structures (HS) such as culverts, weirs, sluice gates, and orifices with the physical dimensions of the structures and use the corresponding HS equations (Dill, 2012), as well as the previous option of defining a flow series for the structure. EE allows the user to view summary of the type of the hydraulic structure and the equation definition (i.e. parameter definition) as shown in Figure 5-23.

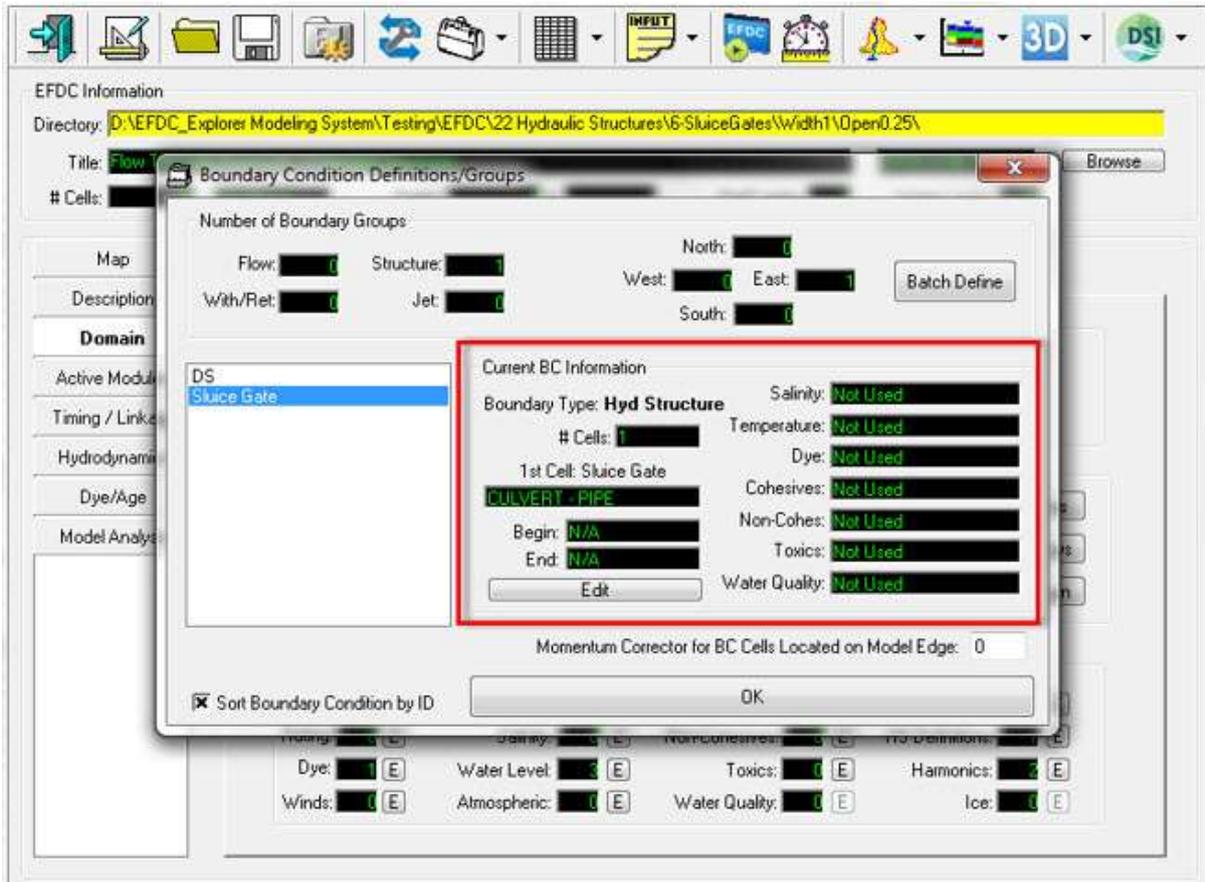


Figure 5-23 Boundary condition groups for Hydraulic Structures.

Using the *Edit* button shown in Figure 5-23 the user may load the *Hydraulic Control Structure Boundary Conditions* form as shown in Figure 5-24. On this form (Figure 4-2), there is a dropdown selection of all available *Flow Control Type* (NQCTYP). When the user has defined a hydraulic structure the EFDC.INP file creates the card C32A to handle these variables. Some of the parameters in C32A are not used, depending on which equation has been selected.

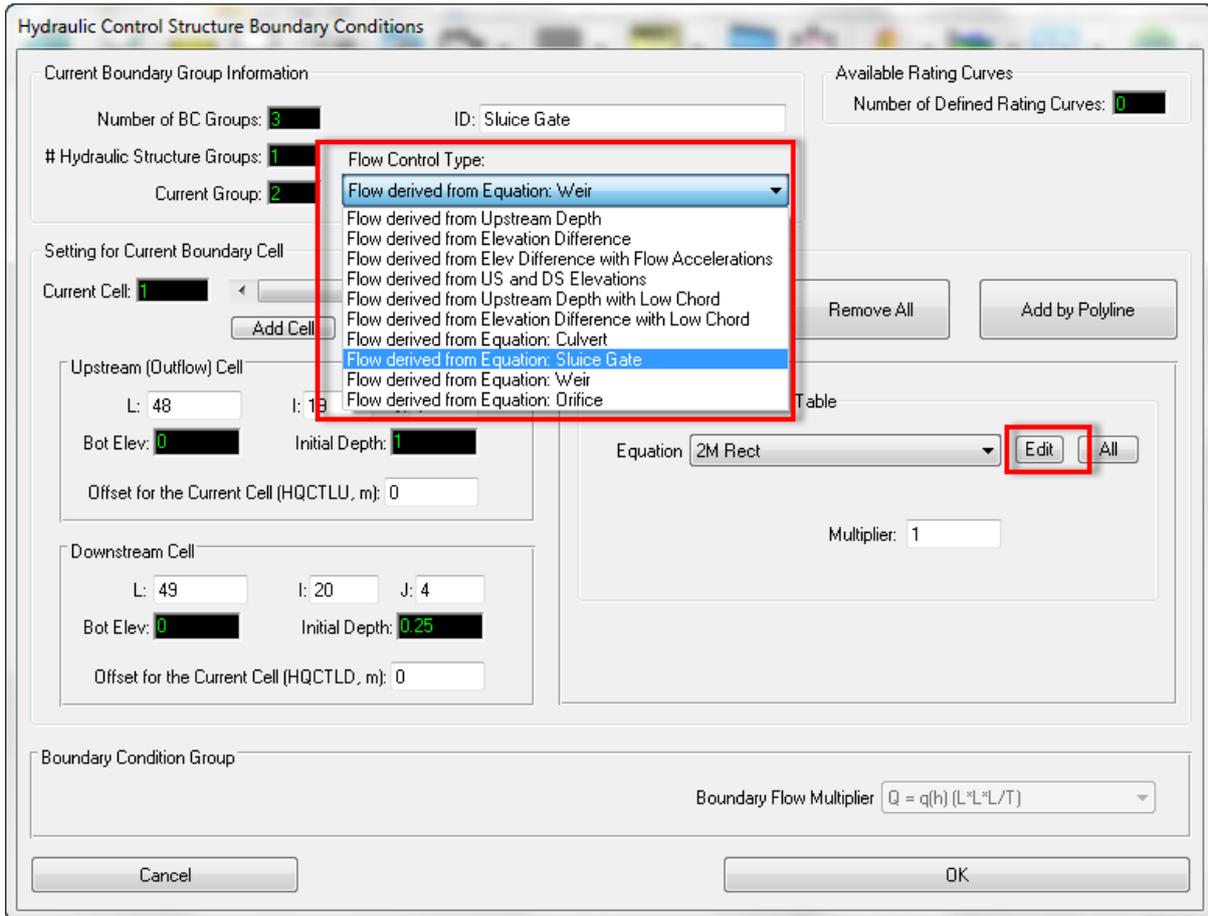


Figure 5-24 Boundary condition editor.

The dropdown list defines the flow derived control structure (NQCTYP < 5) and the new hydraulic control structures (NQCTYP > 4). Based on what the user selects the “*Head Lookup Equations*” and the “*Cell Options*” frames are updated based on the selection.

Selecting the *Edit* button shown in Figure 5-24 opens the equation editor for the flow control type selected. Each hydraulic structure type is described further below. Note that for every equation, there is a check box to indicate whether or not to allow reverse flows.

5.3.8.1 Culverts

To assist the user define the input parameters for the culvert, a *Definition Editor* is provided as shown in Figure 5-25. This form can be accessed by clicking on *Edit* button in Figure 5-24. Here the user may define the *Equation ID*, allowing various culverts dimensions and type to be defined.

The user should select the *Hydraulic Structure Type* from the dropdown menu. In this case, the option chosen is “culvert”. The user should then select the *Cross-section type*. Depending on the options chosen the image of the culvert will change to match the user’s selection. The user can then specify the culvert dimensions in meters, including upstream and downstream elevations of the pipe, length of the pipe, Manning’s roughness coefficient and diameter of the pipe as shown in Figure 5-25. The user may also import 3D structures to better visualize the hydraulic structures in EE8 as shown in Figure 5-26.

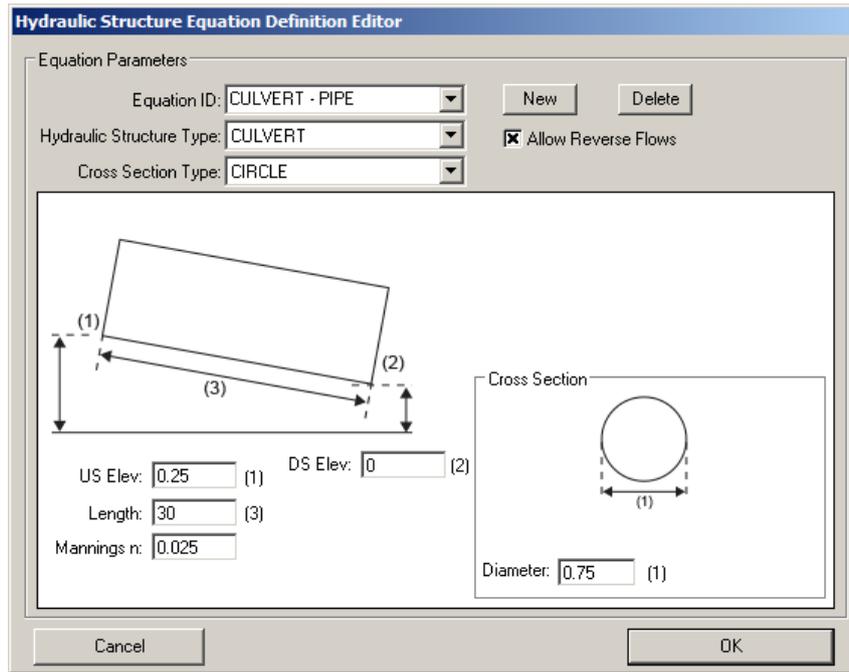


Figure 5-25 Hydraulic Structure Equation Editor: Culverts.

The methods for determining flow through culverts are based on the culvert flow type classification and analysis from Chow (1959). This methodology describes six different types of culvert flow based on the location of the control section within the culvert and the relative elevations of the headwater, tailwater, and culvert invert and crown elevations in meters. The discharge is primarily computed using Manning’s equation which can be expressed as:

$$Q = KS^{1/2}$$

Where conveyance, $K = (A/n)R^{(2/3)}$ and where A = cross-sectional flow area (m); n = Manning’s roughness coefficient, and R = hydraulic radius (m).

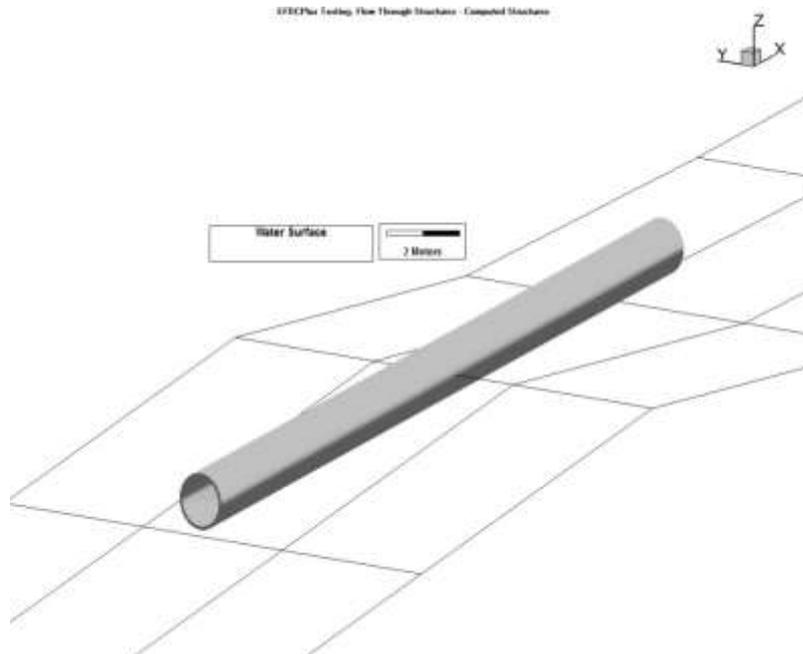


Figure 5-26 Image of culvert in View3D.

5.3.8.2 Sluice Gates

To assist the user define the equation parameters for the sluice gate, a *Definition Editor* is provided as shown in Figure 5-27. The user should define the *Equation ID*, for various sluice gates to be defined.

The user should select the *Hydraulic Structure Type* from the dropdown menu, in this case it is “sluice gate”. The user should then enter the sluice gate dimensions, including sill elevation, height, width, super-critical weir flow, sub-critical weir flow, free sluice flow and submerged orifice flow parameters as shown in Figure 5-27. The user may also import 3D structures to better visualize the hydraulic structures in EE8 as shown in Figure 5-28.

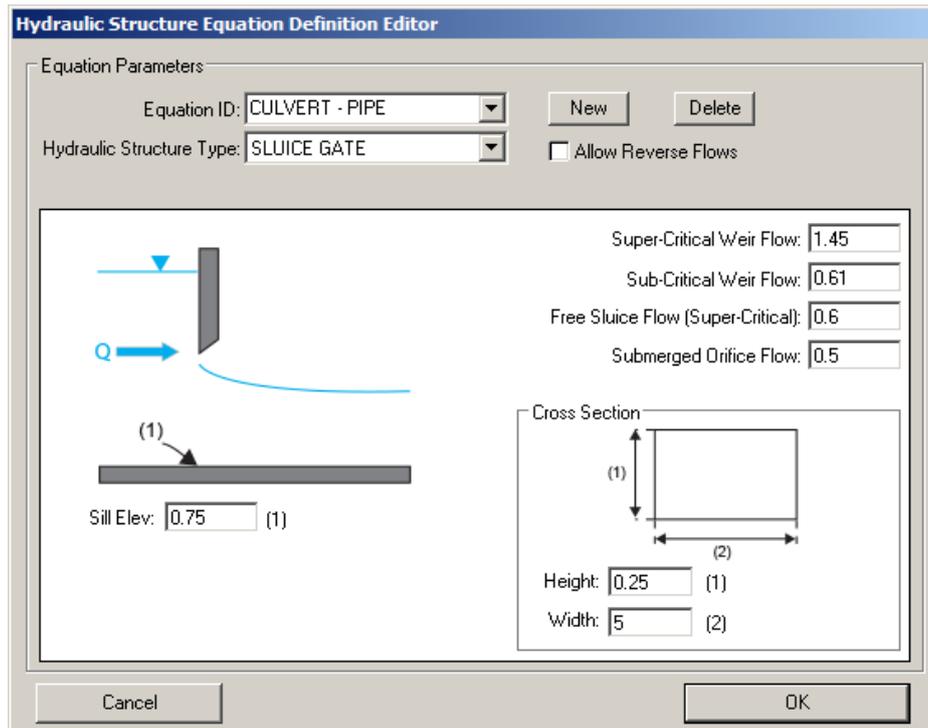


Figure 5-27 Hydraulic Structures Equation Definition: Sluice gate.

Flow through a sluice gate can be characterized by two basic parameters: the tranquility of the flow (i.e., subcritical or supercritical flow) and the water depth (i.e., gate submerged or not).

The equation for free sluice gate flow is

$$Q = C_3WB\sqrt{2gH_u}$$

And for submerged orifice flow

$$Q = C_4WB\sqrt{2g(H_u - H_d)}$$

Where C_3 and C_4 are discharge coefficients for free flow and submerged orifice flow respectively, W is the width of gate, H_u and H_d are headwater and tailwater, respectively.

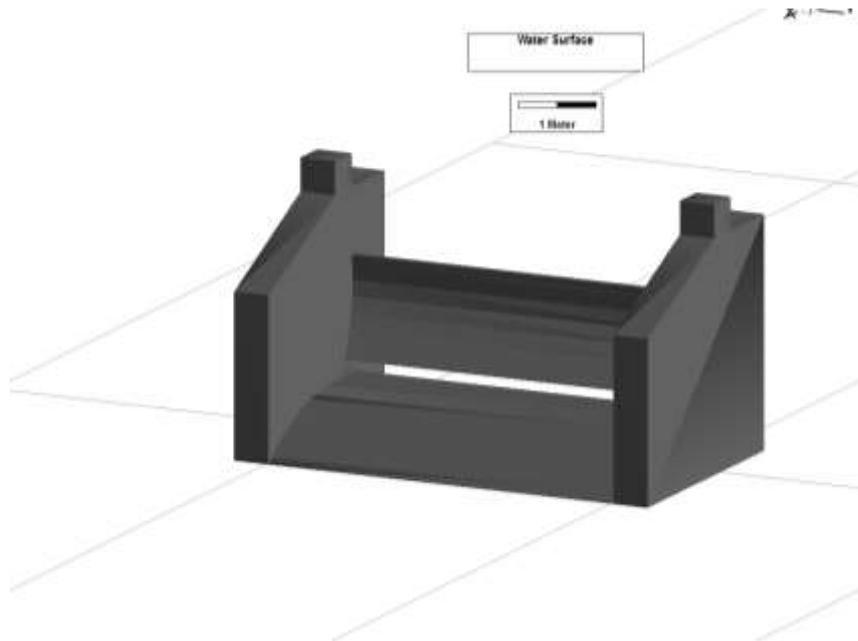


Figure 5-28 Image of sluice gate in View3D.

5.3.8.3 Weirs

To assist the user define the equation parameters for a weir, a *Definition Editor* is provided as shown in Figure 5-29. The user should define the *Equation ID*, for various weirs to be defined.

The user should select the *Hydraulic Structure Type* from the dropdown menu, in this case it is “weir”. Four cross-section types are available to the user: rectangle, v notch, trapezoid and broad crested. This example shows a broad crested weir definition form which requires the crest elevation, width of the weir, and the co-efficient of discharge.

An imported 3D structure image (COLLADA file), used to better visualize the hydraulic structure in *View3D* is shown in Figure 5-30.

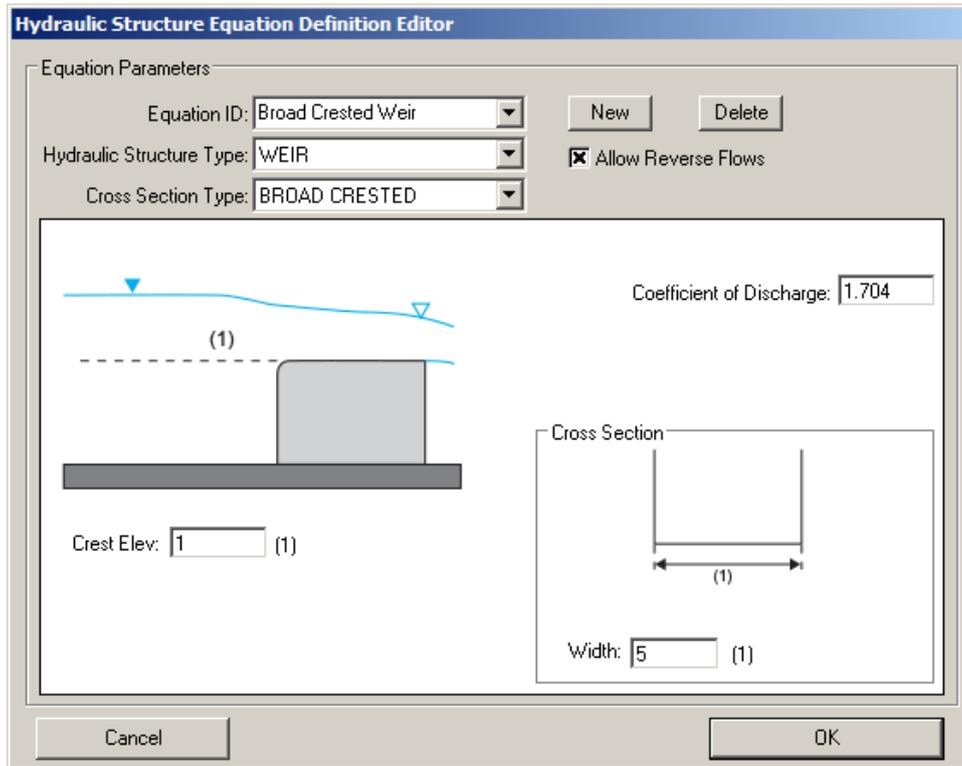


Figure 5-29 Hydraulic Structures: Weir definition form.

The equation to define the flow for weirs are as follows:

$$Q = \alpha CW \sqrt{2g} H_u^\beta$$

Where α is the ratio, C discharge coefficient and β is a exponent coefficient depending on the shape of flow cross-section.

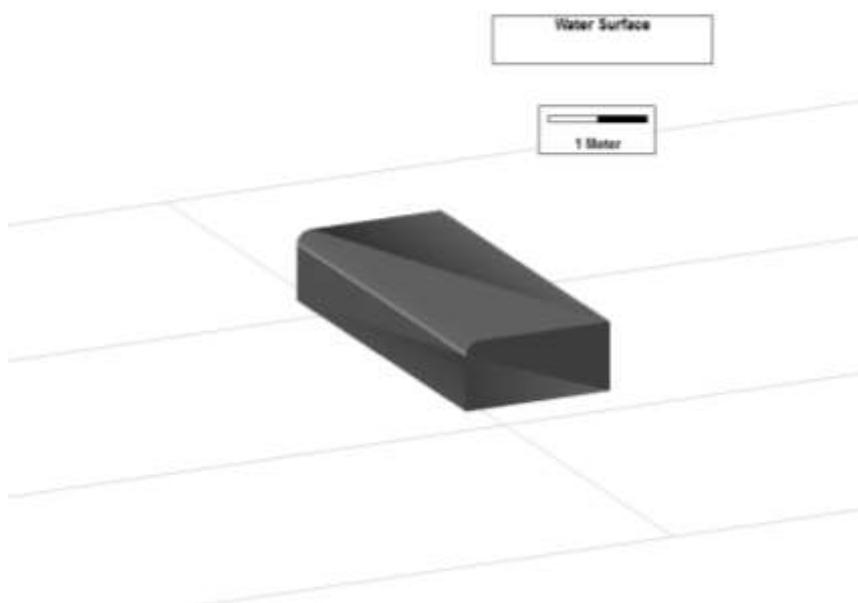


Figure 5-30 Image of broad crested weir in View3D.

5.3.8.4 Orifices

To assist the user define the equation for an orifice, a *Definition Editor* is provided as shown in Figure 5-31. The user should define the *Equation ID*, for various orifices to be defined.

The user should select the *Hydraulic Structure Type* from the dropdown menu, in this case it is “orifice”. Six cross-section types are available to the user: circle, half-circle, ellipse, half-ellipse, rectangle, v notch, and trapezoid. This example shows an orifice with a half circle cross section. The user should send the upstream elevation, diameter of the cross-section in meters, coefficient of discharge for a weir, and coefficient of discharge for an orifice.

An imported 3D structure image (COLLADA file), used to better visualize the hydraulic structure in View3D, is shown in Figure 5-32.

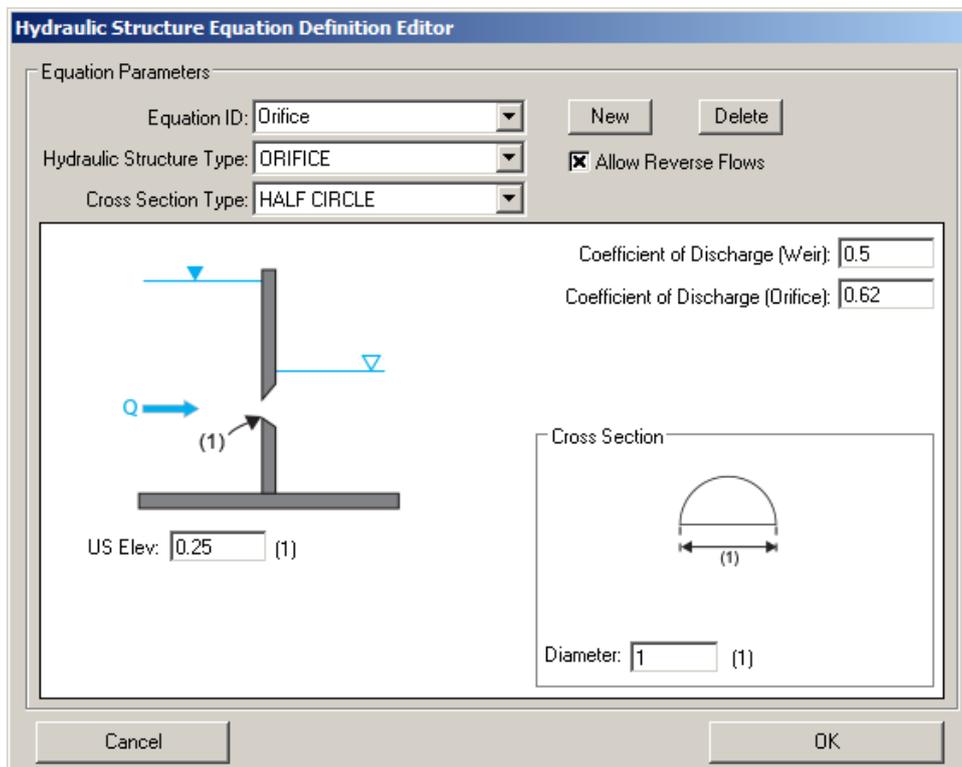


Figure 5-31 Hydraulic Structures: Orifice definition form.

The flow equations for the submerged orifice as defined as follows.

$$Q = CA\sqrt{2g(H_u - H_d)}$$

And for free orifice

$$Q = CA\sqrt{2gH_u}$$

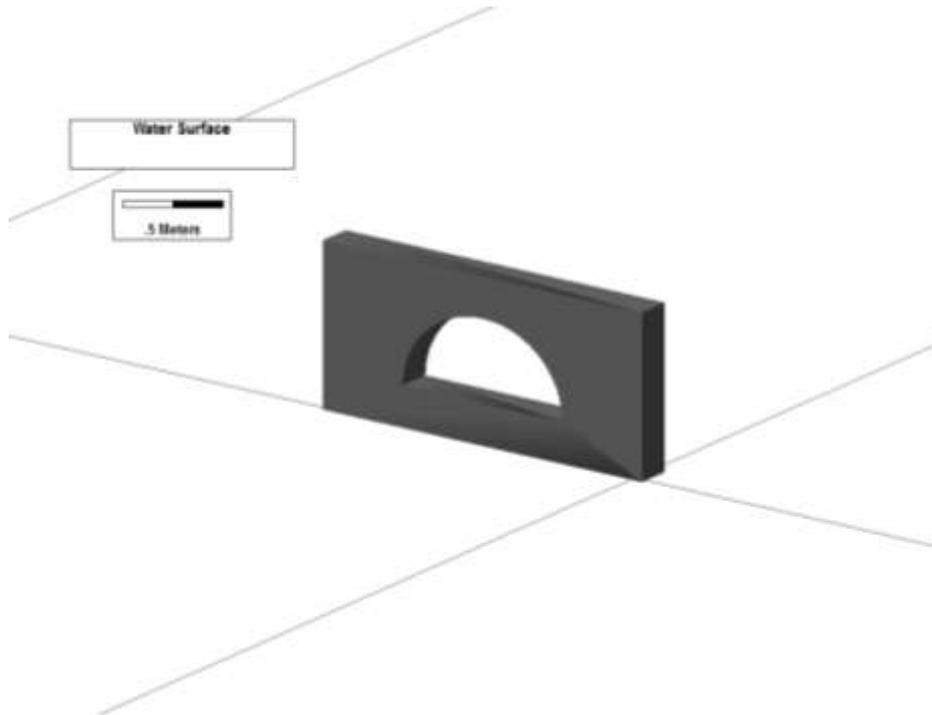


Figure 5-32 Image of half circle orifice in View3D

5.3.9. Open Boundary Condition Editor

The form for the open boundary condition is shown in Figure 5-33. In the *Current Boundary Group Information* frame the user may assign the *Open Face Direction* and *Type of Open BC* with drop down menus.

For open BC's, unlike flow BC's, the concentrations specified in the *Constant Concentrations* frame are always used for boundary assignments. The constant concentrations will be added to any time series concentrations defined. For example, if the user has a tidal time series of salinity that varies from 5 to 10 ppt and specifies a concentration for salinity of 10 ppt in the *Constant Concentrations* frame, EFDC will apply time variable salinity concentrations ranging from 15 to 20 ppt.

Open Boundary Condition/Pressure

Current Boundary Group Information

Number of BC Groups: 16 ID: Mare_Island
 # Pressure/Open Groups: 1 Open Face Direction: West
 Current Group: 1 Type of Open BC: Elevation Specified

Available Pressure Series

Number of Pressure Series: 1
 Number of Harmonic Series: 0

Settings for Current Boundary Cell

Current Cell: 1 Number of Cells: 6
 Add Cell Remove Cell Remove All Add by Polygon

Cell Location

L: 3561 I: 3 J: 212
 Bot Elev: -11.096 Initial Depth: 12.138
 Tangential Factor: 0 Set

Time Series

Pressure: Mare_Island_w_Residual E
 Harmonic: None E
 Series 2: None E
 Interpolation: Assign Reset

Group Settings

Constituent	Bottom	Surface
Salinity (ppt)	0	0
Temperature (°C)	0	0
Dye (mg/l)	0	0
Sed1 (mg/l)	0	0
Snd1 (mg/l)	0	0

Concentration Tables (Time Variable)

Salinity: Series_01 E Toxics: None E
 Temperature: BAY(CAR) E Cohesives: CAR E
 Dye: None E Non-Cohesives: CAR E
 Shell Fish: None E Water Quality: None E

Time Steps for Smooth Transition: 0

Cancel OK

Figure 5-33 Boundary Condition Settings – Flow Boundary.

The *Interpolation* frame provides access to two functions:

- *Assign* generates new pressure series for the unassigned cells interpolated from the cells along the boundary that were assigned prior to pressing *Assign*. Interpolated series always have an ID that begins with "I:" to identify the series as an interpolated series. Each unassigned cell has its own interpolated series generated, then that series is assigned to that cell. Two or more prior assigned cells to existing series is required. The cells at either end of the open boundary must be defined for this process to work properly.

- *Reset* scans the current boundary group and finds any cells whose pressure series ID begins with "I:". If it finds cells with an interpolated series, it deletes the series and sets the pressure series index equal to zero (i.e. resets the assignment).

5.3.10. Harmonic Tidal Boundary Series

EFDC_Explorer provides two approaches for representing tidal forcing boundaries, the simple harmonic forcing boundary and the astronomical tidal forcing.

5.3.10.1 Simple Harmonic Forcing

With the simple harmonic forcing boundary, harmonic constants are specified and EFDC computes the forcing time series using a simple harmonic formulation. This time series then can be combined with a normal pressure time series for different correction purposes, such as storm surge simulation or datum correction.

This forcing boundary type can be selected in the *Domain | Boundary Conditions* tab and clicking "E" (edit) button for *Harmonics* which displays the form shown in Figure 5-34. The user can specify the forcing of an arbitrary number of combinations for harmonic components from 234 predefined tidal constituents. This is done by LMC to select the *Global Tidal Constituents* and then pressing the arrow button on the form to populate the Harmonic Constituents to the right.

These constituents may be sorted either by angular speed (frequency) (degrees/hours) or period (days) with the radial button in the *Sorted by* frame.

In the *Harmonic Coefficient Forcing Type* frame the user has three options; constant, linear variation and quadratic variation. It is generally recommended to use a constant forcing. With the other two options the user must specify additional one or two amplitude and phase for each tidal constituent, respectively. EFDC will then vary the final (i.e. applied) phase and amplitude for each tidal constituent using the specified method and values.

Global Tidal Constituents

ID	Name	Speed (deg/hr)
1	SA	0.0411
2	SSA	0.0821
3	MSM	0.4715
4	MM	0.5444
5	MSF	1.0159
6	MSO	1.0159
7	MF	1.0980
8	KOO	1.0980
9	MKO	1.0980
10	SNU	1.4874
11	SN	1.5603
12	MSTM	1.5696
13	MFM	1.6424
14	2SM	2.0318
15	MSQM	2.1139
16	MQM	2.1868
17	2SMN	2.5762
18	2OK1	12.8450
19	2Q1	12.8543
20	NJ1	12.8543
21	SIGMA1	12.9271
22	MUK1	12.9271
23	NUJ1	12.9271
24	Q1	13.3987
25	NK1	13.3987

Composite Forcing Series

	Name	Speed(deg/hr)	Amplitude (m)	Phase (s)
1	MSO	1.0159	0.005	75.39
2	MF	1.09803	0.01	97.15
3	KOO	1.09803	0.096	110.02
4	MKO	1.09803	0.011	219.56
5	SNU	1.48742	0.305	116.78
6	SN	1.56027	0.009	34.88
7	MSTM	1.56955	0.004	359.3
8	MFM	1.64241	0.004	138.8
9	SSA	0.08214	0.009	359.3

Figure 5-34 Domain Tab: Simple Harmonic Forcing.

Note that when specifying an open boundary, it is possible to specify harmonic tide as an independent boundary condition or both a harmonic series and a pressure series. In the latter case the harmonic series is added to the pressure series for the final pressure to be used by EFDC in the solution. That is how the user could adjust for a datum shift (i.e. the pressure series would just be a constant offset).

5.3.10.2 Astronomical Tidal Forcing

EFDC_Explorer provides a *Tide Generator Tool* for generating a pressure time series computed as astronomical tidal forcing.

The basic formula for the oscillation of water level due to astronomical tides is based on the combination of the tidal constituents as follows:

$$\eta = z_0 + \sum_{i=0}^N f_i H_i \cos\{\omega_i t + (V_0 + u)_i - g_i\}$$

In which

η = tide level (m)

z_0 = mean sea level above the datum (m)

f_i = nodal coefficient to adjust amplitude for the i^{th} component

H_i = amplitude of the i^{th} component (m)

ω_i = speed or angular velocity of the i^{th} component (radians per second)

t = time (s)

$(V_0 + u)_i$ = astronomical arguments of the i^{th} component

g_i = phase lag of the i^{th} component from Greenwich longitude

It should be noted that the units used in EE can be changed so that they are convenient for the users.

The *Tide Generator Tool (EFDC Input Tides)* provides the ability to generate pressure time series from astronomical tidal forcing. This is accessed via the “E” button for the *Pressure* series in the *Domain tab | Boundary Conditions*. In the *Data Series: Water Surface* form the user should click the *Generate from Harmonics* button. This will display the form shown in Figure 5-35. The user should complete the form in a manner similar to that described for simple harmonic forcing above. The user must specify the number of constituents, and import the data file for the constituent parameters (name, amplitude, phase) if available.

Each series can have its own name, and the user may apply a datum shift (z_0) in meters or time shift in hours to the series. A row may be deleted by selecting Shift and RMC. An example of the data structure is provided in Appendix B.

EFDC Input Tides

Units Setting

Amplitude

Meter (m)

Centimeter (cm)

Feet (ft)

Phase

Degrees

Radian

Second

Sorted by

Speed (deg/hr) Period (days)

Global Tidal Constituents

ID	Name	Speed (deg/hr)
1	SA	0.04107
2	SSA	0.08214
3	MSM	0.47152
4	MM	0.54437
5	MSF	1.01590
6	MS0	1.01590
7	MF	1.09803
8	K00	1.09803
9	MK0	1.09803
10	SNU	1.48742
11	SN	1.56027
12	MSTM	1.56955
13	MFM	1.64241
14	2SM	2.03179
15	MSQM	2.11393
16	MQM	2.18678
17	2SMN	2.57617
18	2OK1	12.84500
19	2Q1	12.85429

Composite Forcing Series

Import Export Number of Stations: 1

Series Name: TideF_01 Current Station: 1

Datum Shift (Z0, m): 0 Time Shift (h): 0

Timing

Model Time User Define

Start Date (Julian): 220

Duration (days): 94

Time Step (min.): 60

View

Location Specific Parameters

Number of Constituents: 8

ID	Speed(deg/hr)	Amplitude	Phase	Name
1	92	28.98410	1.07200	M2
2	28	13.94304	0.46100	O1
3	108	30.00000	0.26800	S2
4	40	14.95893	0.25800	P1
5	80	28.43973	0.21600	N2
6	111	30.08214	0.07900	K2
7	1	0.04107	0.07700	SA
8	43	15.04107	0.83400	K1

Cancel Apply

Figure 5-35 Domain Tab: Astronomical Tidal Forcing

5.3.11. Jet Plume Boundary Condition Editor

From release of EE7.2 the jet plume condition is provided, which was previously only available in EFDC but not accessible from EE. When the user creates a new boundary condition there is now the option of type 8, Jet plume. The form for editing the Jet Plume BC is shown in Figure 5-36. EFDCPlus has also been updated to better work with the EE defined jet plume settings.

Similar to flow boundary condition or withdrawal/return user interfaces, the settings for jet/plume boundary conditions are easier to use. Flow data of a jet plume boundary can link to a flow time series, a W/R time series or be by-passed. The diffuser port settings for each discharge cell include the number of ports, the elevation and the diameters of the port outlets and the horizontal (azimuth) and vertical (altitude) angles. Figure 5-37 illustrates the temperature distribution in case of two diffusers in a weak flow stream.

Modify/Edit Jet/Plume BC Properties

Current Boundary Group Information

Number of BC Groups: 3 ID: Jet/Plume
 Number of Jet/Plume Groups: 1 Jet/Plume Type: Use J/P with QSER Flows
 Current Group: 3 Number of Time Steps to Update JP Calculations: 40

Available Flow Series

Number of Flow Series: 1
 Number of Withdrawal-Return Series: 0

Settings for Current Cell

Current Cell: 1 Number of Cells: 1
 Add Cell Remove Cell Remove All Add Cells by Polygon

Jet/Plume Discharge Cell

L: 338 I: 31 J: 7 K: 1
 Bot Elev: 95 Initial Depth: 5

Jet/Plume Withdrawal Cell

L: 0 I: 0 J: 0 K: 0
 Bot Elev: Initial Depth:

Flow Assignm

Flow: Discharge Edit All
 Withdrawal-Return: None Edit
 Constant Flow (m3/s): 0 Distr Q

Diffuser Port Settings for Current Cell

Number of Ports: 1 Diameter (m): 0.1 Elevation (m): 95.1 Angles (Deg): Vertical: 45 Horizontal: 0

Settings for Current BC Group

Constant Concentrations

Constituent	Conc
Salinity (ppt)	0
Temperature (°C)	0
Dye (mg/l)	0
	0

Concentration Tables (Time Variable)

Salinity: None Toxics: None
 Temperature: Discharge Cohesives: None
 Dye: Discharge Non-Cohesives: None
 Shell Fish: None Water Quality: None

Control Parameters

Elements: 10 Entrainment Option: Use Max of Shear or Forced Froude Number Adjustment Factor: 1 Write Log File:
 # Iterations: 150 Entrainment Stop: At specified number of eleme Entrainment Error Criteria: 1 Log Format: 0

Cancel OK

Figure 5-36 Modify/Edit Jet Plume BC Properties.

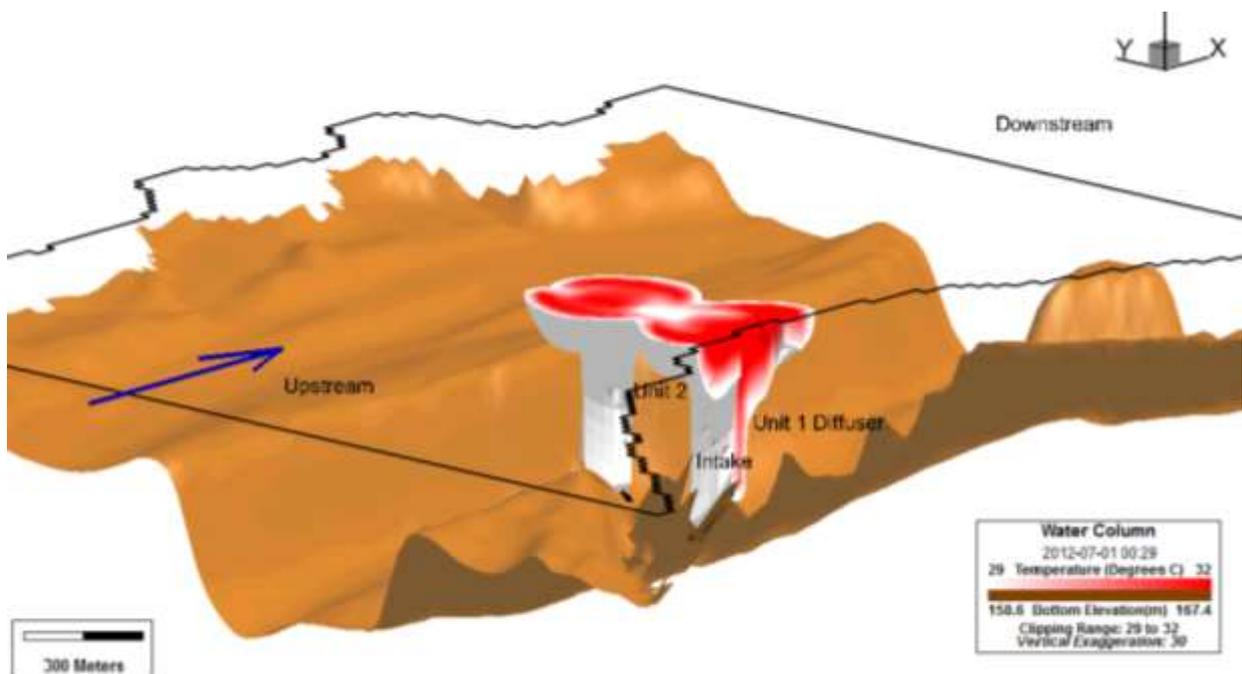


Figure 5-37 Thermal Discharge from Multipoint Diffusers using Jet Plume BC.

5.3.12. Data Series Editing Form

A common function needed for all the boundary forcing data series is the need to edit, view and compare these series. These processes and other time series utilities are available using the *Data Series* time series data management form (Figure 5-38). This form is broken down into several sections.

The *Title Block* displays and allows edits of the title block EFDC requires for the specific boundary file(s). The number of lines varies between boundary forcing files. EFDC_Explorer ensures the correct number of header lines is used for each type of file. Pressing *Reset* will overwrite the current header with a “standard” header for that type of file, using the *Project Title* as the project specific label. The user may also manually edit the header and EFDC_Explorer will maintain those edits. However, only one header is available for all the different series.

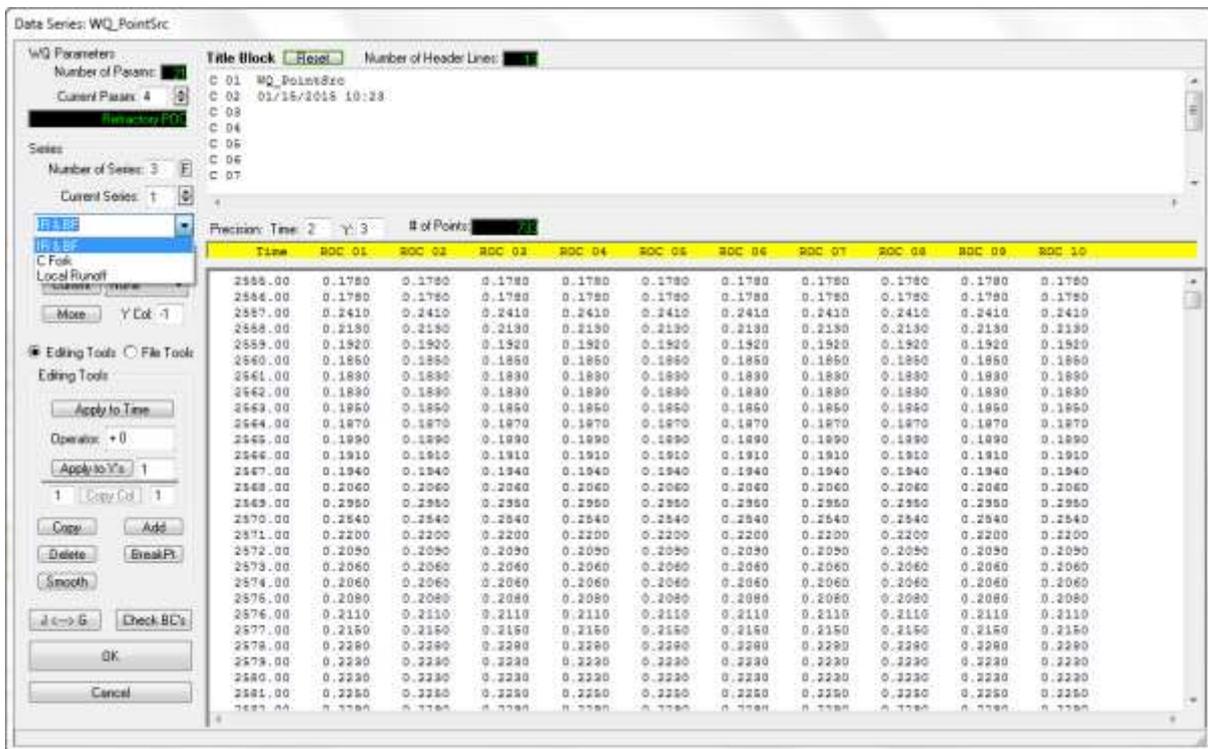


Figure 5-38 Data Series Editor: WQ boundary conditions.

Sometimes, the type of data series has fixed groups for a given series. This is the case for sediments, toxics and water quality. To view and/or edit a series the user must specify the series (e.g. “1” in Figure 5-38) and a group (e.g. “4” for Refractory Organic Carbon). The user can then edit, plot, compare, copy, etc. the currently selected series/group. If the type of series does not use groups (e.g. flows) then the group frame will not be displayed.

The *View Series* frame provides the user with the ability to plot the time series. The *More* button provides access to additional plotting functions. The *Show All Series* button compares already defined series to each other. The user can turn on or off the series by selecting 1 or 0 for each series as shown in Figure 5-39. The *Filters* frame includes *Daily Minimum* and *Daily Maximum*. This allows the user to show any series the user selects on the same plot for the selected parameter in a given column (*Y Col*), also shown in Figure 5-39.

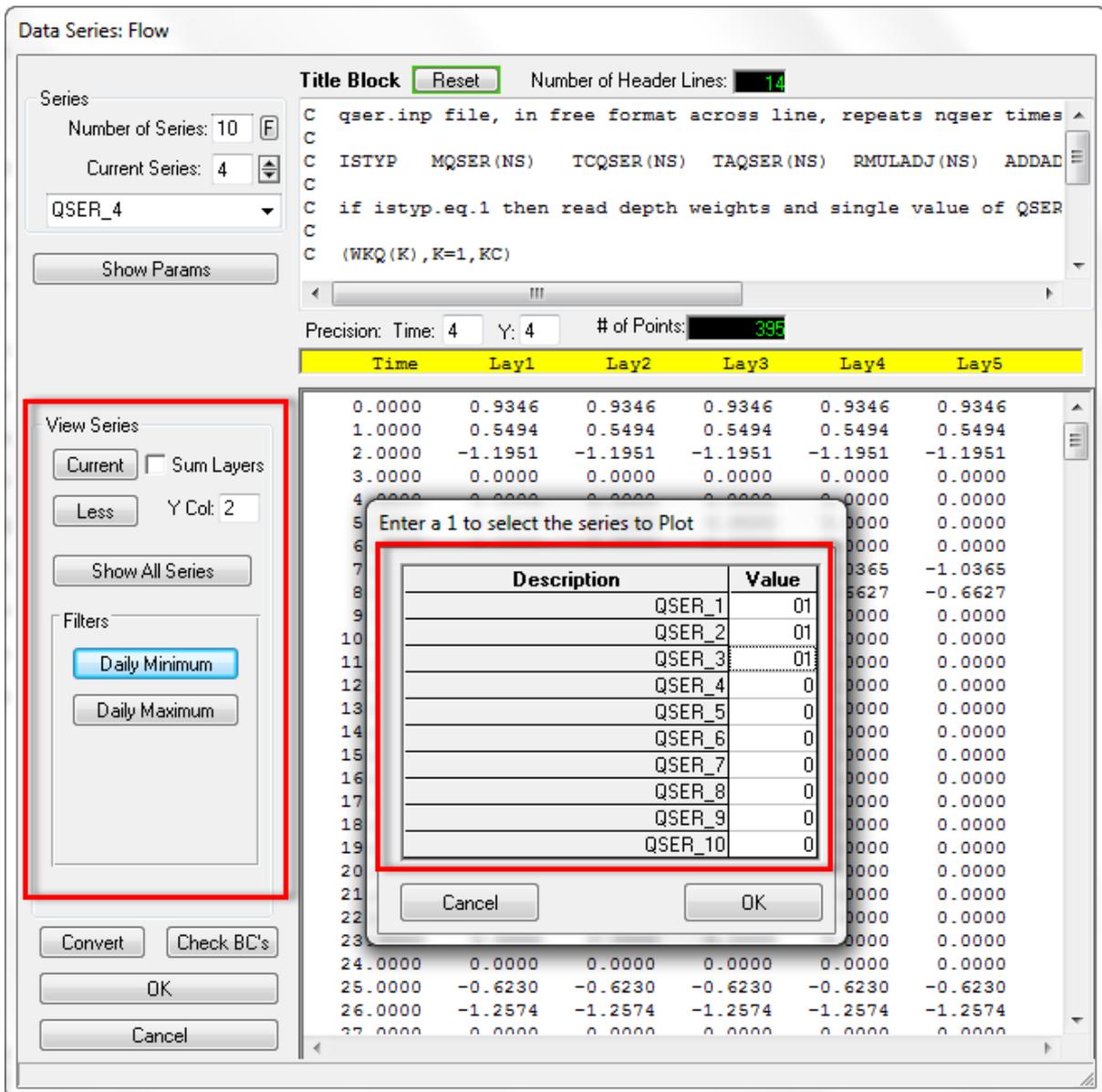


Figure 5-39 Data Series Editor: View Series options.

The option buttons for *Editing Tools* and *File Tools* change the function of the frame below these buttons. The *Editing Tools* is the default frame. This option allows the user to apply *Operator's* to the date column or any/all of the data columns, or a range of columns. The user may enter the column number, or if they want the operator to apply to layers from 1 to 3, then they should enter "1-3" in the *Apply to Y's* input interface. This will apply the operator to these layers for the whole time series. Entering "-1" will apply the operator to all columns and a "P" in front of this will apply to parameters instead of layers.

The following is a description of the various "Editing Tools" functions:

- **Copy** To copy the current series to a new series at the end of the current list of series.

- **Add** Adds a specified series to the current series. This process overwrites the current series with the results. The timing does not need to match. EFDC_Explorer uses the current series' timing and computes the value of the second series at the times of the current series.
- **Delete** Deletes the current series. All the series number above the current series are renumbered to the next lower number and boundary conditions that use these series are updated.
- **BreakPt** This function "breakpoints" the current series. The breakpointing process removes consecutive points that have the same value (within a user specified tolerance), leaving the 1st and last points with the same value. An example of a series breakpointed is shown below.

Raw Series		Breakpointed Series	
X	Y	X	Y
1.0	0.2	1.0	0.2
2.0	0.3	2.0	0.3
3.0	0.3	5.0	0.3
4.0	0.3	6.0	0.4
5.0	0.3		
6.0	0.4		

- **Smooth** Applies a smoothing process to the current series. The weights are 1/6, 2/3 and 1/6. A single pass is applied. The user can apply the smoothing repeatedly to attain the desired smoothing. Since the current series is overwritten with the results of the smoothing process, it is useful to export (via the Time Series plotting function) the unsmoothed time series first. As smoothing is applied, the user can import (via the Time Series plotting function) the original series for comparison.

In the *Series* form there is now also a dropdown menu with a list of boundary conditions that may be selected from as shown.

Note that the time series form has several additional keystroke functions not available on the main form. Figure 5-40 shows a screen capture of the information message box (F2).

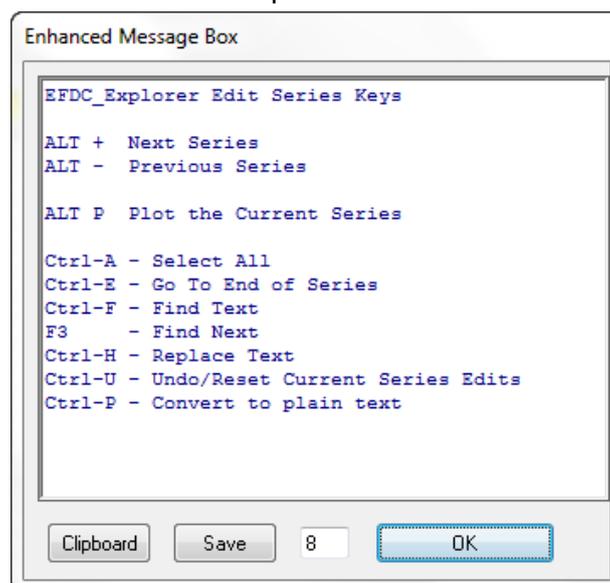
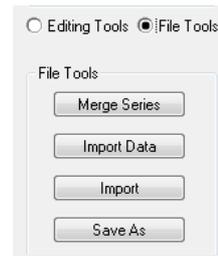


Figure 5-40 Time series keystroke function information message

The *File Tools* option changes the frame to that shown here. The purpose of this option is to provide ways to populate the time series from existing data files. In addition to importing data from existing files, the user can paste data into the time series from another application (e.g. Excel) as long as the formats are compatible.



- *Merge Series* Imports an existing ASCII data file and then interpolates the data series onto the timing of the current series. This is especially useful for time series that have multiple groups for the same series (i.e. sediments, toxics, and water quality). Figure 5-41 shows an example of the ASCII data time series import form.
- *Import Data* Imports an existing ASCII data file and replaces the current series data with the new data. The same import form (Figure 5-41) used for the “Merge Series” is used for this function.
- *Import* Imports an existing EFDC formatted time series for the current time series type (i.e. if editing flows, will import a QSER.INP file). All the currently defined series for the current boundary type are overwritten with the contents of the import file.
- *Save As* Allows the user to write all of the series of the current boundary type to an EFDC formatted file. EFDC_Explorer writes these files during the project save process. However, this function is useful for backup during the editing process or to provide output for other user needs.

ASCII Data Import Form

File to Import

Data Format

EE DAT or WQ Data
 YY MM DD Values
 YY MM DD HH MM Values
 MM DD YY HH MM Values
 YY MM DD MMMM Values (1440 Min Time)

YY MM DD HH Values
 JulianDate Values
 HSPF/WDM Format

YY MM DD HH MM Values
 Date Values
 Time Date Values
 Date Values (Not System)

Delimiter

Space Comma Tab

Import Settings

Rows to Skip: Flow Column:
 Data Column to Import: of
 Import Base Date: Add Date Conversion Factor:

First Line Results of Importing

Date Time: Y Value:

Figure 5-41 ASCII data time series import form.

The following provides a quick guide to the use of the ASCII data import form:

- Select the data file to import using the *Browse* button.
- Select the delimiter.
- Depending on the *Data Format* selected, other options will also need to be selected in the *Delimiter* and *Import Settings* frames. .
- The *Data Column to Import* should point to the column number that contains the Y data.
- As changes are made the information in the *First Line Results of Importing* frame provides the results of the current settings.
- Preview/Graph the results of the current settings to see if the import results are what was expected. If not, make further adjustments, as needed, until the data import plot is correct.
- Press *OK* to finalize the actual importing process.

5.3.12.1 Groundwater

In the *Groundwater* frame (Figure 5-10) the user can select a range of groundwater interaction options. The user should review the EFDC code to ensure the option specification and EFDC function for the groundwater parameters. The current options are:

- Option 0 Disable groundwater interaction;
- Option 1 Allow soil wetting and drying;
- Option 2 Allow groundwater interaction (using GWMAP and GWSER), and
- Option 3 Apply a constant groundwater flux out of the model by zones (using GWSEEP and GWMAP, and available for EFDCPlus only).

The *Modify Series* button gives access to the groundwater class data (Option 3). The number of series is input in the appropriate box and then the grid allows the user to specify the groundwater class data. As with the vegetation class data, the ID and the Description are used only by EFDC_Explorer.

The ID, as with the vegetation classes, is again used to match the groundwater classes to the EFDC cells using the *Apply Overlays* button. The same process as discussed for the vegetation classes is applied here.

The *Apply Polygon* button is similar in function to the *Apply Overlays* button but does not require a matching ID in the polygon file. Open the polygon file and then specify the groundwater class, and then click the *Apply* button to assign all the cells that are *inside* the polygon to that groundwater class.

5.4 Active Modules Tab

The *Active Modules* tab provides access to the computational and transport switches and options that are contained in C6 in EFDC.INP. These switches are the primary activation switches to specify which state variable(s) will be simulated by EFDC. Figure 5-42 displays the maximum number of modules currently allowed in the EFDC_Explorer/EFDCPlus modeling system. Selecting a check box will display a new module in the left hand column, and deselecting a box will hide it.

If the *Activate Cohesive Sediments* or the *Activate Non-Cohesive Sediment* boxes have been selected the user may make changes to the sediments and sediment bed settings.

The user should first define the sediment model intended by selecting the appropriate option in the check box. Two sediment models are available by choosing either *Use EFDC Sediment Model* or *Use SEDZLJ Sediment Model*. The SEDZLJ Sediment sub-model is partially implemented in EFDC_Explorer. EFDC_Explorer can display SEDZLJ input and results including sediment fluxes and active layer thicknesses. However, at this time, the user cannot create or edit the input data. Further settings for sediments must be made in the Sediments Tab (Section 5.14).

SEDZLJ has been developed by Sandia National Laboratories, and the SEDZLJ EFDC User Manual is downloadable from the EE website. In his paper on this sub-model, the primary developer, Scott C. James, provides a detailed description of how recently-developed sediment dynamics formulations are incorporated into the United States Environmental Protection Agency's EFDC. The new approach is an extension of previous models and accounts for multiple sediment size classes, has a unified treatment of suspended load and bedload, and appropriately replicates bed armouring. The resulting flow, transport, and sediment dynamics model is an improvement to previous models because it may directly incorporate site-specific data, while maintaining a physically consistent, unified treatment of bedload and suspended load.

Figure 5-42 Active Modules Tab

The *Model Selection* frame shows the GVC and model selection options. EFDC_Explorer supports two EFDC models, the EFDC_GVC version (with GVC) and the EFDCPlus version.

If the EFDCPlus Model is selected the GVC Model options are not displayed. When the user selected the *Use EPA GVC Model* the Lagrangian Particle tracking and Wave options will be hidden.

When loading an existing model, EFDC_Explorer identifies the type of model and automatically sets the options on this tab, based on the data in the EFDC.INP file. In addition, the user can switch from one type of model to the other using the model selection option in the *Model Selection* frame. When changing from one model type to the other, the user should check the model layering and boundary conditions to ensure the inputs are correct. See Section 5.8 for the settings on the GVC.

The *Global Transport Options* sub-frame allows the user to select from Upwind Difference, Central Difference and Experimental Upwind, as well as to use Anti-Diffusion or Anti-Diffusion Correction methods. This option sets the same mass transport computational approach for all constituents. More granular control is available using the *Details*.

5.5 Timing/Linkage Tab

The *Timing/Linkage* tab provides the user with access to four sub-tabs: *Model Run Timing*; *EFDC_Explorer Linkage*; *Legacy Output*; and *WASP Linkage*, each of which are described in detail below.

5.5.1. Model Run Timing

The model timing and output options available to EFDC_Explorer are shown in Figure 5-43. EFDC has many more output options but the majority of them have become obsolete due to the capabilities of EFDC_Explorer.

In the main frame the user must specify the time to start and end the run, along with the time stepping options. *Time of Start* is the Julian day, relative to the *Beginning Date/Time*, to begin the simulation. The *Duration of Reference Period* is used to define a project specific meaningful period. This is often set to 24 hours to select a 1 day long reference period. The duration of the simulation is then set by specifying the number of reference periods. The ending time is computed from the starting time and duration.

The *Dynamic Timestep Options* subframe allows the user to engage auto stepping by setting the *Safety Factor* to a positive number >0 and <1 . Generally, the safety factor ought to be less than 0.8 but some runs work with the safety factor >1 and some require a value <0.3 . If set to 0 it will result in fixed time steps. Note that if auto time stepping is used then it is important to use a small initial time step, as the auto timestep must a multiple of this number. Therefore, a number like 0.5 or 1 second is advised, not 5 seconds for example.

The number of Ramp-Up Loops can also be set by the user; that is the number of initial iterations to for which to hold the time step to constant during ramp-up. The *Maximum dH/dT* option is ignored if set to zero, but if >0 then CALSTEP will use this additional criteria to set the dynamic timestep.

Figure 5-43 Timing/Linkage Tab: Model Run Timing.

5.5.1.1 Calendar/Julian Date Linkage

If the user wants to relate the model timing to actual calendar dates, it is required to enter a base date from which the model Julian dates will be added to compute the corresponding Gregorian date. The use of the base date and model Julian dates allow EFDC_Explorer to compare model versus data for a range of plots and statistics.

The base date is entered in the *Model Simulation Start Time* frame. Typically this date is the 1st of some calendar year but this is not required, any date/time is acceptable. The user can use the *J<->G* button to convert Julian to Gregorian or visa-versa.

If using Microsoft Excel dates for the Julian day counter, the EFDC_Explorer base date should be set to "01-Jan-1900". This allows number formatted dates in Excel to be directly used by EFDC_Explorer without adjustment. However, a projected oriented base date is recommended to prevent large numbered Julian dates, e.g. 39234.375 (01-Jun-2007 09:00). If 01-Jan-2007 was used as the base date the corresponding Julian date is 151.375.

From release of EE7.2, when the user changes the base date, it is possible to automatically update all of the Julian timing in the model including time series, starting times, etc.

When the user resets the *Beginning Date/Time* as shown in Figure 5-44 they now have the option to see if they want to update all the timing. When the user presses *Apply to All Timing* a popup will ask the user to confirm whether to make changes to other timing or keep the time series time the same.

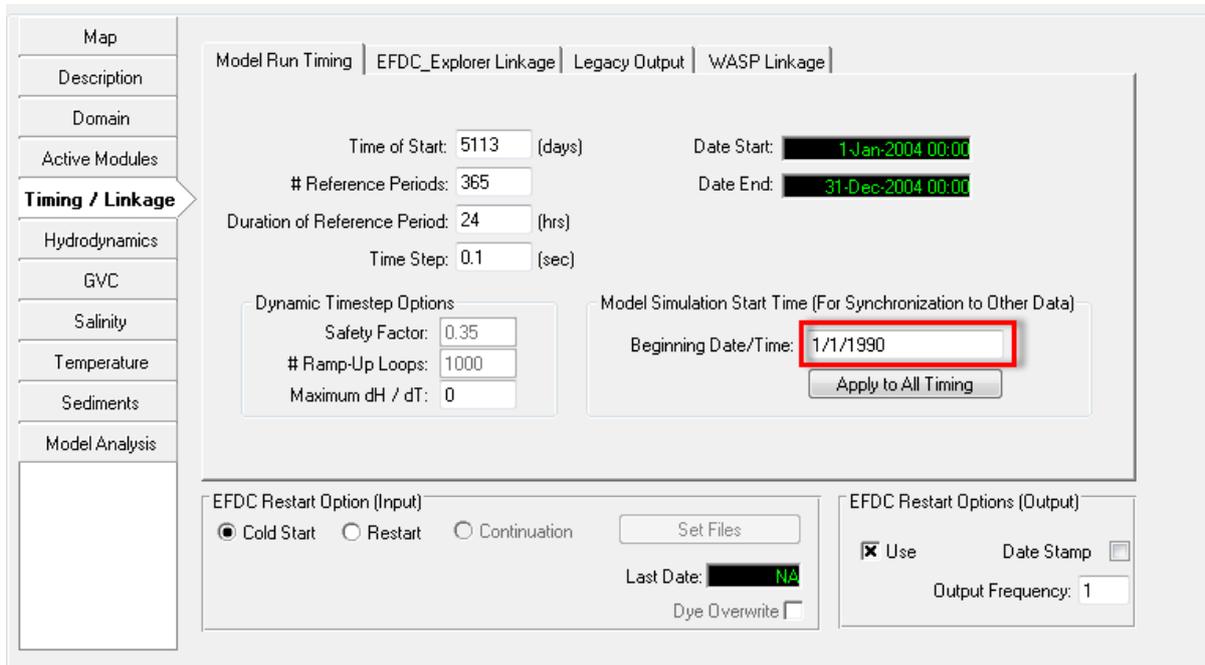


Figure 5-44 Base Date Updating Option.

Note that users must manually copy all the *.EE files as this stores the information regarding base date. This is different to EE70 where if the user edited the *.INP file then the *.EE file would overwrite it. Now in EE71 and later versions you can directly edit the input file and the base date is only stored in *.EE file.

It is important to be aware that selecting *Apply to All Timing* will not update all the calibration series files. It is the user's responsibility to update those files. However, if user puts the base date at top of series in the format (1990-01-01 0:00) then EE will allow for the change.

5.5.2. EFDC Explorer Linkage

In order for EFDC_Explorer to post-process model results, the EFDC_Explorer Output option must be turned on. This is done in the *EFDC_Explorer Linkage* frame by checking the *Link EFDC Results to EFDC_Explorer* check box. The Linkage Output Frequency is used to determine how often EFDC will write the output. This is then multiplied by the Output Interval to determine how often various model results will be written. For example, if the *Linkage Output Frequency* is 60 minutes, then an Output interval of 6 will lead to model results being written every 6 hours for that parameter.

Which data to output is selected in the *Primary Model Results Linkage Options* frame, with the sub-item check boxes, such as *Velocities*. *Water Surface* must be turned on for EFDC_Explorer to post process any of the model results.

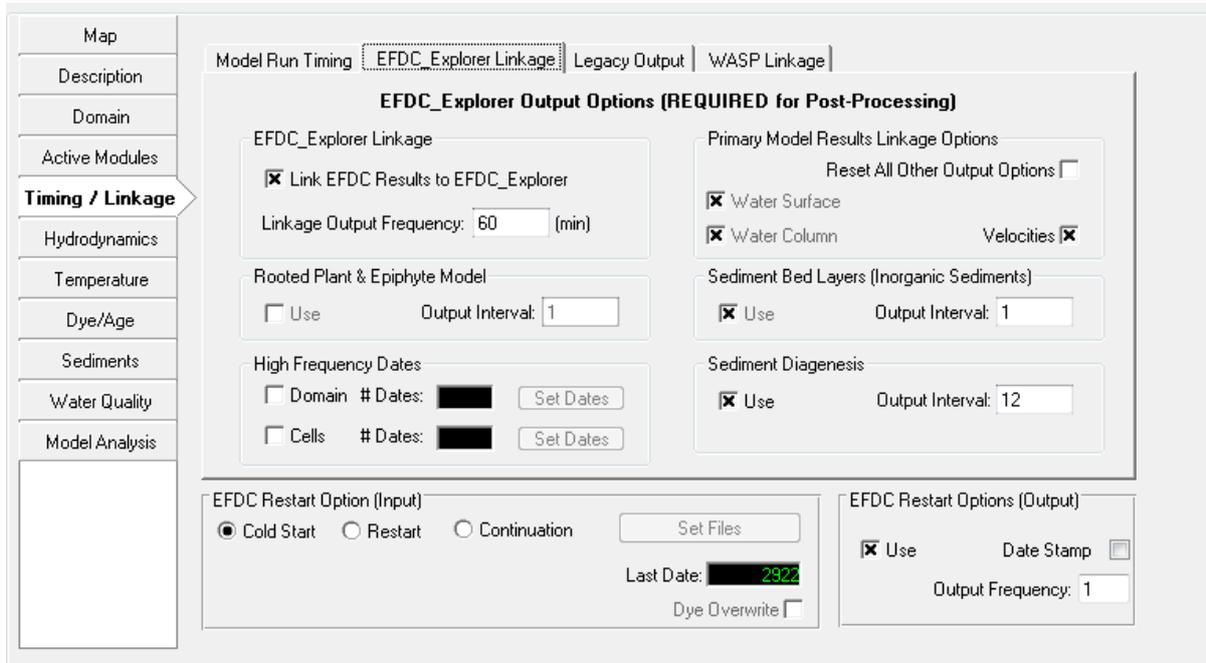


Figure 5-45 Timing/Linkage Tab: EE Linkage.

If simulating water quality with the full sediment diagenesis option turned on, EFDC_Explorer can display the spatial and temporal sediment fluxes and concentrations if the user enables the *Sediment Diagenesis* check box. Because the sediment processes are slow, as compared to water column processes, the user has the option to output the diagenesis data at a slower frequency as described above.

If simulating sediment transport with the maximum number of bed layers > 1, EFDCPlus can write the sediment bed properties by layer. Given that the sediment bed dynamics are generally slow relative to the water column dynamics, the user may want to set the sediment bed layer data output interval to a number greater than 1. For example, if the user is writing the water column data every hour but the user only wants sediment bed date every day, the user would specify an output interval of 24 to tell EFDCPlus to output the sediment data only every 24th water column snapshot.

The user may also manually adjust the output interval for the Rooted Plant & Epiphyte Model when applicable (see Section 5.15.6.1. for details on RPEM).

5.5.2.1 High Frequency Dates

The *High Frequency Dates* option (Figure 5-45) is an EFDC_DSI option that inserts higher frequency output snapshots into the base snapshot frequency defined in the *Linkage Output Frequency*. This function allows the user to use a larger base snapshot frequency, resulting in smaller output files and faster post processing times, and still capture specific times in detail. This approach is very useful when matching model results to specific sampling events.

Selecting the *Domain* check box and then setting the calendar date (or Julian date), frequency and duration of the snapshots. Creates high frequency snapshots covering the whole model domain for the time specified. This approach will clearly lead to slower run times than the approach described above.

Checking the *Cells* checkbox (as in Figure 5-45) and selecting the *Dates* button provides the user with the option of creating high frequency snapshots of individual cells as shown in Figure 5-46. The user may create any number of subsets of the model domain by inputting a number in the *Number of Subsets* text box. Further subsets may be added one at a time with the *Add Subset* button.

High Frequency Snapshots by Subset

Setting Subsets and Timing

Number of Subsets: 3 Add SubSet ReLoad

Subset

Current Subset: 1

Start Time: 2922.500 Duration(H): 50.000 Freq(M): 1.00000

Date: 2003-01-01 12:00 Save

	X	Y	ID
1	394799.69	2934689.00	ID1
2	395392.41	2934858.00	ID2
3	394940.59	2934161.00	ID3
4			
5			
6			
7			
8			
9			
10			

Get I & J Cancel OK

Figure 5-46 Timing/Linkage: High frequency snapshots by subset

The *Subset* frame shows which subset is in view at any given time and allows the user to cycle through the subsets with the *Current Subset* arrows. The Julian start time, duration (in hours) and frequency (in minutes) are set by the user for each subset of cells. Cells are defined by their x, y coordinates and may be designated with an ID for easy reference. The full set of subsets are saved with the *Save* button.

5.5.3. Legacy Output

The *EFDC Generated Time Series* frame is shown in Figure 5-47. It is not recommended to be used as EFDC_Explorer generates its own time series, but the option is available to users.

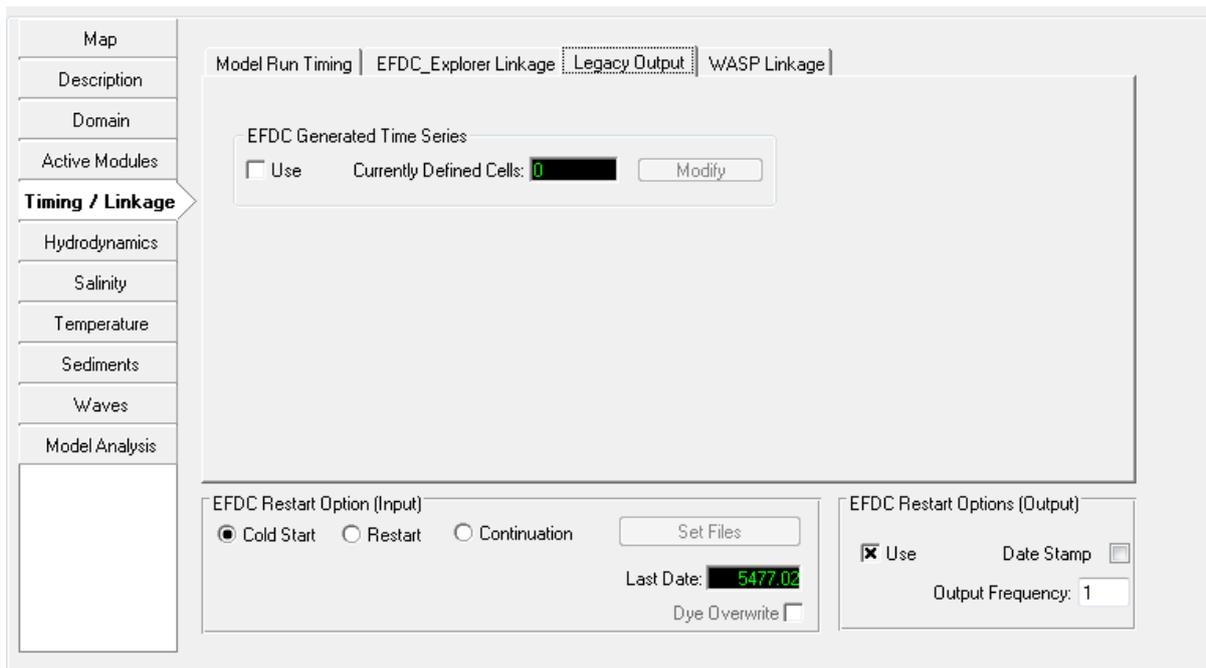


Figure 5-47 Timing Tab: Legacy Output.

5.5.4. WASP Linkage

Linkage to Water Quality Models frame (Figure 5-48) allows the user to bring in data from water quality models such as: WASP, CE_QUAL_ICM and RCA. . The WASP models allows the user to select from EPA DOS Ver 4, EPA DOS Ver 5.1, TT DOS Ver 5 (Old), TT DOS Ver 5 and EPA Ver 6.1 (Windows) and WASP7. The user is referred to the EE website (www.efdc-explorer.com) for a detailed explanation of the linkage procedures and example models.

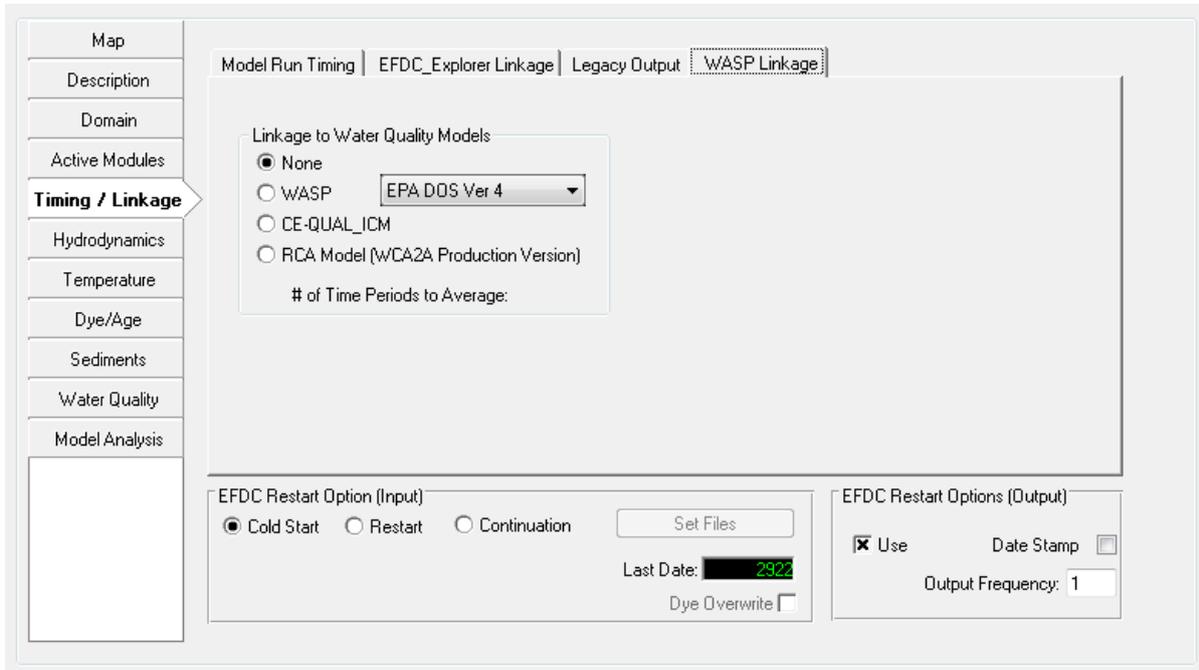


Figure 5-48 Timing Tab: Wasp Linkage.

5.5.5. EFDC Restart Options

The bottom frame of Figure 5-49 shows the *EFDC Restart Option*. An explanation of some of terms is provided below, as well how to use each option.

5.5.5.1 *Cold Start*

Cold start is the normal start of a model run and EFDC will generate the new output files or overwrite the existing output files.

5.5.5.2 *Restart*

The *Restart* is a previously available feature of EFDC and is applicable when a model has stopped prematurely or finished. The user can use it to restart from the point at which it terminated or some other point by selecting the appropriate restart file. In this case there is a hard restart from the time selected. EFDC will create a whole new set of output files which the user will then need to merge later.

Figure 5-49 Timing/Linkage: EFDC Restart Options.

(1) EFDC Restart Option (Output)

EFDC Restart Options (Output) check box provides options for creation of restart files. If the *Use* option has been selected then EFDC will create a RESTART.OUT file. If *Date Stamp* is not checked then one file called RESTART.OUT will be created at the user defined *Output Frequency*, overwriting the previous file each time. If *Date Stamp* is checked then a file called RESTART_YYYYMMDD_HH.MM.OUT is created at the *Output Frequency* for each EFDC sub-module being utilized. Note that if *Use* is not checked it is not possible to create restart file should the model stop or crash for some reason.

DSI standard practice is to always select *Use* and set *Output Frequency* to 1 to be the same as the duration of the reference periods. The user must have this option turned on in order to use restart as this creates the files required for the restart. Date stamp can be left unchecked so that the file is written over each time it outputs. A

(2) EFDC Restart Option (Input)

As noted that if *Use* is not checked for *EFDC Restart Option (Output)* then EFDC will not create restart files and restart function is not available. If it has been checked then the user should select the *Restart* radial button in the *EFDC Restart Option (Input)* frame. The output will be separate from the previous output. In this case EFDC has generated the restart file and EE will copy it for the user. Use the *Set files* button to select the restart files to hot start. *Set files* is used to navigate to the folder where the output files are located. EE will automatically copy and rename the EFDC restart files to the current project directory. The user has to select only the *RESTART.OUT* file and click open then the other restart files (such as, *RSTWD.OUT*, etc.) will be automatically selected by EE based on the requirement of EFDC model (prior to EE7.2 the user had to select each restart file applicable to that model run in turn). These files will normally be in the *#output* folder, with file name to be selected shown in the header and bottom left of the open file interface. EE will rename the files automatically and save them to the project directory after each one has been selected.

Some of the restart files that are created include the *TEMP.RST* and *RSTWD.INP* files if temperature and wetting & drying are being simulated. The *Dye Overwrite* is a legacy option. If the checkbox is selected the dye concentrations in the restart file will be overwritten by *DYE.INP* file. This is useful when restarting a tracer study with a new initial condition.

5.5.5.3 Continuation Run

From release of EE7.2 a number of updates have been provided for restart options. A new option is *Continuation*, whereby when restarting a model, EFDCPlus can now move to the correct location in the EE linkage files and begin writing from the time the model stopped or from the time selected for restart in case of using date stamp. The settings for this restart option are shown in Figure 5-49.

A *Continuation Run* is the same with *Restart* option except that the output will append to an existing run and so is only applicable when there is already model output in the current model directory. If there is no output and a restart file then this option is not enabled. If no date stamp is used EE will display only one restart file without date label which is the last restart file before EFDC terminated. To create the restart file the *Restart Output* should be set to continuous (i.e. $N=1$). EE displays the the date range available for the continuation from the most recent binary file output in the *Last Dates* box.

The process for using continuation runs is as follows:

1. Before running the model ensure *EFDC Restart Options (Output)* is set/checked to *Use*. If *Date Stamp* is selected the user may continue from any snap shot as all snapshots saved, not just the final snapshot. However, this is more memory intensive.
2. Reload the model to update *Last Date* box. In this case (Figure 5-49) the model stopped at $T = 142.75$.
3. Select the *Continuation* radial button (this is not enabled if the model is not reloaded).
4. Do not change the time of start. Save the model in the same folder. If the user wants to save in another folder then they will need to manually copy the output to the new folder.
5. Run the model and select overwrite.

The model will run from the continuation time and automatically merge with the prior output. This removes the necessity of the user having to merge runs as was required in earlier versions of EE. This option is different to the *Append* feature as it is now possible to restart a model at various user defined times.

Note: Whenever a new cold start is run the user should save the model in a new folder. This will prevent restart files from prior runs being available, in which case the *Last Date* may correspond to that prior run.

Other discussed above include: *Warm Start*. This function that allows the user to create the initial conditions for the model at a specified time. This is useful for diagnostic and sensitivity analyses, allowing the user to understand key processes in the system. A *Warm Start* may be created using either the *ViewPlan* or *View3D*. The user goes to the desired time and saves the current model conditions by selecting the highlighted button, shown in Figure 5-50 below. In this case, the new *Warm Start* model would begin with the water column and sediment bed conditions at 271.042. A *Warm Start* model is different from a *Hot Start* model because the momentum is not included. Therefore model would begin from a quiescent system as all velocity values are zero.

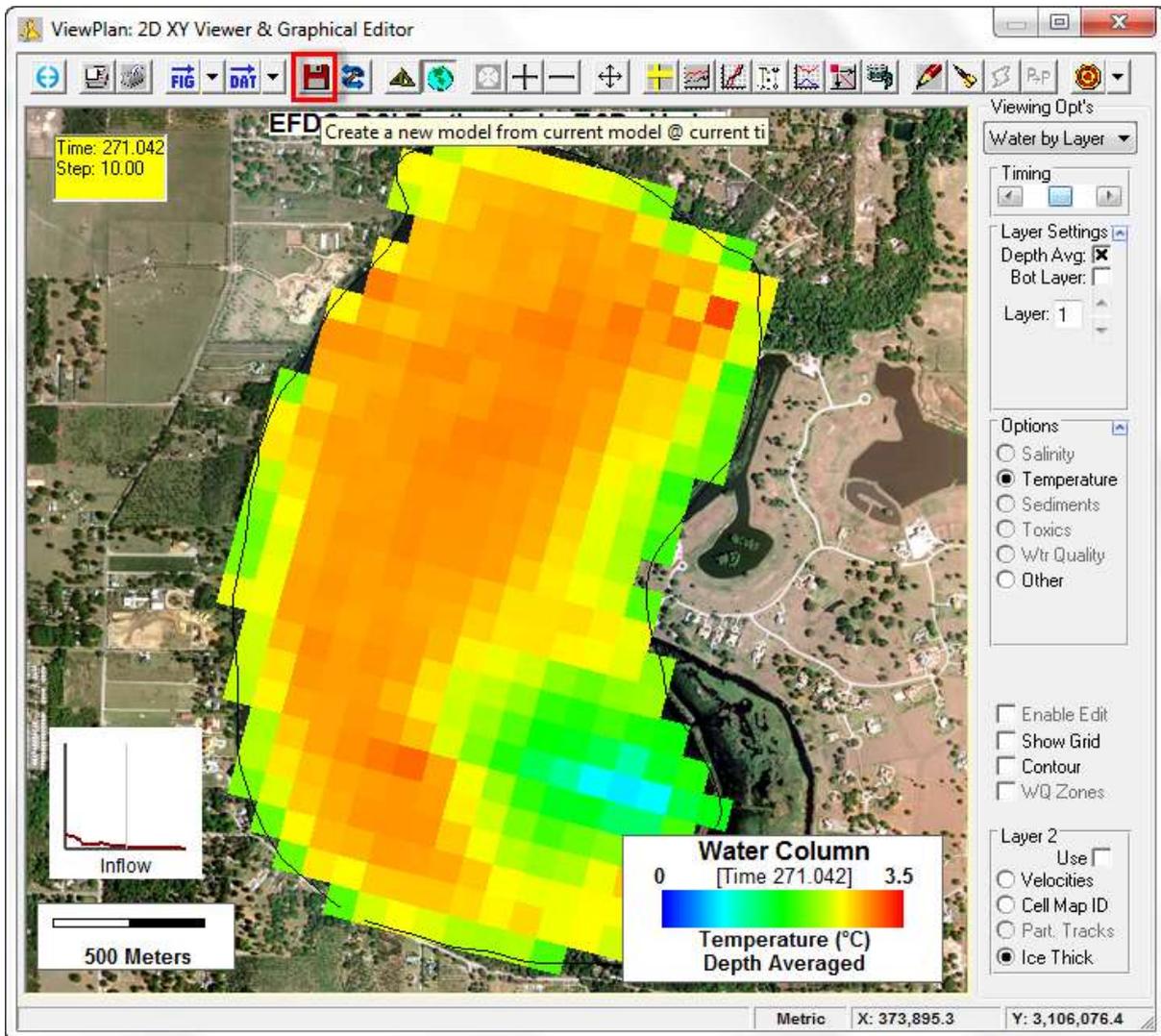


Figure 5-50 EFD Restart Options: Warm Start.

Hot Start means using the existing output files to restart the model.

5.6 Hydrodynamics Tab

The *Hydrodynamics* tab provides the user with two sub-tabs: *General* and *Vegetation*. In the *General* sub-tab shown in Figure 5-51 the user may set the main

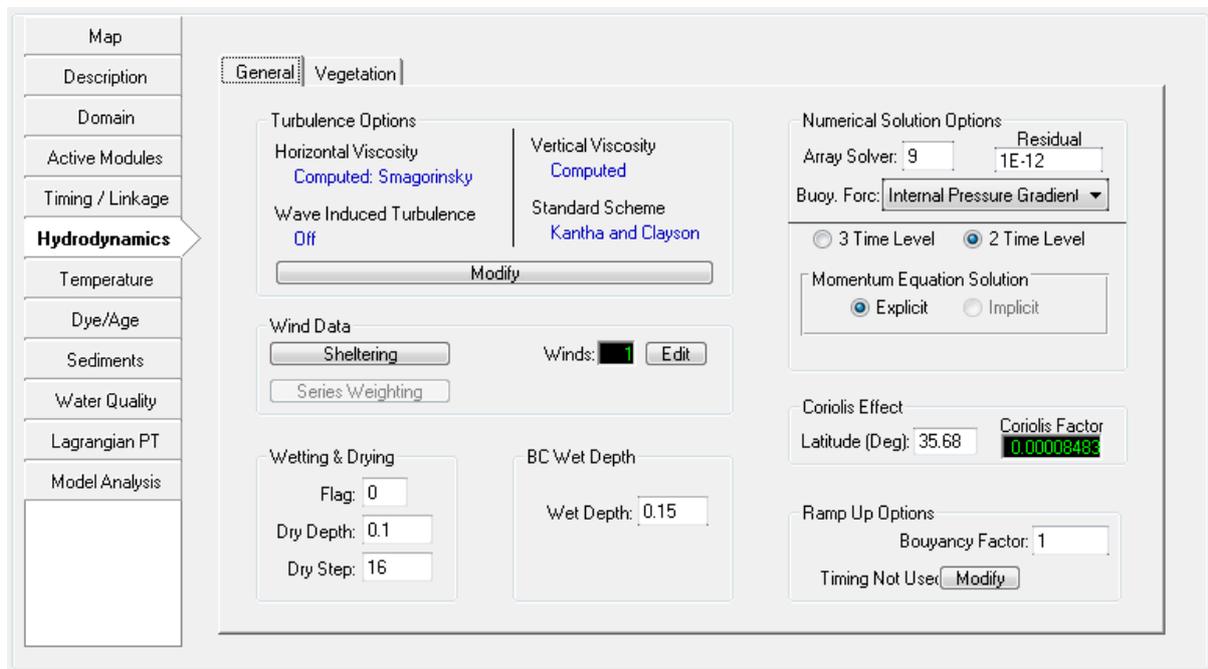


Figure 5-51 Hydrodynamics Tab: General.

5.6.1. Turbulence Options

The *Turbulence Options* frame displays the current settings for various hydrodynamic options such as *Horizontal Viscosity* and *Vertical Viscosity* and the *Standard Computational Scheme* for vertical turbulence. These options and parameter settings can be selected and modified by clicking on the *Modify* button. These options are described in the following sub-sections.

5.6.1.1 *Turbulent Diffusion*

Figure 5-52 shows the main form for the computational options for the horizontal and vertical eddy viscosities and diffusivities. The parameters and options have been grouped according to which dimension they are used for, i.e. horizontal or vertical.

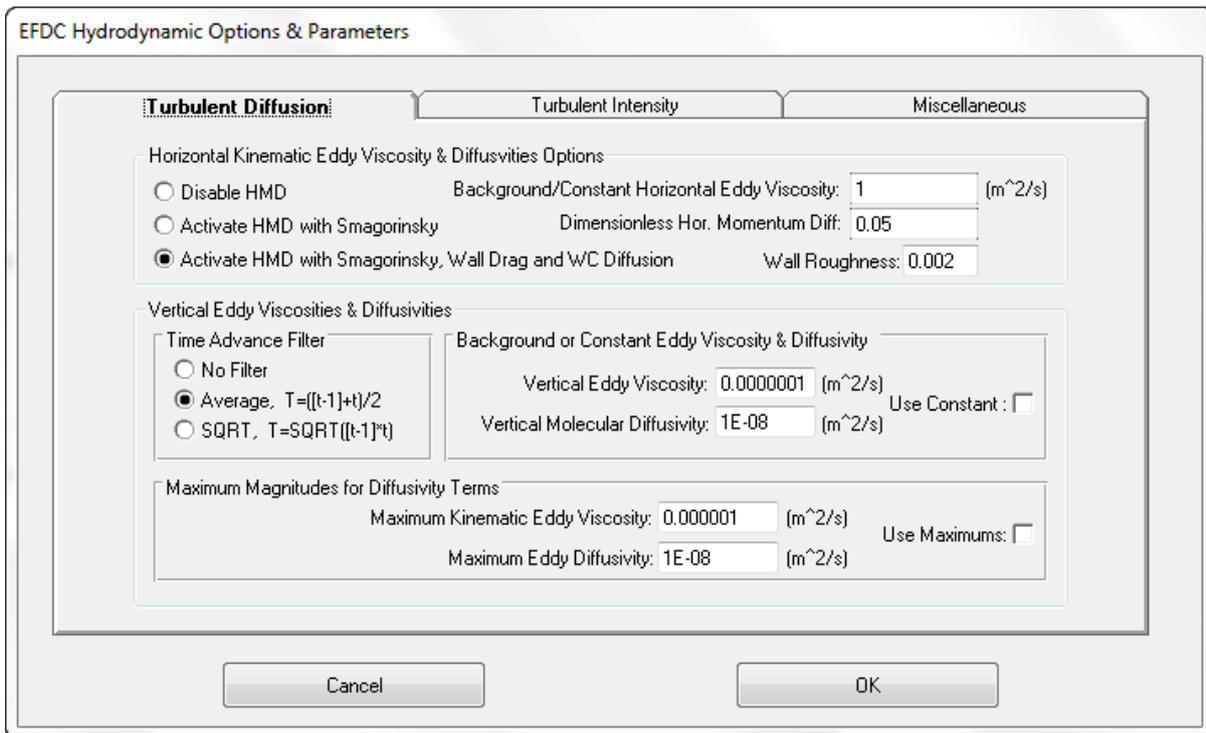


Figure 5-52 Hydrodynamics Options: Turbulent Diffusion.

The *Horizontal Kinematic Eddy Viscosity and Diffusivities Options* form provides an option box which is used to enable the Horizontal Momentum Diffusion (HMD) capability of EE. If the *Disable HMD* option is selected, the HMD is set to the *Background/constant Horizontal Eddy Viscosity* (AHO) set by the user. This is equivalent to the ISHM flag set to 0.

EE8.1 implements a new spatially variable AHO option. When AHO is specified as a negative value, EFDCPlus will compute a separate AHO for each cell using the expression $ABS(AHO) * DX * DY$. This approach reduces the numerical diffusion error when the models have a large range of cell sizes.

The user should set AHD, Smagorinsky's Coefficient, in the *Dimensionless Horizontal Momentum Diffusivity* dialog box when using the *Activate HMD with Smagorinsky* option. When *Activate HMD with Smagorinsky* is selected (ISHMD=1) then EE will apply the background HMD as well as Smagorinsky's subgrid if AHD>0. With this option the contaminant diffusion is off and not accounted for. If AHD=0 then the *Constant Viscosity* option will be used.

When *Activate HMD with Smagorinsky, Wall Drag and WC Diffusion* is selected (ISHMD=2), then the full HMD is used as well as wall effects. This option also applies diffusivities to all constituent transport, which includes salinity and temperatures. This option should be used when simulating a very uniform flow system is constituent transport is needed. The resulting horizontal diffusivity from these options can be viewed from within *ViewPlan* provided velocities are also available. The vertical eddy viscosities and diffusivities (AV & AD arrays in EFDC, respectively) can also be viewed if the user configures the Internal Array Viewer (See Appendix A) to include these arrays.

The *Vertical Eddy Viscosities & Diffusivities* frame allows the user to set the Time Advance Filter and Vertical Eddy Viscosity as well as Vertical Molecular Diffusivity. The *Maximum Magnitude for Diffusivity Terms* allows the user to set the Maximum Kinetic Eddy Viscosity as well as the Maximum Eddy Diffusivity.

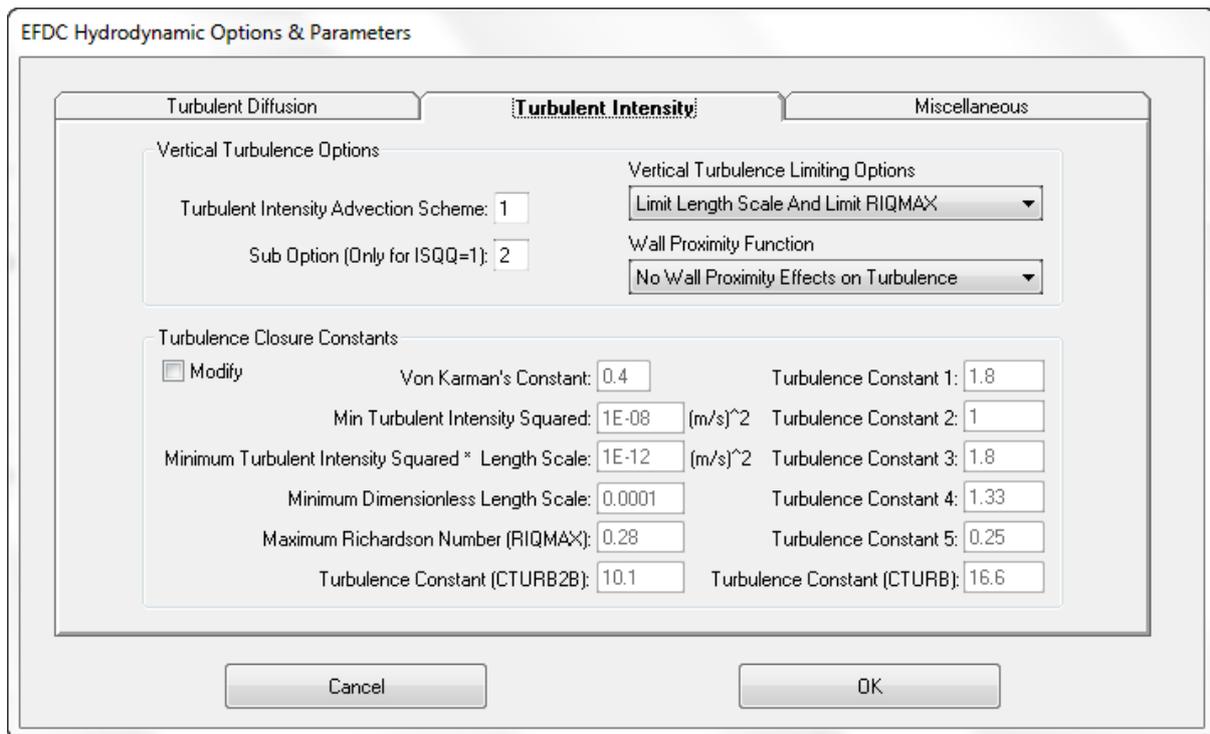
5.6.1.2 Turbulent Intensity

Figure 5-53 shows the Turbulent Intensity tab. Generally, only the *Vertical Turbulence Options* will be changed. At the current time, production runs should set the *Advection Scheme* to 1 and the *Sub-Option* to either Galerpin (Sub-option=1), Kantha and Clayson (Sub-option=2) or Kantha (Sub-option=3).

The *Vertical Turbulence Limiting Options* provide a drop down menu that allows the user to choose from three options: no length scale and RIQMAX limitation; to limit RIQMAX in the stability function only; and finally, to limit both the length scale and RIQMAX. When using multi-layer models and vertical turbulence is limiting, the *Limit Length Scale and Limit RIQMAX* option provides runs with less likelihood of model crashes.

The *Wall Proximity Function* also allows the user three options: no wall proximity effects on the turbulence; to be parabolic over depth wall proximity; and finally open channel wall proximity.

The *Turbulence Closure Constants* may be changed after the *Modify* check box is selected. However, these constants should not be changed without good justification.



The screenshot shows the 'EFDC Hydrodynamic Options & Parameters' dialog box with the 'Turbulent Intensity' tab selected. The dialog is divided into three sections: 'Turbulent Diffusion', 'Turbulent Intensity', and 'Miscellaneous'. The 'Turbulent Intensity' section contains the following controls:

- Vertical Turbulence Options:**
 - Turbulent Intensity Advection Scheme: 1
 - Sub Option (Only for ISQQ=1): 2
- Vertical Turbulence Limiting Options:**
 - Limit Length Scale And Limit RIQMAX (selected)
- Wall Proximity Function:**
 - No Wall Proximity Effects on Turbulence (selected)
- Turbulence Closure Constants:**
 - Modify
 - Von Karman's Constant: 0.4
 - Min Turbulent Intensity Squared: 1E-08 (m/s)²
 - Minimum Turbulent Intensity Squared * Length Scale: 1E-12 (m/s)²
 - Minimum Dimensionless Length Scale: 0.0001
 - Maximum Richardson Number (RIQMAX): 0.28
 - Turbulence Constant (CTURB2B): 10.1
 - Turbulence Constant 1: 1.8
 - Turbulence Constant 2: 1
 - Turbulence Constant 3: 1.8
 - Turbulence Constant 4: 1.33
 - Turbulence Constant 5: 0.25
 - Turbulence Constant (CTURB): 16.6

Buttons for 'Cancel' and 'OK' are located at the bottom of the dialog.

Figure 5-53 Turbulent Intensities.

5.6.1.3 Miscellaneous Options

Further turbulence modification options are also available under the *Miscellaneous Options* tab shown below in Figure 5-54. These options allow various momentum corrections which may be enabled with the *Momentum Correction Flag*. When the flag is set to zero momentum corrections are disabled; when set to 1 they are enabled.

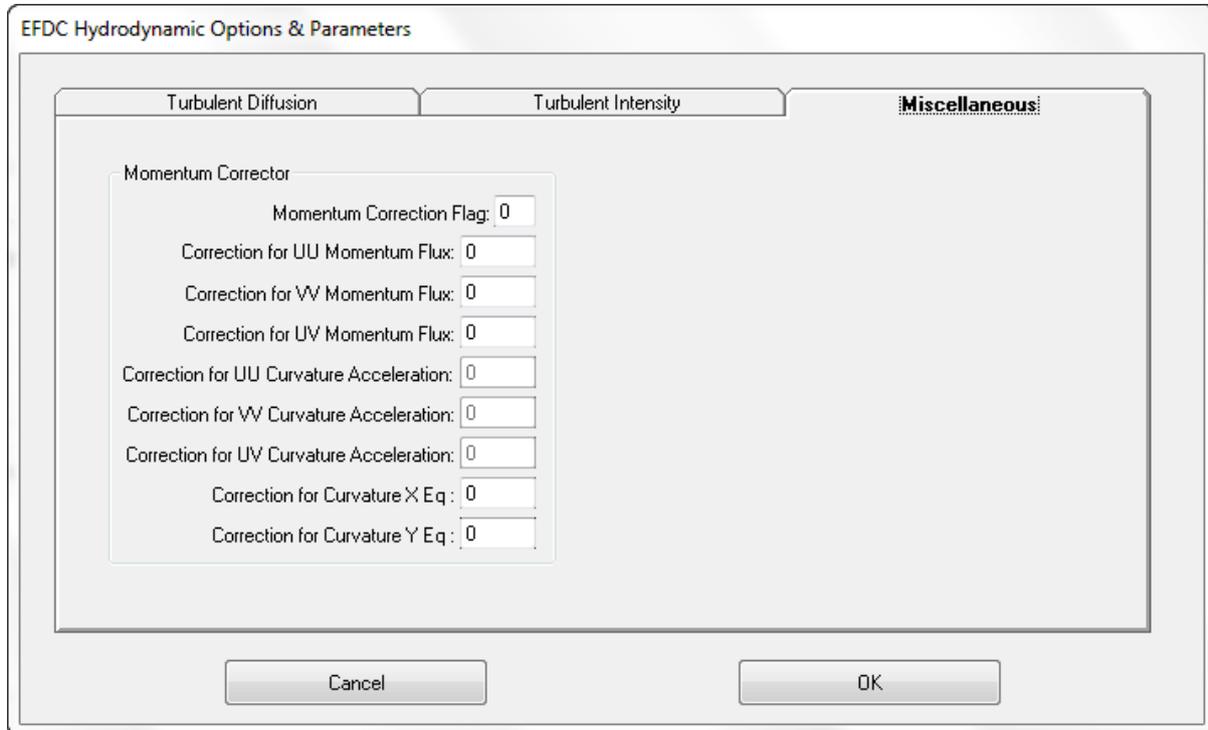


Figure 5-54 Miscellaneous Tab – Momentum Correctors

5.6.2. Wind Data

The *Wind Data* frame provides access to the WSER spatially varying options. The wind sheltering coefficient can be assigned using the *Sheltering* button and/or edited in *ViewPlan*. If more than one WSER series is being used it is necessary to must distribute the wind field assignments. This is done using the *Series Weighting* function described below.

5.6.2.1 Wind Series

EE has the ability to add multiple wind, atmospheric and ice stations. Stations may be defined and edited with the Edit button shown in Figure 5-51.

The user may set the coordinates of the wind series with the *Show Params* button in the *Wind BC Time Series Editing* as shown in Figure 5-55. EE will use the X, Y coordinates in the value column for display purposes. If the user has not entered the X, Y values then EE will automatically calculate X,Y coordinates based on the lat/long values provided. However, if both are entered it should be noted that EE will use the X, Y coordinates. The user can also set the anemometer height of the station.

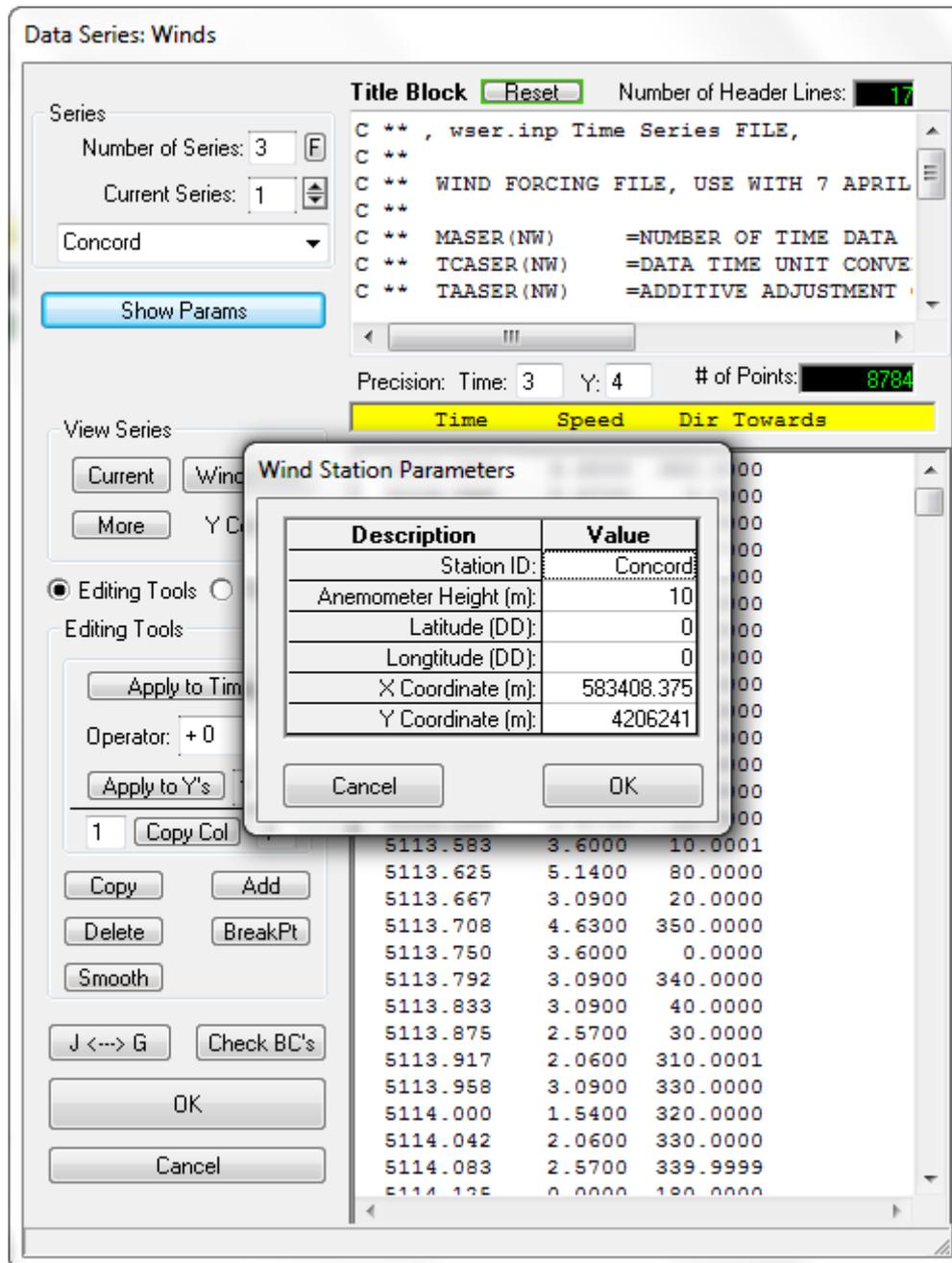


Figure 5-55 Wind Data Series: Station Coordinate Setting.

5.6.2.2 Series Weighting

A new approach has been adopted in EE8 to provide users with a simple tool for managing the data and stations for wind, ice and atmospheric data. This approach allows EE to display the stations in a grid format with a quality index that indicates how the user rates each time series and time block within that series. The stations can now also refer to multiple wind series for different periods of time, and this information is stored in the WNDMAP.INP file. The quality variable, WNDEF, is stored in the WNDMAP.INP for each series. The WNDMAP.INP files also stores the inverse distance from the cell to station.

An example of a model domain with three wind stations is shown in Figure 5-56. This example has three stations S1, S2 and S3 together with 6 time series for wind, also shown in Figure 5-56.

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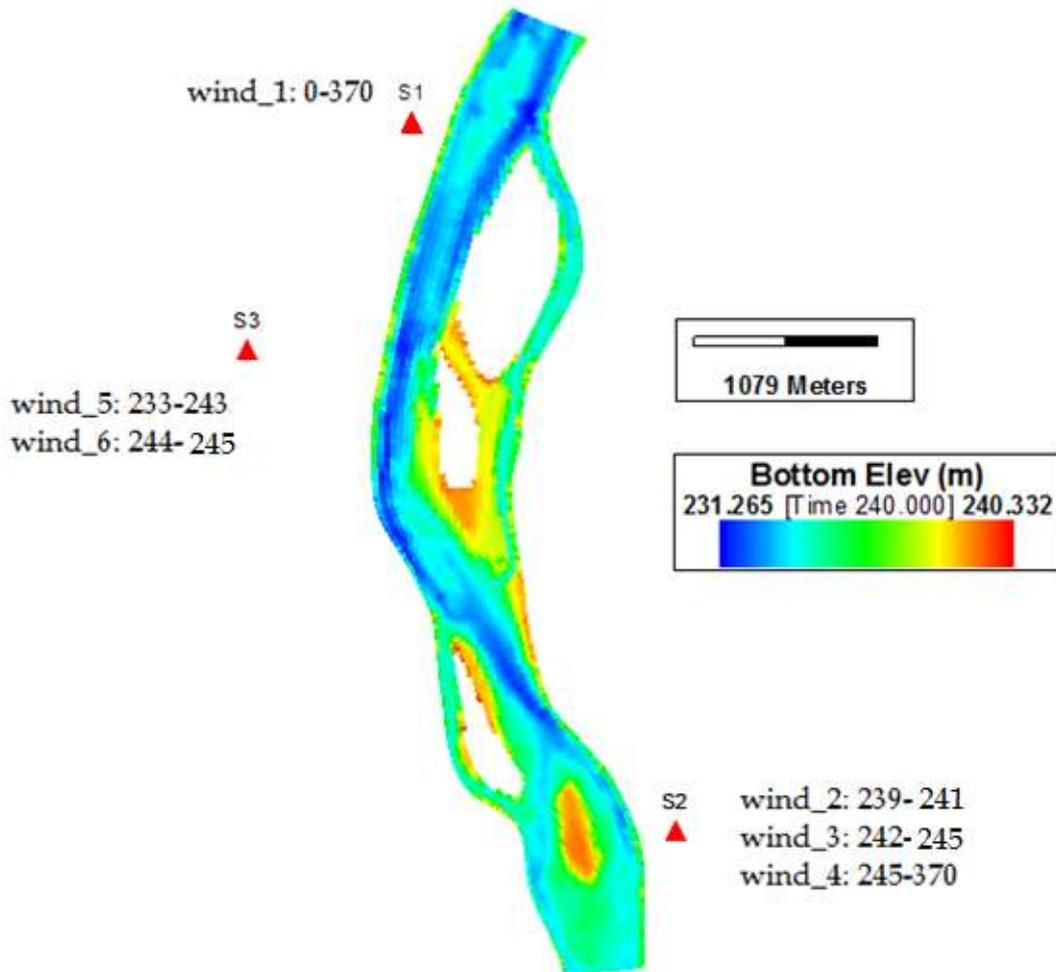


Figure 5-56 Wind stations and time series.

The user now needs to provide each time series with a quality index from 0 to 1. This weighting is based on users judgment of the quality of this data series based on various factors. If the user knows of no problems with the series then they would give it a rating of 1. However, often various factors which will influence the quality of a time series and cause the user to downgrade the series such as the distance from the model domain, or an intervening geographical feature. In this case a lower value for the quality index will be selected, and if another times series is available for that period with a higher weighting it will have a greater impact on the model. When the user selects the *Series Weighting* button EE automatically generates the quality index with the maximum value of one for the default as presented in Figure 5-57

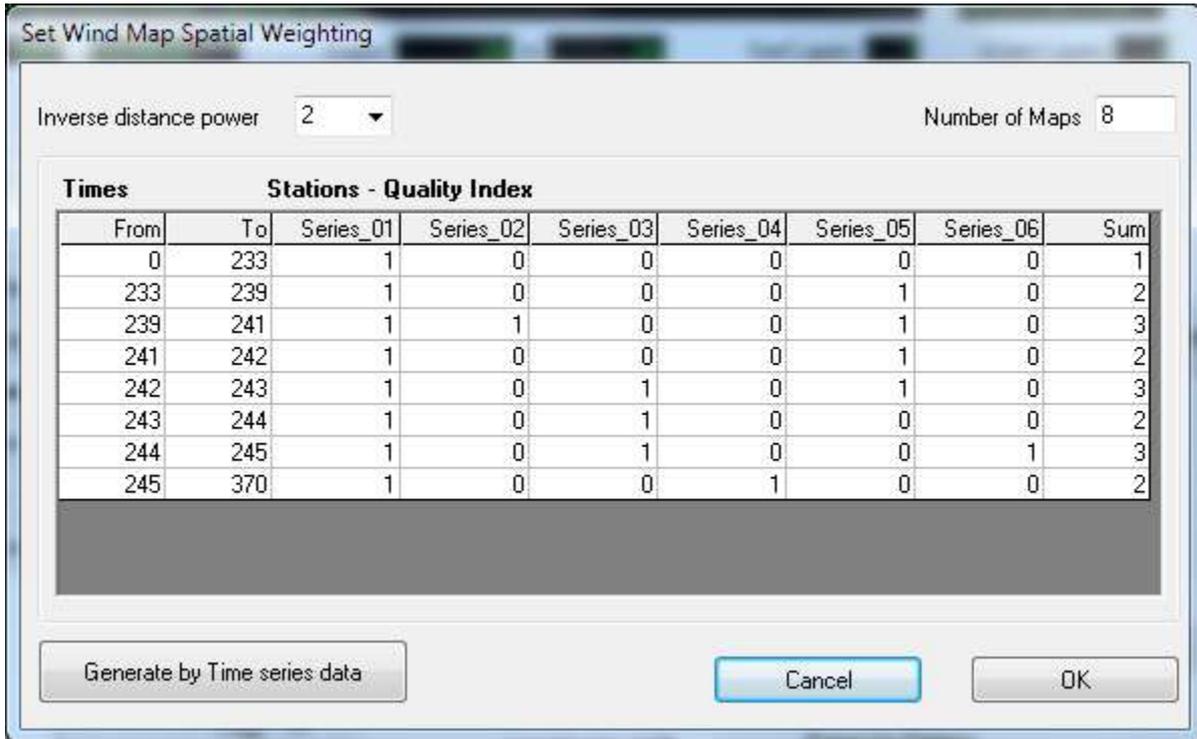


Figure 5-57 Wind Map: Default quality indexes for wind stations and time series.

Each time series can be separated into many parts to set different quality/influence levels if necessary. For example, we can set the quality index for each time series as in Figure 5-58.

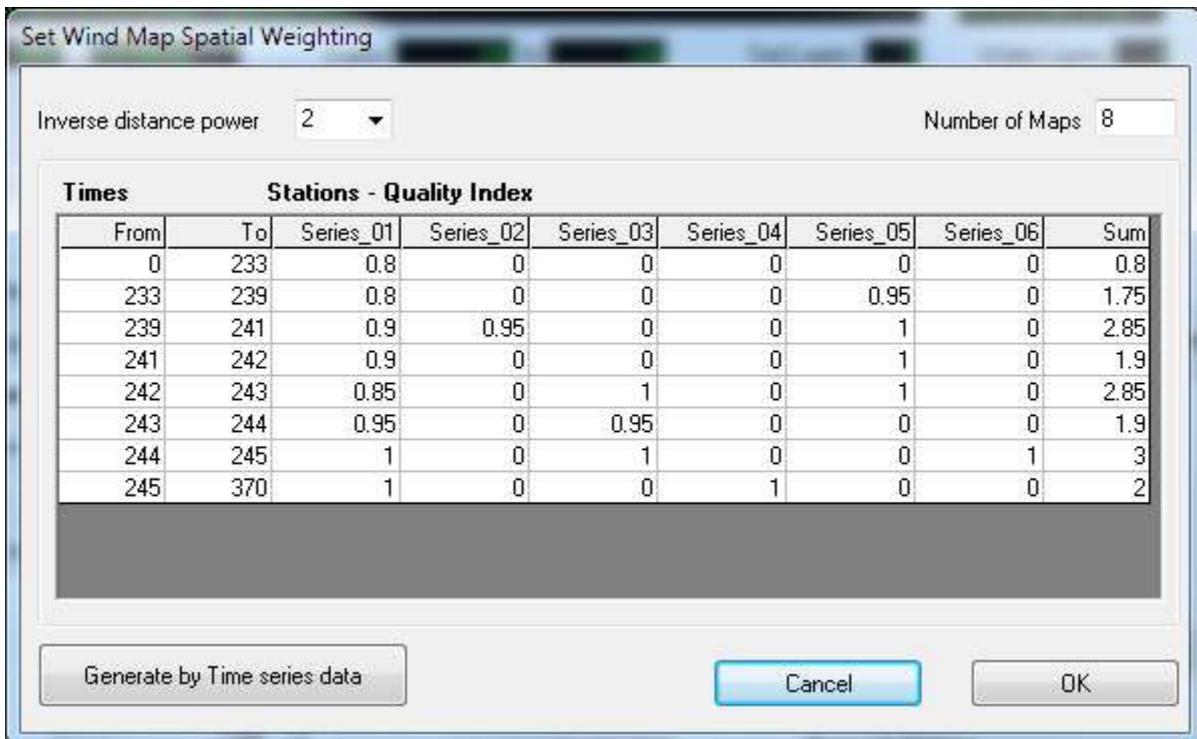


Figure 5-58 Wind Map: User defined quality indexes for wind stations and time series.

EE8 will use the values provided in the *Wind Map Spatial Rating* table (Figure 5-58) to generate the a WNDMAP.INP file, an example of which is provided in the appendix. This file

includes two parts: Part 1 shows that the total number of maps, in this case the model has 8 time maps, that is a table of 8 rows listing the start/end time and the influence level of each time series. It should be noted that the total number of maps is decided based on the number of time series and the number of time points to separate them.

Part 2 is the basic map that contains the inverse squared distances from the cells to the stations. It includes LA-1 data rows (L=2, LA). The format of each row is

$$I, J, \left(\frac{1}{R_n^2}, n = 1, N\right)$$

In which

$$R_n^2 = (XC(L) - XS(n))^2 + (YC(L) - YS(n))^2, n = 1, N \quad (1)$$

N is the total number of time series ($N \geq$ the number of stations),

N=NASER for ASER.INP; N=NWSER for WSER.INP N=NISER for ISER.INP

XS(n), YS(n) UTM coordinates of one station to get time series,

XC(L), YC(L) UTM coordinates of the cell L.

I and J = cell indexes for the EFDC grid, and L = linear index of cell,

Finally, EFDC will combine the influence levels and the inverse squared distances to calculate the true weighting coefficients of each cell for every time step. An example of the WNDMAP.INP file is provided in the appendix for user's reference.

5.6.2.3 Mathematical Formula of Weighting Interpolation

In case of not using the influence level, the interpolated value based on the weighting coefficients in the inverse distance is calculated as follows:

$$V(L) = \frac{\sum_{n=1}^N \frac{1}{R_n^2} V_n}{\sum_{n=1}^N \frac{1}{R_n^2}} \quad (2)$$

In which $V(L)$ is the value of interpolation at the cell L from the given values of N time series, V_n . The formula (2) can be also represented as:

$$V(L) = \frac{1}{S} \sum_{n=1}^N w_n V_n, \quad (3)$$

$$w_n = \frac{1}{R_n^2}, S = \sum_{n=1}^N w_n$$

In general, if the start time and ending time of all the time series and their quality are the same then these weighting coefficients will not depend on time, but they only depend on the distances from the cells to the stations. However, this condition is not always satisfied in practice, because the measurement time and the quality of each time series can be different, therefore the weighting coefficients are adjusted at every cells for every time step. The purpose of the adjustment is to use only the time series that satisfy the calculation time t of EFDC based on their influence levels. In order to carry out this idea, a set of adjusting coefficient named as influence level is used:

$$0 \leq \alpha_n(t) \leq 1, n = 1, N \tag{4}$$

Multiplying the weighting coefficient w_n in the formula (3) by the coefficients α_n in (4) the formula (3) now becomes:

$$V(L) = \frac{1}{S} \sum_{n=1}^N \beta_n V_n \tag{5}$$

$$\beta_n = \frac{\alpha_n}{R_n^2}, S = \sum_{n=1}^N \beta_n$$

In which $\alpha_n(t) \leq 1, n = 1, N$ are the influence levels given in the header block of the map file and the coefficients $\frac{1}{R_n^2}, n = 2, LA$ are given in the part 2 (basic map) of the map file.

5.6.2.4 Wind Rose Plotting

A wind rose plotting function is now available within the Data series editing forms for winds. The winds data series form may be accessed in the *Domain | Boundary Conditions | Number of Input Table and Series* form and pressing the *E* button, or from *Hydrodynamics tab | Wind data | Edit*. Selecting the *Wind Rose* button shown in Figure 5-59 prompts the user the start and end time for the rose data set to be displayed. After entering these data wind rose is displayed as shown in Figure 5-60.

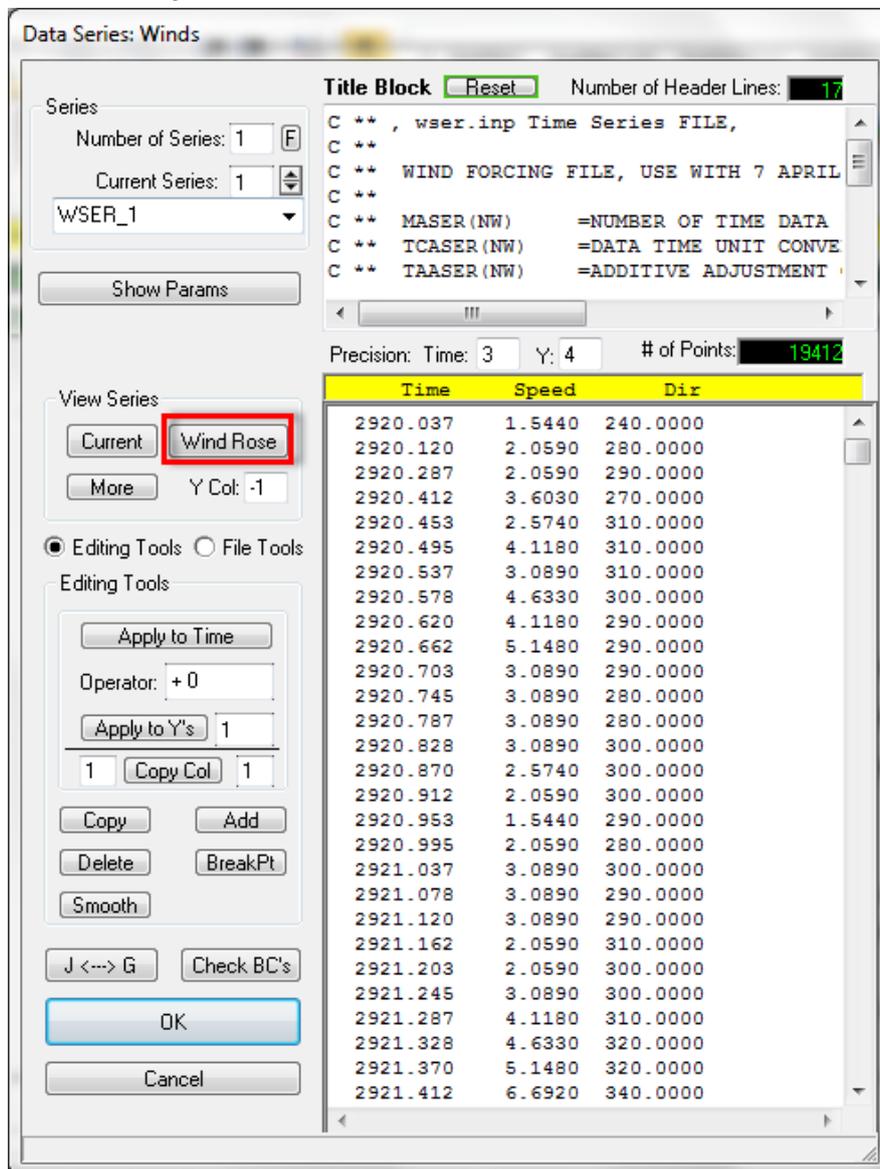


Figure 5-59 Boundary Conditions: Rose Plots for Winds.

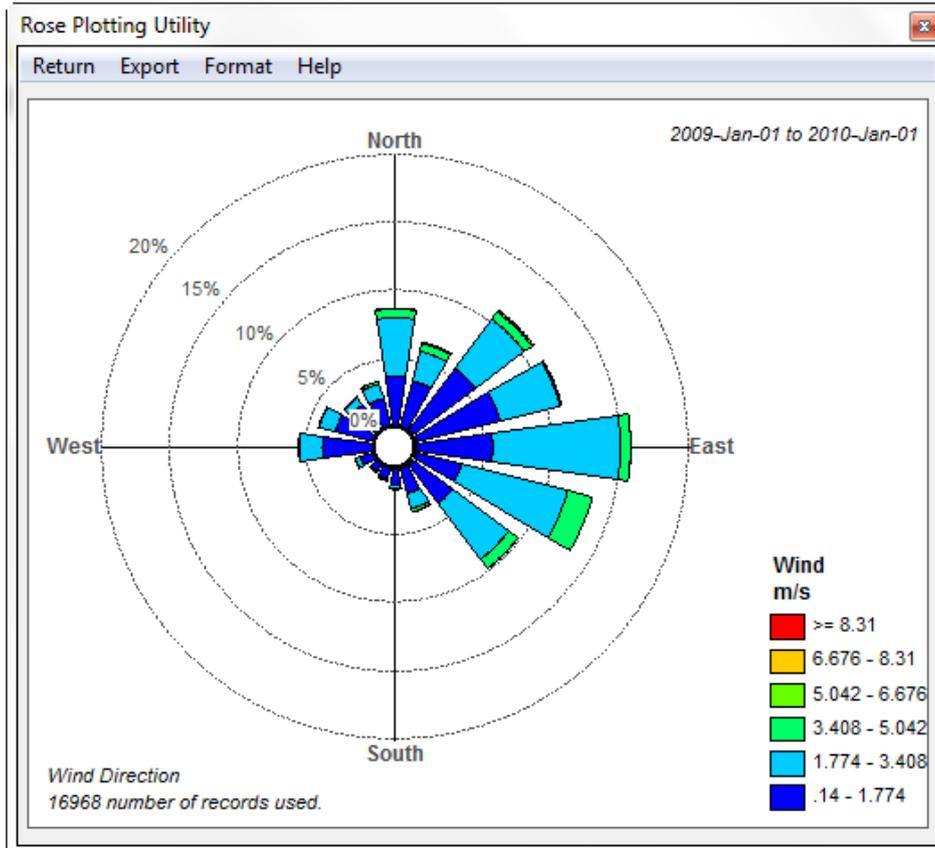


Figure 5-60 Example of a Wind Rose Plot.

A number of export functions are provided including metafile, bitmap and ASCII. The user can also customize the rose format by RMC on the rose or selecting *Format | Scale* in the menu as shown in Figure 5-61.

Other options in the *Format* dropdown include editing the wind rose labels and setting the number of sectors. When setting the sector options the user can select the number of sectors, the number of degrees for the gap between sections and switch on and off the outline of the sectors.

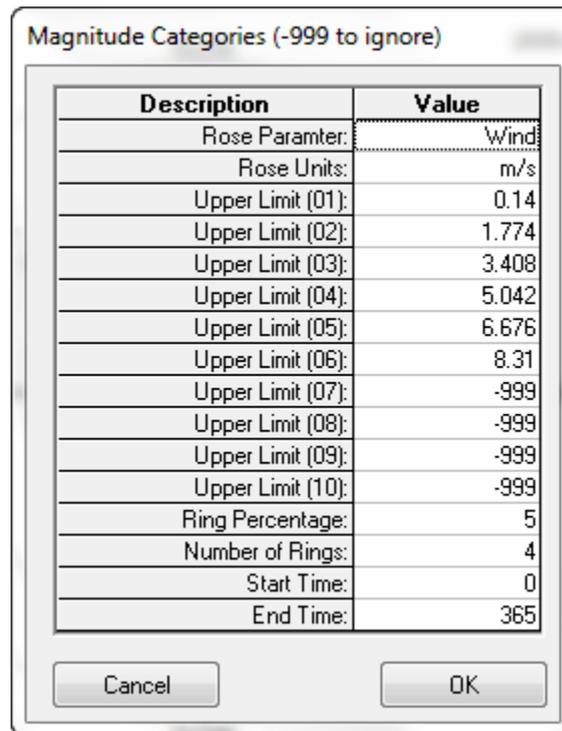


Figure 5-61 Rose Plot Category Options.

5.6.3. Wetting and Drying

The *Wetting and Drying* frame uses a flag to select various options. These options can change depending on the model settings. Setting the flag to ISDRY=0 turns off wetting and drying; abs(ISDRY)>0 turns wetting and drying on, ISDRY>1 but <99 turns wetting and drying on with zero dimension volume balance and ISDRY=99 is the latest algorithm for multi-face wetting and drying. If ISDRY is a negative of the flag (e.g. -99) then EFDC uses cell skipping to improve computational speed. Most applications that need wetting and drying should use ISDRY = -99.

When using wetting/drying the *Minimum Height* in the *Domain* tab | *Water Depth Setting (Legacy)* frame should be less than the *Dry Depth*. Otherwise, the initial water depths everywhere will force all of the models cells to “wet”, even if they should be dry.

5.6.4. Boundary Condition Wet Depth

The boundary condition *Wet Depth* is used to set the minimum depth for withdrawals i.e. it is depth below which withdrawals will be turned off from the cell.

Note

If any of the “multiplicative factor” settings for water depth or bottom elevation are 0 (or blank), EFDC will compute a zero for that parameter for the initial conditions.

5.7 Numerical Solutions Options

The *Numerical Solutions Options* frame provides access to several of the numerical solutions schemes available in EFDC. Most of the recent development and testing has been made using the conjugate gradient solver. Therefore, EFDCPlus only uses the conjugate gradient solver (option 9) and conjugate gradient with normalize diagonal (option 99).

The solution schemes available with EFDC_GVC are *Standardized* (0), *Ordered R/B Conjugate gradient* (2), *Reduced R/B Conjugate gradient* (3), and *Conjugate gradient for Wetting and Drying* (9). Internal Buoyancy forcing option must be specified.

The standard, most tested case is the *Internal Pressure Gradient* option.

The *3 Time Level* (3TL) or *2 Time Level* (2TL) options allow the user to select the method to be used for numerical simulation. If using the EFDC_GVC model with GVC layering, the only Time Level solution available is the “3 Time Level”.

If using the 2TL solution the *Momentum Equations Solution* frame allows the user to choose between explicit and implicit solution options.

If using the 3TL option, the user must specify the momentum solution option (ISCDMA) of Upwind, Central, and Upwind following the MOM momentum advection scheme. There are other schemes (ISCDMA>2) that are experimental.

The 2TL solution is the most robust solution technique and is recommended.

5.7.1. Coriolis Effect

The *Coriolis Effect* frame allows the user to determine the Coriolis number by setting the *Latitude (Deg)*, which is the latitude of the midpoint of the model domain.

5.7.2. Ramp Up Options

The *Ramp Up Options* frame in the lower left hand corner allows the user to modify the timing to full transition physics. Buoyancy can be adjusted with a buoyancy factor that must be between 0 and 1, with 0 being no buoyancy influence and 1 being full buoyancy influence. For some applications, the ramp up time from the ICs to natural physics require the phasing in of the buoyancy and the non-linear terms. This is accomplished using the *Modify* button and applying number of ramp up iterations for the various options.

5.7.3. Vegetation

In the *Vegetation* frame on the main *Hydrodynamics* tab, the user can set the primary computational option for enabling the vegetation feature and at what level (see the tooltips). The vegetation class settings are available via the *Modify Classes* button option which provides a user interface to the data that are needed for the VEGE.INP file (Figure 5-62). First, the user should specify the number of vegetation classes needed. Enter the *Number of Vegetation Classes* into the input box and press return. The grid will be expanded to accommodate the desired number of classes. All of the inputs required by EFDC are shown with a couple of exceptions. The Beta1 and Beta2 variables are actually not used but are included in the list. The VEGE.INP file must have data in those columns but they are not actually used by EFDC. The other exceptions are the ID and Description fields. They are only used by EFDC_Explorer. The ID field is used to match vegetation classes to polygon ID's (see the following description of *Apply Overlays*) to automatically set the vegetation map that is needed for input via the LXLY.INP file. The *Description* field is only used for labeling.

	Veg Class 1	Veg Class 2	Veg Class 3	Veg Class 4	Veg Class 5	Veg Class 6
Description	Open Water	Forested/Emerg	Scrub-Shrub	Foreted	Emergent	Forested/Sc
Plant Density (#/m ²)	0	5	5	1	30	
Stem Diameter (m)	0.01	0.2	0.05	0.5	0.05	
Stem Height (m)	1					
Alpha (depth factor)	0.7854	0.7854	0.7854	0.7854	0.7854	0.7854
Beta1 (not used)	1	1	1	1	1	1
Beta2 (not used)	0	0	0	0	0	0
Drag Coeff Factor	0.5	0.5	0.5	0.5	0.5	0.5

Figure 5-62 Vegetation class parameters.

The *Apply Overlays* button uses the vegetation class ID field and matches it to input polygon ID's. Figure 5-63 shows the form for applying a vegetation map to the model cells. The file containing one or more polygons in the same file (see Appendix B for polygon formats) needs to be opened (via the *Browse* button). The polygon file will be read and the polygon ID's will be matched to the vegetation class ID's. If any vegetation classes do not have any defining polygons the user will be notified. Once the initial matching process is complete the user then must choose to perform the actual vegetation assignment. If there are unmatched vegetation classes, the user can choose to process anyway but they need to be aware that no EFDC cells will be matched to any the vegetation classes that do not have a polygon. The classes can always be edited later, if desired. Figure 5-64 shows a vegetation map that resulted from the polygon/vegetation class assignments.

A simpler approach can be used to assign a single vegetation class to a polygon region if the P2D file contains only one polygon.

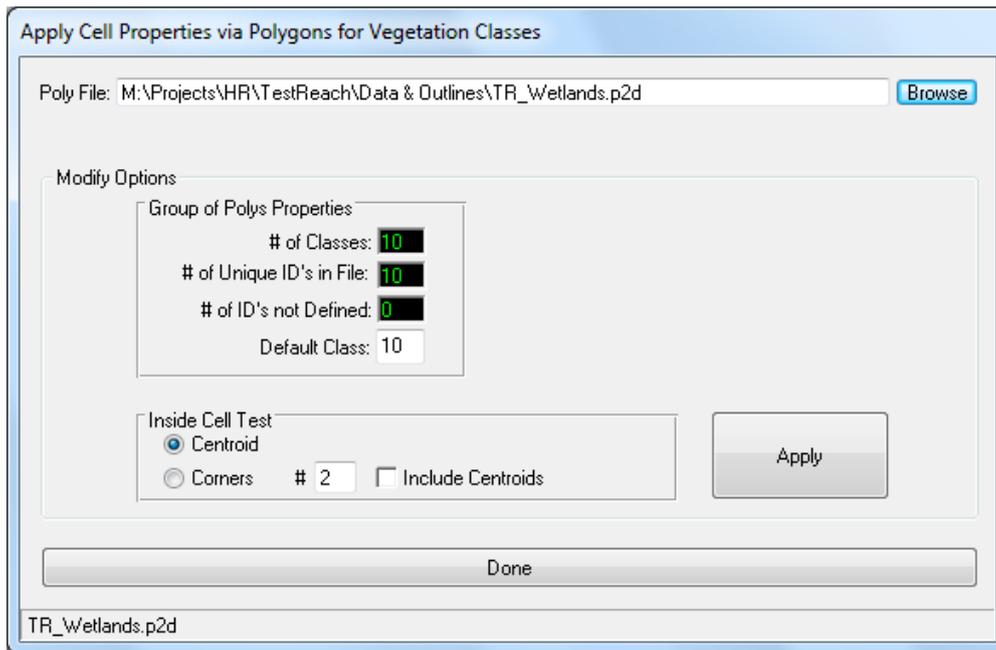


Figure 5-63 Cell property assignments: Vegetation map with IDs.

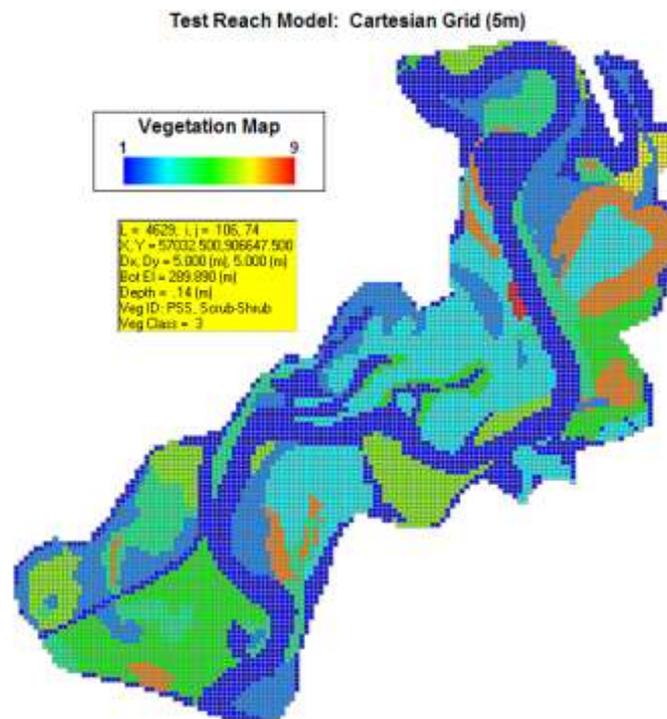


Figure 5-64 Example vegetation map assignment.

5.8 Waves Tab

Bed shear stress associated with waves is an important parameter that contributes to sediment resuspension and transport process in coastal shallow areas and along shorelines. EFDC_Explorer has two options for incorporating waves in the flow model. These are internal wave model and external wave model as shown in Figure 5-65.

The internal wave model internally computes the wind-induced waves using wind data provided in the WSER.INP file. In contrast, the external wave model requires the output results from SWAN, Ref/Rif, STWAVE and other wave models. EE will then generate the WAVE.INP and WAVETIME.INP files from output results to couple with EFDC model.

For all wave models, the user has the option of simulating radiation shear stress with the *Include Radiation Stress* check box as shown in Figure 5-65.. Checking or unchecking this option will change the wave parameters required in the right hand frame.

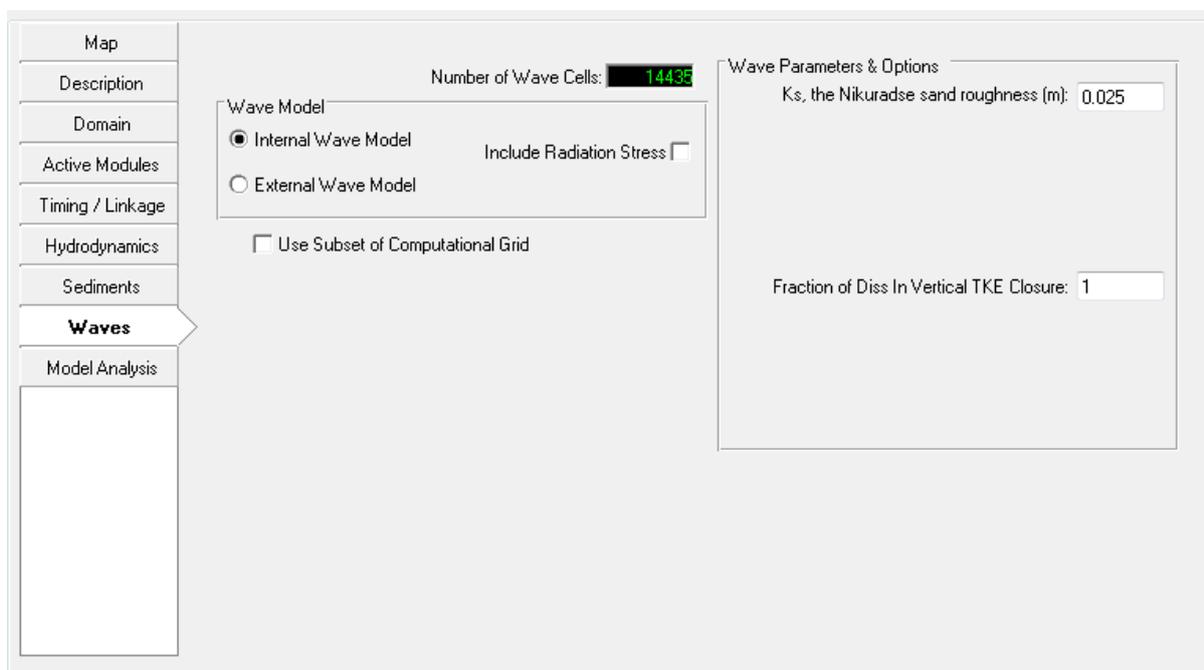


Figure 5-65 Waves Tab: Internal/External Linkage to SWAN Wave Model

5.8.1. Wave Models in EFDC

The wave model within EFDC uses a naming convention as follows:

- No Wave Effects (ISWAVE=0)
- External Linkage–Boundary Layer Only (ISWAVE=1, requires WAVEBL.INP and WV00N.INP, n=1, 2, 3... for version EE7.0, and uses a new format of WAVE.INP for EE7.1 and later. Refer to the EE7.2 guide and later for this format).
- External Linkage–Boundary Layer and Currents (ISWAVE=2, requires the new format of WAVE.INP, the same input file as for ISWAVE=1)
- Internally Generate Windwaves – Boundary Layer Only (ISWAVE=3) (EFDCPlus only)

- Internally Generate Windwaves – Boundary Layer and Currents (ISWAVE=4) (EFDCPlus only)

5.8.2. Internal Wave Model Option

In general the influence of wind on the flow velocity field is important while studying hydrodynamics and sediment transport in lakes, estuarine and coastal areas. Wind effects not only induce the flow current, but also generate surface waves with a wave height up to several meters. To calculate the total bed shear stress in such areas, the model must take the wave factor into account. The wave parameters such as wave height, wave direction and wave period are calculated by the SMB (Sverdrup, Munk and Bretschneider, see Zhen-Gang Ji, 2008) model. The wave direction is the same as the wind direction. This means that the effects of refraction, diffraction and reflection are not taken into account in this internal wave model.

The internal wave model option doesn't require imported external wave to simulate wind generated wave effects on bed shear stress and wave induced currents (Dang Huu Chung and P.M.Craig, 2009). The fetch for each cell by wind sector may be viewed in *ViewPlan* (see Section 7.6, *ViewPlan Main Viewing Options*).

The *Wave Parameter & Options* form allows the user to specify K_s , the Nikuradse sand roughness value as shown in Figure 5-65. This can be estimated as $K_s = 2.5 \times d_{50}$. The Nikuradse roughness is not the same as the hydrodynamic roughness (i.e. bottom roughness, Z_0) used by EFDC to solve the hydrodynamic equations. The Nikuradse roughness is a grain roughness and represents more of a local scale phenomenon.

For the cases of ISWAVE=3 and ISWAVE=4, available only in EFDCPlus, the wind time series provided in the WSER.INP file is used to compute the instantaneous values of wave parameters with fetch calculated for each cell in sixteen directions. The effect of shoreline and EFDC internal masks are included in the fetch calculations. The resulting wave parameters are then used to calculate total bed shear stress, with bed shear stress linked to the current generated shear stress via the Grant Madsen approach.

From EE5 there has been the ability to internally generate wind-induced wave for bed shears only (ISWAVE=3). This can also include the radiation stresses for the whole water column (ISWAVE=4). These options allow the simulation of wave effects and re-suspension of sediments inside EE.

5.8.3. External Wave Model Option

This external wave model option allows the user to import wave parameter fields from other common wave models. The Steady/Unsteady option corresponds to the types of waves being imported into the EFDC model. The steady wave option means that the waves are not changing with time so the EE will not read the WAVETIME.INP file. The unsteady wave option does require the WAVETIME.INP input file. The setting in the frame reflects the way the user has imported the external waves.

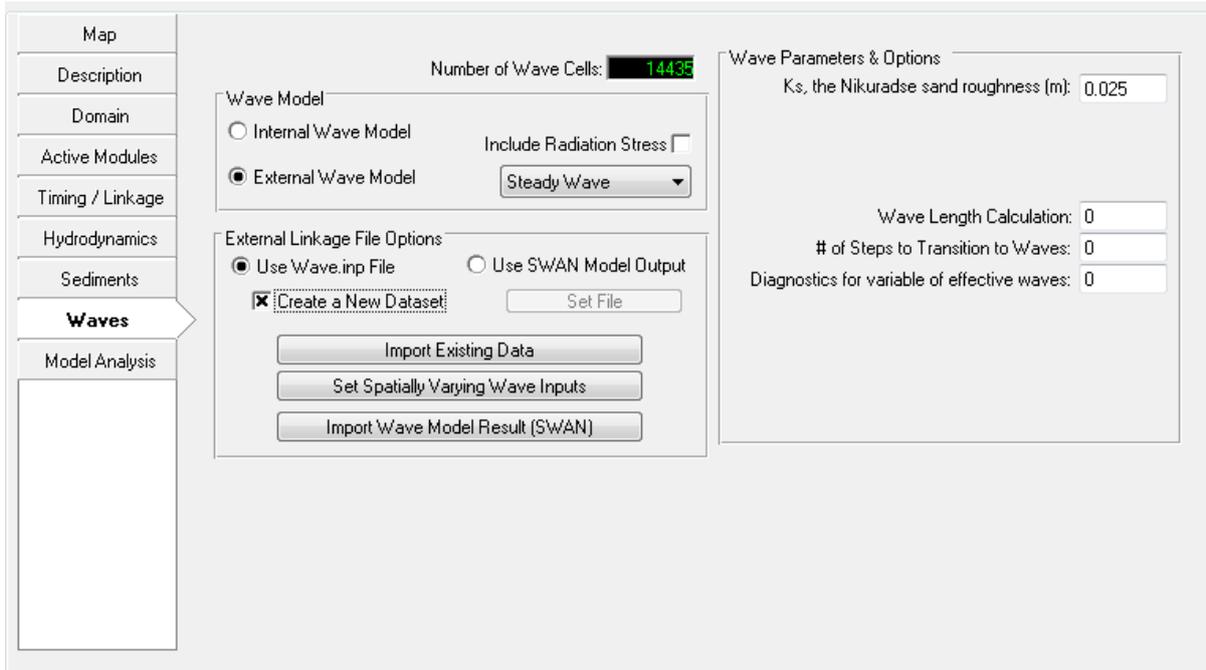


Figure 5-66 Waves Tab: External Linkage to SWAN Wave Model.

There are four different sub-options to take into account while assigning the wave parameters into EFDC model as following;

- a) Use Wave Input File

If the user already has a WAVE.INP file (of format shown in Appendix B 12), then the data is imported first time by checking the *New Dataset* checkbox. If a WAVE.INP has already been imported then the import options described below are greyed out until the *New dataset* box is selected.

- b) Import Existing Data

EE imports an available WAVE.INP file from another project into the current project. It should be noted that two projects must have exactly the same grids.

- c) Set Spatially Varying Wave Inputs

This is an option for EE7 and earlier and it is not advised be used due to the longer time required to prepare the input data. For ISWAVE=1 and ISWAVE=2 the external model results may be imported into EFDC_Explorer which will generate the required wave linkage file, depending on the ISWAVE option. Figure 5-67 shows the main import/field interpolation form for the wave parameters for ISWAVE=2. The user must match the input data file (which should be in XYZ format tab, space or comma delimited) to the parameter specified on drop down list *Wave Field Parameters* (options shown in adjacent inset). The user can either have wave height (2*wave amplitude) or wave energy. EE will compute the one from the other. The user has the option of using a polygon to select which EFDC cells will be used for the assignment. If a Poly file is not selected, then the assignment operation will be for the entire model domain. EE interpolates and converts the wave model results into the formats needed for EFDC. The interpolation process has two options, nearest neighbor interpolation or cell averaging. Cell averaging should be used when the imported data is denser than the EFDC model grid (this will usually be the case). The nearest neighbor interpolation scheme should be used if the imported data is sparser than the EFDC model grid.

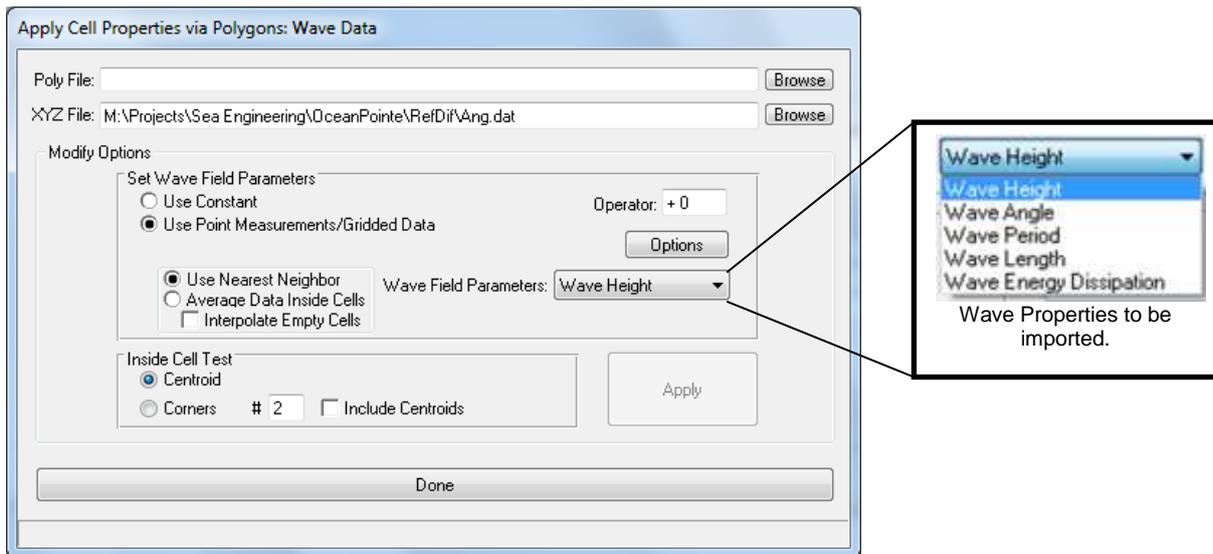


Figure 5-67 Wave generated turbulence, import data form.

DSI has extensively tested and verified the ISWAVE=2 option for both EE and EFDC using the RefDif/ShoreCirc modeling of rip tide currents (Svendsen, et. al., 2000). Figure 5-68 shows EFDCPlus model results for the rip tide test case. The velocity vectors (in white) have been overlaid on the bathymetry. The velocity pattern and magnitude are similar to what was computed by Svendsen.

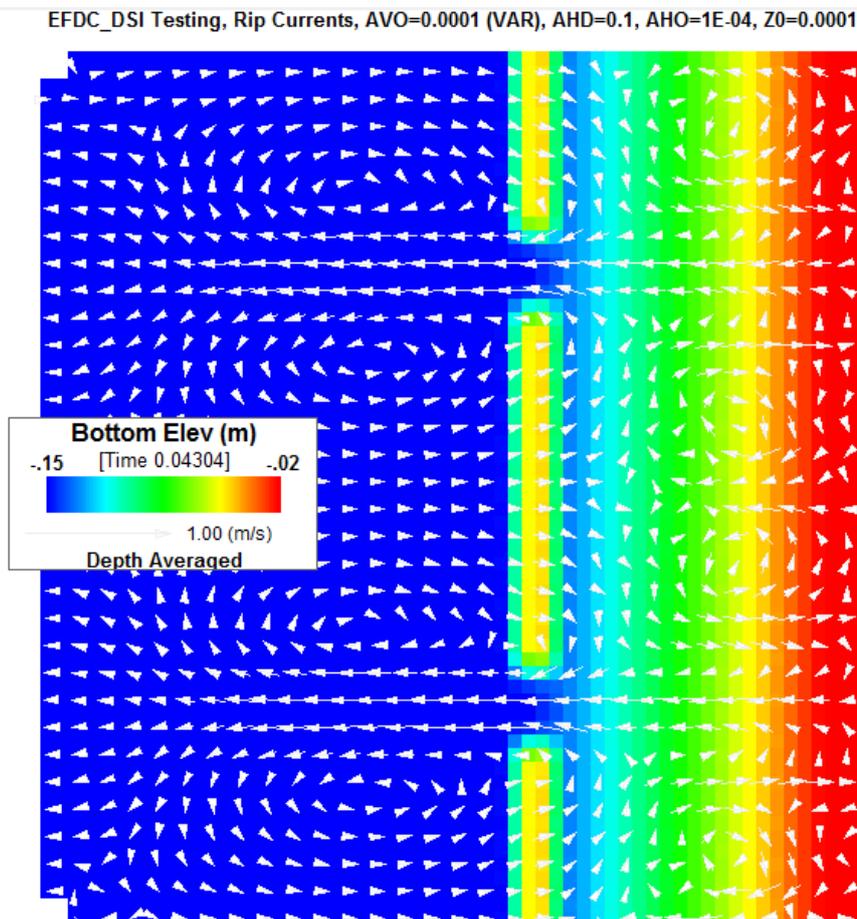


Figure 5-68 Wave generated rip tide currents overlaid on idealized beach.

d) Import Wave Model Results from SWAN

Currently EE only imports data from the SWAN wave model, however, it is anticipated that other models will be included at a later date. If the user chooses to import the SWAN output files through EE then the *Import Wave Model (SWAN)* button should be selected. This displays the form shown in Figure 5-69. The default *Work Path* is the current model directory. The user should browse to a different directory if they want to avoid saving over an existing WAVE.INP file.

In the *Import from SWAN* frame the user should first decide if they are using steady or unsteady waves with the dropdown box. If steady waves are used then EE does not require the WAVETIME.INP file as the waves are at regular time intervals and the option to load this file is disabled. Alternatively, if unsteady waves are being used then browse to the path for the SWAN model outputs and select the wave time file (WAVETIME.INP). Next there are two options for SWAN input:

1. *Using output for locations* option requires the SWAN model to have same grid as the current EE model and uses the group file from SWAN, (SWAN_GRP.INP).
2. *Using output for location* option uses the data as x, y points. This option should be chosen when SWAN and EE use two different grids and wave data was exported at the locations (x, y) from the SWAN model. The latter option requires two input files: a location file and a table file. These should have been defined and saved out from the SWAN model.

Once these files have been selected the user should select the *Import* button. Two files will be created: WAVE.INP and WAVETIME.INP for the EFDC model run.

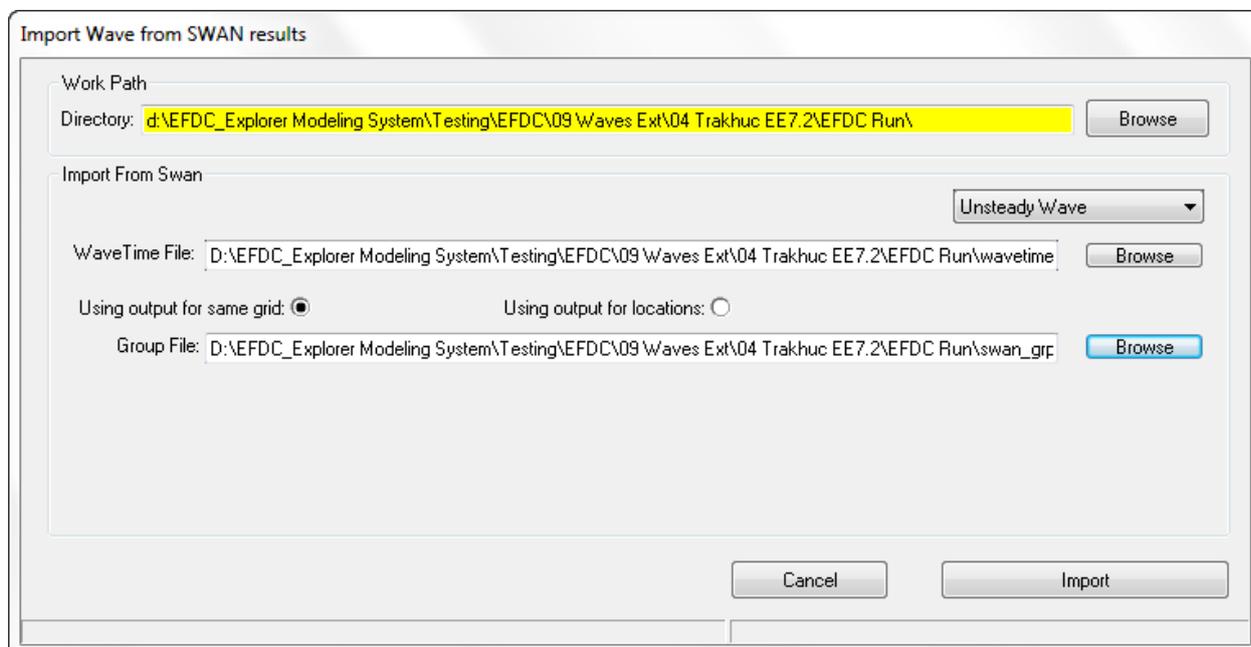


Figure 5-69 Waves Tab: SWAN Import function when using same grid as EE.

5.8.4. Creating SWAN Model Output – Running SWAN from EE

From release of EE7.0 it is possible to build input files for SWAN and then run SWAN directly from EE. Note that this is not fully integrated dynamic coupling between SWAN and the EFDC model at this stage. Instead, EFDC will use the final SWAN output as input for the external wave model.

The steps to run SWAN from EE are as follows. First it is necessary to create a SWAN input file. This is done in *ViewPlan* under the *Export Data* dropdown button, and selecting *Export SWAN* as shown in Figure 5-70. After selecting this option, the *Export to SWAN file* from is opened as shown in Figure 5-71

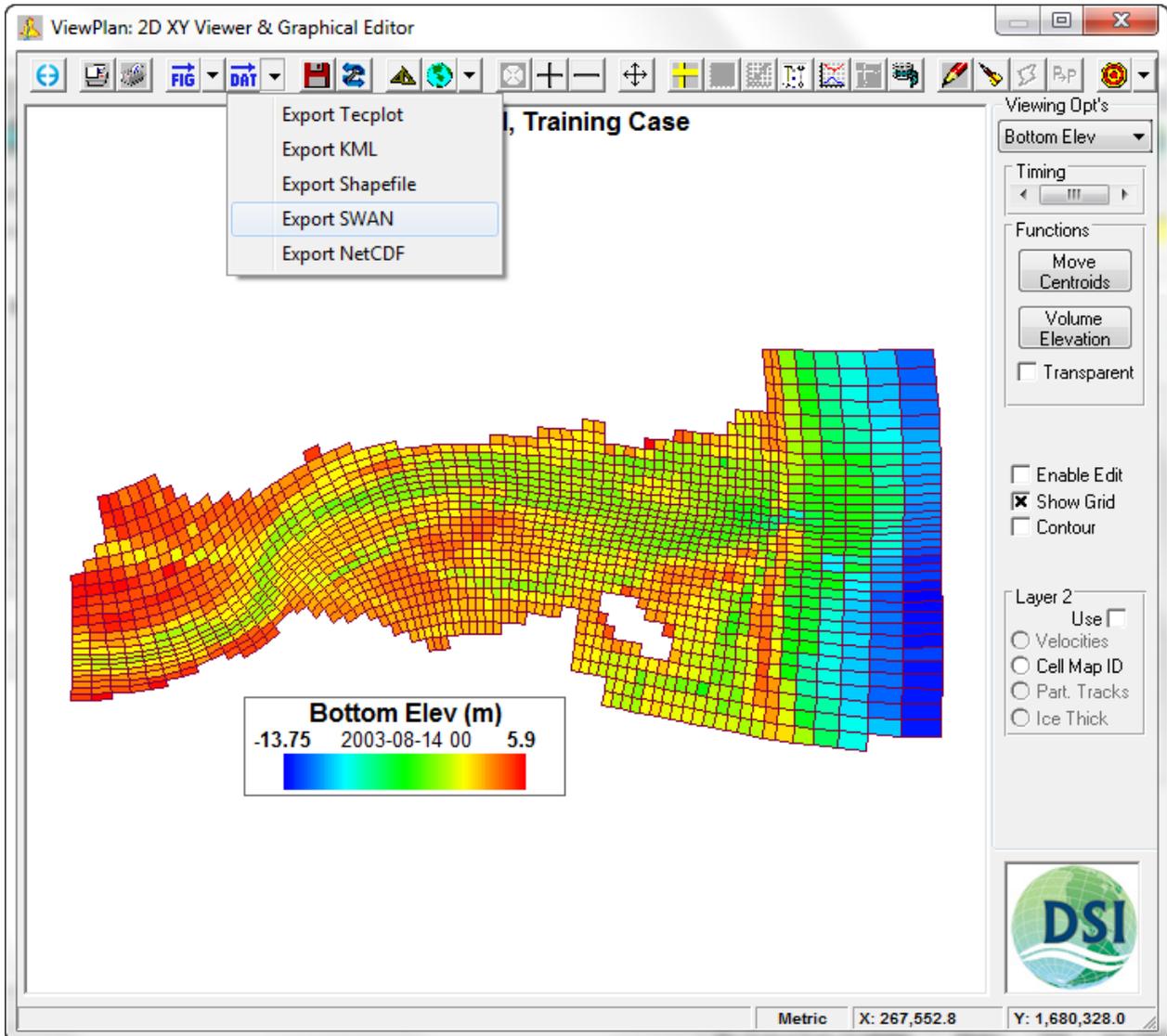


Figure 5-70 External Waves: ViewPlan Export SWAN Option.

The user should select which input data is required for their SWAN model. The *Parameters* button provides further options for the creation of the SWAN inputs. The SWAN user guide should be consulted for details on how to select these parameters (<http://www.swan.tudelft.nl/>). If the user also intends to export the wind series for use in SWAN, the start and end times should be selected as well as the time step for this data.

Navigate to the folder that you want to create the SWAN input files with the *SWAN Working Path* frame before selecting *Export* to create the SWAN inputs.

Figure 5-71 External Waves: Export SWAN Input File from EE.

Once the SWAN input files have been created the user should proceed to the *Waves* tab on the main EE form. When *External Wave Model* option has been selected and the *Create a New Data Set* is not selected, the *Run SWAN* option is displayed. As explained earlier, this provides the option of running SWAN directly from within EE (though not at the same time as EFDC is running i.e. it is not dynamically linked).

Selecting the *SWAN Run* button displays the form shown in Figure 5-72. The user should browse to the work path for the SWAN input files if necessary. The user should then browse to the SWAN executable file. The SWAN exe is installed as part of the installation package for EE. SWAN is freeware under the GNU license and the executable and source code may be downloaded from the University of Technology, Delft <http://www.swan.tudelft.nl/>

The user should select the *Run SWAN* button to run the SWAN model. After the SWAN model has finished running the user should select the *Create a New Data Set* checkbox and use the *Import the Wave Model Results* feature to import SWAN output in to EE.

Figure 5-72 External Waves: Run SWAN internally from EE.

5.8.5. Use SWAN Model Output

The user also has the option of importing the SWAN model outputs directly into EFDC (Figure 5-73). This requires the SWAN user to select either a location file (table) or for a grid file (group) which can be exported from SWAN. Once again the user should know if they are importing steady waves or unsteady waves and select the appropriate option from the dropdown box. The output files names from SWAN should be saved as:

SWAN Location file: SWAN_LOC.INP & SWAN_GRP.INP or

SWAN Table file: SWAN_TBL.INP

The radial buttons in form *USE SWAN Model Output* allow the user to select which type of input file is being input. The EFDC.INP is then updated to tell EFDC which will then look for the appropriate files in the root level of the project directory.

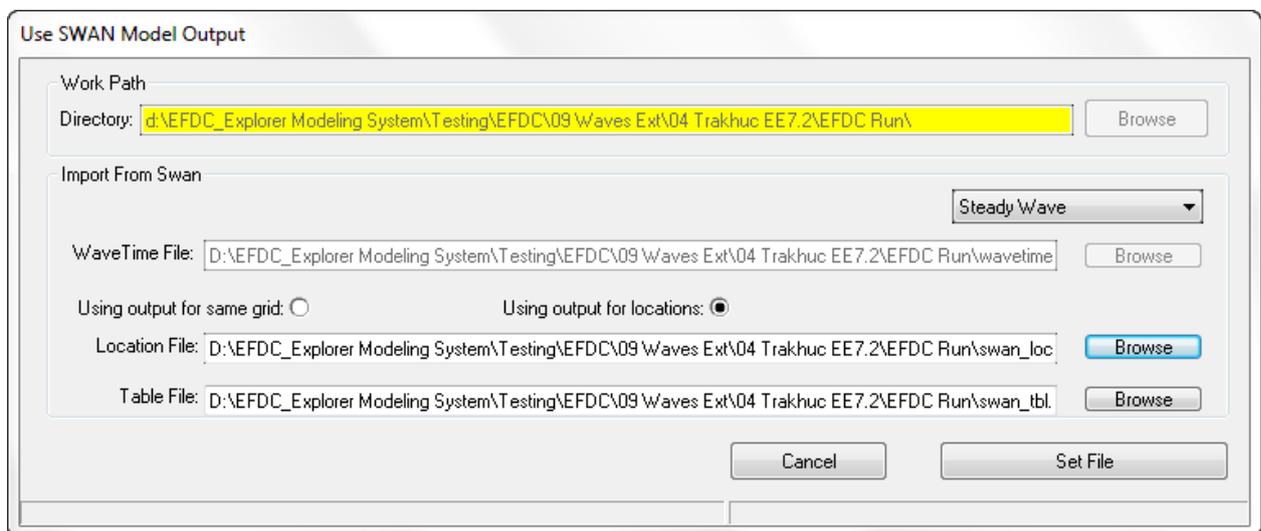


Figure 5-73 Waves Tab: Use SWAN Model output.

5.9 General Vertical Coordinates (GVC) Tab

When using the EPA GVC Model the GVC options are enabled as shown in Figure 5-74. The user must specify which layering option to use with the GVC model, either a Standard Sigma Vertical Grid (pre-GVC) layering option or a Generalized Vertical Grid (GVC) option that allows the number of layers to vary in the model.

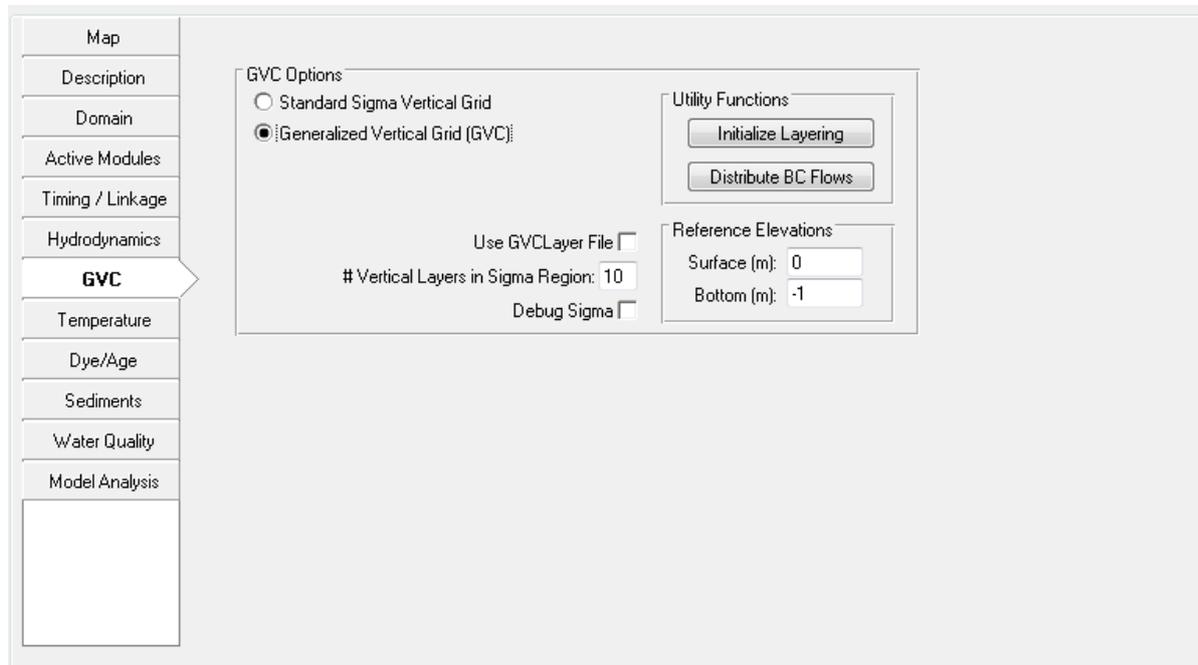


Figure 5-74 GVC Tab

If the GVC layering option is selected the following sub-options must be specified:

- *Use GVC Layer File*: Check to manually set the cell by cell layers. When checked the GVCLAYER.INP file is written by EFDC_Explorer and then used by EFDC_GVC during the model run. If not checked, EFDC_GVC automatically assigns the GVC layers using the Surface and Bottom Reference Elevations. EFDC_Explorer can set and display the GVC layering. Use the *Initialize Layering* button to set the layering automatically, using the *Surface* and *Bottom Reference Elevations*. You can then view, modify and reset the layering in the *ViewPlan* function.
- A GVC grid has two types of cells, Local Sigma or GVC cells. Local Sigma cells use the number of layers specified in the *# of Vertical Layers in Sigma Region*. The number of layers must be less than or equal to KC.

The *Utility Options* frame allows the redistribution of the total flow into the active layers for all the flow type Boundary Conditions by pressing the *Distribute BC Flows* button. When using the GVC Grid, the *Initialize Layering* button allows the user to initialize the GVC layering using the Surface and Bottom elevations specified in the Reference Elevations form.

The Surface and Bottom Reference Elevations should initially be set to something near the maximum water surface elevation and minimum bottom elevation, respectively. These can be altered at any time and the layering recomputed using EFDC_Explorer to determine their validity. The validity of the layering can be viewed in the *ViewPlan* function, under *Fixed Params* viewing option.

5.10 Salinity Tab

Figure 5-75 shows the *Salinity* tab options. The method for assigning initial conditions for salinity is similar to that described for other water column parameters in Section 5.3.2.1. The user may also edit the time series data for this parameter with the *Edit* button in the *Time Series Data* frame.

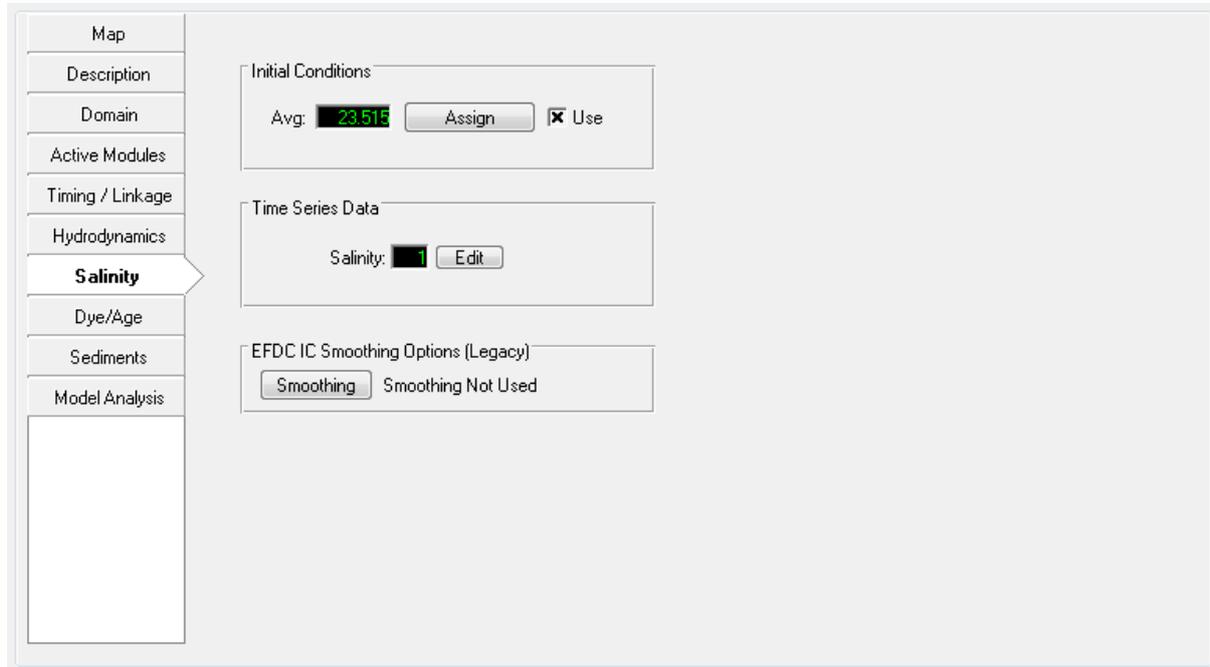


Figure 5-75 Salinity Tab

5.10.1. EFDC IC Smoothing Options

This is used to smooth initial conditions for the SAL/bottom elevation inside EFDC. However it is recommended that smoothing be performed by EFDC_Explorer rather than the EFDC model. Pressing the *Smoothing* button brings up a form whereby the user may select the number of smoothing passes and smoothing factor for bathymetry and salinity.

5.11 Temperature Tab

If the user has selected the *Activate Temperature* checkbox in the *Active Modules* tab the *Temperature* tab will be enable as shown in Figure 5-76. There are two tabs available with for the temperature option, *General*, and *Ice Options*.

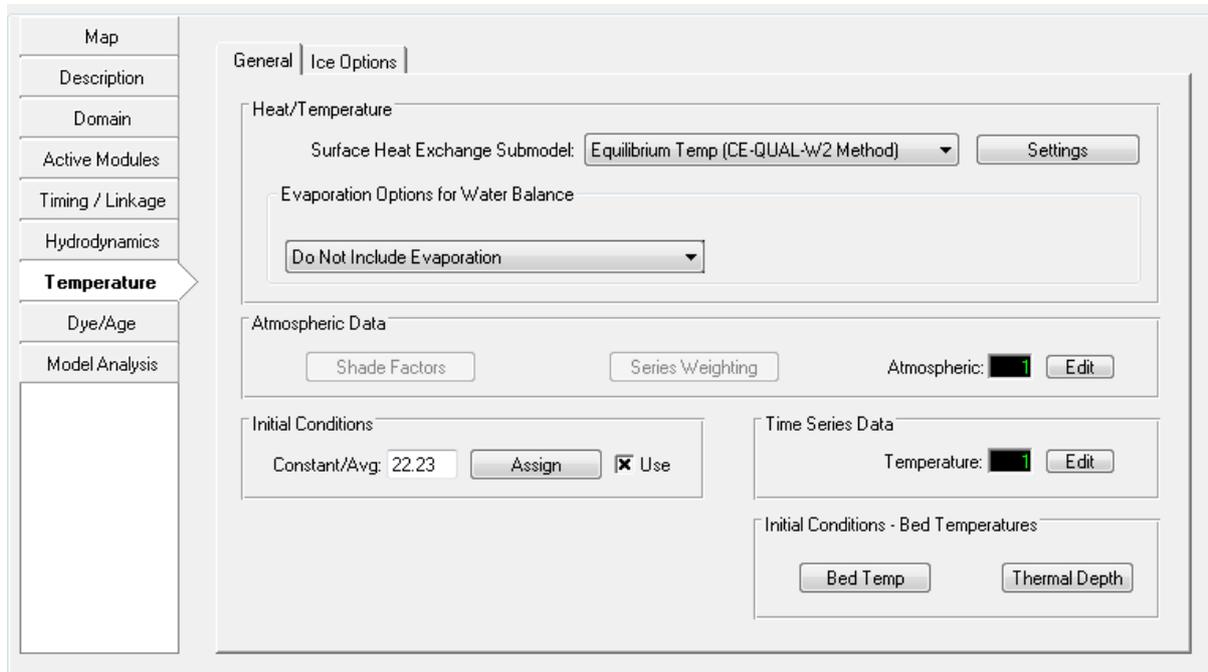


Figure 5-76 Temperature Tab

5.11.1. Heat / Temperature

The *Heat / Temperature* frame provides a drop down list for *Surface Heat Exchange Submodels*, with options including: Atmospheric linkage, Full Heat Balance, External Equilibrium Temperature, Constant Equilibrium Temperature and Equilibrium temperature (CE-QUAL-W2 method, EFDCPlus only).

To activate the heat sub-model in EFDC, the temperature constituent must be activated (*Active Modules | Sub-Model Computational Options | Details*). The ASER.INP file must be used for all of the thermal sub-models to compute the surface and bottom heat exchange processes.

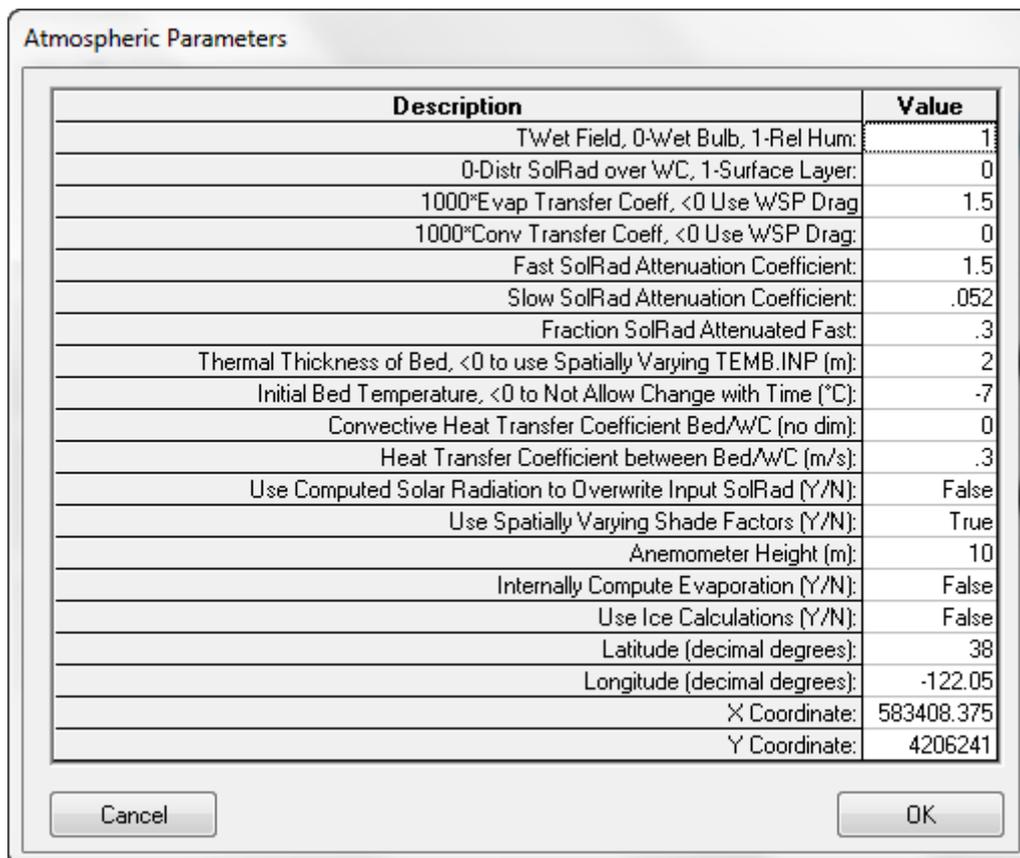
Depending on whether the current model is EFDC_GVC or EFDCPlus, the EFDC_Explorer form will have different options shown in the *Heat/Temperature* frame. The following provide an overview of the approaches.

The EFDC_GVC model uses a new thermal bed model to determine the bed/water column heat exchange (Tetra Tech, 2007c). A sediment thermal thickness is assigned for the entire model. This thickness is not related to either the sediment transport model's bed or the water quality sediment bed. This thermal layer is then divided into KBH layers (must be >2). A constant initial bed temperature can be used or alternatively the TEMPB.INP file can be used to assign a spatially variable initial temperature, by layer. Check the *Use TEMPB.INP* checkbox in the *Bed Thermal Options* frame for this option.

The EFDCPlus version of the model has two different approaches for the bed heat sub-models. If the standard EFDC full heat balance (ISTOPT(2)=1) sub-model is used, the

water/sediment bed heat exchange model of the pre-GVC version is used. If the user has selected the equilibrium temperature sub-model (ISTOPT(2)=4) then the bottom heat exchange is computed using the heat exchange coefficient and the user can assign spatially varying sediment thicknesses and initial temperatures using the TEMB.INP file.

Various atmospheric parameters can be adjusted using the *Settings* button in the *Heat/Temperature* form. An example of the *Atmospheric Parameters* values box is shown in Figure 5-77. The parameters shown in Figure 5-77 change slightly depending on which heat sub-model is being used.



Description	Value
TWet Field, 0-Wet Bulb, 1-Rel Hum:	1
0-Distr SolRad over WC, 1-Surface Layer:	0
1000*Evap Transfer Coeff, <0 Use WSP Drag	1.5
1000*Conv Transfer Coeff, <0 Use WSP Drag:	0
Fast SolRad Attenuation Coefficient:	1.5
Slow SolRad Attenuation Coefficient:	.052
Fraction SolRad Attenuated Fast:	.3
Thermal Thickness of Bed, <0 to use Spatially Varying TEMB.INP (m):	2
Initial Bed Temperature, <0 to Not Allow Change with Time (°C):	-7
Convective Heat Transfer Coefficient Bed/WC (no dim):	0
Heat Transfer Coefficient between Bed/WC (m/s):	.3
Use Computed Solar Radiation to Overwrite Input SolRad (Y/N):	False
Use Spatially Varying Shade Factors (Y/N):	True
Anemometer Height (m):	10
Internally Compute Evaporation (Y/N):	False
Use Ice Calculations (Y/N):	False
Latitude (decimal degrees):	38
Longitude (decimal degrees):	-122.05
X Coordinate:	583408.375
Y Coordinate:	4206241

Figure 5-77 Atmospheric Parameters.

5.11.1.1 Evaporation Options

See section 6.4 for details on this option.

5.11.2. Atmospheric Data

The *Atmospheric Data* frame provides access to the ASER spatially varying options. The solar radiation shading factor can be assigned using the *Shade Factors* button and/or edited in *ViewPlan*. If you are using more than one ASER series you must distribute the atmospheric data series assignments. This is done using the *Series Weighting* function. The same approach discussed for the WSER series weighting is used for the ASER series weighting assignments (see Section 5.6.2). The atmospheric series weight for each station used must be assigned. In *ViewPlan*, EFDC_Explorer provides an atmospheric series weighting map for each station or the wind weighting total (as a QC to make sure it adds up to 1.0). An

As described for the Wind Series, EE previously had the ability to add multiple wind and atmospheric stations and provide a user defined weighting to each station. Now it is possible to automatically weight the multiple series based on their distance from the model domain..

To set the coordinates select the *Show Parameters* button in the *Atmospherics BC Time Series Editing* tool as shown in Figure 5-78. EE will use the X, Y coordinates in the value column. If the user has not entered the X, Y values then EE will automatically calculate X, Y coordinates based on the lat/long values provided. However, if both are entered it should be noted that EE will use the X, Y coordinates.

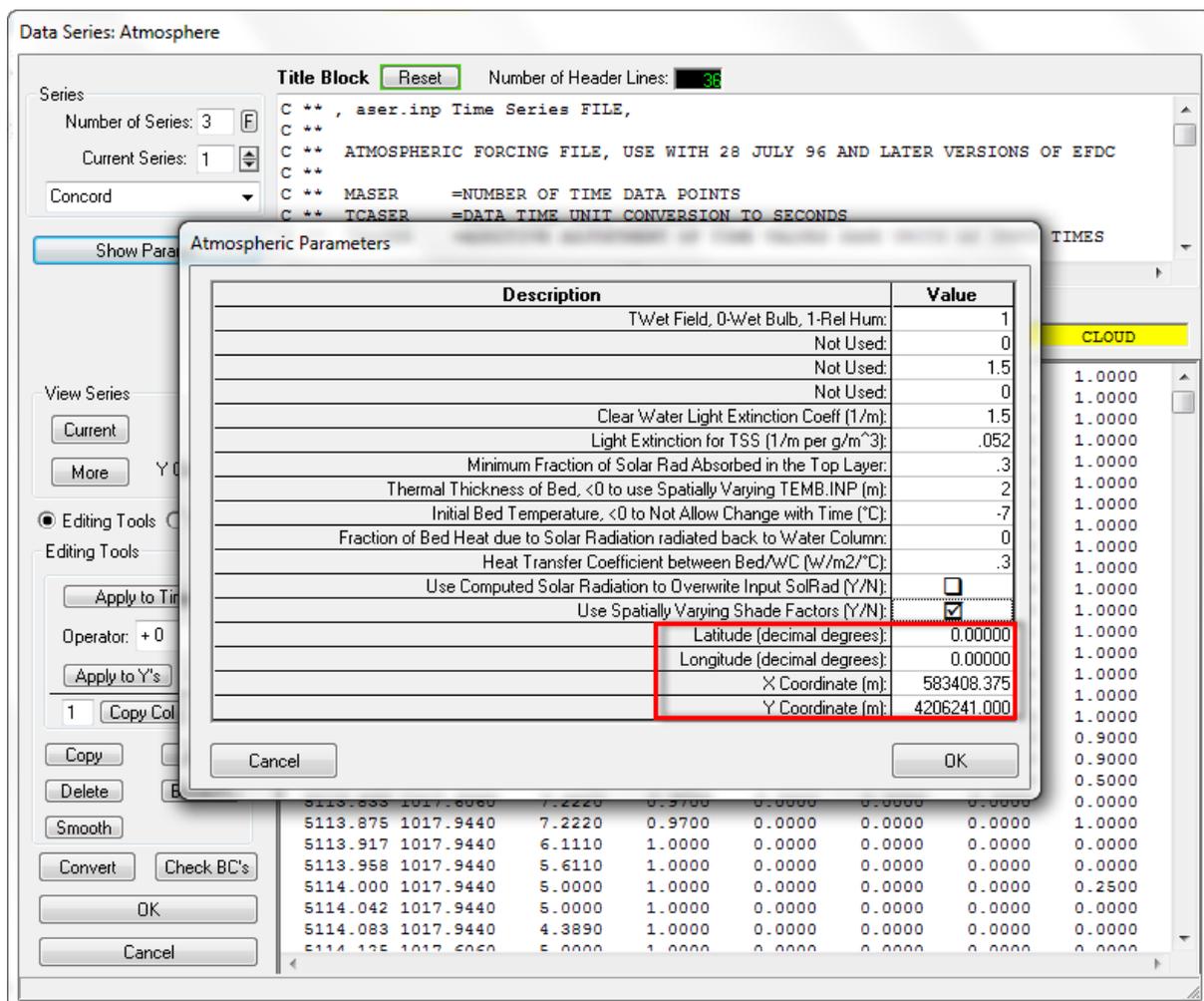


Figure 5-78 Atmospheric Data Series: Station Coordinate Setting.

The user should now select the *Series weighting* button from *Temperature | Atmospheric Data* for atmospheric. To set the spatial weighting, select the *Generate Using Station Coordinates* radial button as shown in Figure 5-79. XYZ interpolation options can be set in terms of the number of sectors and inverse distance power. An example of wind weighted stations displayed in *ViewPlan* is shown in Figure 5-80.

A new approach has been adopted in EE8 to provide users with a simple tool for managing the data and stations for atmospheric data (as well as wind and ice). This approach allows EE to display the stations in a grid format with a quality index that indicates how the user rates each time series and time block within that series. The stations can now also refer to multiple atmospheric series for different periods of time, and this information is stored in the ATMMAP.INP file. The quality variable, ATMEF, is stored in the ATMMAP.INP.

An example of a model domain with three atmospheric stations is shown in Figure 5-79. This example has three stations S1, S2 and S3 together with 2 time series for wind, also shown in Figure 5-79. Details on how to use spatial weighting are provided in Section 5.6.2.2 which describes the principled behind the series weighting.

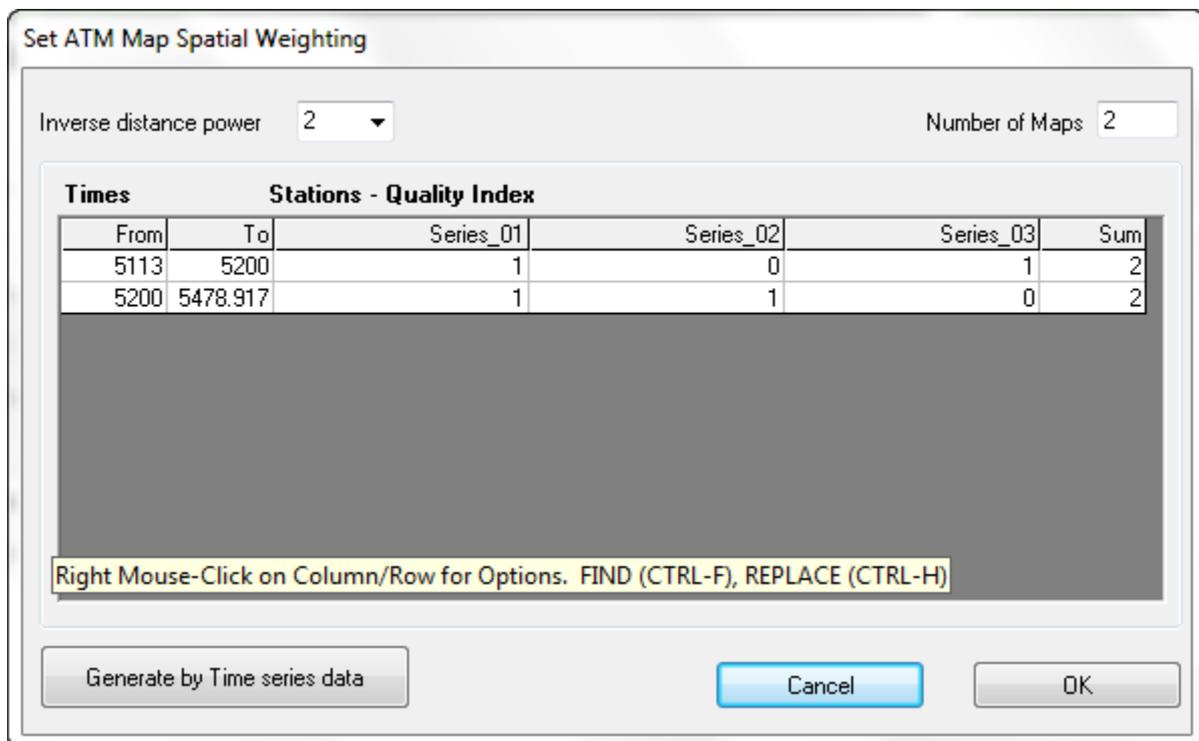


Figure 5-79 Atmospheric Series Weightings: Automatic Option.

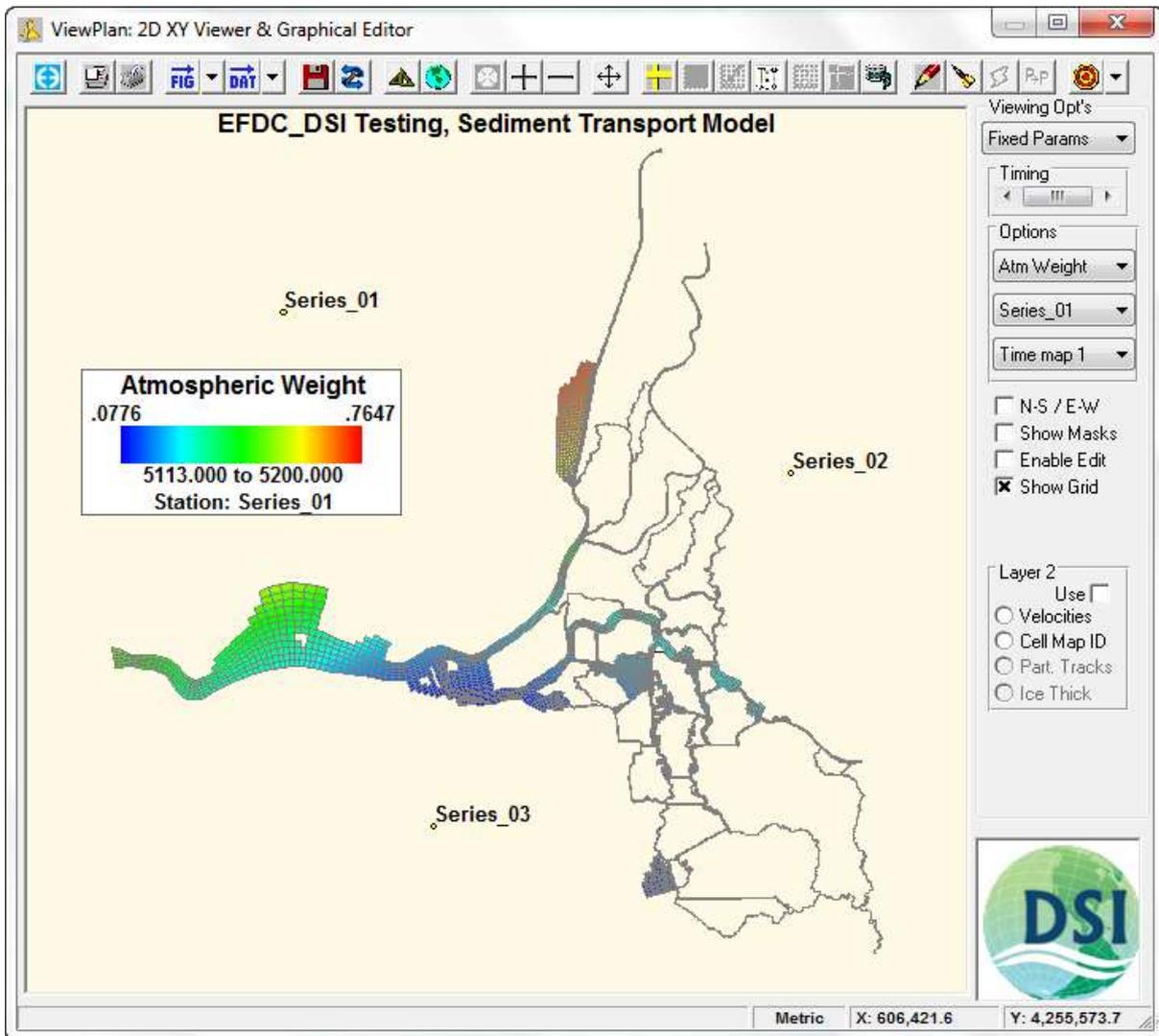


Figure 5-80 ViewPlan: Automatic Wind Series Weightings.

5.11.3. Initial Conditions

See Section 5.3.2.1. for how to use the *Assign* button for setting initial conditions.

5.11.4. Ice Options

A robust ice sub-model is available from release of EFDC_Explorer7.3. Previous versions of EFDC had relatively limited ice modeling ability. In EE7.2 and earlier the ice conditions had to be fully specified by the user for every cell for the model simulation period. The creation of the input files was also external to EE. Now ice formation and melt is simulated by EFDC using a coupled heat model and fully handled by EFDC_Explorer.

Note that ice dynamics are not modeled at this stage. An ice dynamics sub-model would simulate the constriction of the channel by ice and the resulting bed shear caused by the transport of ice chunks. An ice dynamics sub-model is being considered for a later release of the EE modeling system.

Ice options are now available under a new *Ice Options* sub tab under the *Temperature* tab as shown in Figure 5-81. For all the options, ice is only enabled if the user is simulating temperature.

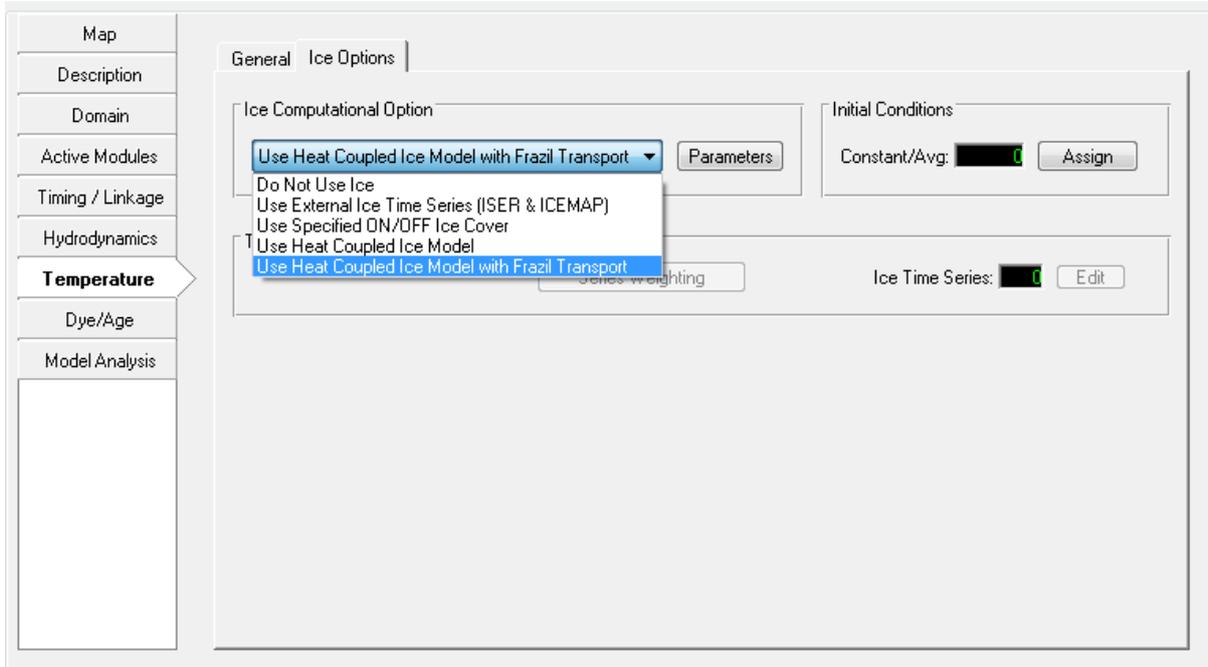


Figure 5-81 Temperature Tab: Ice Sub Model Options.

Options for the ice sub model include:

ISICE = 0	Do not use ice
ISICE = 1	Use External Ice Time Series (ISER & ICEMAP)
ISICE = 2	Use Specified ON/OFF Ice Cover (ISTAT)
ISICE = 3	Use Heat Coupled Ice Model
ISICE = 4	Use Heat Coupled Ice Model with Frazil Transport

Application and operation of each of these options is explained in the following sections.

5.11.4.1 Use External Ice Time Series (ISICE = 1)

This option is similar to the ice option available prior to EE7.3 and does not compute ice formation/melt and it is not linked to the heat balance. This option simply requires the user to provide a fraction of ice coverage and thickness of ice for every cell using formats provided in Appendix B-16 and B-17. The primary impact of the ISICE =1 option is on processes that occur at the air/water interface and has no direct impact on ice melt. For those cells where ice is present the ice sub-model will:

- Limit water surface heat exchange and moderate the layer KC temperature to the specified ice temperature.
- Reduces or eliminates (based on fraction of ice coverage) reaeration of oxygen into the water column.
- Reduces or eliminates the shear stress on the surface of the water due to winds.
- Reduces or eliminates the wind speed used for all other surface exchange processes.

For the option ISICE=1, EFDC uses the ISER.INP to read time and ice thickness for externally specified ice cover, and ICEMAP.INP for the weighting coefficients of ice thickness in case of more than one time series given in ISER.INP.

ICEMAP with the NISER weightings (the number of ice series) when NISER>1 can now be read and written.

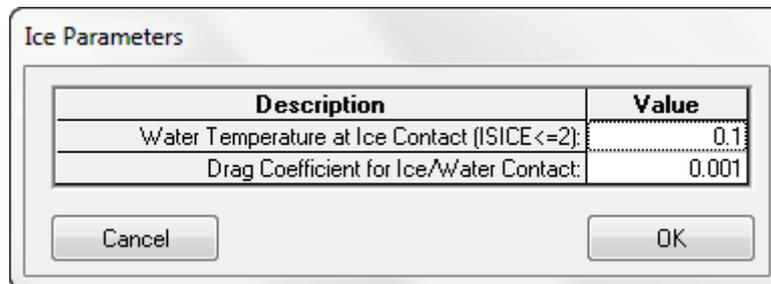


Figure 5-82 Temperature Tab: ISICE =1.

5.11.4.2 Use Specified ON/OFF Ice Cover (ISICE = 2)

This option is effectively a global toggle so that ice may be turned on or off over the whole domain. The time series file that populates this option lists a date and toggle on and toggle off with the input file ISTAT.INP.

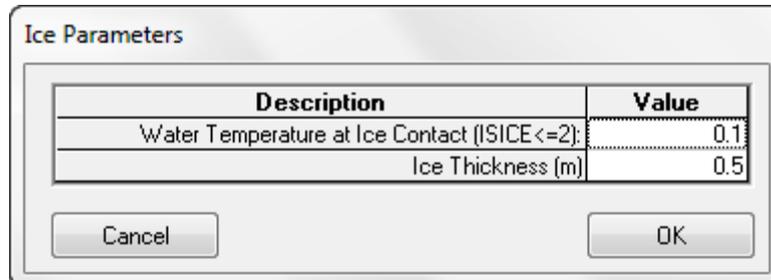


Figure 5-83 Temperature Tab: ISICE =2.

The input file ISTAT.INP file is same as old the ICECOVER.INP, with a time stamp and a status of ice cover. The convention is quite similar to that for other time series. The header contains the number of data lines, time conversion coefficients. The remaining block includes two columns: Julian time and the status of ice cover, either 0 or 1, off or on. The ice temperature and the ice thickness are stored in EFDC.INP file in C46A.

Appendix B shows the format for this file. EFDC reads the file and applies it in the same way as ICECOVER.INP. All the other computations are the same as those for ISICE=1 except the initialization is whole model on or off rather than based on the ICEMAP.INP file. EFDC can also handle multiple ice series and weights based on different series like NISER.

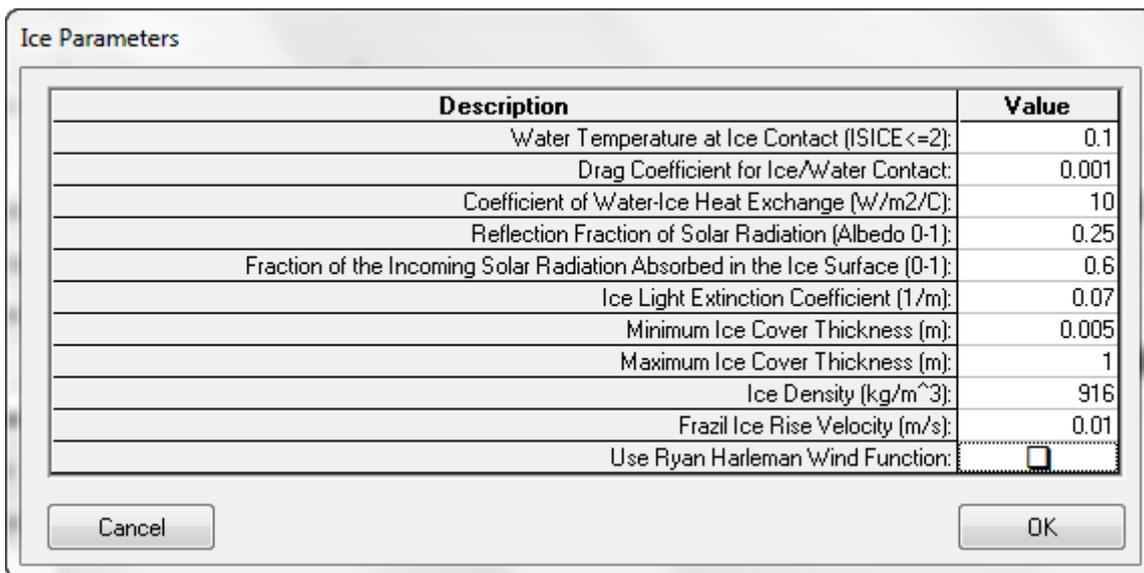
5.11.4.3 Use Heat Coupled Ice Model (ISICE = 3)

The Heat Coupled Ice Model applies mass conservation during ice growth/melt. Ice is always calculated in the heat coupled ice model, similar to CEQUAL-W2 model upon which the EFDCPlus ice sub model is based.

This option is most recommended for model simulations of lakes and reservoirs with relatively thick layers. For rivers, this option and frazil ice option are not fully representative. This is due to small layer thickness in most river models. Generally, the layers used in rivers are too thin to produce ice. Even though ice crystals form, they are not thick enough to form an ice cover.

Currently the ice submodel in EFDCPlus is only an ice cover model and not an ice and snow cover model. The snow cover would account for snow on top of the ice and is expected to be added for an upcoming release. The ice cover model allows light to be attenuated through the ice. The solar radiation absorption is accounted for in this process. To implement this in EFDC, routines such as CALQVS and CALHEAT were modified. CALPUV was also updated so that the bed heat is handled when the elevation is below the bottom of the cell.

Figure 5-84 shows the default values of the ice parameters that are required to simulate ice in EFDCPlus model. A checkbox is provided for the *Use Ryan Harleman Wind Function* option if desired.



Description	Value
Water Temperature at Ice Contact (ISICE <= 2):	0.1
Drag Coefficient for Ice/Water Contact:	0.001
Coefficient of Water-Ice Heat Exchange (W/m ² /C):	10
Reflection Fraction of Solar Radiation (Albedo 0-1):	0.25
Fraction of the Incoming Solar Radiation Absorbed in the Ice Surface (0-1):	0.6
Ice Light Extinction Coefficient (1/m):	0.07
Minimum Ice Cover Thickness (m):	0.005
Maximum Ice Cover Thickness (m):	1
Ice Density (kg/m ³):	916
Frazil Ice Rise Velocity (m/s):	0.01
Use Ryan Harleman Wind Function:	<input type="checkbox"/>

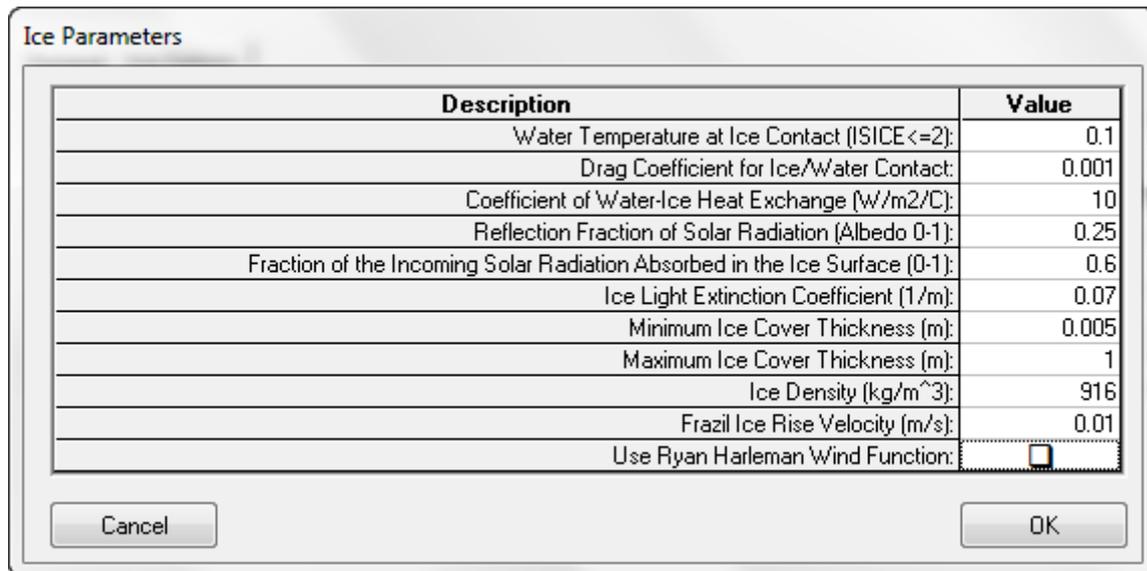
Figure 5-84 Ice Sub model: Heat Coupled Ice Parameters (ISICE =3).

ICE.INP is the initial conditions file that is only needed for ISICE = 3 & 4. The format for this file is provided in Appendix B. Note that EFDC assumes the top of ice is equal to the water surface elevation thereby allowing for higher flows in restricted depth.

5.11.4.4 Frazil Ice Transport (ISICE = 4)

When calculating ice formation in a river, if the air temperature is less than freezing temperature (a value that may be lower than zero in salt water) generation of ice crystals takes place in the water. These crystals are called frazil flakes. As the frazil flakes are lighter than water they float and cause “ice pans” which may then become “ice floes”. As the frazil ice rises, it is necessary to input a rising velocity into EE to account for this.

In addition to the modification to the EFDC subroutines outlined for ISICE =3, a new routine, CALTRANICE is created to simulate frazil ice as a concentration.



Description	Value
Water Temperature at Ice Contact (ISICE<=2):	0.1
Drag Coefficient for Ice/Water Contact:	0.001
Coefficient of Water-Ice Heat Exchange (W/m ² /C):	10
Reflection Fraction of Solar Radiation (Albedo 0-1):	0.25
Fraction of the Incoming Solar Radiation Absorbed in the Ice Surface (0-1):	0.6
Ice Light Extinction Coefficient (1/m):	0.07
Minimum Ice Cover Thickness (m):	0.005
Maximum Ice Cover Thickness (m):	1
Ice Density (kg/m ³):	916
Frazil Ice Rise Velocity (m/s):	0.01
Use Ryan Harleman Wind Function:	<input checked="" type="checkbox"/>

Figure 5-85 Ice Sub model: Frazil Ice Parameters (ISICE =4)

5.11.4.5 Visualization of Ice

Output from the ice sub model can be displayed in a number of ways in EE. A 2D plan view of the ice thickness or temperature may be viewed by selecting *ViewPlan* and then *Viewing Options | Heat: Bed/Ice*. Figure 5-86 shows an example of frazil ice formation in a river in Alberta, Canada. Note that initially ice forms on the river banks where depths are shallower and flow is lower.

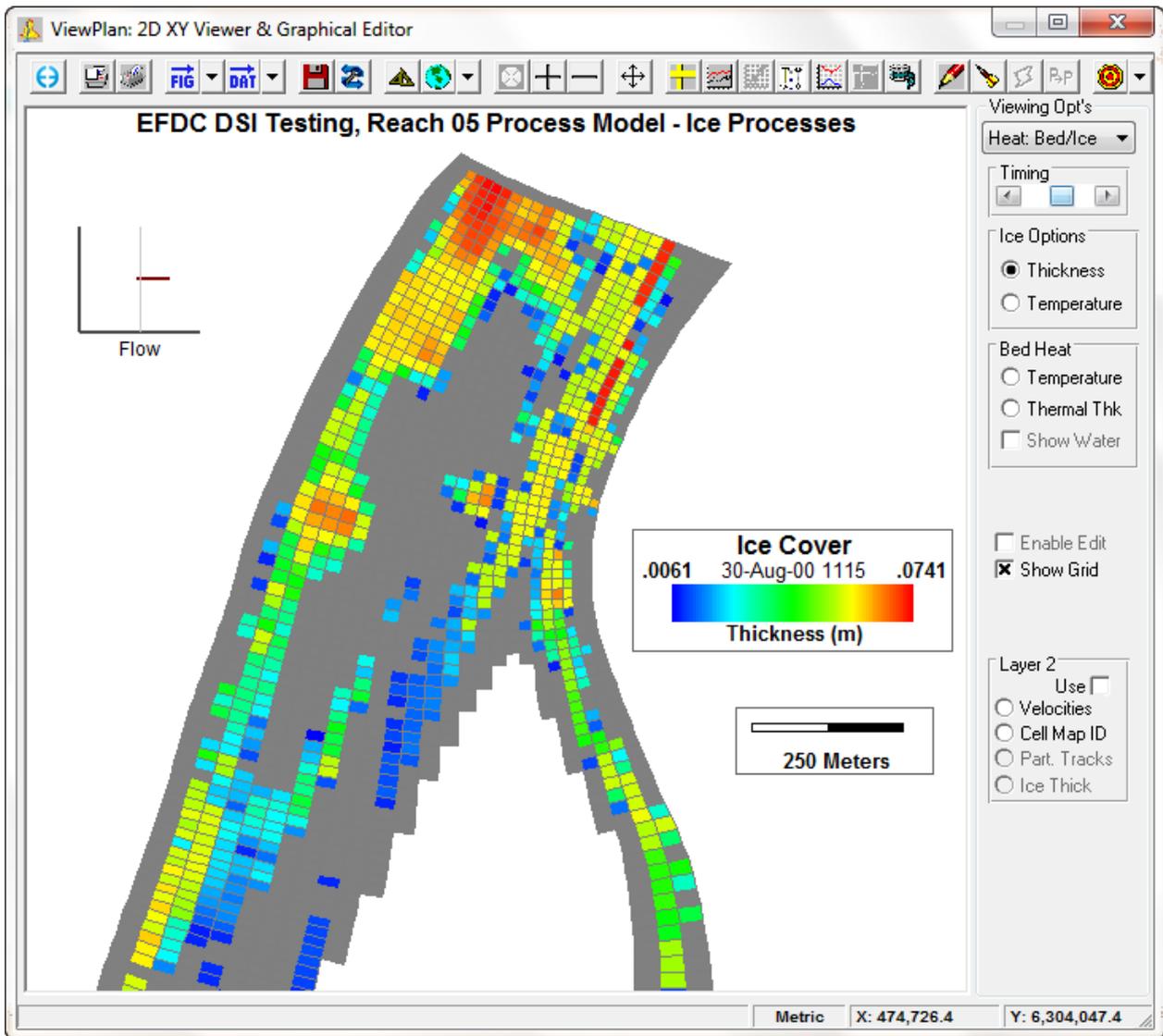


Figure 5-86 Ice Sub model: ViewPlan frazil ice thickness.

The user can also visualize ice on the water column in the *ViewProfile* tool. This displays as a solid grey color as shown in Figure 5-87. The vertical exaggeration of the ice layer can be modified by the user to show it more clearly as shown in Figure 5-88.

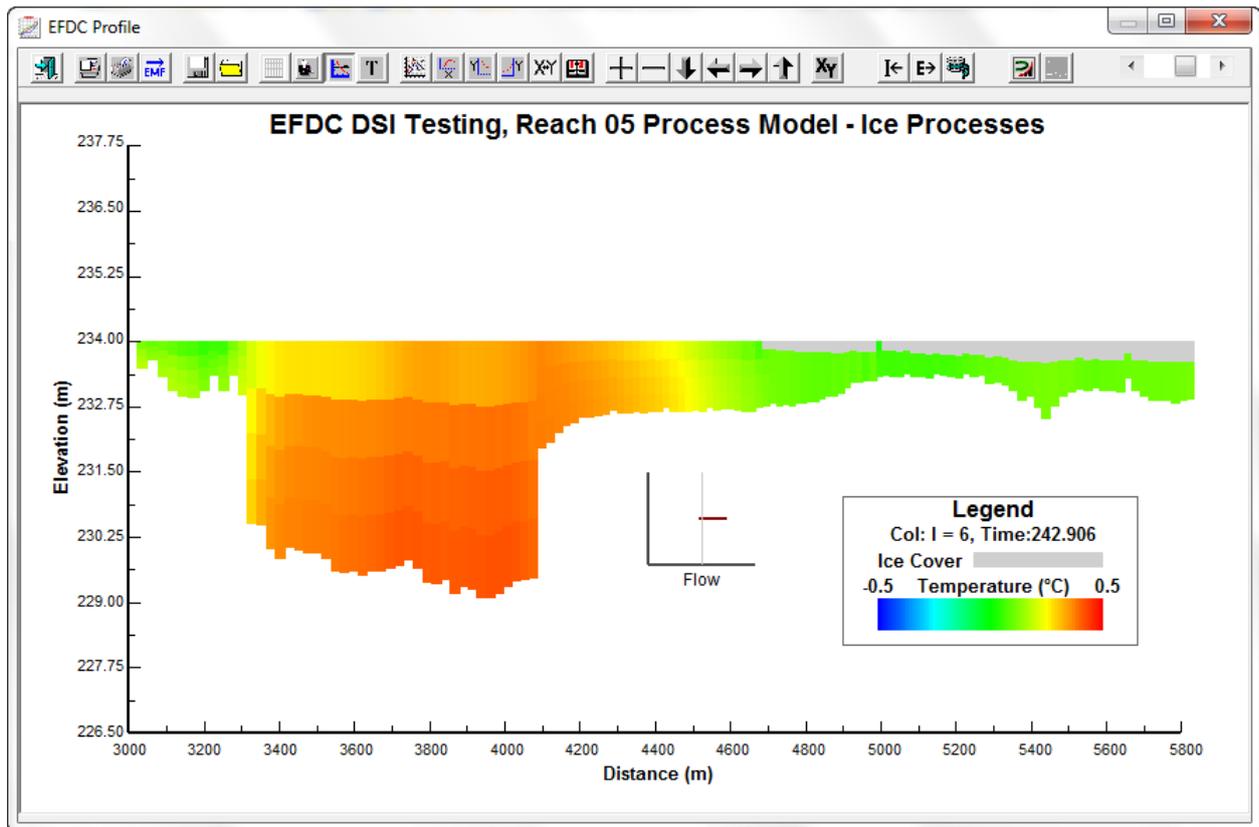


Figure 5-87 Ice Sub model: ViewProfile ice cover and WC temperature.

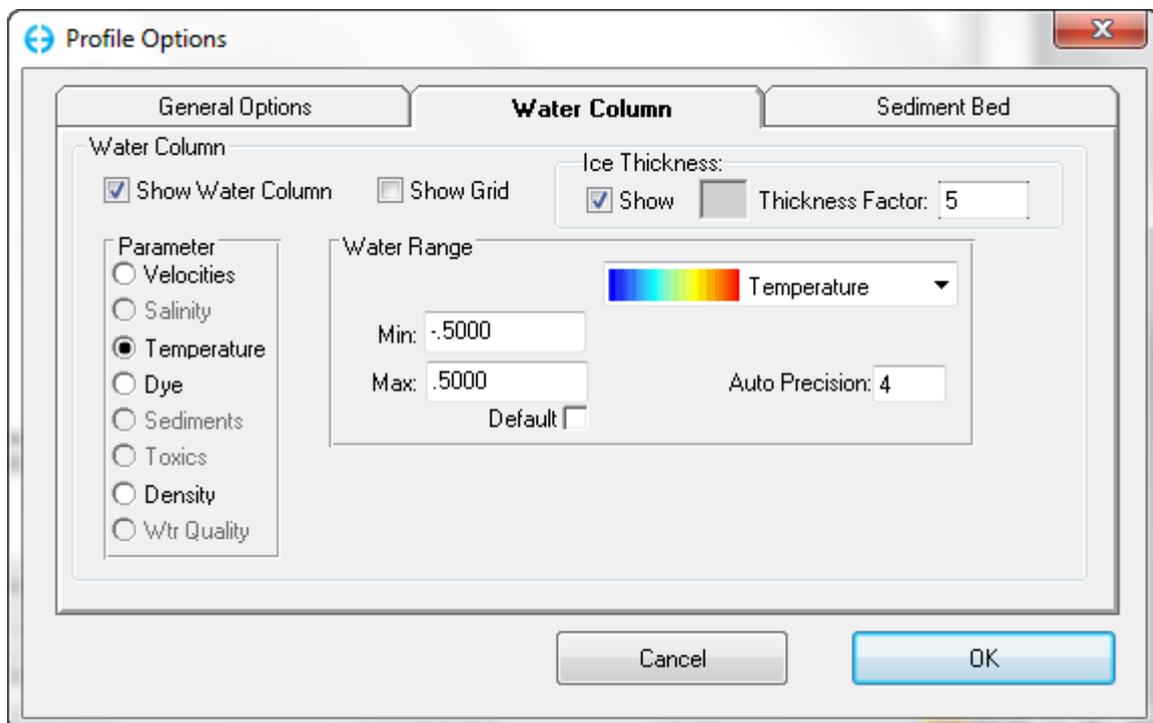


Figure 5-88 Ice Sub model: ViewProfile Options.

Ice may also be viewed in 3D with the *View3D* tool as shown in Figure 5-89.

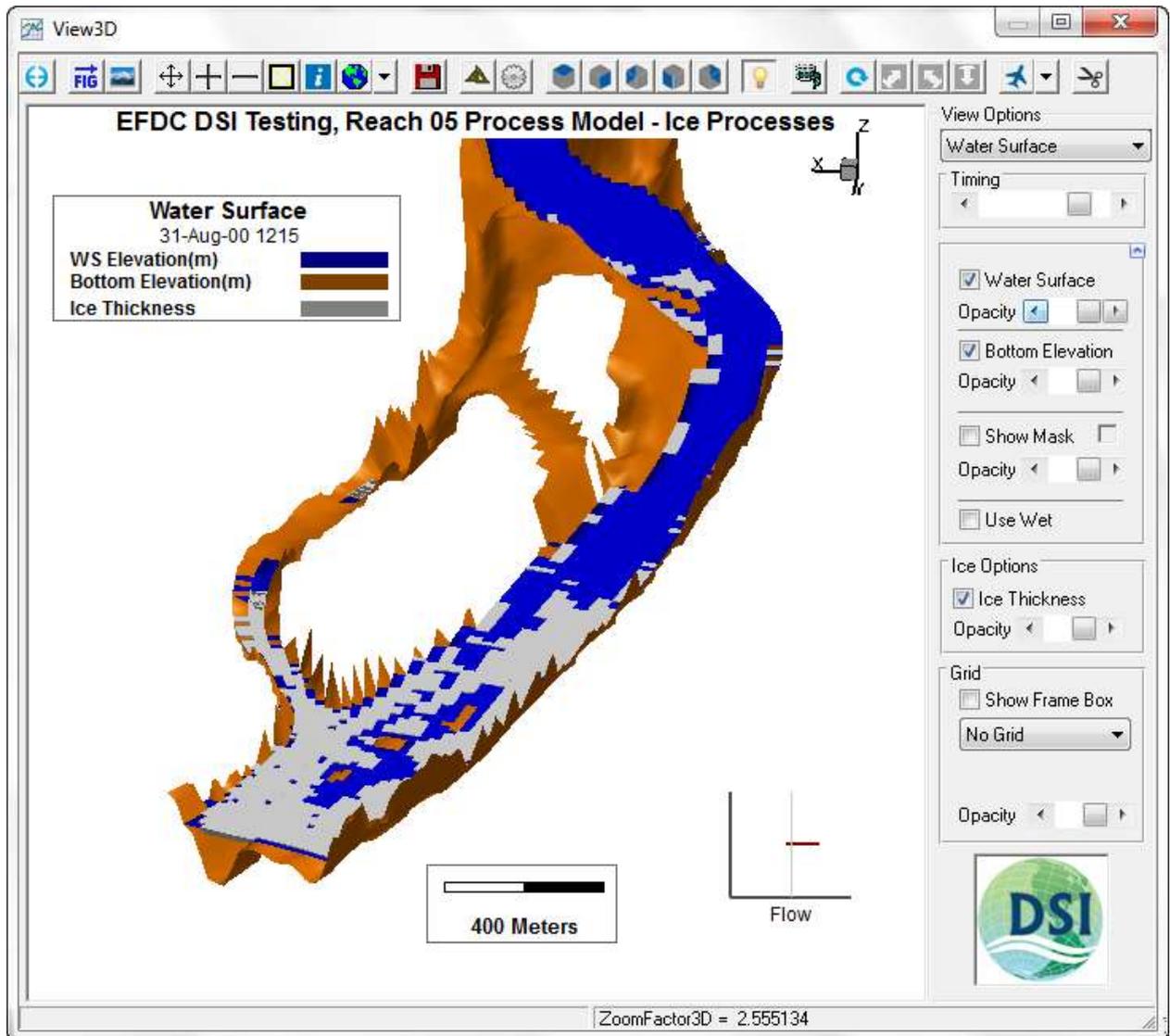


Figure 5-89 Ice Sub model: View3D ice cover and water surface elevation.

5.12 Dye/Age Tab

If the dye computational option is selected as shown in Figure 5-90 then the user may assign a “decay” rate to the otherwise conservative tracer.

The “dye” constituent may also be used as an “age of water” function to compute residence times and visualize domain/boundary water mixing if this option is selected. This option is available in EFDCPlus only.

See Section 5.3.2.1 as to how to apply cell properties via polygons with the *Dye* button in the *Initial Conditions* frame.

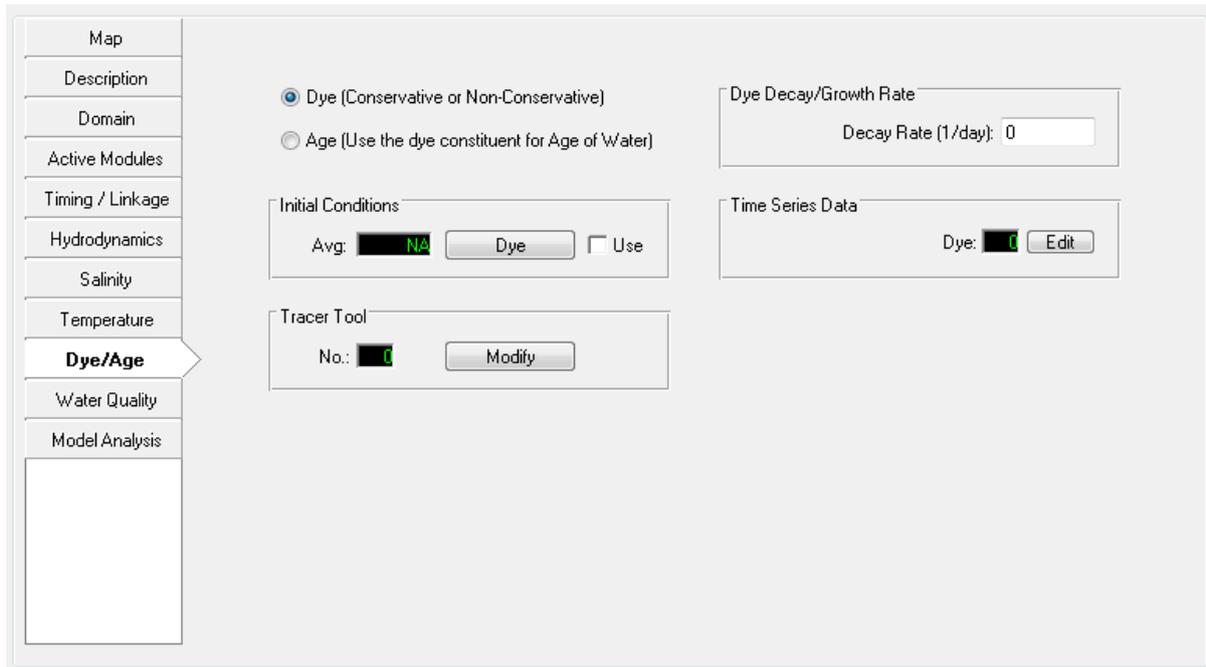


Figure 5-90 Dye/Age Tab

The “decay” rate options are shown in Table 5-1.

Table 5-1 Dye “decay” rate options.

Dye “Decay” Rate	EFDCPlus Operation
>0	First order decay rate
0	Conservative tracer
<0	First order growth rate (EFDCPlus Only)

Depending on the decay rate option, the user can view and animate the dye concentrations or age of water in *ViewPlan*.

If using the restart option, the user can initialize a dye field using the DYE.INP file by selecting the *Dye Overwrite* check box on the *Initial* tab, located in the *EFDC Restart Option* frame.

5.12.1. Tracer Tool

The purpose of the tool is to provide a quick way to setup EFDC computational options and boundary conditions for point source tracer injections. Figure 5-91 shows an example of the tracer tool. The list in the upper left of the *Dye Injection Point* frame shows the tracers currently defined. The list on the right shows all the currently defined flow type cells. The user needs to assign an existing cell or create a new dye injection point and then assign the flow and dye concentration for each point.

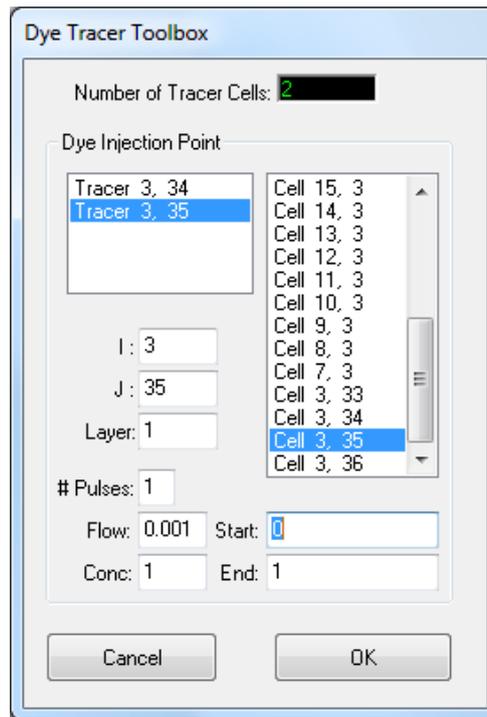


Figure 5-91 Tracer generation tool.

To define an existing boundary cell as a tracer, select the cell from the list on the right and press INS to add it to the tracer list. You must then define the flow and dye injection characteristics for each tracer cell. You can delete tracers by selecting the cell on the left and pressing DEL.

5.13 Toxics Tab

If the toxics have been selected in the *Active Modules* tab the *Toxics* tab will be enabled as shown in Figure 5-92. The *Initial Conditions* frame provides the *Assign* button for applying cell properties via polygons, more fully described in Section 5.3.2.1.

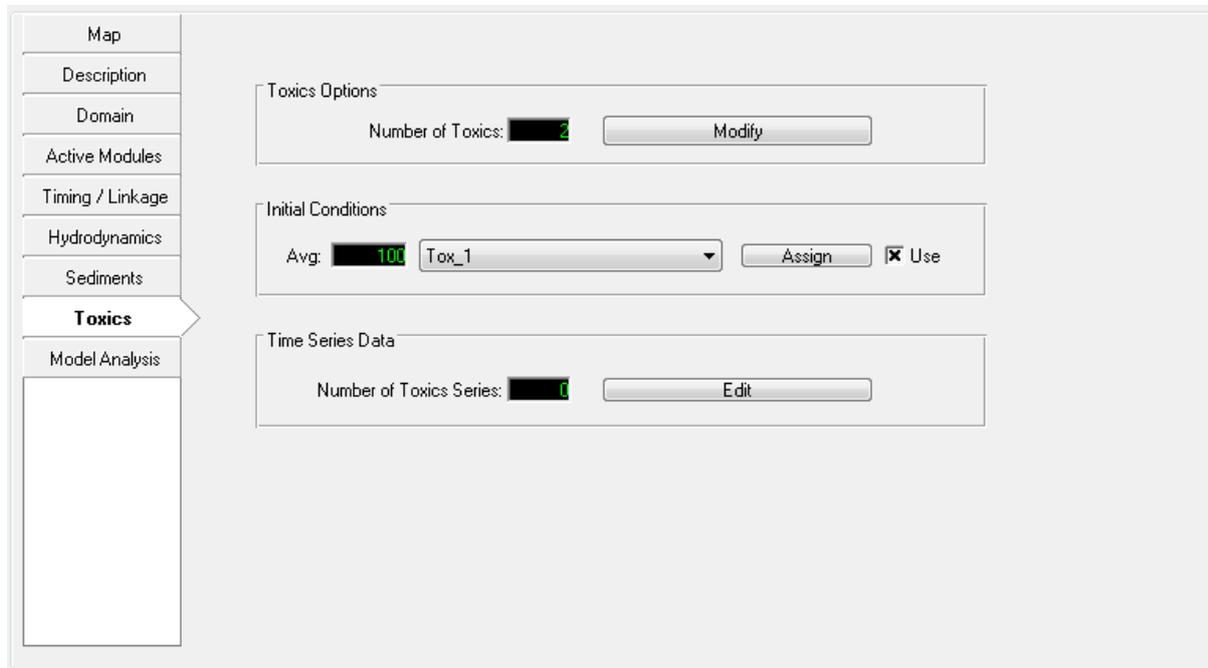


Figure 5-92 Toxics Tab

5.13.1. Toxic Transport Options

The toxic transport parameters and options are set using the form shown in Figure 5-93. The number of toxics included in the simulation are displayed in the top frame titled *Major Settings*. This can be changed by the user, but since boundary and initial conditions are predicated on the number of toxics, changing this value resets many of the toxics inputs. Therefore, this should only be changed when the user is prepared to reset all the initial and boundary conditions. A special case here is if the user sets the number to 0; then the toxics inputs are skipped for that project from that time forward.

To enable the simulation of Toxics you need to select *Compute Toxics* checkbox or set the simulate toxics (ISTRAN(5) = 1) under the *Active Modules* tab.

Each toxic has many of its own settings so the user must first select the toxic to be edited/entered by using the drop down list in the upper left corner of the *Toxic Transport Parameters* frame. Once a toxic has been selected all the appropriate information is displayed on the form. The *Toxic Name* field is only used by EFDC_Explorer for labeling and information.

The series of tabs allow the user to define the toxics parameters in detail. In the *Partition Coefficients* tab the user should select the sorption model to be implemented from the radial buttons available, which include: Simple Kd; DOC and fraction of organic carbon x TSS (POC); DOC and POC; and fraction of organic carbon x TSS only. The contents of the grid (i.e., field) will change based on the partitioning model selected.

The partitioning factors and the concentration factors units must be consistent. Typical units for the toxic concentrations are mg/kg or µg/kg.

Toxics and Sediment Bed Toxic Properties

Major Settings

Compute Toxics # Toxics: **Warning!**
Changing this may cause loss of currently defined initial and boundary conditions.

Toxic Transport Parameters

Toxic 1 Toxic Name:

Loss Terms & Diffusion Assignments

Partition Coefficients Initial Conditions

Sorption Model

Simple Kd DOC and POC
 POC Only, foc*TSS Dependent DOC & foc*TSS (POC)

Parameter	Co 1	NCo 1	NCo 2	DOC
WC Partition Coeff (l/mg)	0.00291	0.00291	0.00291	0.00291
WC Solids Based Flag (0 or 1)	1	1	1	NA
WC Solids Exponent (if Flag=1)	1	1	1	NA
Bed Partition Coeff (l/mg)	0.0218	0.0218	0.0218	0.0218

foc's	Co 1	NCo 1	NCo 2
Water Column	0.1	0.05	0.05
Sediment Bed	0.1	0.05	0.05

Figure 5-93 Toxic Transport Options.

The *Initial Conditions and Other Parameters* tab is shown in Figure 5-94. From this tab the user may set the Sediment/Water Column Interface Pore Water Diffusion rate. The Initial Conditions relating may also be assigned: for spatially varying water column (requires TOXW.INP file); spatially varying bed conditions (requires in TOXB.INP file); and spatially variance for both bed conditions and water column (requires both TOXW.INP and TOXB.INPO).

Toxics and Sediment Bed Toxic Properties

Major Settings

Compute Toxics # Toxics: 3 **Warning!**
Changing this may cause loss of currently defined initial and boundary conditions.

Toxic Transport Parameters

Toxic 1 Toxic Name: Pesticides

Loss Terms & Diffusion Assignments

Partition Coefficients **Initial Conditions**

Initial Condition Options (Global for ALL Toxics)

Constant Water Column and Bed
 Spatially Varying Water Column
 Spatially Varying Bed Conditions
 Spatially Varying Bed & Water Column

Bed Mass Specification Water Column Constant IC

Total Concentration (ug/l)
 Mass Tox/Sed (mg/kg)

Bed Toxic IC: 0.2 WC Toxic IC: 0.3

Cancel OK

Figure 5-94 IC and Other Parameters - Toxic Transport Options.

The *Assignments* tab is shown in Figure 5-95. The water column DOC may be set to constant or vary spatially, in which latter case the user should use the DOCW.INP file to assign the constant time – spatially varying DOC. If the Sediment Bed DOC is set to spatial variance, then the user must use the DOCB.INP file to assign the constant time – spatially varying DOC.

In the case of the Water Column POC, if set to Spatial Varying POC the user should use the POCW.INP file to assign the constant time – spatially varying POC. The spatially varying POC with fPOC option uses WC Seds and fPOC (Seds). The spatially varying POC/fPOC option uses WSeds and spatially varying fPOC from the FPOCW.INP file.

For the Sediment Bed POC, if set to Spatial Varying POC the user should use the POCB.INP file to assign the constant time – spatially varying POC. The spatially varying POC with fPOC option uses the bed sediments and fPOC (bed). The spatially varying POC/fPOC option uses WCSeds and spatially varying fPOC from the FPOCB.INP file. The Functional Specification of POC option means the user must modify the EFDC subroutine SETFPOCB to set POC in the bed.

Toxics and Sediment Bed Toxic Properties

Major Settings

Compute Toxics # Toxics: 3 **Warning!**
Changing this may cause loss of currently defined initial and boundary conditions.

Toxic Transport Parameters

Toxic 1 Toxic Name: Pesticides

Partition Coefficients Loss Terms & Diffusion	Initial Conditions Assignments:
<p>Water Column DOC</p> <p><input type="radio"/> Constant DOC: 6 g/m3</p> <p><input checked="" type="radio"/> Spatially Vary</p>	<p>Sediment Bed DOC</p> <p><input checked="" type="radio"/> Constant DOC: 10 g/m3</p> <p><input type="radio"/> Spatially Vary</p>
<p>Water Column POC</p> <p><input type="radio"/> Constant POC: 3 g/m3</p> <p><input type="radio"/> Spatially Vary POC</p> <p><input checked="" type="radio"/> Spatially Vary POC w/ fPOC</p> <p><input type="radio"/> Spatially Vary POC/fPOC</p> <p><input type="radio"/> Func Specification of POC</p>	<p>Sediment Bed POC</p> <p><input type="radio"/> Constant POC: 5 g/m3</p> <p><input type="radio"/> Spatially Vary POC</p> <p><input checked="" type="radio"/> Spatially Vary POC w/ fPOC</p> <p><input type="radio"/> Spatially Vary POC/fPOC</p> <p><input type="radio"/> Func Specification of POC</p>

Cancel OK

Figure 5-95 Assignments - Toxic Transport Options.

5.14 Sediments Tab

If the user has selected the *Active Cohesive Sediments* or the *Activate Non-Cohesive Sediments* checkboxes in the *Active Modules* tab the Sediments tab will be displayed as shown in Figure 5-96.

As described in Section 5.4, the user should have already determined the sediment model intended to be used. Two sediment models are available, though the SEDZLJ Sediment sub-model is only partially implemented in EFDC_Explorer. EFDC_Explorer can display SEDZLJ results including sediment fluxes and active layer thicknesses. The user may also display the input data in *ViewPlan*. However, at this time, the user cannot create or edit the input data. The user should build the SEDZLJ model external to EE and may refer to the SEDZLJ input file formats provided in the appendices to this manual to aid this.

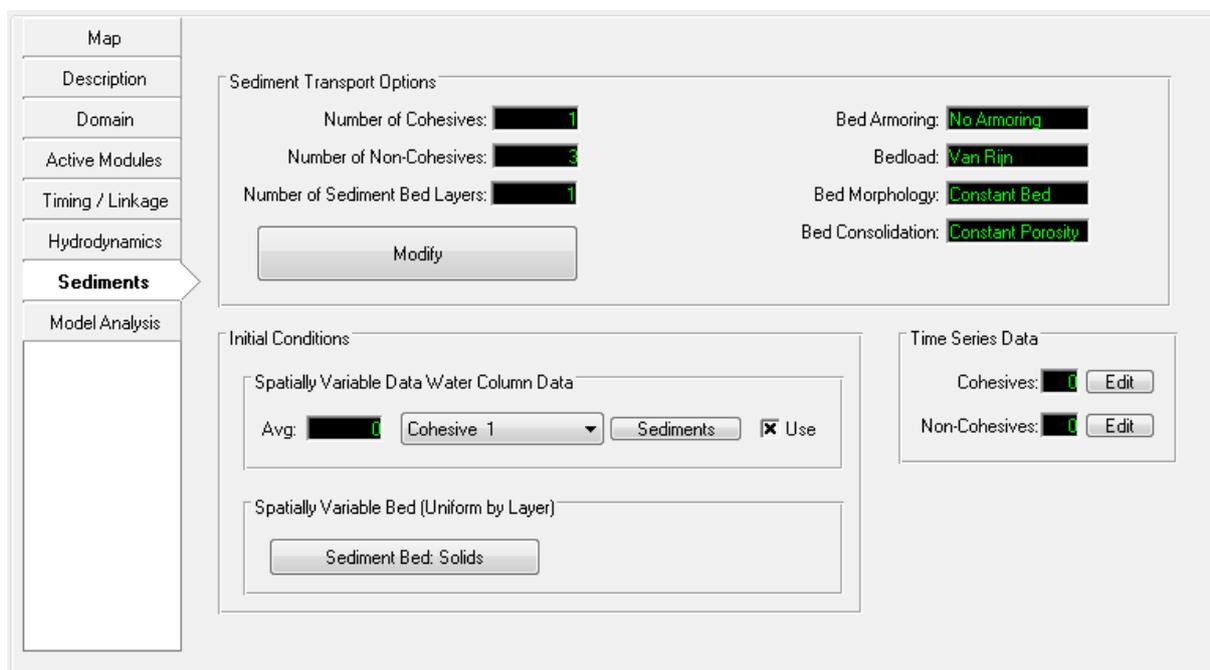
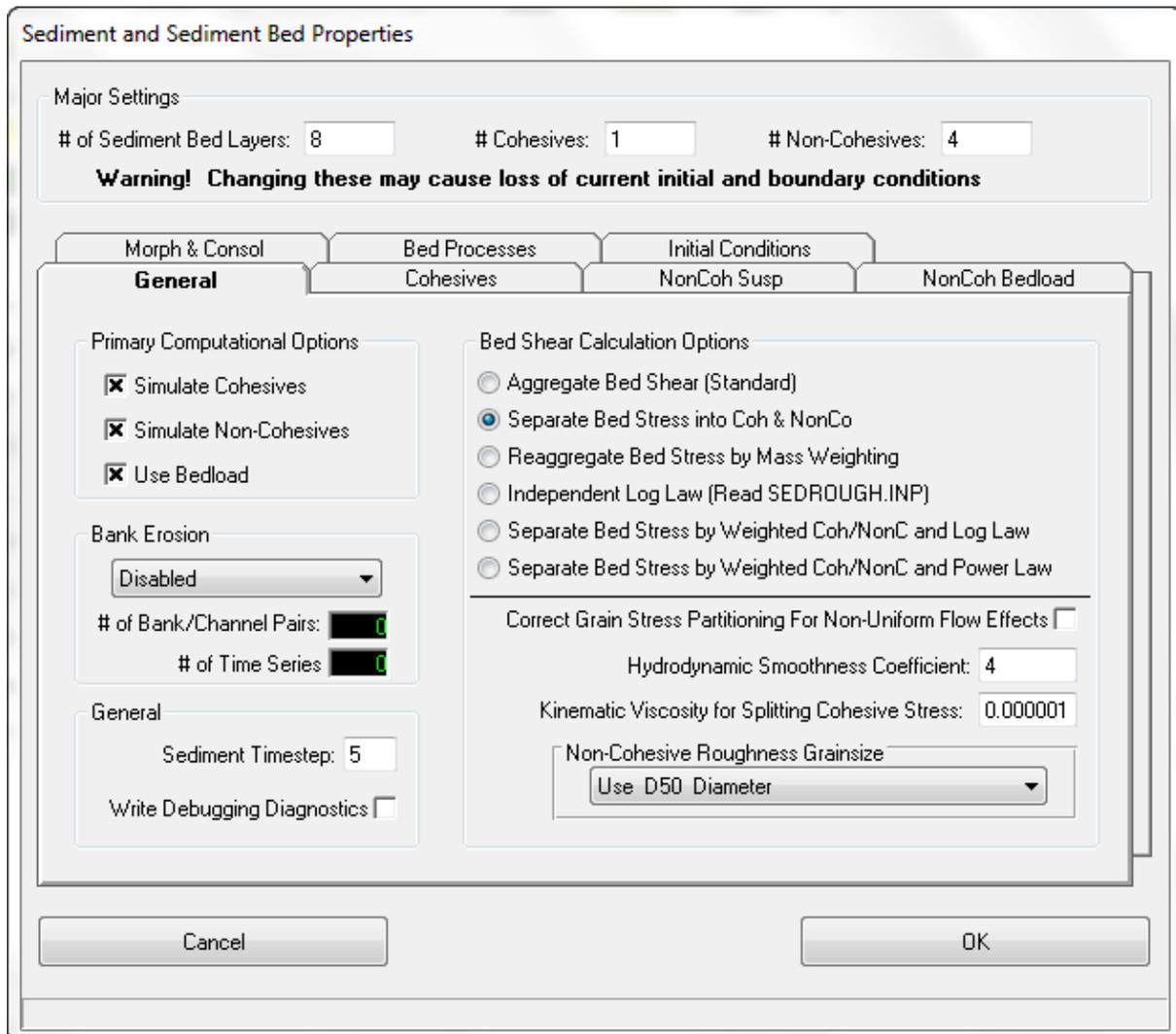


Figure 5-96 Sediments Tab.

5.14.1. Sediment Transport Options

The sediment transport parameters and options are set using the *Modify* button, which forms shown in Figure 5-97 to Figure 5-103.

The user also has further option for setting the sediment bed with EE's *Sediment Bed Initialization Tools*. These are described in detail in the *ViewPlan* discussion (Section 7.6.9.1).



The screenshot shows the 'Sediment and Sediment Bed Properties' dialog box with the 'General' tab selected. The 'Major Settings' section at the top shows '# of Sediment Bed Layers: 8', '# Cohesives: 1', and '# Non-Cohesives: 4'. A warning message states: 'Warning! Changing these may cause loss of current initial and boundary conditions'. Below this are four sub-tabs: 'Morph & Consol', 'Bed Processes', 'Initial Conditions', and 'NonCoh Bedload'. The 'General' sub-tab is active and contains two main sections: 'Primary Computational Options' and 'Bed Shear Calculation Options'. 'Primary Computational Options' includes checked boxes for 'Simulate Cohesives', 'Simulate Non-Cohesives', and 'Use Bedload'. 'Bed Shear Calculation Options' includes radio buttons for 'Aggregate Bed Shear (Standard)', 'Separate Bed Stress into Coh & NonCo' (selected), 'Reaggregate Bed Stress by Mass Weighting', 'Independent Log Law (Read SEDROUGH.INP)', 'Separate Bed Stress by Weighted Coh/NonC and Log Law', and 'Separate Bed Stress by Weighted Coh/NonC and Power Law'. Other options include 'Bank Erosion' (set to 'Disabled'), '# of Bank/Channel Pairs' (2), '# of Time Series' (2), 'Sediment Timestep' (5), 'Write Debugging Diagnostics' (unchecked), 'Correct Grain Stress Partitioning For Non-Uniform Flow Effects' (unchecked), 'Hydrodynamic Smoothness Coefficient' (4), 'Kinematic Viscosity for Splitting Cohesive Stress' (0.000001), and 'Non-Cohesive Roughness Grainsize' (set to 'Use D50 Diameter'). 'Cancel' and 'OK' buttons are at the bottom.

Figure 5-97 Sediment Transport – General.

5.14.1.1 *General Tab - Sediments*

The principal settings for the number of sediment classes and bed layers are specified in the top frame under *Major Settings* as shown in Figure 5-97. The user should define the number of sediment bed layers, cohesive and non-cohesive sediments. However, as with the toxics, these *Major Settings* parameters should only be changed with care and usually early in the model calibration process so as not to lose your initial and boundary conditions.

In the *General* tab the user can tell EFDC whether or not to simulate cohesives and/or non-cohesives and the approach to compute bed shear stresses for sediment transport. Unchecking the *Simulate Cohesives* and/or *Simulate Non-Cohesives* check box does not delete previously defined sediment transport parameters, it just turns off the EFDC computations for that parameter.

The *Sediment Timestep* is a multiple of the number of hydrodynamic time steps to calculate between each sediment bed process computation (i.e. deposition, erosion, consolidation, etc.). Because the bed processes are slow, relative to the hydrodynamics, this number can often be 10 or greater. The user should conduct testing by starting with a low number and increase the *Sediment Timestep* until the user detects a noticeable difference in the model results. Then the number should be reduced by some amount in order to provide a safety factor. This can then be used for the subsequent calibration and production runs.

The *Bed Shear Calculation Options* allows the user to choose from a number of different calculation options for bed shear stress computations. If non-cohesive and cohesive calculations are being performed, it is generally preferred to use the *Separate Bed Stress in Coh & NonCo* option.

5.14.1.2 Cohesives Tab - Sediments

Figure 5-98 shows an example of the *Cohesives* tab in the *Sediment Transport* form. The user should specify the *Cohesive Settling Flag* where: 0-Simple; 1-Huang and Metha; 2-Shresta and Orlob; 3-Ziegler and Nesbit; 98-Lick Flocculation; 99-Lick Flocculation with Advective. If the *Apply Vertical Diffusion* check box is selected then vertical diffusion will be applied to the cohesives. When the *Use Bulk (Mass) Erosion* check box is selected the bulk erosion critical stress and rate will be used in the functions CSEDTAUB and CEDRESSB (still experimental at this time).

The number of columns shown in the input parameter grid varies with the number of classes to be modeled. The Diameter setting located at the bottom of the parameter grid sets the grain size that will be used in calculating d_{50} 's for the sediment bed. It is not used for any other calculations.

Maximum and minimum *Cohesives Fluid Concentrations* may be set by the user. Checking the *Use Fluid Mud* checkbox will include cohesive fluid mud viscous effects using function CDEVIS (SEDT).

For many of the fields in the *Erosion & Deposition Parameters* grid, clicking on a cell and pressing F2 pops up helpful information for that field.

Sediment and Sediment Bed Properties

Major Settings

of Sediment Bed Layers: 8 # Cohesives: 1 # Non-Cohesives: 4

Warning! Changing these may cause loss of current initial and boundary conditions

Morph & Consol Bed Processes Initial Conditions

General **Cohesives** NonCoh Susp NonCoh Bedload

Cohesive Settling Flag: 0

Apply Vertical Diffusion

Cohesive Armoring

Use Bulk (Mass) Erosion

Cohesive Fluids Concentration

Use Fluid Mud

Min: 10000 (mg/l)

Max: 50000 (mg/l)

Erosion & Deposition Parameters

Parameter	Coh1
IC W/C Conc (mg/l)	10
IC Bed Mass (g/m2 per layer)	25000
Specific Vol (m3/g)	4.4000e-7
Specific Gravity	2.65
Settling Vel (m/s)	0.0001
Tau Critical-Deposition (m2/s2)	0.001
Tau Critical-Erosion (m2/s2)	0.002
Ref. Surf Erosion Rate (g/m2/s)	0.001
Erosion Exponent	1
Surface Erosion Opt [IWRSP] (0-3)	0
Reference Void Ratio [IWRSP=2,3]	0
Cohesive Hiding Factor Exponent	0
Correct Bottom Layer Conc (0-1)	0
Probability of Deposition (0-3)	0
Diameter (um) [Viewing Only]	10

Cancel OK

Figure 5-98 Sediment Transport – Cohesives.

5.14.1.3 Non-Cohesives Suspended Tab - Sediments

Figure 5-99 shows the form with the *Non-Cohesives Suspended* tab shown. It is similar in function and operation to the *Cohesives* tab. Grain size for each non-cohesive class is required for the sediment transport computations. This value is also used as the grain size for the d_{50} calculations. A number of options for computing equilibrium concentrations are available in the *Equilibrium Conc* frame. This includes the option of equilibrium concentrations calculated from Sedflume data with or without critical shear stress. Setting the settling velocity or the critical shear stress values to numbers <0 results in EFDC computing those parameters values using the Van Rijn equations (1984a, 1984b).

Pressing F2 for help pops up information relevant to the current input field.

The *Sediment Info* button provides a sediment properties calculator which uses the Van Rijn equations to compute the critical stress and setting parameters. Pressing the *Set Parameters* button will initialize the sediment properties using the Van Rijn equations if the sediment diameter is specified prior to pressing the button.

Sediment and Sediment Bed Properties

Major Settings
 # of Sediment Bed Layers: 8 # Cohesives: 1 # Non-Cohesives: 4
Warning! Changing these may cause loss of current initial and boundary conditions

Morph & Consol Bed Processes Initial Conditions
 General Cohesives **NonCoh Susp** NonCoh Bedload

Settling Flag: 0
 Apply Vertical Diffusion

Equilibrium Conc
 Direct Input
 Garcia & Parker
 Van Rijn
 Smith & McLean
 Sedflume w/o CS
 Sedflume with CS

Incipient Motion Data
 Sediment Info
 Set Parameters

Erosion & Deposition Parameters

Parameter	NonCo1	NonCo2	NonCo3
IC WC Conc (mg/l)	5	0	0
IC Bed Mass (g/m ² per layer)	10070	10070	10070
Specific Vol (m ³ /g)	3.7736e-7	3.7736e-7	3.7736e-7
Specific Gravity	2.65	2.65	2.65
Settling Vel (m/s) [<0-VanRijn]	0.01351	0.05925	0.102
Median Diameter (micron)	135	400	800
rit Shear Stress (m ² /s ²) [<0-VanRijn]	0.0001535	0.0002054	0.0004026
Critical Shields Stress	0.0703	0.0317	0.0311
G&P Initiate Resusp Opt (1-3)	1	1	1
E&H Initiate Bedload Opt (1-3)	1	1	1
Rouse Number Calc Opt (0-1)	0	0	0
Transport Frac Main Opt (0-4)	0	0	0
Transport Frac Shear Opt (0-1)	0	0	0
Transport Frac RSNDM Switch	0	0	0

Cancel OK

Figure 5-99 Sediment Transport – Non-Cohesives Suspended.

5.14.1.4 Non-Cohesives Bedload - Sediments

Figure 5-100 shows the tab for the *Non-Cohesives Bedload*. The use of the Gamma parameters varies slightly between the different EFDC codes. The user should know how the Gamma's are used by reviewing the code prior to finalizing the desired inputs.

Pressing the *Initialize Constants* button will bring up a dialog box asking the user to select the bedload approach to use. EFDC_Explorer sets the bed load transport constants to standard literature values for the computational approach selected. The user should know how the Gamma's are used by reviewing the code prior to finalizing the desired inputs.

The *Bedload Phi Options* frame allows the user to choose from the following options Constant/Manual, Van Rijn, Engelund-Hansen, and Wu, Wang &Jia.

The *Cell Face Transport Rate Option* allows calculation based on the following options: Downwind Projection; Downwind Projection with Corner Correction; and by Averaging Vector Components. The *Maximum Allowable Adverse Slope for Bedload* setting will prevent bedload movement if cell to cell slope is > BLBSNT when BLBSNT is > 0.

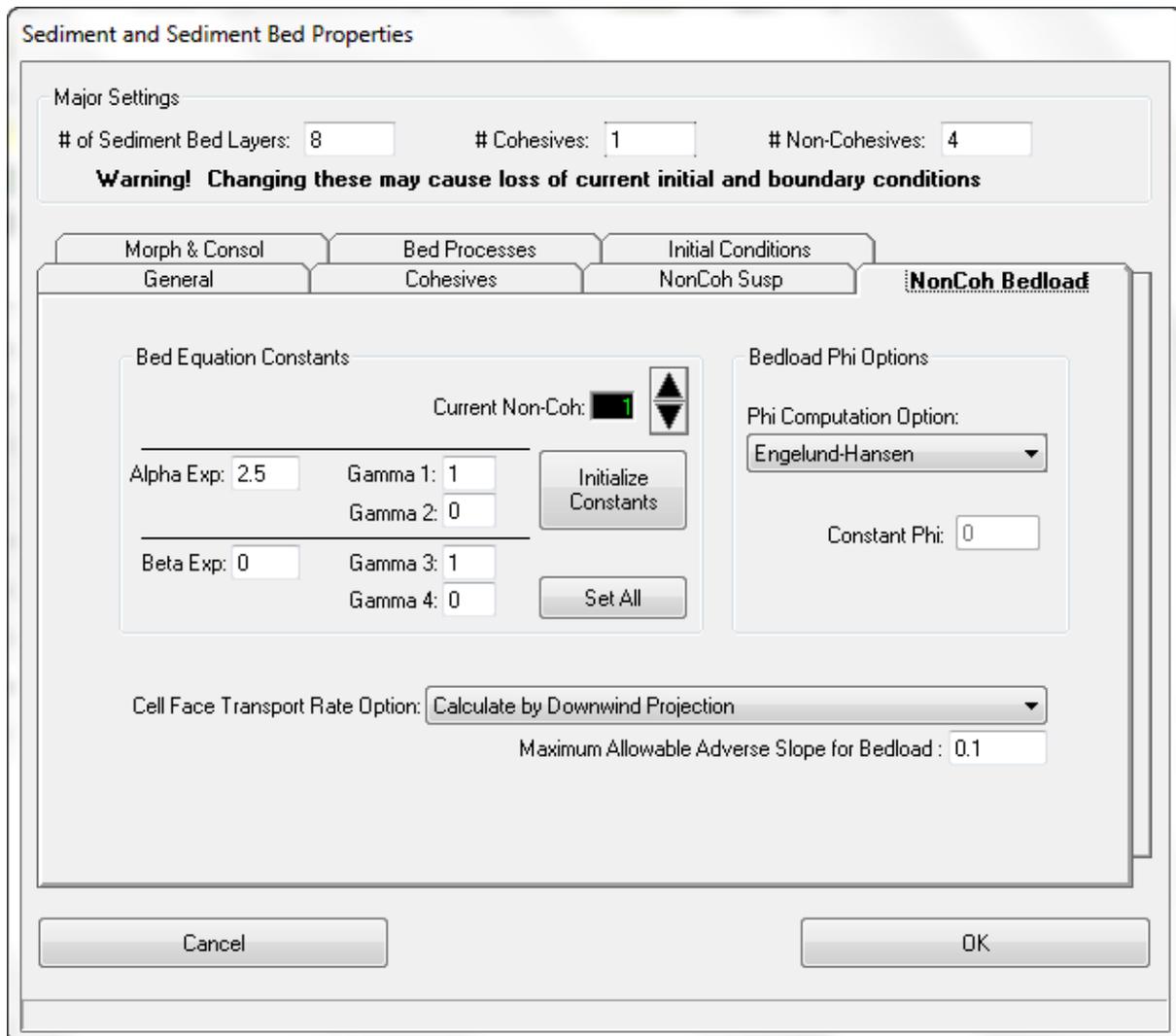


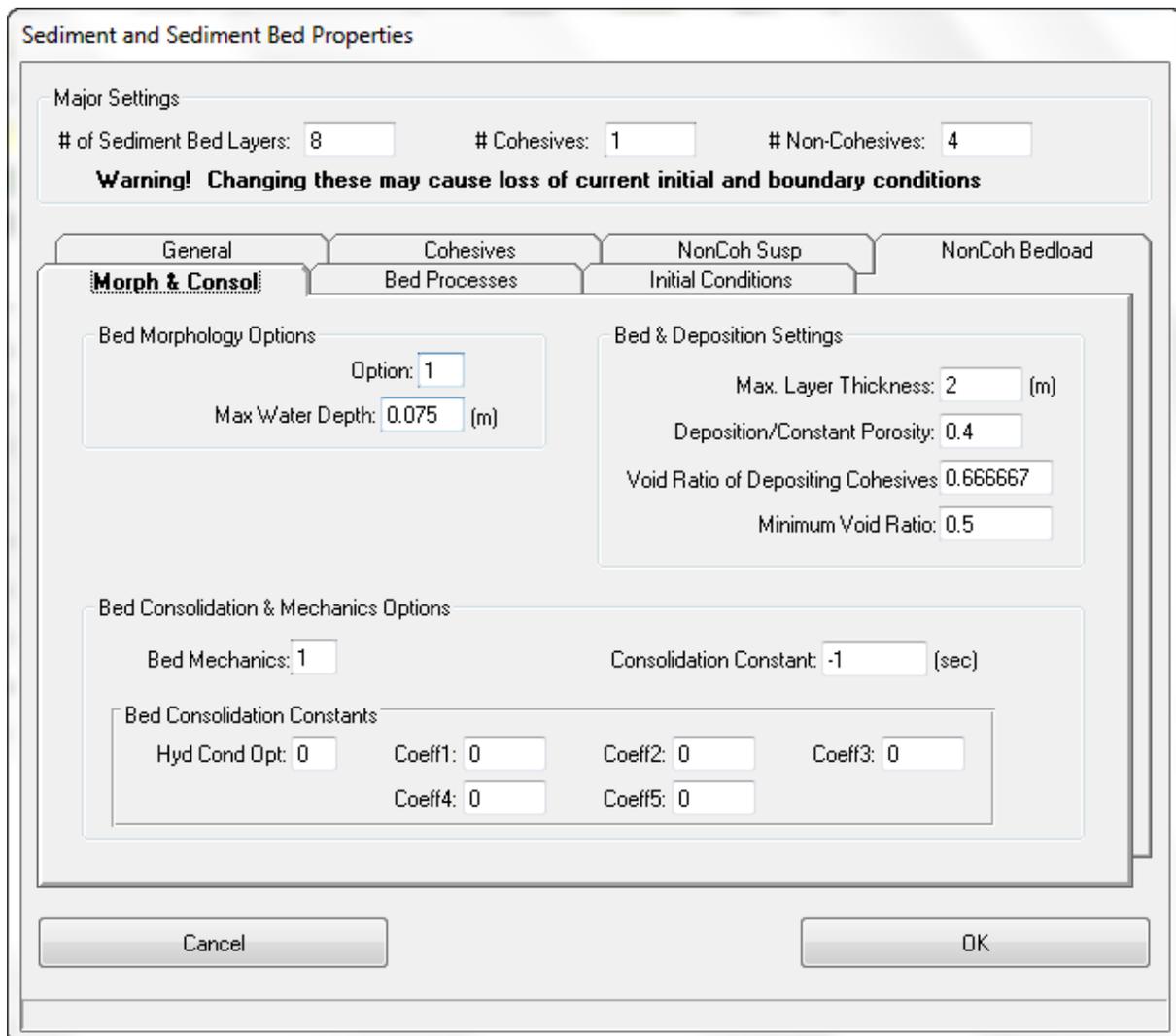
Figure 5-100 Sediment Transport – Non-Cohesives Bedload.

5.14.1.5 Morphology and Consolidation Tab - Sediments

Figure 5-101 shows the tab for the *Morphology & Consolidation* of the sediment properties option. In this tab the user may specify various bed consolidation and bed morphology settings.

The *Bed Morphology Options* form allows the user to choose between no bed changes (option 0) and allowing bed elevation changes (option 1). The *Max. Water Depth* is the maximum allowable depth to allow for the “lost” due to “NEG DEPTH” morphological change (EFDCPlus version only).

Bed Consolidation & Mechanics Options frame provides input to the main sediment bed consolidation options. The *Bed Mechanics* option must be 0-None, 1-Simple, or 2-Finite Strain. Option 2 is very a specialized approach and requires a detailed understanding of the of the Finite Strain implementation in the FORTRAN code. The consolidation rate is in seconds, not 1/seconds as earlier versions of EFDC.INP reported. The rate will usually be >100,000 seconds. The impact of the rate of consolidation can easily be tested using EFDC_Explorer’s *Single Column Sediment Layers* post-processing function (see Section 6.5.2).



Sediment and Sediment Bed Properties

Major Settings

of Sediment Bed Layers: 8 # Cohesives: 1 # Non-Cohesives: 4

Warning! Changing these may cause loss of current initial and boundary conditions

General Cohesives NonCoh Susp NonCoh Bedload

Morph & Consol Bed Processes Initial Conditions

Bed Morphology Options

Option: 1

Max Water Depth: 0.075 (m)

Bed & Deposition Settings

Max. Layer Thickness: 2 (m)

Deposition/Constant Porosity: 0.4

Void Ratio of Depositing Cohesives: 0.666667

Minimum Void Ratio: 0.5

Bed Consolidation & Mechanics Options

Bed Mechanics: 1 Consolidation Constant: -1 (sec)

Bed Consolidation Constants

Hyd Cond Opt: 0 Coeff1: 0 Coeff2: 0 Coeff3: 0

Coeff4: 0 Coeff5: 0

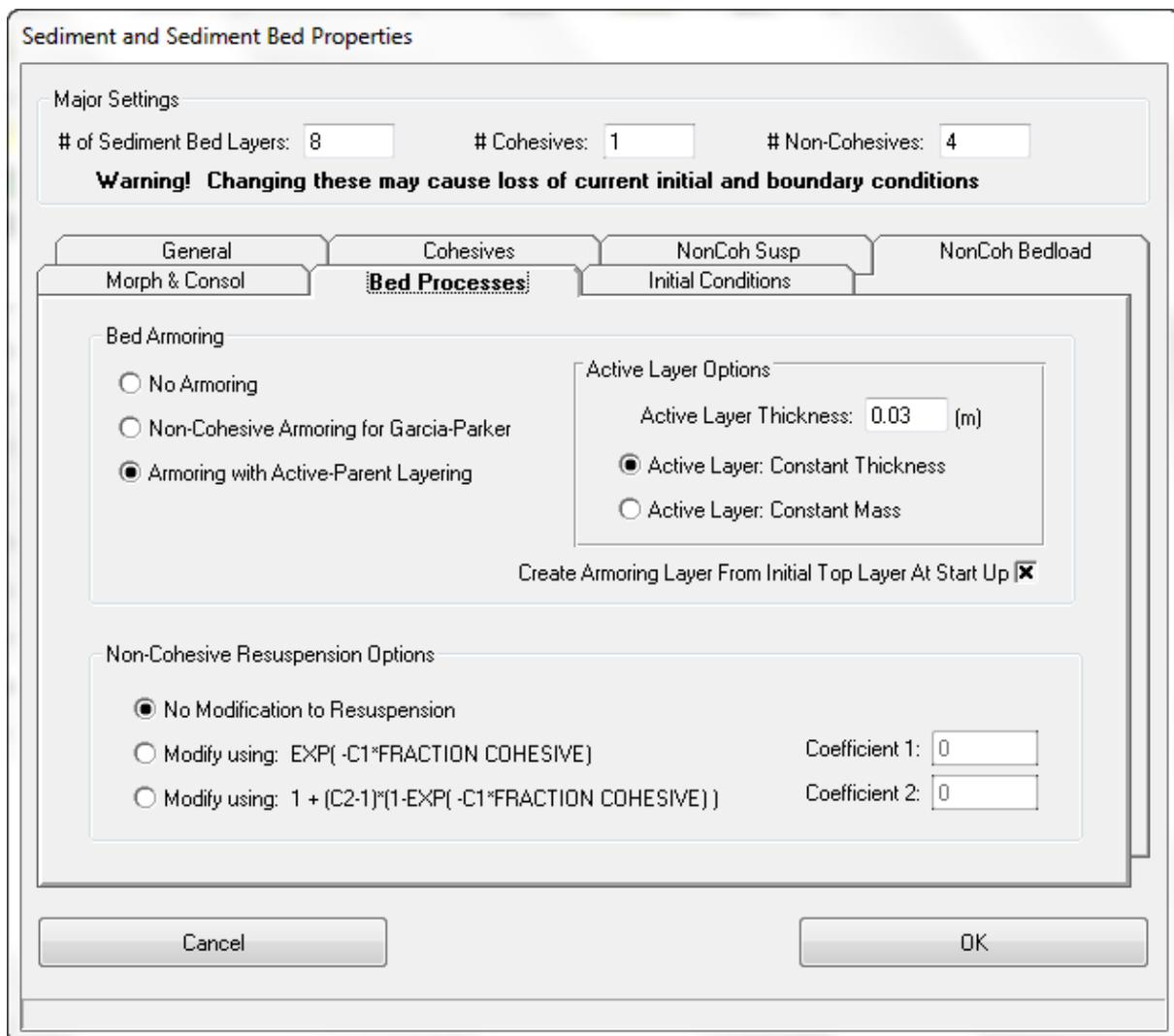
Cancel OK

Figure 5-101 Sediment Transport – Morphology and Consolidation.

5.14.1.6 Bed Processes – Sediments

The user options for the Bed processes tab are shown in Figure 5-102. EFDC_Explorer now employs bed armoring functionality, allowing the user the options of: No Armoring; Non-Cohesive Armoring for Garcia-Parker; and Armoring with Active Parent Layering. The layer options frame is displayed based on which armoring option is selected. For the case of armoring with Active-Parent layering, the user needs to specify an active layer thickness, usually <5 cm but based on the d_{50} 's, and whether the active layer is controlled by mass or thickness. EFDC can optionally initialize the active layer using the initial condition bed layering. This is a good approach for initial setup of a model when the bed configuration is not well defined.

The user may also specify the *Non-Cohesive Resuspension Options*, with a choice of modifications based on coefficients input by the user. This option modifies the critical shear stress for resuspension (i.e TAUR) based on the fraction of cohesives.



Sediment and Sediment Bed Properties

Major Settings
 # of Sediment Bed Layers: 8 # Cohesives: 1 # Non-Cohesives: 4
Warning! Changing these may cause loss of current initial and boundary conditions

General Cohesives NonCoh Susp NonCoh Bedload
 Morph & Consol **Bed Processes** Initial Conditions

Bed Armoring
 No Armoring
 Non-Cohesive Armoring for Garcia-Parker
 Armoring with Active-Parent Layering

Active Layer Options
 Active Layer Thickness: 0.03 (m)
 Active Layer: Constant Thickness
 Active Layer: Constant Mass

Create Armoring Layer From Initial Top Layer At Start Up

Non-Cohesive Resuspension Options
 No Modification to Resuspension
 Modify using: $\text{EXP}(-C1 \cdot \text{FRACTION COHESIVE})$ Coefficient 1: 0
 Modify using: $1 + (C2-1) \cdot (1 - \text{EXP}(-C1 \cdot \text{FRACTION COHESIVE}))$ Coefficient 2: 0

Cancel OK

Figure 5-102 Sediment Transport – Bed Processes.

5.14.1.7 Initial Conditions Tab - Sediments

Figure 5-103 shows the sediment parameters form with the *Initial Conditions* tab selected. On this form the user selects how they would like to initialize the bed sediments for the model. This is done by selecting the option from the *Sediment Initial Conditions Options* frame. These options include: Constant Water Column and Bed; Spatially Varying Water Column; Spatially Varying Bed Conditions; and Spatially Varying Bed and Water Column.

If the user elects to set the *Bed Mass Specification Option* to specify the mass fraction, then the BEDLAY.INP will be required as an additional IC file.

Sediment and Sediment Bed Properties

Major Settings
 # of Sediment Bed Layers: 8 # Cohesives: 1 # Non-Cohesives: 4
Warning! Changing these may cause loss of current initial and boundary conditions

General Cohesives NonCoh Susp NonCoh Bedload
 Morph & Consol Bed Processes **Initial Conditions**

Sediment Initial Condition Options
 Constant Water Column and Bed Spatially Varying Bed Conditions
 Spatially Varying Water Column Spatially Varying Bed & WC
 Bed Mass Specification Options
 Specify Mass/Area
 Specify Mass Fraction

Initialization of Sediment Beds
 Use Polygon DSM Use Sediment Cores with Grainsize
 File: E:\EFDC_Explorer Modeling System\Testing\DS members\Bac Paul\Tra Khuc\Soil Analysis Data

	Max (um)		Number of Initial Layers: 1	Minimum Layer Thickness (m): 0.2
1	75			
2	250			
3	500			
4	1000			

 Constant Porosity: .4 Use Constant Porosity

Figure 5-103 Sediment Transport – Initial Conditions.

To set up a simple horizontally uniform sediment bed for the model the user can select the *Create Uniform Bed* option. This brings up a dialog form that asks the user to input the number of layers, the number and types of sediments, and allows the user to specify the sediment fractions, thickness, and bulk densities for each layer. The user must still set the cohesive and non-cohesive erosion & deposition parameters, but once the user finishes this option, the sediment bed configuration is ready for EFDC.

5.14.2. Initial Conditions Settings

The *Spatially Variable Water Column Data* frame contains settings for the various classes defined. The *Sediments* button allows the user to set up the inorganic sediment bed for uniform layers as shown in Figure 5-104. In the *Sediment Information* frame the user may set the number of sediments and how many of those are cohesive. The user may then define the sediment information for each of these classes of cohesive and non-cohesive sediment.

In the *Bed Layer Settings* frame the user may specify the number of bed layers and subsequently the thickness, porosity (thus void ratio) and mass distribution by layer. Once the sediment bed is generated the user can modify the sediment bed properties in *ViewPlan*, as needed. The layer configuration settings can be saved and later retrieved using the *Save* and the *Load* buttons in the *Bed Properties Definitions* frame.

Inorganic Sediment Bed Constructor: Uniform Layers

Sediment Information

Sediments: # Cohesives: # Non-Cohesives:

	Co1	NonCo1	NonCo2	NonCo3	NonCo4
Diameter (um):	30	135	400	800	2000
Specific Grav:	2.65	2.65	2.65	2.65	2.65

Bed Properties Definitions

Project Name:

Bed Layer Settings

Number of Bed Layers:

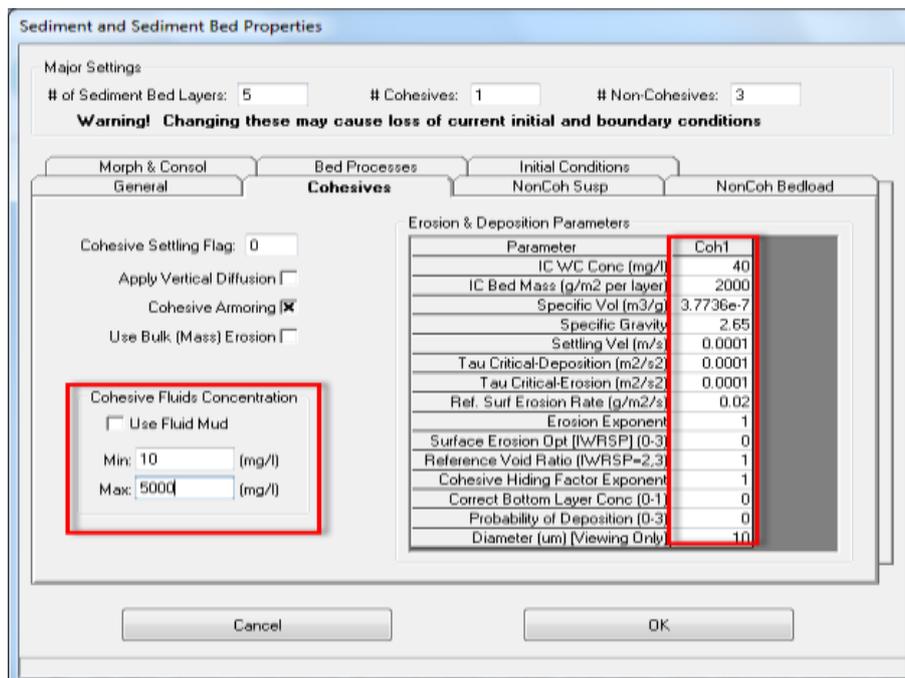
	Thick (m)	Porosity	FracCo1	FracNonCo1	FracNonCo2	FracNonCo3	FracNonCo4	Layer Densities (kg/m3)	
								Bulk/Wet	Dry
Layer8	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530
Layer7	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530
Layer6	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530
Layer5	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530
Layer4	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530
Layer3	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530
Layer2	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530
Layer1	0.5	0.8	0.2	0.2	0.2	0.2	0.2	1330	530

Figure 5-104 Uniform sediment bed generation tool.

5.14.3. Steps To Set up a Sediment Bed Model:

1. Enter the *Sed/Tox/Others* Tab and click on the *Modify* button in the *Sediment and Sediment Bed Settings* frame.
2. Define the number of sediment bed layers, cohesive and non-cohesive sediments as shown in *Major Settings* of Figure 5-97 (it is important do this first to avoid losing data).
3. Set the options in the *General* tab for the *Primary Computational Options* and the *Bed Shear Calculation Options*.
4. In *Cohesive* tab the user should enter the appropriate values for the relative parameters as well as defining the minimum and maximum values of Cohesive Fluids Concentration as shown in Figure 5-105.

5. In the *Non-Cohesive Suspended Load* Tab the user should define the Equilibrium Concentration Option and enter the appropriate values for the relative parameters and non-cohesive layers.
6. In the *Non-cohesive Bed Load* Tab the user should click on *Initialize Constants* button and enter the number for the approaches desired e.g. enter “1” for the Van Rijn approach.
7. In the *Morphology & Consolidation* Tab the user should select the Bed Morphology Options: 0-No Bed Change, 1-Allow Bed Changes. The user should also set the Max Layer Thickness and Constant Porosity to be the same values as in the input sediment file (refer to Appendix B-9 for the DSM format of the file).



Sediment and Sediment Bed Properties

Major Settings:
 # of Sediment Bed Layers: 5 # Cohesives: 1 # Non-Cohesives: 3

Warning! Changing these may cause loss of current initial and boundary conditions

General **Cohesives** NonCoh Susp NonCoh Bedload

Cohesive Settling Flag: 0
 Apply Vertical Diffusion
 Cohesive Armoring
 Use Bulk (Mass) Erosion

Cohesive Fluids Concentration
 Use Fluid Mud
 Min: 10 (mg/l)
 Max: 5000 (mg/l)

Erosion & Deposition Parameters

Parameter	Coh1
IC W/C Conc (mg/l)	40
IC Bed Mass (g/m2 per layer)	2000
Specific Vol (m3/g)	3.7736e-7
Specific Gravity	2.65
Settling Vel (m/s)	0.0001
Tau Critical-Deposition (m2/s2)	0.0001
Tau Critical-Erosion (m2/s2)	0.0001
Ref. Surf Erosion Rate (g/m2/s)	0.02
Erosion Exponent	1
Surface Erosion Opt [W/RSP] (0-3)	0
Reference Void Ratio [W/RSP-2,3]	1
Cohesive Hiding Factor Exponent	1
Correct Bottom Layer Conc (0-1)	0
Probability of Deposition (0-3)	0
Diameter (um) [Viewing Only]	10

Cancel OK

Figure 5-105 Sediment Bed Model: Cohesives Tab.

8. In the *Initial Conditions* Tab: select the *Sediment Initial Condition Options*. There are 2 options to initialize bed layers: Uniform bed and use initial data file.
9. Initialize the sediment bed from file, browse for the input sediment file
10. Check *Use sediment cores with grain size*
11. Define the maximum grain size for each size class relatively to cohesive and non-cohesive layers as displayed in the in the red frame in Figure 5-106.
12. If the required information has been entered then the *Apply* button is visible. After clicking on *Apply*, the sediment bed will be initialized.

Sediment and Sediment Bed Properties

Major Settings
 # of Sediment Bed Layers: 6 # Cohesives: 1 # Non-Cohesives: 3
Warning! Changing these may cause loss of current initial and boundary conditions

General Cohesives NonCoh Susp NonCoh Bedload
 Morph & Consol Bed Processes **Initial Conditions**

Sediment Initial Condition Options

Constant Water Column and Bed Spatially Varying Bed Conditions Bed Mass Specification Options
 Spatially Varying Water Column Spatially Varying Bed & WC
 Specify Mass/Area
 Specify Mass Fraction

Initialization of Sediment Beds

Use Polygon DSM Use Sediment Cores with Grainsize

File: ramento\CALFED\Task05\data\Sediment Bed Cores\Sediment Bed Cores-2011-08-24 Rev02.dat

	Max (um)	
1	35	
2	250	
3	1500	
4	10000	

Number of Initial Layers: 1 Minimum Layer Thickness (m): 0.2
 Constant Porosity: .4 Use Constant Porosity

Figure 5-106 Sediment Bed Model: Initial Conditions Tab.

5.14.4. Digital Sediment Model

A very useful feature in EFDC_Explorer is its ability to build the EFDC sediment files from a defined digital sediment model (DSM) that was generated by some third party package (e.g., Spatial Explorer). The DSM format requires a polygon followed by the layer thickness, bulk density, porosity and grain size distribution for each depth available (sediment depth intervals are based on data). More information on the data structure is available in Appendix B. EFDC_Explorer uses the DSM coupled with the number of size classes requested, the maximum size for each class, the number of sediment layers and the layer options (e.g., minimum layer thickness) to build the EFDC sediment files. The “Max (µm)” sediment diameters, one for each sediment class, are needed to break the sediment grainsize curves into ranges. These diameters are not the class diameters but represent the grainsize breakpoints whose geometric mean of the upper and lower limits is the corresponding sediment class’ diameter.

When the user clicks on the *Apply* button after all the inputs have been provided, EFDC_Explorer generates the sediment map in memory and then writes out the files. The current sediment map (if any) will be replaced by the new one. It is recommended that the project be saved into a new subdirectory prior to implementing this option in order to save different versions of the sediment bed configurations.

Figure 5-107 shows an example of a digital sediment model derived from sediment cores. The data contained grain size distributions by depth interval. The black diamond symbols show the locations of the cores. The plot shows the resulting depth averaged d_{50} grainsize.

The user also has many option for editing sediment cores within the *ViewPlan* form, described in detail in Section 7.6.9.

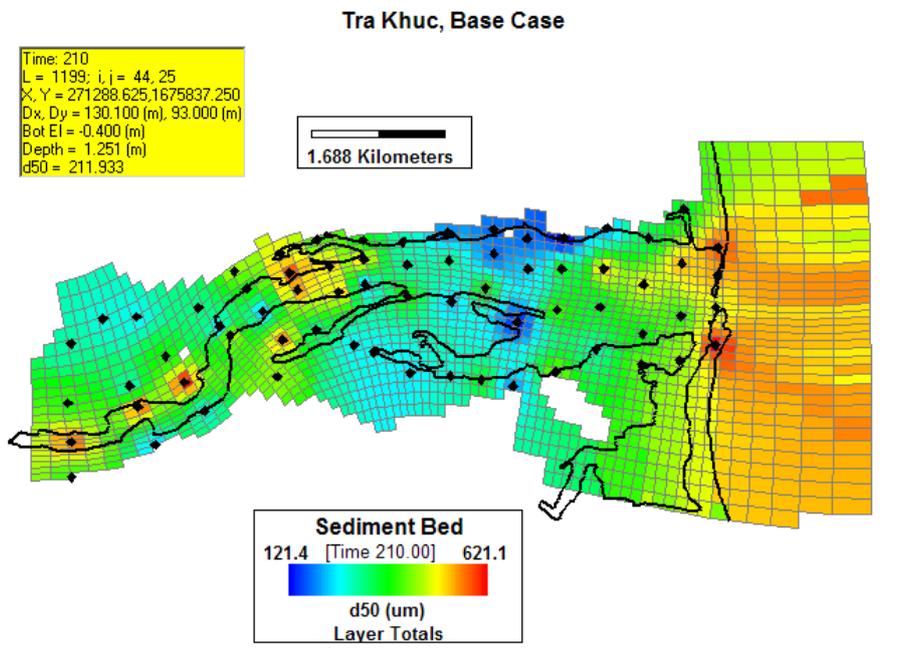


Figure 5-107 A digital sediment model generated from sediment cores with grain size.

5.15 Water Quality Tab

The water quality tabs of *WQ-General*, *Benth/Nutrients* and *Algae/WQ ICs* provide the user with a graphical user interface to the water quality sub-model of EFDC, sometimes called HEM3D (Park, et. al. 2000). The implementation of the water quality varies between versions of EFDC so the user should be aware of what is contained in the source code for their particular version of EFDC.

5.15.1. Water Quality Kinetics

The *WQ - Kinetics* tab is shown in Figure 5-108. Some of the user options include setting the Global Kinetic Options from one of several modules. For the EFDC_GVC version, the standard kinetic model is contained in Module 3 (ISWQLVL=3). While the other kinetic modules may be used (with care) when using the EFDC_GVC version in the standard sigma mode, if the GVC option is selected ONLY module 3 works. For the EFDCPlus version, the standard full kinetic module is Module 1 (ISWQLVL=1). Once the kinetic option has been chosen the user still needs to select which parameters will be varied/simulated within the selected kinetic option. Clicking the *Params* button brings up the list of parameters whose simulation (i.e. advection and dispersion) can be switched on or off. However, even if a parameter is not simulated, since it is still part of the kinetics, the IC concentration is used for all of the kinetic calculations.

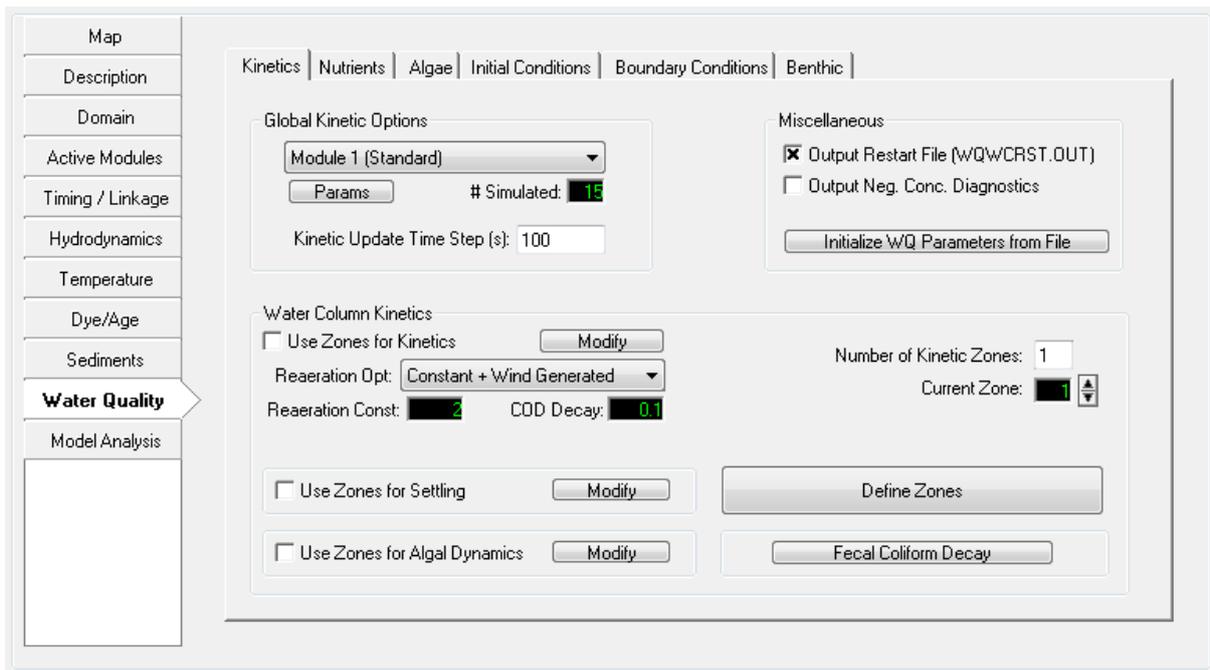


Figure 5-108 Water Quality Tab: Kinetics.

The best way to initialize the water quality sub-model is to initialize the current model using data from another EFDC_Explorer model. This is done using the “*Initialize WQ Parameters from File*” in the *Miscellaneous* frame. This operation should only be conducted once at the start of the water quality model construction. This process overwrites all of the current model’s settings.

EFDC allows for water column zones for the assignment of many of the water quality parameters. The WQ zones can be set using the *Define Zones* button or can be set in *ViewPlan* (*Water Column/Wtr Quality* then check *WQ Zones* checkbox). Clicking on the *Define Zones* button brings up the *Apply Cell Properties via Polygons* form (see Section 5.3.2.1). The user must first enter the maximum number of desired zones in the *Number of*

Kinetic Zones box. This number can be changed at any time during the model building process.

Zones are assigned by water column layer and cell, so it is possible for the same cell to have more than one zone assigned to it, if $KC > 1$. The parameters that vary by zone are shown in the frame *Water Quality Kinetics*. There are three groups of parameters that can vary by zone: Kinetics, Settling, and Algal Dynamics. For each group, the use of zones or not is separately controlled using the check boxes for that group. The specific parameters for the *Current Zone* for each group are modified by clicking on the *Modify* button.

The *Fecal Coliform Decay* button allows the user to set the decay rate and temperature effect constant.

5.15.2. Nutrients

Within the *Nutrient Options and Parameters* frame (Figure 5-109) settings for many of the basic nutrient parameters may be made. The nutrient parameters have been grouped by nutrient type and can be edited by clicking on the respective button. For example to edit the Nitrogen settings the user would click on the *Nitrogen* button.

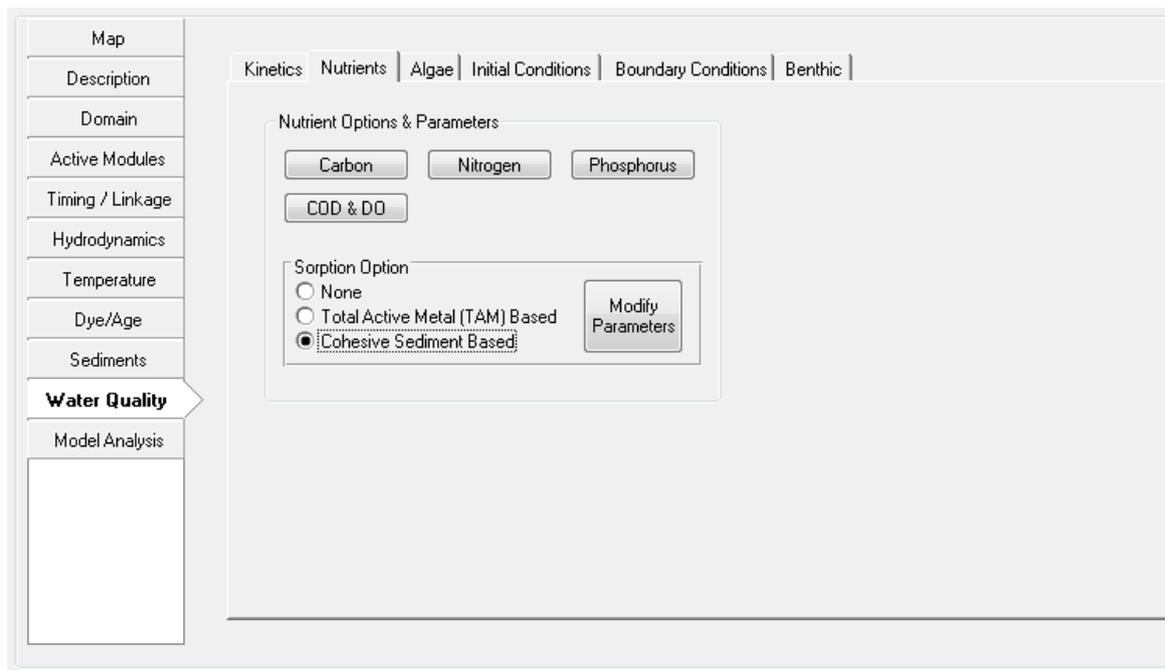


Figure 5-109 Water Quality Tab: Nutrients.

The user may also specify the *Sorption Options*. The default is “None” and parameters cannot be modified. However, if *Total Active Metal (TAM) Based* or *Cohesive Sediment Based* radial buttons are selected, the user may alter these nutrient sorption parameters with the *Modify Parameters* button.

The atmospheric wet deposition concentrations for the constituents being simulated with the kinetic module selected are edited via the *Wet Deposition* button. The dry deposition mass fluxes are edited via the *Dry Deposition* button.

5.15.3. Algae

Figure 5-110 shows the tab for *Algae/Water Quality Initial Conditions*. The *Algae Options* frame contains several buttons that, if pressed, allow the user to make adjustments to logical parameter groups. For example the *Algal Dynamics* button brings up a form as shown in Figure 5-111. This allows the user to modify the algal default or “background” algal growth rates.

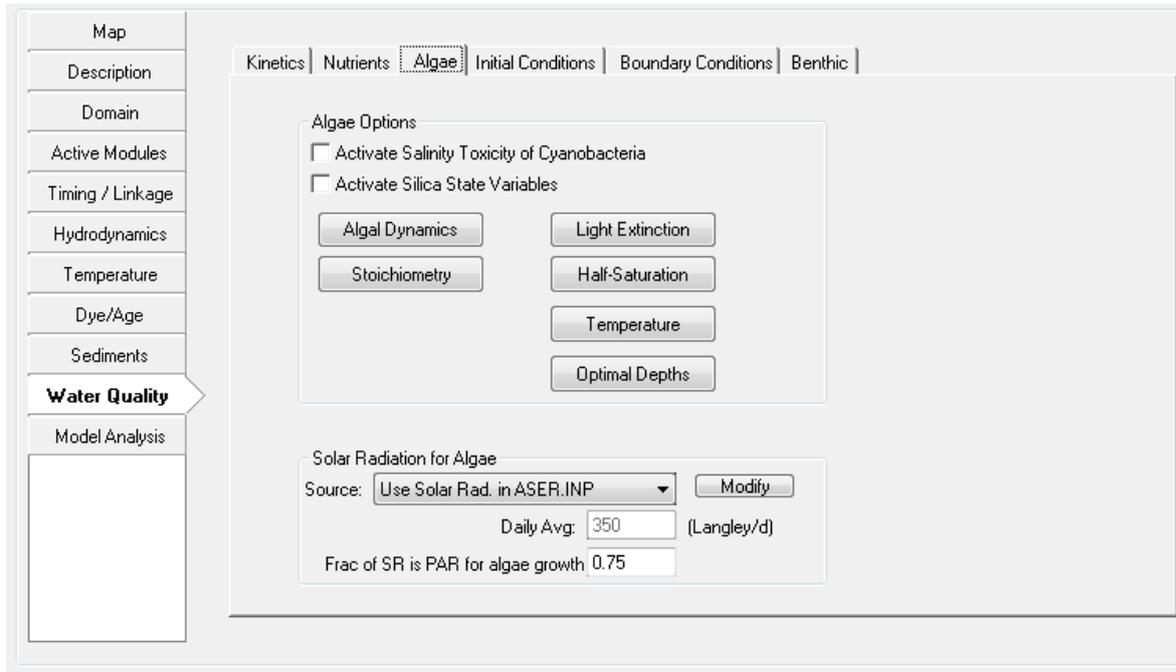


Figure 5-110 Water Quality Tab: Algae.

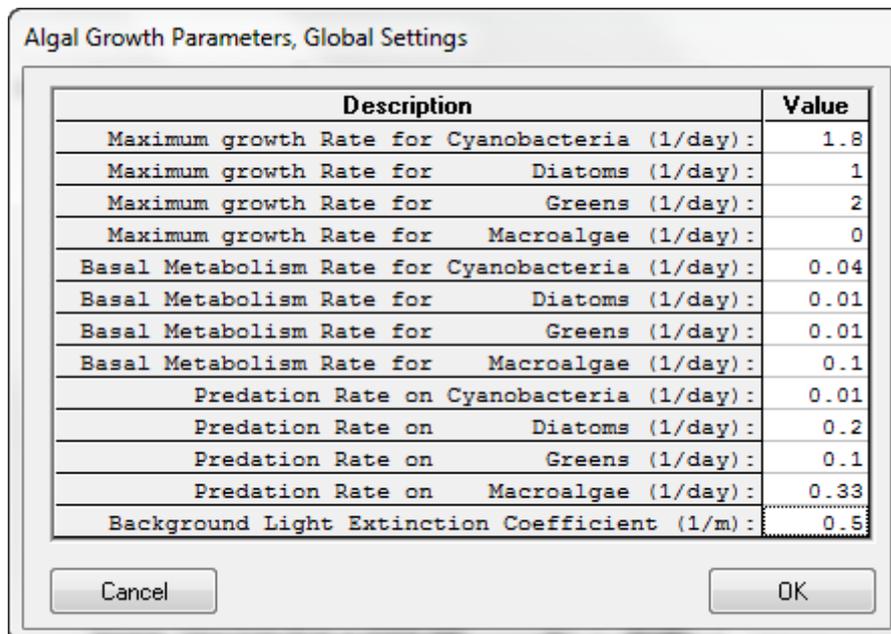


Figure 5-111 Algal Dynamics parameter form.

5.15.3.1 Solar Radiation

The *Solar Radiation for Algae* form provides the user with a drop down menu from which the source for radiation data may be selected, these include: Constant; Read Daily Average (SUNDAY.INP); and Use Solar Radiation in ASER.INP. The *Modify* button then allows the user to set various solar radiation options including initial solar radiation at the water surface, minimum optimum solar radiation, fraction of day that is daylight amongst others.

5.15.4. Initial Conditions

The *WQ Initial Conditions* tab, shown in Figure 5-112, provides access to the sediment initial conditions settings for Water Quality. Here the user may select spatially constant or spatially varying initial conditions for each of the water quality parameters. To set spatially varying initial conditions for the water quality parameters the user must interpolate data onto the model cells using the *Apply Cell Properties via Polygons* utility. If the EFDC model uses spatially varying IC's, then the user must specify which input data format to use, i.e. WQWCRST.INP or the WQICI format. EFDC_Explorer will generate the IC's in the format specified. Pressing the *Initialize IC's* button assigns the entire domain for all parameters to the values specified as the spatially constant IC's.

The user may later edit (*Enable Edit* must be checked) any of these IC fields using ViewPlan. To access the data the user should select *Water Column* as the main Viewing Option then *Water Quality* as the sub-option, then select the parameter desired.

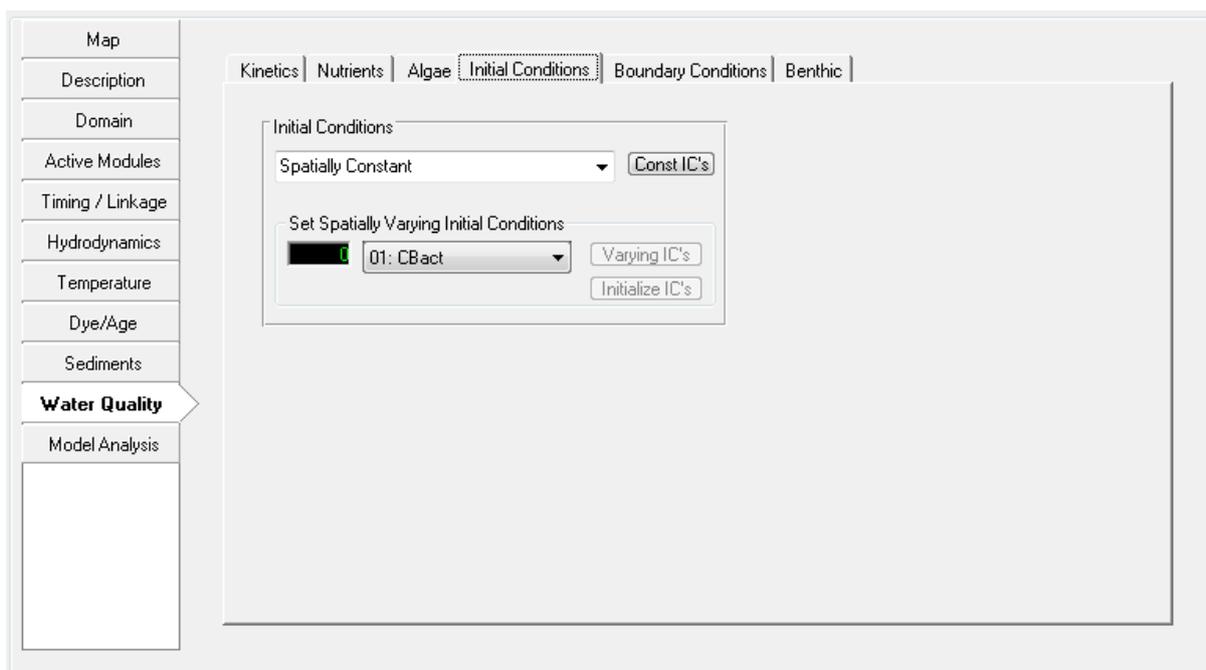


Figure 5-112 Water Quality Tab: Initial Conditions.

5.15.5. Boundary Conditions

A recent feature of EFDC_Explorer is the ability to be able to define Water Quality Boundary Conditions with Load Concentrations rather than Mass Loading files. The tab that allows the user to select from various options for *Water Quality Point Source Loading Option* is shown in Figure 5-113.

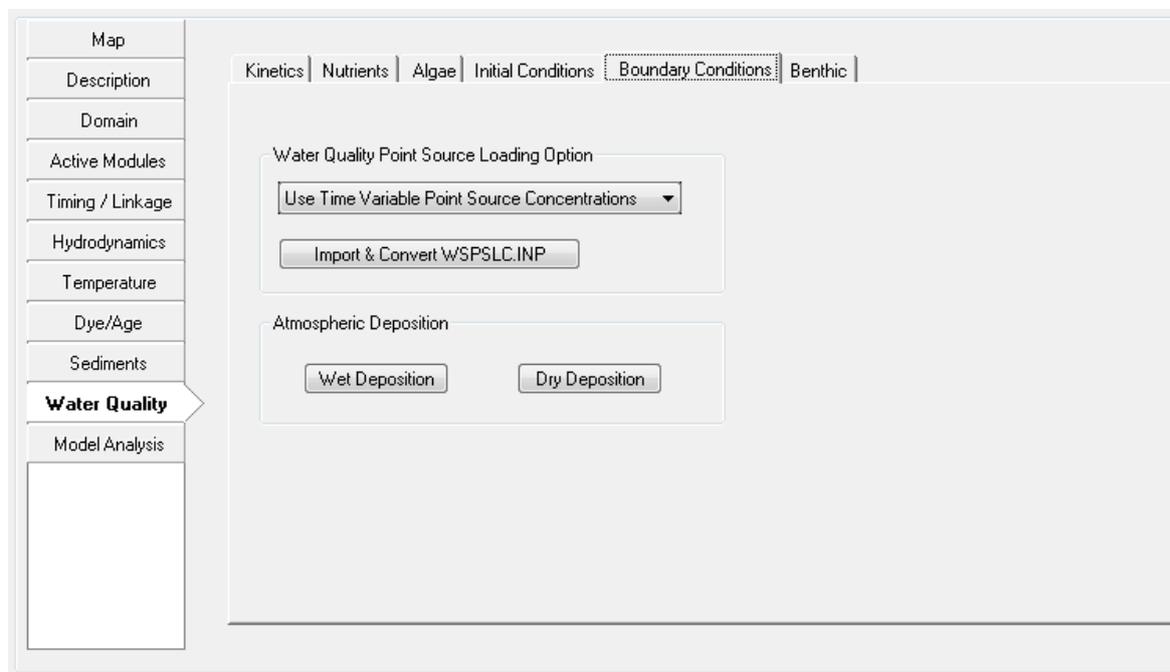


Figure 5-113 Water Quality Tab: Boundary Conditions.

The *Water Quality Point Source Loading Option* provides a drop down table with the following three options: *Use Constant Point Source Loads*, *Use Time Variable Point Source MASS Loadings*, and *Use Time Variable Point Source Concentrations*.

EFDC_Explorer previously only used the larger Mass loading files. The new *Load Concentrations* option provides the user with smaller files and greater control. When the user selects an option different to that previously selected, EFDC_Explorer informs the user of the current BC and asks whether they want to switch to the new option. If the user responds affirmatively then EFDC_Explorer will convert and save out the option selected.

With the aid of the *Import & Convert WSPSLC.INP* button the user can either overwrite or append a new Water Quality Time Series, which is a Load Concentration file, with concentration in kg per day. The WQ BC Load Concentrations rely on two new input files: WQPSLC.INP and WQPSL.INP. Note that WQPSL.INP is an EFDC_Explorer file, and is not used by EFDC. It is often a very large file.

When the user returns to edit the Water Quality Tables and Series in the *Boundary* tab EFDC_Explorer displays all 21 WQ parameters. In the MASS Loadings option these parameters are depth averaged and not layered, and so are vertically constant. However, after converting to Concentrations loadings, the user is informed that the values have been converted, and now are now stored layer by layer. Initially these values will be an average as calculated by EFDC_Explorer, but the user can now specify certain layers and assign new values as required.

5.15.6. Benthic Flux

Diagenesis/benthic flux settings are made in the *Benthic* tab shown in Figure 5-114. The nutrient benthic flux computational options are set using the *Modify Parameters* button in the *Benthic Flux* frame.

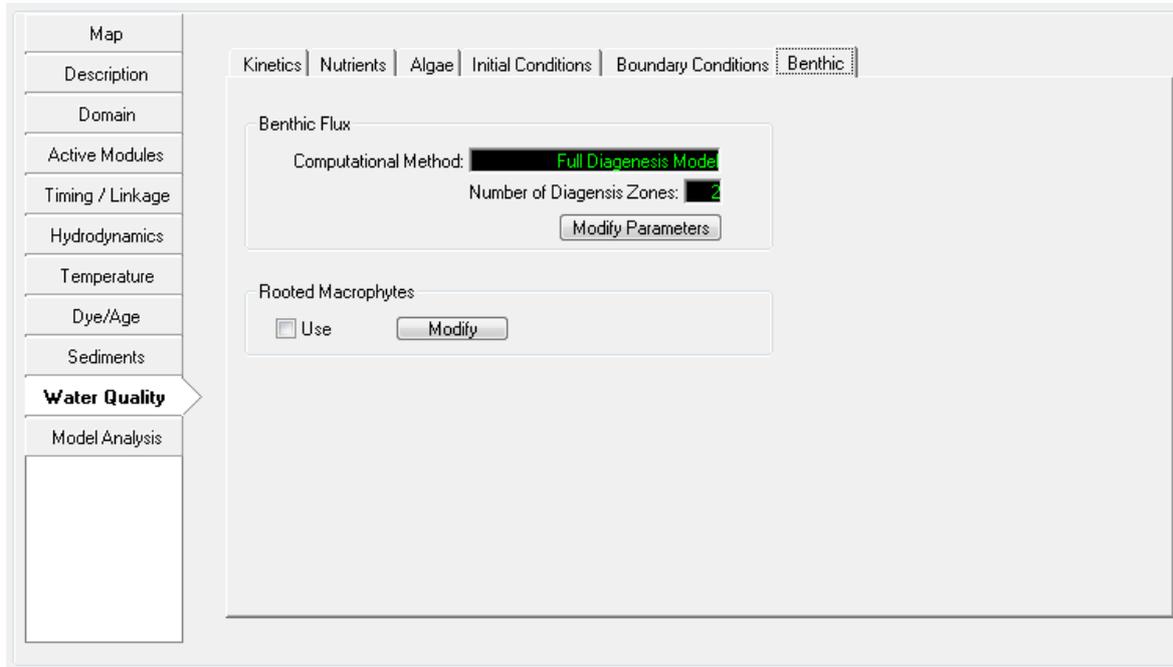


Figure 5-114 Water Quality Tab: Benthic.

Clicking the button brings up the form shown in Figure 5-115. The top frame, Benthic Nutrient Flux Method is the option that controls EFDC’s benthic flux approach. If the nutrient mass fluxes are to be specified, either as constants or variable in time and space, then the diagenesis tabs are not used and consequently disabled. If the Full Diagenesis Model (DiToro & Fitzpatrick, 1993) option is selected then the three diagenesis tabs are available to allow the user to specify the diagenesis parameters.

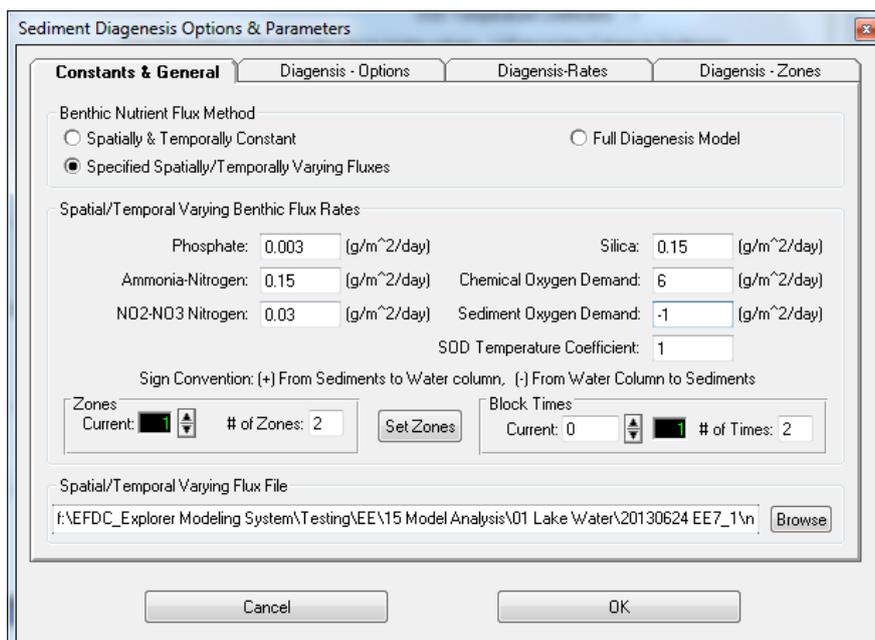


Figure 5-115 Sediment nutrient flux – Sediment Diagenesis Options and Parameters.

Figure 5-116 shows one of the diagenesis tabs for defining the diagenesis parameters. The best way to initialize all of the diagenesis parameters is to use the *Load Settings* button. This will read an existing WQSD3D.INP file from another project and initialize the settings for the current project with those from the loaded project. After the user initializes the parameters they can modify the settings during the model development stages. The diagenesis values from the Chesapeake Bay ICM application (Cercó & Cole, 1995) provide a good starting point for diagenesis model parameterization.

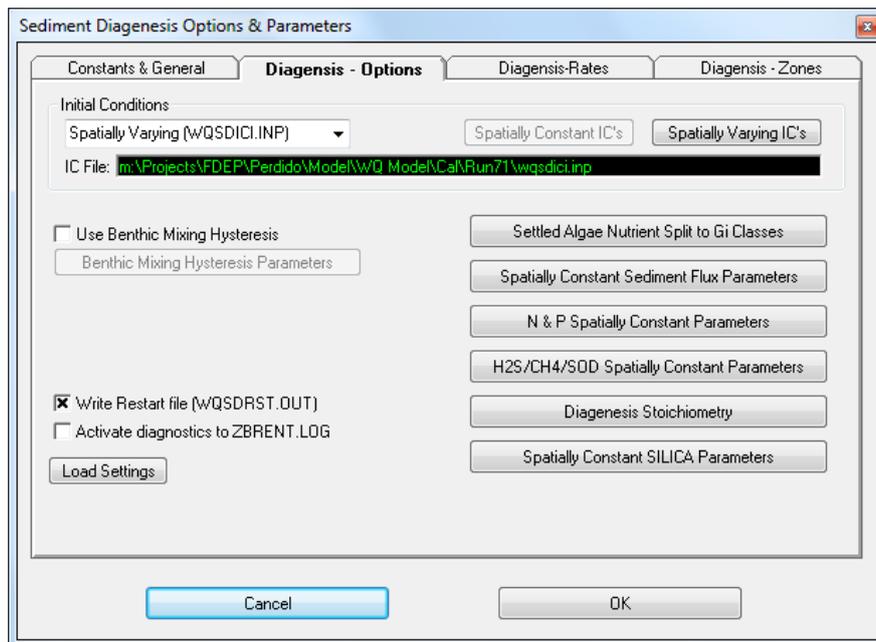


Figure 5-116 Sediment Diagenesis: Diagenesis – Options.

In addition to the diagenesis kinetic parameters, the sediment bed diagenesis initial concentrations also need to be specified. This can be accomplished by applying measured data for each parameter using the *Spatially Varying IC's* button. When pressed, the form shown in Figure 5-117 is displayed. For each of the required parameters, the user can interpolate the data onto the model. Each nutrient reaction class, i.e. G1 (most reactive), G2 and G3 (least reactive or inert) must be separately specified. The *Operator* can be used to factor or otherwise modify the interpolated field or a previously defined IC field. The data can be interpolated for the entire model in a single operation or using only selected cells by specifying a *Poly File*.

The user can initialize the spatial field to a set of constants using the *Initialize to Constants* button. It should be noted that the sediment diagenesis bed is not linked in any way to the sediment transport sub-model bed definition, scour or deposition processes.

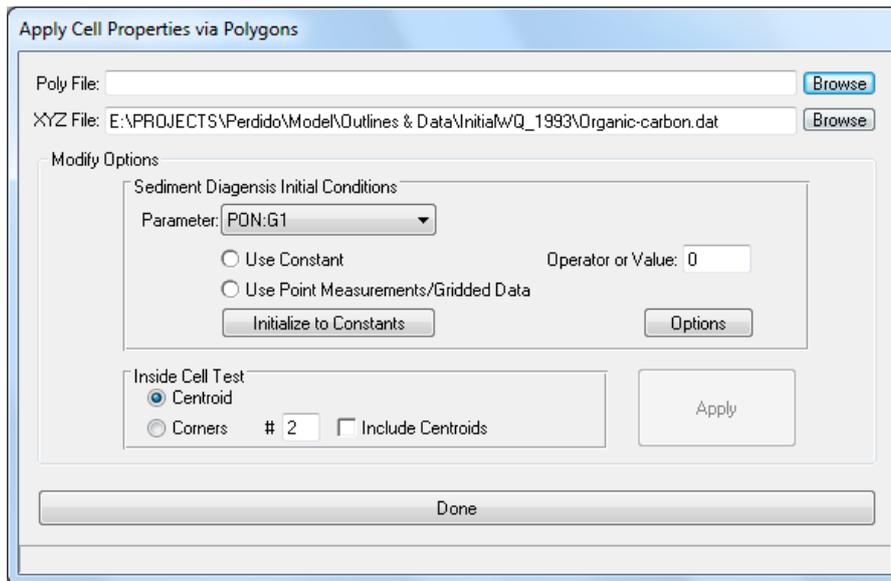


Figure 5-117 Sediment Diagenesis: setting the initial conditions.

The diagenesis kinetic parameters can be divided into zones. Figure 5-118 provides access to setting the zones and assigning the zone specific parameters. The maximum number of zones needed is set by entering the appropriate number in the “# of Zones” field. To edit a specific zone, the user should scroll to the desired zone using the up/down arrow control.

The zones and the zone specific parameters can be viewed and editing using the *ViewPlan* by selecting the View Option *Diagenesis*, then checking the *Show Zone* option. If the *Enable Edit* is checked, then RMC'ing on a cell allows the user to edit the cell's corresponding diagenesis zone's kinetic parameters. The cell's diagenesis zone assignments can be edited using the Property Copy function.

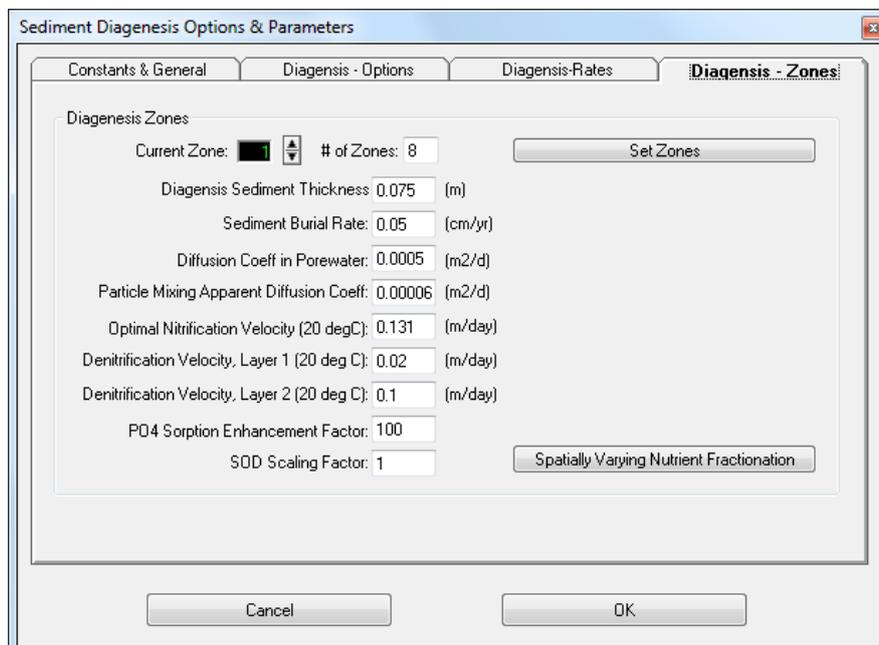


Figure 5-118 Sediment Diagenesis: Diagenesis kinetic zones.

5.15.6.1 Rooted Macrophytes

If the user wished to implement the *Rooted Plant and Epiphyte Model (RPEM)* the *Use* button should be selected. The *Modify* button in the *Rooted Macrophytes* frame allows the user to set various constants associated with RPEM as shown in Figure 5-119.

The *RPEM: General* tab allows the user to enable or disable a variety of combinations for RPEM, including enabling simulation of rooted plants or epiphytes; enabling epiphytes growing on rooted plants; enabling RPEM – Water Column Nutrient Interaction; enabling RPEM – Sediment Diagenesis Interaction.

For details on the theory behind this sub-model, please refer to “A Generic Rooted Aquatic Plant and Epiphyte Algae Sub-Model for EFDC” (Hamrick, 2006).

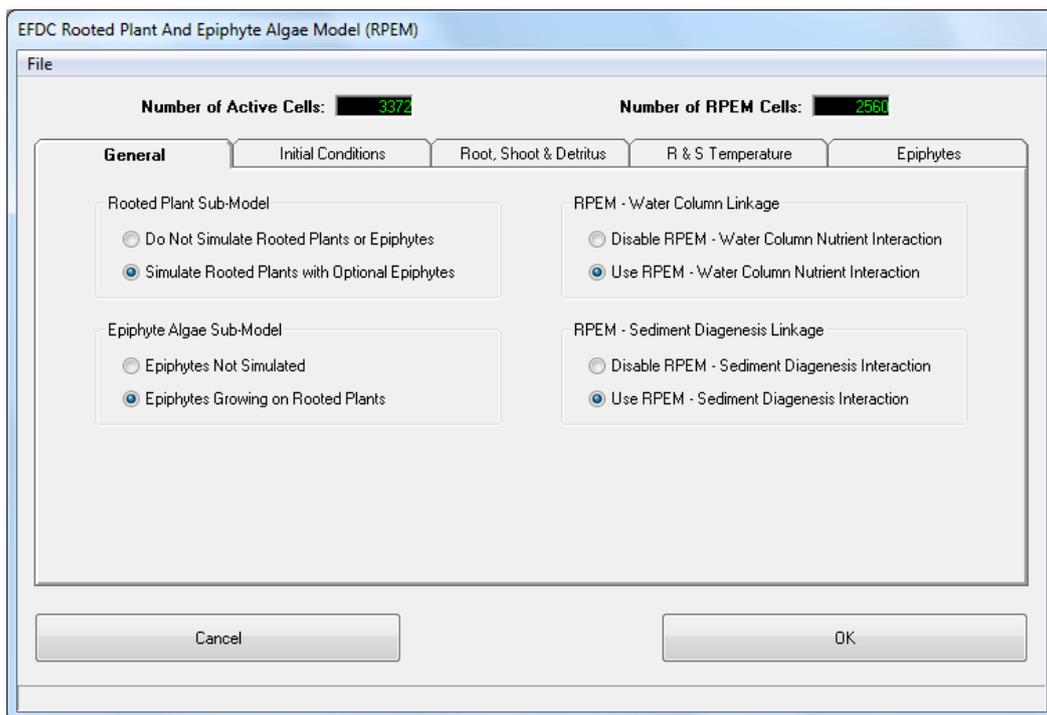


Figure 5-119 RPEM: General.

The *Initial Conditions* tab is shown Figure 5-120. This tab allows the user set various approaches for the RPEM such as: Constant IC's, Spatially varying IC's - WQRPEMSIC.INP, and Spatially varying IC's - WQRPEMRST.INP. These latter two options allow user to input a variable carbon biomasses rather than setting them as constant values. Clicking on any of the buttons for setting shoot, root, epiphyte or detritus carbon ICs will bring up a form as shown in Figure 5-121. Using this form the user may import a polyfile or datafile for the IC.

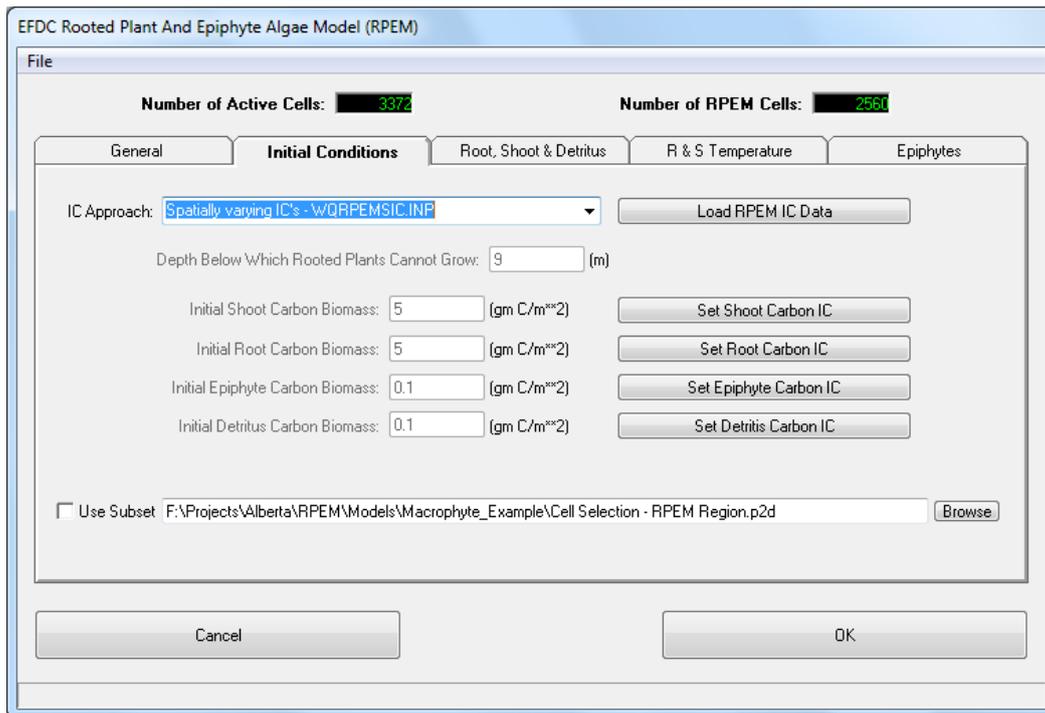


Figure 5-120 RPEM: Initial Conditions.

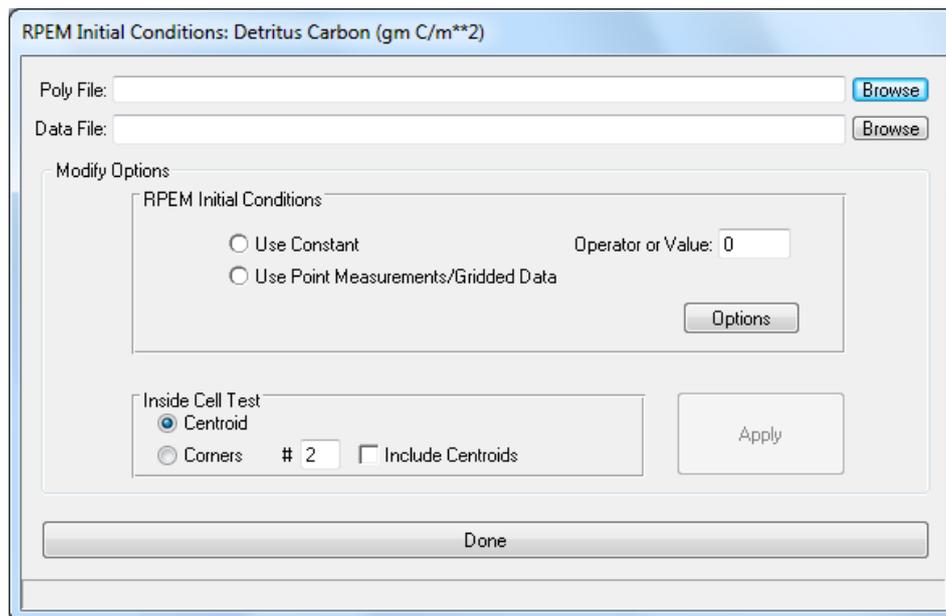


Figure 5-121 RPEM: Initial Conditions: Shoot Carbon

The *Root, Shoot & Detritus* tab sets growth and respiration rates amongst other parameters for shoots, roots and detritus as shown in Figure 5-122.

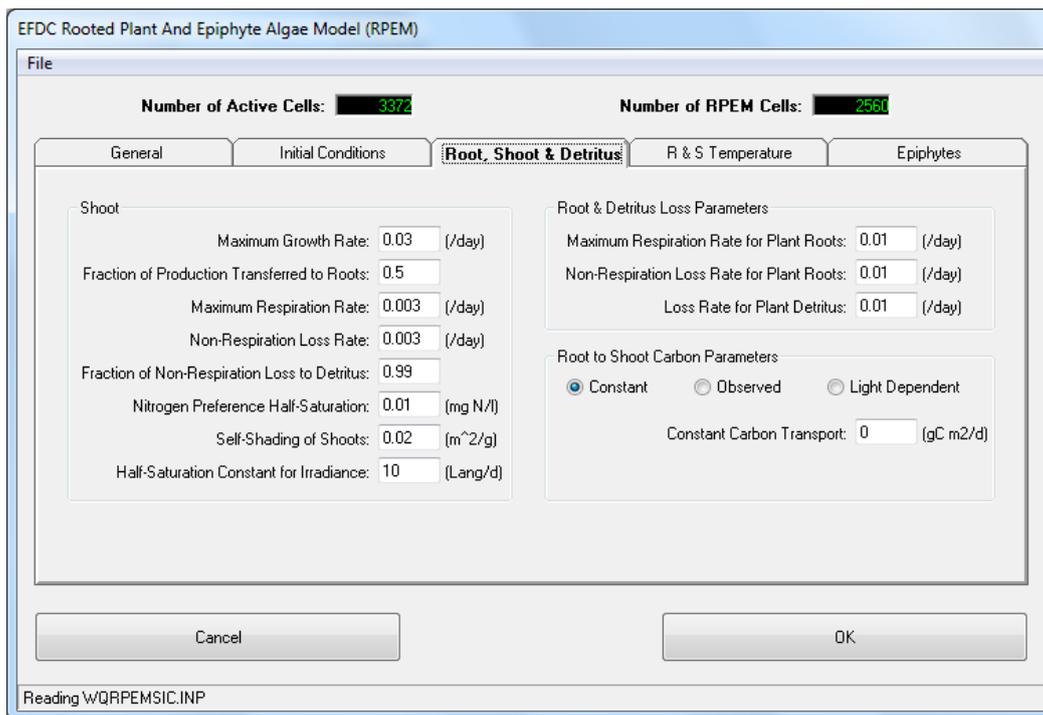


Figure 5-122 RPEM: Root, Shoot and Detritus.

Root and Shoot temperatures may be set in the *R & S Temperature* tab as shown in Figure 5-123.

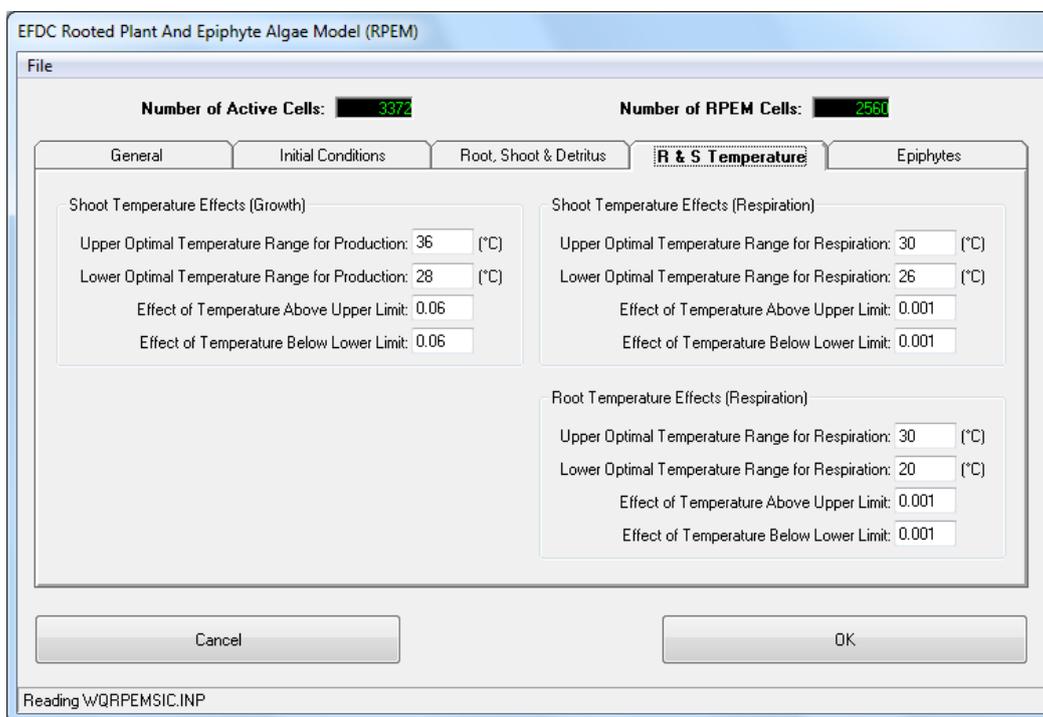


Figure 5-123 RPEM: Root & Shoot Temperature.

Constants for epiphyte growth respiration, light limitation, temperature effects for growth and respiration may be set in the *Epiphyte* tab as shown in Figure 5-124.

EFDC Rooted Plant And Epiphyte Algae Model (RPEM)

File

Number of Active Cells: 3372 Number of RPEM Cells: 2564

General Initial Conditions Root, Shoot & Detritus R & S Temperature **Epiphytes**

Epiphyte Growth Respiration And Loss Parameters

Maximum Growth Rate for Epiphytes: 1 (/day)

Maximum Respiration Rate for Epiphytes: 0.025 (/day)

Non-Respiration Loss Rate for Epiphytes: 0 (/day)

Nitrogen Half-Saturation for Epiphytes: 0.01 (mg N/l)

Epiphyte Temperature Effects (Growth)

Upper Optimal Temperature Range for Production: 30 (°C)

Lower Optimal Temperature Range for Production: 20 (°C)

Effect of Temperature Above Upper Limit: 0.001

Effect of Temperature Below Lower Limit: 0.001

Epiphyte Light Limitation And Extinction Parameters

Light Extinction Coefficient due to Epiphytes: 0.02 (/m Chl a)

Carbon-to-Chlorophyll Ratio for Epiphytes: 0.05 (gC/mgChl)

Max for Optimum SSW for Root Growth: 120 (Lang/d)

Max for Optimum SSW for Epiphyte Growth: 100 (Lang/d)

Epiphyte Temperature Effects (Respiration)

Upper Optimal Temperature Range for Respiration: 30 (°C)

Lower Optimal Temperature Range for Respiration: 20 (°C)

Effect of Temperature Above Upper Limit: 0.001

Effect of Temperature Below Lower Limit: 0.001

Cancel OK

Reading WQRPEMSIC.INP

Figure 5-124 RPEM: Epiphytes.

5.16 Lagrangian Particle Transport (LPT)

EFDC_Explorer has been updated to incorporate the pre- and post-processing of LPT's (Dang Huu Chung and P.M.Craig. 2009). Use of LPT's can be helpful when modeling oil spill tracks, emergency response, water quality applications and plume tracking. The *Lagrangian Particle Tracking* tab is shown in Figure 5-125.



Figure 5-125 Lagrangian Particle Tracking Tab.

The EE pre-processing provides full control for initial particle seeding, LPT computational option selection and plotting. The EE post-processing allows for a range of display options for the tracks, animations to the screen and or AVI files, and the ability to export any or all of the particle tracks to ASCII files.

The LPT sub-model has been implemented with the following major options:

- Particles are free to move in full 3D,
- Particles can be fixed at a user specified depth, and
- A random walk component can be added to either of the two options above.

The numerical solution was separately divided into the advective transport and random components. This approach allows the user to enable (i.e. turn on random walk) or disable (advective transport only) the random components for either the horizontal and/or the vertical directions.

The method used for the solution of the differential equations is the Runge-Kutta 4 method: This method has the approximation of $O(\Delta t^4)$. It has been determined that the Runge-Kutta 4 method is preferred due to its higher level of numerical accuracy. It has been shown that the computational burden of the Runge-Kutta 4 method is not significant within the overall model run times compared to other methods tested.

Within the *Lagrangian Particle Tracking Options/Drifters* frame (Figure 5-125) is reported the number of drifters set, the time for release of the drifters and the end time for the observation of the drifters. In order to set the values related to the drifters the user should select the

Options/Particle Seeding button. This displays the various options for setting the drifters as described below.

5.16.1.1 LPT Main Options Tab

Figure 5-126 shows the *LPT Main Options* tab. Within the *LPT Computational Method and Timing* frame the user must switch on drifters with the *Compute Drifters* check box before LPT can be implemented. Here the user may also set the release day and end day for the particle in Julian days. The user may also specify the output frequency in minutes.

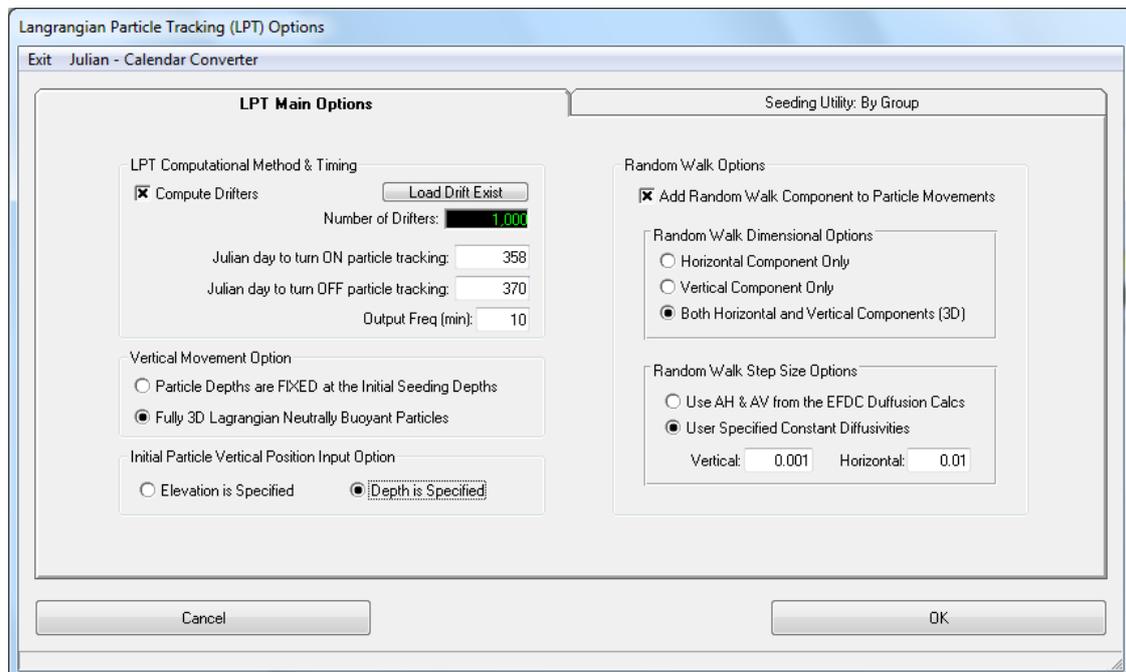


Figure 5-126 LPT Options: Main Options.

The *Vertical Movement Option* frame provides the user the option of fixing the particles at their initial seeding depths. If this is unchecked the particles will drift vertically as *Fully 3D Lagrangian Neutrally Buoyant Particles*.

Within the *Initial Particle Vertical Position Input Option* the user may also specify whether the vertical positions provided are elevations or depths.

If the *Random Walk* checkbox is checked the user has a number of options for the *Random Walk Dimensional Options*. The user may select the random walk in only the vertical direction, in only the horizontal direction, or in both vertical and horizontal directions at the same time. In addition the user may specify the *Random Walk Size Options* by selecting to allow EFDC Diffusion calculations to be used for the AH and AV. Alternatively there is the option for *Specified Constant Diffusivities* that should be inputted by the user.

5.16.1.2 Seeding Utility: by Group - Tab

Figure 5-127 shows the tab for use when a group of drifters is to be released. The *Seeding Options* frame allows the user to select from *Uniform Spacing* or *Random Placement*. The Uniform Spacing option enables the user to selecting the X and Y coordinates at “LL X” and “LL Y”, as well as the spacing between each seed with the “Delta X” and “Delta Y” input.

In the *Vertical (Depth) Options* frame the user may select from one of three options: Random Depth, Fixed Elevation, and Fixed Depth. For the latter two options the user should enter the elevation or depth as appropriate. When the seeding options have been selected by the user, the *Create* button should be pressed which will save the selection. Another drifter may then be defined and *Create* selected until all the drifters have been defined.

The *Group Options* frame allows the user to define a series of groups of drifters with a user defined ID, set with the *New* button. For each group the release and end days, as well as settling velocity, may be defined by the user. When the *Clear Group* button is pressed all the user defined particle groups will be erased.

The *Distribute Release Dates* button distributes the release times for the particles defined in the current group. Pressing the button displays a form with options for setting the starting and ending date. By default these values are the same as those specified as the start and stop dates for the group, however adjusting the start and stop time will update these distributed release times. Pressing *OK* will distribute between the range entered, whereas pressing *Cancel* will use a constant release. Even though the distributed dates are not displayed EFDC will use values the user previously selected. Pressing the *Distribute Release Dates* button again will reset the distributed release dates to the default start and stop dates for the group.

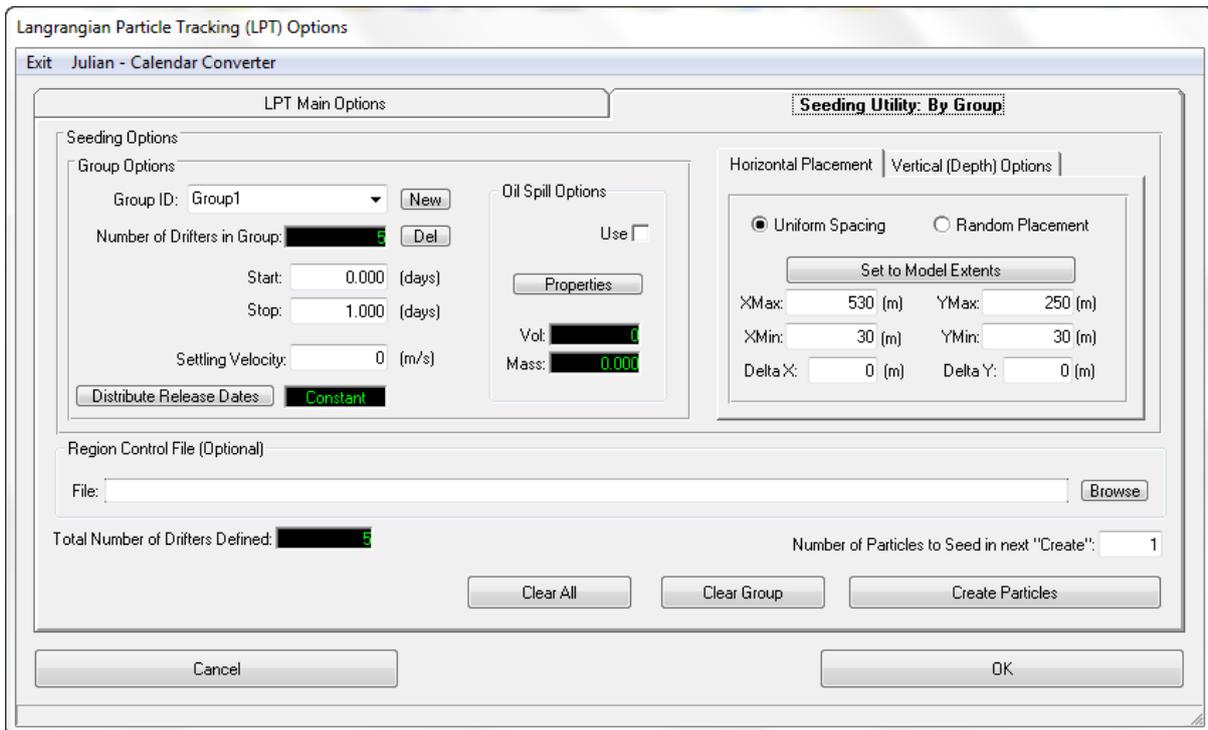


Figure 5-127 LPT Options: Seeding Utility: By Group

The user may view the location of the drifters by selecting *OK* and then selecting *Particle Tracking* in *View Grid* editor. Selecting *Show IP* will display the initial position of the particle seeds. The user may create or delete drifters by right clicking on the grid.

An alternative to manually entering the drifter coordinates within the *Initial Position Seeding Utility*, is the option of loading a *Regional Control File*. This is a .P2D file which contains the coordinates and elevations of the drifters. Pressing the *Create* button will load the file into EFDC_Explorer.

5.16.1.3 Examples of LPT Function

An example of the LPT function may be seen in Figure 5-128. This example consists of a rectangular domain with flat bottom, an open boundary to the east and a flow boundary along the southwest edge. U component masks were inserted to demonstrate the functionality of the Lagrangian Particle Tracks computations when masks are used.

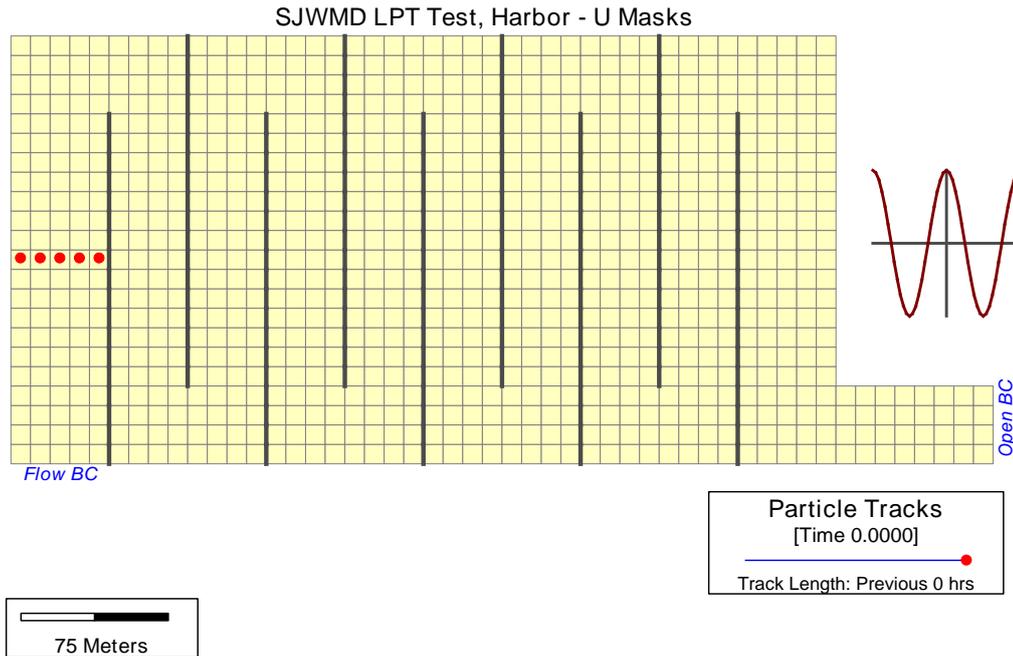


Figure 5-128 Harbor_U grid showing the masks, boundaries and initial particle locations.

The model represents the vertical component as a depth averaged system with 1 sigma layer. The depths of the 5 drifters are initialized at specified depths.

The results of the simulations are presented in Figure 5-129 showing the trajectories of the 5 drifters over one day.

Figure 5-130 shows the particle tracks colored by elevation and with random walk applied. Even though there was no vertical component, the tidal range is seen to result in changing particle elevations.

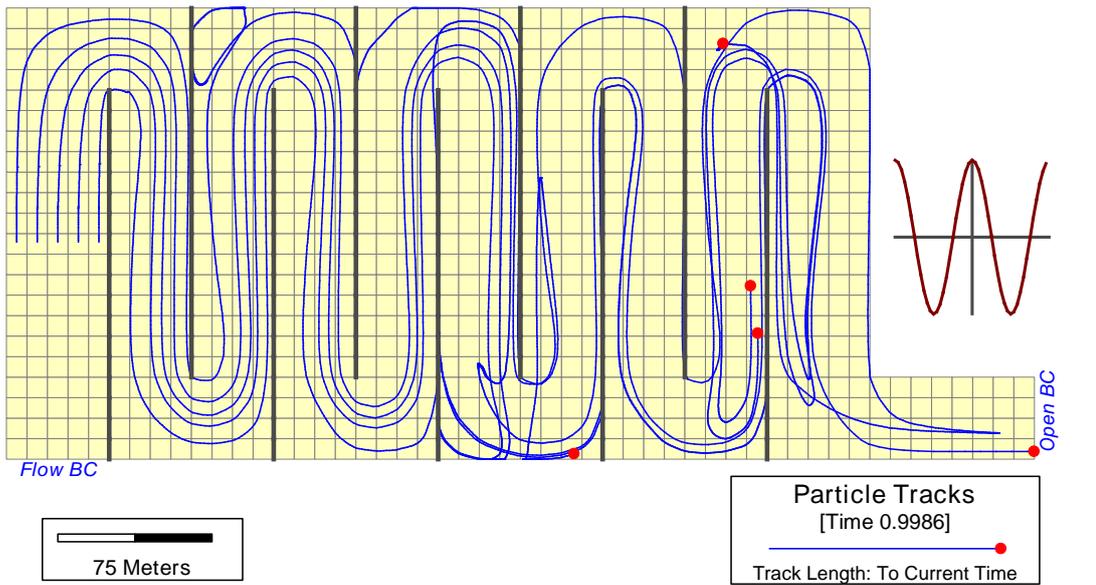


Figure 5-129 Harbor_U: Trajectories of 5 drifters over 1 day (no random walk).

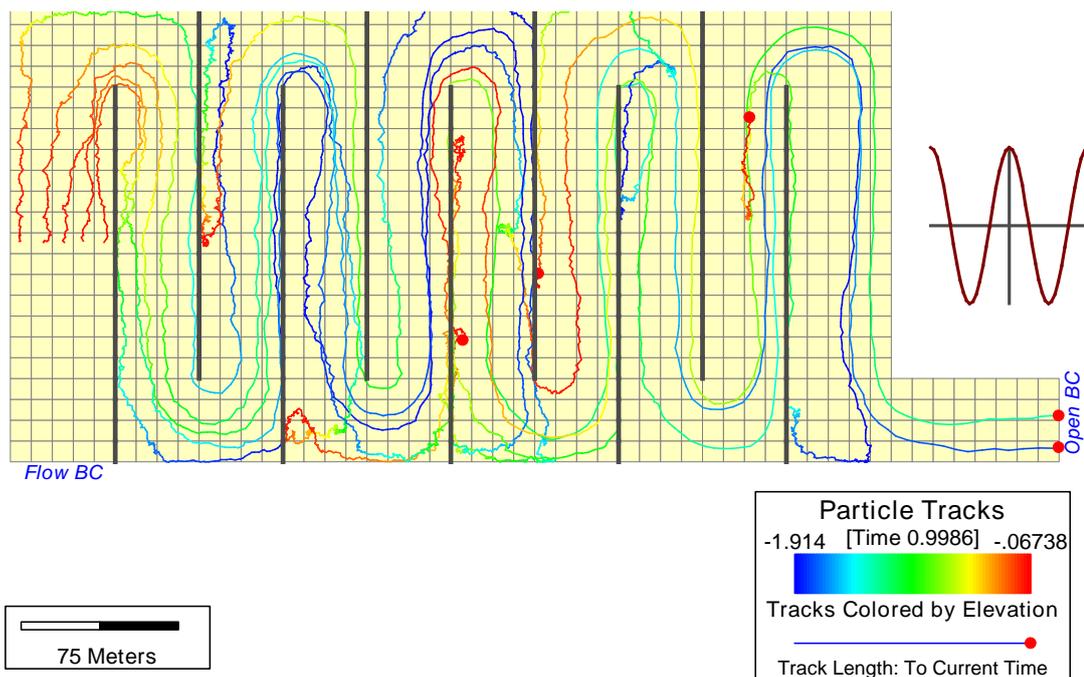


Figure 5-130 Harbor_U: Trajectories of 5 drifters over 1 day (random walk).

5.16.1.4 Oil Spill Modeling with Lagrangian Particle Tracking

EE7.2 and later allow the user to simulate oil spill based on drifters. Oil is maintained at the surface layer and is moved along with the hydrodynamic impacts similar to Lagrangian particles and broken down by evaporation and biodegradation.

The Seeding Options | Group Options frame is shown in Figure 5-131 below for oil spill. As there are many types of oils and different weathering of these types of oils, a group should be defined which has its own chemical property and volume per seed. When Oil Spill Options are enabled all the seeding options defined will apply to the group currently selected for the Group ID and the Properties button for oil spill will be enabled. In addition, below the Properties button, the volume and mass of oil for that group are displayed.

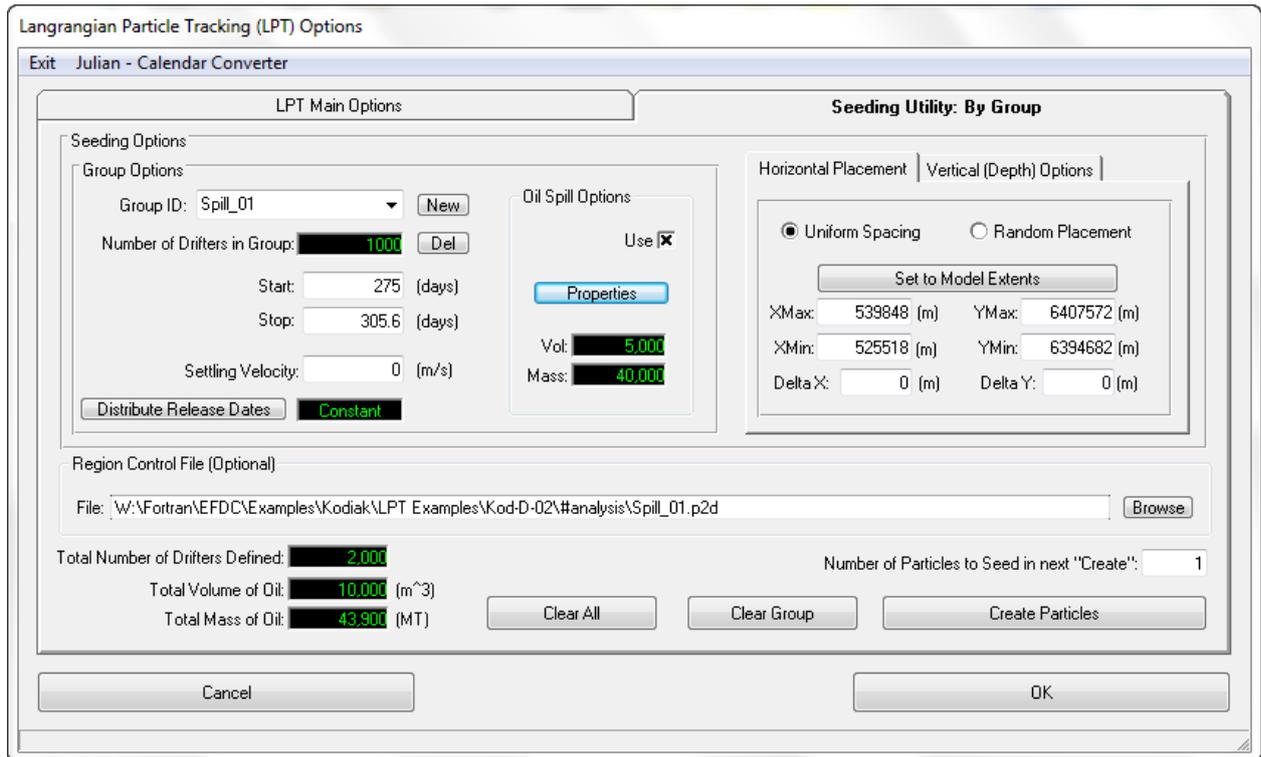


Figure 5-131 LPT: Seeding Utility by Group.

Clicking the *Properties* button will display the oil parameters settings as shown in Figure 5-132 . Each oil group requires a separate ID along with the density and the volume of oil per drifter. Biodegradation and vapor pressure are entered to provide the properties for all the drifters in the current group. Though temperature is optional, it is recommended that heat transfer be included, as the oil spill evaporation process depends on the temperature of the ambient environment. Winds also impact evaporation and it is expected that with any realistic oil spill model, winds will be included.

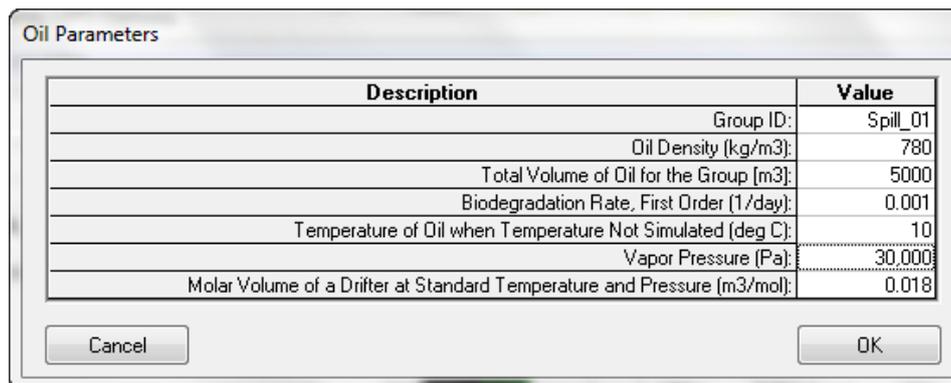


Figure 5-132 Oil Parameters Setting.

It should be noted that EFDC will cause the drifter to disappear when the oil per drifter is less than 1.0 mm^3 . The user may manually choose to hide concentrations of oil higher than this by using the crop below in *ViewPlan* or clipping in *View3D*. For post-processing of the oil simulation, *ViewPlan* provides several options for displaying the oil within *Viewing Options*. Oil thickness, mass and volume may also be displayed.

When configuring an oil spill model it should be noted that use of the *Vertical Movement Option* is ignored for groups that are designated as simulating oil. If the density of oil is less than that of water then the particles are always in the surface layer. If the oil is heavier than water, then the fully 3D option is enabled.

For simulation on the oil evaporation process, the theory of surface evaporation presented in the paper of Warren Stiver and Donald Mackay (1984) is used.

EFDCPlus allows for effects of biodegradation of the oil based on user defined biodegradation rate with a simple first order decay approach based on Stewart (1993). A rate of 0.011 per day leads to an approximately two month half- life for oil. If temperature of an oil drifter is provided by the user then this is used as the reference rate for the optimal biodegradation.

In order to simulate a conservative oil, the user would set the degradation rate and the vapor pressure as zero.

6 Post-Processing - Form Operations

Most of the post-processing visualization features of EFDC_Explorer are located in the *ViewPlan* and *ViewProfile* functions, which are discussed in Section 7. However, there are several other features for post-processing model runs that are available from the main form (see Figure 2-10). The post-processing functions are located in the *Model Analysis* tab in the main form. Three tabs provide access to these features (Figure 6-1), as discussed below.

At the top left of the form is the *Output File Loading Options* frame. This is used to show whether or not model results have been loaded for analysis. The *Reload* checkbox forces EFDC_Explorer to reload the output files even if the files have already been loaded. This is necessary at times when an error occurs or the user is reviewing the progress of a run (see Section 3.7.4).

The user can review a run in process by:

- Pausing the EFDC execution (pressing any key within EFDCPlus will pause the execution).
- Checking the *Reload* checkbox.
- Using the *ViewPlan* or *ViewProfile* review the model progress.
- Restart the model, if desired, by pressing any other key than that which stopped it. Or the user may completely end the model run and make adjustments, save and re-run.
- Repeat as needed.

6.1 Model Calibration

Figure 6-1 displays the *Model Calibration* tab that provides access to some of the calibration features available in EFDC_Explorer. The *Time Series Comparisons*, *Correlation Plots* and *Vertical Profile Comps* provide a linkage of water column model results to measured data. Once the model/data linkage has been defined once, calibration plots and statistics can be quickly generated after each model run.

Once defined, calibration plots and statistics may be generated automatically by selecting the *Generate Calibration Plots and Statistics* checkbox in *Run Options* before running a model. It should be noted that if a new model is opened while the current model is running that plots and statistics will not be automatically generated.

Pressing *Plots* allows the user to review the plots on screen and set each plot's style. Before viewing the plots the user will be prompted as to whether they want to *Automatically Generate Defined Plots*. If the user selects this option then EE will save the plots to the project directory into a folder entitled *#calib_plots*. If the user selects *Automatically Export ASCII Data for the Defined Plots* the .DAT files are saved into a folder entitled *#calib_extraction*.

Figure 6-1 Post Processing Options - Main Form.

The plot styles are saved in the EFDC_Explorer configuration file “CalForm_TS.EE,” “CalForm_CP.EE” and “CalForm_VP.EE” for the time series, correlation and vertical profile plots respectively. In addition, the file “CalForm_MMA.EE” contains plot styles for the time series option of *Min-Avg-Max* plots (see Section 9 for more details).

The time series, correlation and vertical profile model-data linkages provided in this section are only one means of conducting model-data comparisons. Almost any model parameter can be compared to data using the *Import Data* feature of the time series plotting utility. See Section 9 for more details.

6.1.1. Model Comparison Statistics

The error statistic is selected at the beginning of each statistical report generation process. The statistics for each parameter and station, as well as parameter composite statistics, are reported. The user may also select to automatically generate reports as shown in Figure 6-2. The reports will be automatically saved in the project directory in the “#calib_stats” folder. Figure 6-3 shows an example of a statistical report for salinity and temperature. In this example, two of the stations had time series records from data loggers (BR31 and CCORAL) and one stations data were from manually collected data (CES09). The report provides station and layer information, time span of the measured data within the model run time, the number of model-data pairs, the selected statistic and the averages for the paired data only. The model bias can be computed, if desired, by subtracting the *Model Average* from the *Data Average*.

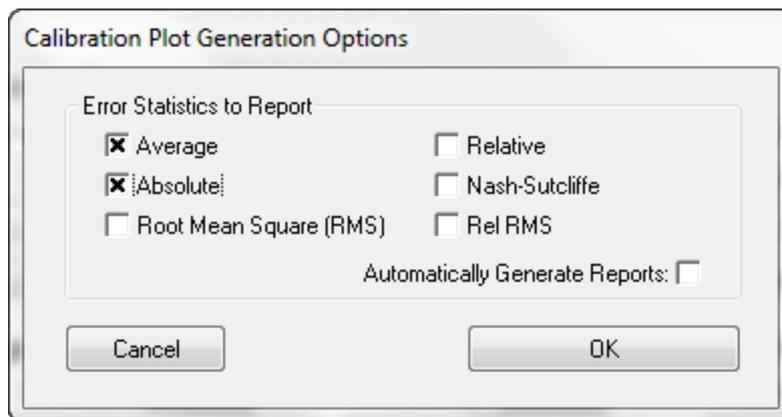


Figure 6-2 Calibration plot generation options.

There are six pre-defined statistics available for the model-data statistical reports. They are:

Average Error (AE)

$$AE = \frac{\sum_{i=1}^N (O_i - X_i)}{N}$$

Where:

AE – The average error statistic

O – The observed value,

X – The corresponding model value in space and time, and

N – The number of valid data/model pairs.

Relative Error (RE)

$$RE = \frac{\sum_{i=1}^N |O_i - X_i|}{\sum_{i=1}^N O_i} \times 100$$

Average Absolute Error (AAE)

$$AAE = \frac{\sum_{i=1}^N |O_i - X_i|}{N}$$

Root Mean Square (RMS) Error

$$RMS = \sqrt{\frac{\sum_{i=1}^N (O_i - X_i)^2}{N}}$$

Relative Root Mean Square (RMS) Error

Also known as Normalized RMS Error.

$$RelRMS = \frac{\sqrt{\frac{\sum_{i=1}^N (O_i - X_i)^2}{N}}}{O_{max} - O_{min}} \times 100$$

Nash-Sutcliffe Efficiency Coefficient

t

$$NSEC = 1 - \frac{\sum_{i=1}^N (O_i - X_i)^2}{\sum_{i=1}^N (O_i - O_M)^2}$$

Where O_M is the mean of the observed data.

Station ID	Parameter	Layer/Type	Starting Date/Time	Ending Date/Time	# Pairs	RMS Err	Data Average	Model Average
FMVER	Water Surface (ft)	Surface	31-Dec-2003 23:30	30-Dec-2004 20:30	8652	0.286	0.946	0.194
CESD9	Salinity (ppt)	Layer 4	05-Jan-2004 11:02	29-Mar-2004 10:15	2	7.074	28.047	21.462
CESD9	Salinity (ppt)	Layer 1	16-Feb-2004 03:49	29-Mar-2004 10:15	2	4.927	29.270	20.728
SB31 (Top)	Salinity (ppt)	Layer 4	01-Jan-2004 00:00	30-Dec-2004 21:00	8757	1.385	1.292	0.686
SB31 (Bot)	Salinity (ppt)	Layer 1	01-Jan-2004 00:00	30-Dec-2004 21:00	9757	1.234	1.566	1.136
CCORAL (Top)	Salinity (ppt)	Layer 4	08-Jan-2004 13:00	30-Jul-2004 02:00	4656	3.008	13.386	10.437
CCORAL (Bot)	Salinity (ppt)	Layer 1	08-Jan-2004 13:00	30-Jul-2004 02:00	4656	2.539	13.386	13.896
CESD9	Temperature (°F)	Layer 4	05-Jan-2004 11:02	01-Dec-2004 09:28	21	1.526	78.943	79.161
CESD9	Temperature (°F)	Layer 1	11-Oct-2004 10:56	11-Oct-2004 10:56	1	0.187	80.003	79.516
SB31 (Top)	Temperature (°F)	Layer 4	01-Jan-2004 00:00	30-Dec-2004 21:00	8691	3.302	77.494	74.708
SB31 (Bot)	Temperature (°F)	Layer 1	01-Jan-2004 00:00	30-Dec-2004 21:00	8692	3.370	77.133	74.311
CCORAL (Top)	Temperature (°F)	Layer 4	16-Apr-2004 13:00	30-Jul-2004 01:00	2506	1.452	83.843	84.132
CCORAL (Bot)	Temperature (°F)	Layer 1	05-Nov-2004 00:00	05-Nov-2004 23:00	24	4.031	72.965	76.887

Parameter	# Pairs	RMS Err	Avg Obs	Avg Model
Water Surface Elevation (ft)	8652	0.286	0.946	0.194
Salinity (ppt)	24913	1.979	1.409	4.822
Temperature (°F)	19955	3.058	78.131	76.728

Prepared by EFDC_Explorer(c), developed by Dynamic Solutions-Intl, LLC

Figure 6-3 Example time series calibration statistics report.

The bottom of the report contains a listing of the composite statistics for the entire model run. The parameters may be copied to the clipboard for pasting into Excel or some text editor. A good practice is to save these statistics in each run's directory for quick future reference.

6.1.2. Time Series Comparisons

6.1.2.1 Model-Data Configuration

The *Time Series Comparisons* frame contains the buttons that configure (*Define/Edit*) and plot (*Plot*) a series of EFDC cells and measured time series data. Once configured, the linkages between the EFDC cells and the data is automatically available and the user only needs to press the *Plot* button to compare model to data for each run. Figure 6-4 displays the form used to link cells to data and other parameters. Right mouse click on the cells to obtain additional input options or guides.

If a link is incorrectly configured and the file cannot be found at that pathname it will appear with a red highlight.

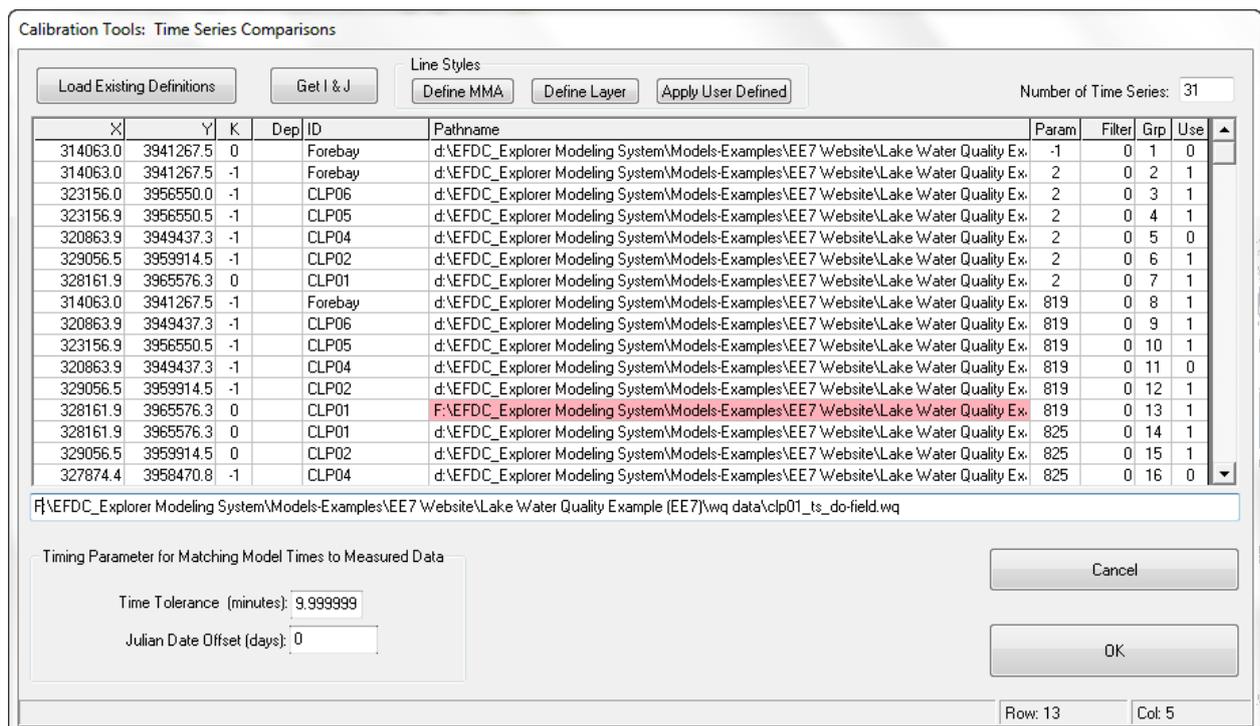
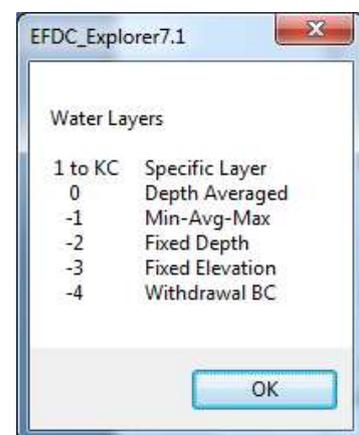


Figure 6-4 Time series calibration EFDC cell and data linkage definitions.

When first starting with the model-data linkage process, the *Number of Time Series* field will be “0”. To initially define or add/remove linkages, enter the number of desired linkages. When the user presses “Enter” the data grid will be displayed with the number of lines required. The number of model-data linkages can be changed at any time. However, the definitions above the maximum number of linkages will be deleted.

The *Get I & J* button allows the user to input X and Y values in the LXLJ units to determine the corresponding values of I & J. The *Line Styles* frame provides a way to define (i.e. the *Define MMA* and *Define Layer*) and then apply (via the *Apply Defaults*) common formatting for all currently defined model-data linkages.



For each model-data pair, the user must specify the information listed in each column:

X & Y: Enter the X and Y in meters of the location of the data station. The coordinate system must be the same as that used for the model. Using these coordinates the matching model cell is determined.

K: This is the layer specification option. There are three options as shown. The Min-Avg-Max (MMA) option generates three model time series for the cell, based on the water column layer results.

ID: The ID field is used for labeling the plots and statistics reports.

Pathname: This field contains the full path to the data file, in DAT or WQ formats, for the specific parameter, location and layer option. The user can enter a "None" or "Skip" in this field to only display a model time series. Rows that are shown in pink indicate pathnames that are not valid (e.g. files were deleted by the user after initial setup) and need to be redefined.

Param: Enter the parameter code that will be extracted from the model for comparison to the data contained in the corresponding data file. The list of currently available parameters is shown in Figure 6-5. RMC'ing on this field (after it has focus) pops up the browse function to allow the user to select or change the file.

Group: This is the plot number. If each line uses a unique Group # then each model-data pair will be displayed on a separate plot. If two or more model-data lines use the same Group # they will be displayed on the same plot.

Use: This is a flag to optionally turn on or off the plots and statistics computation for each model-data pair.

The *Timing Parameter for Matching Models to Measured Data* is used to set the time tolerance in minutes, such that there is a time match when the MODEL_TIME is within the DATA_TIME +/- the tolerance. The Julian date offset is used when Julian dates have been used in the data files rather than Gregorian dates. This offset allows the user to add this number of whole days to the Julian dates



Figure 6-5 Available calibration parameter codes.

6.1.2.2 Time Series Plots

The *Plots* function allows the user to view on screen or export the plots that are currently defined and enabled (i.e. Use flag = 1). The *Plots* function loads the EFDC model linkage files (e.g. EE*.out), reads the observed data files and then scans the model linkage files to build the model-data plots. The user can press ESC during the model output loading process to abort the loading and plotting. When the data has been loaded the time series plotting utility is displayed. This is the same utility used for all other time series and X-Y plots. However, when viewing the time series calibration plots three (3) additional function are available on the toolbar. The following graphic shows the time series plotting toolbar with the three calibration specific functions outlined in red.



These buttons all close the current calibration plot and, in order of the buttons shown, move to the previous plot, move to the next calibration plot or exit the time series calibration viewer. When moving from one plot to the next, when the last plot has been viewed the user is requested to either continue viewing the plots (starting over at plot 1) or exit the viewer.

Figure 6-6 and Figure 6-7 provide example plots produced by the time series calibration tool. Figure 6-6 is for a water surface elevation comparison (layer option K=0). Figure 6-7 shows a MMA time series plot (the “average” series is turned off for this example) of dissolved oxygen (layer option = -1).

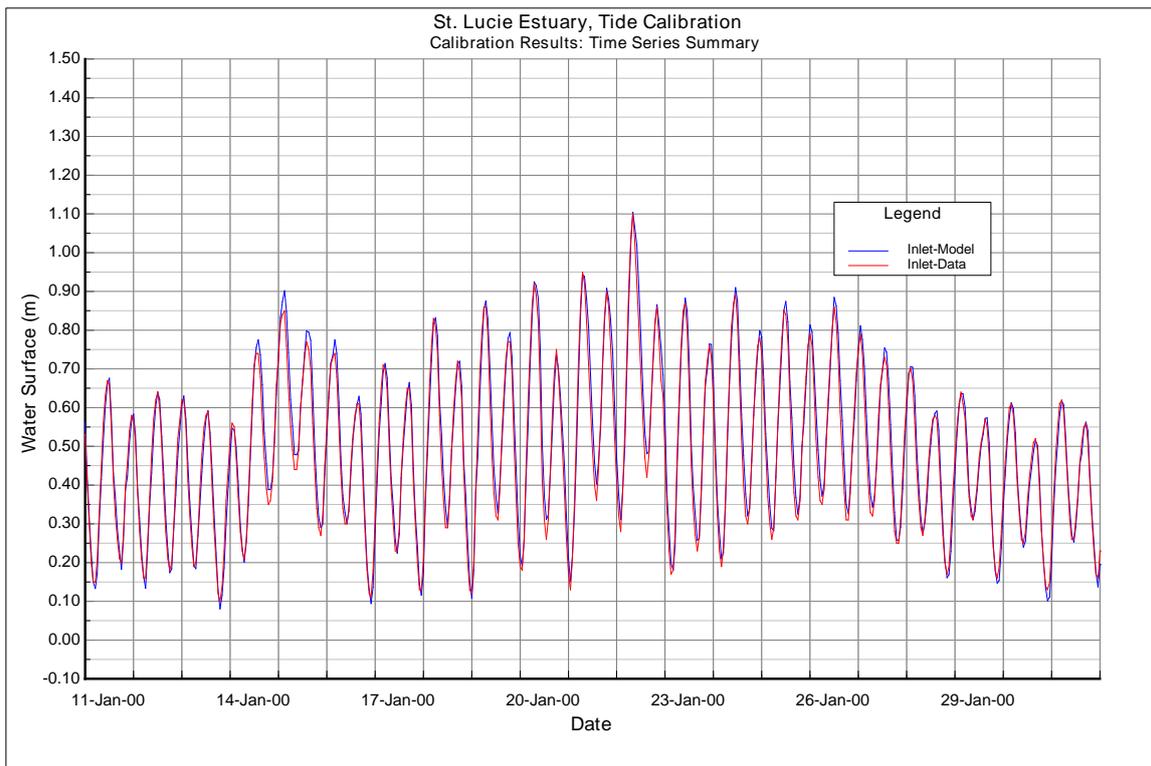


Figure 6-6 Example model-data time series comparison for water levels.

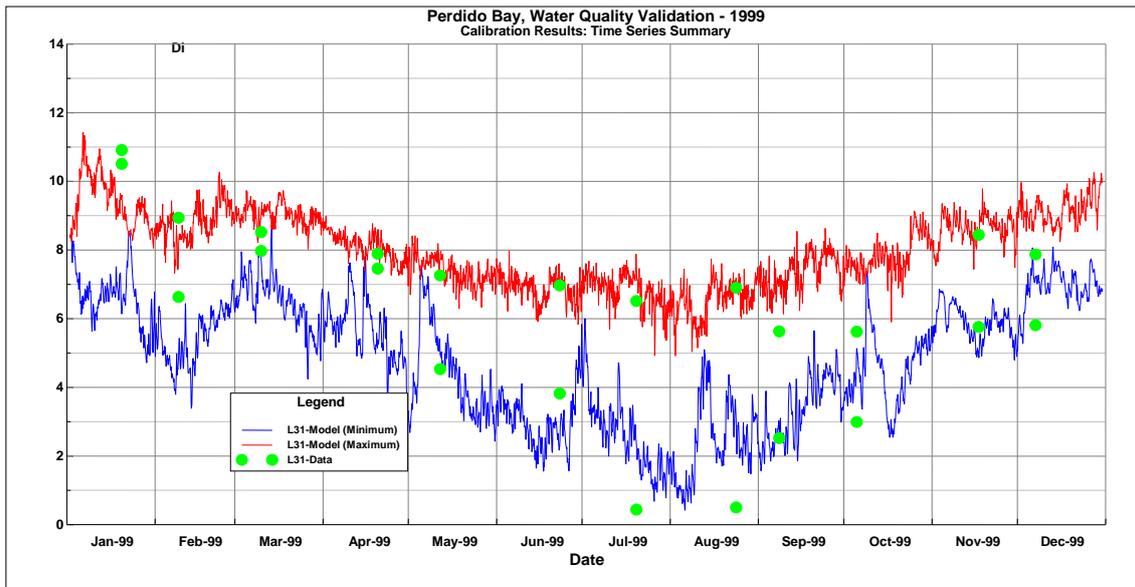


Figure 6-7 Example model-data time series comparison for dissolved oxygen.

6.1.2.3 Low and High Pass Filter

The *Model Calibration | Time Series Comparisons* tool has also been updated to allow comparison with a low and high-pass filter. To access the *Low Pass* option set the *Filter* (formerly *R Avg*) column to a number less than zero as shown in Figure 6-8. The number set is the number of hours for the low pass filter i.e. if *Filter* = -12.4 then the low pass filter is 12.4 hours as shown in Figure 6-9. The options for specifying the type of filter can be accessed by right mouse clicking on the *Filter* field as shown in Figure 6-8.

Figure 6-8 High and Low Pass Filter for Time Series Calibration Plotting.

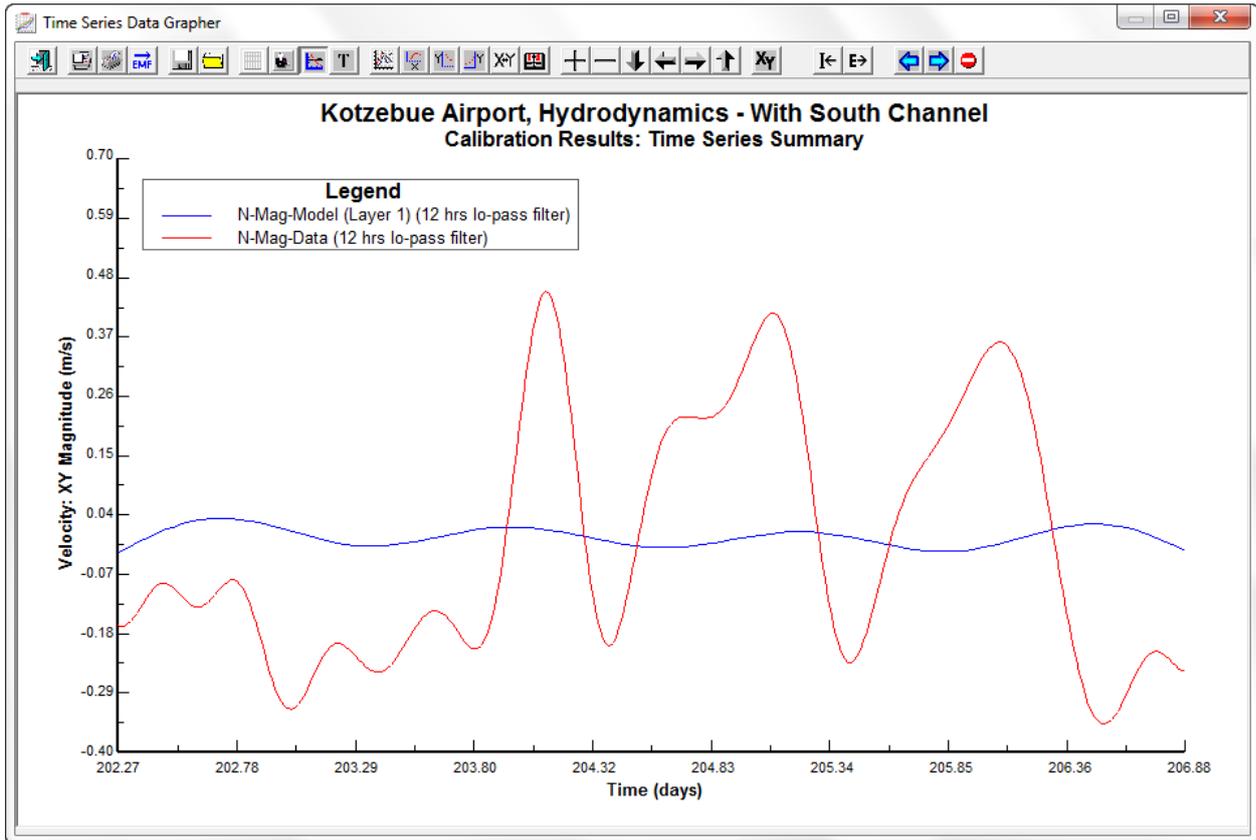


Figure 6-9 Low Pass Filter Calibration Results.

6.1.3. Correlation Plots

A recent feature of EFDC_Explorer is the ability to plot correlations between the model and existing data to assist the user in calibration. The method for setting up correlation plots is similar to that for *Model-Data Configuration* in Section 6.1.2.1. The setting up of linkages is the same as that for *Time Series Comparisons*, however, with *Correlation Plots* the user is able to select which error statistics will be displayed on the plot, as shown in Figure 6-10.

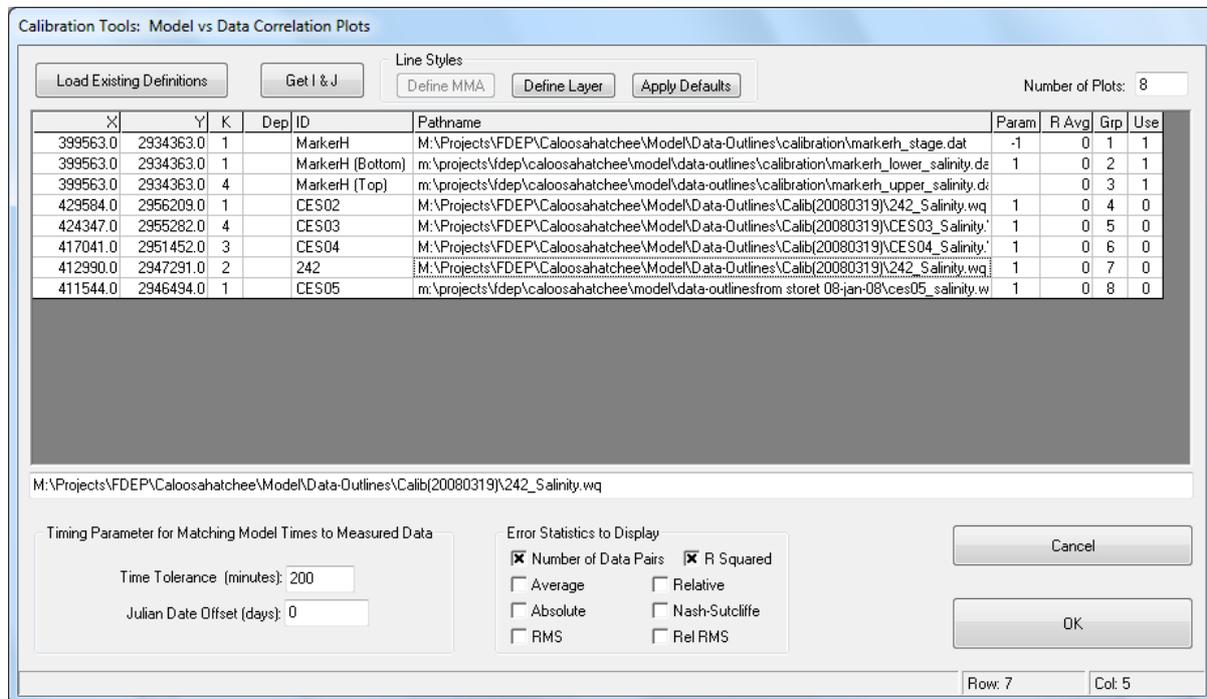


Figure 6-10 Calibration tool: Model vs Data Correlation Plots.

Error statistics which may be displayed are explained in Section 6.1.1 and include:

- R Squared
- Average
- Absolute
- RMS
- Relative
- Nash-Sutcliffe
- Relative RMS

An example of a correlation plot is shown in Figure 6-11. Note that observed data is shown on the x-axis and the model data is shown on the y-axis.

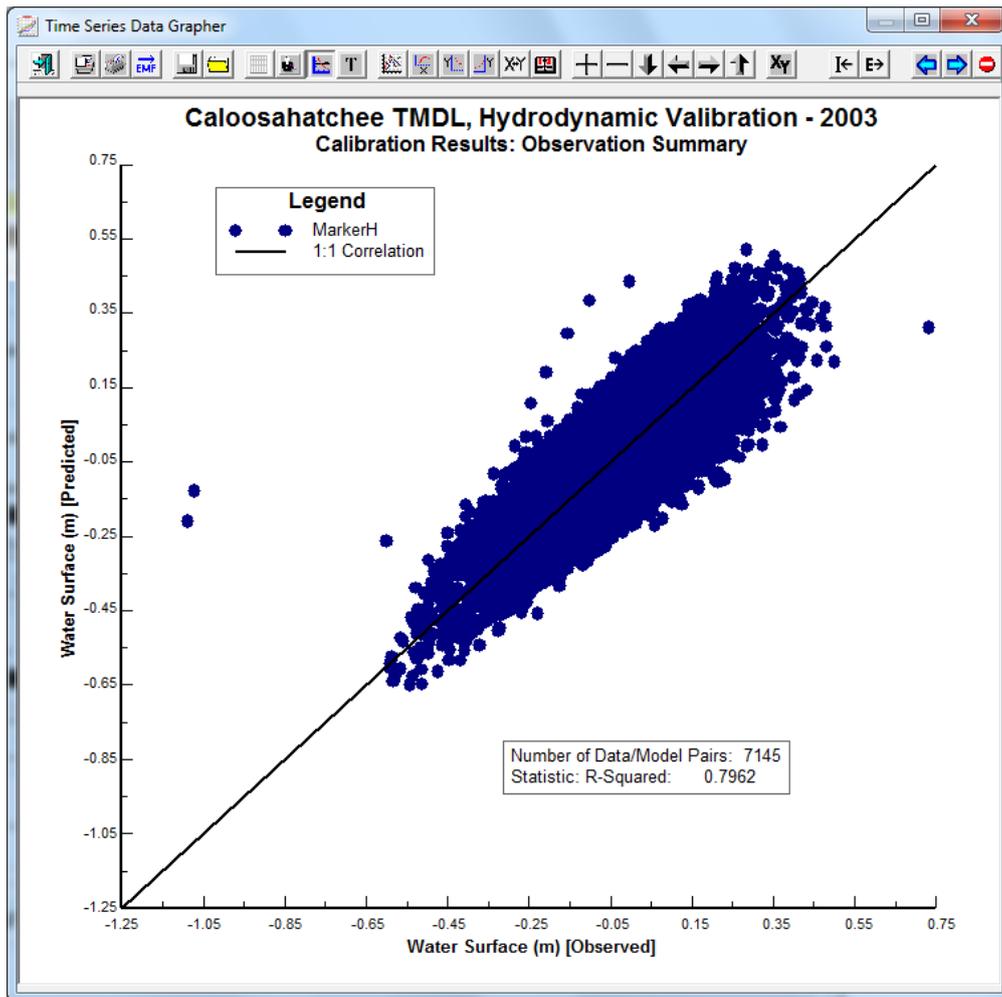


Figure 6-11 Example model data Correlation Plots comparison for water surface elevation.

An additional feature of the *Calibration plot* function is that the box size for each plot may be saved. This means that even though screen aspect ratios may vary between different computers, they will still produce the same final plots. CTRL-W sets the size of the plot box size, and when the user saves the project the size of the plot will also be saved.

6.1.4. Vertical Profile Comparisons

The *Vertical Profile Comparisons* frame contains the buttons that configure (*Define/Edit*) and plot (*Plot*) vertical profiles of EFDC cells and measured profile data. Once configured, the linkages between the EFDC cells and the data is automatically available and the user simply needs to press the *Plot* button to compare model to data for each run. Figure 6-12 displays the form used to link cells to data and other parameters. RMC on the cells to obtain additional input options or guides.

Calibration Tools: Vertical Profile Comparisons

Load Existing Definitions Get I & J Line Styles: Define MMA Define Layer Apply User Defined Number of Profiles: 18

X	Y	ID	Pathname	Param	Use
328161.0	3965576.0	CLP07	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	2	1
320863.9	3949437.3	CLP06	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	2	1
323156.9	3956550.5	CLP05	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	2	1
327874.4	3958470.8	CLP04	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	2	1
329575.0	3958860.8	CLP03	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	2	1
329056.5	3959914.5	CLP02	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	2	1
328161.9	3965576.3	CLP01	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	2	1
314531.5	3941574.0	CLP07	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	819	1
320863.9	3949437.3	CLP06	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	819	1
323156.9	3956550.5	CLP05	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	819	1
327874.4	3958470.8	CLP04	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	819	1
329575.0	3958860.8	CLP03	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	819	1
329056.5	3959914.5	CLP02	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	819	1
328161.9	3965576.3	CLP01	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	819	1
314531.5	3941574.0	CLP07	d:\EFDC_Explorer Modeling System\Models-Examples\EE7.2\Website\Lake Water Quality Example (EE7.2)\wq data\c1p	810	1

Timing Parameter for Matching Model Times to Measured Data

Time Tolerance (minutes):

Julian Date Offset (days):

Cancel OK

Figure 6-12 Vertical profile calibration EFDC cell and data linkage definitions.

The information is very similar to the time series model-data linkage form. However, the *Group* column is missing as the profile plot structure is pre-defined. One other major difference is the format of the data contained in the *Pathname* field. Appendix B (Format B-8) provides guidance on the format. This file can contain one or more snapshots in time for the same station and parameter.

6.1.4.1 Vertical Profile Plots

The *Plots* function allows the user to view on screen or export the plots that are currently defined and enabled (i.e. Use flag = 1). The *Plots* function loads the EFDC model linkage files (e.g. EE*.out), reads the observed data files and then scans the model linkage files to build the model-data plots. The user can press ESC during the model output loading process to abort the loading and plotting. When the data has been loaded the vertical profile plotting utility is displayed. This utility displays up to 8 model-data vertical profiles per page. The following graphic shows the toolbar functions.



The first group of left and right buttons move to the previous and the next vertical profile stations, respectively. The →1 and →A buttons export the current or all defined dates for the current station, respectively, to a Windows EMF file. The – and + buttons move back and forward in time for the current station. The PgUp and PgDn keys have the same functionality. The remaining buttons provide formatting control over the plots.

As an example of the vertical profile plotting function, Figure 5-13Figure 6-13 shows a single page containing a subset of time snapshots for salinity for a data single data station for a 5 layer model.

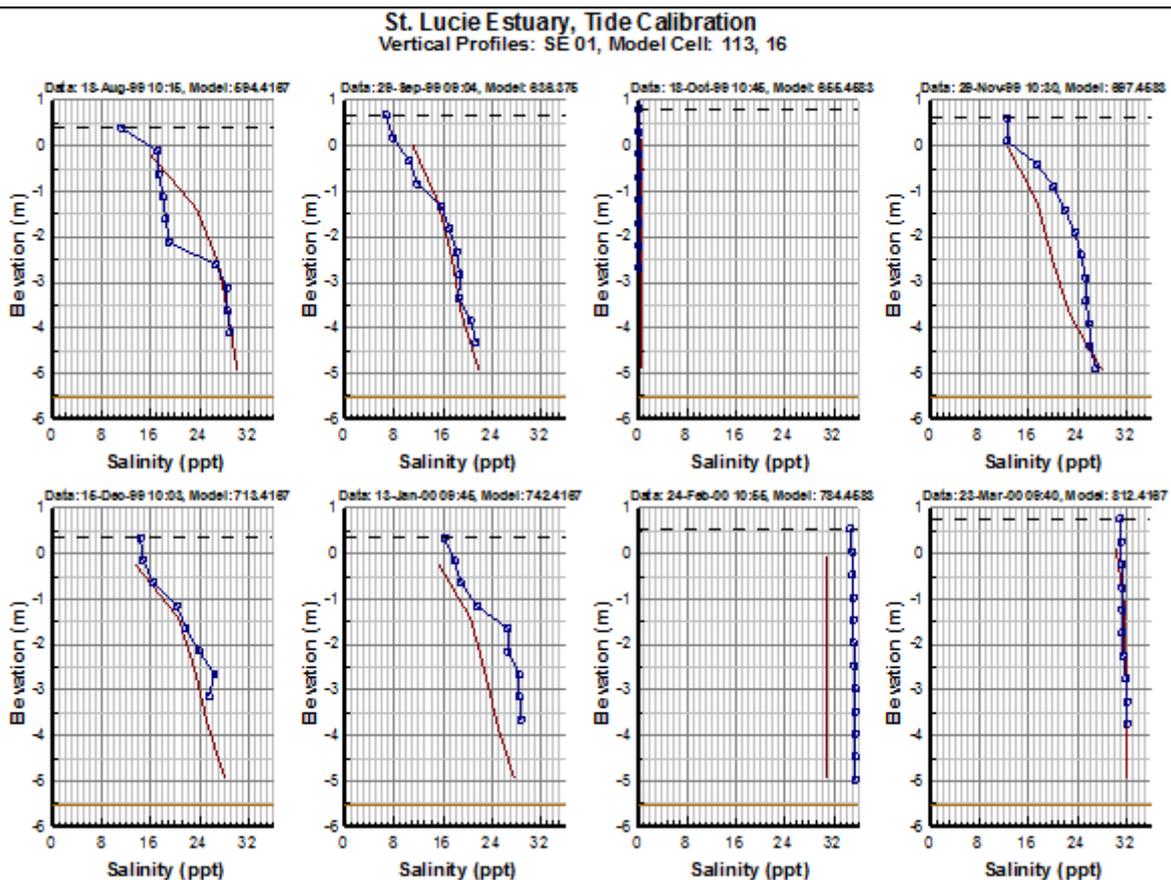


Figure 6-13 Example model-data vertical profile plot for salinity.

6.1.5. High Frequency Time Series

See Section 5.5.2.1 for details of this function.

6.1.6. Flux Comparisons

The flux comparison tool is provided to assist the user in calibration of flux or flow across a user defined line and is accessed as shown in Figure 6-1. The “# of Comps” label displays for the user the number of comparisons that have been defined. The user may *Define/Edit* these comparisons with the appropriate button which displays the form shown in Figure 6-14.

This form provides the user with option of defining the number of time series to be compared in the text box in the top right corner. The user should define an ID (usually a station name), and set the path to the predefined flux like as well as the data file for that flux line. The following five columns are used to set the parameter (based on the parameter codes shown earlier in Figure 6-5). The “R Average” column is used to filter the data with a moving average. The “Mult” column is used as multiplier and “Use” will activate or deactivate this comparison.

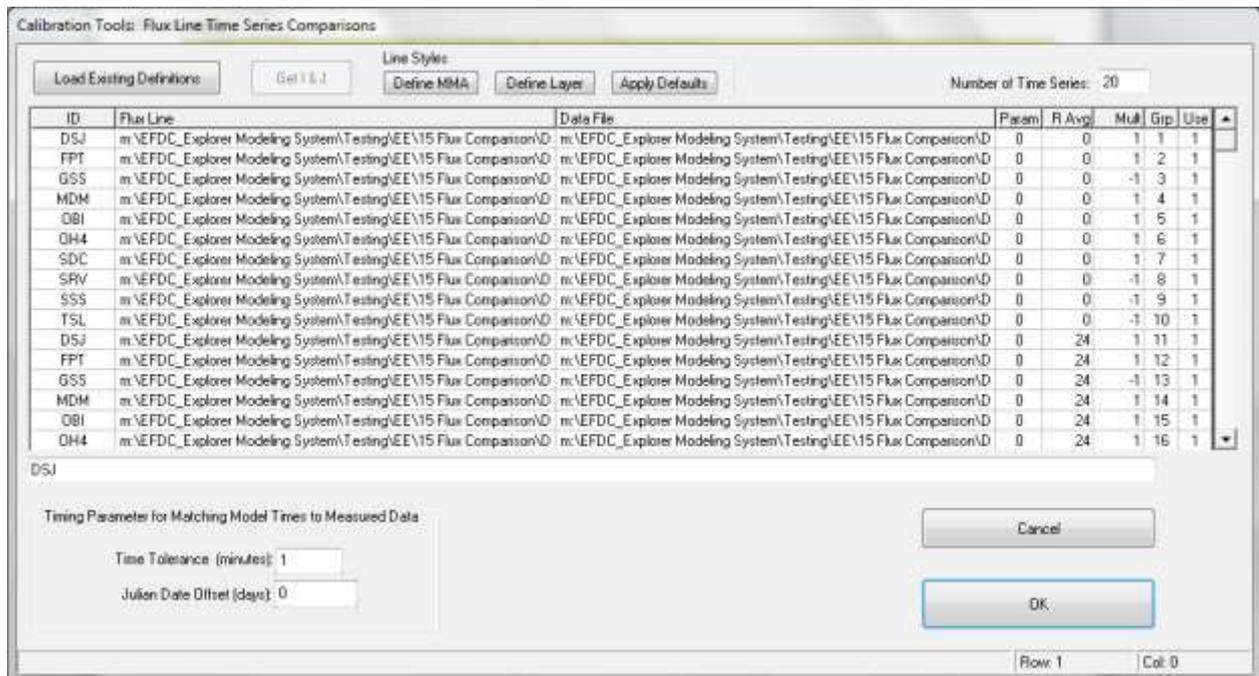


Figure 6-14 Flux Calibration

6.1.7. Cruise Plot Comparisons

Cruise plot comparisons are useful when the user wants to compare a series of continuous sampling data with model output over some distance in the domain. In *ViewPlan* mode the user may define a “cruise line”, which corresponds to the location of data sampling transects that have been undertaken on the waterbody. EE is now able to extract the data from the user defined line and compare with the measured data. This tool can be accessed in *Model Analysis | Model Calibration | Cruise Plot Comparisons* as shown in Figure 6-15.

Figure 6-15 Cruise Plot Comparisons Form.

The user should click on the *Define/Edit* button to set the cruise plot data as shown in Figure 6-16. EE allows the use of two different kinds of cruise plot data. These are defined by station or by track. The user should define a cruise number ID for each data set. This ID will correspond to the USGS defined station IDs. If using native USGS data sets the user should select type 1 for the cruise data type. In this case the format is as shown in Figure 6-17. If using track data the data form should be as shown for type 2.

The data path should be set for text files that are tab delimited format required for the following parameter as explained above and shown in Figure 6-16. All the common parameter types are shown in Figure 6-17. This information box is displayed with the user RMCs on the parameter field.

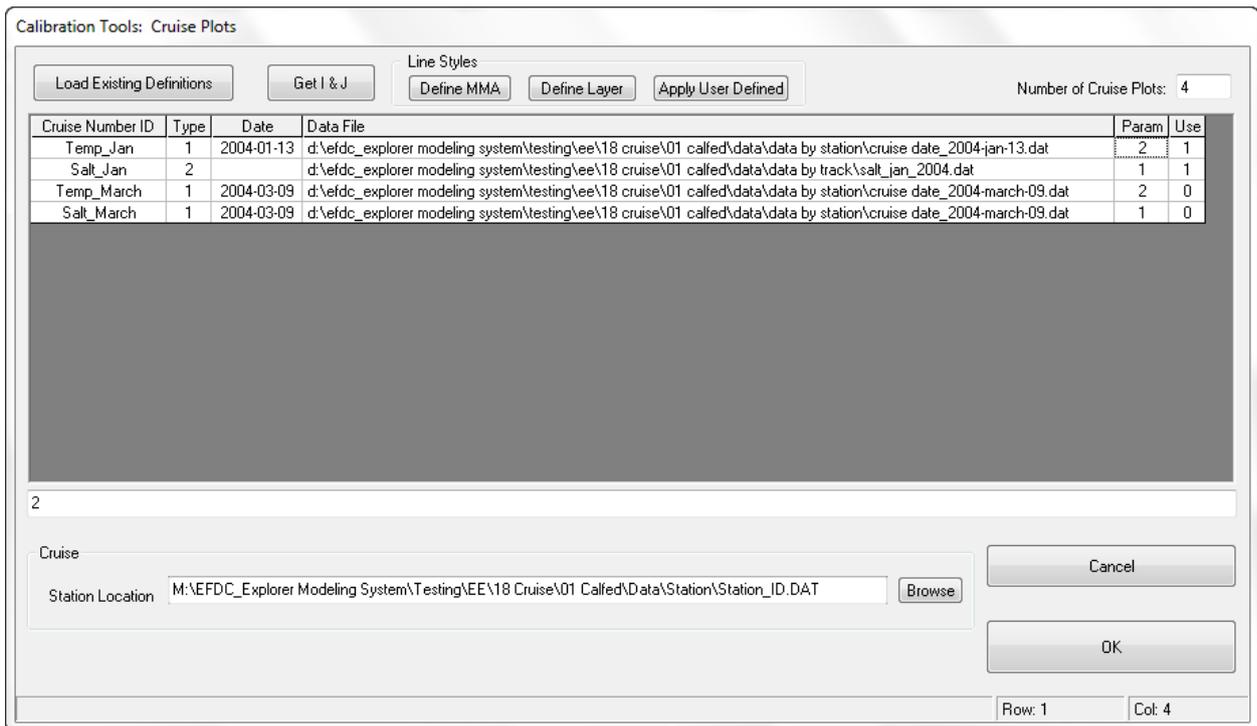


Figure 6-16 Cruise Plot Comparisons – Setting Definitions and Date File Format.

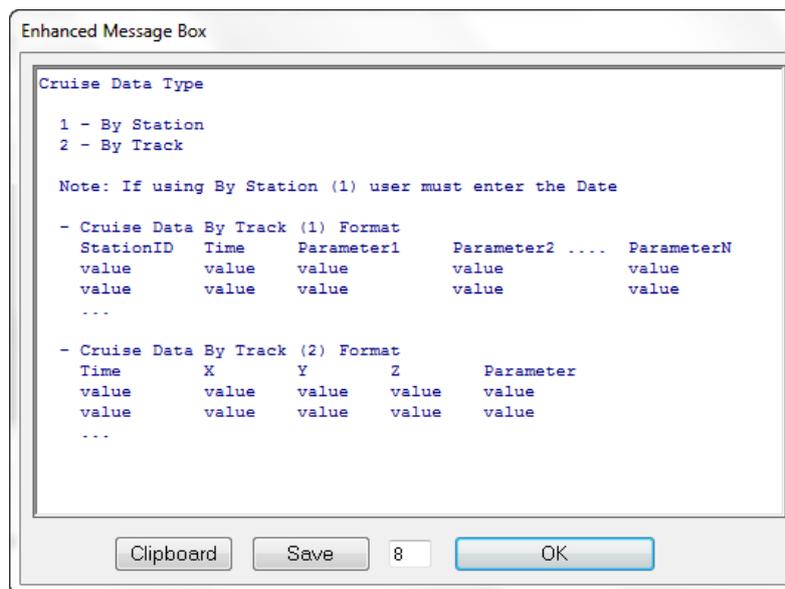


Figure 6-17 Cruise Plot Comparisons – Time Series Plot.

An example *Cruise Plot* is shown below (Figure 6-19) for two parameters: temperature (parameter 2) and salinity (ppt) (parameter 1). Figure 6-18 shows a cruise plot track in San Francisco Bay. Figure 6-19 shows a measured salinity track data from the USGS website and underneath the model output for a study on the San Joaquin – Sacramento Delta.

The colored contour represents the longitudinal and vertical distributions of salinity from the bottom to the surface of the water column. Red represents high salinity concentration, and blue represents low salinity concentration. Color patterns from left to right represent

longitudinal variability, following the cruise line. Color variations from top to bottom show the vertical variability of salinity from the water surface to the bottom. In the cruise plot, all the major locations that are located on the cruise path are displayed as the vertical dashed line.

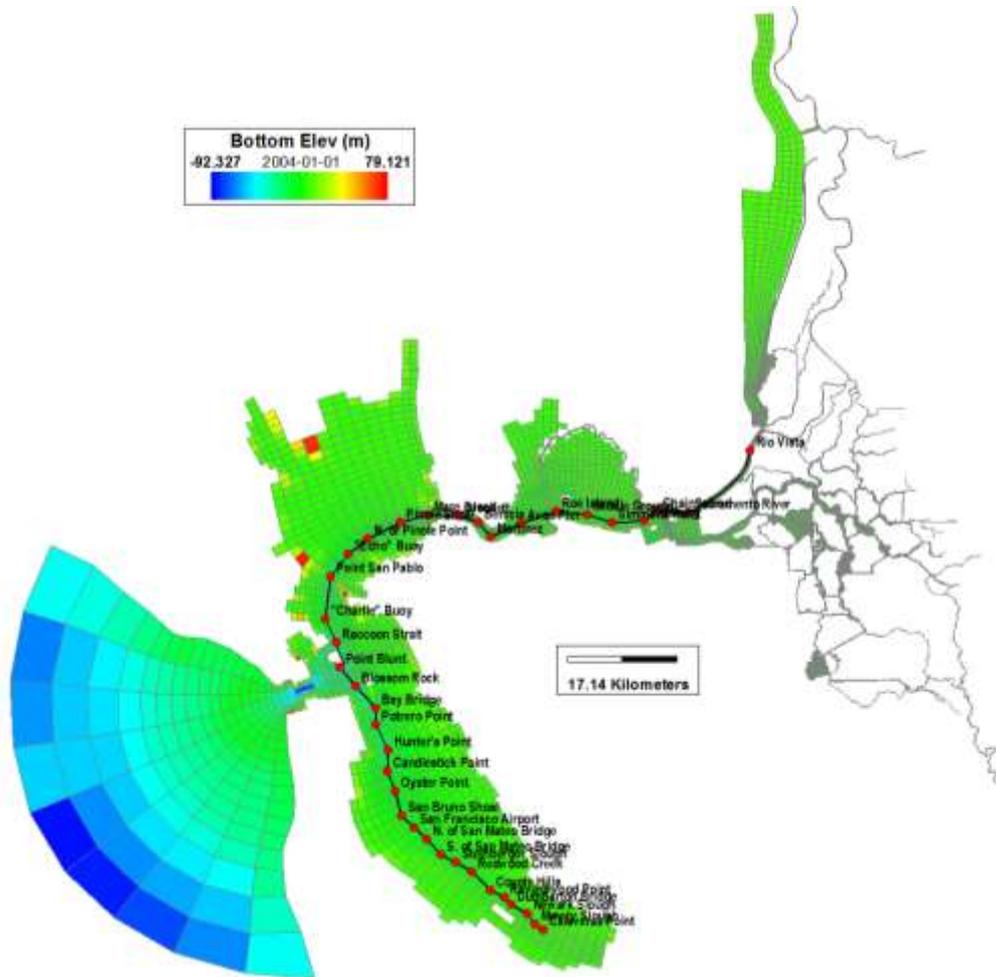


Figure 6-18 Cruise Plot Track in ViewPlan.

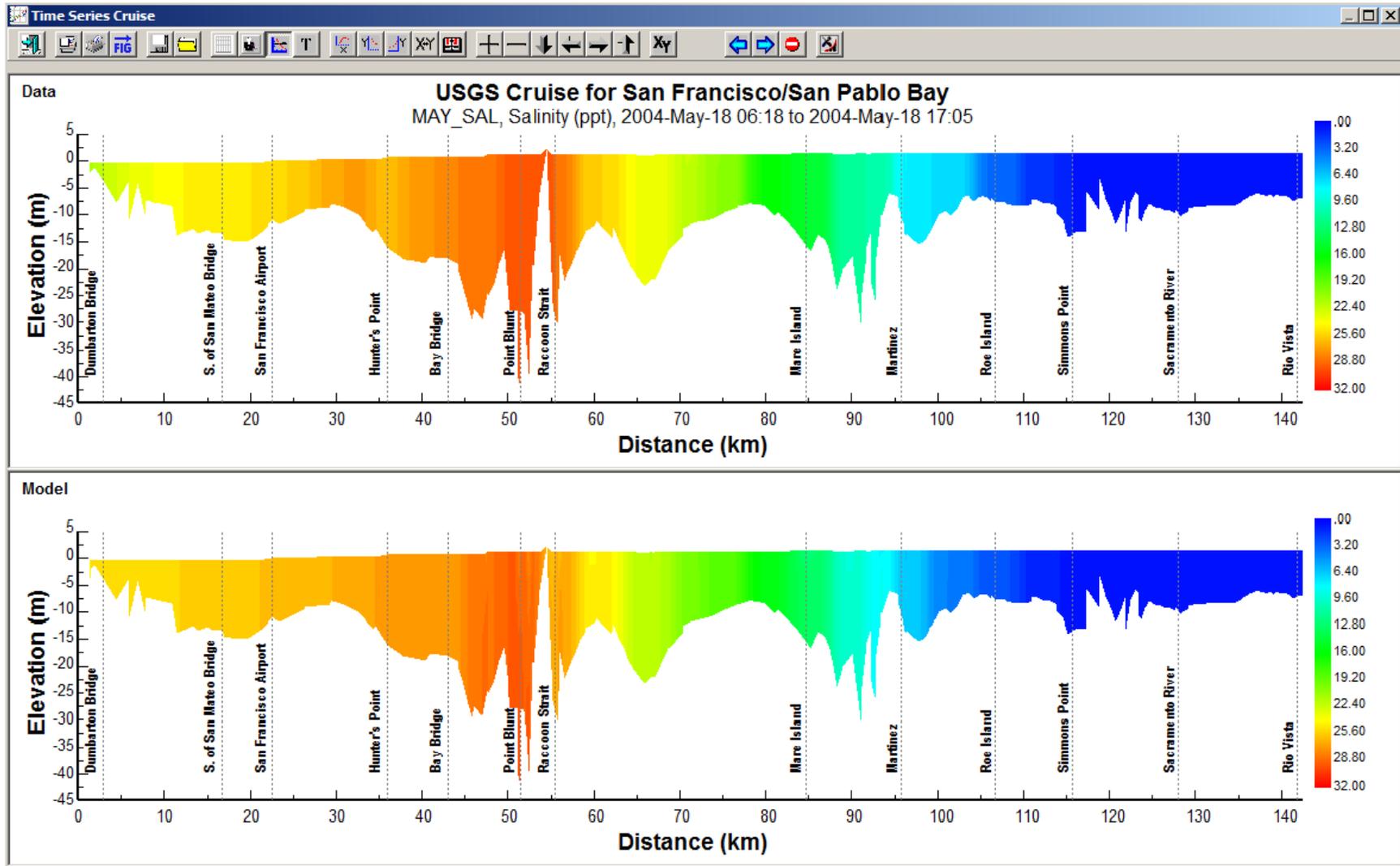


Figure 6-19 Cruise Plot Comparisons – Time Series Plot.

6.1.8. Load 2D Measured Data

The *Load 2D Measured Data* button brings up the form displayed in Figure 6-20. Currently, only velocities can be loaded here, but this feature will be expanded as resources become available. The options area is context sensitive to the option selected for importing.

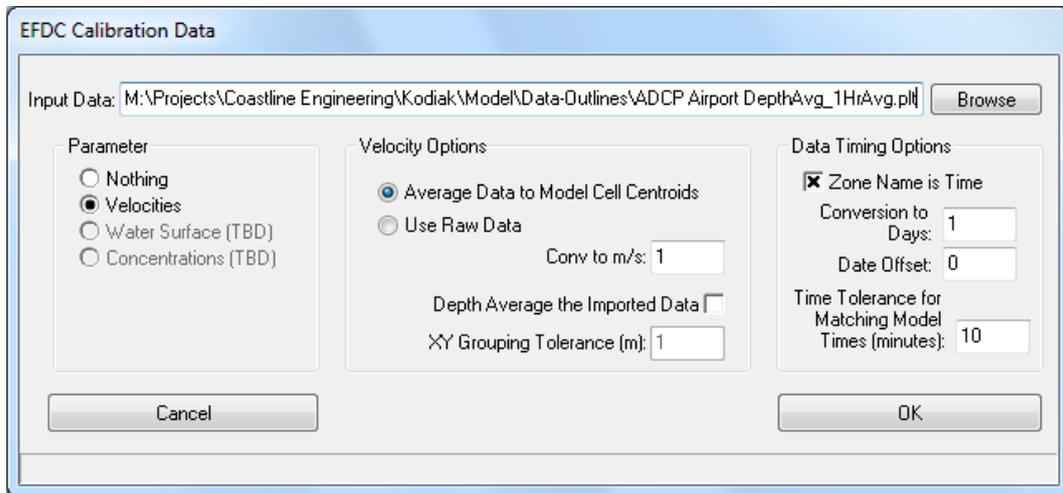


Figure 6-20 Loading measured 2D calibration data.

The data format used for the 2D data currently is the ASCII PLT format used by Tecplot®. An I, J and K 3D regular grid or a series of discrete measured 3D vectors (X, Y, Z, Vx, Vy, Vz) can be input. Pre-processing of the data is expected to be completed so that the data are ready for direct comparison to the model results. For example, if Acoustic Doppler Current Profiler (ADCP) data are being used, the spatial and temporal averaging must be done prior to importing to average the Reynolds stresses (i.e., turbulent fluctuations). One exception to this is EFDC_Explorer has the ability to average the data into the matching EFDC cells.

If the Tecplot formatted data includes multiple depths for a single location, these data can be displayed using the *ViewPlan* layering options or the user can select the *Depth Average the Imported Data* option to collapse all the data into a single X and Y component for each time. Multiple stations can be included in the same file. EFDC_Explorer reports on the data loaded. Please review this summary to ensure that it corresponds to the expected (i.e. the users understanding of the data in the Tecplot file) data.

The *Data Timing Options* frame provides some options of how EFDC_Explorer will interpret the data loaded and convert to the EFDC time reference. If varying time data is to be entered, the Tecplot Zone ID should be used to contain the data time (e.g. Zone="15-Mar-2008 14:45"). If there is more than one zone in the Tecplot data file, during the viewing in *ViewPlan*, the data will only be displayed if the EFDC model time is within the *Time Tolerance* of the measured data.

Once imported, these data are available for plotting and statistical analysis via the *ViewPlan | Velocities* option. To view and calculate statistics for both the model and the data, make sure the *Show Comparison* check box is checked. Figure 6-21 shows an example of two ADCP stations (data shown in red) located in a coastal region being compare to the EFDC model results (model vectors in blue). These model-data comparisons can be animated, if desired.

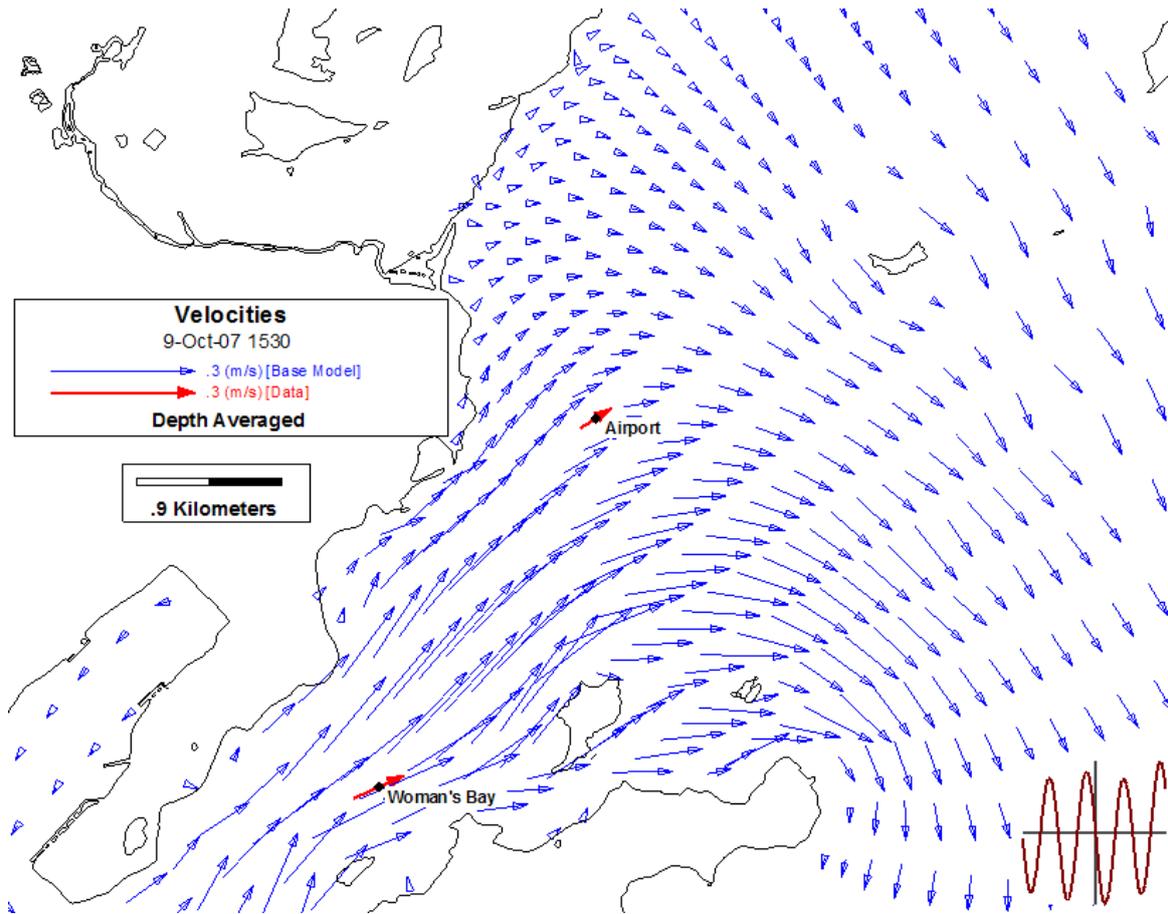


Figure 6-21 Example 2D velocity data comparison.

6.2 Saved Plots Tool

From release of EE7.1, there is a saved plots function which allows the user to apply EE in command line mode for doing batch analyses. This is accessed in *Model Analysis | Saved Plots | Plan View Plots* as shown in Figure 6-22.

In general, when viewing a model for which the user wants to create a standardized plot every time they view it, they first set up the desired view in *ViewPlan* mode. For example the user may want to specify the size of the frame, the location the legend and timing frame. When this is setup to the user's satisfaction they should press *Alt-K* and save the exact layout to a file, and use *Alt-L* to reload it later. This saves a file with extension *.V2D* in *ViewPlan* and *.V3D* in *View3D* (in versions prior to EE8 this extension was *.EEV*). However, it should be noted these saved plots do not record the constituent viewed or the model time.

When the user wishes to use a fixed time and constituent for a whole series of plots the *Saved Plots Function* is required as shown in Figure 6-22. This is selected by pressing the *Define/Edit* button which displays the *Saved Plots* form shown in Figure 6-23. Here the user sets the ID for the constituent, the pathname for the folder containing the *.V2D* file, time for the snapshot and whether to use this plot or not. After the user selects *Generate Plots* all the plots will be saved in a common folder for easy comparison.

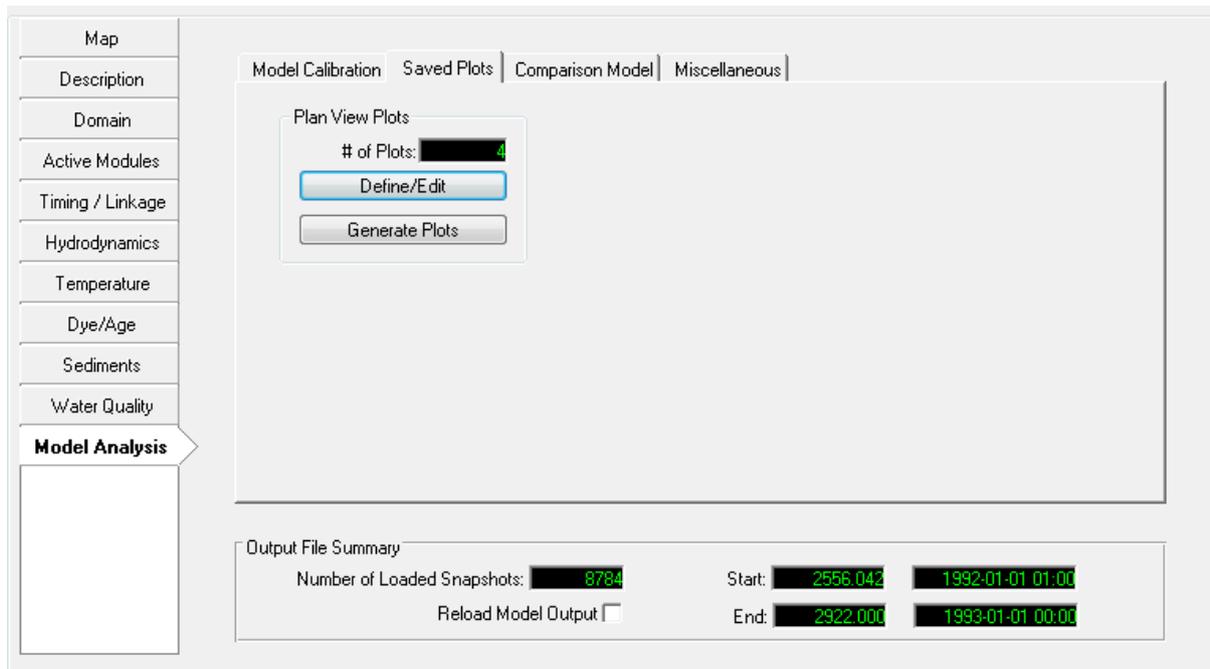


Figure 6-22 Model Analysis: Saved Plots Tool.

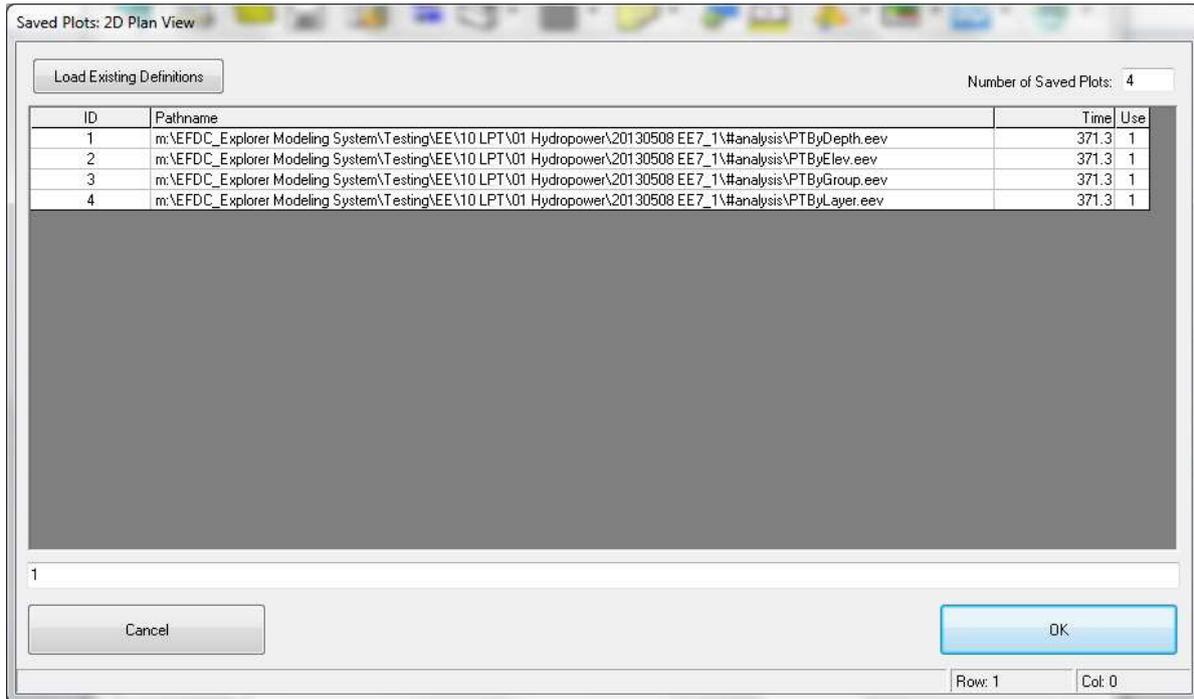


Figure 6-23 Model Analysis: Saved Plots definition form

6.3 Model Comparisons

The *Model Comparisons* tab shown in Figure 6-24 provides the user with access to the compare model input (currently limited to bathymetry) and model results (currently limited to water surface and velocities) functions.

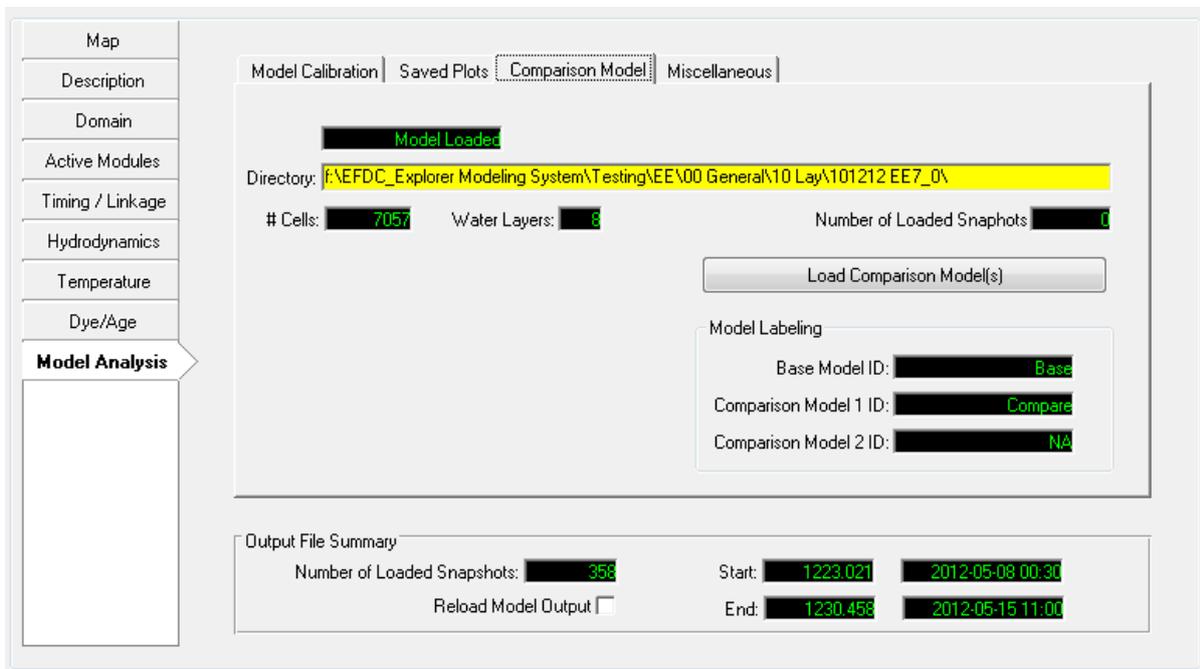


Figure 6-24 Model Analysis Tab: Comparison Data.

6.3.1. Load Comparison Model

The *Load Comparison Model* button allows the user to load a comparison model into EFDC_Explorer for plotting a range of comparisons between the two models. Figure 6-25 shows the model comparison options form. Currently, this option is functional for comparing bottom elevations, water levels, fixed parameters, velocities, sediment bed, water column and inundation extents. The results of any model comparisons are available in the appropriate viewing option of *ViewPlan* by pressing alt-M as shown in Figure 6-26.

The currently loaded model is the *Base* model. Use the browse to the project directory and then select the *Compare* model desired.

To only compare model bathymetry between models the current project's output does not need to be loaded. However, to compare the water depths and/or velocity fields between two models the output data for the current project must be loaded. If the current project's data are loaded, EFDC_Explorer allows the user to load the water depths and velocities from the *Compare* model.

The *Time Matching Option* frame provides a comparison of the snapshot frequency output between the two models. The *Time Tolerance* input box allows for some slight differences in model output times when comparing time snapshots during the simulation.

Once all the options are set, the user should press the *Load Compare* button. Until this button has been pressed, no input or output data for the Compare model is loaded.

The *Load 3rd Model* button is only used to compare water depths and elevations in *ViewPlan*. The viewing option of *Water Depths/Areal Extents* allows the user to overlay the areal extents and depths (as a function of duration and depths) for up to three scenarios. If using this option, the base model should have the largest extents with the second and/or third model having the smallest extents. A typical example would be to display the areal extents of a 100 year flood (the *Base* model), a 50 year flood (*Compare Model*) and a 10 year flood (*3rd WD* model).

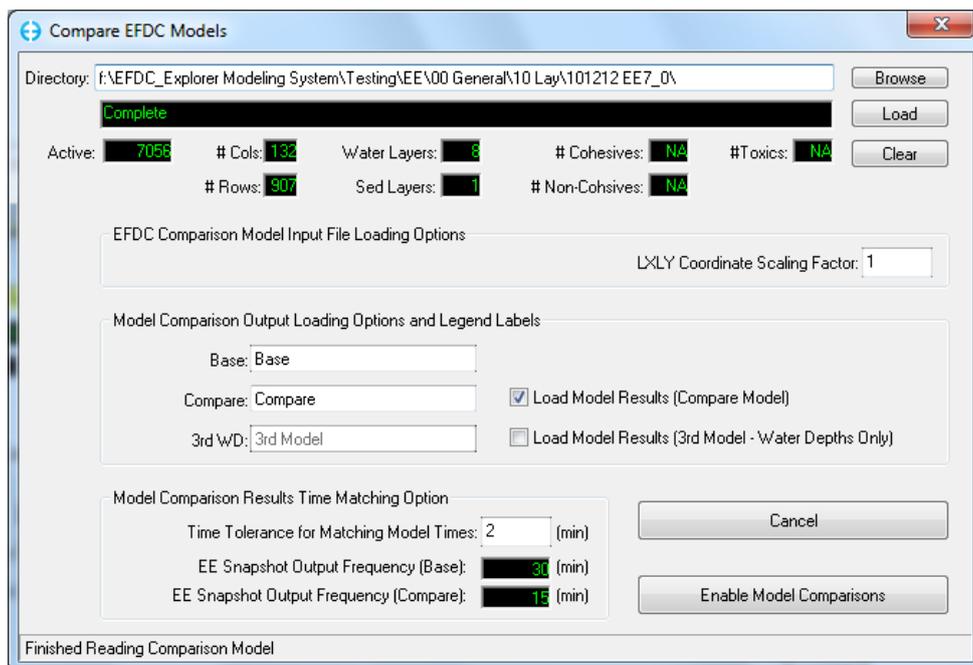


Figure 6-25 Load a comparison EFDC model .

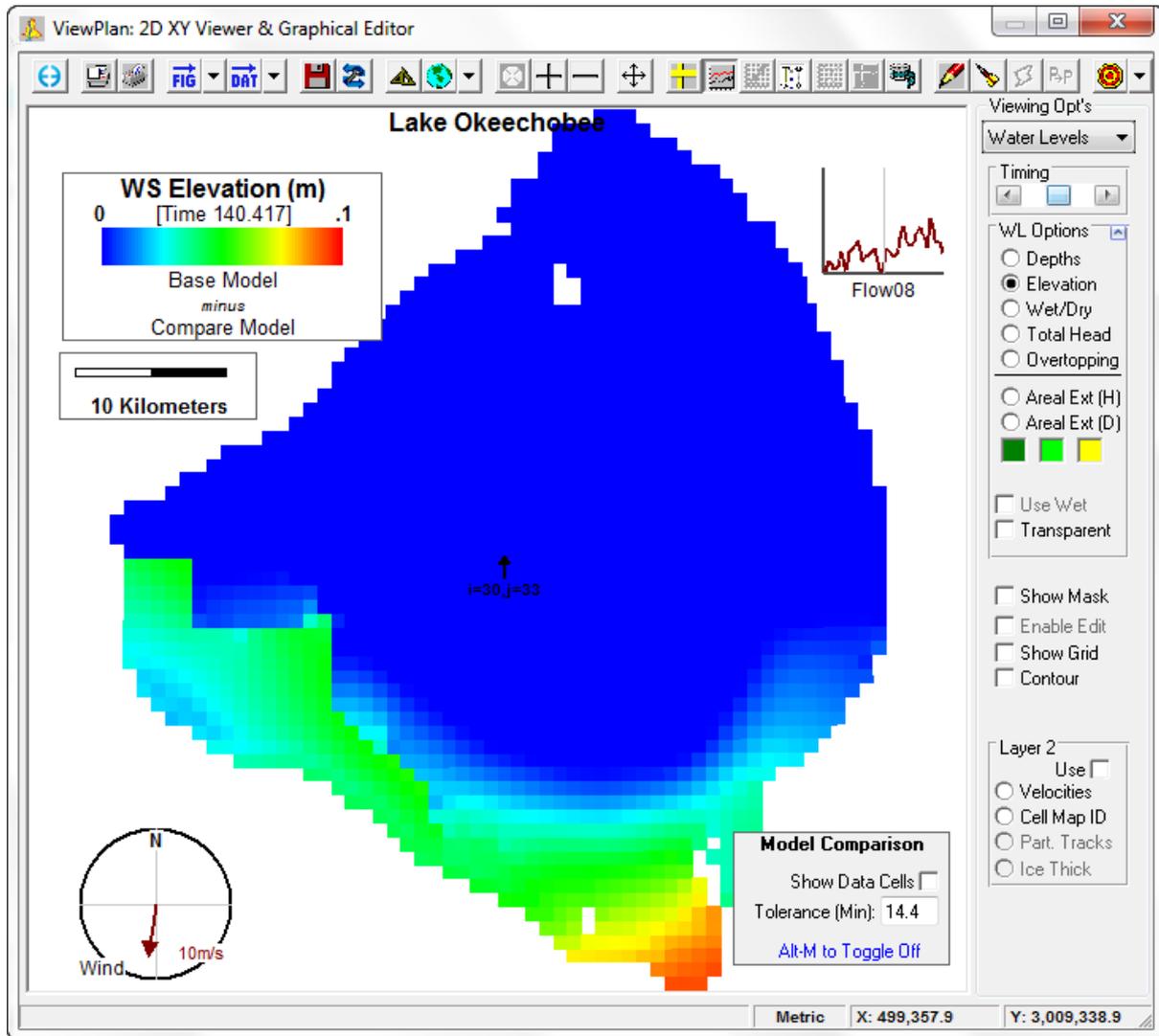


Figure 6-26 ViewPlan: Model Compare for WS Elevation.

When a user has a comparison model loaded it is also possible to view the time series extraction comparison between models. After selecting Alt-M in *ViewPlan* to compare the model results as shown in Figure 6-26, extract the time series Base – Compare models as shown in Figure 6-27.

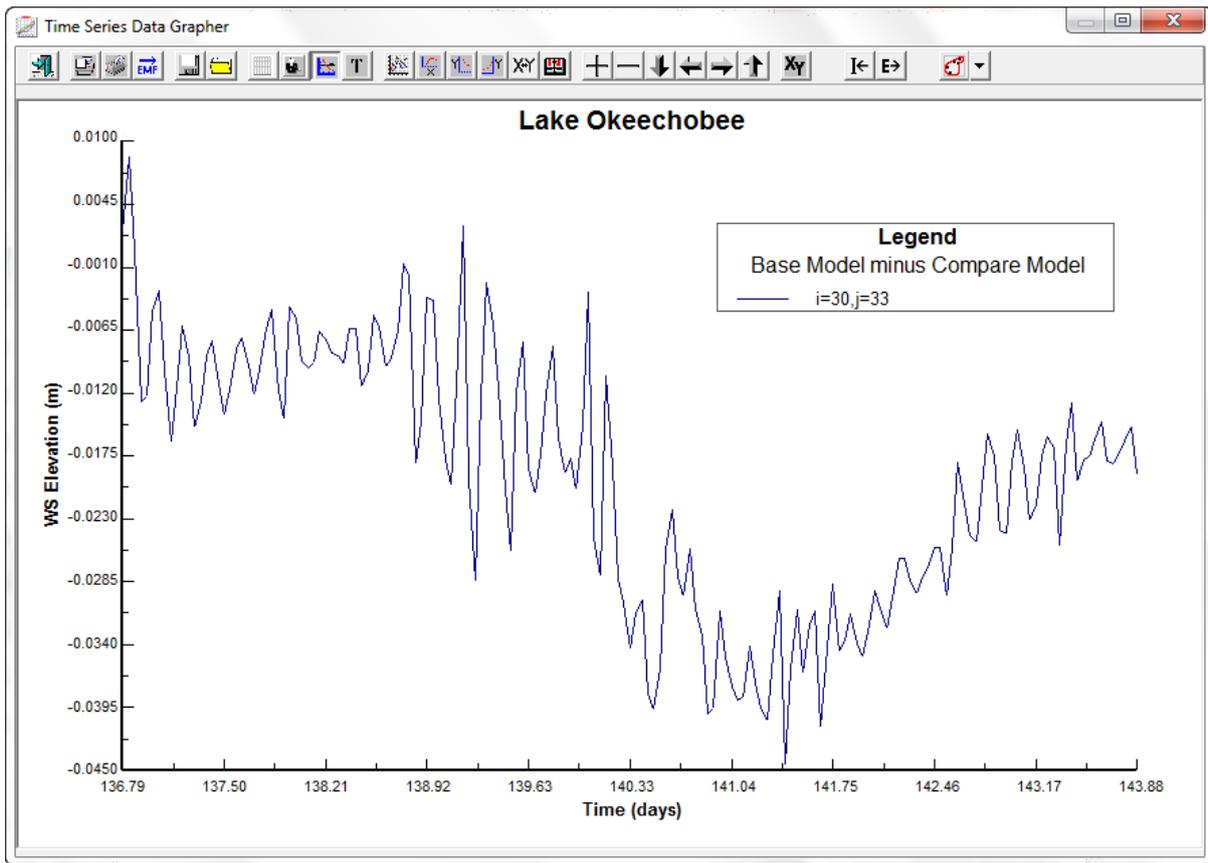


Figure 6-27 Time Series Extraction: Model Compare for WS Elevation.

6.4 Forced Evaporation

The *Forced Evaporation (FE) Analysis* capability has been developed to quantify increased evaporation induced by increased water temperatures due to releases from thermoelectric power plants. These power plants withdraw cooling waters, which once run through the plant and are returned/discharged to rivers or lakes at a higher temperature than the ambient water temperature. This higher temperature water causes additional evaporation (forced evaporation) from the river or lake. This additional evaporation is counted as water consumption by regulators as it is no longer available to downstream users.

Evaporation is dependent on wind speed, atmospheric humidity, and water temperature. There are a number of methods to compute FE using different wind functions as listed in Table 6-1. The wind functions are computed using data contained in the ASER file (ASER.INP) in EFDC.

Table 6-1 List of Evaporation Calculation Methods

IEVAP	Evaporation Approach	General Usage
0	Do Not Include Evaporation	
1	Use Evaporation from ASER	Measured or Externally Estimated
2	EFDC Original	
3	Ward, 1980	Cooling Lake
4	Harbeck, 1964	Cooling Lake
5	Brady et al, 1969	Cooling Pond
6	Anderson, 1954	Large Lake
7	Webster-Sherman, 1995	Lakes
8	Fulford-Sturm, 1984	Rivers
9	Gulliver-Stefan, 1986	Streams
10	Edinger et al., 1974	Lakes/Rivers
11	Ryan-Harleman 1974	Lakes/Rivers

Using these various evaporation methods, the model is first run with the power plant, and then run again without the power plant. EE then subtracts the output from two models and displays the difference which is the consumption of water from the power plant. The user may select “with power plant” option to calculate evaporation in the *Temperature* tab in the *Heat/Temperature* frame as shown in Figure 6-28. The evaporation options are only available if temperature is being simulated and the ASER file is used.

Once temperature is activated and the correct *Surface Heat Exchange Sub-Model* option has been selected the user can choose which evaporation approach is desired. Even if evaporative losses are not a major concern, the evaporative mass fluxes should normally be activated for most models.

Heat flux due to evaporation is always included for the *Full Heat* and the *Equilibrium Temperature (W2)* options.

EFDCPlus/EFDC_Explorer Forced Evaporation (FE) toolset results have been compared to the Electric Power Research Institute’s (EPRI) FE estimates. EPRI’s once through cooling FE analysis for river discharges is based on a USGS report on water consumption by thermoelectric power plants (USGS, 2013; EPRI, 2013).

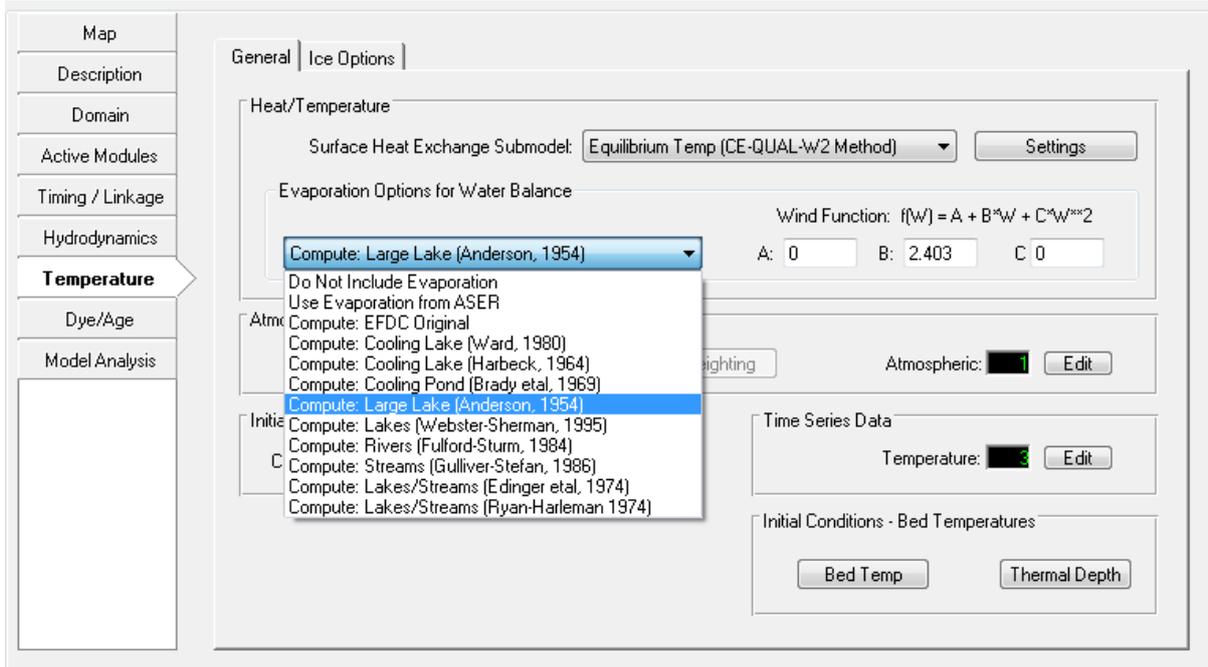


Figure 6-28 Forced Evaporation: Evaporation Options for Water Balance.

Once the models runs have been completed, the user should go to the *Model Analysis | Forced Evaporation* tab where the options for model comparison are provided as shown in Figure 6-29.

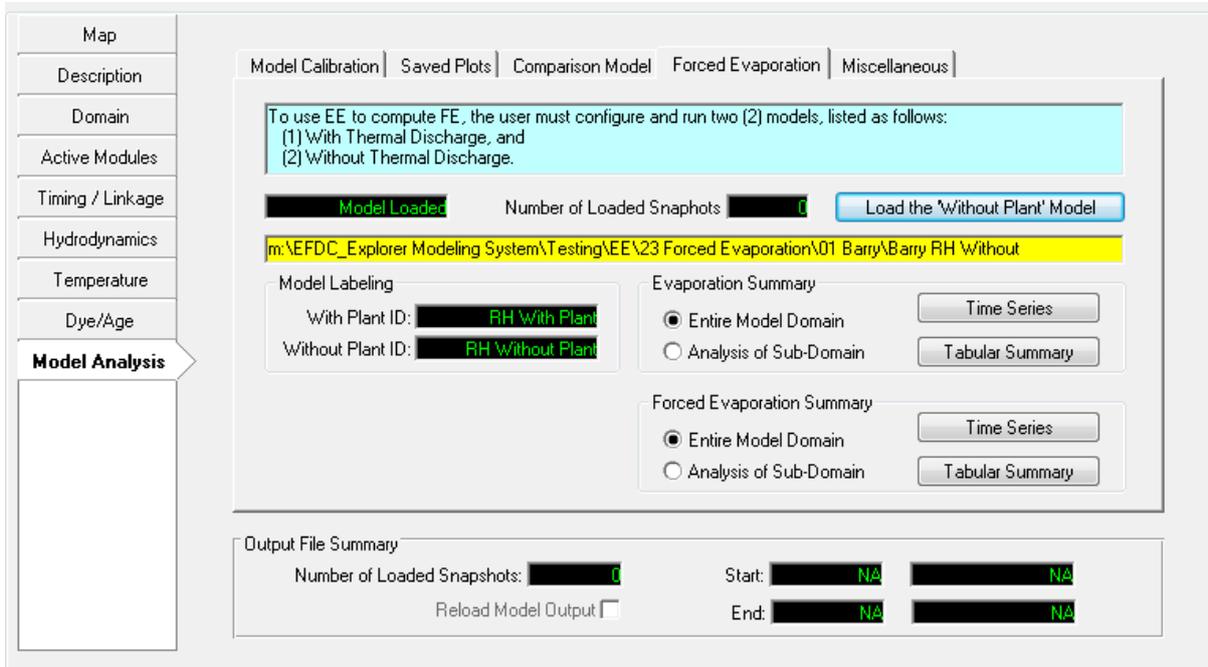


Figure 6-29 Forced Evaporation Options GUI

To display the general instructions on how to conduct a forced evaporation (FE) analysis using EE, click on the blue text box shown in Figure 6-29. EE will display the instructions shown in Figure 6-30.

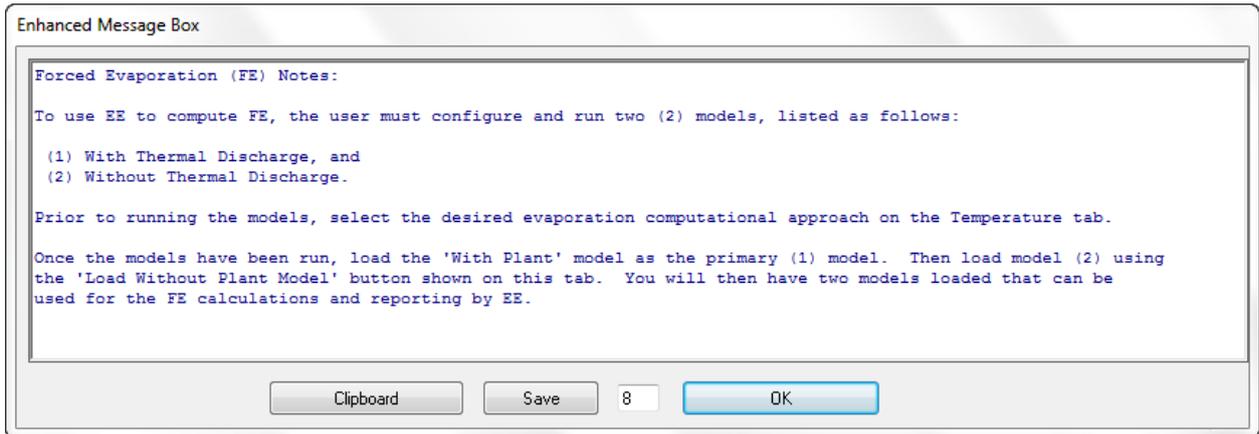


Figure 6-30 Forced Evaporation Analysis Setup Instructions.

As outlined Figure 6-30, the user should then load the *With Plant* model as the primary (1) model. Next load model (2) using the *Load Without Plant Model* button shown in Figure 6-29. This will display the form shown in Figure 6-31. After selecting *Enable Model Comparisons*, two models will have been loaded that can be used for the FE calculations and reporting by EE.

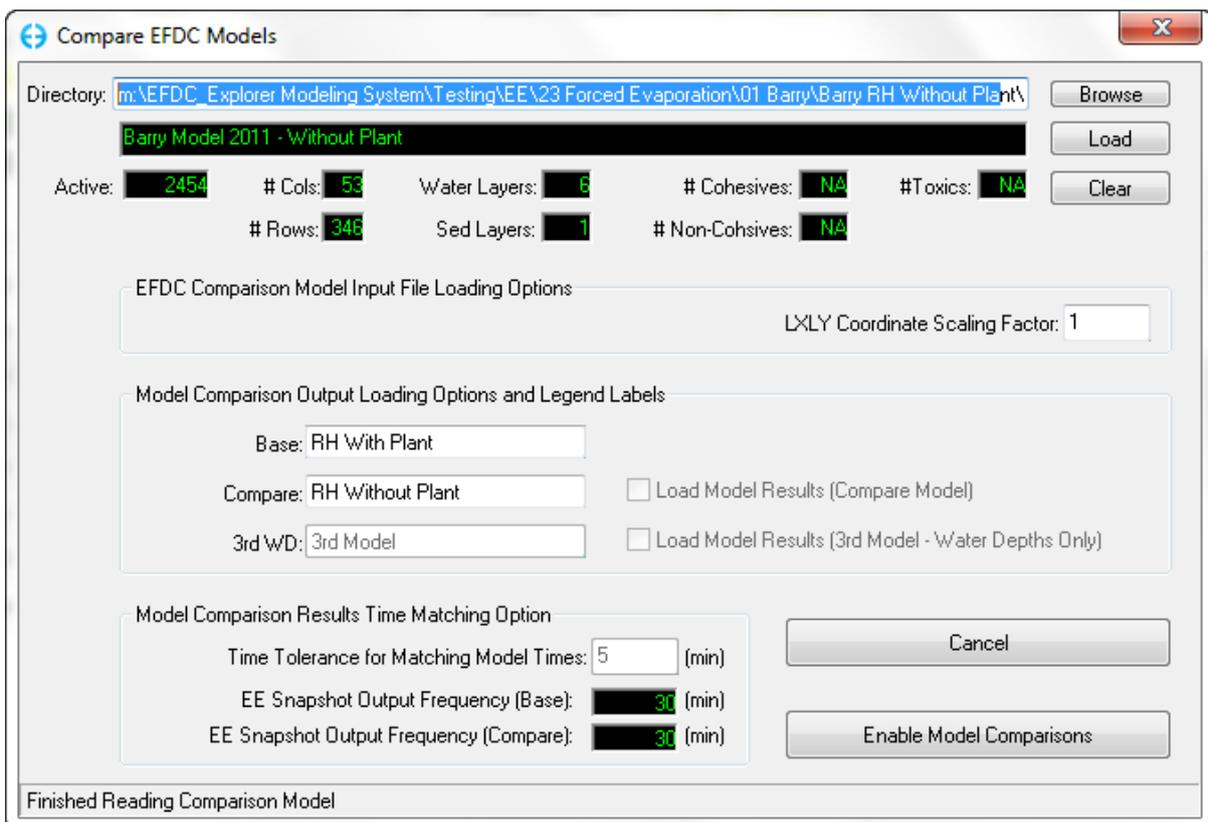


Figure 6-31 Forced Evaporation: Compare Models Options.

The *Model Labelling* frame in Figure 6-29 tells the user the type of FE option that has been selected. In Figure 3-2, “RH with Plant” refers to model run that used Ryan-Harleman approach. Time series plots may be automatically generated for either evaporation (no plant) and forced evaporation (with plant) using the buttons in the respective frames. A plot of forced evaporation (mm/day) and cumulative volume of forced evaporation is shown in Figure 6-32.

The user can also produce summaries of evaporation and forced evaporation using the *Tabular Summary* button as shown in Figure 6-29.

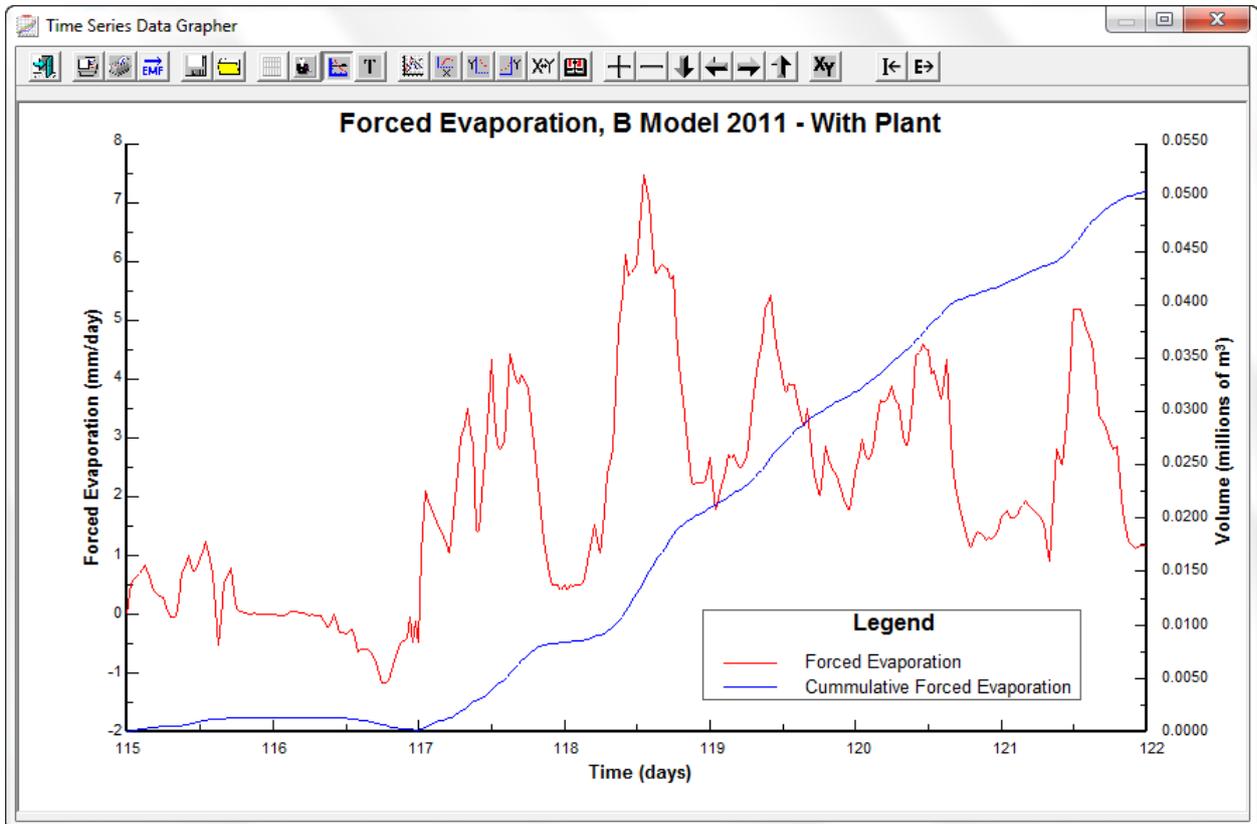


Figure 6-32 Forced Evaporation: Time series using Anderson evaporation approach.

Another way to display the impact of FE between the two models is in *ViewPlan*. Here the user should select the *Volumes | Evaporation* viewing option. Selecting Alt M will toggle on the *Model Comparison* tool which allows the user to visualize evaporation/rainfall as “With Plant” minus “Without Plant” models as shown in Figure 6-33.

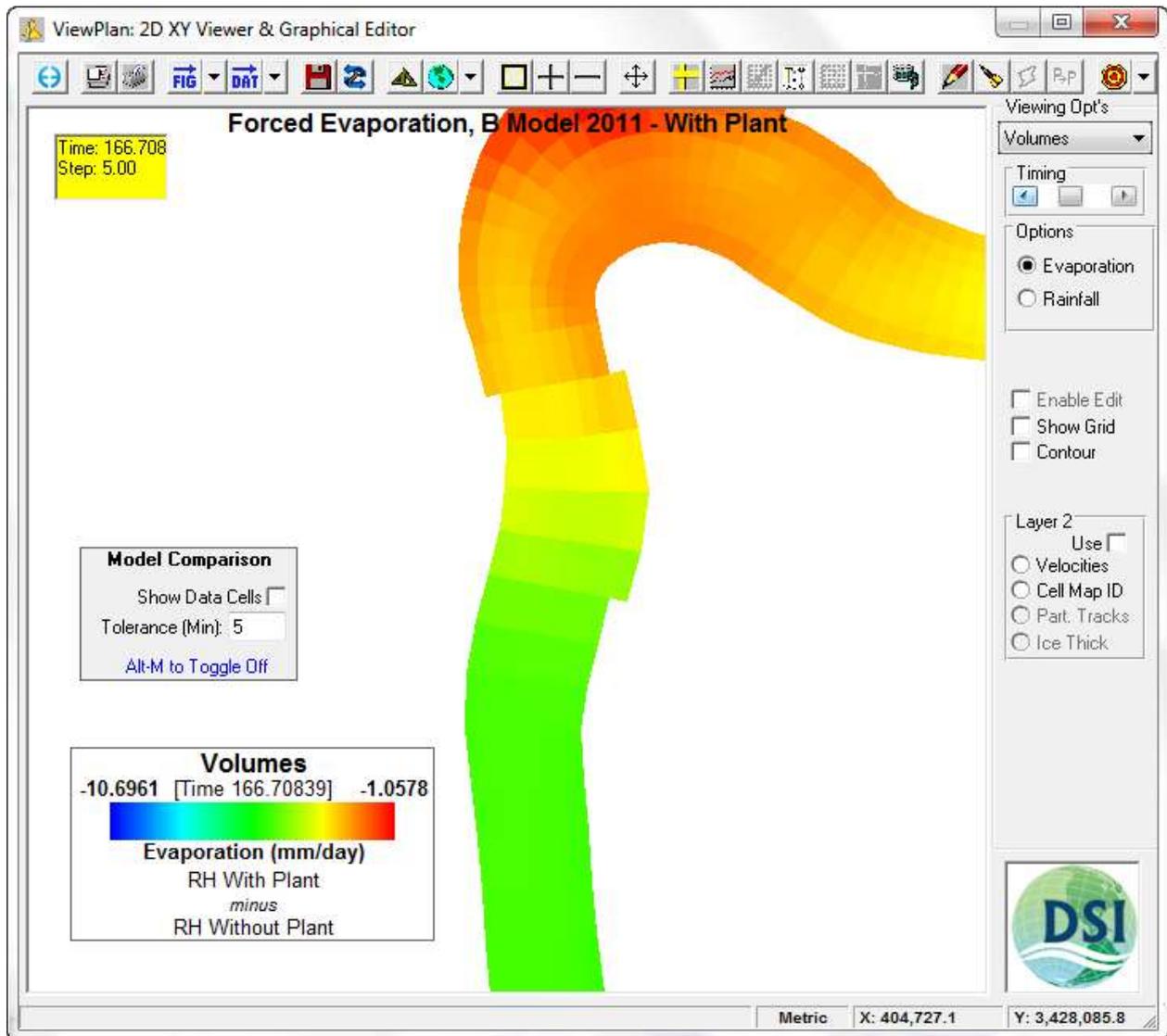


Figure 6-33 Forced Evaporation: Model Comparison using Anderson approach.

Another new and related feature in EE7.3, is the user can now generate time series of the differences in water column results as shown in Figure 6-34. DT means “delta temperature”.

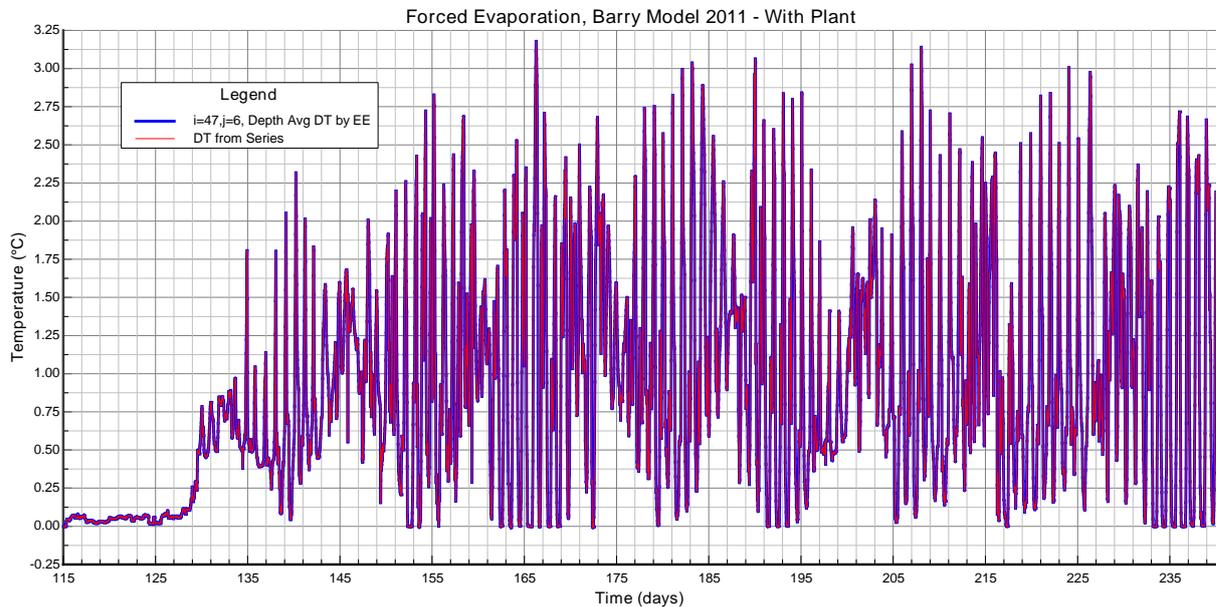


Figure 6-34 Forced Evaporation: Time series of model comparison for temperature.

6.5 Miscellaneous/Profile/Series

Figure 6-35 show the Miscellaneous Tab for Model Analysis. The various features are described under each frame below.

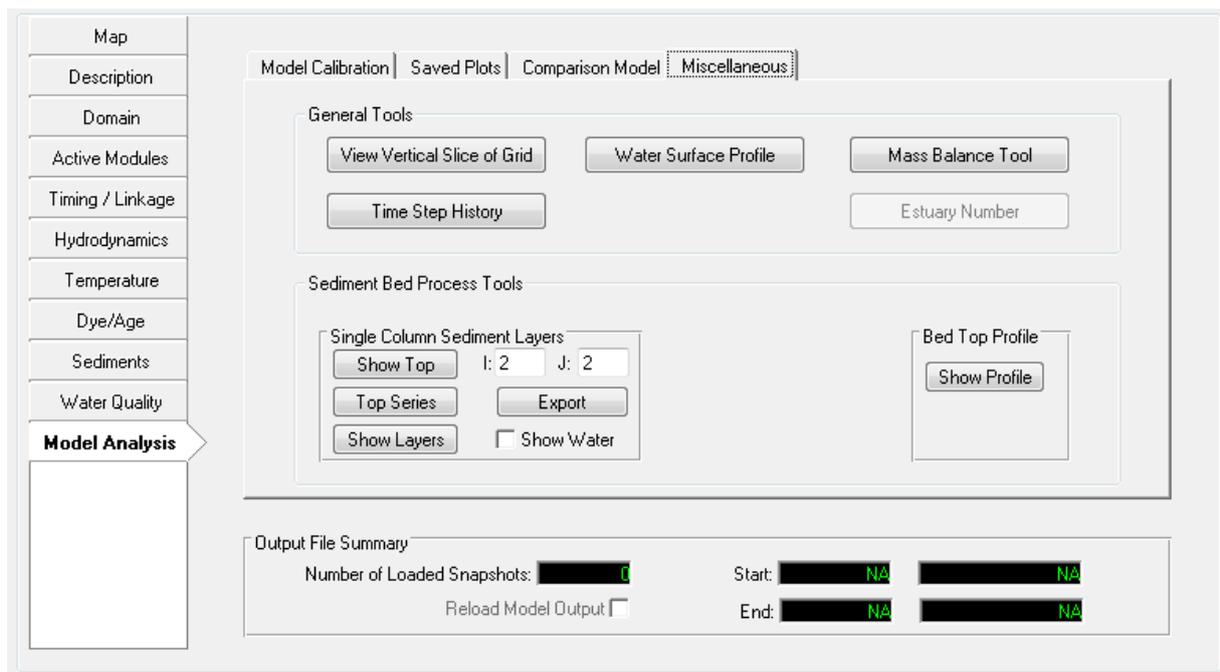


Figure 6-35 Model Analysis Tab: Miscellaneous.

6.5.1. General Tools

Access to some of the profiling and time series options are available on the *Profile/Series* tab (Figure 6-36). Each major option or feature will be discussed below.

The *Profile Location Option* frame needs to be set first before a profile can be extracted from EFDC *ViewProfile* or any of the profiles shown in the *Post Processing* form. There are three profile extraction options. The user may either select a value of I to extract the active J cells along that I, or select a value of J to extract the active I cells along that J. The third option is to use a *Drape Line*, which is a polyline in the same coordinate system as the LXLY data. The I & J's from along the line will be assembled and the profile will be output along that slice.

6.5.1.1 *View Vertical Slice of Grid*

The *View Vertical Slice of Grid* button simply extracts a profile using the settings in the *Profile Location Option* frame and displays the water column and sediment bed layering (if KB>0). Figure 6-36 shows an example slice. If the drape line or the I/J extraction falls across inactive cells a gap will be displayed. The water surface displayed is based on the initial condition depths.

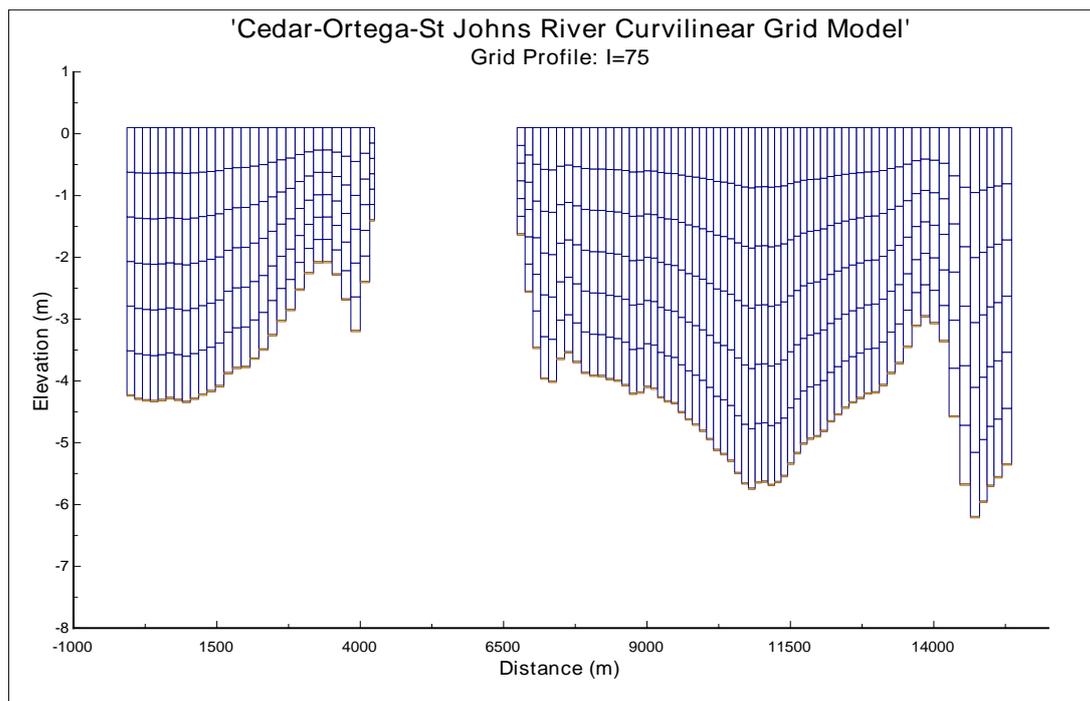


Figure 6-36 Example grid profile plot.

The *Time Step History* button provides a time series plot of the internal time step that EFDC used for the simulation being reviewed. This is of particular interest only when dynamic time stepping was used for the simulation.

6.5.1.2 *Water Surface Profile*

The *Water Surface Profile* button extracts a profile using the settings in the *Profile Location Option* frame and then displays the results. Two lines are shown, one for the water surface elevation and the other for the bottom. The user can “scroll” up and down along all the

snapshot times by pressing the PgUp and PgDn keys using a snapshot increment of 1. Larger snapshot increments are available using the Shift key for increments of 10 and the Ctrl key for increments of 100. Many other functions are available and may be by pressing F2. See Section 9 for a detailed explanation of how to format and use *XY Times Series* graphs. An example water surface profile is shown in Figure 6-37.

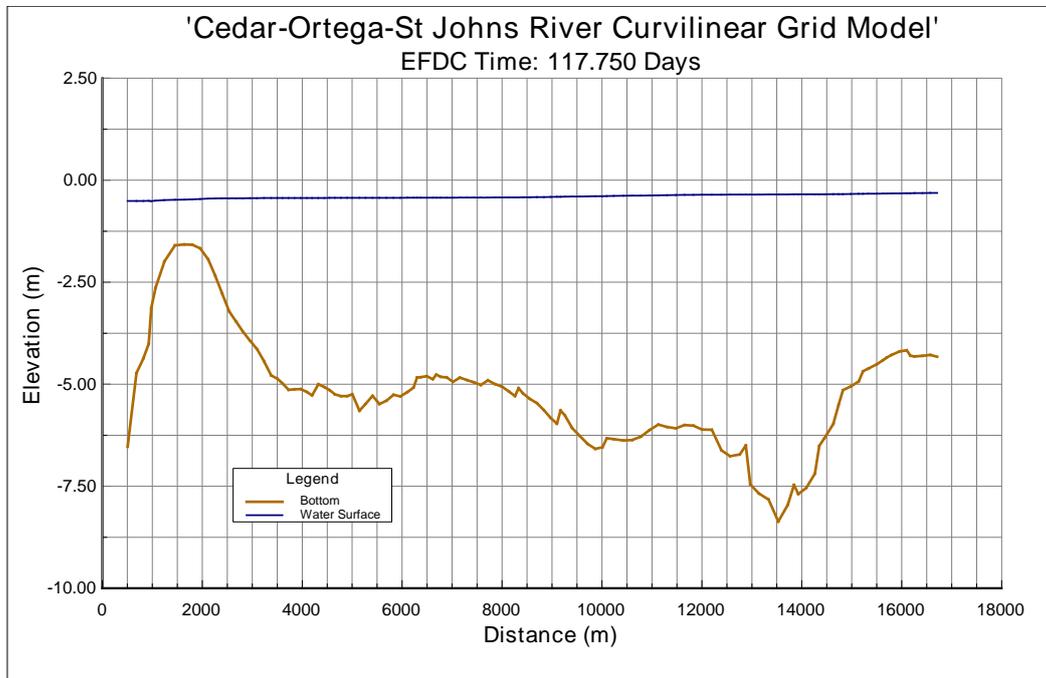


Figure 6-37 Example water surface elevation profile with bathymetry.

6.5.1.3 Mass Balance Tool

The *Mass Balance Tool* (Figure 6-38) allows the user to evaluate the total model's sediment and/or toxic balance as well as determining the mass fluxes through each boundary. Time series plots of the mass loading through the flow type boundaries can also be obtained (see Figure 5-14). The mass loading plots can be obtained and used without computing the mass balance.

This tool is computing the mass balance based on model output snapshots. The smaller the output snapshot interval the more accurate the reported results will be.

EFDC Mass Balance Toolbox

Model Results Timing			Mass Balance Computation Options	
	From	To	From	To
Water Surface:	2922.04	2953.21	2922.04	2953.21
Water Column:	2922	2953.2		
Sediment Bed:	N/A	N/A		
Velocities:	2922	2953.2		
Water Quality:	2922	2953.2		
			Parameter:	Water

View Timesteps:

Export File:

Figure 6-38 Mass Balance Tool Options Form.

6.5.2. Sediment Bed Process Tools

The features located in the *Single Column Sediment Layers* frame all deal with analyzing in detail a single cell and its sediments with time. These options produce single cell plots similar in style to the profile plots, but for only one cell. You can use the PgUp and PgDn keys to scroll up and down in time or press the animate toolbar button to view the consolidation in time.

Figure 6-39 provides examples of results using the *Show Layers* option with *Show Water* checkbox checked. This example used simple bed consolidation (IBMECH=1) with bed elevation changes (IMORPH=1). The consolidation rate (SEDVRDT) was set to 100,000 sec. Note that as the sediment consolidates (Figure 6-39(a) to Figure 6-39(b)), the water depth increases, reflecting the extrusion of water from the sediment porosity.

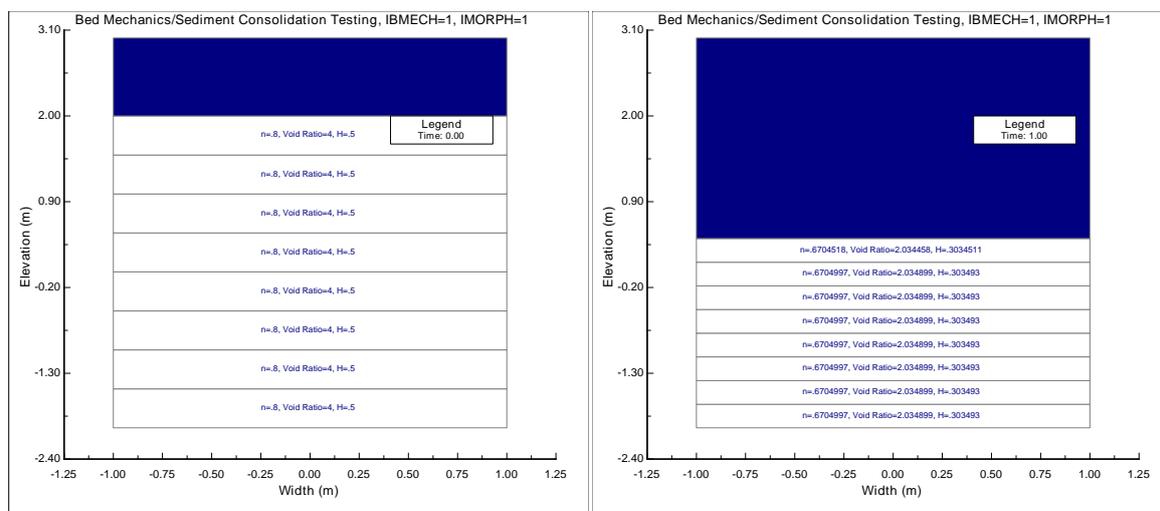


Figure 6-39 Sediment column consolidation: (a) Initial conditions (b) End of Day 1.

6.5.3. Bed Top Profile

The *Bed Top Profile* function provides a 2D plot of a vertical slice through the model showing the water column and the sediment bed. Figure 6-40 provides an example for the Pa Vinh (Son La Province, Vietnam) dam's tailwater sediment transport analysis. Each bar represents a model cell. The thicker top bar represents the water column concentrations of total suspended solids (TSS) and the bottom, horizontally grouped, bars represent the sediment bed.

The height of the water column bar represents the water depth. The color of the water column bar represents the TSS concentration of the cell at the time shown in the legend. The color range corresponds to the TSS values shown on the key, above the color bar.

The height of the sediment bars represent the thickness of the upper most sediment layer that is interacting with the water column. There is a separate sediment bar for each grain size class being simulated. The color range corresponds to the mass fraction shown on the key, below the color bar. If the cell contains no sediments in a given class, that class' bar is not filled. The sediment class grain size is labeled in the key for each sediment bar.

RMC'ing on the legend or pressing the toolbar legend button will provide access to adjustments to the plot settings.

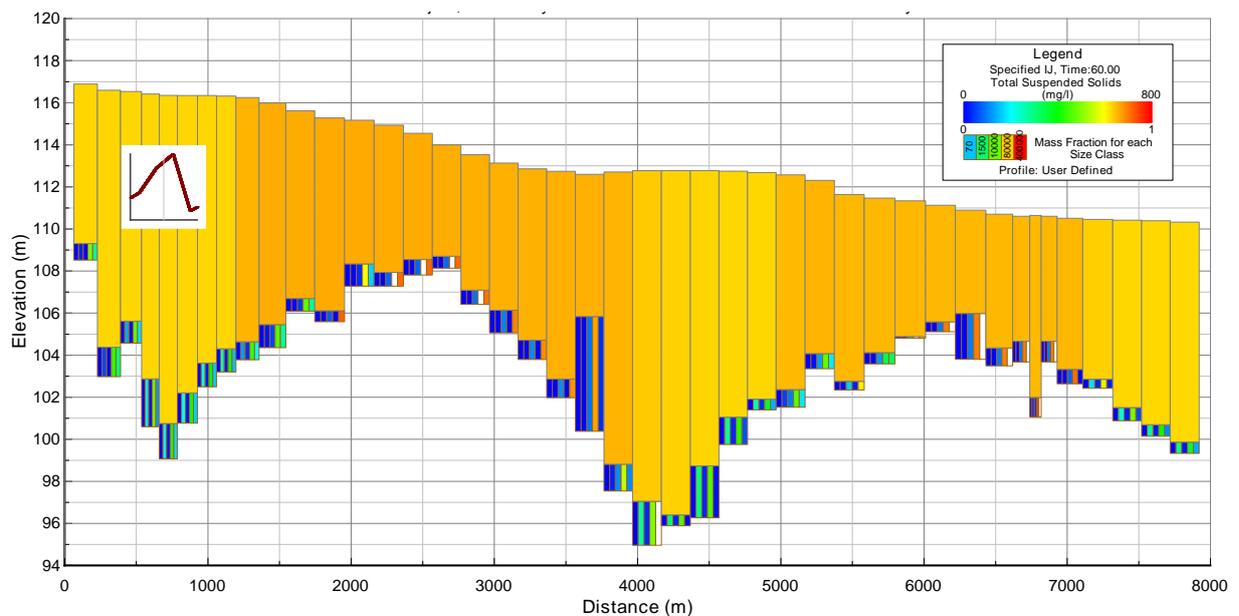


Figure 6-40 Example “Bed Top Profile” for water column and sediment bed.

7 ViewPlan



The *ViewPlan* button of the main toolbar provides access to the primary utility for the pre-processor visualization and map based interface functions as well as the primary post-processing utility.

ViewPlan button provides the user with a dropdown menu comprising the following options:

View Initial Conditions: This option may be used with the user is setting up the model or wants to view the ICs prior to the model run

View Model Results: This option is used after the model has been run and the user wished to analyze the model results.

View Model Results (Re-scan Output): This option should be used if the user has merged two models or has continued a model run and want EE to go back to the beginning of the output data set.

Table 7-1 contains a list of the main parameters that can be displayed using *ViewPlan*. The Sub-Options column lists only the major sub-options. Almost every function has a number of sub-options and features to combine and split the data in a range of different ways. These sub-options are explored in more detail in the following sub-sections.

Table 7-1 Main Functions of ViewPlan.

ViewPlan Option	Description	Sub-Options	Time Variable
Cell Indices	Displays EFDC model number schemes for I & J indexes and the linear L index.	NA	No
Cell Map	Displays the computational cell map that is saved in the CELL.INP file	NA	No
Bottom Elevation	Displays the bottom elevations	NA	Yes
Water Levels	Displays various views using the water levels	Depth Elevation Wet/Dry Total Head, Overtopping Areal Extents (FEMA) Areal Extents (Depth)	Yes
Boundary C's	Displays the model domain with the boundary cells shown by type	NA	Yes
Fixed Parameters	Displays the model input parameters that are (generally) fixed in time.	Roughness Cell Angles Wind Shelter Shading Factors GVC Layers Groundwater Map Wind Weightings Atm Weightings	No
Model Metrics	Displays some model metrics. Some of the sub-options are time variable and others are fixed.	CFL Time Step Courant # Orthogonal Deviation Celerity	Yes

ViewPlan Option	Description	Sub-Options	Time Variable
		Froude # Richardson # Densimetric Froude # Reynolds #	
Velocities	Displays velocity vector plots and flux tool. Velocity vectors can be overlaid many of the other <i>Viewing Opt's</i>	2D Velocity Vectors Magnitudes, Vertical Velocities Velocity Anchor Point Regular Grid Extraction Flux Tool	Yes
Bed Shear	Displays bed shear stress.	Shear – Total Shear – Cohesives Shear – Non-cohesives Wave Only Current Only	Yes
Sediment Bed	Displays the sediment bed parameter values for the selected sup-option.	Top layer Layer Thickness Sediment mass Sediment fraction Porosity Computed d_{50} Delta (scour/deposition) Bed Shear Stress Edit Sediment Cores	Yes
Heat: Bed/Ice	Displays the heat in the sediment bed or in the ice layer	Ice Temperature Ice Thickness Bed Heat Temperature Bed Heat Thermal Thickness	Yes
Volumes	Displays rate of changes in water column volume	Evaporation Rainfall	Yes
Water Column <i>Water by Layer or Water by Depth</i>	Displays the water column parameters values for the selected sup-option	Salinity Temperature Sediments Toxics Dissolved, POC bound, DOC Complexed Water Quality 21 EFDC Parameters Trophic State Index Other Derived Params WQ Kinetic Zones Age Water Density Secchi Depth % Irradiance Habitat Analysis Volumetric Analysis	Yes
Diagenesis	Displays organic and nutrient sediment concentrations (by G class) and nutrient fluxes.	Concentrations of PON, POP, POC, NH ₄ HN, NO ₃ -N, PO ₄ -P, H ₂ S, Silica Benthic Stress Sediment Temperature	Yes

ViewPlan Option	Description	Sub-Options	Time Variable
		Flux Rates PON, POP, POC, SOD, COD, NH4, NO3, PO4, Silica	
Vegetation Map	Displays a map of the vegetation classes	NA	Yes
Modify Channel	Displays the channel modifier showing connectivity	NA	No
Wave Parameter	Displays the wave parameter values for the selected sub option	Energy Height Radiation Shear Stress XX, YY, XY Dissipation Angle Period Total Depth (Derived) Water Surface Elevation (Derived)	No
Computed Variable	Displays the internal EFDC for the selected sub option	Horizontal diffusivities Other User Defined	Yes

7.1 Simulation Results Loading

As a post-processor, *ViewPlan* requires the output data, as well as the input data, to be loaded. The user can control when output data is loaded using the *Output Loading Frame* as shown in Figure 7-1. When a file is initially loaded the *Output File Loading* frame will appear as *No Results Loaded* until the *ViewPlan* button is pressed. Once *ViewPlan* has been used the *Output File Loading* will appear as *Model Results Loaded*. After output files have been loaded, they will not be reloaded for that project unless the user selects the *Re-Scan* option on the dropdown, checks the *Reload* check box in the calibration section (see Section 6.1), loads a new project or exits EFDC_Explorer and then restarts it.

The user should note that this is a redesign from previous versions of EE. The user can now choose from the drop down menu to load model results or not (IC only). The default option, if the main toolbar button is selected is *View Model Results*. If no model results are available, only the IC's will be available for display.



Figure 7-1 Model results loading options.

The *Re-Scan* menu option is useful when the user is loading the results while the EFDC model is running (see Section 3.7.4). It is better to pause EFDC before you load the data to prevent file handling errors but it is not required, especially if EFDC is writing to the EFDC_Explorer files infrequently. If the *Re-Scan* menu option is used, it will cause EFDC_Explorer to reload the model results requested at that time.

The water depths are automatically loaded as they are necessary for any post processing to be performed. The depths are stored in the EE_WS.OUT file. This file contains the depths for all the cells for every snapshot time. This file is completely loaded into memory when post-processing. If the water surface file is not loaded, no post processing is available.

For all other model results, only the current time is loaded. This approach allows for quicker file loading and viewing and allows for very large model results files (>4 gigabytes) to be saved and used. However, when generating any time series type processing, each snapshot has to be loaded for all the times requested. Many hard disks have caches to allow frequently accessed files to load quicker. Therefore, the first time a time series is processed the data may load slowly. However the subsequent processing may be much faster.

During the file loading process, pressing the ESC key aborts the file loading process and returns to the main EFDC_Explorer form.

7.2 Introduction ViewPlan Form

The *ViewPlan* form viewing options is adjusted based on what parameters were simulated, what data has been loaded, and what option has been requested by the user. Figure 7-2 shows an example of the *ViewPlan* form with the *Water Column* option selected. This plot shows several standard features of *ViewPlan* including the *Timing Frame*, *Legend* and the *Horizontal Scale*. With the exception of the *Legend*, these features can be turned on or off.

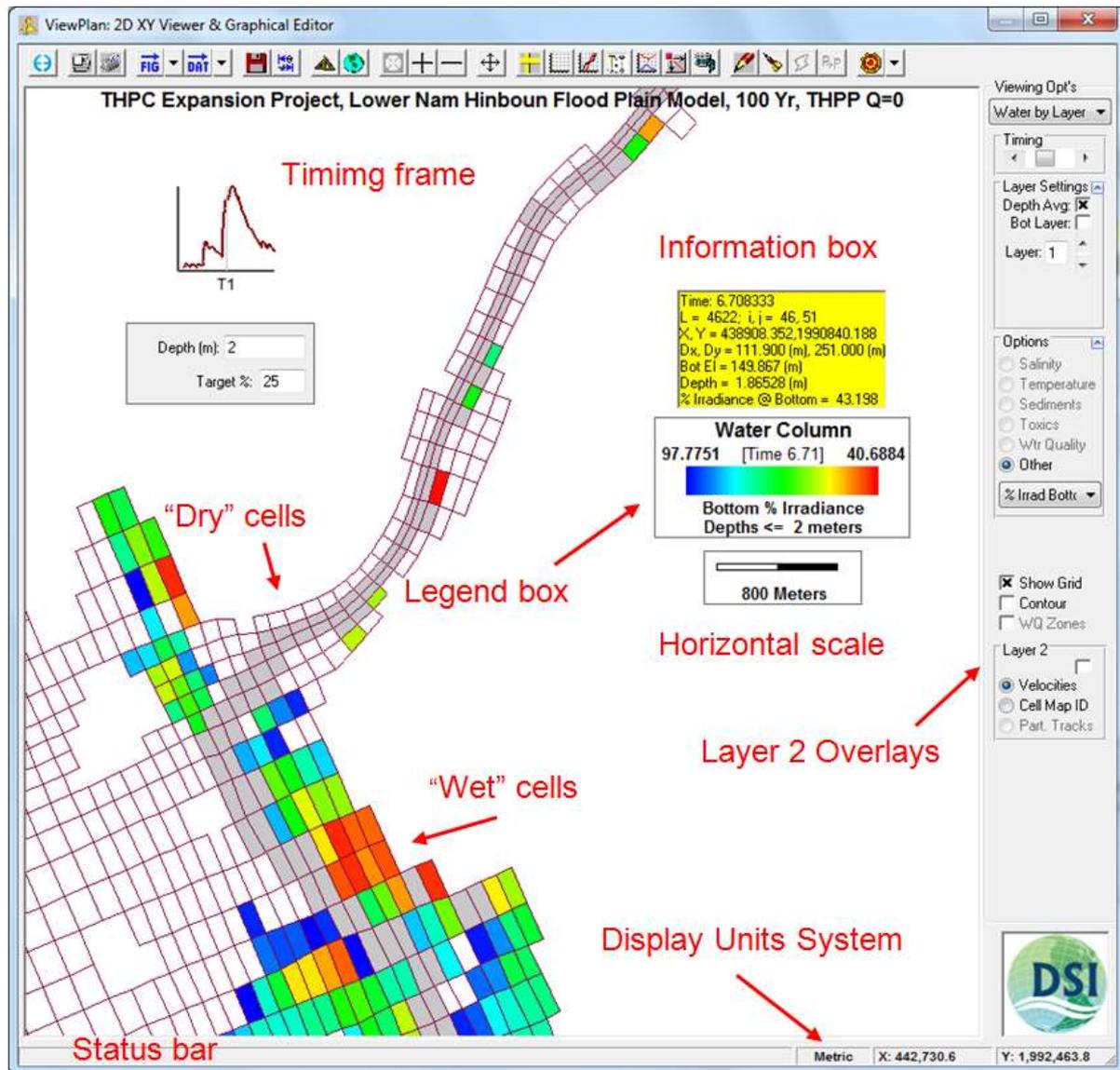


Figure 7-2 ViewPlan main form.

The *Viewing Opt's* frame contains a dropdown list of all the available viewing, editing, and/or post-processing major topics. The list of items in this list may change each time the user changes parameters in the pre-processor function or loads a different model results file (see Section 7.1). Figure 7.3 shows the *ViewPlan* context sensitive area for alternative *Viewing Opt's*. It can be seen that having selected the *Water Column* major option different options are available. Within the context area only the appropriate options will be shown.

The toolbar located at the top of the form provides functions that operate on/with the current *Viewing Opt's* selected. For example, clicking on the animate button animates the variable that is being displayed. Table 7-2 provides details of the various functions available from the toolbar. Section 7.6 provides more details on the various *Viewing Opt's* available.

The *Timing* frame provides a scroll bar that provides direct access to the model output snapshots. When the slider bar is scrolled completely to the left (Timer = 0) the data displayed are the initial conditions specified in the model input. The current time is displayed in Julian date in the legend. The resolution of the time display is controlled by the EFDC_Explorer settings for time resolution.

The form may be resized (shrinking it too small will cause EFDC_Explorer to limit the size), maximized and minimized. However, if minimized, it must be restored prior to doing anything with EFDC_Explorer.

7.2.1. Mouse Functions

The toolbar changes the function of some of the mouse clicks, but in general the following summarize the basic mouse click functions.

7.2.1.1 *Repositioning Legend & Other Objects*

To reposition EFDC_Explorer pop-up's, the legend, labels, notes, dialog windows and frames the user may left mouse click, hold it down and drag it to move the object to another location on the plot. If the legend is moved off the display and the form resized so that the legend is no longer visible, it will be repositioned to the center of the current view.

7.2.1.2 *Cell Information*

Using the mouse, point to a specific cell and then left mouse click (LMC) to display that cell's general information along with the data of the currently selected parameter, with any sub-options. Right mouse click (RMC) copies this information to the Windows clipboard. Figure 7-3 shows an example for salinity.

```

Time: 117.7917
L = 2628; i, j = 75, 95
X, Y = 435674, 3351958.4
Dx, Dy = 171.3, 133.8
Bot EI = -4.059177
Depth = 3.589025
Salinity = 8.365221
    
```

Figure 7-3 Cell Information example.

7.2.1.3 Right Mouse Click

Right mouse click (RMC) on the object to perform the following:

The Legend Brings up the Display Options form.

A Cell (BC) Displays the pop-up shown which allows the options of editing the cell, deactivating the cell, or *Set as show I,J*. This sets the I and J in *Run Time Status* form within the *Grid & General* tab. Depending on the BC type clicked, the view cell will display the primary boundary condition parameter as well as the corresponding concentrations. The view group displays total group flows or fluxes.

A Cell (Edit) When displaying the domain with the *Enable Edit* check box selected, except for boundary conditions, a *Modify Cell* form (Figure 7-4) is displayed that allows the user to modify many of the cells properties in one location.

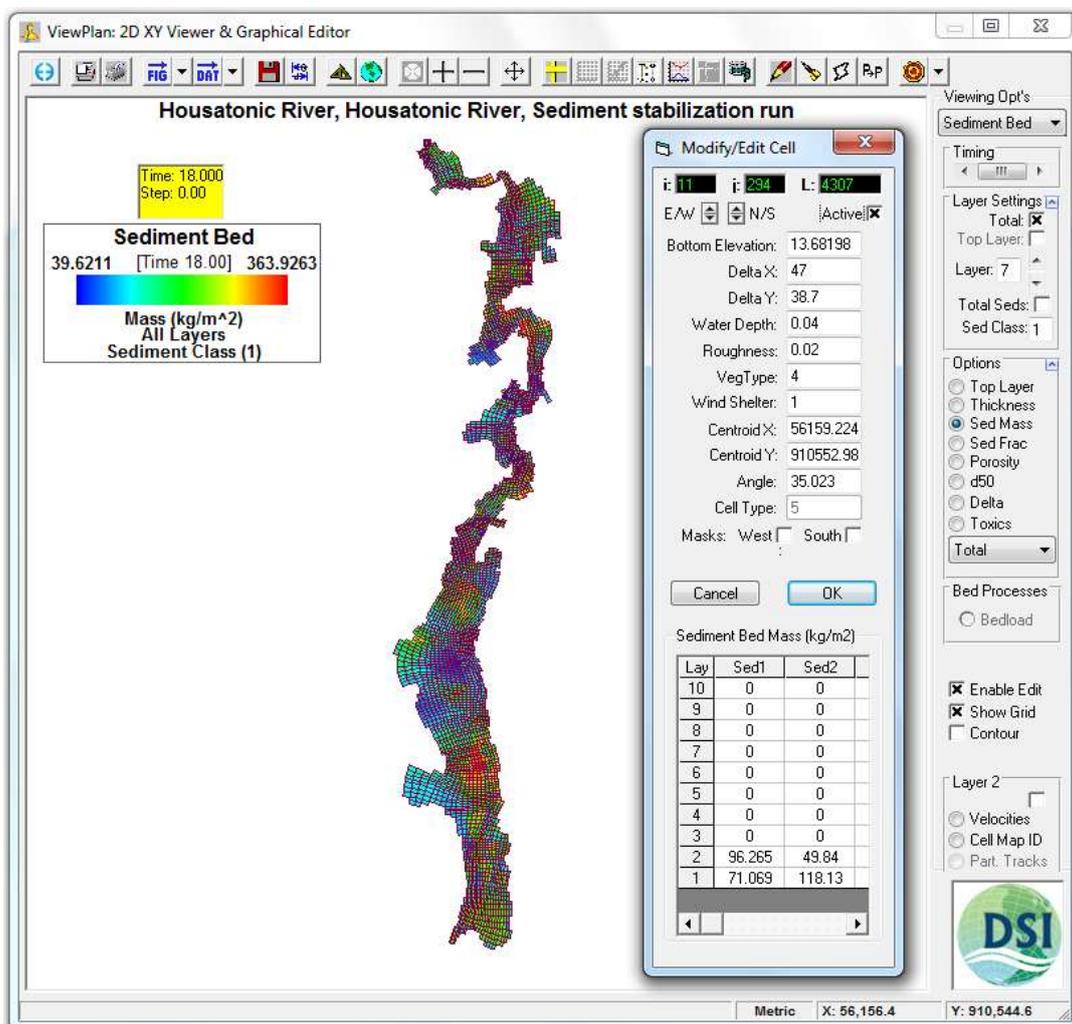


Figure 7-4 Modify Cell form with bed layer-sediment mass sub-option.

In addition to these functions, RMC'ing on zones for the water quality, diagenesis and vegetation zones allows the user to edit the data for the entire zone.

During post-processing water quality, if viewing dissolved oxygen with the time series toggle on, the user can select from a series of pre-defined "bundles" of nutrients.

7.2.2. Keystroke Functions

To obtain help on the keystroke functions press, F2. What is actually shown in the message box pop-up depends on what data/model results are loaded and the currently selected view. Table 7-2 provides a listing of the keystroke functions in *ViewPlan*.

Table 7-2 ViewPlan keystroke function summary.

Panning & Zooming	
Space LMC	Pan with cursor
Mouse Scroll	Zoom in and out
F3	Modify Pan & Zoom Increments. The size of the panning and zooming steps are adjusted here.
F5	Refresh Current View
left	Pan East.
right	Pan West
up	Pan North
down	Pan South
+	Zoom In
-	Zoom Out
Ctrl-E	Zoom Model Extents
Cell Property Copy Editing	
Alt-LMC	Get Property. Alt-LMC'ing on a cell will copy that cell's current property to the operator box.
Ctrl-RMC	Set Property. Ctrl-RMC'ing on a cell will apply the value or operator in the operator box to that cell (Copy Cell Property must be enabled)
Smoothing of Initial Conditions Field	
Ctrl-S	Smooth the Currently Selected IC Field. This applies only to bottom elevations and the water column.
Rectangular Cell Selection (for Editing Cell Properties)	
	To Select Cells in a Rectangle hold the ALT key down and Right Mouse drag. The 'Enable Edit' checkbox must be selected.
Post Processing – Time Selection	
PgDn	Show Next Snapshot
PgUp	Show Previous Snapshot
Shift-PgDn	Show Next Snapshot – Increment:12
Shift-PgUp	Show Previous Snapshot – Increment:12
Ctrl-PgDn	Show Previous Snapshot – Increment:120
Ctrl-PgUp	Show Previous Snapshot – Increment:120
Ctrl-G	Goto a Specific Date. Format of date to enter depends on whether the user is displaying Julian or Gregorian dates.
Specific View: Water Levels, Inundation Extents	

Ctrl-O	Export the displayed inundation outline as a P2D file.
Specific View: Sediment Bed, Bed Shear Stress	
Alt-P	Toggle Display of Bed Shear or Stream Power
F7 or Ctrl-T	Toggle Sediment Core Editing
Specific View: Water Column	
Alt-B	Conduct a Bottom Irradiance Analysis
Alt-C	Conduct a Volumetric Analysis
Alt-H	Conduct a Habitat Analysis
Specific View: Comparison Model	
Alt-M	Toggle the display of model comparison
Alt-V	Compute and display the volume differences between two models in bottom elevation view
Specific View: Velocities	
RMC	Define Velocity Profile (Velocity View Only)
Calibration Data Display	
Ctrl-<	Go to previous data snapshot. If calibration data has been configured and the current view is the water column, this keystroke will cause EFDC_Explorer to jump forward to the next measured data point and display the model results with the data or residuals labeled.
Ctrl->	Go to next data snapshot.
Series/Profile Locations	
Alt-I	Load the Series/Profile Locations from a File
Alt-O	Save the Series/Profile Locations to a File
Layout and Viewing Options	
Ctrl-W	Set the View Port to a Specified Size
Alt-W	Set the View Port to a Specified Scale
F6	Toggle Grid Display
F7	Toggle Julian Date as Date Format
F8	Toggle Display of Masks
F9	Toggle Transparency for Current View
F11	Toggle the Display of Titles
F12	Toggle On/Off Greyscale Color Ramps
Alt-K	Save the Layout (form size, scale, legend location, etc.) to a File
Alt-L	Load a Layout from a File and apply it to the current view.
Miscellaneous Functions	
Ctrl-A	Animate the Current View
Alt-E	Export the Current View as a Metafile

Ctrl-M	Toggle Metric/English Display Units
Alt-R	Compute and Display time series plot of River Kilometer versus time for a target value.
Ctrl-V	View a Specified Cell using L or I,J.
Ctrl-P	Photo Viewer – load an image to display on the <i>ViewPlan</i> workspace

7.2.3. Toolbar Summary

The *ViewPlan* toolbar provides access to a range of different functions and utilities (Figure 7-5). Some of these functions are dependent on the current context while some are not. Table 7.3 contains a summary of each function.

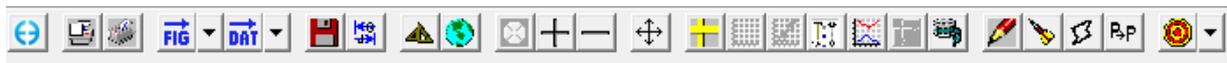


Figure 7-5 ViewPlan Toolbar.

Table 7-3 Summary of ViewPlan toolbar.

	Exit <i>ViewPlan</i> .	General
	Printer setup options.	
	Print to current printer the current view.	
	Export the current view to a Windows enhanced metafile (.EMF) or as a Bitmap (.JPG)	
	Export the current major option to Tecplot, KML, Shapefile or to SWAN	
	Create a new EFDC model using the current time to assign the IC's.	
	Julian date \leftrightarrow Gregorian calendar calculator.	Display
	Display options for color ramp, vectors, grid lines, overlays, etc.	
	Toggles the display dereferenced bitmap backgrounds.	Navigation
	Zoom extents.	
	Zoom in at fixed increments.	
	Zoom out at fixed increments.	
	Pan Left.	

	Pan Right.	
	Pan Up.	
	Pan Down.	
	Distance tool. Distances are displayed in the status bar.	
	Time series tool. Point and click on cells to build a group of cells.	Post-Processing
	Vertical profile tool. Available in Water Column option of ViewProfile.	
	General statistics tool. Results are copied into the clipboard.	
	Longitudinal profile tool.	
	Water and Mass flux (see below for details)	
	Animation tool. Output animations to the screen and/or AVI files.	
	Polyline/polygon creation/edit tool (see below for details).	
	Model Results Extraction Tool - a point & click data extraction tool.	
	Multi-cell selection tool for general purpose editing using Modify Cell form.	Pre-Pro
	Copy cell property button. A rapid point & click method of cell by cell adjustments using operators.	
	View calibration stations, data and/or Model-Data residuals.	Post-Pro

7.2.3.1 Printer Setup

The current default printer is automatically used by EFDC_Explorer. Figure 7-6 shows an example printer setup form that appears when the highlighted toolbar button is clicked. If no printers are available during the startup of EFDC_Explorer, it will display a warning but will continue. Besides being used for printing, the settings from this form also impact certain exported graphics. The primary setting used is the portrait versus landscape option to set page orientation.

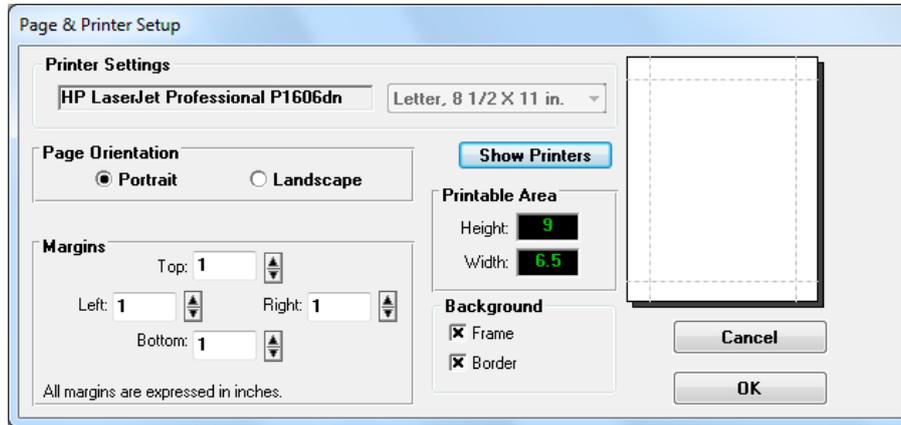


Figure 7-6 Printer Setup.

7.2.3.2 Export EMF and Bitmap Files

As most of the modeling efforts end up in engineering and scientific reports, it is very important for EFDC_Explorer to have the ability to produce high quality graphics that can go directly into all of the most popular word processing packages. The ability to export enhanced metafiles (EMF's) meets this need. EMF's are a native Windows based graphic that easily imports into almost all word processing and presentation packages.

The size and shape of the metafile depends on two things in EFDC_Explorer. If you are exporting the results using the *Show Border* check box, then the size and shape will reflect the printer settings. If the check box is not displayed then the size and shape will reflect the current *ViewPlan* window.

Another useful format for images for reports and presentations is bitmap (.BMP). EFDC_Explorer has the ability to export bitmaps at user defined resolutions as shown in Figure 7-7. Here the user may set the resolution in dots per inch and the size of the bitmap in pixels in the X and Y directions.

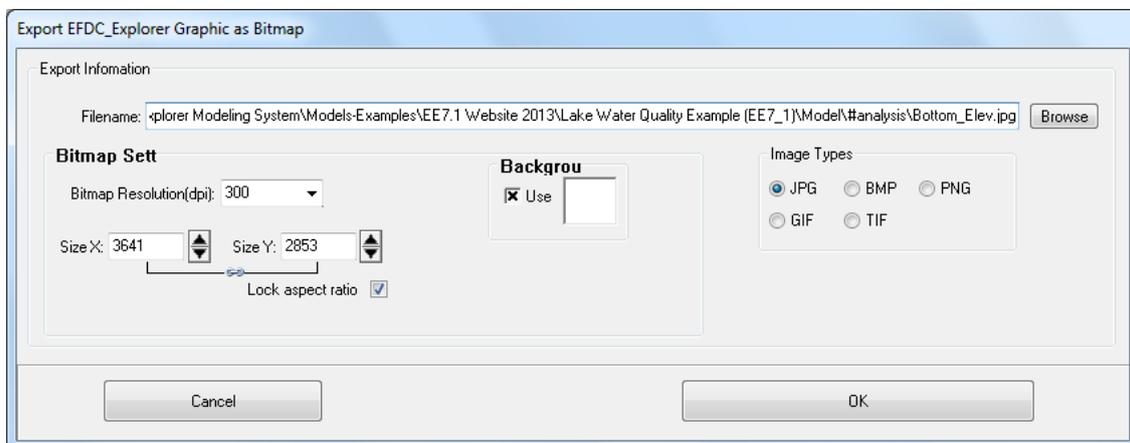


Figure 7-7 Export EMF file as Bitmap.

7.2.3.3 Export Tecplot, KML, Shapefile Files

It is recognized that EFDC_Explorer does not and will never handle all the post-processing desires/needs of every project. Therefore, the capability to export the data to third party packages via an ASCII file is provided by the inclusion of the TP function from the toolbar whereby the user may export Tecplot® files. When selected, *ViewPlan* displays the form shown in Figure 7-8. Here the user can select the beginning and ending times to export as well as the skip interval. From EE7.3 users can export the water column parameters in addition to bed parameters directly to Tecplot. The Tecplot export function in *Water By Layer* and *Water By Depth* option has also been implemented. When exporting the sediment bed toxics EE exports the real values and does not truncate the output.

The user must select the times to be exported. The user may manually select the times using the Windows standard LMC, Ctrl-LMC and Shift-LMC to select one or more times. Another time selection option is to press *Select All* (the button then toggles to *Select None*) and set the *Output Interval*. An Output Interval of 1 will output all selected times, a value of 2 will output every other snapshot, etc. The number of snapshots that will be exported is shown in the *# Selected* box.

The *Horizontal Skip* is used to set a skip count for exporting the model cells. A skip count of 1 means every cell will be exported.

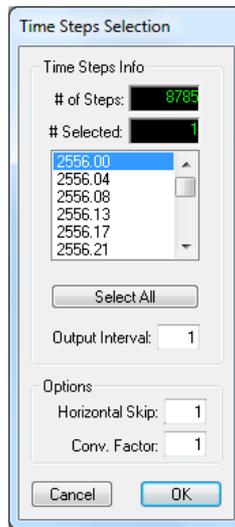


Figure 7-8 Tecplot export timing options.

Also on the *ViewPlan / DAT* button drop down menu is the ability the export KML (Keyhole Markup Language) files. KML are native Google Earth[®] files, using a type of XML language used for expressing geographic annotation and visualization within web based, 2-D and 3-D maps. After selecting this option and entering a file name the user is prompted for the UTM Time Zone (1 to 60) and Opacity (%). After creating a KML the file may be loaded into Google Earth[®] where each I,J cell is displayed as a place (see Figure 7-9).

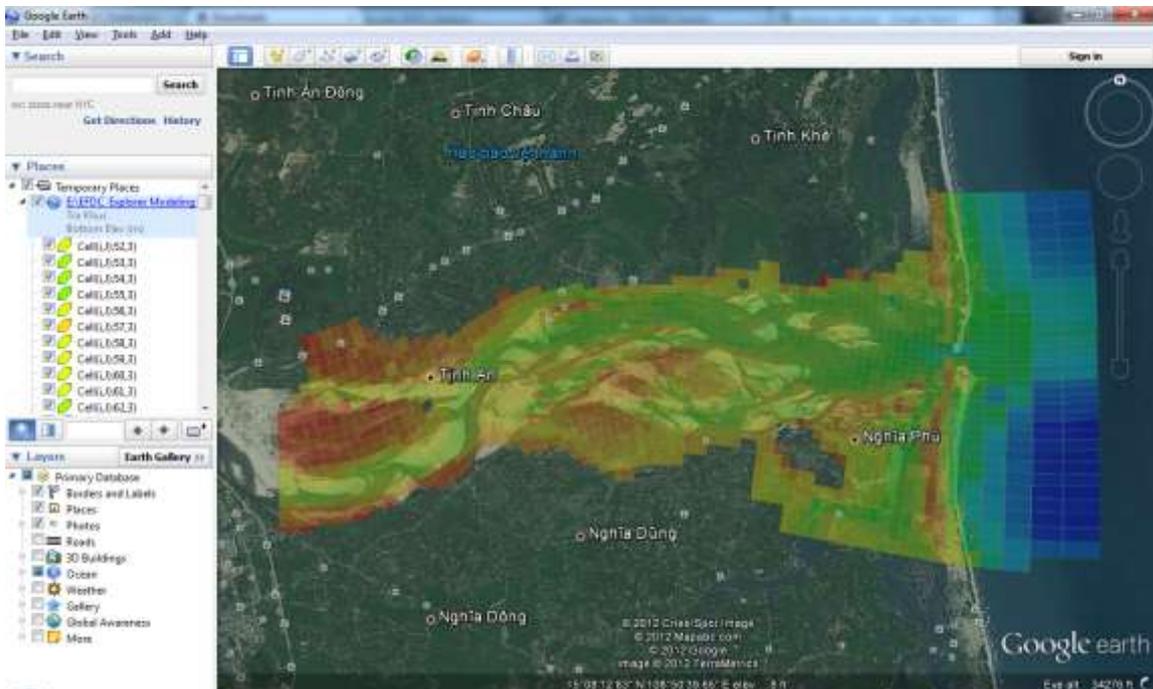


Figure 7-9 KML file exported from EFDC_Explorer to Google Earth[®].

As of release of EE7.2 there is an option to export whichever *Viewing Option* is selected in ESRI © shapefile format. In addition to the shapefile, the projection file is also provided and the sample shapefile loaded in ArcGIS is shown in Figure 7-10.

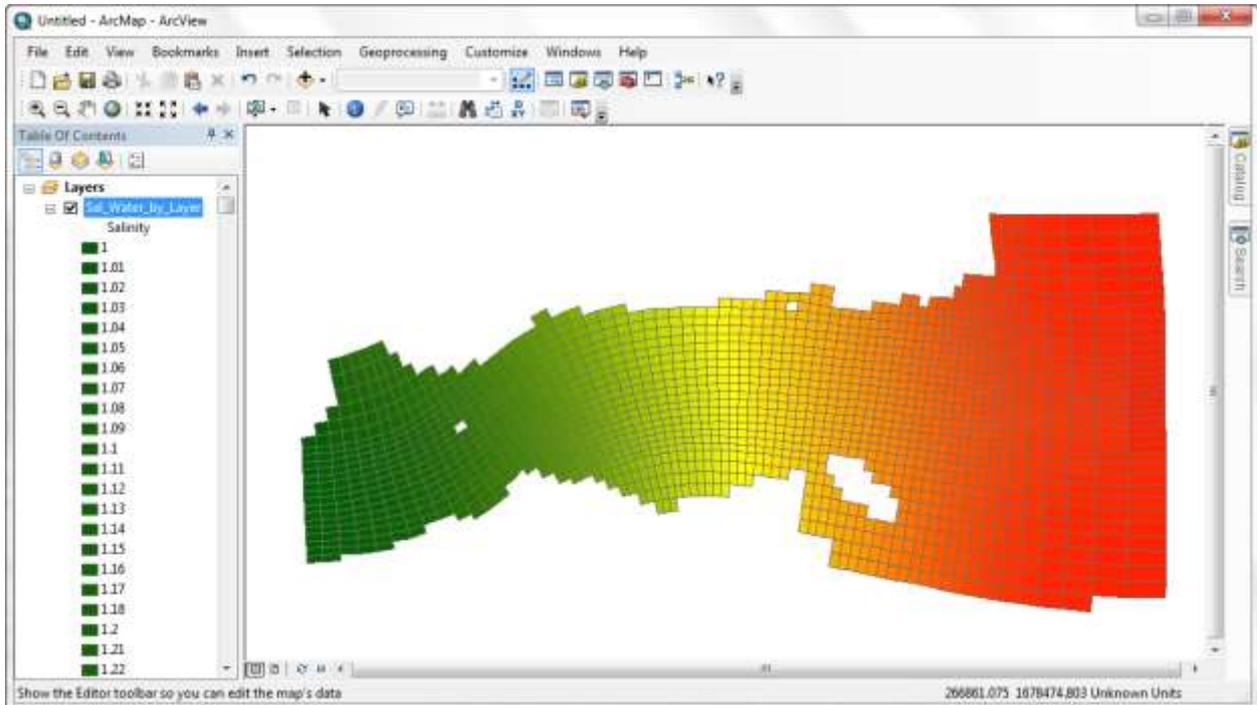


Figure 7-10 Shapefile showing Salinity viewed in ArcView.

7.2.3.4 Export NetCDF Files

From the release of EE7 it is possible to export model output in NetCDF format. NetCDF (Network Common Data Form) is a community standard for sharing scientific data. Developed by Unidata, it is a set of software libraries and machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data.

EE uses the CF (Climate and Forecast) conventions which Unidata describes as “designed to promote the processing and sharing of files created with the NetCDF API. The CF conventions are increasingly gaining acceptance and have been adopted by a number of projects and groups as a primary standard. The conventions define metadata that provide a definitive description of what the data in each variable represents, and the spatial and temporal properties of the data. This enables users of data from different sources to decide which quantities are comparable, and facilitates building applications with powerful extraction, re-gridding, and display capabilities.”

<http://www.unidata.ucar.edu/software/netcdf/>

Figure 7-11 shows the dropdown menu for exporting data from *ViewPlan*. When the user selects the *Export NetCDF* option then form shown in Figure 7-12 is displayed.

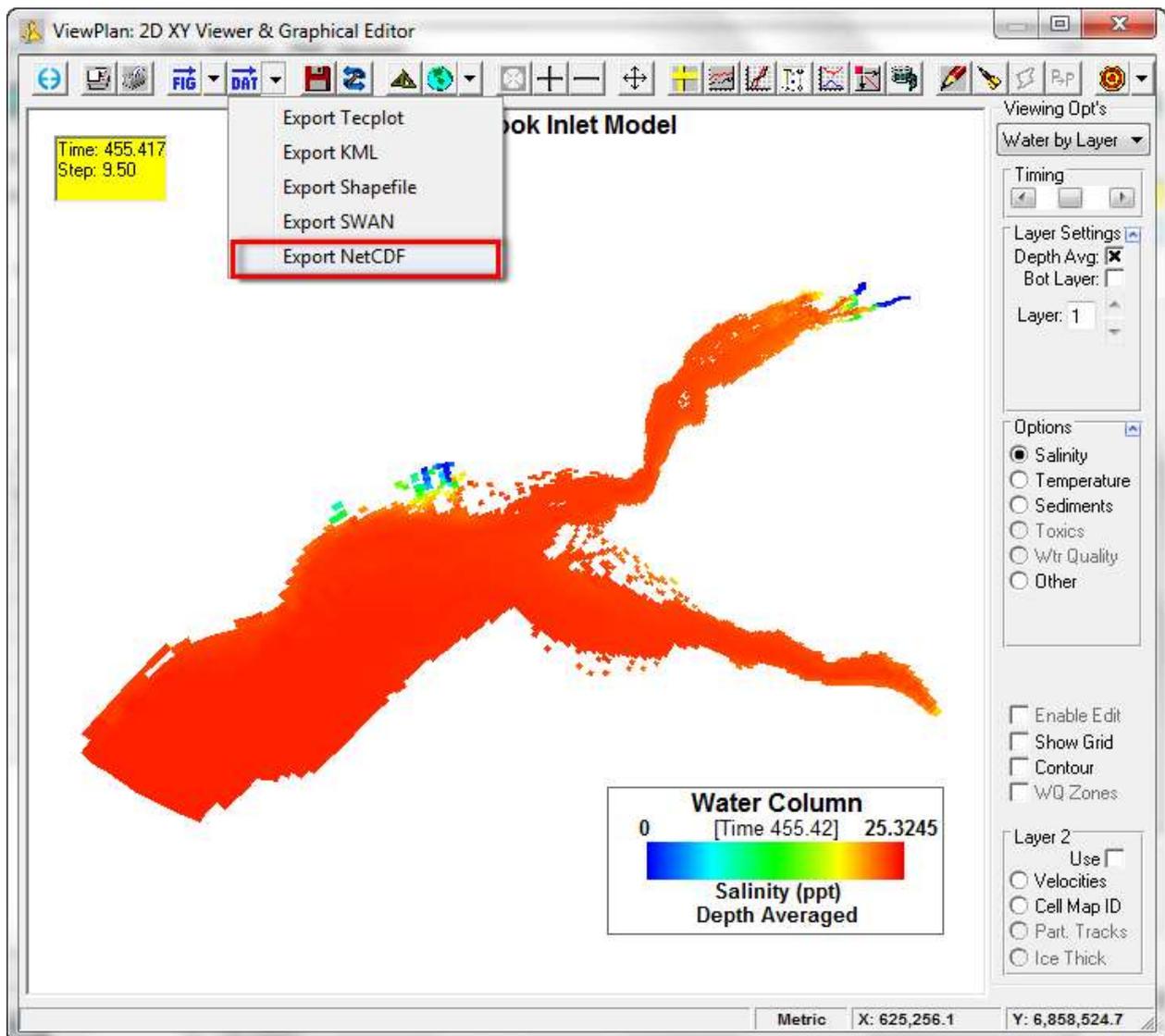


Figure 7-11 ViewPlan: Export NetCDF Option.

Here the user may select which data is to be exported. The *Export to NetCDF files* form allows the user to select static data such as the model grid and initial bottom elevations to be exported. Dynamic data from hydrodynamics and constituent transport may also be exported. The user should select the begin and end time for the export of the data.

In the *File Creation* frame the user may select from exporting all the NetCDF data in one file, or separate it into a series of files, one for each day.

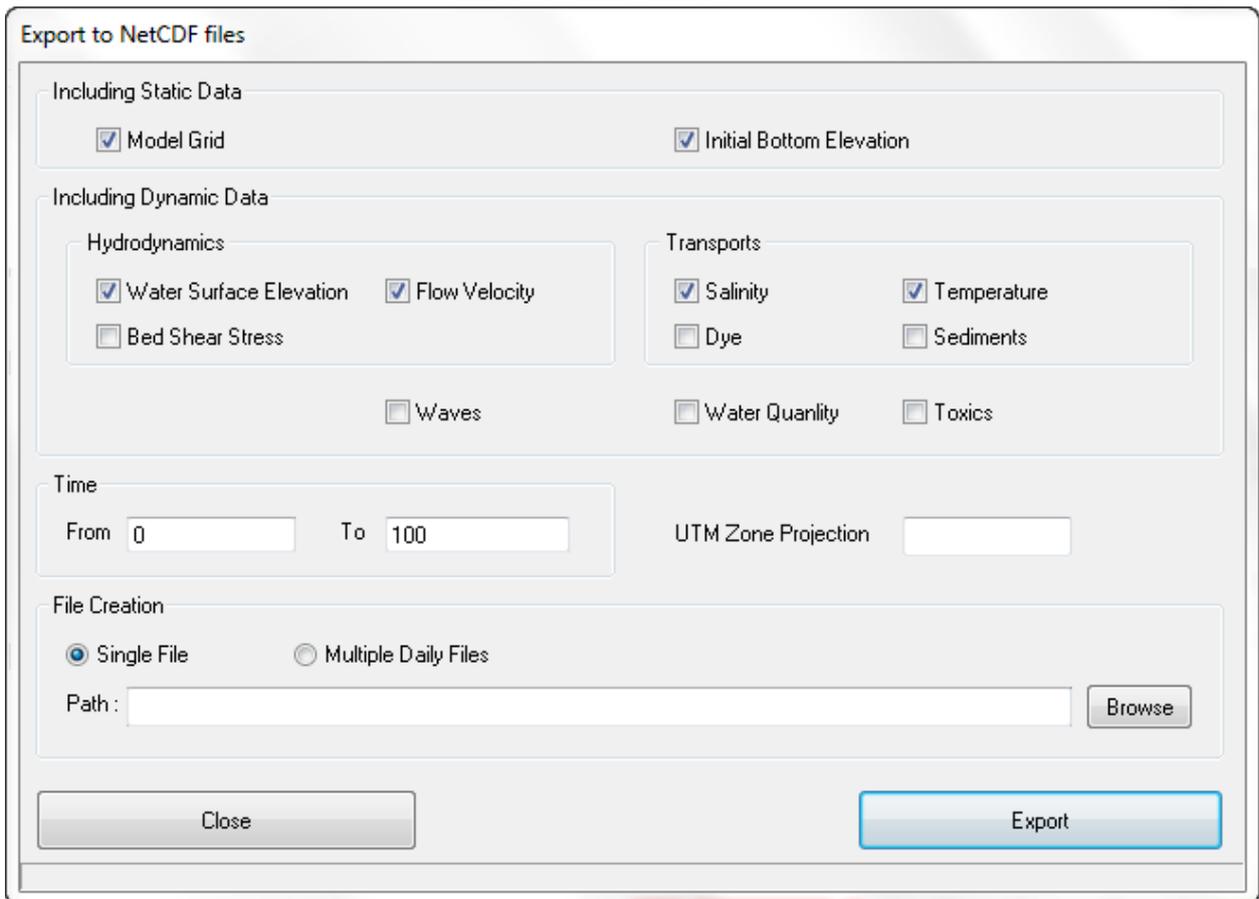


Figure 7-12 Export NetCDF Files Options.

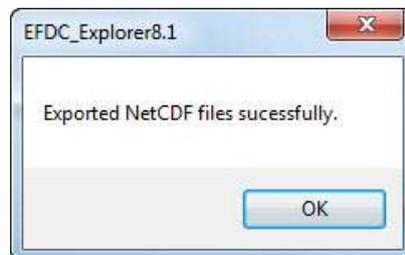


Figure 7-13 NetCDF Files Exported

7.2.3.5 Create New EFDC Model

This function saves to disk a new project using the model results at the time of current view (as indicated in the legend) as the initial conditions. When selected the user is prompted to select a new project directory to save the new model to. All appropriate flags and settings are adjusted in the current model to allow the user to load the newly saved model (the original model is still the current project) and run EFDC. All parameters being simulated use a spatially variable initial conditions file.

This feature is useful for testing various adjustments or corrections to the model inputs after a particular date. An example would be to test why a model crashed after a certain time by adjusting boundary or wetting//drying options and running a “continuation” model. If appropriate, the model results from a continuation model can be merged with the original model to produce a single model output for plotting and analysis. See Section 5.5.5 for more detail.

7.2.3.6 Polyline/Polygon Creation Tool

EE makes extensive use of polygons when applying cell properties and the *Polygon Tool* is the primary utility in EFDC_Explorer to create and edit the various polylines and polygons that the user may need to help define boundary cells, flux lines, model annotation, velocity profiles, etc. . In these cases, cells that are inside the polygon(s), using the *Inside Cell Test* options, are adjusted according to the options specified in the *Modify Options* frame. When the toolbar button is pressed, EFDC_Explorer asks the user for a file to load in order to edit existing data. The user can either select the file to edit or press cancel to start with no existing lines.

From the release of EE7.2 this tool is greatly simplified and provides the user with separate toolbar on the workspace. The Polyline button is shown in Figure 7-14 using a small red rectangle on the top menu. When selected, it provides the user with a number of options for creating and editing polylines and polygons which are described in Table 7-4. Note that LMC commences a new line and RMC ends the line. After RMC the user must select an ID String for the polyline (Figure 7-14). However, it is important to note that entering a value here does not save the polyline and if left blank will delete the polyline. A .P2D file may contain multiple polylines each with different ID strings. After entering the ID the user must select the *Save* button for the polyline/s to be actually saved for later use. Though the default format is P2D, DX files can also be written by explicitly specifying the file extension as DX.

When the polygon/polyline editing tool is active many of the other standard mouse operations are disabled.

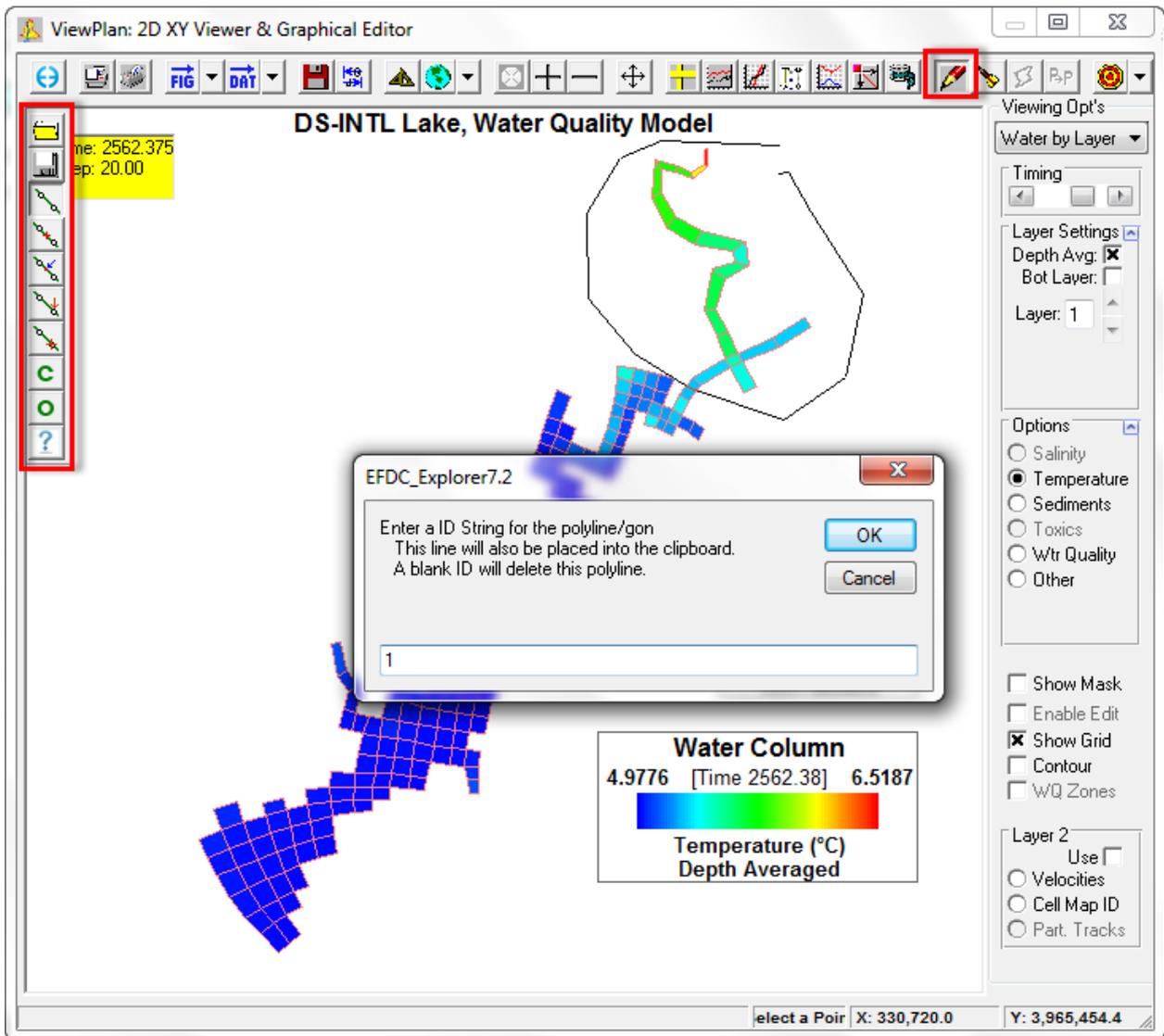


Figure 7-14 ViewPlan: Polygon Tool.

Table 7-4 Polyline Tool Buttons.

	Open an existing polyline for editing.
	Save a polyline. It is necessary to select this icon for the polyline to saved.
	Draw a new line. LMC in the workspace creates a point. Moving the mouse and LMC in another location creates another point with a line joining the two points. RMC to end drawing the polyline.
	Delete previously created line. When this icon is selected, clicking on a line will delete it.
	Insert points on an already created line. Once a point is inserted it can be moved to reshape the line.
	Move points on a polyline.
	Delete points on a polyline.
	Close the current polyline to create a polygon
	Open the current polygon to make a polyline.
	Help for using polyline tool

7.2.3.7 Water and Mass flux

This tool is used to calculate the water and mass flux for WQ parameters such as salinity or DO and is most useful when wanting to compute pollutant loadings

To use this tool the user must first have a flux line, or create a flux line with the polyline tool in *ViewPlan*. The user should then select the Water and Mass flux button and select polyline over which the flux is to be calculated as shown in Figure 7-15. From this dialog box the user may also select from various flow options, including total flow, the I,J direction for which flux will be calculated, or the dominant flow.

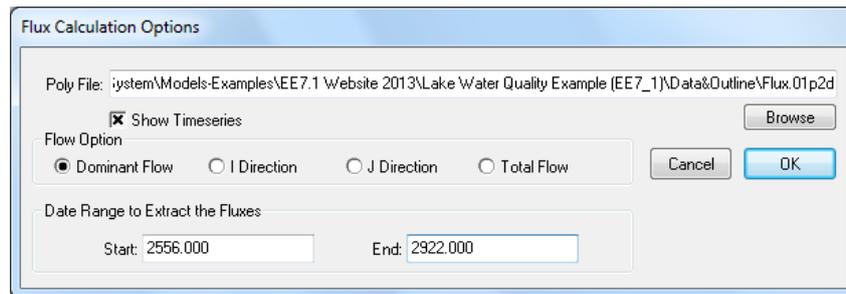


Figure 7-15 Flux calculation options.

EFDC_Explorer will then calculate a time series showing the flow, mass flux (g/s) and average concentration. If the user switches off time series check box then a table of EW and NS total and absolute fluxes is reported for the mass flux past that line for the time period specified.

7.2.3.8 View Calibration Data

When calibration data in the Time Series (Section. 6.1.2) or Vertical Profile (Section. 6.1.4) has been configured the user can use the *View Calibration Data* function to display calibration information on selected plots. The symbols, fonts and time tolerance use the data posting options in the Display Options form (Section. 7.3). The data components of this function only apply to the *Water Column* view. When viewing the water column results EFDC_Explorer matches the viewing parameter to the data parameter. If there is no data currently configured data for the current viewing parameter a message will be displayed

The View Calibration Data toolbar function toggles on and off the display of the following:

Show Data Stations: Label the current plot with Station IDs. This information will be displayed on most views even if there is no matching parameter in the calibration data.

Show Data Values: Labels the current plot with calibration data if there is a parameter match to the data and the data is within the tolerance time of the current view.

Show Data Residuals: Labels the current plot with residual (Model – Data) if there is a parameter match to the data and the data is within the tolerance time of the current view.

Use Layer Options/Show All Layers: This option enforces the calibration data layer options to the current view. If not checked the data and residuals displayed will be based on depth averages.

Set Model/Data Time Tolerance: Allows the user to set the number of minutes allowed between the model snapshot time and the data time. If the absolute time differences are less than or equal then EFDC_Explorer will consider the two time the same and display the appropriate data or residuals.

Show Previous Data: This function jumps the current view backwards in time to the previous model-data match for the current parameter. If a match is not found, or the current model time is less than the first data record, a message will be displayed in the status bar indicating that there was no match. Ctrl-< keystroke performs the same function.

Show Next Data: This function jumps the current view up to the next model-data match for the current parameter. If a match is not found, or the current model time is greater than the last data record, a message will be displayed in the status bar indicating that there was no match. Ctrl-> keystroke performs the same function.

7.2.3.9 Model Results Extraction Tool - Export XY data file as I,J

The *Model Results Extraction Tool* (for extraction of x, y and current value using the mouse or pointer) in *ViewPlan* has been updated from release of EE7.2 with a function to extract/load model results as I,J. Previously EE only allowed exporting as X,Y points. The new GUI is shown in Figure 7-16.

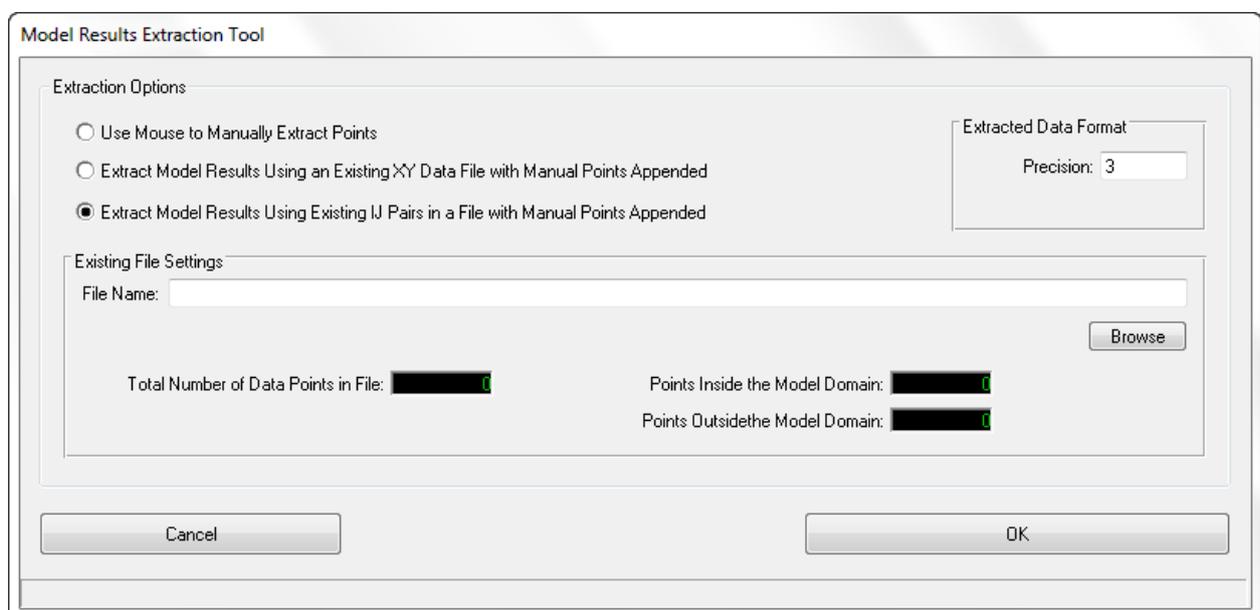


Figure 7-16 Extraction Data Tool.

7.2.4. Navigating the View

The *ViewPlan* toolbar has a range of different viewing navigation functions. However, the mouse and mouse – keyboard combination also have some very useful navigation capabilities. The following summarize the two main navigation features not on the toolbar.

Zooming: The user may zoom to any region of the view simply by RMC, holding down and dragging the mouse. When the user releases the mouse button the screen will be zoomed, centered on the area selected.

Panning: The user may pan in any direction by holding the Shift key down and RMC, holding down and dragging the mouse in the direction and distance desired.

The other zooming and panning functions provided on the toolbar are also available. At times the zoom extents button is grayed out due to the view already being zoomed to full.

7.2.5. Reporting Units

EFDC_Explorer can generate the plots and tables in either metric (the default) or English (Imperial) units. This feature is toggled on and off using the Alt-M keystroke. The current reporting units system is shown in the status bar at the bottom of the form. The user can also LMC the units label on the status bar to toggle the units.

EFDC and EFDC_Explorer require the model generation and inputs to be in the metric system. The use of the English units for display is only for reporting. In order to edit or change the model inputs the reporting units must be set to metric.

7.2.6. Second Layer

Many of the *Viewing Opt's* can be overlaid with either velocity vectors or cell indexes using the options in the *2nd Layer* frame. The display format of the 2nd Layer parameter is controlled by the current settings for that parameter. For example, if velocity vectors are to be overlaid water column TSS and the user wants to change the format and/or plotting locations of the velocities, the user must go to the Velocity view, make the desired changes and then go back to the Water Column view and redisplay the TSS concentrations. The velocity vectors will then be overlaid on the TSS plot in the new format.

7.3 ViewPlan Display Options

The primary display options form for *ViewPlan* is displayed by one of several access methods. They include pressing the button on the toolbar or RMC'ing on either the legend, horizontal scale or timing frame. The *Display Options* form consists of five tabs shown in Figure 7-17 to Figure 7-24.

7.3.1. General Options Tab

The *General Options* tab is shown in Figure 7-17. In the *Model Grid Characteristics* frame the user may change a line format or color for a particular option. This is done by LMC on the picture box displaying the format. A format form will be displayed allowing the user to make the desired adjustments. The background color of the plot may similarly be adjusted in the corresponding frame.

The values that represent the blue and red ends of the color ramp can be specified. The direction of the color ramp depends whether the blue value is > or < the red value. If the *Autoscale with View* option is selected then the blue and red range will be reset to the minimum and maximum values for the current parameter that are within the current viewport.

From release of EE7.3 the user has a number of options for displaying *Color Ramps* in *ViewPlan* and *View3D*. The typical choice is the temperature color ramp which shows blue for low values and red for high values. Many other color ramps are now available from the dropdown list. If the user selects *Single Color* from the dropdown then the color ramp will use a gradient based on the *Single Color* option selected beneath the drop down list.

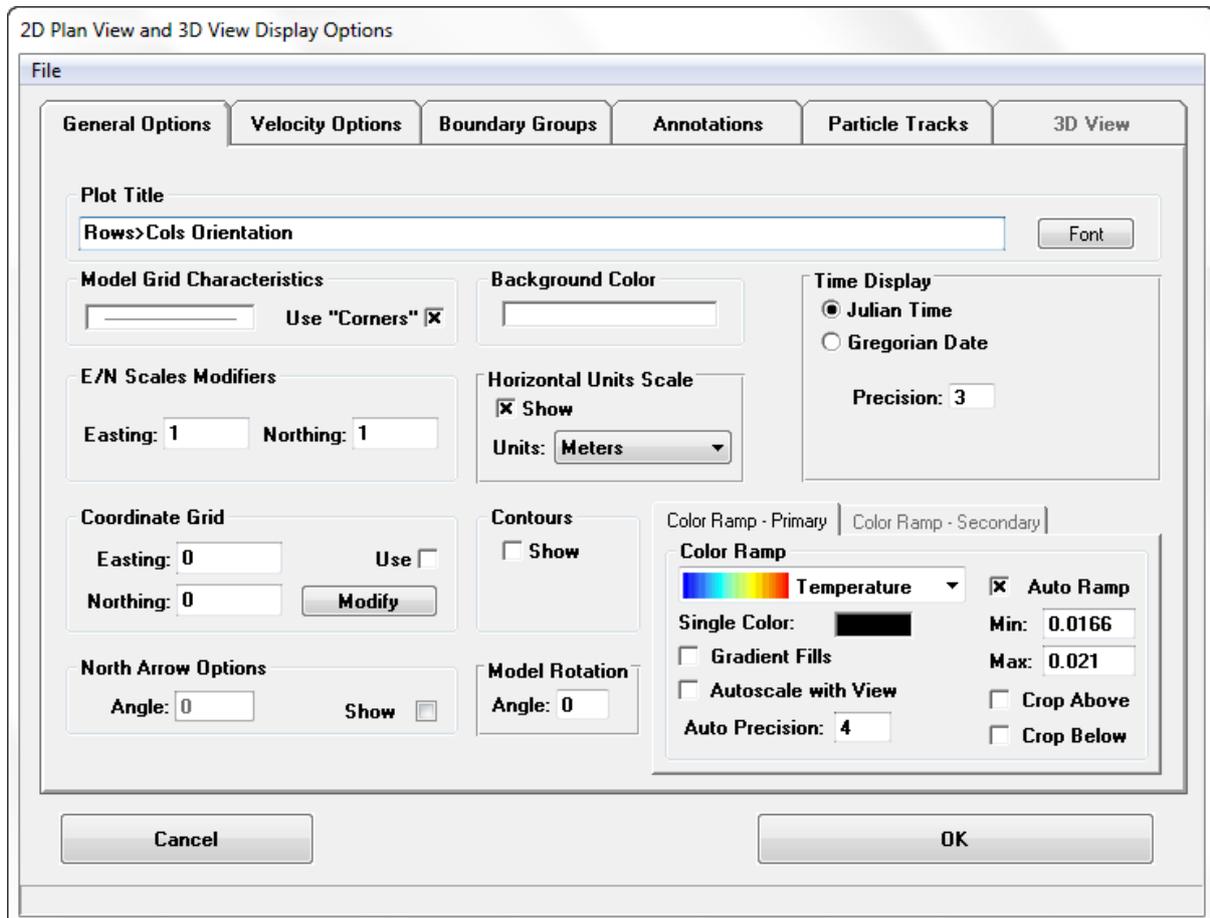


Figure 7-17 ViewPlan Display Options: General Options.

The *E/N Scale Modifiers* is used to scale up one dimension in order to better view a model. This should only be used for models that only have one active cell across the dimension needing scaling. For example, viewing a test case model of a straight river 100 km long (I component) and 100 meters wide (J component). If viewed with a 1:1 horizontal scale it would be difficult to see the model cell colors. Using a scaling factor of 5 in this case would produce better visualizations.

The display of the horizontal scale is optional. The units are set in the *Units* dropdown list. The scale units are set independently of the current reporting units (Section 7.2.5).

A grid can be overlaid on the model using *Coordinate Grid* options. The desired delta X and delta Y spacing should be entered in the Easting and Northing fields, respectively. The label and line styles can be adjusted by pressing the *Modify* button. On the formatting form, the user can select the *Link* check box to assign the same format for both the X and Y.

ViewPlan will display a north arrow when the *Show* box is selected in the *North Arrow Options* frame. The user may also rotate the arrow to align with the actual northerly direction by rotating the arrow clockwise by the number of degrees input. Furthermore, a *Model Rotation* option enables the user to rotate the model for display, thereby allowing it to fit better on the screen or printed page and improve visual alignment. As the model rotates, the north arrow automatically is updated based on the new rotation selected. While EE could previously rotate the model domain about a centroid, this new feature from release of EE7.2 changes the real co-ordinates in order to rotate the model.

Rotation is in the clockwise direction, however, the user may also enter a negative angle for counter-clockwise rotation. Note that by default the north arrow rotates with the model and may be manually adjusted if required. Figure 7-21 shows an example of a rotated model.

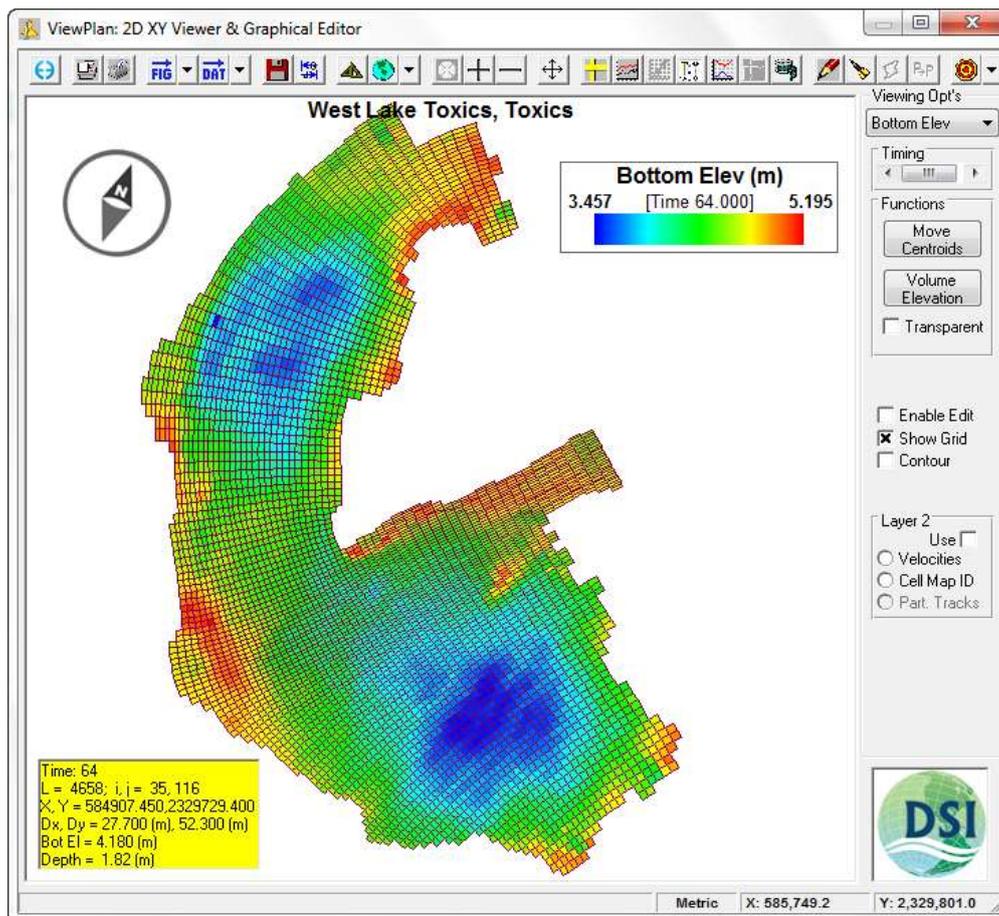


Figure 7-18 ViewPlan: Model Rotation.

7.3.2. Velocity Options Tab

Figure 7-19 shows the *Velocity Options* tab of the *Display Options* form. This tab provides access to the velocity vector formatting options including scaling, display units, and many other formatting options. If the *Scale Vectors* check box is checked then the length of the velocity vectors will be proportional to the *Scale* factor. If this checkbox is not selected then a constant length vector with the correct rotation will be shown and the magnitude will be labeled next to the vector.

The *Primary* vector controls the vector display format of the currently loaded EFDC model's velocities. The *Secondary* vector controls either a second model's velocities (see Section 6.3.1) or data (see Section. 6.1.8). To change the style of the vectors, LMC on the displayed vector.

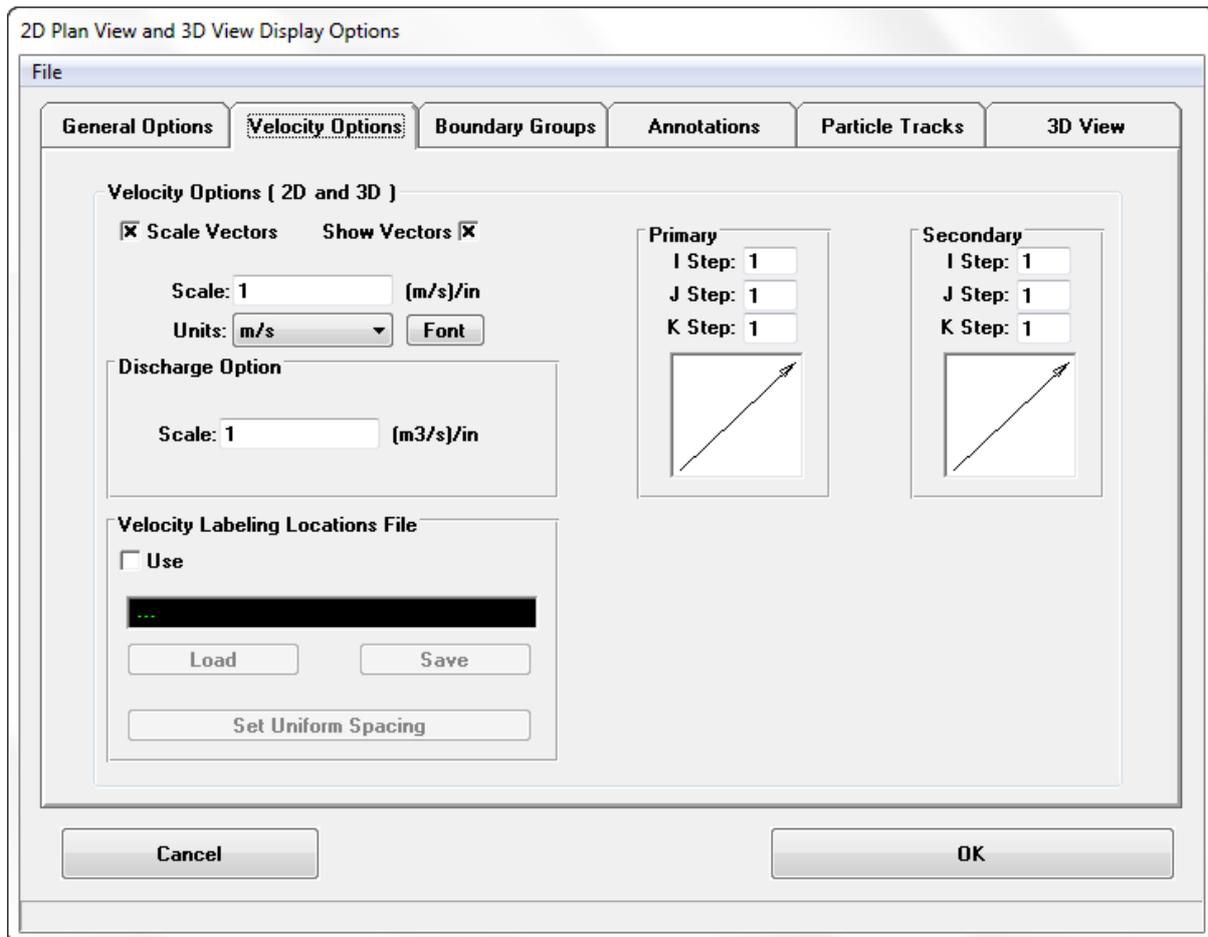


Figure 7-19 ViewPlan Display Options: Velocity Options Tab.

When plotting the velocity vectors, EFDC_Explorer generally loops over the I and J components with the steps shown (e.g. “i Step”). If more control is needed for a project, the user may select the *Velocity Labeling Locations* file. This file is an ASCII file (DAT or P2D format) containing a list of XY coordinates. If selected, EFDC_Explorer loads the XY’s and determines the corresponding cell list. If points are outside the model domain they are ignored. Then when plotting velocity vectors, only those cells in the list will be plotted.

Another feature of EE is the ability to be able to set velocity vectors at regular user-defined intervals independent of the grid and cell size. This is useful when a model varies from fine to coarse grid resolutions. In this case it is not helpful to have velocity arrows sparse in some areas and crowded in others. Selecting the *Set Uniform Spacing* button prompts the user for the delta X and delta Y for the velocity posting file, and subsequently prompts the user for the X and Y point of the lower left corner for the calculation of the spacing. By default this is the lower left corner. EE the creates a velocity map of the posting locations. The user may also load and save the labels and grid for

The user may also set the anchor point of vector: as start, midpoint or endpoint. This is done by clicking on vector arrow in *Velocity Options* which displays a form shown in Figure 7-20. Various other formatting options are available such as the color, taper and anchor point symbol.

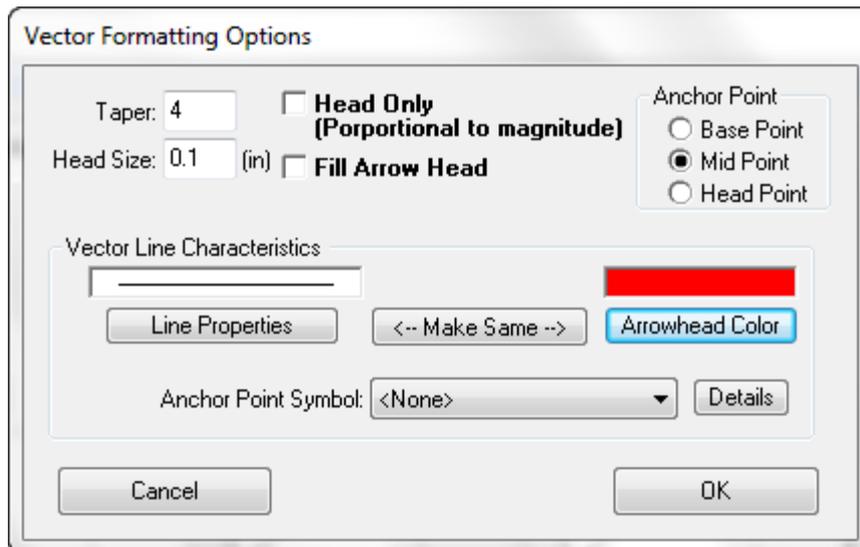


Figure 7-20 ViewPlan Display Options: Vector Formatting Options

7.3.3. Boundary Groups Tab

The way boundary conditions are displayed may be specified by the user as shown in Figure 7-21. The boundary conditions are listed in the *Boundary Condition Display* form. The *Color Cells by Groups* check box will allow all boundary conditions of a similar type to be of the same color.

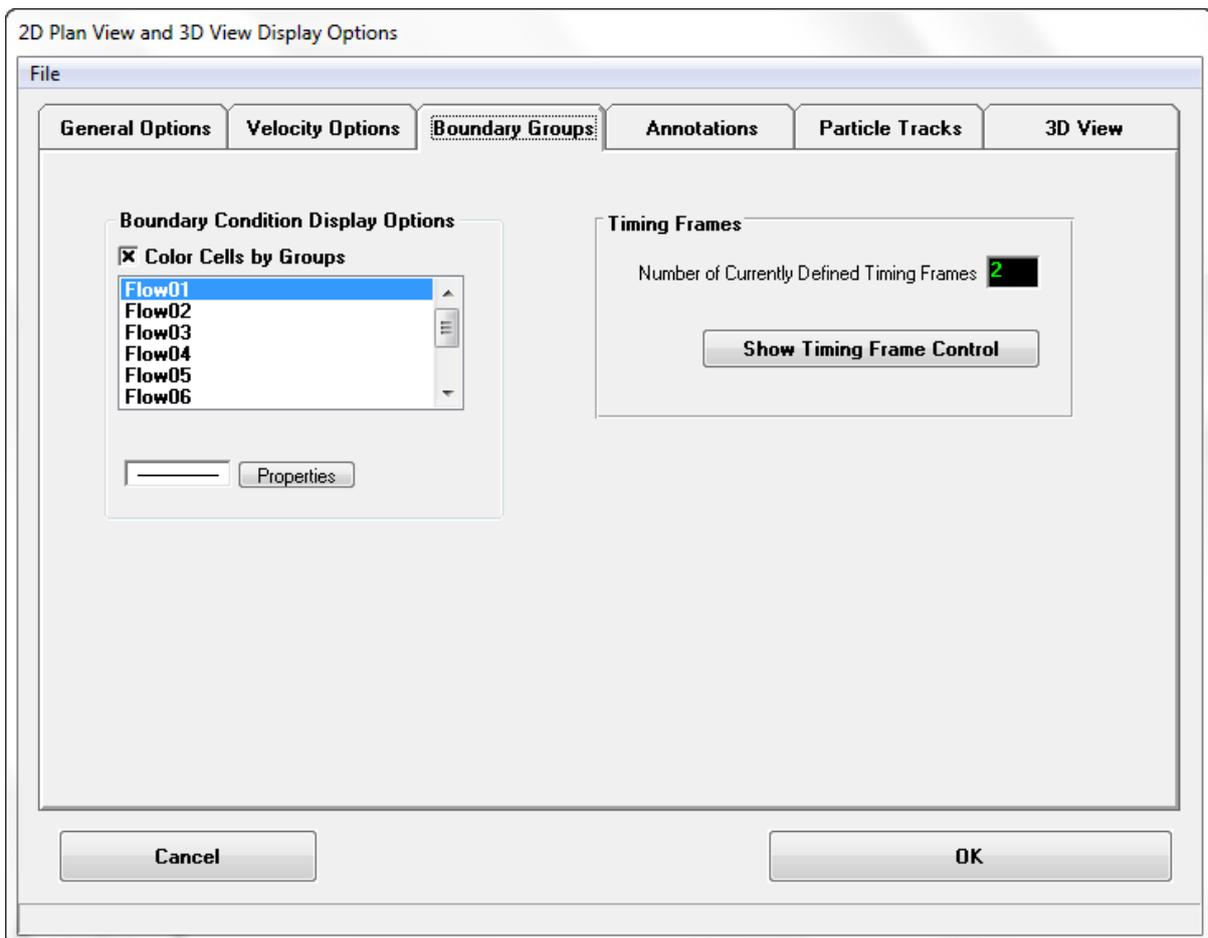


Figure 7-21 ViewPlan Display Options: Boundary Conditions.

Clicking on one of the boundary conditions followed by the *Properties* button allows the user to select the polyline properties such as color, like thickness and line style as shown in Figure 7-22.

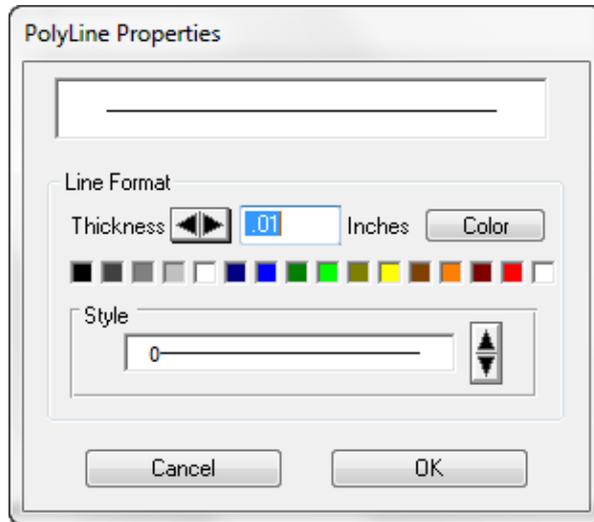


Figure 7-22 Typical Polyline Properties Options.

The *Timing Frames* frame provides the user with the number of currently defined timing frames that are displayed for each boundary condition on the *ViewPlan*. To edit this select the *Show Timing Frame Control* button. The form shown in Figure 7-23 allows the user to define new frames by selecting the *New* button. Each defined frame corresponds to boundary condition listing in the *Boundary Group to Show* frame with the selected BC highlighted in blue. The scale of the timing frame may be adjusted up or down to set the Y-axis to most suitable level.

The value of the scale field is dependent on what type of boundary forcing time series is selected. For winds the scale is m/s, for flows and pressure the scale is days. RMC on the *Timing Frame* allows the user to jump to the time selected on the frame.

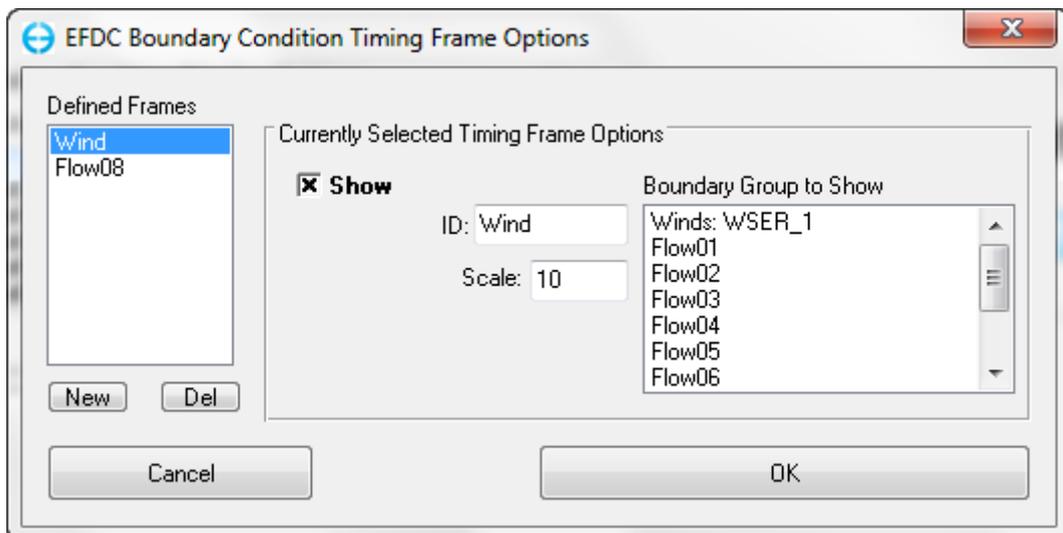


Figure 7-23 Timing Frame Options Control.

7.3.4. Annotations Tab

The main user labeling and overlays are controlled in the fourth tab of the *Display Options* form (Figure 7-24). A labels file and a data posting file are essentially the same format (X Y Label). The main difference is the labels in the labels file can be individually formatted while those in the data posting file all use a single format. For labels, EFDC_Explorer uses a file with the same name as the file with the labels but with a LBF extension to save the individual label formats.

Google Maps © standard .KML files may also be imported as a data posting or labels file.

When calibration data in the *Time Series* (Section 9) or *ViewProfile* (Section 8) has been configured the user can use the *View Calibration Data* (Section 7.2.3.8) toolbar function to display calibration information on selected plots. The symbols, fonts and time tolerance in the *Data Posting File* frame control the display format of the calibration data.

The *Global View* checkboxes allow the user to turn on or off the entire corresponding feature. For both labels and overlays, individual items can be turned on or off also.

To change the display format of an overlay line, LMC on the line display.

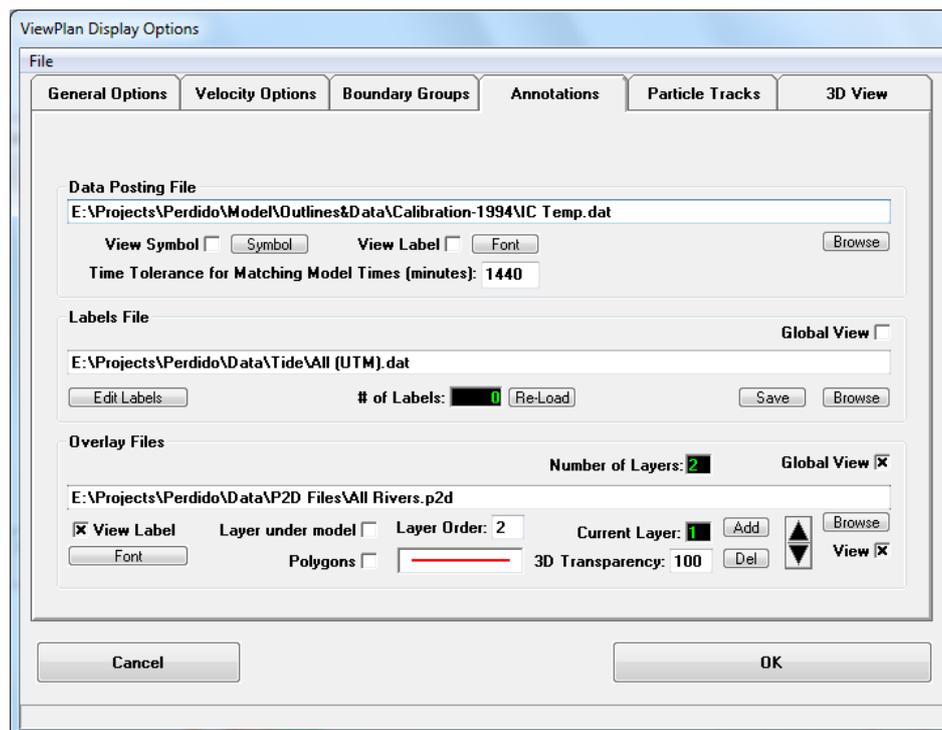


Figure 7-24 ViewPlan Display Options: Annotations.

The *Layer under model* checkbox tells EFDC_Explorer to plot the specified layer first and overlay model results on this.

The *Polygons* check box will display the XY data as closed polygons.

7.3.5. Particle Tracking

When the using the Particle Tracking functions, the user is able to configure the display characteristics of the particles in the *Particle Tracks* tab as shown in Figure 7-25. The user is able to set the *Time History* of the particles, such as whether to display:

- the entire track to the current time,
- the entire track (for the whole time),
- the recent history of the track, up to a time specified by the user,
- current position of the particle only.

In addition to this, the user may also specify the width and colors of the tracking lines, and set the symbols for the particles.

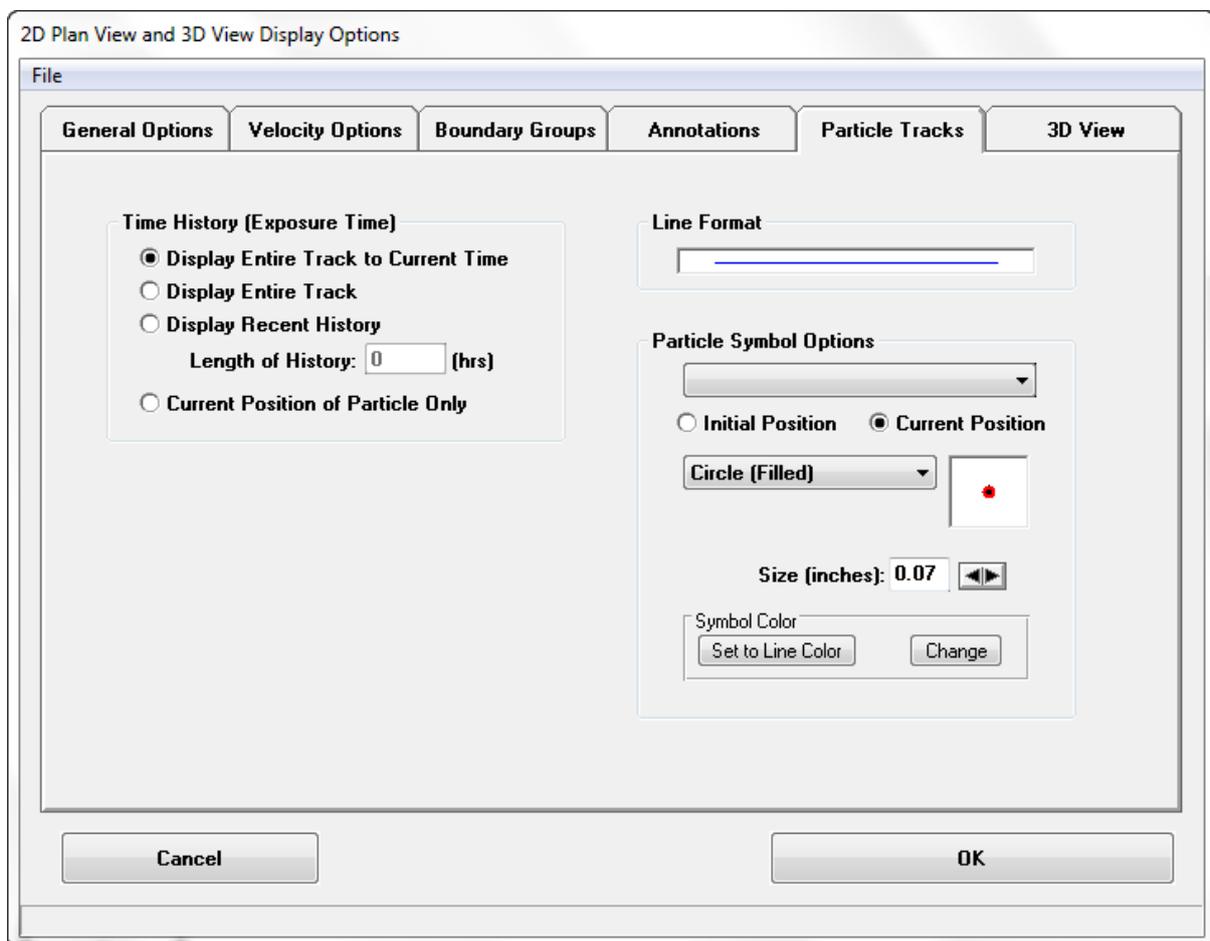


Figure 7-25 ViewPlan Display Options: Particle Tracks.

7.4 General Pre-Processing Functions

ViewPlan provides access to the visual/point & click editing features of EFDC_Explorer. The features and functions discussed in this section relate to more than one Viewing Opt. View specific pre-processing functions are discussed in the respective sections below.

ViewPlan is used for both pre- and post-processing. Therefore, if model results are loaded, the user needs to make sure the current time is set to the 0th time or initial conditions. Of course, only initial conditions data can be edited, the model results cannot be edited. When the user desires to edit the initial conditions, make sure the timing scroll bar is moved to the far left. The *Enable Edit* check box should then be displayed and enabled. As a safeguard to prevent inadvertent data modification, you can only edit data if the *Enable Edit* check box is checked. The following discussions assume that the above two conditions have been met.

7.4.1. Single Cell Edits

To edit the cell properties of a single cell, RMC on the desired cell. Depending on the Viewing Opt either the cell editing form will be displayed or a popup menu will be displayed. If a menu is displayed select *Edit*. The *Modify/Edit Cell* form is then displayed (see Figure 7-4). You may enter a new value for any of the parameters displayed or use an operator (see Section. 1.3.4).

7.4.2. Multiple Cell Edits

A group of cells may be edited at the same time using the same *Modify/Edit Cell* form shown in Figure 7-26.. The groups of cells may be selected in one of two ways. The simplest is to use the Alt-RMC and drag method to select a group of cells within a rectangular box. All the cells whose centroids are within the box will be included in the group edit. The second method is to use the polygon based *Multi-cell selection tool* from the *ViewPlan* toolbar (). Click on the toolbar button and you will be asked for a polygon file. This option allows you to have more control over which cells will be selected than a simple rectangle. Select your file and the selection method and then press *Apply*. A list of cells that match the criteria will be included in the cell group to edit.

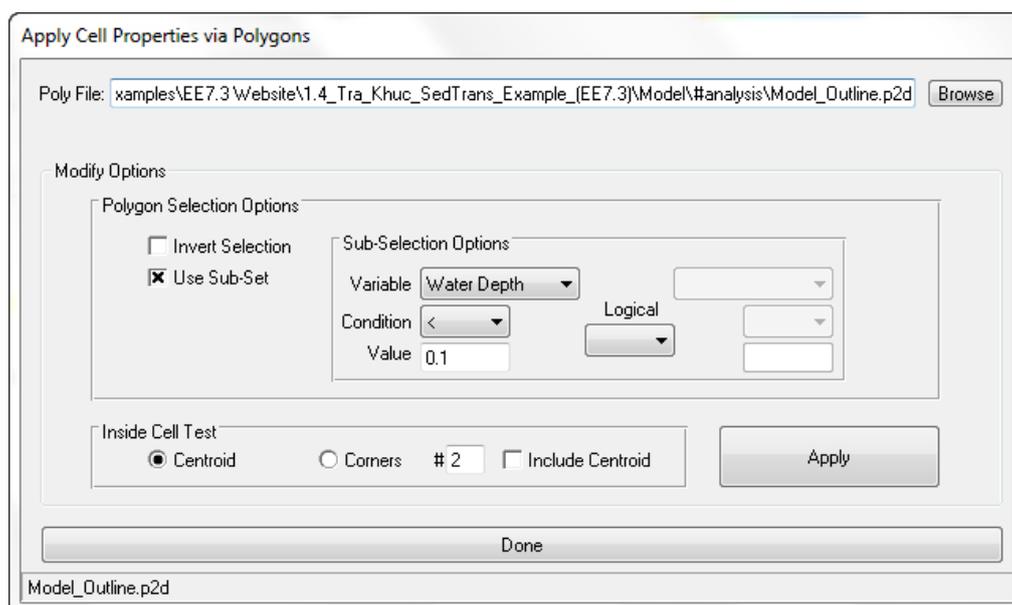


Figure 7-26 ViewPlan: Apply cell properties with a polygon.

The *Edit/Modify* form will come up allowing the user to make group changes to the parameters. Some properties do not have a value in the input box because that property varies between the selected cells. If a fixed value is shown, then that value is constant for the selected cells. To replace a property with a new value, enter the new value into the appropriate input box. To apply the *Operator* function to offset or otherwise adjust all the properties in the selected region, put a "+", "-", "*", or "/" as the first character followed by a space and then the value to apply. For example, say the user wants to lower a region's bottom elevations by 0.5 meters. Select the region desired, then type in the *Bottom Elev.* input box "- 0.5". EFDC_Explorer will then lower all the bottom elevations of the cells in the group by the amount specified. The method can be used for any of the cell properties.

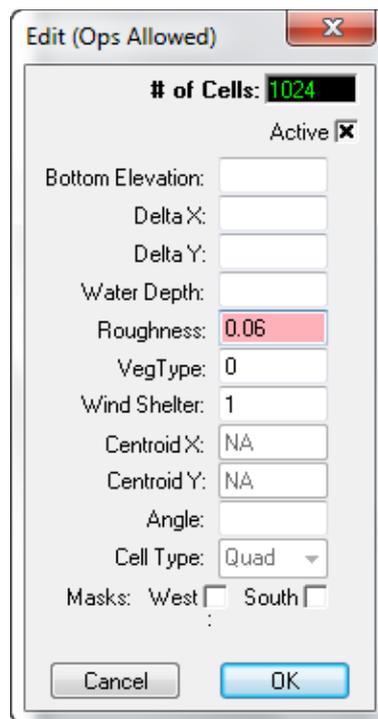


Figure 7-27 ViewPlan: Editing cell parameters.

7.4.3. Cell to Cell Copy/Assign

This feature allows the user to select a "Source Cell" and then copy the current property into subsequent cells ("Target Cell"). First the user must turn on the *Copy Cell Properties* button on the toolbar. The "Source Cell" is then selected using Ctrl-LMC. An input box is then displayed and filled with the Source Cell's property. The user can change the value or use the operator method noted above. The user can then apply the "Source Cell" property (or whatever is in the property input box) by Ctrl-RMC. The user can keep applying the value or operator by continuing to Ctrl-RMC'ing on the desired cells.

The user can also apply Operators using this function. For example, to apply a rise of 50% over the current value of whatever parameter is being edited, follow these steps:

- Select the desired *Viewing Opt's*.
- If output data is currently loaded, set the current time back to the start. The *Enabled Edit* will be enabled if the user is at the IC timing position.
- Check *Enable Edit*.
- Press the P→P button on the toolbar. This is a toggle button. This function will be active until the user toggles it off by pressing the button again or changing the "Viewing Opt's".
- Enter "* 1.5" in the *Cur Value* field (note the space between the * and the 1.5 is required).
- RMC'ing on the cells, while holding down the Control key, will apply a 150% factor to the value of the cell. For example, if bottom roughness is being edited and the initial value was 0.02 m, after Ctrl-RMC'ing the updated value would be 0.03 m. The cell color would be updated.

7.4.4. Data Field Smoothing

The bathymetry, salinity and temperature data can be smoothed over the whole domain or using a polygon to subset the cells. Pressing Ctrl-S displays the smoothing control form. The *Load* button in the *Polygon* frame can be used to input the polygon file, otherwise the entire domain will be used. Enter a weight in the *Smoothing Factor* input box and then click *Apply* as many times as desired. Each click performs a single pass through the data. After each pass the data are redisplayed so that the user can view the results prior to applying another smoothing pass.

7.5 General Post-Processing Functions

The basic use of EFDC_Explorer's ViewPlan post-processing function is 2D maps of various parameters at user specified times. The viewing options have many variations depending on the context. For example, for water column information the user may specify depth averaged results or review the results for each layer of the water column. Another example is for the sediment bed, for which the user may view the results as either mass weighted depth averaged results (e.g. d_{50} 's), total mass summed over all the layers, or layer by layer.

The desired time is scrolled to using the *Timing* scroll bar, using the PgUp/PgDn keystroke combinations or Ctrl-G to jump directly to a specific date. The output settings are set using the *Display Options* form accessible from either the toolbar or RMC on the legend, timing frame or horizontal scale.

Some of the general features of the post-processing will be discussed in the following subsections.

7.5.1. Time Series

A family of time series curves of the same parameter can quickly be displayed. Press the *Time Series* button on the toolbar and then LMC on each cell to be displayed. For all parameters except for the water depth derived parameters, each time the user selects a new cell the *Cell Selection List* is updated with the I, J and K of that cell and the cell location is shown on the model domain as shown in Figure 7-28. A number is shown next to each cell selected that corresponds to the cell # in the list. There is no limit to the number of time series can be shown at once.

The user may manually adjust the I, J and K value in the list, as well as turn on or off the cell by setting *Use* to 0. Selecting *Clear* clears the whole list. The user may save and reload a list of time series location for use at a later time. Selecting *Show* causes the time series data to be loaded and displayed for the selected parameter and cells in the list. Section 9 provides a discussion of the use and options for the *Time Series* utility.

Toggle the *Time Series* button to reset the series list or change the view option. The previously used list of cells is remembered after the user returns the time series option.

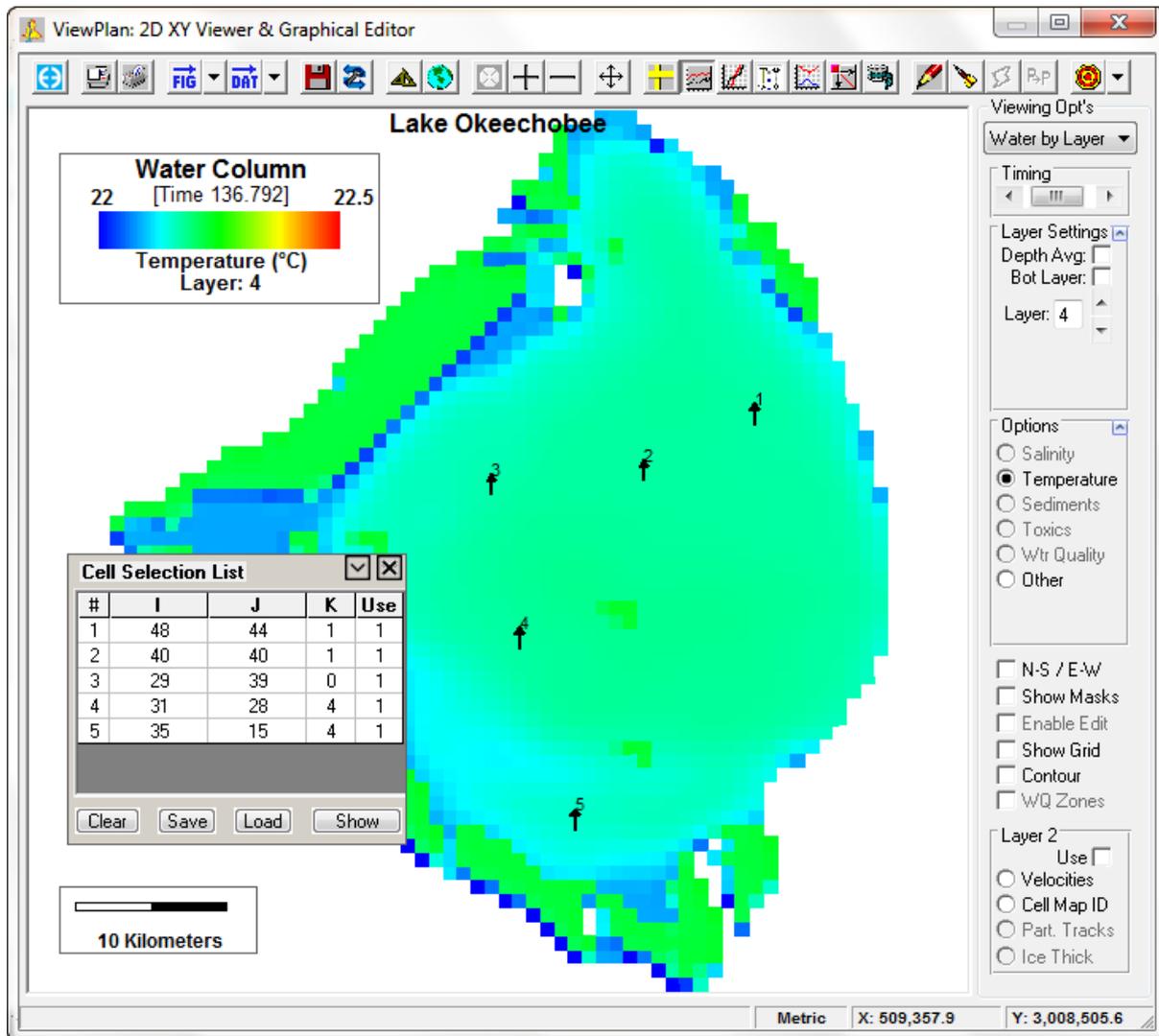


Figure 7-28 ViewPlan: Cell selection for times series plots.

7.5.2. General Statistics

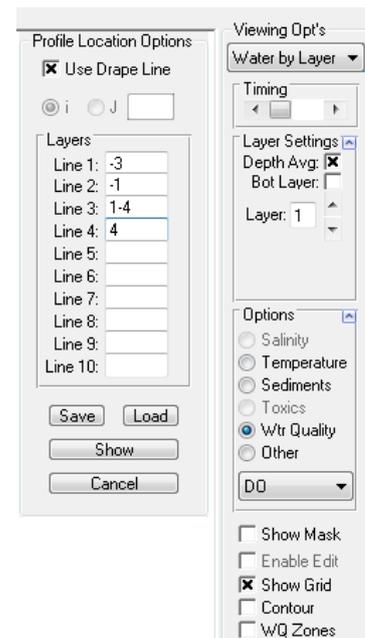
ViewPlan has the ability to calculate some general statistics of the current parameter and snapshot time. Click the *General Statistics* button and the user will be prompted with a browse window to select a polygon file. If the user clicks *Cancel*, EFDC_Explorer will use the current window (not the entire domain). If the user selects a polygon file, then the cells inside that polygon will be used for the calculation.

From the selected cell list a set of general statistics of the currently displayed snapshot in time will be computed. The exact statistics vary with the parameter. It is anticipated that this functionality will be enhanced in the future as resources become available.

7.5.3. Longitudinal Profile Plots

When viewing the water column in many of the *ViewPlan | Viewing Options* the drop-down the Longitudinal Profile tool is available on the toolbar (the button is greyed when not available). This function is similar to the 2D profile *ViewProfile* but provides an XY longitudinal plot of the current parameter along some profile. The approach to define the data extraction location is identical to the 2D *Slice/Extraction Options* used by *ViewProfile* (see Section 8-1). If a *Use Drape Line* is selected the user should define the layers required, and after selecting the *Show* button will be prompted for the drape line.

Up to ten lines are allowed per plot. The water column data selected is the main parameter to be plotted. However, the layering options are controlled by the *Longitudinal Profile* tool, not the settings in the *Layer Settings* frame. There are some special cases available for display. The following list provides the options available for each line.



Layer # A specific layer number or a range of layers to average. In the adjacent graphic the “Line 4” field has “1-4” entered. Therefore for that line DO being plotted is the average DO for those layers.

- 0 If a “0” is entered then the value extracted will be the depth averaged value.
- 1 Special Case: Water surface elevation.
- 2 Special Case: Water depth.
- 3 Special Case: Bottom elevation.
- 4 Special Case: Bed shear stress.

If the layer field is blank for a certain line, it will be skipped.

The *Profile Locations Options* graphic above shows five lines being defined with three of the lines extracting dissolved oxygen (DO) for layer 1, the average of layers 1-4 and layer 4. Once the options have all been set, the user must press *Show* to view the profile. The user can save and later reload a set of line definitions using the *Save* and *Load* buttons, respectively. Figure 7-29 shows the longitudinal profile plot resulting from the selections. These profiles can be animated to the screen or AVI file using the animate button from the toolbar.

Users may display graph/plot labels in metric or British imperial units using the CTRL M keystroke to toggle the units. Selecting ALT M will toggle the x axis from feet to miles.

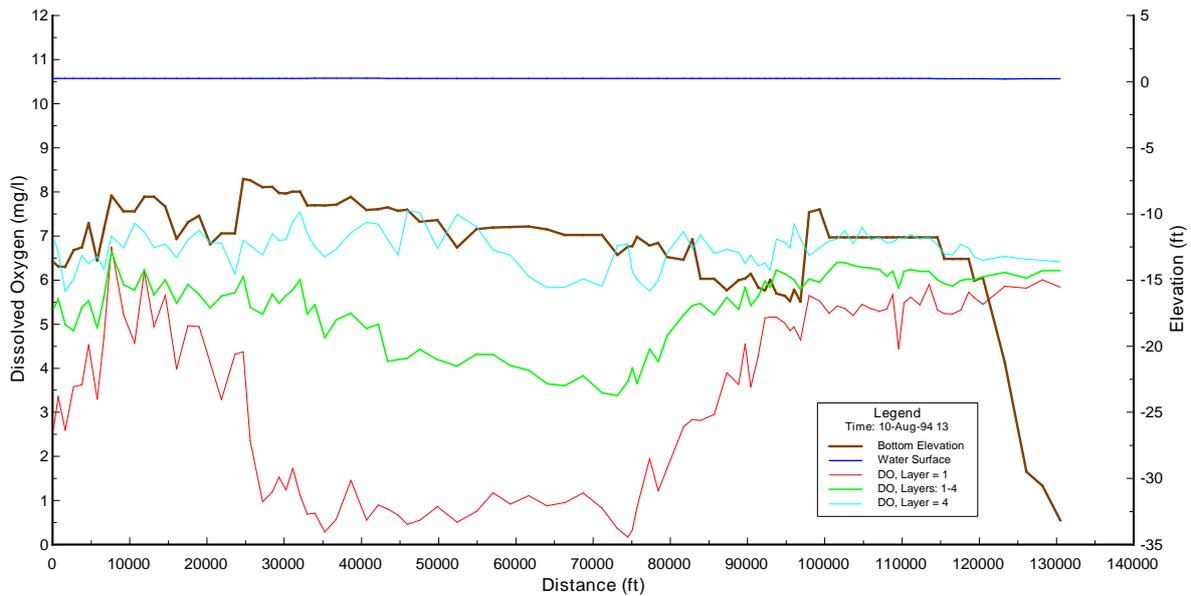


Figure 7-29 Water Column longitudinal profile of dissolved oxygen.

7.5.3.1 Timing Frame

The *Model Timing Options* button provides the user with access to the *Profile Options* form wherein is a *Timing Frames* frame. Selecting the *Show Timing Frame Control* allows the user to toggle on and off the timing frame as shown in Figure 7-30 below.

Multiple timing frames may be defined and displayed by the user similar to the user of this tool in the *ViewPlan* mode as shown in Figure 7-31.

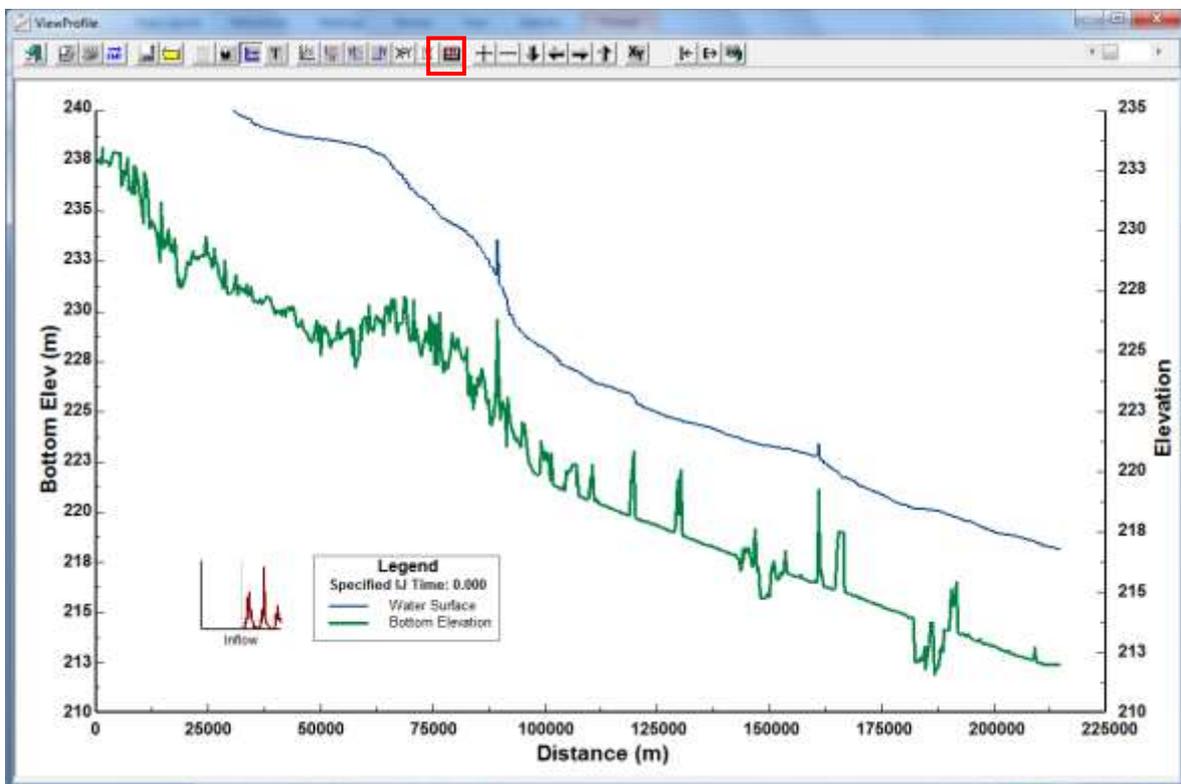


Figure 7-30 ViewPlan: Longitudinal Profile Plots Timing Frame

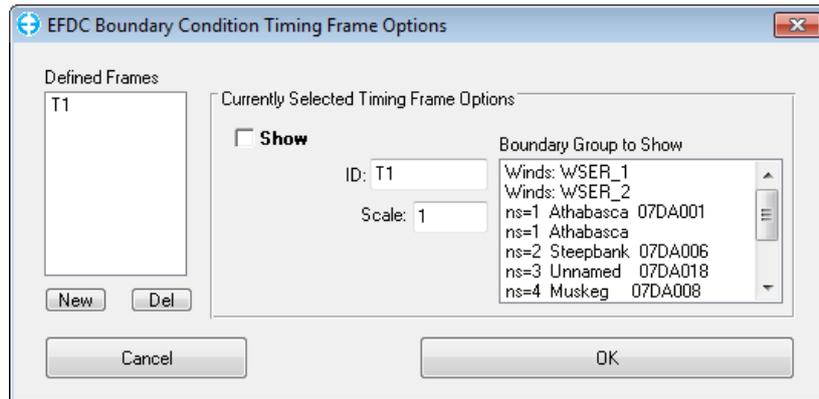
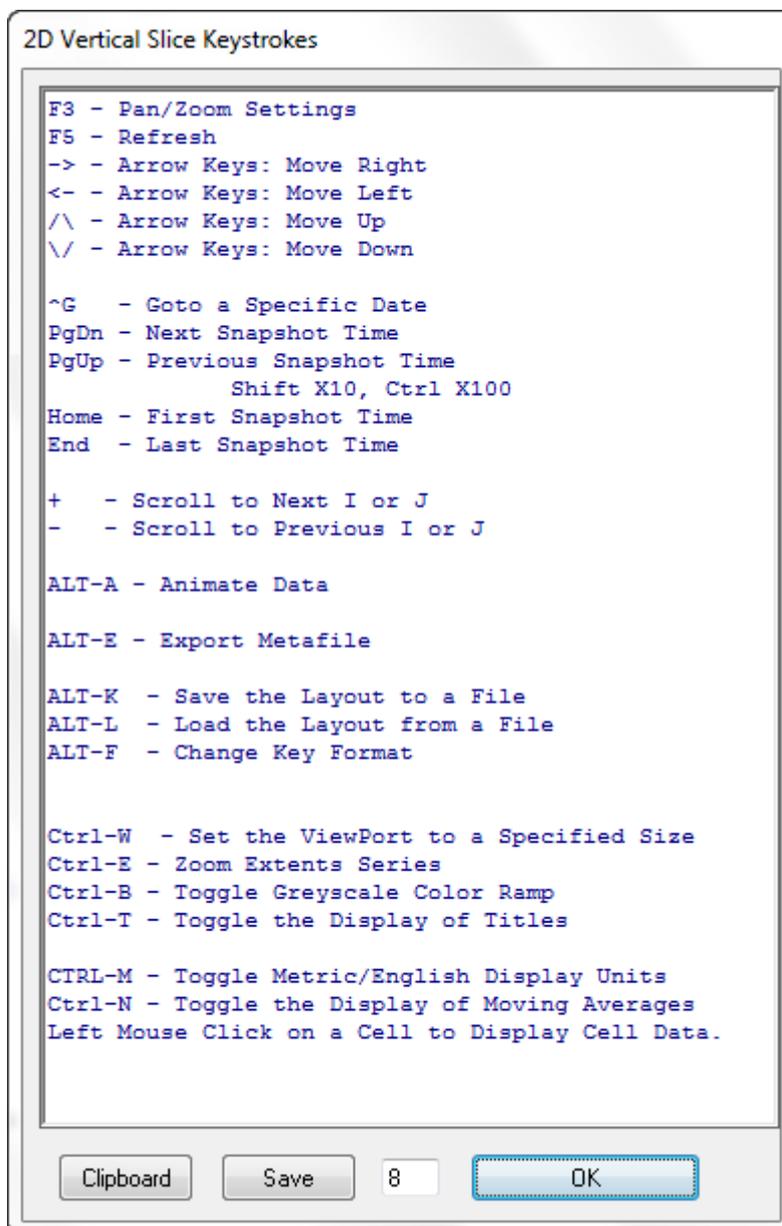


Figure 7-31 ViewPlan: Profile Plots Timing Frame Options.



7.5.4. Animation of Results

The results of any of the time dependent results can be output as an animation to either the screen or an AVI file. If the animation is to be saved to an AVI file, the user is asked for the number of frames per second to be output to the file. This will be application specific, but a number of 4 frames per second generally provides a fairly smooth, but not too fast animation. The user should be aware that these files can get quite large quickly. The frame size of the animation will match the frame of the *ViewPlan*. Press any key to stop an animation.

7.6 ViewPlan Main Viewing Options

As previously mentioned the *ViewPlan | Viewing Opt's* is adjusted based on what parameters are being modeled, what data has been loaded, and what option has been requested at a particular time by the user. All of the available options are described below.

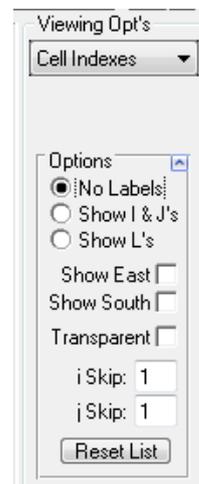
7.6.1. Cell Indexes

This *Viewing Opt* displays the EFDC indexes of I & J and the linear index "L" on a cell map based on LXLY coordinates. The data posting label format is used to display the indexes.

The *i Skip* and *j Skip* fields can be used to reduce the frequency of labeling, if the labels are too crowded. To only label certain cells do the following:

- Enter very large skip values for both the i and j indexes.
- RMC on the cells to be labeled.
- Refresh the view. Until the *Reset List* is pressed, each time the user views the Cell Indexes only the user defined cells will be labeled.

The *Transparent* check box causes the grid displayed to use no fill so only the grid outline is displayed. This feature is also applied for the water column cells, if the cells are "dry". This feature is needed when using geo-referenced bitmap backgrounds to reveal the underlying background.



7.6.2. Cell Map

The Cell Map Viewing Opt displays the cell as stored in the computer memory. Figure 7-32 shows an example cell map using the *Uniform Grid* option. The I and J axes can be labeled, as they are in this example.

Cells can be deactivated or activated using this view. RMC'ing on a cell pops up a menu that allows the user to *Edit*, *Activate*, *Deactivate*, or *Set as Show IJ*. The user can deactivate cells from several *Viewing Opt* views. Deactivated cells are still defined and are in memory. The number of active cells does not change until the user saves the project. When the user reloads the project the deactivated cells will be completely removed.

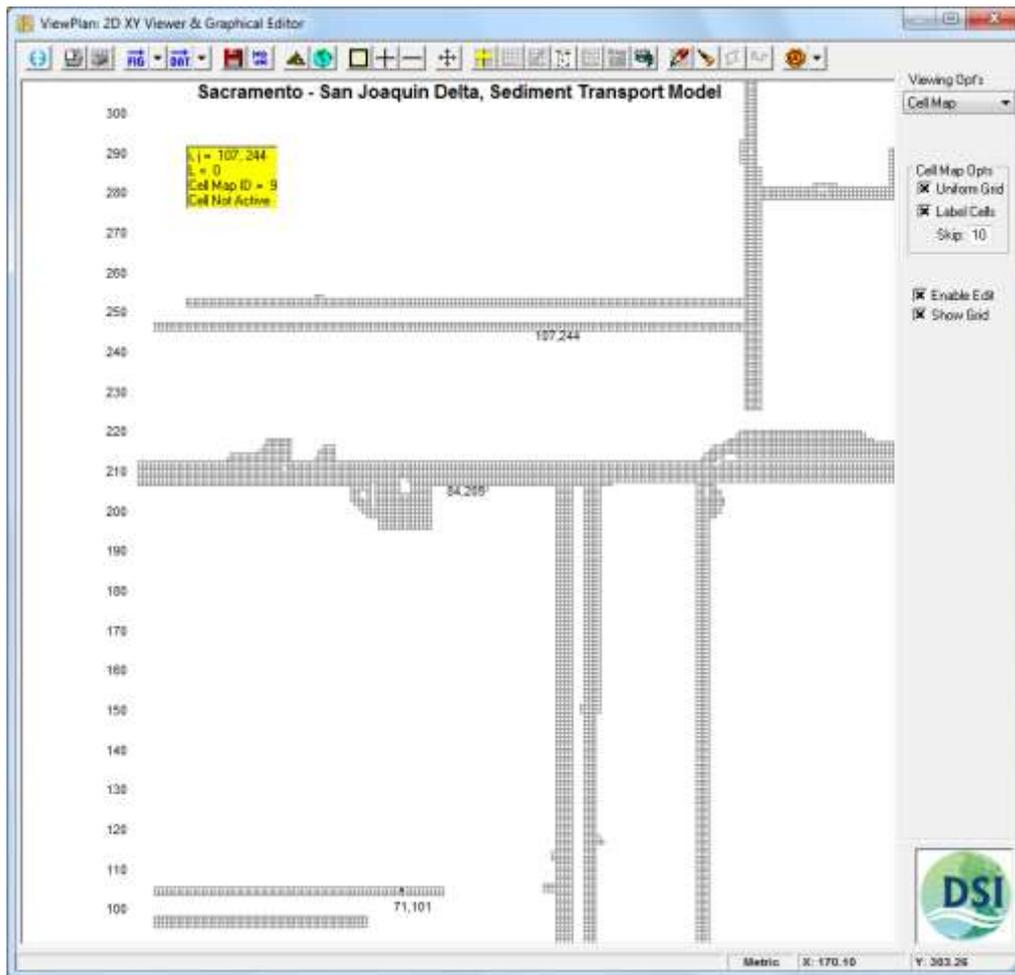


Figure 7-32 ViewPlan: Example Cell Map.

Retaining deactivated cells in memory allows the user to reactivate a cell without losing information, if needed, during the cell editing process. To reactivate a deactivated cell or a originally deactivated cell, RMC on the cell and select activate. If the cell was previously activated it will just change the active cell flag to on. On the other hand, if the cell was not previously activated EFDC_Explorer looks to the immediately adjacent active cells to try to set the appropriate cell dimensions, depth, rotation, etc. Because EFDC_Explorer is using adjacent cells to assign properties, the user should add cells in a manner that has the most active cells adjacent to the cell being activated. The cell properties are displayed to allow the user the opportunity to make adjustments to the cell properties before accepting the activation.

If cells are activated near the edge of the IJ space, EFDC_Explorer adds to the appropriate dimension and shifts the model to reflect the new IJ's.

7.6.3. Bottom Elev

The *Viewing Opt* | *Bottom Elev* displays a plan view of the model bathymetry. The scales can be changed in the *Display Option* form to show resolution, if desired.



An option to shift the cell centroids is available by pressing the “Move Centroids”. The *Volume Evaluation* button displays a XY plot of the volume-area relationship and the area-elevation relationship.

Use the *Transparent* function to view an underlying georeferenced bitmap. If the *Show Grid* option is not checked the grid outlines will be colored but the cells will not be filled.

7.6.3.1 Bathymetry Comparison

If a *Comparison* model has been loaded (see Section 6.3.1) alt-M allows the user to compare the bathymetry between two models, the current model and the Comparison model. Alt-M toggles the display of *Model Comparison* allowing the bathymetry differences (Base - Compare) to be displayed instead of elevations. This feature is also available for other Viewing Options (see Section 7.2.6). The volume differences can be computed with the Alt-V keystroke. The total cut/fill/net volumes will be displayed and then placed onto the clipboard.

7.6.4. Water Levels

Water Levels option provides for a range of water depth derived parameters. The two main uses of this option are to plot water depths and water surface elevations. Some of the functions only use the water depths and bathymetry, which is always available, but some of the functions also require velocities to have been loaded. The graphic to the right shows some of the water level options grayed out because the velocities were not available. The following summarizes the other options:

Wet/Dry: Provides a two color display for wet cells (blue) and dry (gray). The wet/dry determination is made using the dry depth unless the *Use Wet* option is checked, in which case the wetting depth will be used. The areas and the numbers of wet/dry cells are reported.

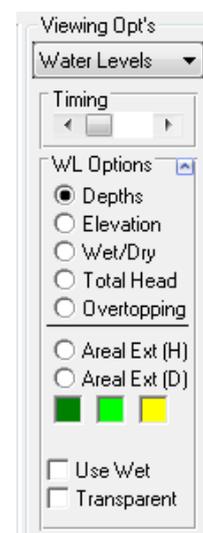
Total Head: Displays the total head, water surface elevation + velocity head ($v^2/2g$). Only available if the velocities have been loaded.

Overtopping: This displays the FEMA defined overtopping depth which is defined as: depth + velocity head ($v^2/2g$). Only available if the velocities have been loaded.

Areal Ext (H): This option displays the FEMA velocity hazard level defined as depth * velocity head ($v^2/2g$). The areas displayed and the areas computed are based on the computed hazard level over a specified minimum. The user can change the minimum level and EFDC_Explorer will recompute the areas and display the results.

Areal Ext (D): This option displays an inundation map and computes areas using a specified minimum depth and duration. The user can change the minimum depths and durations and EFDC_Explorer will recompute the areas and display the results. If a Compare model or a Compare model and a 3rd model have been loaded (Section 6.3.1) then each model's results will be plotted in the order of Base, Compare then 3rd. The colors displayed for each model can be changed by LMC'ing on the colored boxes beneath the *Areal Ext* checkboxes.

Figure 7-33 provides an example using a Base and a Compare model. Note the areas computed and displayed in the yellow information box.



Delta: Displays the differences in water surface elevations between the Base model and the Compare (i.e. $\Delta = \text{Base} - \text{Compare}$). A Compare model, with depths, must be loaded for this option to be available.

The default is to use the “dry depth” as the cutoff between “wet” and “dry” cells. If *Use Wet* is checked then the “wet depth” water level will be used. Using the wet depth results in less cells being considered wet. This option is only applicable for models using wetting/drying options.

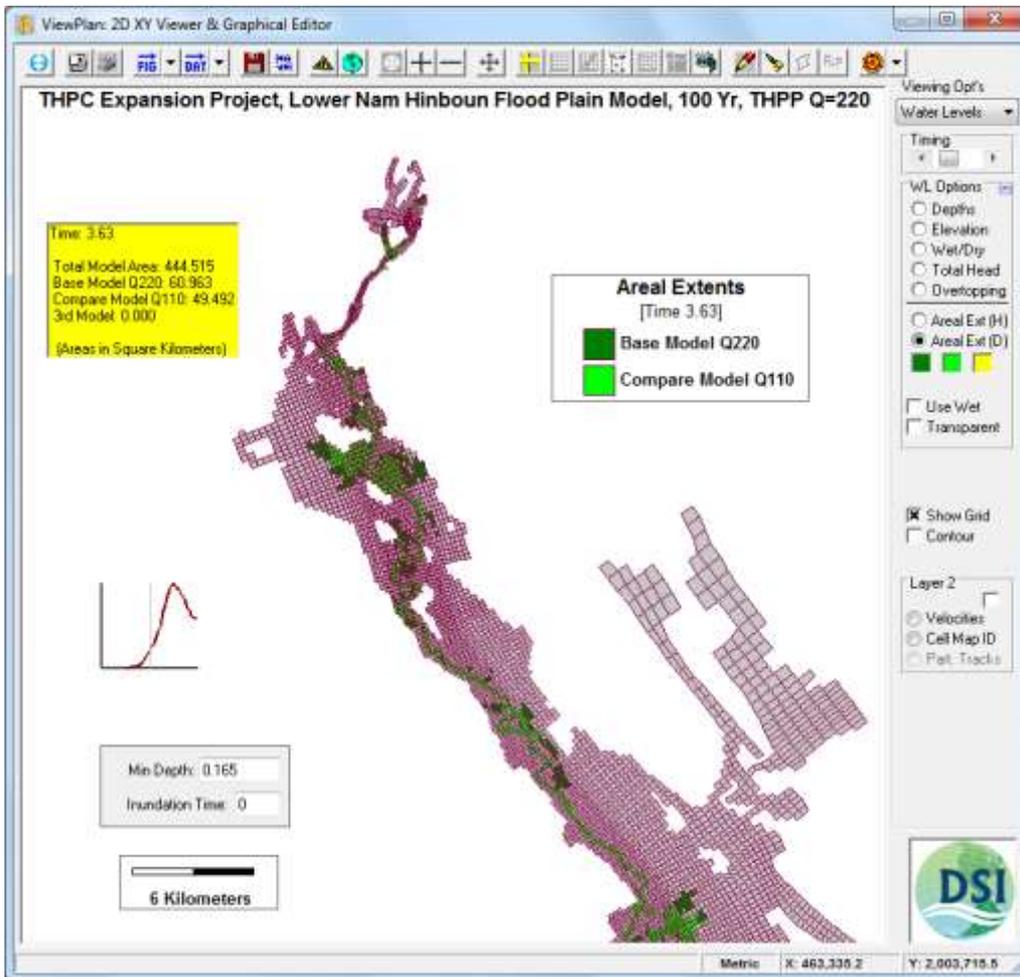


Figure 7-33 View Plan: Water Level showing Areal Extents based on depth-durations.

7.6.5. Boundary Conditions

The *Viewing Opt | Boundary C's* allows the user to display the location and type of boundary conditions currently defined. The user may also view the associated time series forcings. These depend on the type of time series defined: whether lookup table or equation based. The *View Cell Lookup Table* and *View Group Lookup Table* are used when the HS uses a lookup table. If the HS uses an equation then the *View Cell Time Series* and *View Group Time Series* options are enabled as shown in Figure 7-34. An example of how to use these options is provided below.

If editing is enabled when the user RMC's on a cell, the menu (shown adjacent) is displayed. The user can choose:



Options Area

Edit To edit the boundary group.

New To add a new boundary condition group. The new group is not required use the cell RMC'd.

Delete To delete the boundary group.

Add to Adjacent Adds the cell RMC'd to an existing boundary group that has as one of its current cell as an adjacent cell.

LMC'ing on a cell that has one or more boundary conditions currently assigned to that cell lists the boundary group(s) and reports on the boundary forcing at the time shown in the Options Area. The user can enter new times between the Min and Max shown and the forcings will be displayed.

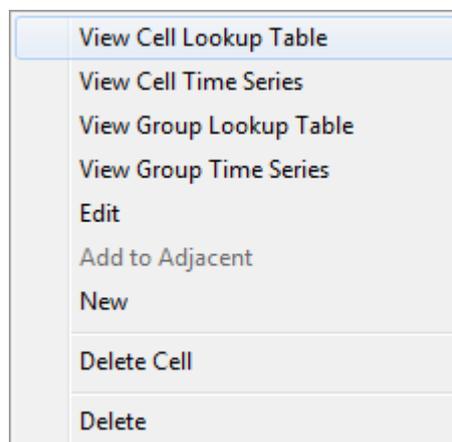


Figure 7-34 View Plan: Boundary conditions RMC popup menu.

EE8 has the capability to plot the flow time series of an actual boundary condition including hydraulic structures defined by equations. efdc+ creates a new output file, EE_BC.OUT that stores the flows for each boundary condition / cells at each time step. The user can now RMC on any BC in a model that has model output loaded and see the time series of flow.

An example of how to view the time series is shown in Figure 7-35. This model has an open (tidal) boundary at the western boundary and an open (tidal) boundary in the eastern boundary. A culvert has been configured in the middle of the domain, with the upstream cell of the culvert marked with a "U" and the downstream cell marked with a "D". The downstream (D) cell for the culvert has been RMC'd and the user can now select a look-up

table or time series. If the culvert does not use a look-up table this option is not available. In this case the culvert has a time series for flow which will be displayed as shown in Figure 7-36.

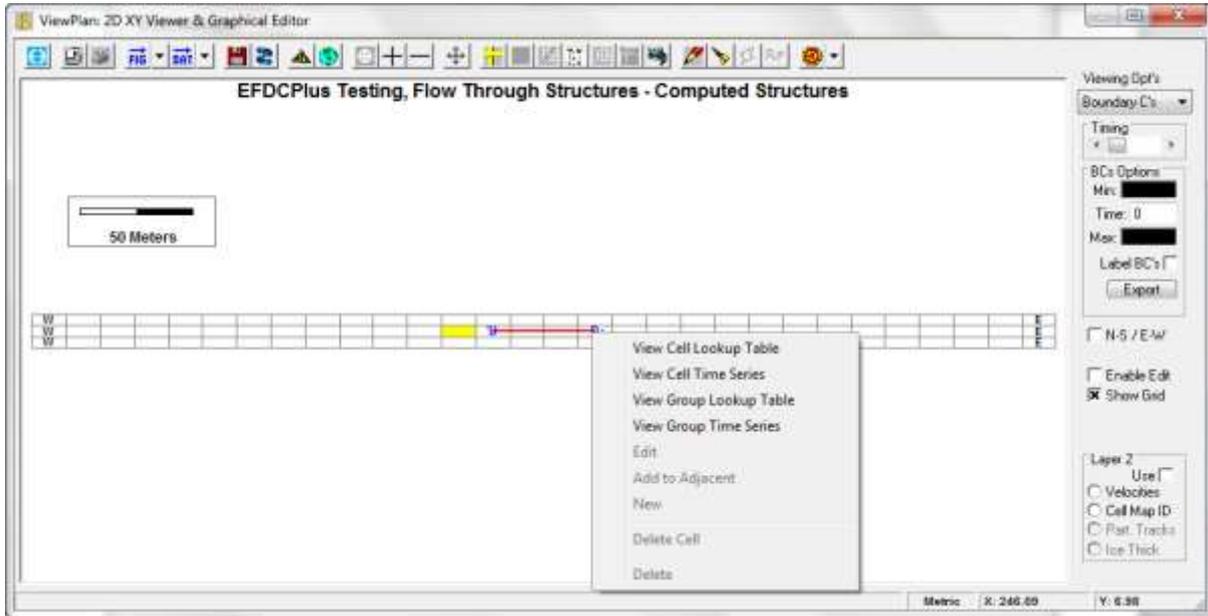


Figure 7-35 Viewing flow time series in a culvert.

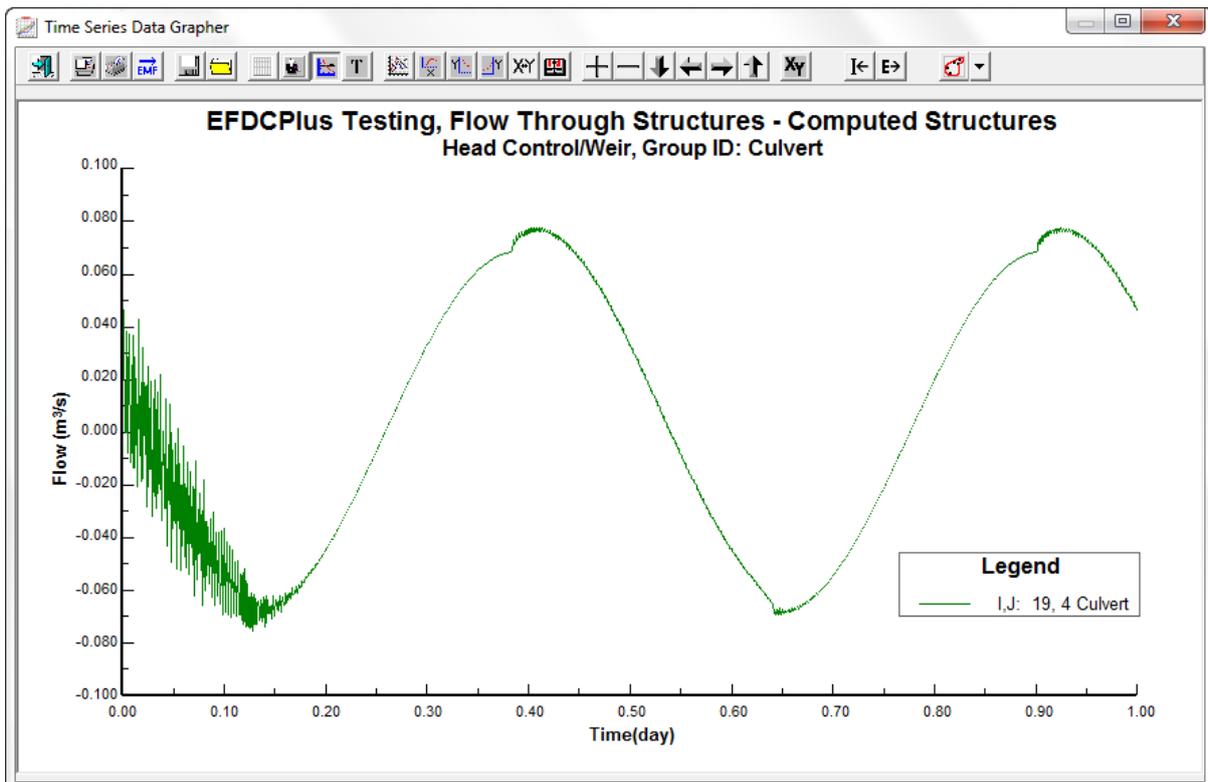


Figure 7-36 Time series for a culvert.

7.6.6. Fixed Parameters

The *Fixed Params* viewing option provides access to viewing and editing parameters that are invariant in time. These parameters include:

- *Roughness*
- *Cell Angles*
- *Cell Connectors* (N-S and E-W cell mapping)
- *Wind Shelter* (shown only if WSER>0)
- *Shading Factors* (shown only if shading is used)
- *GVC Layers* (shown only if GVC Model is used)
- *Groundwater Map* (shown only if groundwater is activated)
- *Wind Series Weightings* (shown only if NWSER>1)
- *Atmospheric Series Weightings* (shown only if NASER>1)



Most of the *Fixed Params* do not have sub-options. Only the *GVC Layers* option has sub-options. The adjacent graphic shows the options area when the *GVC Layers* was selected.

GVC Layers

When viewing the *GVC Layers*, RMC'ing on the model provides the user with several options to reset the layering or compute the layering using specified surface and bottom reference elevations. The GVC layering type impacts the assignment process. The vertical layering type needs to have been set to 1 for GVC, or 2 for local Sigma. *Bad layers* will display the cells whose bottom elevation, relative to SELVREF, is bad when using automatic layering.

7.6.6.1 Cell Connectors

In EE8 and efdc+ users can connect disconnected sub-domains via N-S and E-W connectors. See Section 4.1.2.1 on how to import multiple domains. To connect the sub-domains, the user should navigate to *ViewPlan | Viewing Options: Fixed Parameters | Cell Connectors* or *Bottom Elevation* and select *Enable Edit*. In order to view any existing connection the *N-S / E-W* checkbox should also be selected. When the user RMCs on the workspace a number of option for creating, deleting and editing cells connections is displayed as shown in Figure 7-37. If no cell connections are currently configure then only the *New Cell Connections* option is accessible, and *Delete Cell Connection*, *Delete All Cell Connections*, and *Edit Cell Connections* are greyed out.

Selecting *New Cell Connections* provides three options, including the *New Single Cell Connection*. This allows the user to simply LMC on a border cell on each subdomain and create a connection. The user can also draw polylines for the connections to be made with the *New Group Connection Across 2 Polylines*. Alternatively, the user may have existing polylines created that can be loaded and used to make the connections with the *New Group Connection in existing Polyline Files* option.

If the user chooses the option of *New Group Connection Across 2 Polylines* shown in Figure 7-37, they can then draw a new polyline on each subdomain.

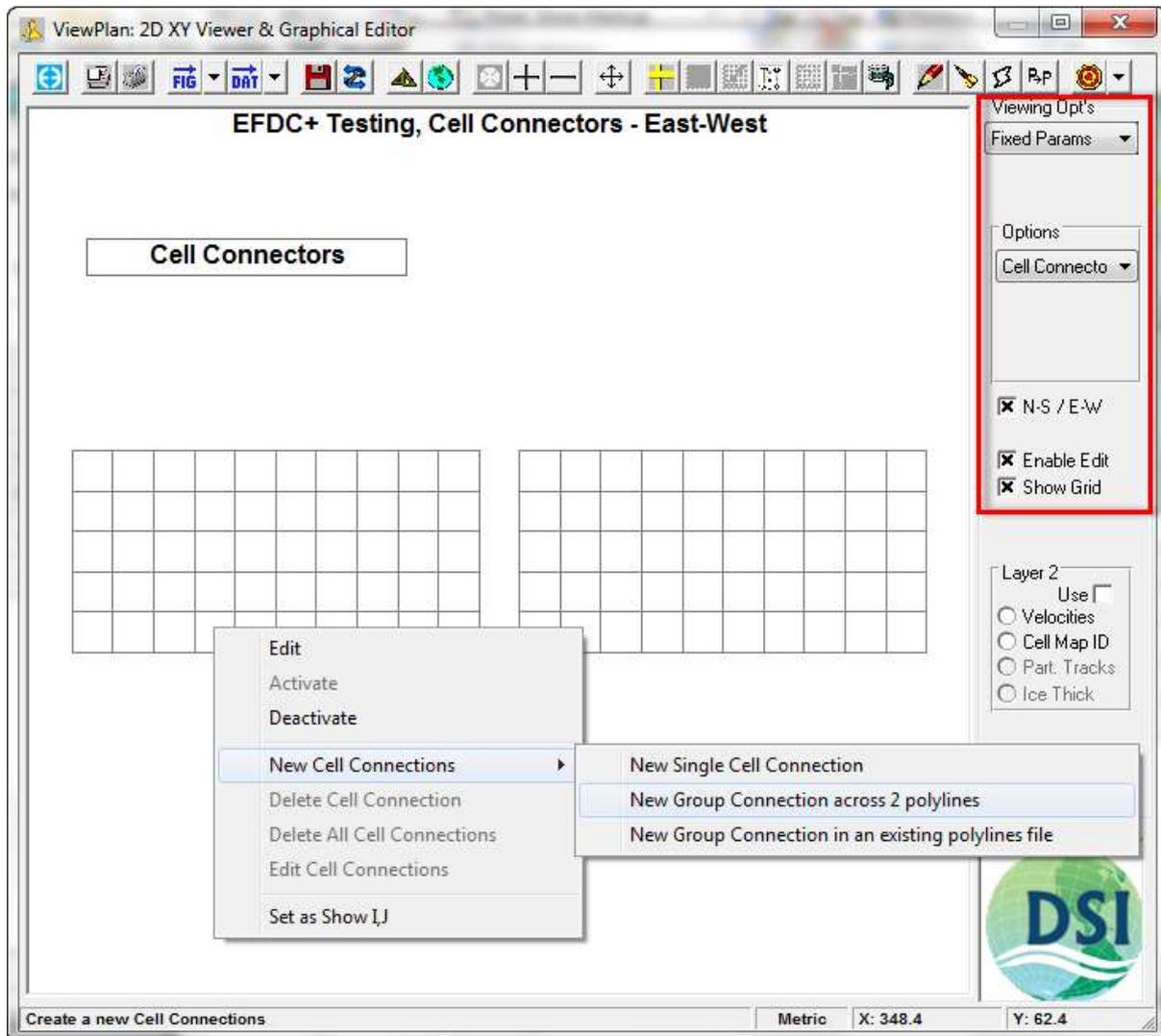


Figure 7-37 ViewPlan: Sub-domain connection options.

The user should LMC to start a polyline, and then make LMC each point required to create a polyline on the subdomain border, and then RMC to end the polyline. Once the two polygons have been created, one for each subdomain, EE will prompt the user for N-S, E-W or both kinds of connections by entering the number 1, 2 or 3 respectively as shown in Figure 7-38. EE will then automatically make the connections for the user as shown in Figure 7-39.

Note that in some cases some connections may be made that are not wanted by the user and these should be deleted with the *Delete Cell Connection* option in the RMC form.

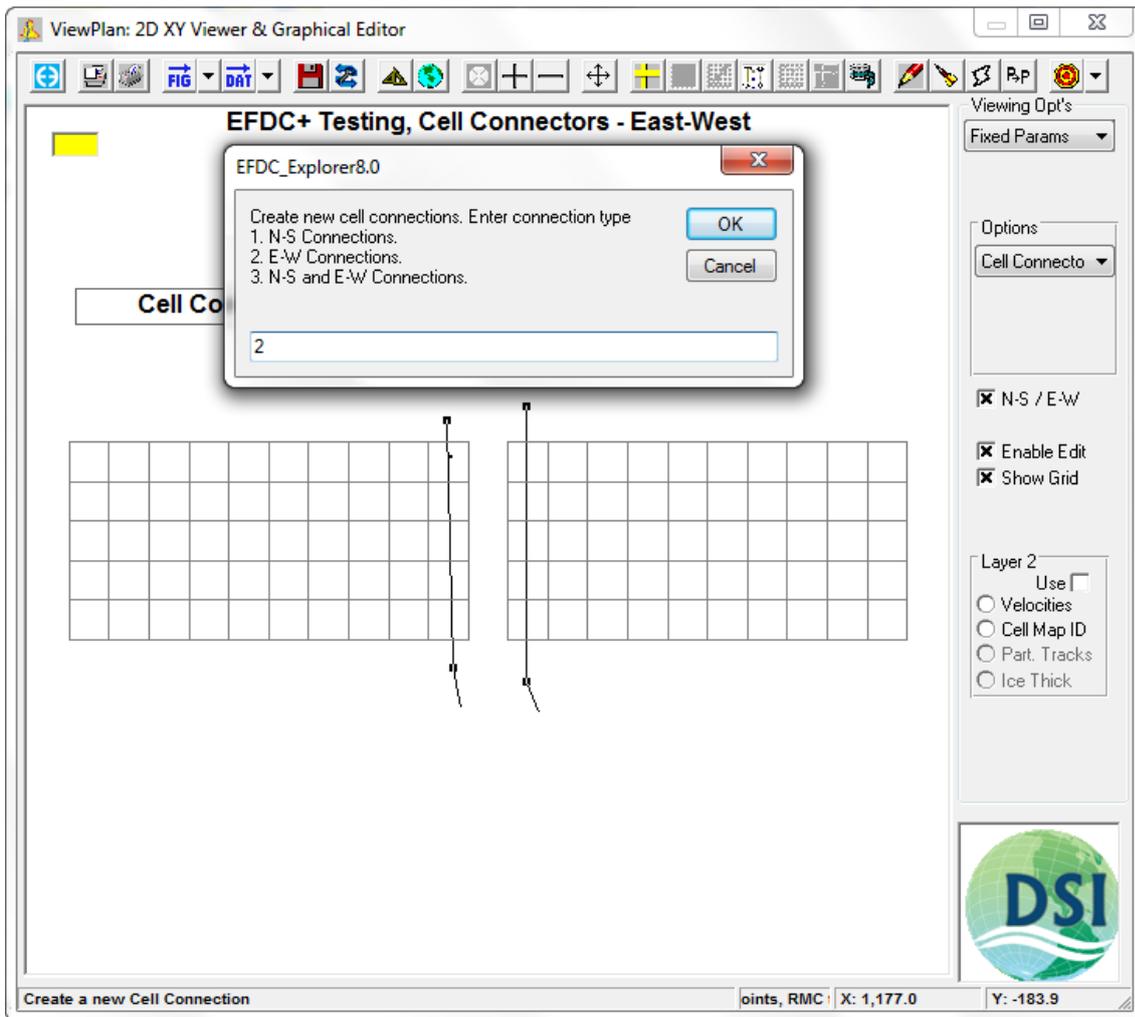


Figure 7-38 ViewPlan: E-W Connections defined by two polylines.

If the connectors line up in a way that does not match with the requirement of the user, it is possible to select the option *Edit Cell Connections* from the RMC on the connectors. This provides the user with a form to move the connector in a more convenient way with the L index list of both East and West cells. The user should select one cell with a LMC or multiple cells with “Control + LMC” and then use the *Up* and *Down* buttons to shift these connections as shown in Figure 7-40.

An example of the MAPPGEW.INP file that EFDC uses to map the connectors is provided in the appendix for the user’s reference.

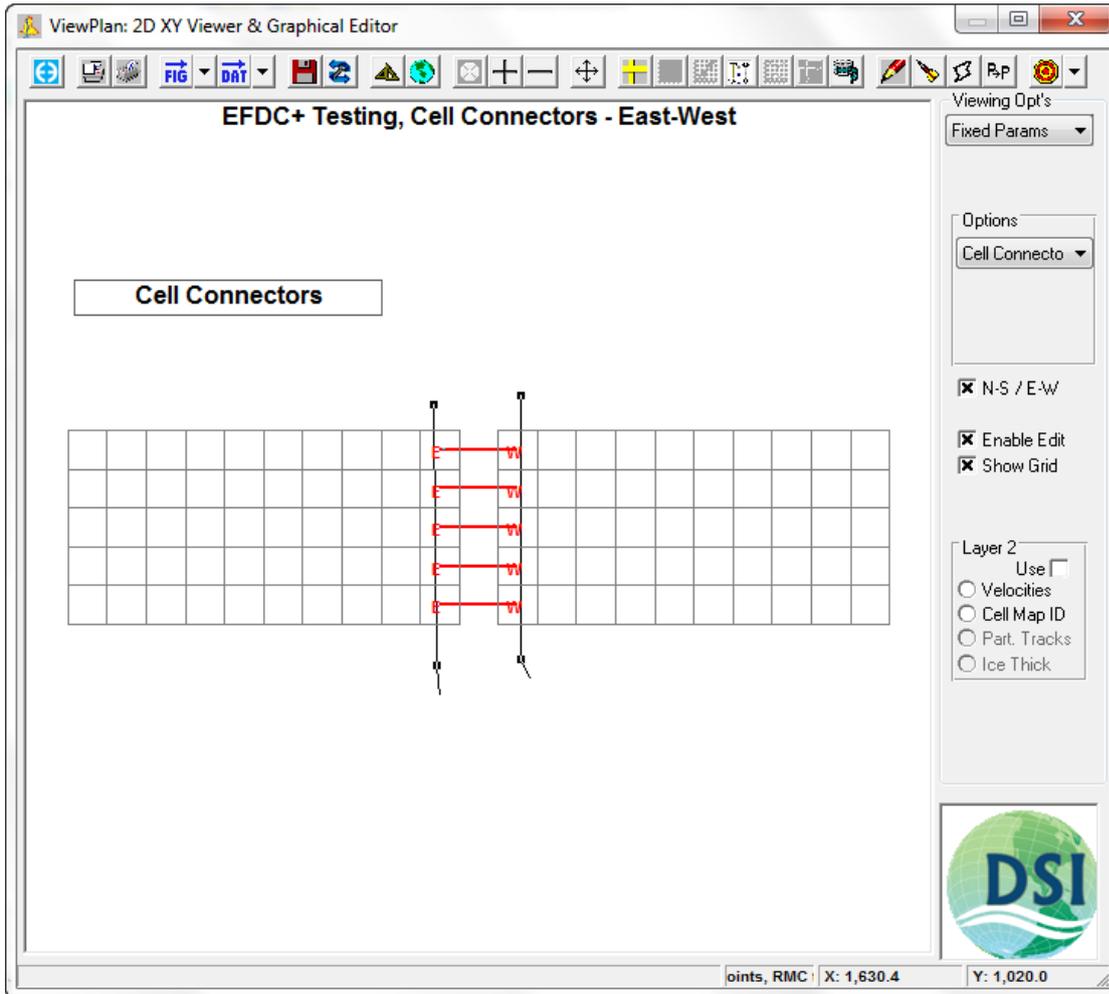


Figure 7-39 ViewPlan: E-W Connections created via a polyline.

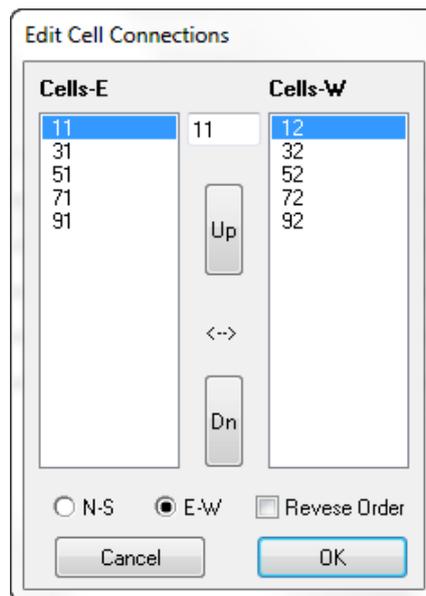


Figure 7-40 ViewPlan: N-S & E-W connection editor.

7.6.7. Model Metrics

The options available to the user in *Model Metrics* drop down menu are:

CFL Time Step Displays the Courant-Friedrichs-Levy (CFL) time step computed for each cell. This is a good guide to the appropriate time step, especially if using the two time level solution.

Courant # Displays the Courant numbers for the model based on the time step settings of the model. If adaptive time stepping is specified, the time step used for the initial display of the Courant numbers will be 0 seconds. A *Courant Calculator* is available by setting the focus to the plot and then pressing "T". This allows the user to specify a new time step to be used for the Courant numbers.

Orthogonal Deviation Displays the orthogonal deviation for the model grid. The computations require four cells, therefore, the top and right edge cells are skipped. The average of the absolute deviation is reported in the legend.

Celerity Displays the computed celerity for each cell.

Velocities must be loaded for the following options to be available:

Froude # Displays the computed Froude Number for each cell.

Richardson # Displays the computed Richardson Number for each cell.

Densimetric Froude # Displays the computed Densimetric Froude Number for each cell.

Reynolds # Displays the computed Reynolds Number for each cell at the selected time step for each layer. The kinematic viscosity is used for the computations of the Reynolds number.

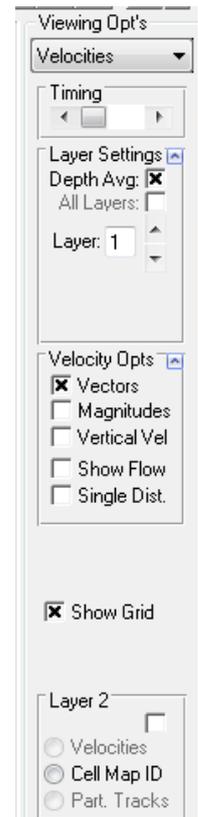
7.6.8. Velocities

Viewing Opt | Velocities displays the velocity vectors and magnitudes for the model. The velocities from a run are stored in the EFDC_Explorer linkage file EE_VEL.OUT file. The first option the user needs to select is the layering option. There are three ways to handle the layers; depth averaged, a specified layer or display all layers. For the *All Layers* option, the vectors for each cell are to correspond to the layer, blue for layer 1 and red for layer KC.

The *Velocity Opts* frame controls the type of velocity plot to display. These options can be combined. For example, the user can plot the 2D vectors over cells that have been colored base on vertical velocity magnitudes. The details of the formats of the color ramps and vector styles is adjusted using the Display Options form.

The *Show Flow* checkbox, when checked, causes EFDC_Explorer to report flows instead of velocities when LMC'ing on the form and when cutting a profile (Section 7.6.8.1)

EFDC computes the velocities on the south and west faces of a cell. These are the velocities saved in the linkage file. When displaying the velocity field, EFDC_Explorer transforms the cell face velocities in IJ space to cell centered velocities in XY space. When computing fluxes, EFDC_Explorer uses the IJ space cell face velocities.



7.6.8.1 Profile Tool

EFDC_Explorer provides a quick method for displaying a velocity profile or a flow profile, if the option “Show Flows” is checked. While in the velocity view, RMC on a cell located on one side of the desired profile location. A popup menu will ask the user if they want to generate a “Profile”. When clicked the message “Starting i, j = ?,?””. Now select the end point with the Right Button”. Press OK to continue. If the next mouse click is a RMC, EFDC_Explorer will extract the velocities or flows from the cells between the two cells selected, inclusive. Multiple profiles can be extracted, However, they will all be for the current time.

7.6.8.2 Water Flux Tool

Another method to extract flows across certain cell boundaries is provided via the *Flux Tool*. This method calculates the flow across one or more *flux lines* contained in the P2D file. Selecting the *Flux Tool* button display the option form shown in Figure 7-41.

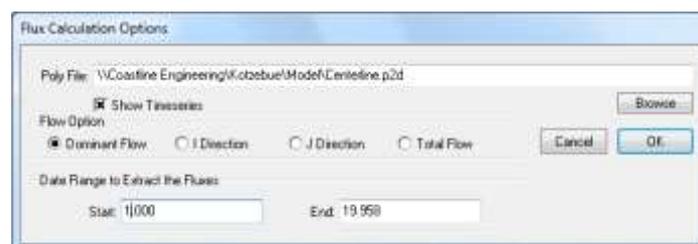


Figure 7-41 Water flux tool control options.

The water flux tool computes either total discharge across the section or on a layer by layer basis, based on the options selected on the *ViewPlan* form. If a single snapshot is selected then the results will be displayed in a dialog box and also placed onto the clipboard. If *Show Time-series* is selected then the user must specify which flow component desired. The following is a description of each type:

Total Flow: The absolute value of the total flux across the section.

EW Flow: The sum of the flows in the EW (based on the cell map, i.e. EW=I component flow)

NS Flow: The sum of the flows in the NS (based on the cell map, i.e. NS=J component flow)

Dominant Flow: Computes the total flow across the section and assigns a sign based on dominance.

The *Dominant Flow* option is the most useful for most applications.

If the “Poly File” has more than one section/flux line defined, EFDC_Explorer will compute the fluxes for all the defined lines (up to 10 max). Figure 7-42 shows an example of total discharge using the dominant flow option for the San Francisco Bay application.

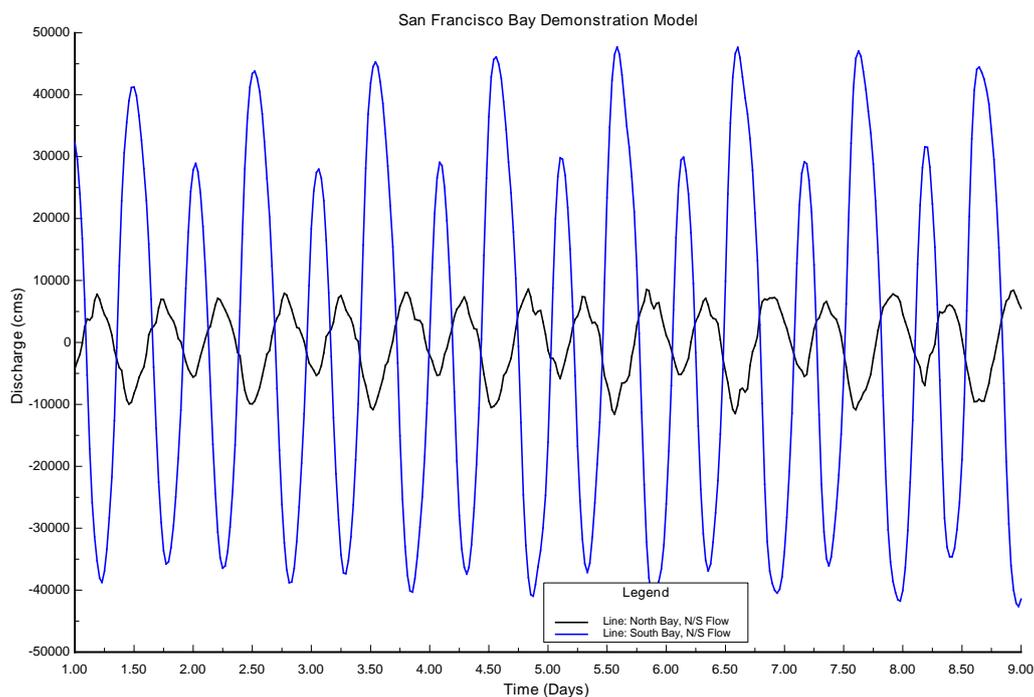


Figure 7-42 Water Flux tool example results using Dominant Flow.

7.6.8.3 Velocity Profile

The *Velocity Profile* feature allows the user to pass a straight line over the model domain for the cells in which a 2-D velocity profile is to be displayed. This feature is different from the longitudinal profile that is located on the top menu on View Plan. The user may access this function with RMC within the model domain to select the *Profile* option as shown in Figure 7-43. The location where the user RMCs, that would be the starting point for the new profile. The user is then prompted to the end the line with another RMC. Multiple lines may be created and plotted together by starting a new profile where the user is asked whether to add, reset or abort the new profile. If the user selects “add”, then the multiple profiles would be plotted on the same plot.

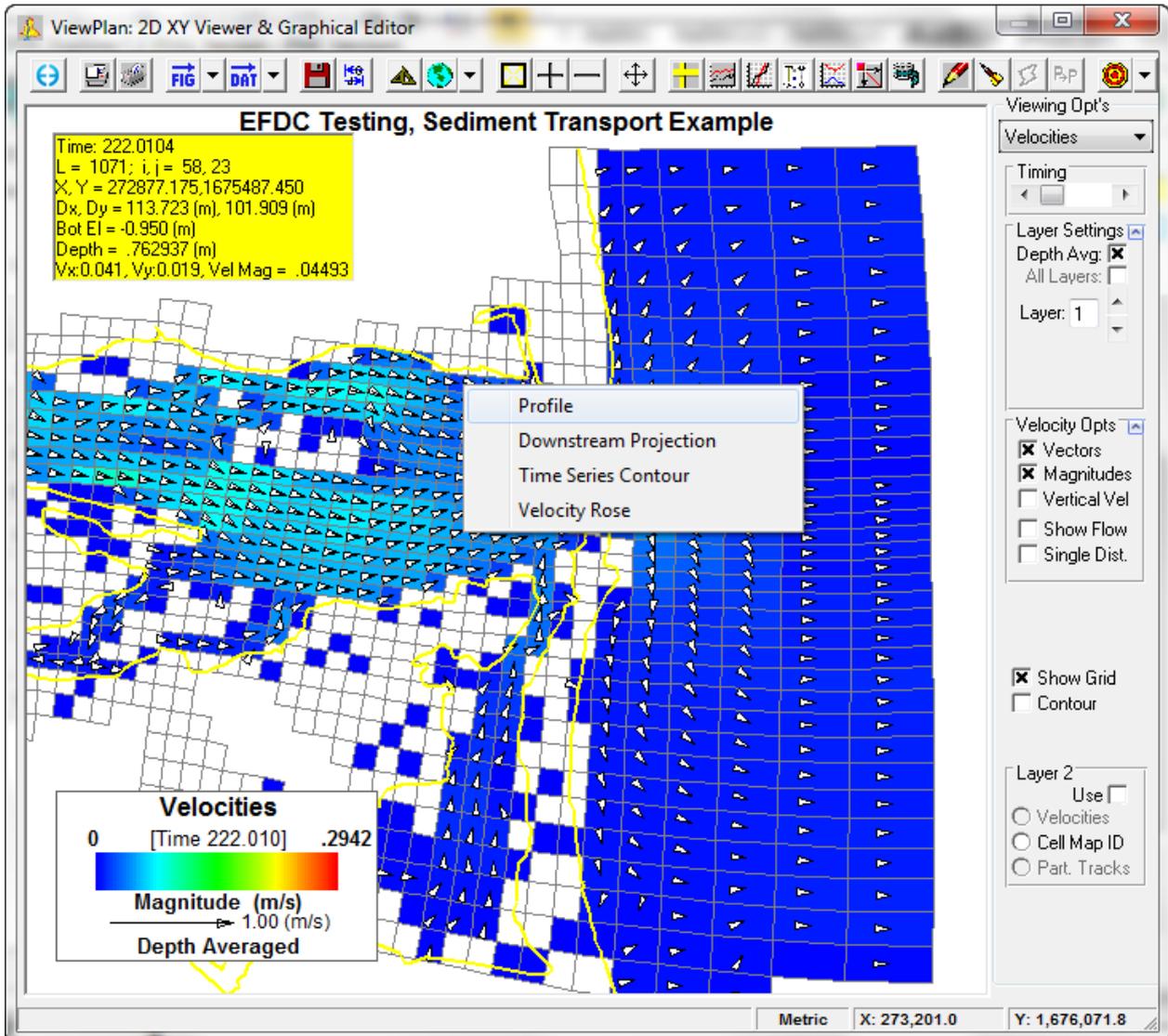


Figure 7-43 ViewPlan: Velocity Profile Selection.

An example of the profile is shown in Figure 7-44.

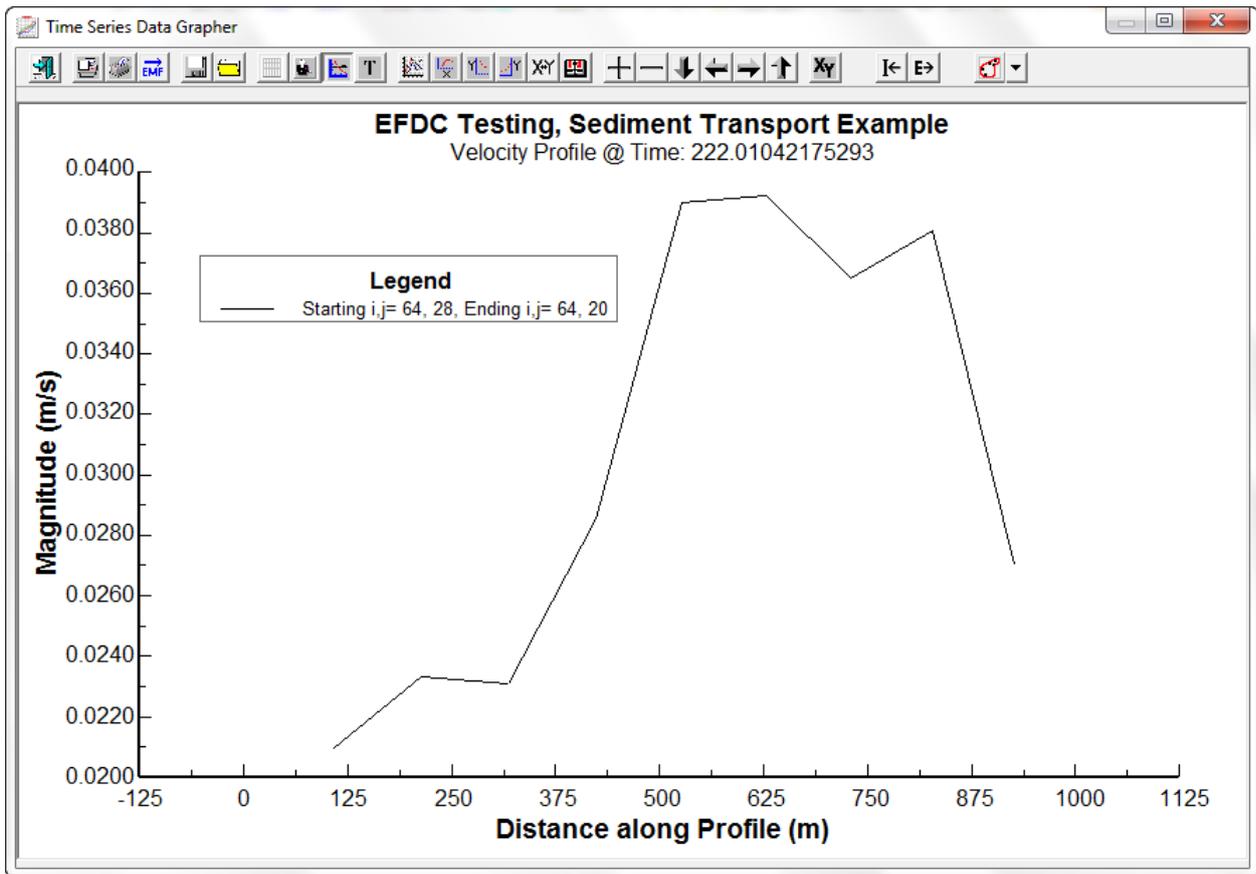


Figure 7-44 ViewPlan: Velocity Profile.

7.6.8.4 Downstream Projection for Velocities:

This feature allows the user to specify an orientation angle (degrees clockwise from north, looking downstream) in order to plot velocity magnitude of upstream and downstream flow during the EE data extraction. It is accessed by RMC when in the *Velocities* viewing option as shown in Figure 7-43.

If the user has selected *All Layers* in the *Layer Settings* then the user can optionally plot the average current velocity for the water column entirely or partly. This feature is primarily used when an exact comparison of model results with measured data is required in cases where the depth below the surface of the measuring device is known. For the settings shown in Figure 7-45 EE will produce the plot shown in Figure 7-46 for all layers. *From (%)* is used to indicate the percentage of the water column to be displayed from the bottom of the water column up to the *To (%)*. For example, in a 10 m water column, from 10% to 90% means the velocity magnitude it will be plotted from 1 m above the bottom and up to 9 m from the bottom.

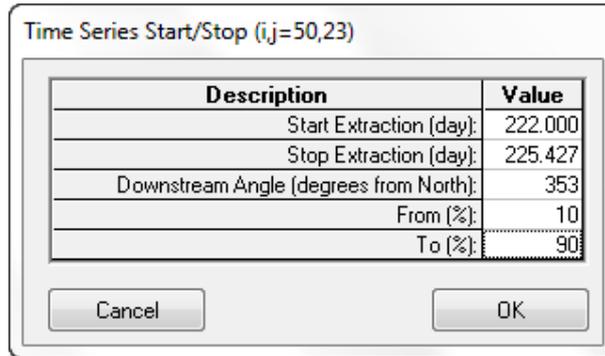


Figure 7-45 ViewPlan: Time Series – Velocity Orientation Output.

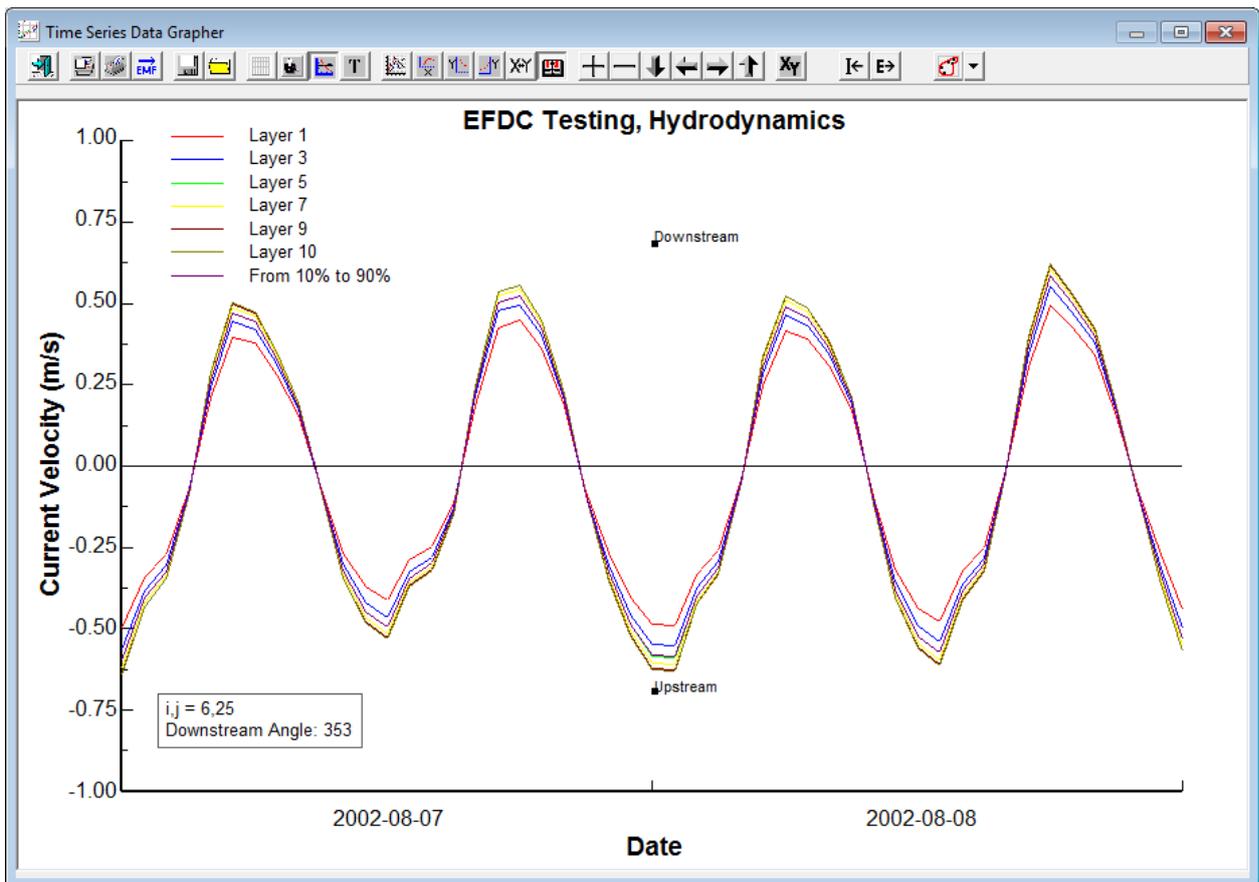


Figure 7-46 Velocity Projection Plot for all layers (layers 2, 4, 6, 8 hidden for clarity).

7.6.8.5 Velocity Rose

This feature allows the user to view the speed and direction distribution at a given cell over a user defined period of time. To plot the velocity rose, *velocities* viewing option should be selected in the *ViewPlan* and the user can select the location of interest with RMC. This tool is available for all layers as well as depth averaged and displays a rose as shown in Figure 7-47. The location of the cell being displayed is shown in the bottom left hand corner of the form. The velocity roses can be attached to the *ViewPlan* or can be floating as a separated window. If desired, the velocity rose can be attached to plan view by clicking on the *Show rose on the ViewPlan* under the Export drop down menu in Figure 25. The user may export the rose plot as a metafile, bitmap or ASCII file from the *Export* menu.

The *Format* menu provides options for editing the labels, setting the scale, and adjusting the sectors. The user may also save the defined rose plot format and reload it at a later time, or use it for another cell to apply the same formatting style with the *Save* and *Load* options.

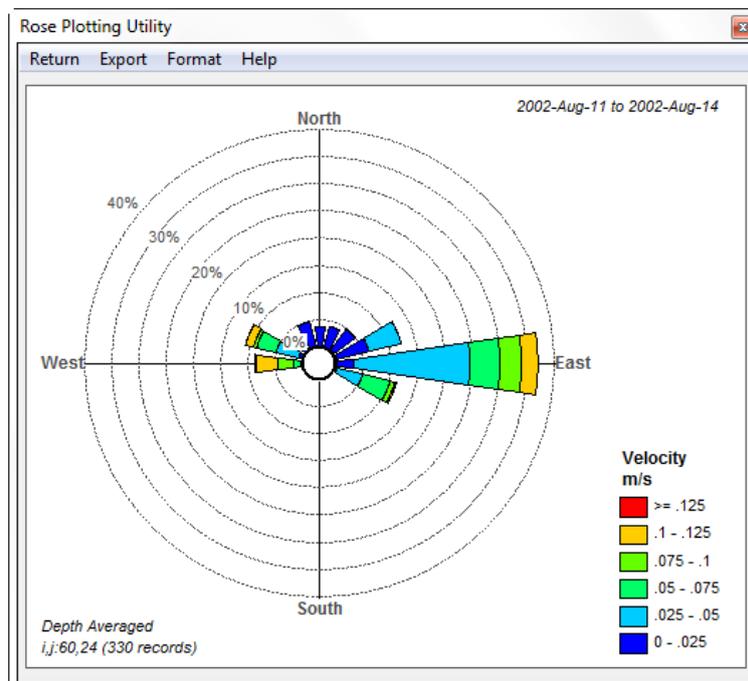


Figure 7-47 Time Series: Rose Plots for Velocity.

Multiple velocity roses may be displayed in *ViewPlan* by selecting the *Show on ViewPlan* option and change the value to 1 as result shown in Figure 7-48. Selecting *Export | Save* will save the layout and magnitude categories as set by the user and later loaded again to maintain the format.

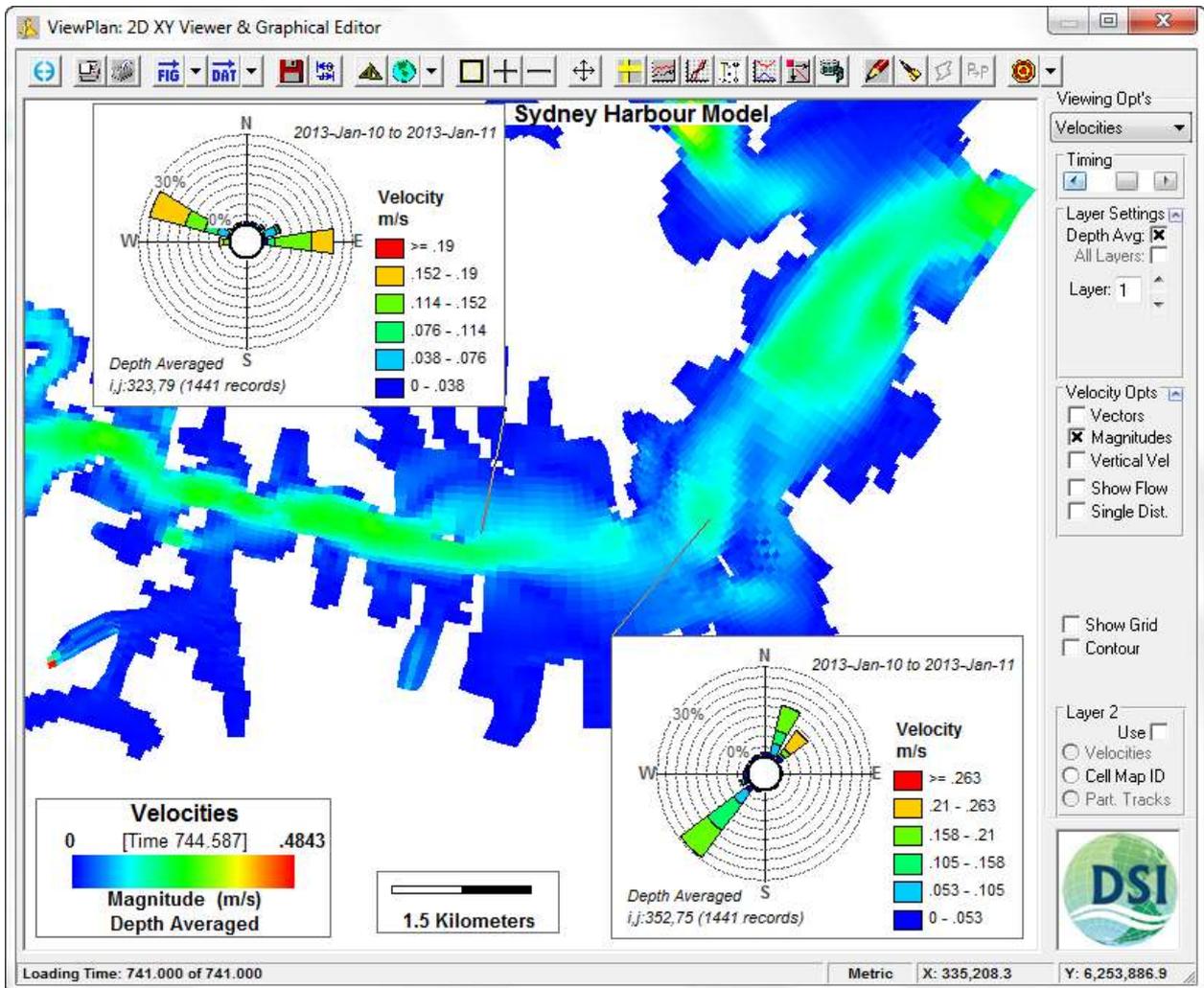


Figure 7-48 Multiple Velocity Rose Plots.

7.6.9. Sediment Bed

The *Sediment Bed* Viewing Opt provides access to the cohesive and non-cohesive sediment transport bed properties. The suspended sediment plotting and analysis capabilities are available in the *Water Column Viewing Opt*. Figure 7-49 shows the *ViewPlan* with Sediment Bed Viewing Opt selected. The cell edit form also shown in Figure 7-49 is a typical view when editing sediment mass (this model used $KB=10$). The *Sediment Bed* option is always available, even if sediment transport is not being simulated. This option is always available because the bed shear stress is always computed and available to post-process.

When viewing sediment data, the first option to set is the *Layer Settings*. EFDC uses a sediment bed layering scheme where the sediment-water column interface layer number can vary from cell to cell. The maximum number of layers (i.e. KB) is set in the Sediment parameter form (Section 5.14). The user has three options for viewing sediment data: *Total* (i.e. sum of all the layers), a specified layer or the *Top Layer*. The layer number that is in contact with the water column can vary so the *Top Layer* option provides an easy way to view the sediment layer that is in contact with the water column.

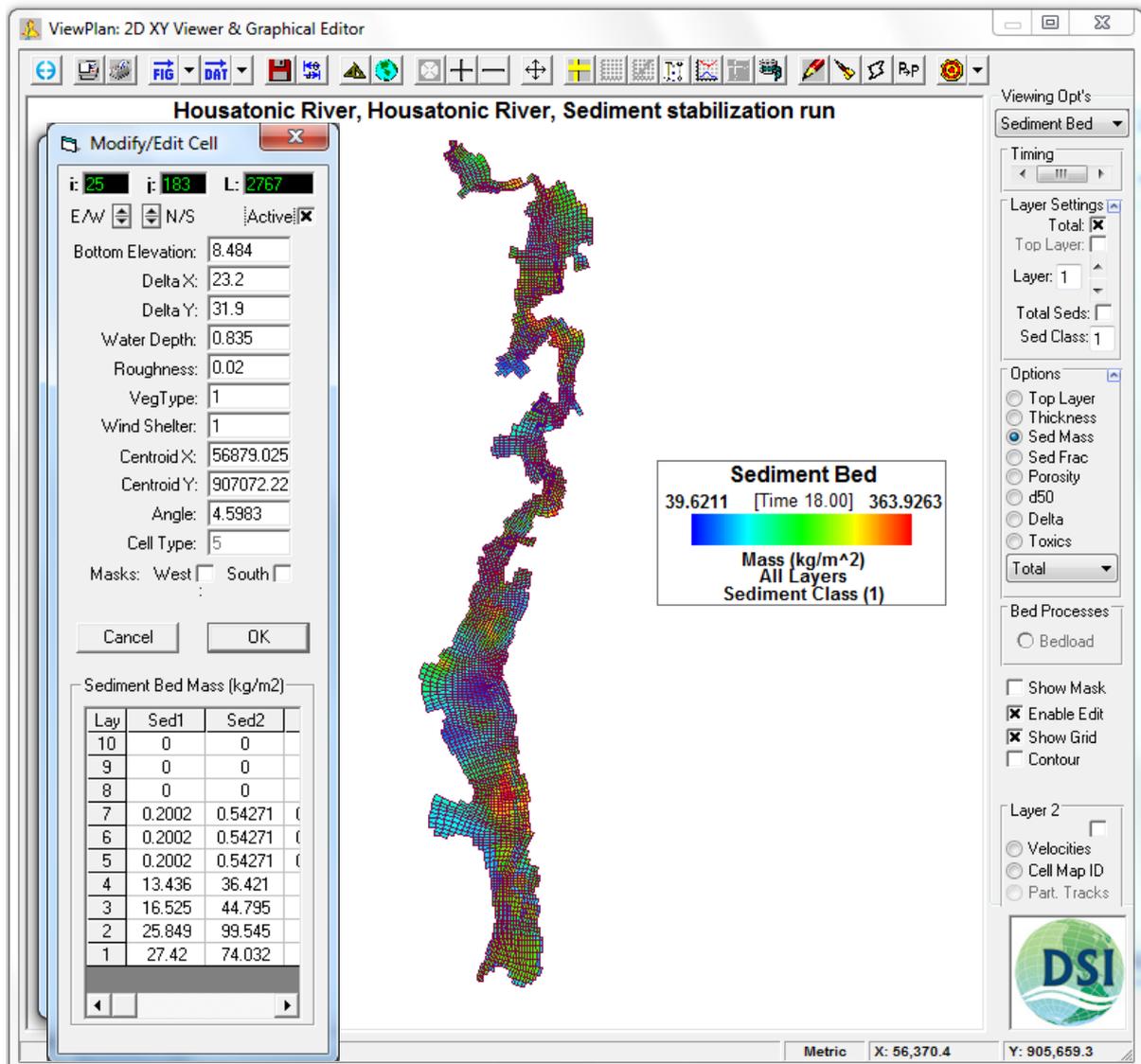


Figure 7-49 ViewPlan: Sediment Bed with Cell Editing.

The sediments can be viewed a single class at a time or all together as total sediment. The user needs to specify either the *Total Seds* checkbox to select all classes. If only one class is desired, uncheck the *Total Seds* option and specify the class in the *Sed Class* field.

The *Delta* function displays the differences in bottom elevation between the initial condition elevation and the bottom elevation at the current time. The computation is $BotEl_{cur} - BotEl_{IC}$ therefore, delta's < 0 indicate scour and delta's > 0 indicate deposition. In order for the *Delta* option to function the bed morphology option needs to be set to 1 (*Bed Morphology Options* in *Bed & Consol* tab of the *Sediments* form), which allows the bottom elevations to change with sediment transport.

Note

When drawing the Flux Lines be aware of the fact that the velocities in EFDC are computed on the South and West faces. Try to draw the Flux Lines along cell faces to obtain the most accurate fluxes.

Cell selection is based on the Flux Line crossing through any part of a cell. The entire cell face will be used to compute the flux for that cell.

7.6.9.1 Sediment Bed Initialization Tools

To facilitate rapid building of sediment bed models EE implements a powerful sediment core initialization bed tools within *ViewPlan*. If the model is configured for sediments then F7 toggles on and off the sediment bed tool. RMC and selecting *Load Cores* allows the user to bring in the sediment core file (.DAT file). This produces a list of all the cores, number of cores and sets the sediment bed. The user is then prompted to plot the cores labeled with d50's or the label with core ID. The top layer of the sediment cores is then plotted in *ViewPlan*.

RMC and selecting *Edit Core* core displays the *Sediment Core Editing* tool as shown in Figure 7-50. This tool allows the sediment core data and sample interval data to be edited.

RMC on an existing sediment core provides several options including defining the core as "Current", deleting the core, and editing the core. Defining the core as "current" allows the user to then RMC in another location and copy the "current" core to that location by RMC and selecting *Add a new [core no.]*. This will add a new core to end of the file, and duplicates the core number.

RMC anywhere else in the viewing area allows the user to define a new core at that point as well as load and save the sediment core data.

Note that if the editing window is closed that editing is switched off, but data is not saved until the user RMCs and selects *Save Cores*.

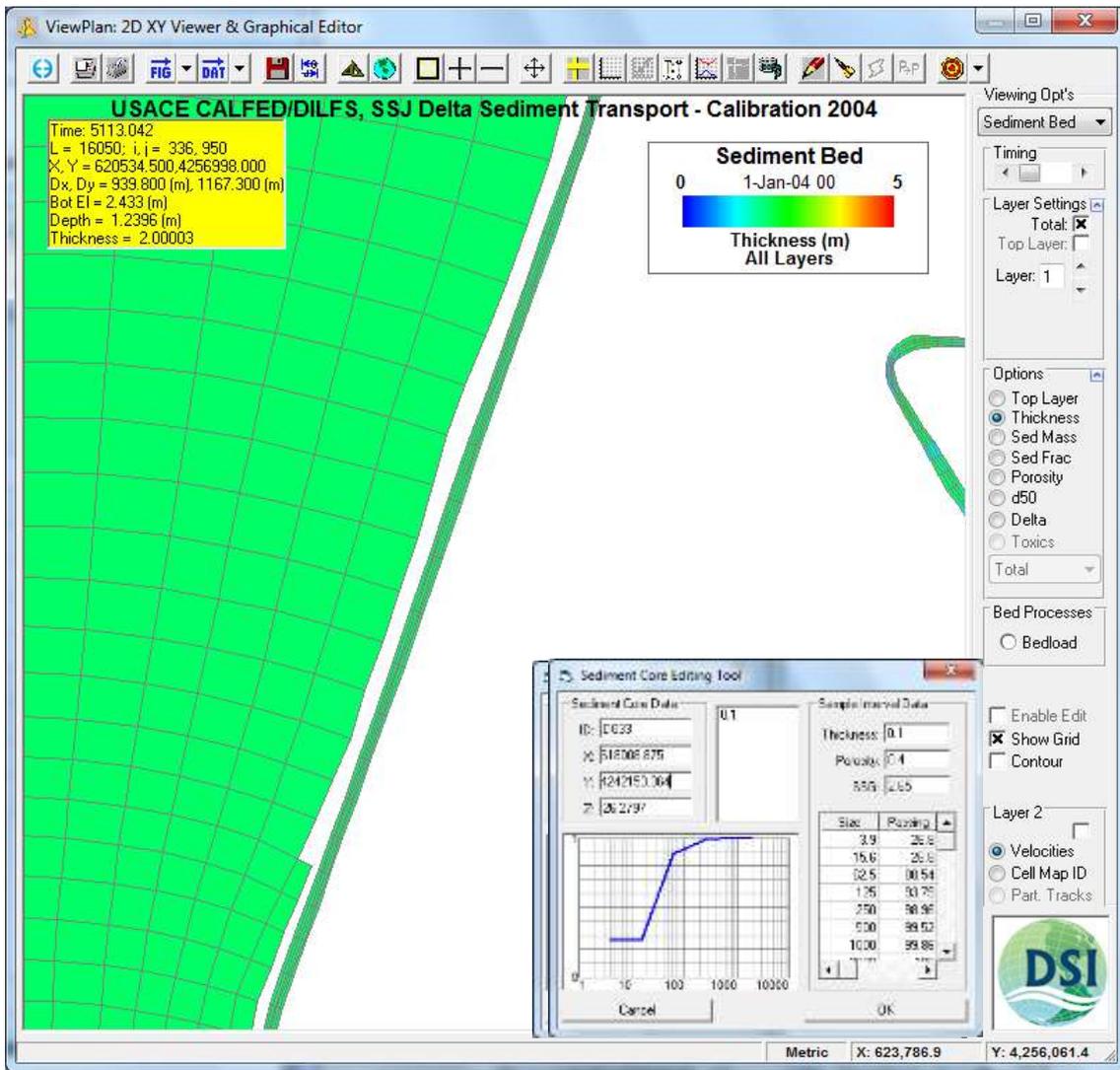


Figure 7-50 ViewPlan: Sediment core editing.

7.6.10. SEDZLJ Option

An alternative to the standard sediment transport approach is the the start-of-the-art SEDZLJ submodel. The SEDZLJ Sediment sub-model is implemented in EFDC_Explorer for display of SEDZLJ input data and results. However, at this time, the user cannot create or edit input data.

If the user has created a valid SEDZLJ model then the option for SEDZLJ may be displayed. The options available include display of the *Core Zone*, *Erosion Rate*, *Deposition Rate*, *Net Dep/Erosion Rate*, *Bedload Concetration*, *d50 (Active Layer)*.

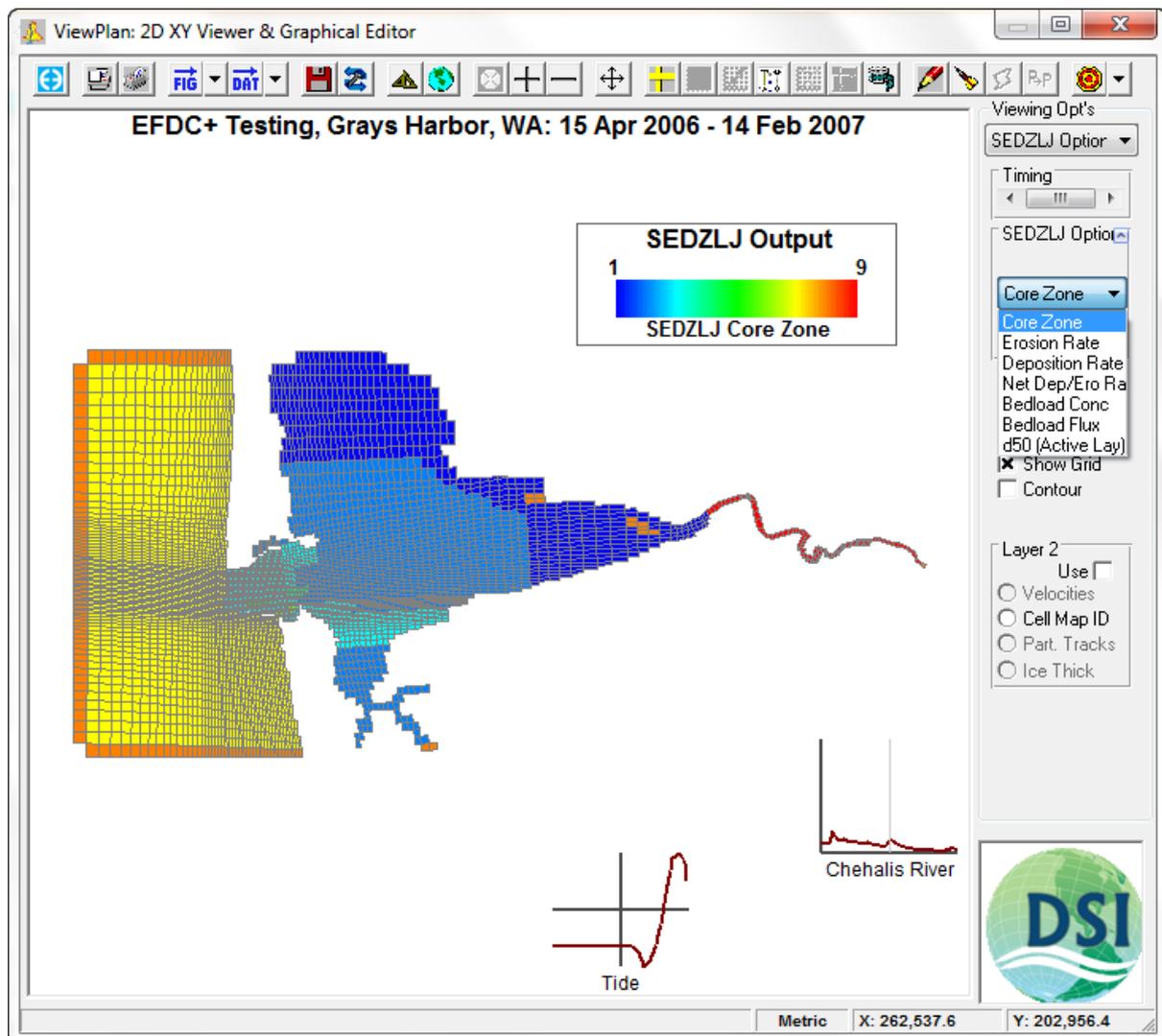


Figure 7-51 ViewPlan: SEDZLJ viewing options.

7.6.11. Toxics

The *Toxics* option is enabled only if toxics are being simulated. When selected, the labels in the Layer Settings frame changes. The *Total Seds* becomes *Total Tox* and the *Sed Class* becomes *Tox Class*. Their function is the same but they apply to toxics classes instead of sediment classes. In addition the user can select the state of the toxics, either:

Total Total toxic concentration for the class option selected.

Tox (Diss) Dissolved phase concentrations for the class option selected.

Tox (DOC) Toxic concentration of the dissolved organic carbon (DOC) complexed phase for the class option selected.

Tox (POC) Toxic concentration of the particulate organic carbon (POC) adsorbed phase for the class option selected.

POC The POC concentrations assigned to the sediments.

DOC The DOC concentrations assigned to the sediments.

7.6.12. Bed Processes

In the *Bed Processes* frame several options are available to display bed shear stress: total bed shear, cohesive fraction bed shear and non-cohesive fraction bed shear. The availability of the bed shear stress option is influenced by the bed shear stress computational option specified in Section 5.14.1.6.

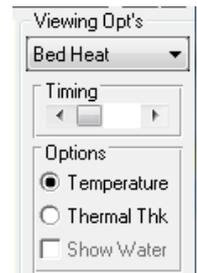
When viewing bed shear stress, the user can toggle between stream power (Watts/m²) and bed shear (Newton/m²) by pressing Alt-P. Set the focus to the plot by LMC on the plot.

The bedload flux rate, if simulated, can be displayed by selecting the *Bedload* option.

7.6.13. Bed Heat

Viewing Opt | Bed Heat allows the user to view bed heat in terms of temperature or thermal thickness. The nature of the information displayed depends on whether the model is EFDC_GVC or EFDCPlus.

When viewing the Temperature option only the top layer (i.e. the layer in contact with the water column) is displayed. If the *Time Series* toolbar function is on then the *Show Water* checkbox is enabled and the user can view the time series of the sediment temperature and the bottom water layer (which varies for the GVC model) together.



7.6.14. Water Column – by Layer and by Depth

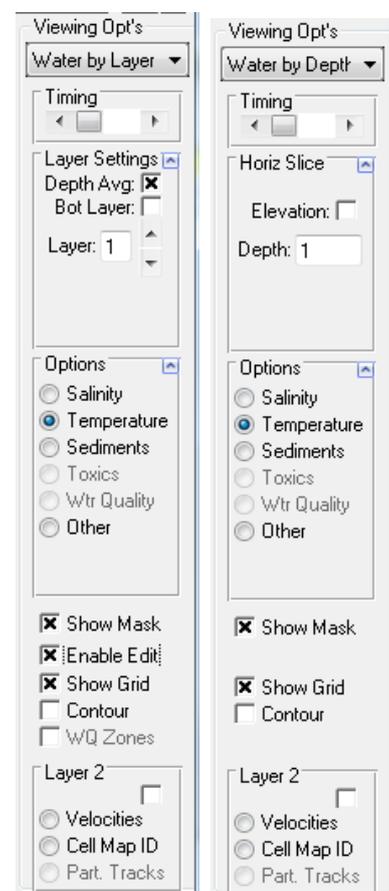
The *Water Column Viewing Option* is the primary 2D viewer for all of the water column related parameters. The water column may be viewed by layer or by depth. For the former, the first options to set are the *Layer Settings*. There are three layering options for processing the water column data. They are *Depth Avg* for depth averaged results, *Bot Layer* for viewing the bottom active water column layer (this varies in the GVC model, standard sigma model this is layer 1) and a specified layer.

When viewing sediments or toxics the *Total Sedts/Total Tox* and *Sed Class/Tox Class* are used to decide how to treat the display results, i.e. as totals or by class.

The data displayed in the 2D plot can be edited using the editing tools available if the current time is set to the initial conditions.

The options listed in the *Options* frame will only be enabled if the correct computational flags are set. The *Density* option is only available if salinity and/or temperature are being simulated. If only salinity is simulated the temperature is taken as a constant 20°C.

For most *Viewing Opt's* the *Statistics* tool on the toolbar is available to compute a range of statistics on the current view. For the *Water Column* option the *Statistics* tool provides additional capability. The *Statistics* tool can compute a time series of the mass weighted averages for any parameter for all or any subset of the model.



7.6.14.1 Water Quality

If water quality is being simulated the *Wtr Quality* option button is enabled as is the parameter dropdown list. In addition to the 22 EFDC water quality parameters, EFDC_Explorer has 26 derived parameters that can also be displayed. Table 7-5 provides a complete list of the EFDC and EFDC_Explorer derived parameters.

The kinetic subroutines in EFDC allow the parameters to be turned on and off, depending on the level of detail in a model. However, when a parameter is not turned on it still has a value (i.e. the initial condition) and may be used in the kinetic equations of parameters that are being simulated. Therefore, EFDC_Explorer always allows the display of all EFDC parameters. However, to make it clear as to which parameters were simulated and which were not, a “(NS)” is placed at the end of the parameter abbreviation shown in the dropdown list for those parameters not simulated.

For the EFDC_Explorer derived parameters a “(DP)” is placed on the end of the abbreviation to clearly indicate that the parameter was derived.

7.6.14.2 Irradiance

The ability to determine the % Bottom Irradiance can be useful when the user is interested in cases where the amount of light penetration must be determined, such as where there are macrophytes or aquatic vegetation. Note that this tool only determines the potential for irradiance, and does not allow for day or night or factor in cloud cover etc. Pressing ALT-B accesses the Bottom Irradiance Tool. The user is first prompted for analysis of a polygon, which must then be loaded, or the whole model.

The subsequent option form is shown in Figure 7-52. The user should enter the *Maximum Bottom Depth* in meters. Cells deeper than this depth are displayed as white. As depths will vary due to tides it is usually most useful to calculate an average for the *Depth Criteria Approach*. The user should finally enter the *Irradiance Target* as a percentage. EFDC_Explorer will then calculate all the cells that fit the criteria and calculate statistics for those cells.

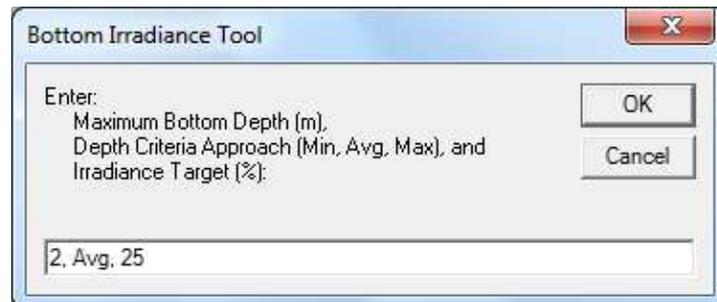


Figure 7-52 ViewPlan: Water Column, % Irradiance Tool.

Table 7-5 Water quality parameter list available for display.

EFDC/HEM3D Parameters		EFDC_Explorer Derived Parameters (cont.)	
Abbrev	Name	Abbrev	Name
CBact	Cyanobacteria	POrg C	Particulate Organic Carbon
Alg-D	Diatom Algae	POrg N	Particulate Organic Nitrogen
Alg-G	Green Algae	TKN	Total Kjeldahl Nitrogen
RPOrg C	Refractory Particulate Organic Carbon	Tot N	Total Nitrogen
LPOrg C	Labile Particulate Organic Carbon	Chl a	Chlorophyll a
DOrg C	Dissolved Organic Carbon	TION	Total Inorganic Nitrogen
RPOrg P	Refractory Particulate Organic Phosphorus	LimP-C	Algae Limit: Phosphorus-Cyanobacteria
LPOrg P	Labile Particulate Organic Phosphorus	LimP-D	Algae Limit: Phosphorus-Diatom Algae
DOrg P	Dissolved Organic Phosphorus	LimP-G	Algae Limit: Phosphorus-Green Algae
TPO4-P	Total Phosphate	LimN-C	Algae Limit: Nitrogen-Cyanobacteria
RPOrg N	Refractory Particulate Organic Nitrogen	LimN-D	Algae Limit: Nitrogen-Diatom Algae
LPOrg N	Labile Particulate Organic Nitrogen	LimN-G	Algae Limit: Nitrogen-Green Algae
DOrg N	Dissolved Organic Nitrogen	LimNP-C	Algae Limit: N and P-Cyanobacteria
NH4-N	Ammonia Nitrogen	LimNP-D	Algae Limit: N and P-Diatom Algae
NO3-N	Nitrate Nitrogen	LimNP-G	Algae Limit: N and P-Green Algae
PBioSi	Particulate Biogenic Silica	LimL-C	Algae Limit: Light-Cyanobacteria
AvailSi	Dissolved Available Silica	LimL-D	Algae Limit: Light-Diatom Algae
COD	Chemical Oxygen Demand	LimL-G	Algae Limit: Light-Green Algae
DO	Dissolved Oxygen	LimT-C	Algae Limit: Temperature-Cyanobacteria
TActM	Total Active Metals	LimT-D	Algae Limit: Temperature-Diatom Algae
FColi	Fecal Coliform	LimT-G	Algae Limit: Temperature-Green Algae
MacAlg	Macroalgae	LimA-C	Algae Limit: All Factors-Cyanobacteria
EFDC_Explorer Derived Parameters		LimA-D	Algae Limit: All Factors-Diatom Algae
Tot C	Total Organic Carbon	LimA-G	Algae Limit: All Factors-Green Algae
Tot P	Total Phosphorus	TSI	Carlson's Trophic State Index
TORN	Total Organic Nitrogen	TSS	Total Suspended Solids (Inorg & Org)
TORP	Total Organic Phosphorus	POrg P	Particulate Organic Phosphorus

7.6.14.3 Habitat Analysis

The user may undertake a habitat analysis of the water column when the *Water by Layer* drop down is selected as shown in Figure 7-53. This tool is access by ALT-H. The user may analyze any of the parameters displayed in the Options in frame in the right hand column. The user should set critical levels (in this case temperature, °C), critical depths and critical duration (in hours) and press *Display*. EFDC will then calculate the number of cells for which these criteria apply, displaying the area and volume in the yellow *Habitat Criteria* box, as well displaying the critical cells. A second critical duration may also be displayed concurrently.

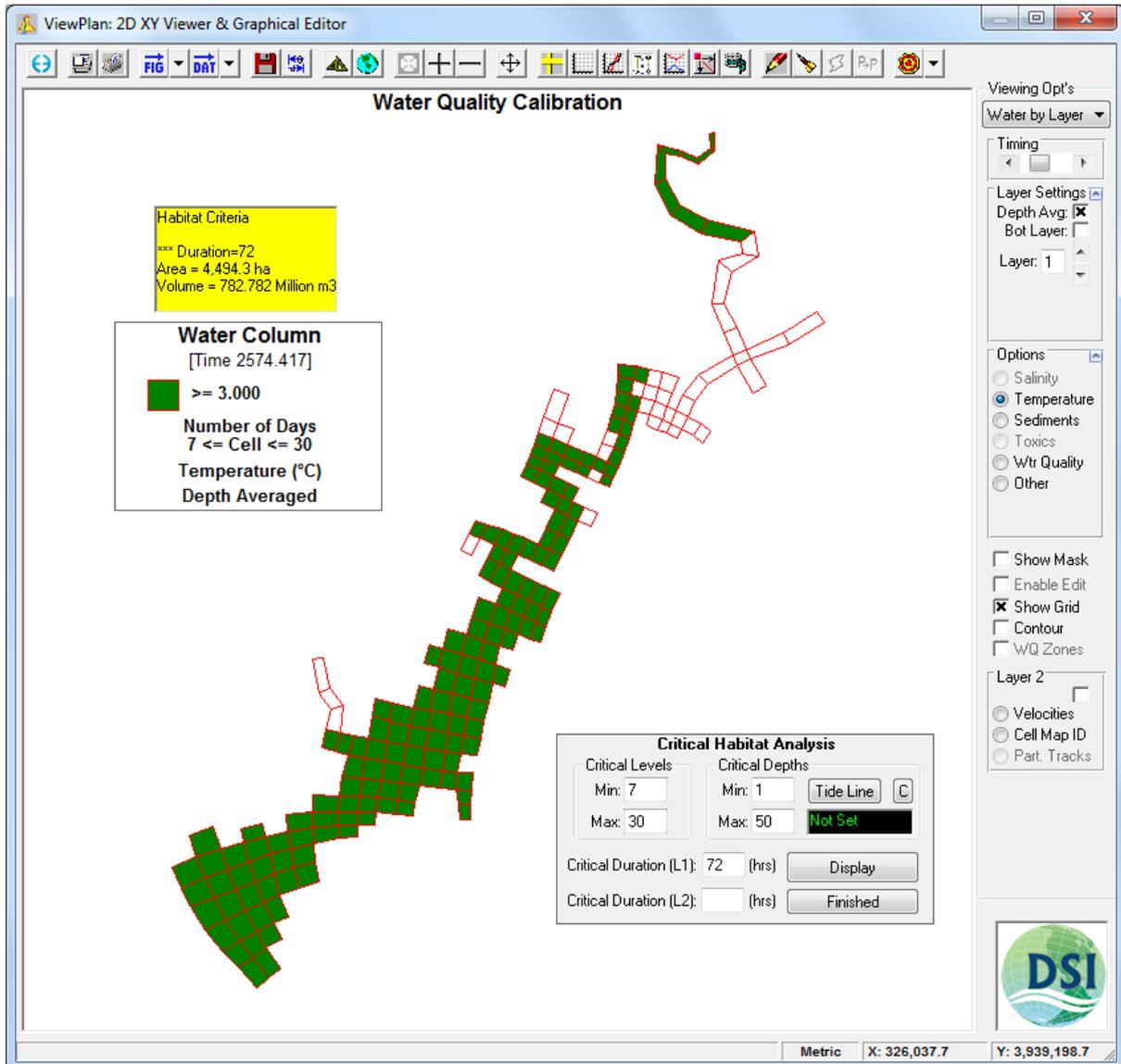


Figure 7-53 ViewPlan: Water by Layer, Habitat Analysis tool.

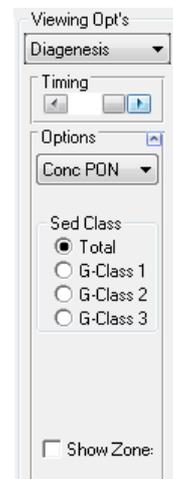
7.6.15. Sediment Diagenesis/Specified Fluxes

If the full sediment diagenesis sub-model is being used then the user has the ability to view the concentrations and/or resulting nutrient fluxes using *Viewing Opt | Diagenesis*. If the user is applying a constant or time variable specified nutrient flux then the user can view the nutrient flux zones and flux rates using *Viewing Opt | Sediment Flux*.

7.6.15.1 *Sediment Diagenesis*

When the full diagenesis option has been selected the *Viewing Opt | Diagenesis* is available to view/edit the initial concentrations and, after a model run, post-process the concentrations and nutrient fluxes. An example of the *Options* frame is shown in the adjacent graphic. Below the dropdown list for the diagenesis parameter is a sub-option area that changes with the parameter selected.

The *Show Zone* checkbox overrides the current parameter and shows the diagenesis zones instead. For pre-processing, the zones can be edited using the cell property copy function and the diagenesis parameters can be edited by RMC'ing on a cell (if *Enable Edit* is checked).



The diagenesis parameters that are available for viewing are provided in Table 7-6. The sub-options that are available for each parameter are also listed.

Table 7-6 List of sediment diagenesis parameters and sub-options available.

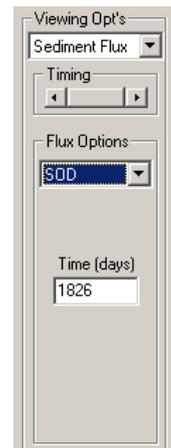
Abbrev	Name	Sub-Options
Conc PON	Concentration of PON	Total or by G Class
Conc POP	Concentration of PON	Total or by G Class
Conc POC	Concentration of PON	Total or by G Class
Conc NH4-N	Concentration of Ammonium	Total or by Layer
Conc NO3-N	Concentration of Nitrate	Total or by Layer
Conc PO4-P	Concentration of Phosphate	Total or by Layer
Conc H2S	Concentration of Hydrogen Sulfide	Total or by Layer
Conc Silica	Concentration of Silica	Particulate Biogenic or by Layer
Benthic Stress	Benthic Stress	
Sed Temp	Sediment Temperature (not linked to heat sub-model)	
PON Flux	PON Flux between Sediment-Water	Total or by G Class
POP Flux	POP Flux between Sediment-Water	Total or by G Class
POC Flux	POC Flux between Sediment-Water	Total or by G Class
SOD	Sediment Oxygen Demand	Total or Only Carbonaceous or Only Nitrogenous
COD	Chemical Oxygen Demand Flux	
NH4 Flux	Ammonium Flux between Sediment-Water	
NO3 Flux	Nitrate Flux between Sediment-Water	
PO4 Flux	Phosphate Flux between Sediment-Water	
Silica Flux	Silica Flux between Sediment-Water	

7.6.15.2 Sediment Flux

There are two specified flux options, one for invariant fluxes horizontally and temporally, and another that varies by zones in conjunction with mud/sand distributions (not linked to the sediment transport sub-model).

The parameters that are available for display are:

- Mud Zone
- Sand Zone
- Percent Mud
- Sediment Oxygen Demand (SOD)
- Chemical Oxygen Demand (COD)
- Dissolved Available Silica (SAD)
- Nitrate (NO₃)
- Ammonium (NH₄)
- Phosphate (PO₄)



If the temporally varying option was selected the *Time (days)*: field is displayed to view the nutrient fluxes assigned for that day. These are input flux rates, not computed flux rates by EFDC.

7.6.16. Vegetation Map

If vegetation has been activated then *Viewing Opt | Vegetation Map* is available. There are no sub-options available. When LMC'ing on a cell, the vegetation class information for that cell is displayed. The cell property copy feature is available to quickly edit vegetation class assignments.

7.6.17. Internal Variables (EFDCPlus Only)

After the model has been run and the EFDCPlus source code has been properly configured, the EFDC_Explorer linkage file EE_ARRAYS.OUT will have been generated. When post-processing a model run, if this file exists, EFDC_Explorer builds a parameter list from the data contained in the linkage file. Any of these variables contained in the linkage file can then be displayed, time series'd, etc.

7.6.18. ModChannel

If the channel modifier feature of EFDC has been activated then *Viewing Opt | ModChannel* is available. The *Channel Modifier Flag* must be set in the *Domain* tab in the the main form (see Section 5.3.15.3.1).

When selected, the model grid will be displayed with gray lines representing the “pipes” or channel modifiers shown. This function enables the user to create and edit channel modifiers (i.e. pipes). The user should then enable edit and use the right mouse click to choose the start point for the channel modifier. The user will then be prompted for the end point and edit form shown in Figure 7-54. In this way the user can add, delete or modify channel modifiers. Care should be exercised in using channel modifiers as model instability is sometimes increased and mass balance errors can occur.

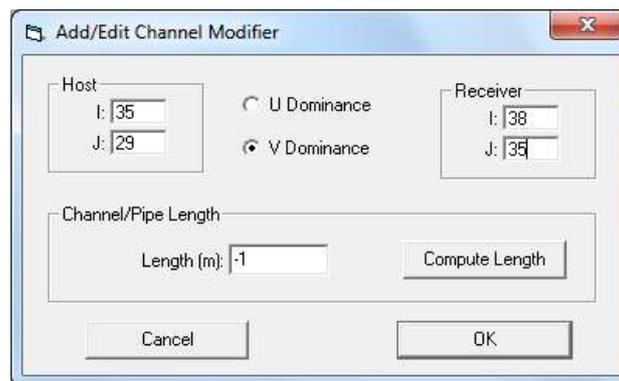


Figure 7-54 Add/Edit Channel Modifier option form.

7.6.19. Wave Parameters

If the wave options have been activated (*Active Modules* tab) then *Viewing Opt | Wave Parameter* will be available. This feature displays the 2D assignment of the wave parameters. The input parameters that can be displayed are:

- Wave Cells
- Wave Energy.
- Wave Height.
- Radiation Shear Stress: XX Component.
- Radiation Shear Stress: YY Component.
- Radiation Shear Stress: XY Component.
- Dissipation Losses.
- Wave Angle.
- Wave Period

In addition, the derived parameters listed below are available:

- Total Depth (with wave heights).
- Water Surface (with wave heights).

7.6.20. Volumetric Analysis

A Volumetric analysis may be undertaken to determine the volume of water influenced by the selected water column parameter. The volumetric analysis is accessed by the Alt-C keystroke which displays the input table shown in Figure 7-55.

Description	Value
Compute Incremental (i) or Total (T) Volumes/Areas (i/T):	T
Display Time Series (Y/N):	N
Display CDF's (Y/N):	N
Bottom Cutoff:	0
Breakpoint 01 (Blank or 0 to Skip):	2
Breakpoint 02 (Blank or 0 to Skip):	5
Breakpoint 03 (Blank or 0 to Skip):	10
Breakpoint 04 (Blank or 0 to Skip):	
Breakpoint 05 (Blank or 0 to Skip):	
Use a Polygon file to subset cells (Y/N):	Y

Figure 7-55 ViewPlan: Volumetric Analysis Tool.

The user may compute the volume, area and shoreline length either incrementally or as a total. If *Incremental* is selected EE will calculate from the *Bottom Cutoff* to *Breakpoint 01*, then from *Breakpoint 01* to *Breakpoint 02*, and so on. If *Total* is selected then EE will calculate from the *Bottom Cutoff* to each *Breakpoint* separately. The user should also select whether to calculate a subset of the model with a polygon or the whole model area.

Figure 7-56 displays the output of the *Volumetric Analysis* for salinity with the breakpoints as shown in Figure 7-55.

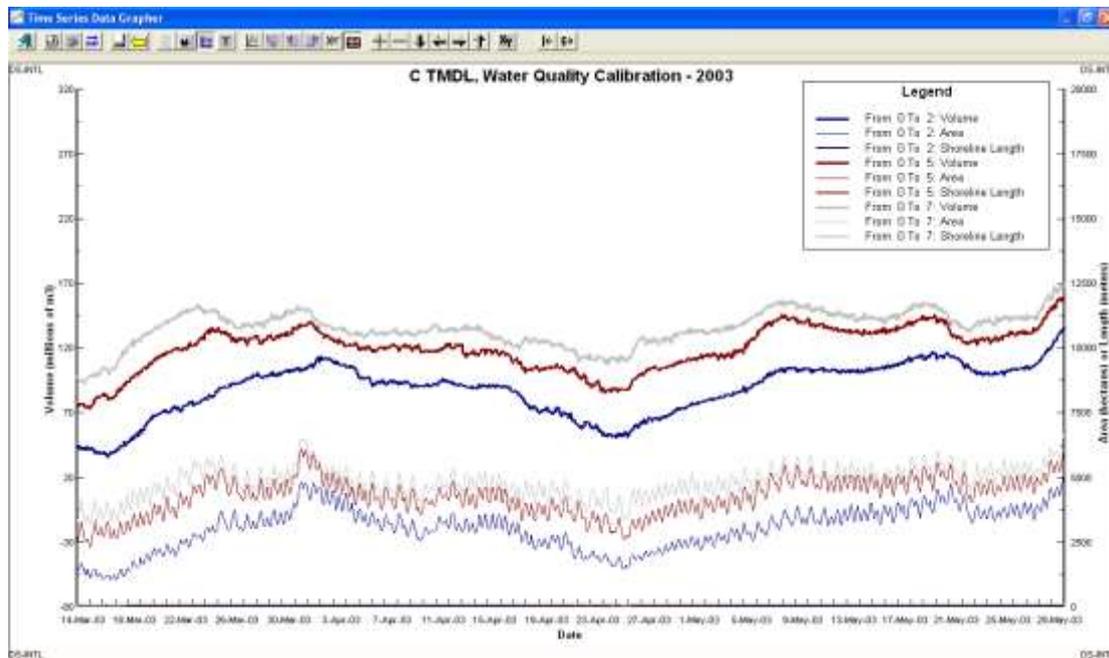


Figure 7-56 ViewPlan: Volumetric Analysis Time Series.

7.6.21. 2D Contour Lines

Within the *ViewPlan* tool, EE has the capability to plot 2D contour lines for any simulated parameters at any time steps. The contour option is enabled by selecting the *Contour* check box in the Viewing Options form. Beside the check box is a button to open the *Contour Control Form* which contains two tabs such as *Formatting* and *Contour Intervals* as shown in Figure 7-57

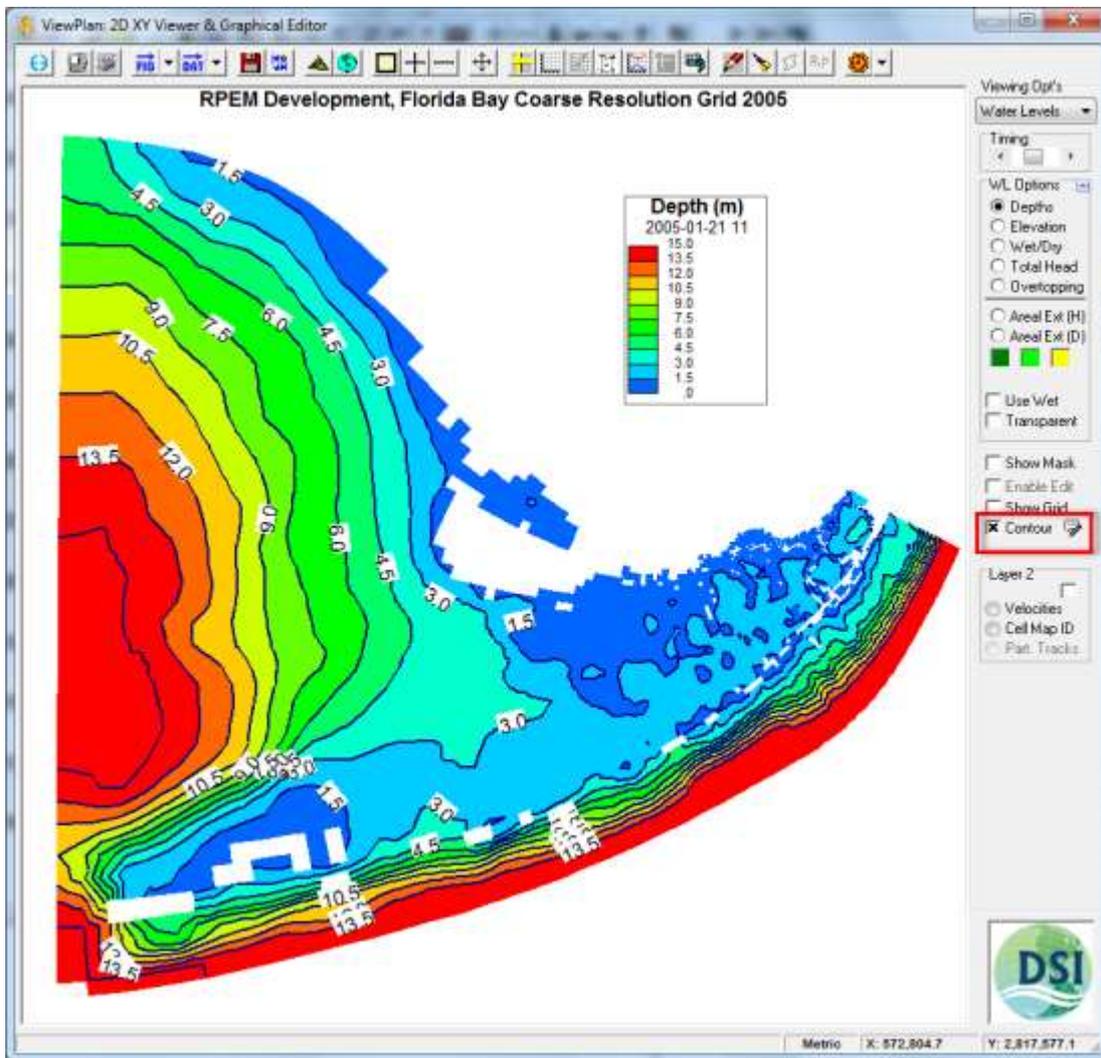


Figure 7-57 ViewPlan: Contour View.

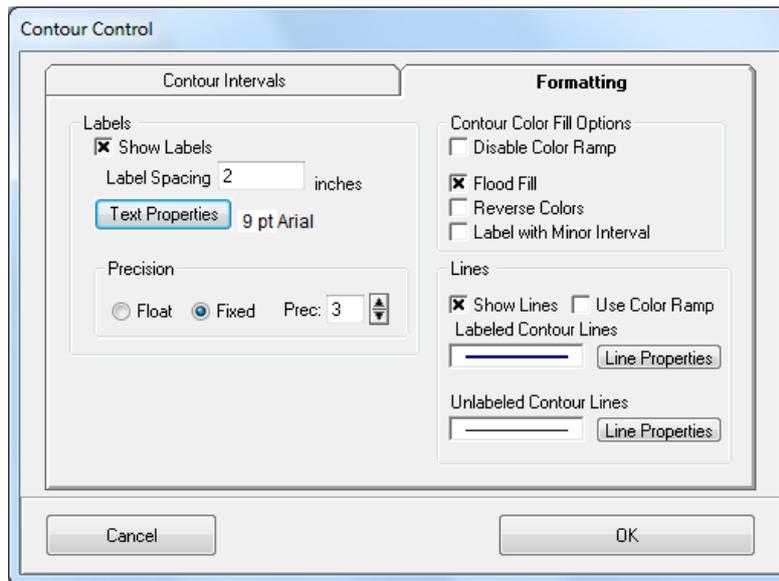


Figure 7-58 ViewPlan: Contour Control Form – Formatting.

7.6.21.1 Formatting Tab

The *Formatting* tab provides numerous formatting options as shown in Figure 7-58. The *Labels* frame provides a check box to switch on or off the labels and a text box for entering the spacing between the labels. The style and font of the labels may also be edited with the *Text Properties* button. In addition the background and foreground colors, label position and label precision may also be modified.

The *Data Points* frame allows display of symbols at the cell corners and editing of the symbol properties with the adjacent button. The user may also display values of the parameter currently being viewed with the *Show Values* check box. The font and position of the labels may be edited with the adjacent button.

The *Precision* frame provides two options for the numerical precision of the contour labels, floating or fixed. If *Float* is selected the precision value is ignored. Only if the *Fixed* button is selected is the label displayed to the numerical precision entered in the text box.

Contour Color Fill Options provide the capacity to “flood fill,” that is to fill the space between contours with the color based on the legend color ramp. It is recommended that when using contours the user should apply flood fill as it provides a constant color over the midpoint of the contour intervals. Note however, that this option overrides the *Outline Only* option in the *Labels* tab. The *Reverse Colors* check box reverses the color ramp in the legend.

The *Lines* frame provides various options for editing the contour lines. Lines may be toggled on and off with the *Show Lines* check box. The color of the contour from the color ramp is toggled on and off with the *Contour Color* check box. For both the major (labeled) and minor (unlabeled) lines, line thickness, color and style may be edited with the *Line Properties* button.

7.6.21.2 Contour Intervals Tab

The *contour internals* tab is shown in Figure 7-59 below. The *From the Data* frame displays upper and lower limits for the parameter selected for the user's information. The contour tool assumes the minimum and maximum contour interval from this data and automatically sets the number of contours to 11, basing the major interval on this. The minor interval is set by default as one third of the major interval. Adjusting the minor interval will recalculate the major interval and number of contours accordingly. Modifying the number of contours will recalculate the major and minor interval values.

The *Clip Range* button will clip all contours outside the max and min contour values defined by the user.

The *View Options* frame provides two options for methods of calculating the contours: based on the corners of the cell, or on the cell centroid. The *Searching Radius* text box tells EE what radius of cells should be used in the calculation of the contours. The *Use Spline* check box will employ a spline function for calculation of the contour line. The number of points to be used in the spline calculation is user defined.

The *Outline Only* checkbox will turn off the legend and background colors and display only the contour lines. Note that this will not be visible if *Flood Fill* has been selected.

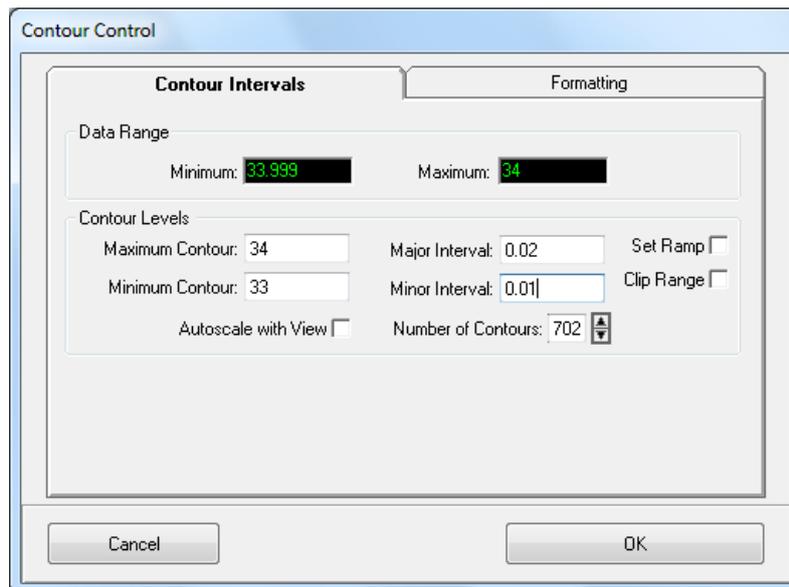


Figure 7-59 ViewPlan: Contour Control – Limits

7.6.22. Time Series Contours

Time series of velocity contour profile is a feature developed from release of EE7.2 to plot the vertical constituent contours over the water depth column, somewhat like a “heatmap”. Effectively they are the I,J Component on a time-depth background.

This feature is accessed by RMC from *Velocities* or *Water by Layer* or *Water by Depth* viewing options, and provides a time series of that constituent’s contour profiles as shown in Figure 7-60. This is useful for analyzing the velocity speed of river or tidal discharge from the bottom to the top of the water column. Other transport parameters such as temperature and salinity are also available with this option. Figure 7-61 shows the time series contour plot control which is accessed by RMC on legend. This allows the user to define the maximum and minimum contours and to set the precision of the values as either floating or fixed.

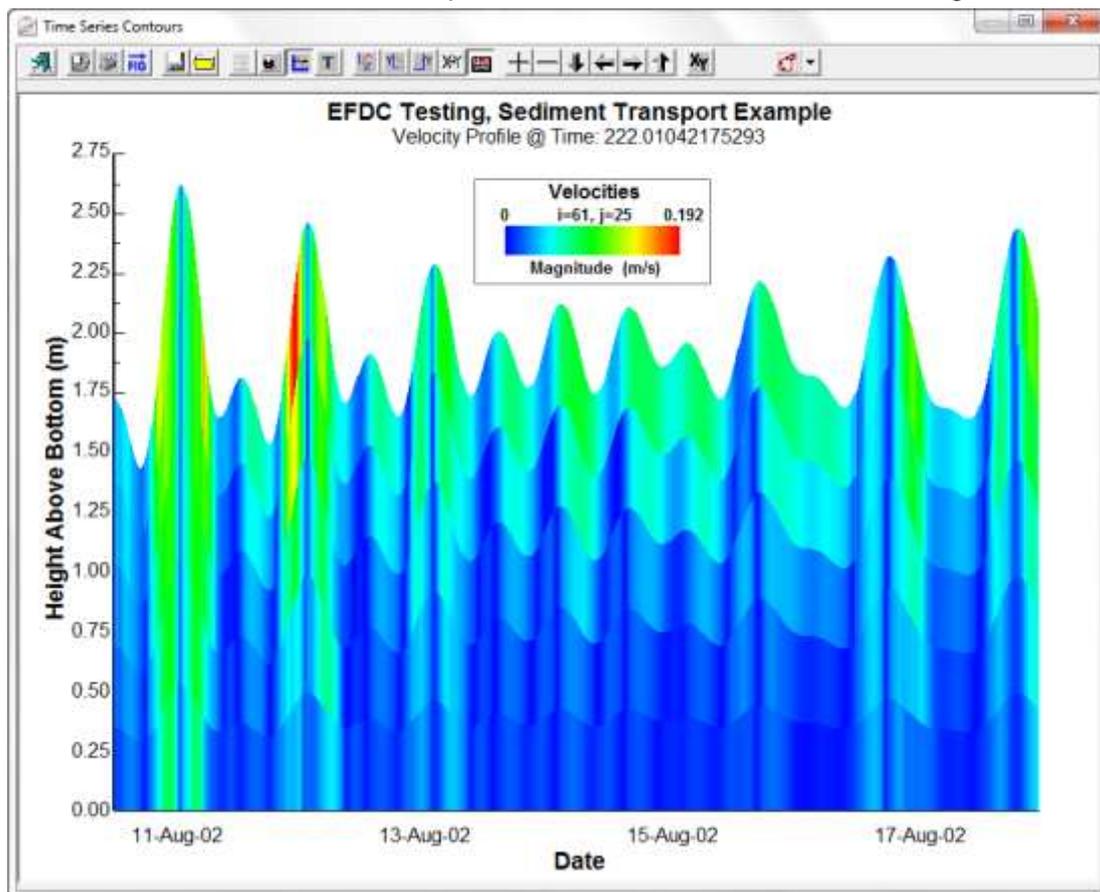


Figure 7-60 Time Series: Velocity Contour Plot.

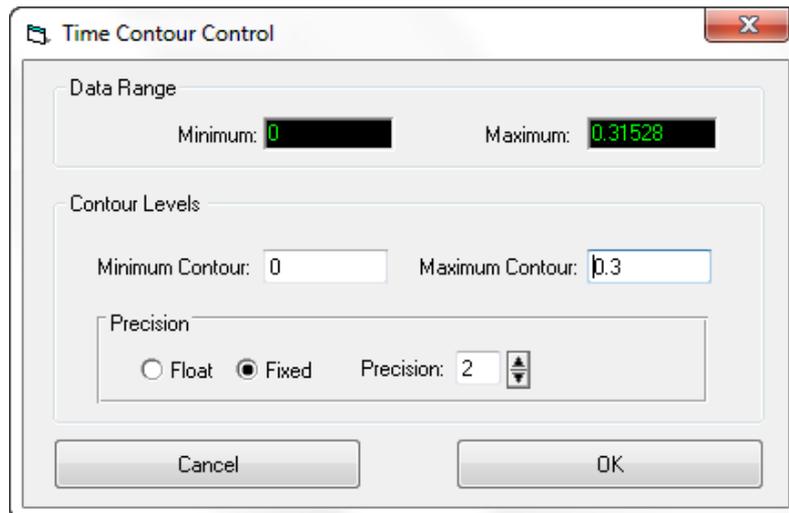


Figure 7-61 Time Series: Velocity Contour Plot Control.

The user can also select to plot a *Time Series Contour* by each layer, depth averaged or for all layers.

7.6.23. High and Low Pass Filter for Time Series

EE has filtering capabilities which are applicable for any time series plots. This involves the integration of a low pass and a high pass filtering to the time series plotting utility. Two type of filters (Lanczos and Fast Fourier Transforms) are available. This feature has also been added to the *Time series Comparison* form and *Statistics tools* in the *Model Analysis* tab as described in the next section.

The method of High- and Low-pass Filtering is that the instantaneous current velocity can be represented as the sum of time-averaged value and fluctuations of high and low frequencies as follows:

$$v_i = \bar{v} + \widetilde{v}_h + \widetilde{v}_l \quad (1)$$

where v_i is instantaneous current velocity; \bar{v} is time-averaged velocity; and $\widetilde{v}_h, \widetilde{v}_l$ are fluctuations due to the high and low frequencies respectively.

Based on the Fast Fourier Transform (FFT) method for energy spectra in frequency domain, these fluctuations were obtained dependent on the defined cut-off frequency i.e. at 1, 3, and 5 filtering hours. After that the inverse FFT was used to plot the high or low frequencies results.

High-Pass option: $v_i = \bar{v} + \widetilde{v}_l$ (2)

Low-Pass option: $v_i = \bar{v} + \widetilde{v}_h$ (3)

In the *Time Series Plotting* utility, the user can choose any time series to filter. There is an option to *Create to new line* in order to add this filtered line into the plot as shown in Figure 7-62. If *Apply to this Line* is selected the time series will be replaced with its filtered series, an example of which is shown in Figure 7-63.

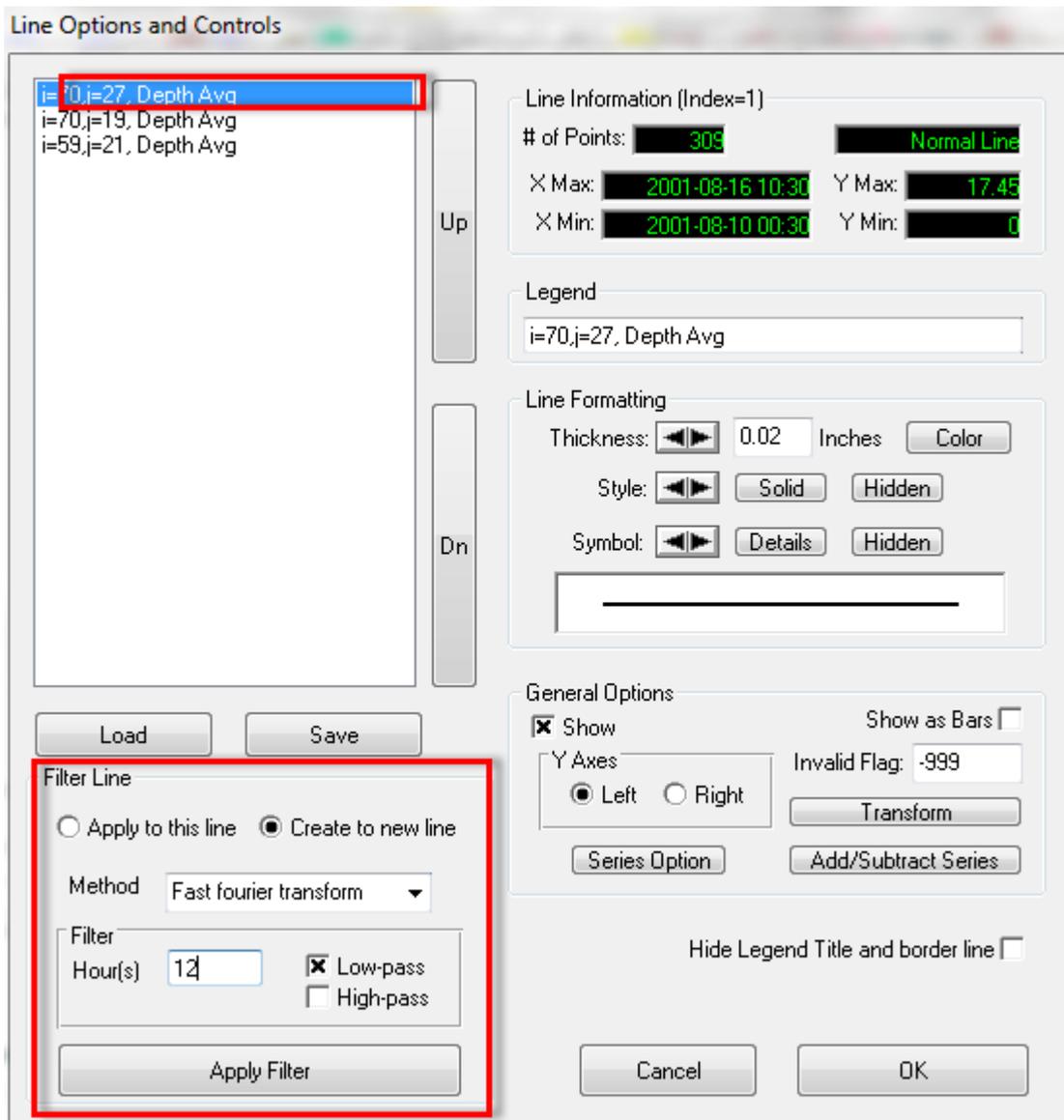


Figure 7-62 High and Low Pass Filter for Time Series Plotting.

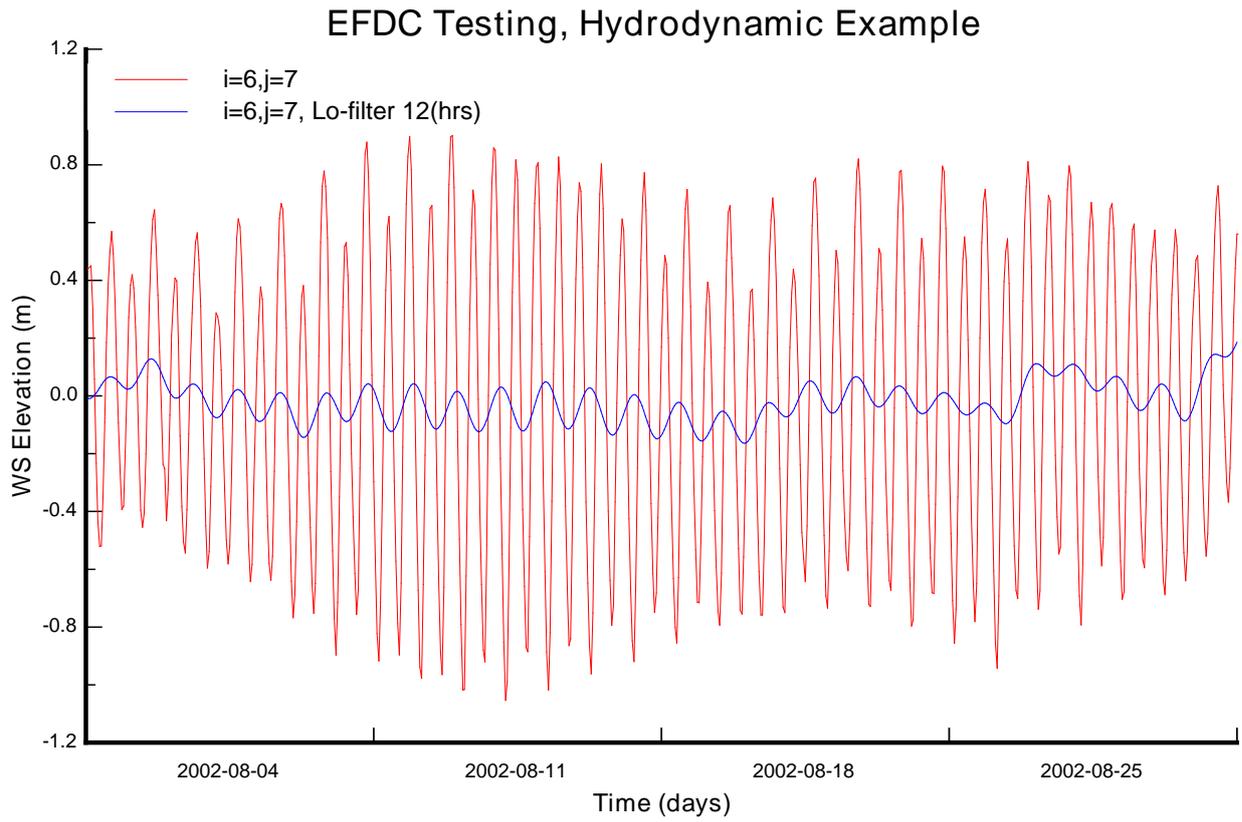


Figure 7-63 Time Series plot of WSEL (red) and low pass filter (blue) at location $i=6, j=7$.

7.6.24. Mean Mass Transport - Averaging of 2D/3D fields

The mean mass transport (MMT) tool is used to remove tidal series or environmental time series by providing a running average of 2-D and 3-D fields. The MMT tool essentially displays a single snap shot calculated for an averaging period of a given number of hours. The averaging period is set from the start time to end time of the residual field and displayed for every cell. The tool can be accessed from *ViewPlan* using the CTRL-R keystroke. The user is then prompted for the *Start Time* and *End Time* in Julian or Calendar time. Pressing *Apply* will display the MMT for that time period as shown in Figure 7-64 for this estuary model.

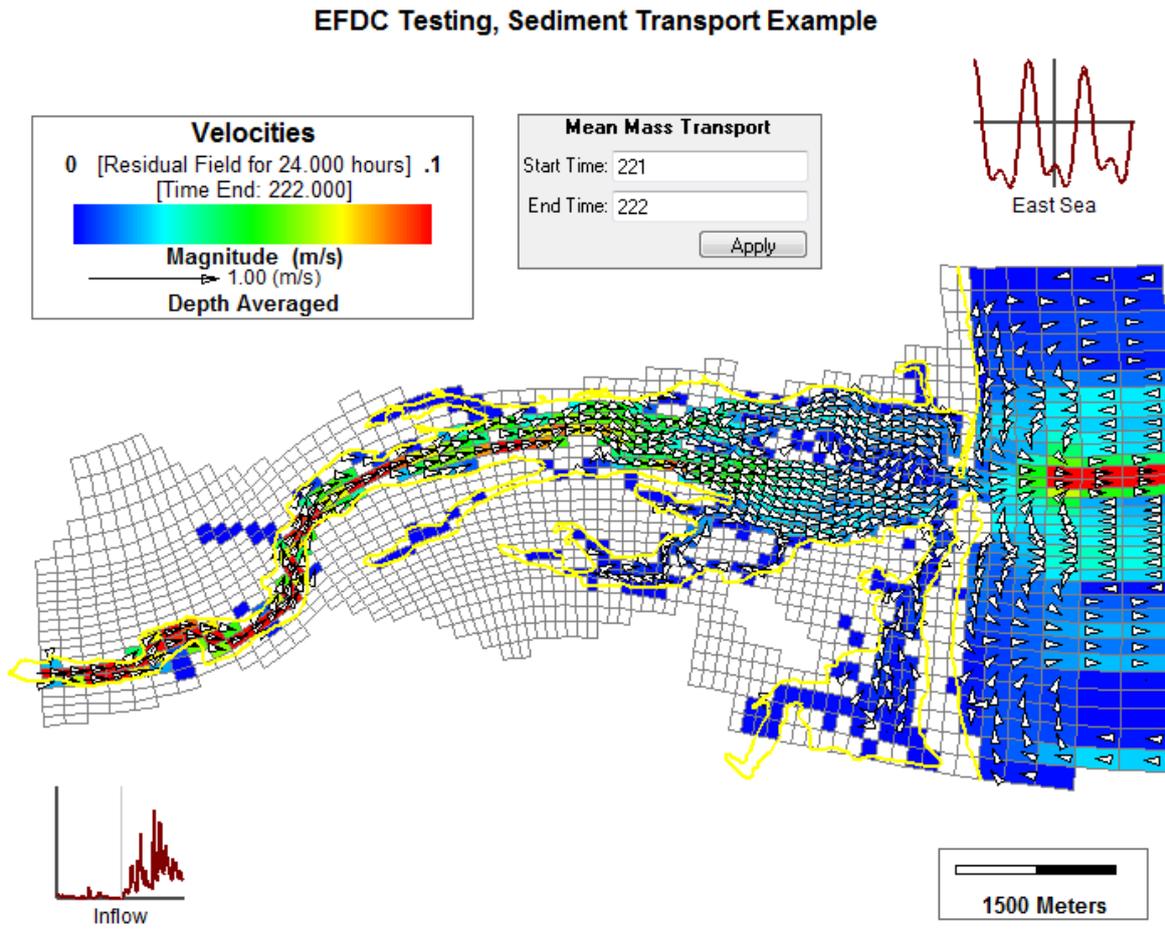


Figure 7-64 ViewPlan: Mean Mass Transport.

7.6.25. Particle Tracks and Oil Spill

The Viewing Option for Particle Tracks provides the user with a number of options for display of particle tracks and oil spill. The drop down box *Show Drifter* also allows options for *Oil thickness*, *Oil mass* or *Oil volume* of oil is being simulated. If the drifters are displayed instead of oil then various *Color Options* may be selected, including color by elevation, by depth, by layer, by time or by group. The latter option is shown in Figure 7-65.

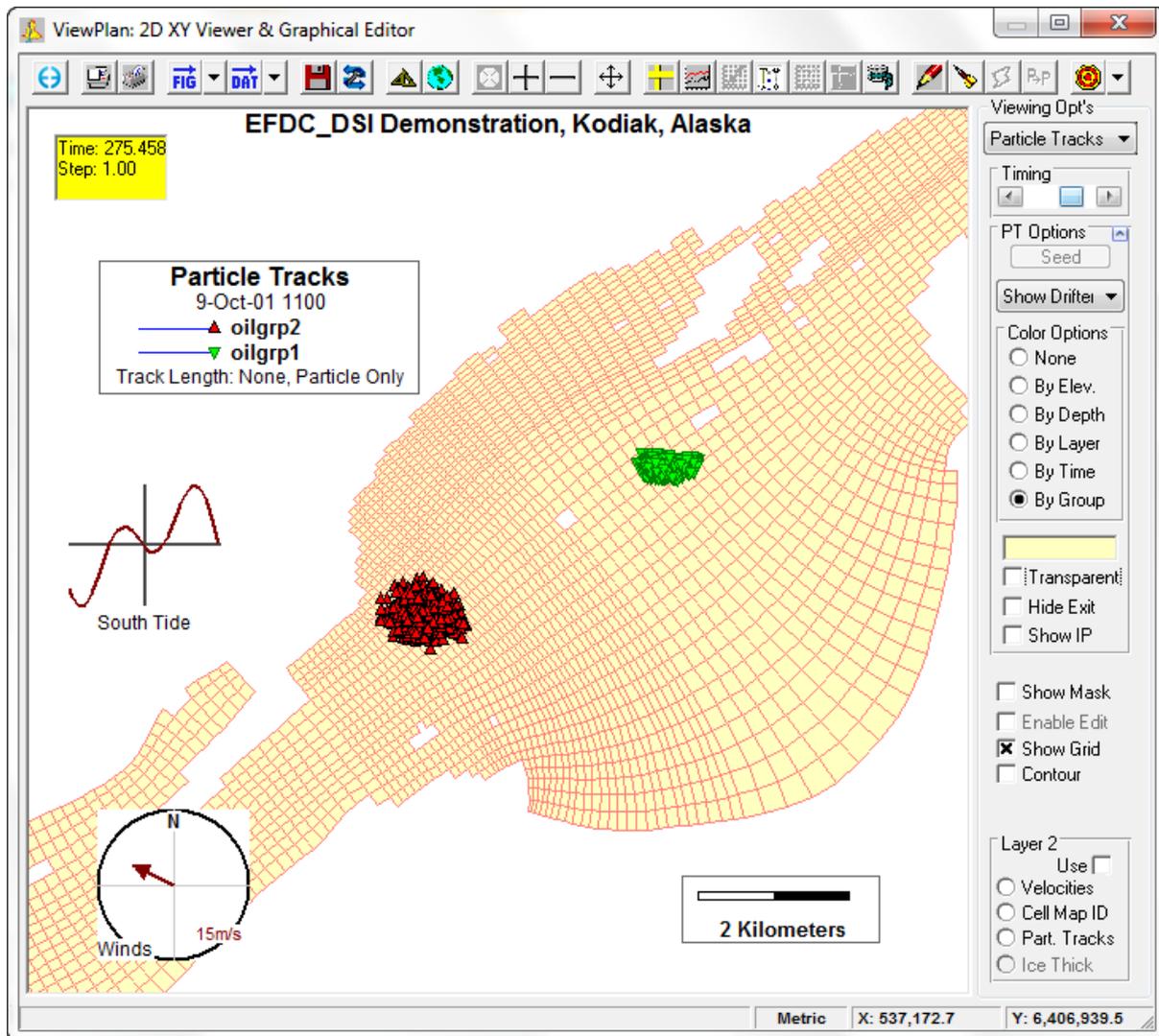


Figure 7-65 ViewPlan: Particles displayed by groups.

In the particle tracking submodel of earlier versions of EE, particles that reach the model boundary stick to the edge of the boundary. This is to show that the particles have left the model domain and are no longer being calculated. From EE7.3 a new method has been added which provides the user an option to allow the particles to disappear if the *Hide After Exit* check box is selected (see section 10.1.7 for an example).

As each group has its own chemical property and volume per seed to allow for different oil type, EE calculated the summation of all the groups to display total thickness or mass. These summaries of total oil volume and area are provided in the *General Statistics* button for the current time and as a time series.

If oil is being simulated by any of the drifter groups, then the total oil volume and total mass of oil is displayed at bottom of the form as shown in Figure 7-66.

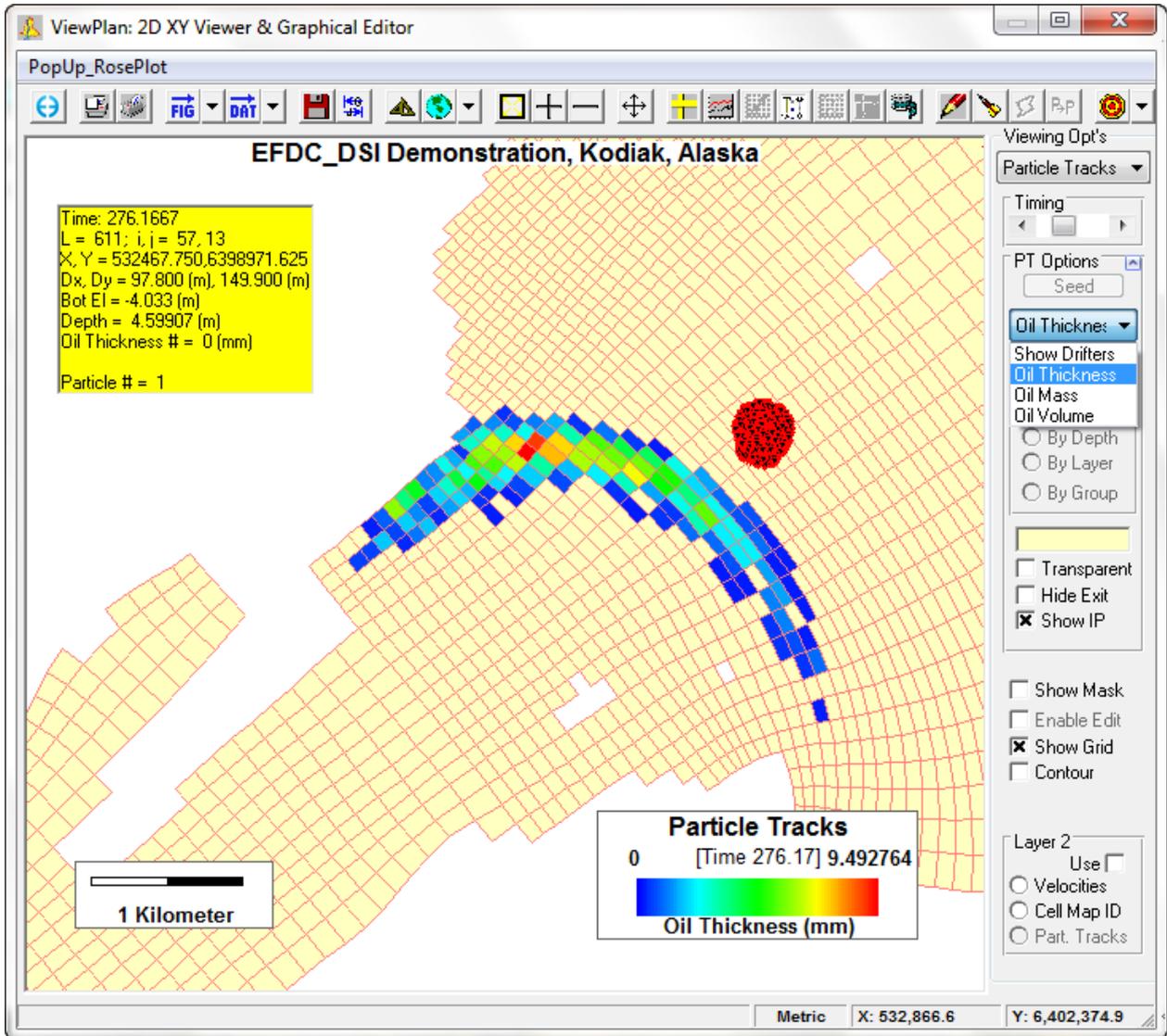


Figure 7-66 ViewPlan: Oil Spill viewing options.

7.7 Other Features

7.7.1. Photo Viewer

A new function in *ViewPlan* is the ability to add images to work space to illustrate the model domain. This is accessed via the *CTRL-P* keystroke which turns on the image viewer. RMC on a cell to *Add* and then browse to an image that location for it to be added to the workspace as shown in Figure 7-67.

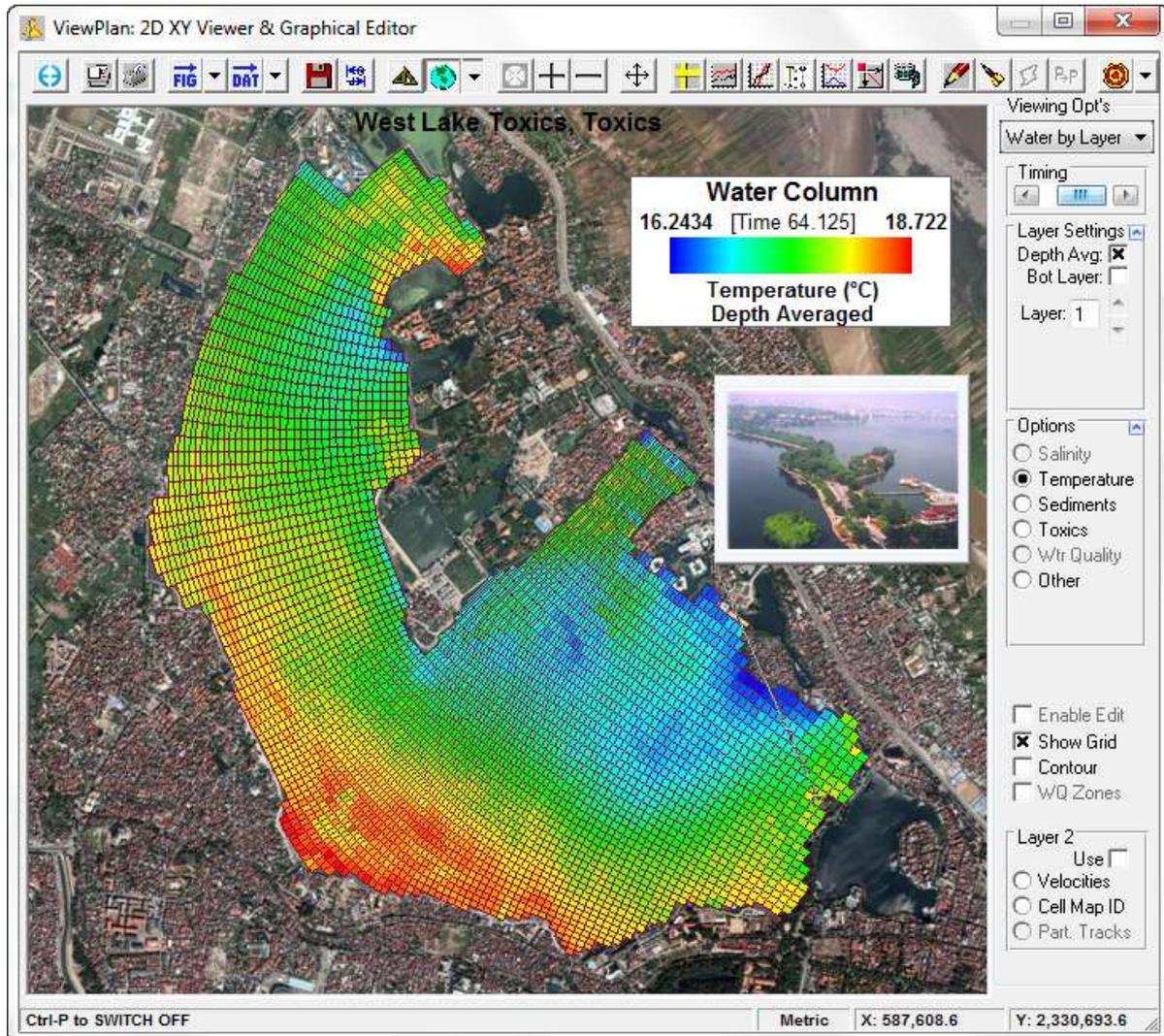


Figure 7-67 ViewPlan: Image Viewer.

7.7.2. Change Legend Font Sizes

EE has the option of adjusting the font, color and size of the text label in the legend in *ViewPlan*. This can be achieved by using ALT- F and selecting options as shown in Figure 7-68

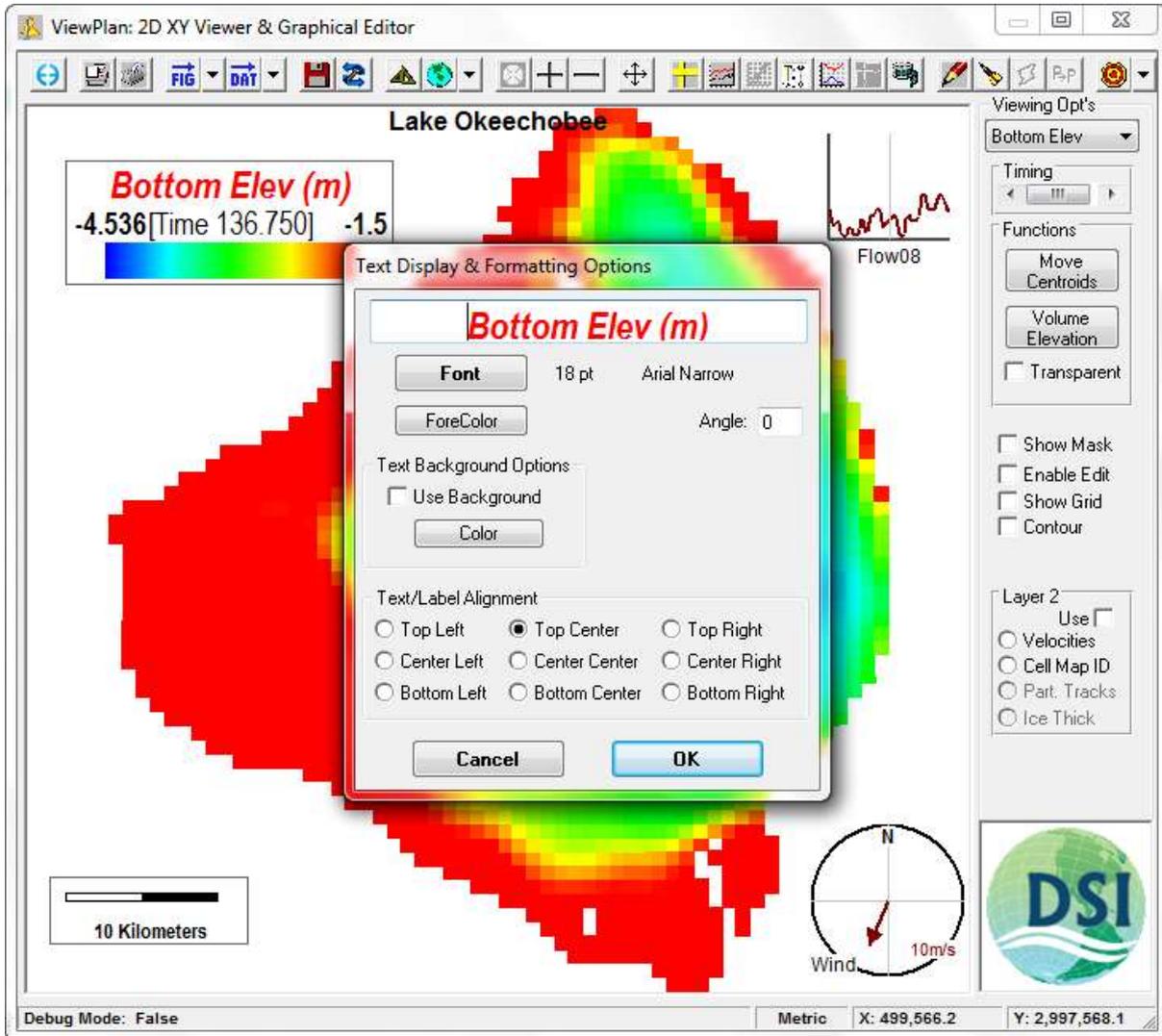


Figure 7-68 ViewPlan: Adjustable legend front sizes.

7.7.3. Display Symbols in Titles and Legends

EE8 allows the user to include symbols and alternative fonts in the titles and legends. This is primarily designed to provide the option to include Greek symbols in the plot axis. The user should select the “Control + Insert” key when editing a legend or title for the font option and table of characters to be displayed as shown in Figure 7-69.

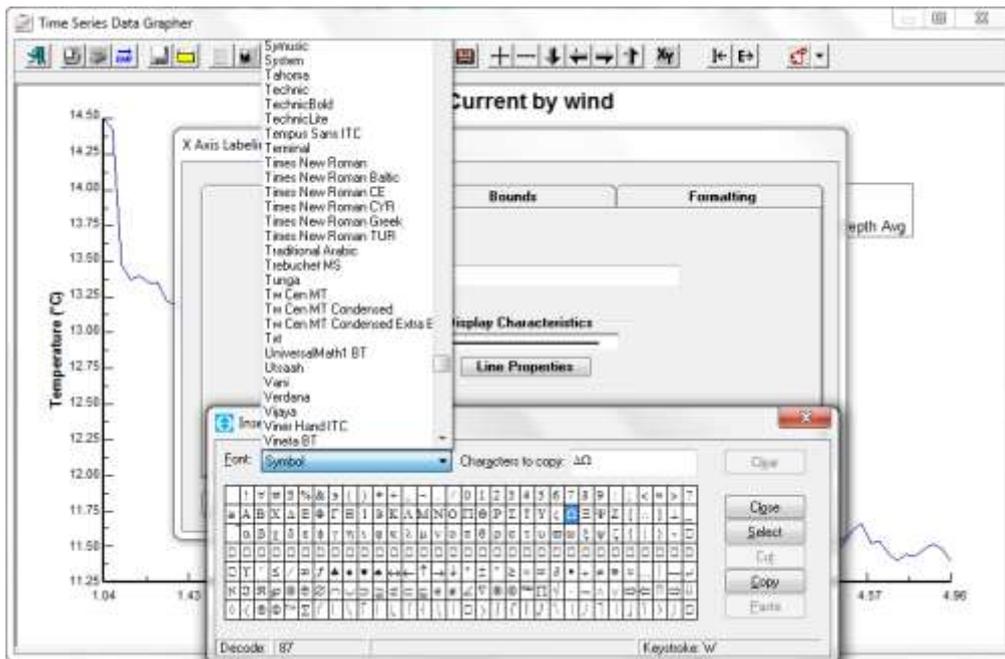


Figure 7-69 Selecting Greek symbols for Legend and Y-axis label.

If the user wishes to mix Latin and Greek fonts together in one line it is recommended to use the Greek Arial font and select the appropriate characters as both fonts can be combined with this option as shown in Figure 7-70.

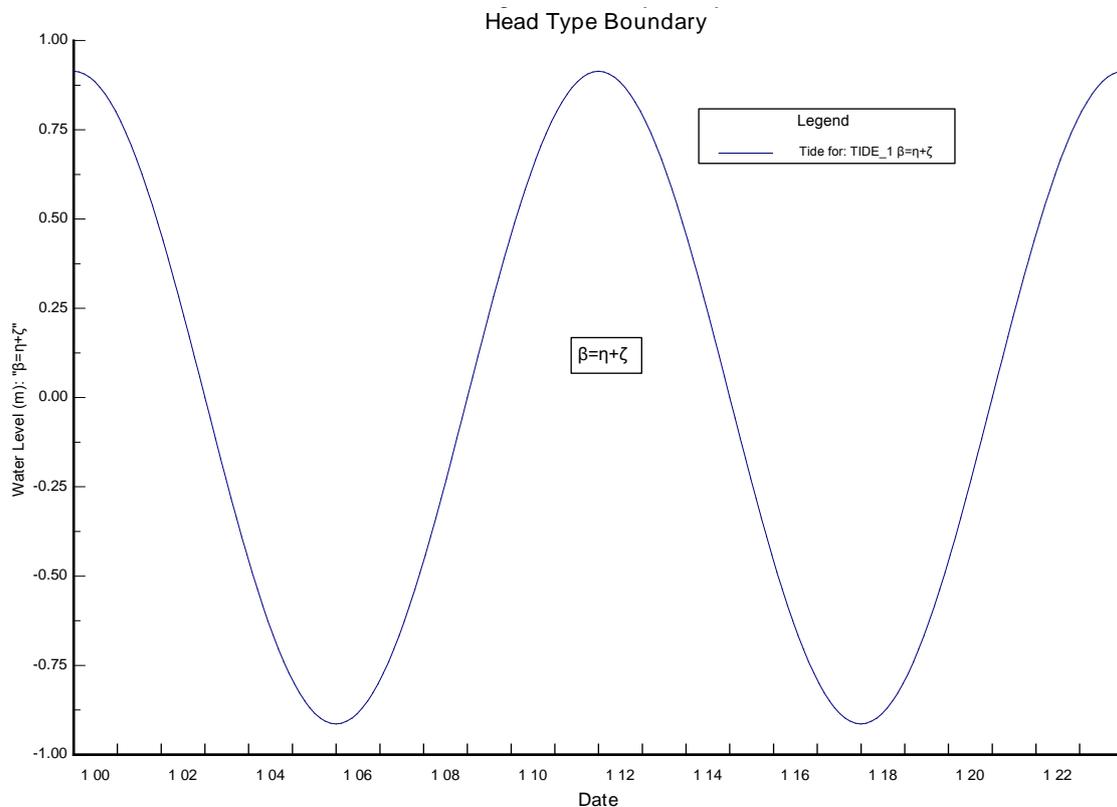


Figure 7-70 Greek symbols in legend and Y-axis label.

8 ViewProfile



The *ViewProfile* button of the main toolbar provides access to the profile/cross section post-processing utility of EFDC_Explorer. An example of the type of plot available is shown in Figure 8-1. The contents of the current cell can be displayed, as in *ViewPlan*, by LMC'ing on the cell. Many of the operations of this feature are similar to *ViewPlan*.

Similar to *ViewPlan*, the *ViewProfile* button provides the user with a dropdown menu comprising the following options:

View Initial Conditions: This option may be used with the user is setting up the model or wants to view the ICs prior to the model run

View Model Results: This option is used after the model has been run and the user wished to analyze the model results.

View Model Results (Re-scan Output): This option should be used if the user has merged two models or has continued a model run and want EE to go back to the beginning of the output data set.

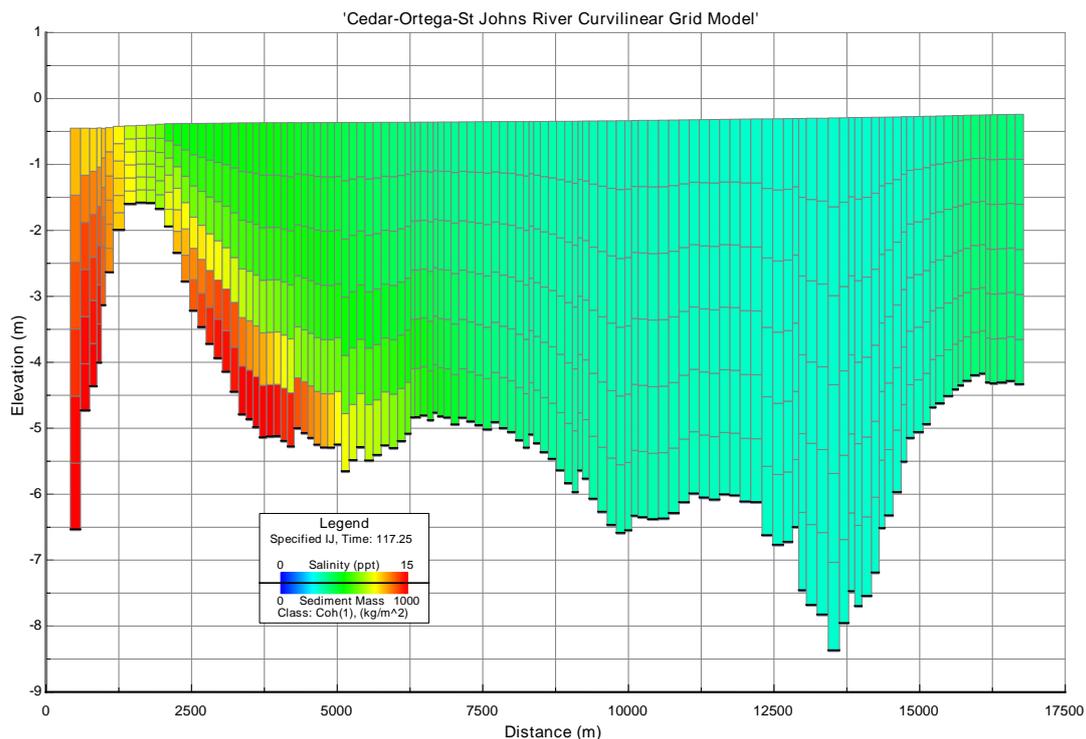


Figure 8-1 ViewProfile example for salinity at one snapshot in time during a tidal cycle.

8.1 Slice/Profile Selection

The *Slice/Extraction Options* frame needs to be set first before a profile can be extracted from EFDC. There are three options. The user may either select a value of I to extract the active J cells along that I, or select a value of J to extract the active I cells along that J. The

third option is to use a “Drape Line”, which is a polyline in the same coordinate system as the LXLY data. The I & J’s from along the line will be assembled and the profile will be output along that slice.

If an I or J extraction is used, the user can use the + /- keys to scroll up and down the selected coordinate. For example, if the I5 was selected, the + keystroke would display the I6 section, the – keystroke would display the I4 section. This feature is not applicable to the “Drape Line”.

8.2 Toolbar Summary

The *ViewProfile* toolbar provides access to a range of different functions and utilities. Some of these functions are dependent on the current context while some are not. Table 8-1 contains a summary of each function.

During animations it is usually better to fix the Y axis (elevations). The default is automatic scaling. During an animation the water surface elevation changes due to tides and/or storm events. If the axis is set to automatic scaling the plot appears to jump around due to different scaling at different times. This problem is solved by setting the elevation minimum and maximums to an appropriate range.

8.3 Primary Display Options

The user may select which parameters are to be displayed by accessing the *Display Options* form by RMC’ing on the legend, pressing Ctrl-O or using the toolbar. An example of the form is shown in Figure 8-2.

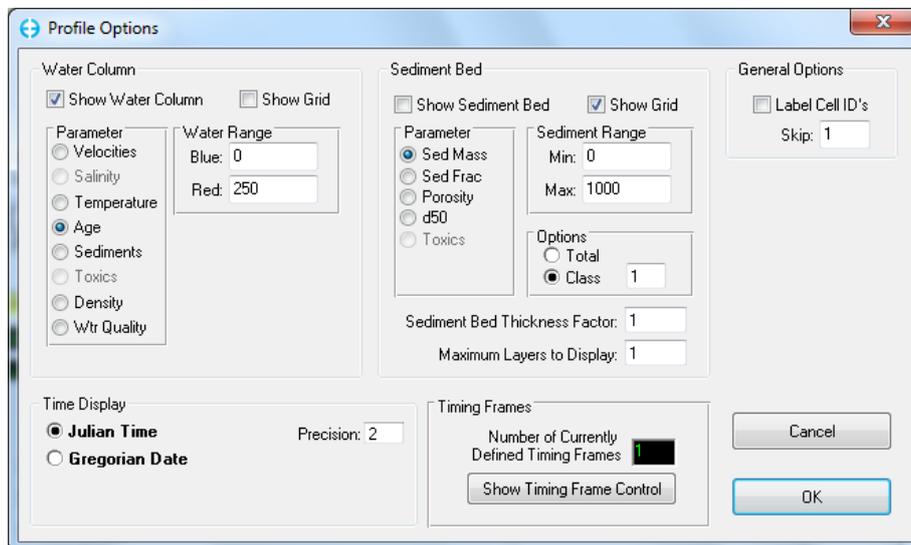


Figure 8-2 ViewProfile display options.

Table 8-1 Summary of ViewProfile toolbar.

General Functions	
	Exit ViewProfile.
	Printer setup options.
	Print to current printer the current view.
	Export the current view to a Windows enhanced metafile (EMF).
Toggles & Options	
	Toggle the grid.
	Show/Edit comment boxes
	Show/Hide markers
	Toggle between Julian date/Gregorian date formats
Plot Format and Labels	
	Edit text and fonts for the titles.
	Parameter display options/settings.
	Access the X axis options form.
	Access the left Y axis options form.
	Access the right Y axis options form.
	Set all the axes formats to the one last edited.
Navigation Functions	
	Zoom in at fixed increments.
	Zoom out at fixed increments.
	Pan Left.
	Pan Right.
	Pan Up.
	Pan Down.
Utility Functions	
	Toggle the display of the coordinates.
	Animation tool. Output animations to the screen and/or AVI files.

8.3.1. Velocity Magnitude by Color in ViewProfile

EE can display the velocity magnitude in the *ViewProfile* screen in much the same way as it does in the *ViewPlan* screen. This may be seen in Figure 8-7 below where arrows indicate direction of flow and the color.

Note that the user may go to any date with the *Go to Date* function (Control-G) and scroll along the i or j axis with “+” and “-“keys on the keyboard.

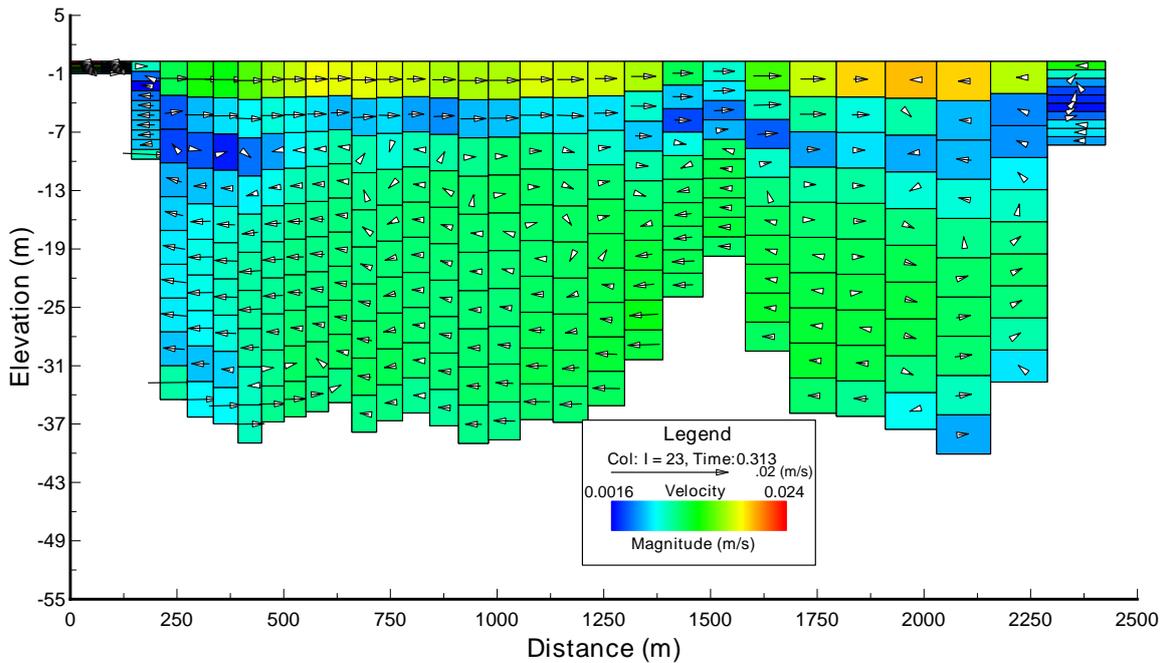


Figure 8-3 ViewProfile: Velocity color by magnitude.

8.3.2. Contour Lines in ViewProfile

EE now has the capability to produce contour lines in the *ViewProfile*. The contour option is enabled by selecting the “Show Contour” check box in Viewing Options form shown in Figure 8-4.

Beside the checkbox is a button to open and modify the *Show Contour Control* with two tabs, *Formatting* and *Limits*. The function of these buttons is the same as those for the *ViewProfile* contour features explained above.

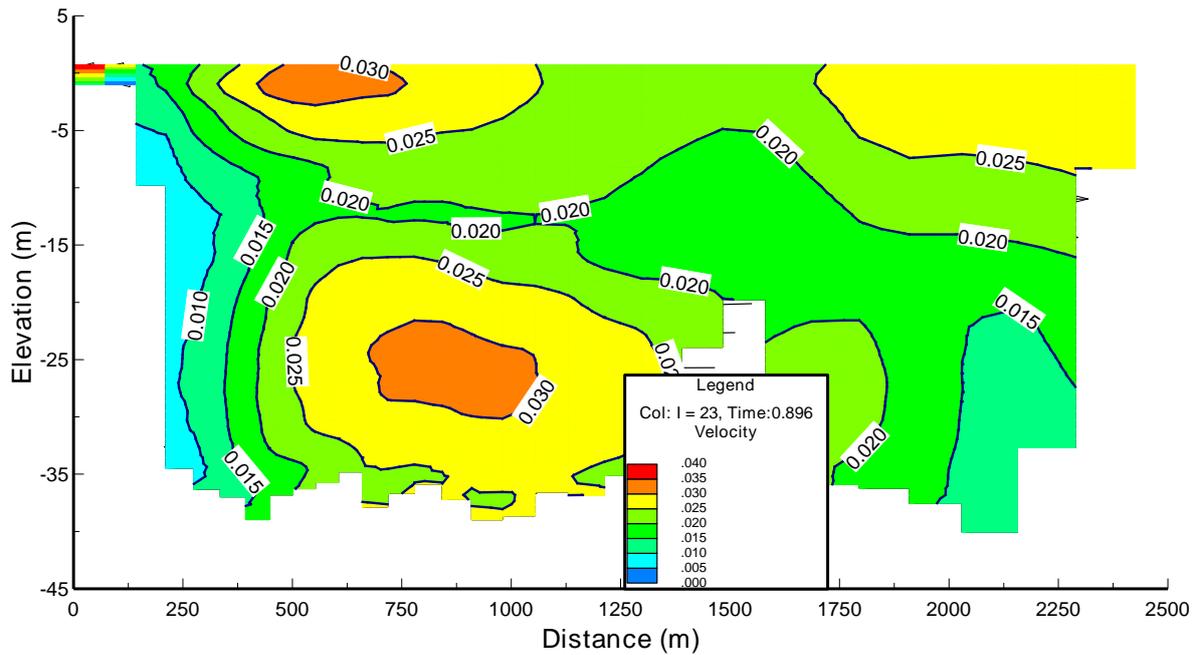


Figure 8-4 ViewProfile: Contour view.

8.3.3. Function Keys

During both pre- & post processing of the model the shortcut keys can be used to edit the graphs as shown in Figure 8-7. This form can be accessed via function key F2.

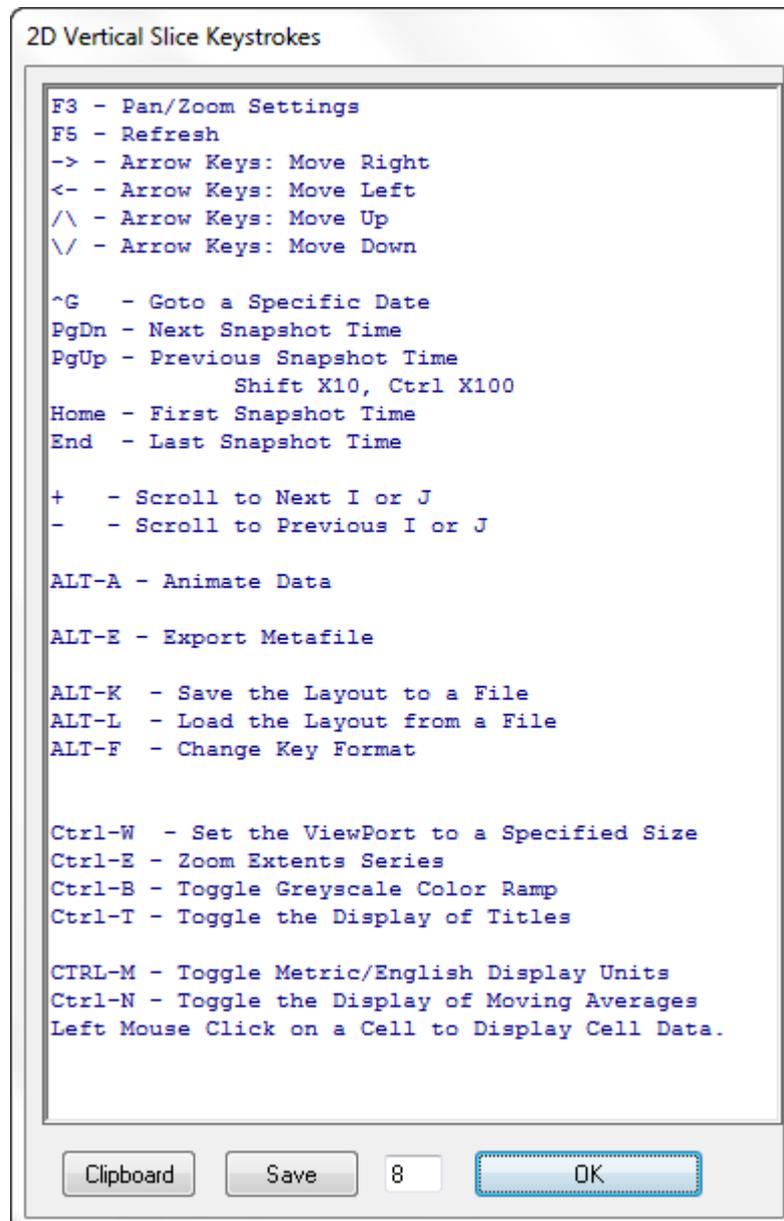


Figure 8-7 ViewProfile keystroke functions.

9 Time Series Graphing

Many of the plotting features of EFDC_Explorer use the *Time Series Graphing (TSG)* utility. In addition to time series plotting, the *TSG* is also used for any XY plot as well as *ViewProfile* (but with a completely different plotting subroutine). Figure 9-1 shows a screen capture of the *TSG*. This figure demonstrates the capability of the *TSG* to import multiple data files for comparison with model results.

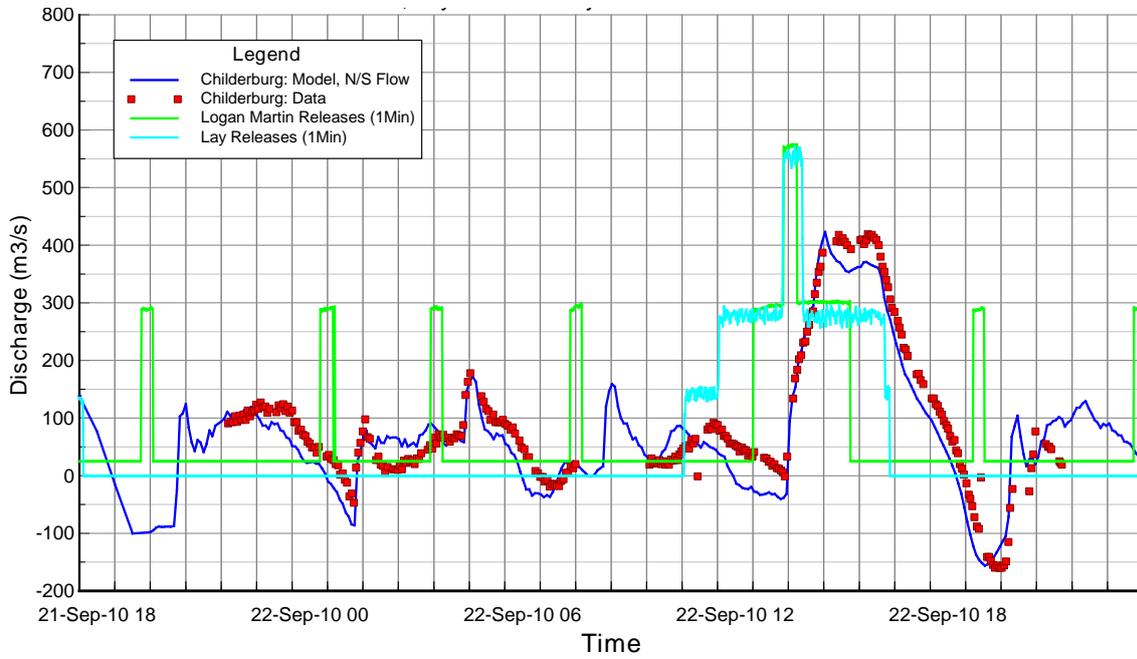


Figure 9-1 Time Series Plotting (TSG) utility.

Most of the functionality of the *TSP* is provided in the toolbar at the top of the utility but some of the functionality is accessed via keystrokes (see Figure 9-2).

Table 9-1 provides a brief summary of the toolbar functions. This is very similar to the *ViewProfile* toolbar. The main difference is the import (I←) and export (E→) data series features. These are extremely useful to save a data series out to a file, and then later, when viewing another model or other series, load that series in for comparison. The format of these files is shown in Appendix B. A “DAT” file (the default extension) can contain an almost unlimited series. Since the *TSP* is used to view every time series from water column to sediments and boundary forcing series, the user can develop their own series from data for calibration or any other comparison purposes.

Exporting: When exporting, the *TSP* exports only the data in the current view. If data has been loaded but “turned off” that data will not be exported. The legend is exported with each series.

Importing: The *TSP* utility first requests a file to import. It then loads all the lines in the file and displays them with the legend and asks the user which series to import. Once the series to be imported is selected, the user is then asked which series to insert the imported series into. The *TSP* makes an initial series assignment but the user can select any series from 1 to 10. Existing series can be overwritten during the import process, if desired.

The left (primary) and right (secondary) Y axes can be edited by using the toolbar buttons shown in Table 9-1 or they can be edited by RMC'ing on the areas of the axis labels. The same method applies to access to the X-axis editor.

Table 9-1 Summary of Time Series Plotting Utility toolbar.

General Functions	
	Exit ViewProfile.
	Printer setup options.
	Print to current printer the current view.
	Export the current view to a Windows enhanced metafile (EMF).
	Save settings
	Read settings
Toggles & Options	
	Toggle the grid.
	Show/Edit comment boxes
	Show/Hide markers
Plot Format and Labels	
	Edit text and fonts for the titles.
	Display options/settings.
	Access the X axis options form.
	Access the left Y axis options form.
	Access the right Y axis options form.
	Set all the axes formats to the one last edited.
	Toggle between Julian date/Gregorian date formats
Navigation Functions	
	Zoom in at fixed increments.
	Zoom out at fixed increments.
	Pan Left.
	Pan Right.
	Pan Up.
	Pan Down.
Utility Functions	
	Toggle the display of the coordinates.
	Import Series from a file
	Export Data to a file
	Animation tool. Output animations to the screen and/or AVI files.

9.1 Analysis and Statistics

For any defined time series the user can use the keystroke functions (F2) to toggle the display for box & whisker plots (Alt-1). The shortcut keys which can be used to edit the graphs are shown in Figure 9-2

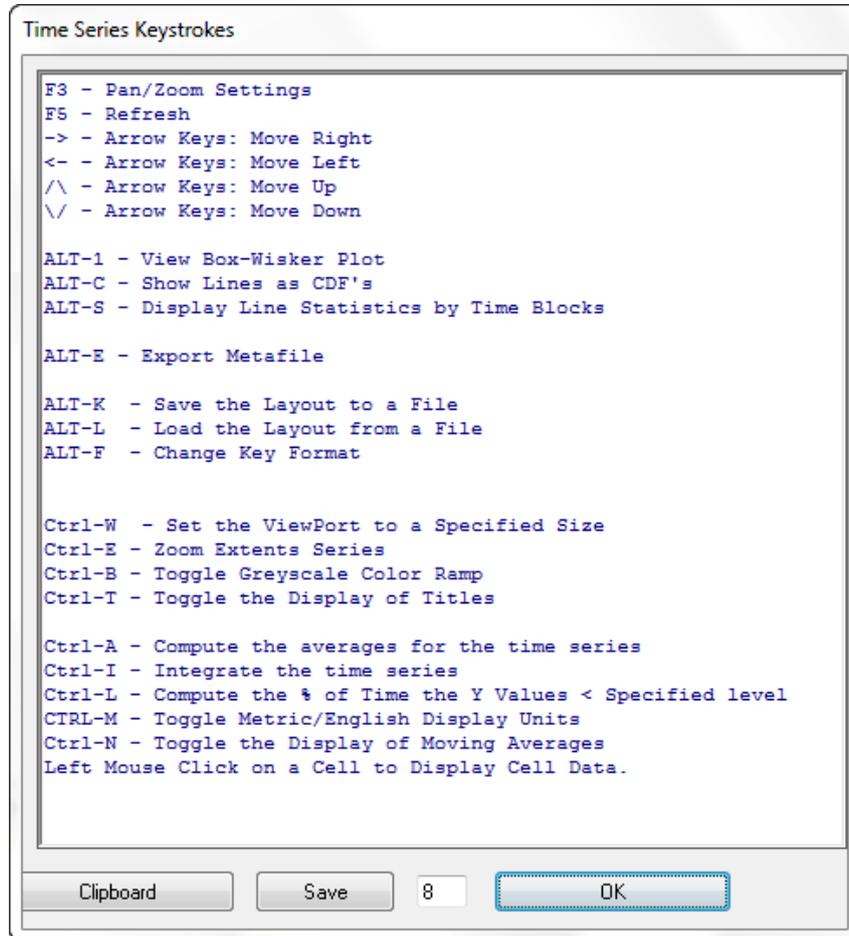


Figure 9-2 TSP Utility keystroke functions.

EE has the ability to display lines as *Cumulative Distribution Functions* (CDF's). This feature may be toggled on and off with the use of ALT-C. Other useful tools are the ability to display *Line Statistics by Time Blocks* (ALT-S) and to be able to compute the % of time the Y Values are at a specified level (Ctrl-L).

Ctrl-A calculates average of the data, which is then sent to the clipboard so it can easily be copied to Excel™ or other programs.

Ctrl-M allows the display of moving averages. The user is prompted for the time step and block time in hours.

Ctrl-I allows the user to integrate curves using a simple multiplication, where x is time, and y is Q in m³/s as shown in Figure 9-3. However, as the time is in days the user must adjust the units between days and seconds when prompted.

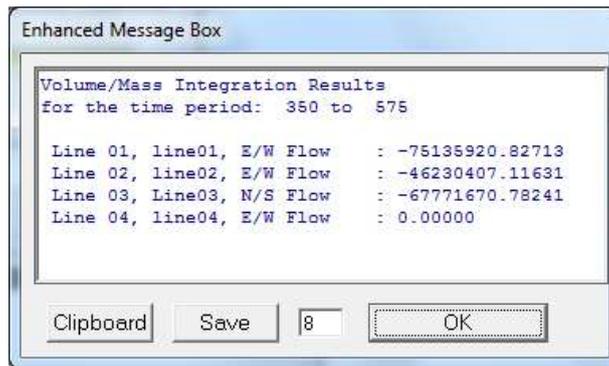


Figure 9-3 TSP: Integration of Time Series.

Line statistics by time block may also be displayed with the keystroke Alt-S. This is similar to a box and whisker plot data, but it generates a set of statistics. When the user wants to analyze each line by month they should select “1 M”. All the data is tab delimited and copied to the clipboard. The statistics generated are the average, standard deviation, minimum, maximum, lower quartile, median, upper quartile, standard error 95% and confidence interval.

9.2 Series Options

The user may select which parameters are to be displayed by accessing the *Line Options and Control* form by RMC'ing on the legend or using the toolbar. An example of the form is shown in Figure 9-4. The lines available for viewing are displayed on the left in the selection box. On the right of the form is the *Line Information* which for the line selected tells the user the number of points in the line as well as the maximum and minimum values of the line. The user may change the legend text for the selected line. In the *Line Formatting* frame the user may set the thickness, color and style with drop-down menus.

In the *General Options* frame the user can toggle the display of each line by checking *Show* for the series selected. An extra Y-axis can be added to the right of the graph by setting the *Right* tab in the “Y-axis” sub frame. Other features include changing lines to bar graphs with the “Show as Bars” check box.

In *Options* form provides options for the user to adjust the data for plotting purposes. The edited data does not update the EFDC data directly. If desired an edited series can be exported from the TSP and used to update the model input data.

In early versions of EE only 10 lines were allowed on a plot at any one time, but this limitation has now been removed. LMC on one of the series in the right hand box will highlight that series. Holding down the control key allows the user to select multiple series. The user can then change line/point styles in the *Line Formatting Frame*. The *Legend* frame modifies what title will appear on the legend for the last series selected.

The series formatting and axes formatting can be saved for later retrieval using the save and load settings buttons on the toolbar.

A series can be adjusted by pressing the *Transform* button having selected the series. This displays a form with additive and multiplicative adjustment factors for both the X and Y components. Clicking OK to this form immediately applies the adjustments.

The form also provides a means to add or subtract one series from another and place the resultant series into a specified series # with the *Add/Subtract Series* button.

The user also has the options to delete (rather than just turn off or hide) lines from the *Time Series Grapher* tool. This is shown in Figure 9-5 where the user has selected two lines. Then by selecting the *Delete* button the lines are removed from the legend after the user has confirmed they want to remove these lines (Figure 9-6). The lines are also removed from the time series display and from the *Line Options and Controls* menu as shown in Figure 9-7.

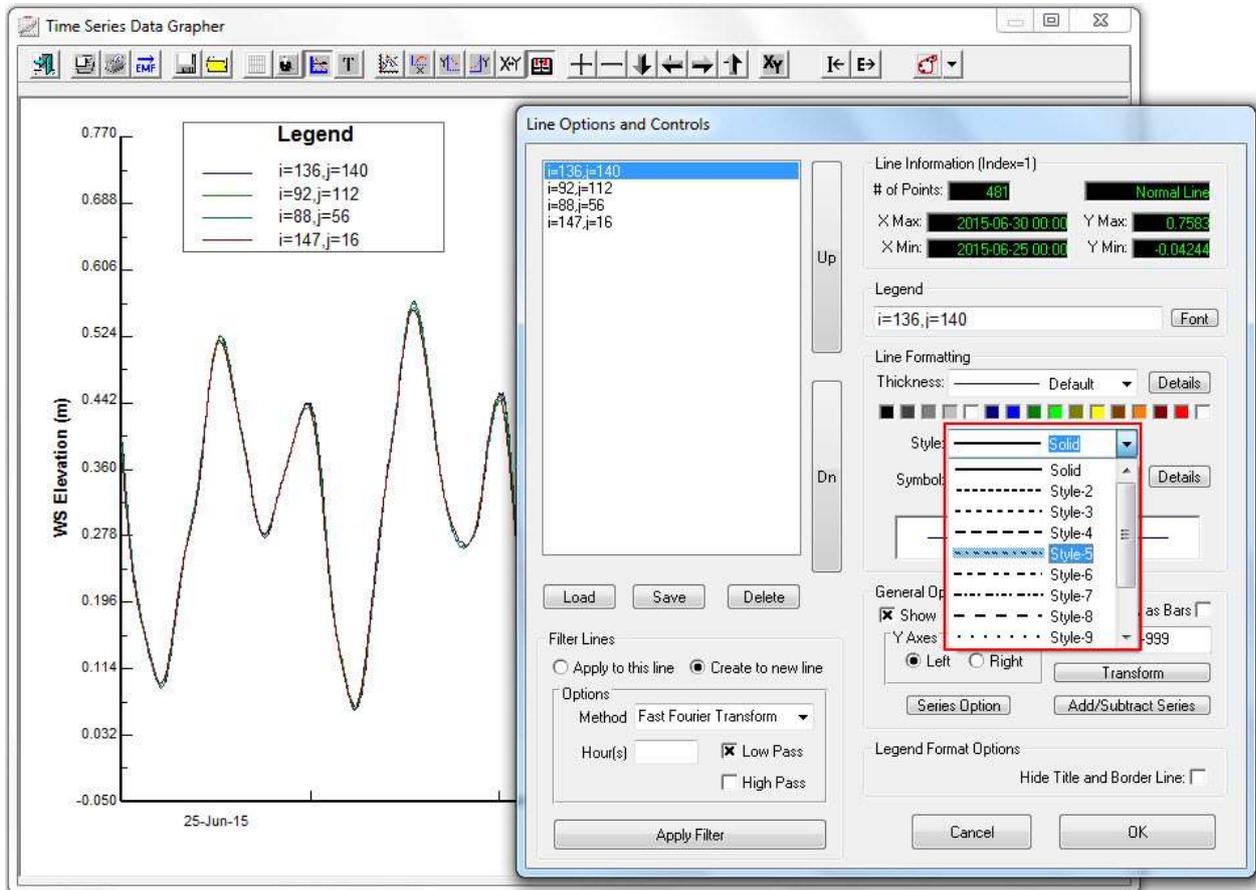


Figure 9-4 Time Series Grapher: Line Formatting

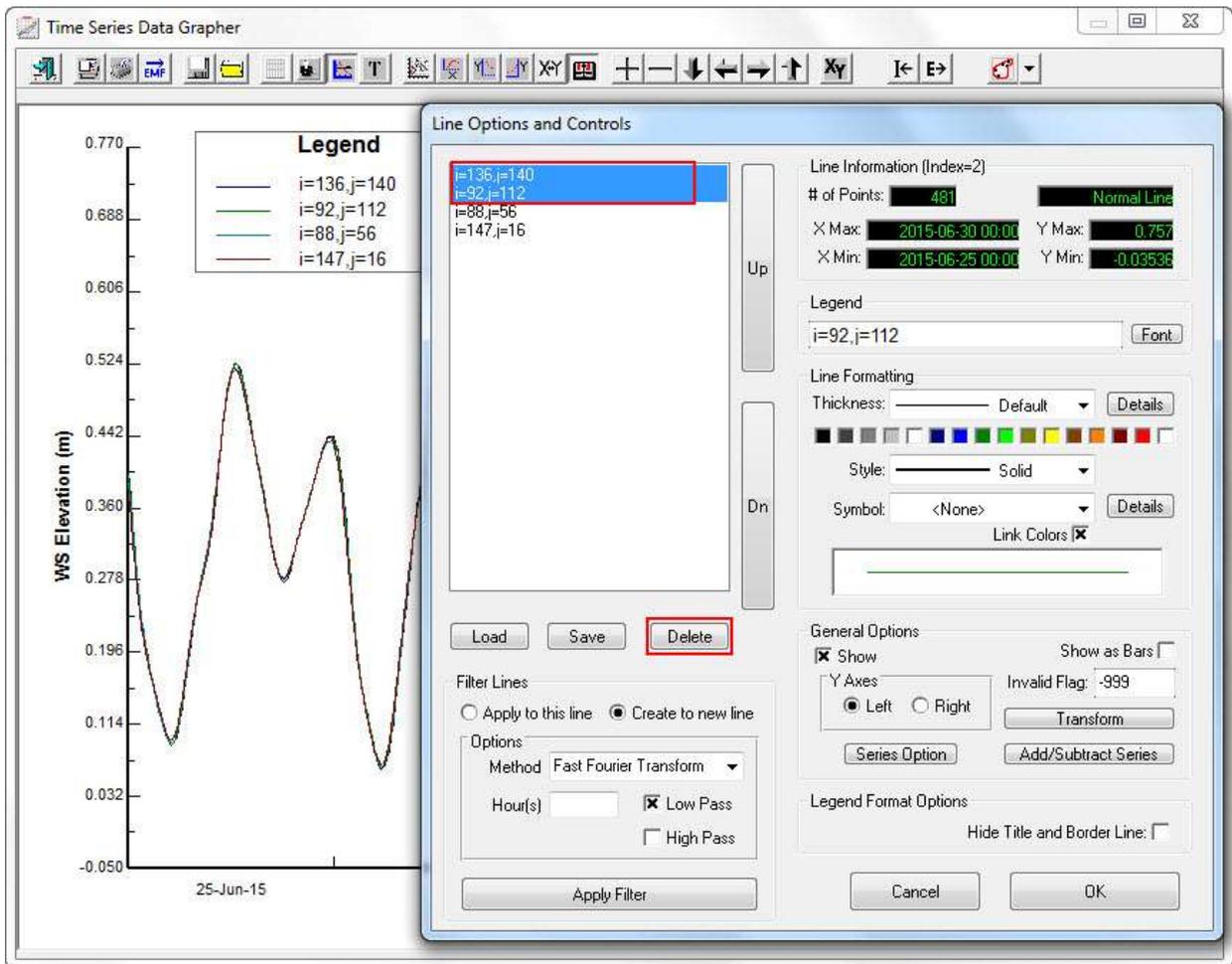


Figure 9-5 Time Series Grapher: Deleting lines.

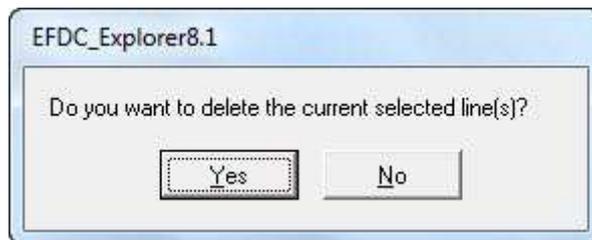


Figure 9-6 Confirmation to delete selected lines

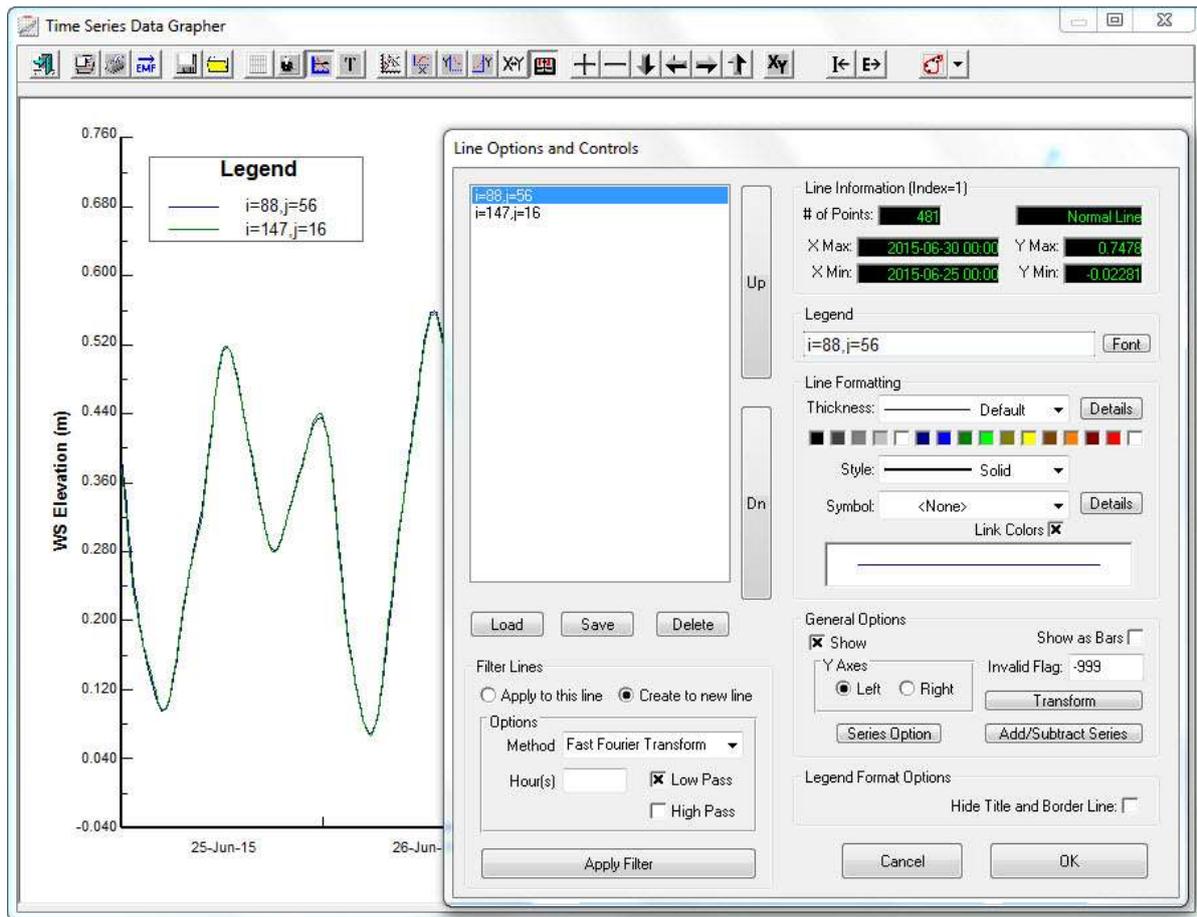


Figure 9-7 Time Series Grapher: Deleted lines.

9.2.1. Axis Labeling Options

The standard value Y-axis formatting form is accessed by RMC on the axis and is shown in Figure 9-8 and Figure 9-7. The use of these forms is intuitive. Axis labels may be entered in the *Main Label* box, however the formatting for the label is set in the *Formatting* tab. The user may specify the color and thickness of the Y axis line by pressing the *Line Properties* box in the *Axis Display Characteristics* frame.

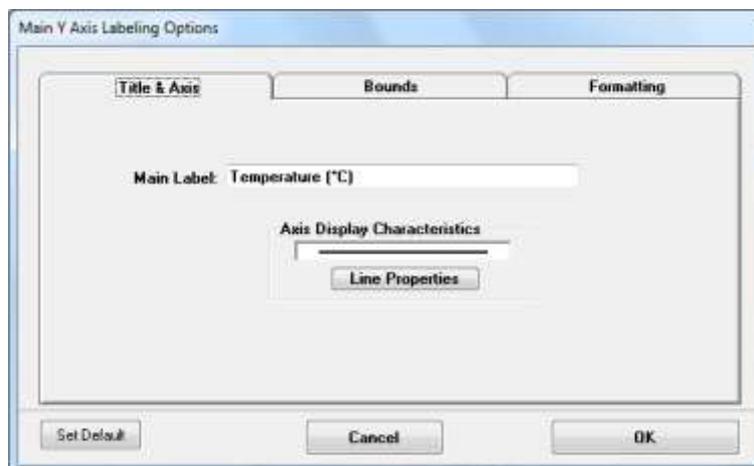


Figure 9-8 TSP Utility – Titles and Axis tab.

Scaling options include use of logarithmic axis, automatic scaling, or user specified max and min for both major and minor tick marks, as shown in Figure 9-7. Other options include reversing the order of the series (applicable only for the X axis) and showing logarithmic ticks.



Figure 9-7 TSG Utility – Axis bounds options tab.

Formatting options available are shown in Figure 9-8. Here the user may set font types, colors, alignment and size for both the title and the labels. Grid line styles and colors for major and minor grid lines may also be set. The number of significant figures may be set in the *Label Precision* frame.

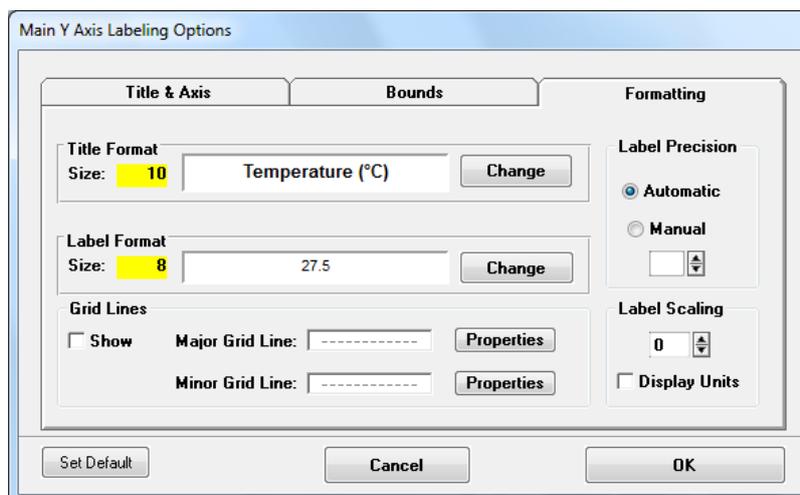


Figure 9-8 TSG Utility – Axis Formatting options tab.

The axis labeling method for the X axis is the same as that for the Y axis when using Julian dates. However, when a Gregorian date format is used on the X axis an alternative date axis form is provided as shown in Figure 9-9. Most of the options in this form are intuitive. However, one shortcut to selecting a calendar year is to enter the year number (e.g. 2003) in either the min or max field and then hit enter or tab and the dates will be set, along with appropriate tick marks.

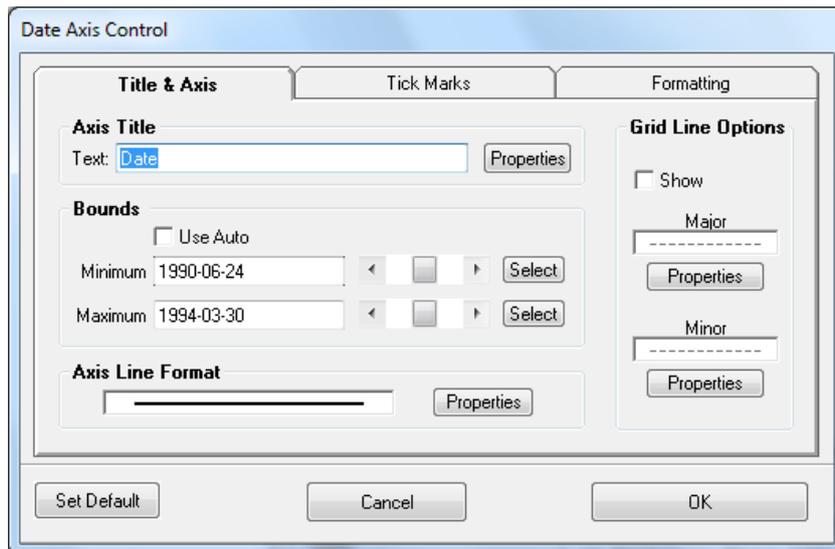


Figure 9-9 TSG Utility date axis options form.

9.2.1.1 Subscript and Superscript in Graph Legends

The *Time Series Grapher* and *EFDC Profile* tools have been updated to display user defined subscripts and superscripts in the legends. This is done using two underscore key strokes (“_”) and a single caret (“^”) for subscripts and superscripts respectively. An example of implementing subscripts and superscripts is shown in Figure 9-10. If several characters are part of a group they should be placed in curly brackets (“{ }”). For example to display: $x^2 + \log_2 x + \log_{10} x$, the user should write `x^2 + log__2x + log__ {10}x` as the label as shown in Figure 9-10.

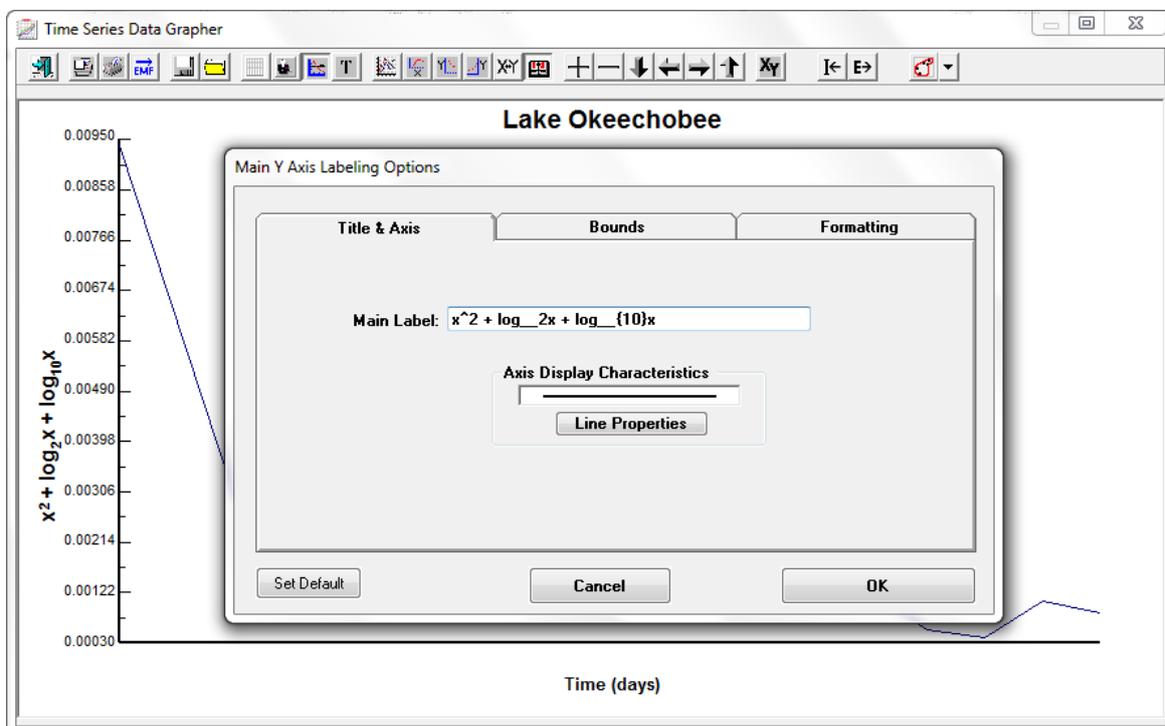


Figure 9-10 Time Series Grapher: adding subscripts and superscripts.

9.2.2. Zoom Pan Inset

A new option available within the TSP Utility (and also available in *Model Timing Options* of the *Longitudinal Profiler* tool) is that of displaying a *Zoom Inset Frame* so the user can zoom in to areas of interest in the time series and show the context of the zoomed area. This option is shown in Figure 9-11 below. The user may zoom in and then move about the plot with the zoom window in the inset frame (note that if the zoom or pan buttons are used the user must manually refresh the inset box by moving the zoom window).

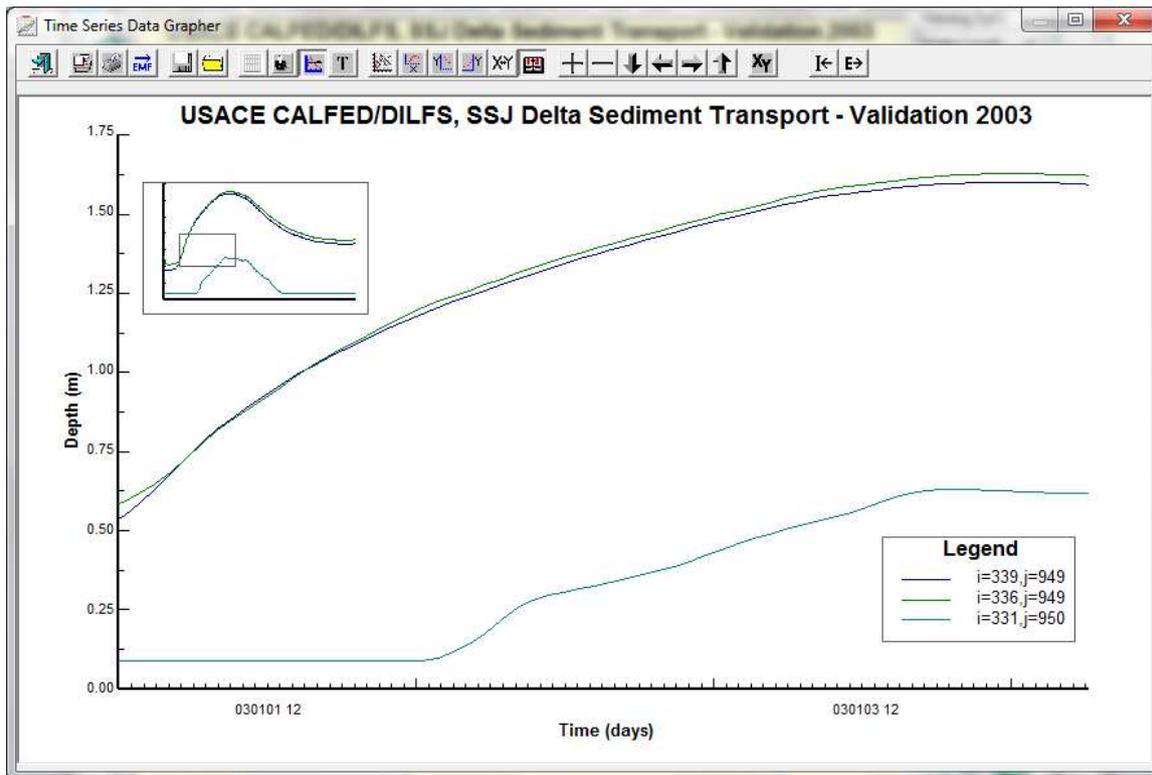


Figure 9-11 TSP Utility: Zoom Inset

The *Zoom Inset Options* are as shown in Figure 9-12. The user must switch on or off this setting from the *Control Line Plotting Options* which is accessed by RMC the legend and selecting "Series Options" then the *Zoom Inset Frame Options* and checking the *Show Zoom Inset Frame* box.

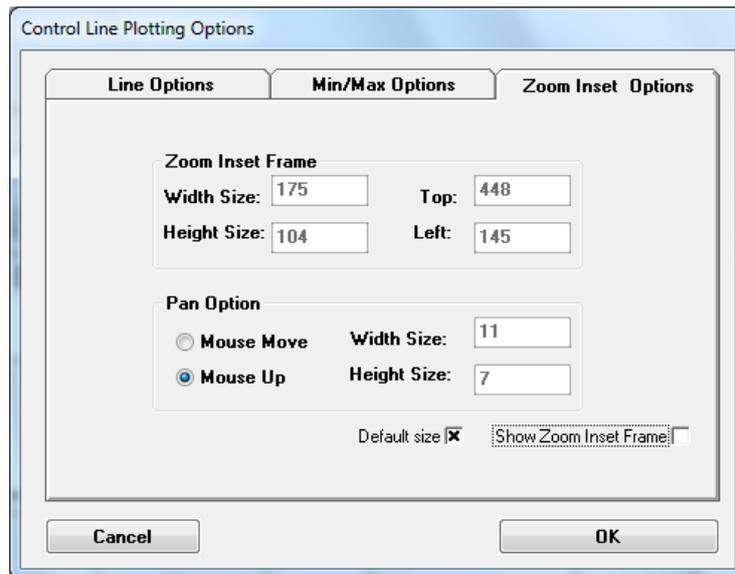


Figure 9-12 TSP Utility: Zoom Inset Options

9.3 Annotated Time Series

A new function in the *Time Series Plotter* is the ability to add a sub-frame with a geo-referenced map and annotations to illustrate the locations of time series stations. This is accessed with the “Show Plan Annotations” button in Figure 9-13. Options from this button include setting the *Plan Annotation Options* which has the same function as the *Annotation* tab in the *2D Display Options* in *ViewPlan*. Here the user may select posting or label files, as well as overlay files to be loaded and displayed in the sub-frame as shown in Figure 9-13 . Other options in the dropdown button include zoom to extents, load or hide a geo-referenced background, and hide or display the Annotation viewer. The *Save picture* option allows the user to save the sub-frame as a .jpg file.

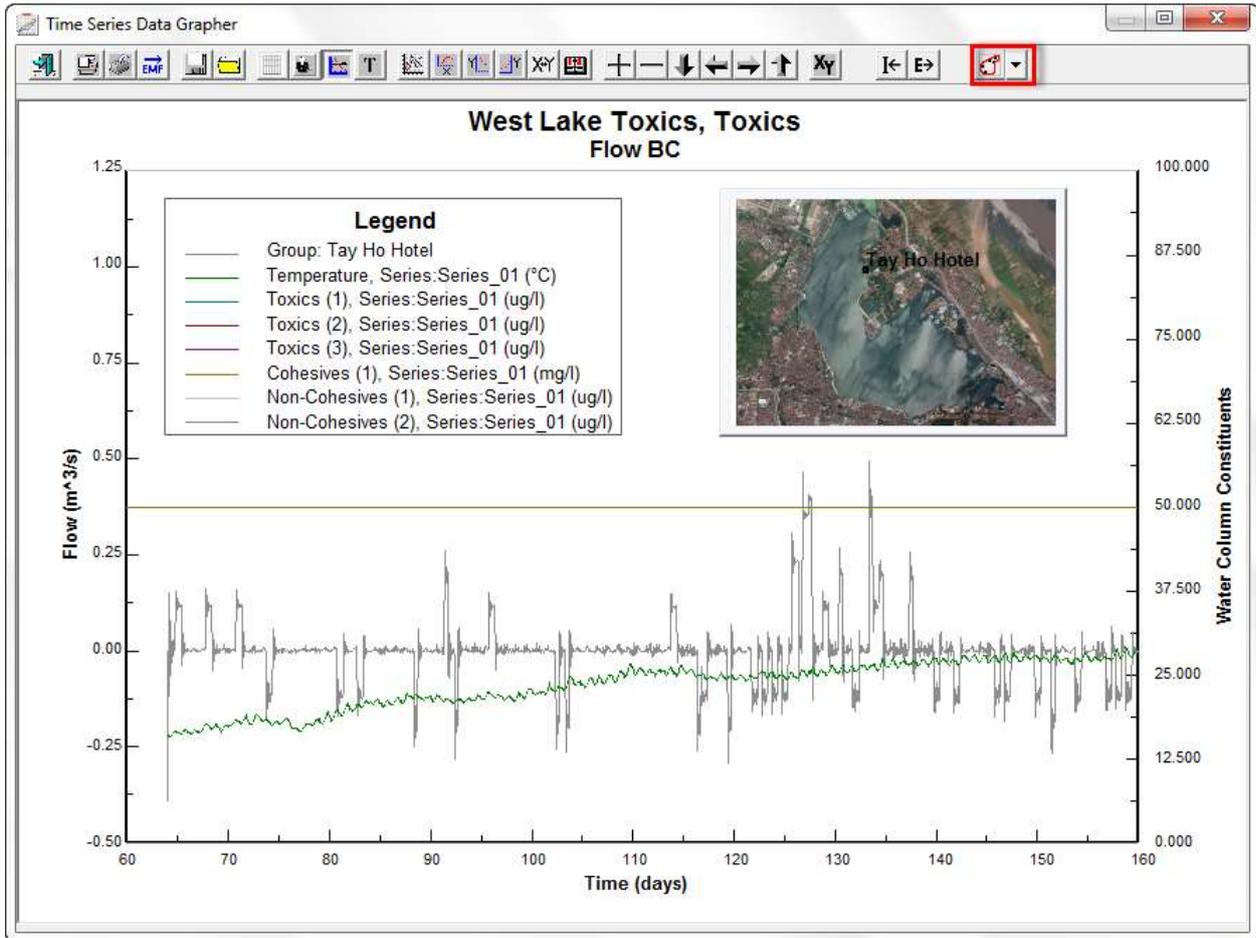
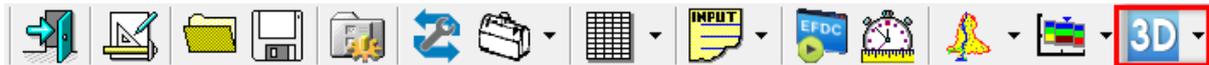


Figure 9-13 TSP: Show Plan Annotations Feature.

10 View3D



Release of EE7.1 provided the capability to view the model domain in three dimensions with the tool *View3D* as shown in Figure 10-1.

Much like the *ViewPlan* mode, the user may select which view option is desired in the *View Options* drop down. Each option provides a different interface in the right hand column. When viewing water surface the user may toggle water surface and bottom elevation, as well as adjusting the degree of opacity of each for better visualization. The options currently available include: water surface, water column, velocities, bed shear, sediment bed, bed heat, oil spill.

The *Grid* frame is available in all options and provides the user with the ability to switch between views of the grid at the water surface, flat grid, grid at bottom, 3D grid and no grid. The opacity of the grid may also be adjusted by the viewer to suit the visualization effect required. A frame box may also be toggled on and off to help the viewer interpret the viewing angle.

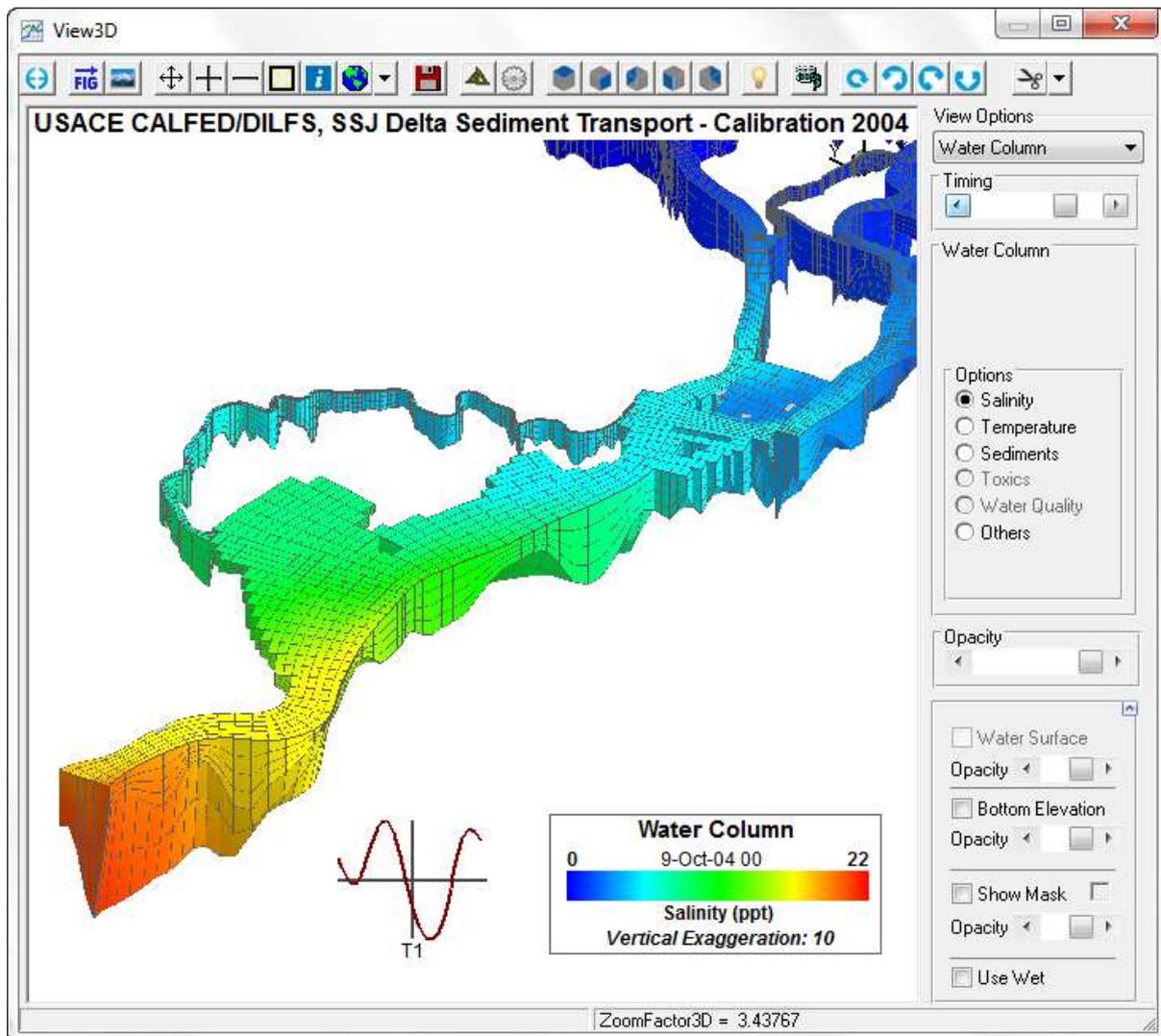


Figure 10-1 View 3D: Viewing Options

A number of further options are available in the toolbar at the top of the form. Those that differ from *ViewPlan* are described in Table 10-1 below.

Table 10-1 Summary of View3D toolbar.

General Functions	
	Exit to main screen.
	Save image to file
	Copy image
	Display options for color ramp, vectors, grid lines, overlays, etc.
	Export the current view to a Windows enhanced metafile (EMF).
	Configuration of 3D rotation and camera
	Animation tool. Output animations to the screen and/or AVI files.
	View XY plane from above
	View from East to West
	View from West to East
	View from North to South
	View from South to North
	Adjust light settings and toggle light on and off
	Animate Z axis rotation
	Animate index I blanking
	Animate index J blanking
	Animate index K blanking

Right clicking the legend also provides the user with a number of configuration options in the *3D View* tab of the *Plan View Display Options* form as shown in Figure 10-2. When using 3D the user has the ability to display two color ramps simultaneously, a primary and secondary color ramp. Within each of these options the user may define the color ramp cut offs or whether to auto-color based on the parameter min and max. The user may also simply display a gray color ramp or used a fixed color. The gradient fill option blends the color from one cell to another providing a more realistic appearance.

The *View Options* frame is used to set the elevation of the text and overlay in the 3D elevation viewing mode. The user should adjust this so that they overlay sits above the model outputs for the view required. The *Overlay 3D Elevation* sets the default elevation to set overlays when they do not have elevations associated with them. A “Z offset for WC bottom” sets the vertical offset when displaying the water column and bottom surface.

Due to horizontal scales typically orders of magnitude larger than the vertical scales, the user may adjust the scale factor with the *Vertical Scale Magnification* option.

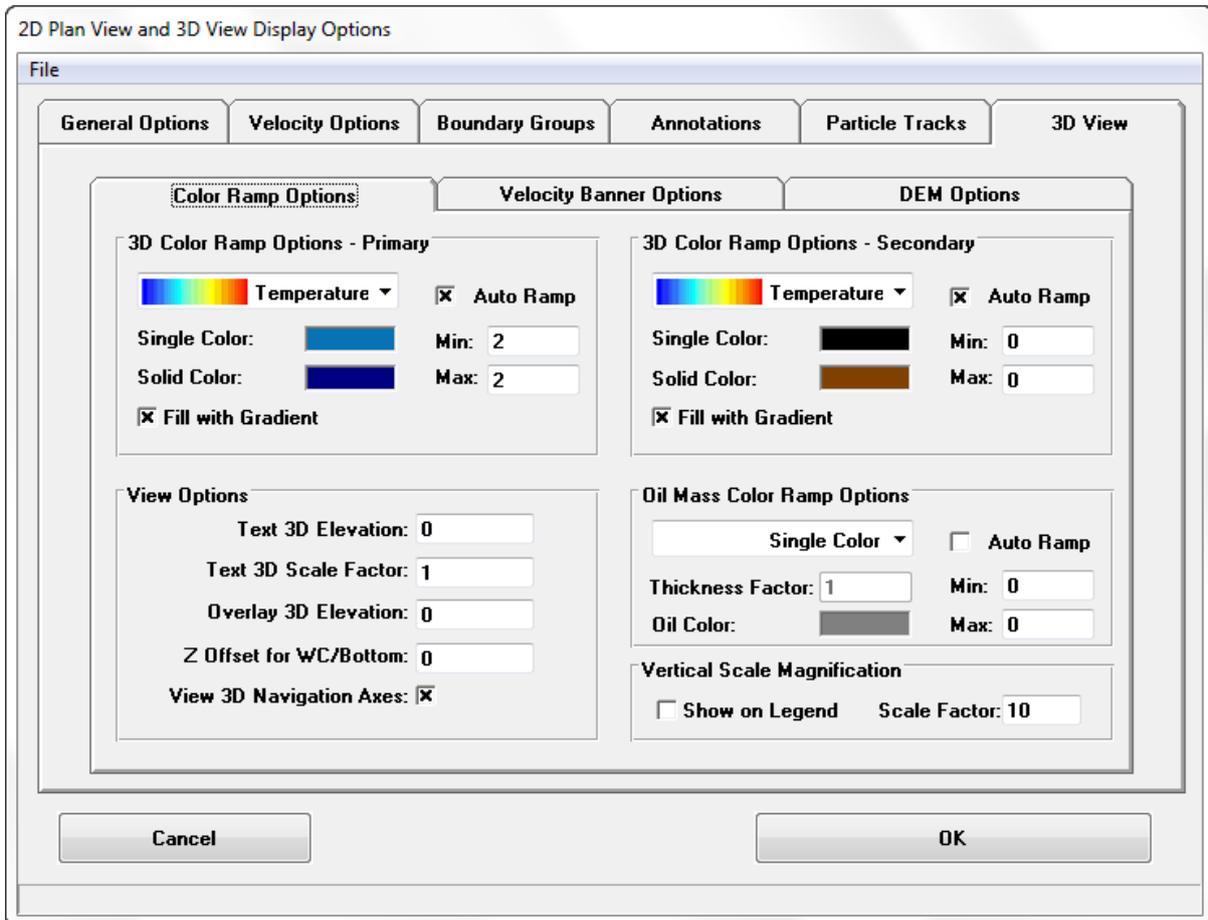


Figure 10-2 View 3D: Display Options

The *Oil Mass Color Ramp Options* also provides the color ramp, single color and auto ramp functions. A *Thickness Factor* may be applied to increase the vertical exaggeration of the oil spill for visualization purposes.

10.1.1. Velocity Banners

The *Velocity Banner* feature is accessed from the *Viewing Options* in *View3D*. Effectively this displays the 3-D velocities in a profile for each cell, something like a “wind sock”, which may be colored by depth or magnitude. A pole runs between the bottom and water surface from which the velocity profiles face in different directions as shown in Figure 10-3.

The user may fix the color of the banner using the *Display Options | 3D View tab | 3D Color Ramp Options*.

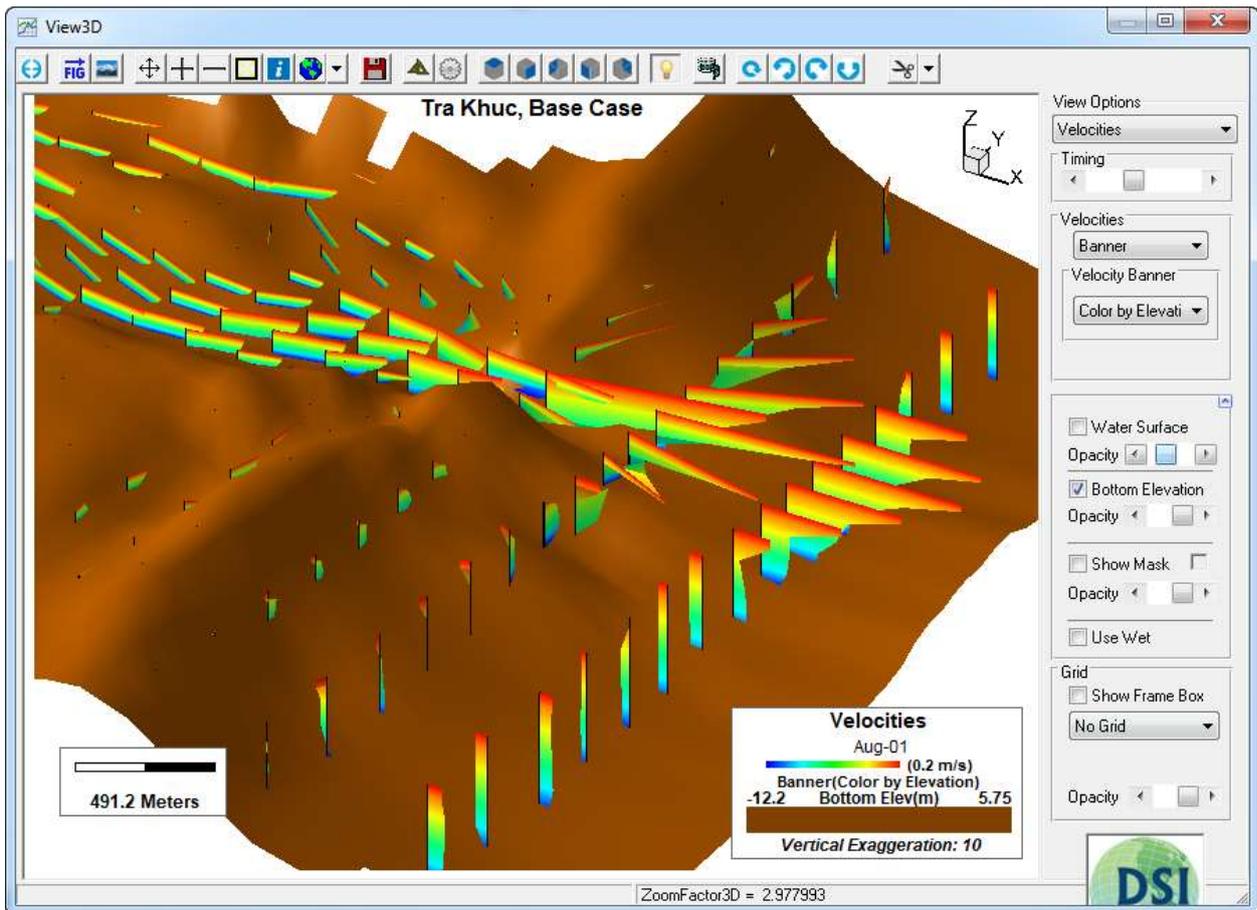


Figure 10-3 View3D: Velocity Profiles.

The user should navigate to *Display Options | 3D View | Velocity Banner Options* tab to set where the profiles begin and set the frequency that they are displayed on the grid. The user may also set the color of the pole and pole thickness as shown in Figure 10-4.

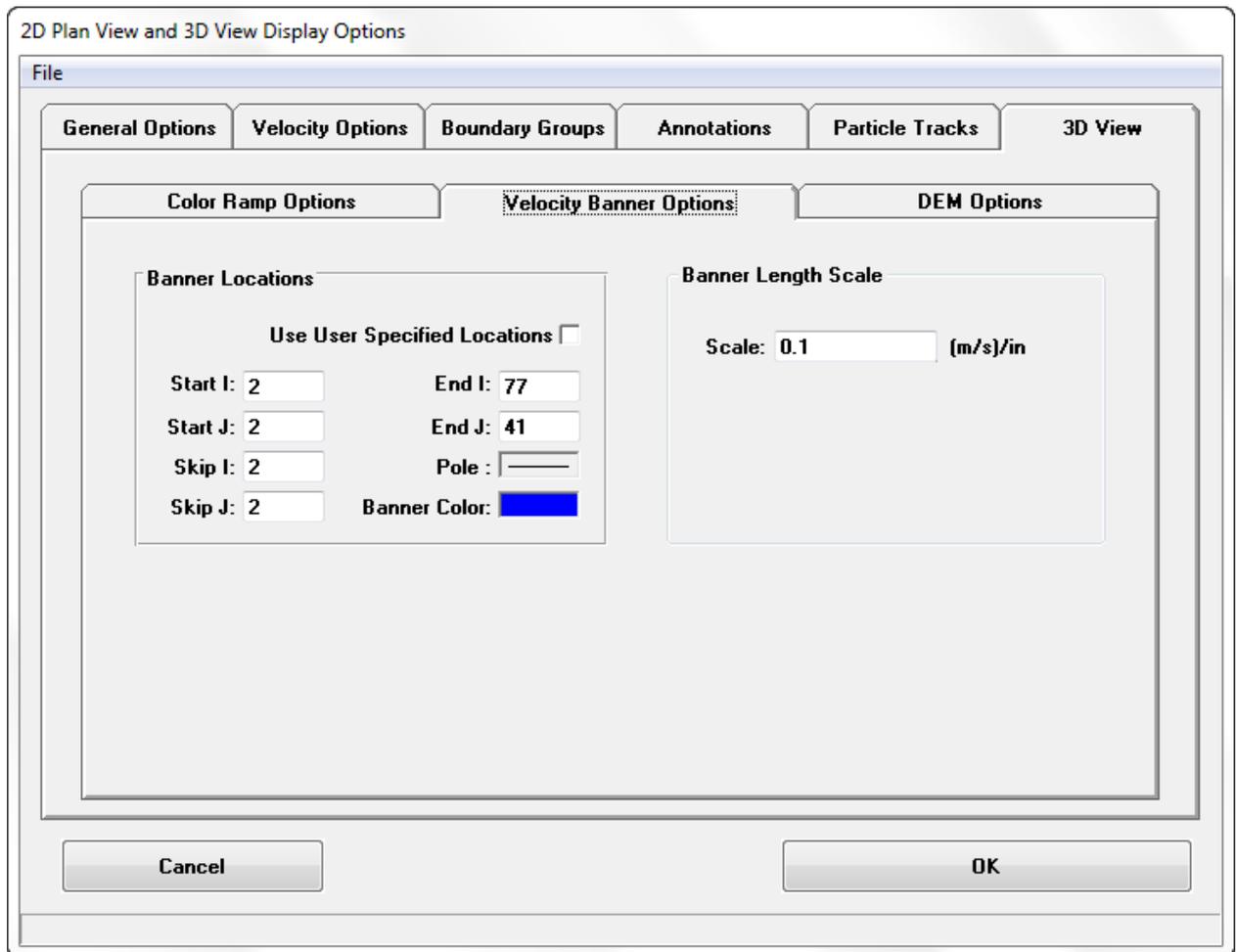


Figure 10-4 View3D: Velocity Profiles display options.

As in the *ViewPlan* for 2D plan view, the *Velocity Profile* setting allows the user to define where to start and end the profiles as well as set the skip function to skip a certain number of cells. The user may also use the *Velocity Labeling Locations File* which will set the points for display. Velocities will only display at the locations set in the file.

10.1.2. Flight Path Animation

The flight path animation tool allows the user to define and edit a flat path and then create an automated animated sequence through the model domain in *View3D*. To create a flight path select *Show/Hide Flight Path Tools* from the dropdown menu as shown in Figure 10-5. Using the controls now displayed the user may define, save, load and edit a flight path.

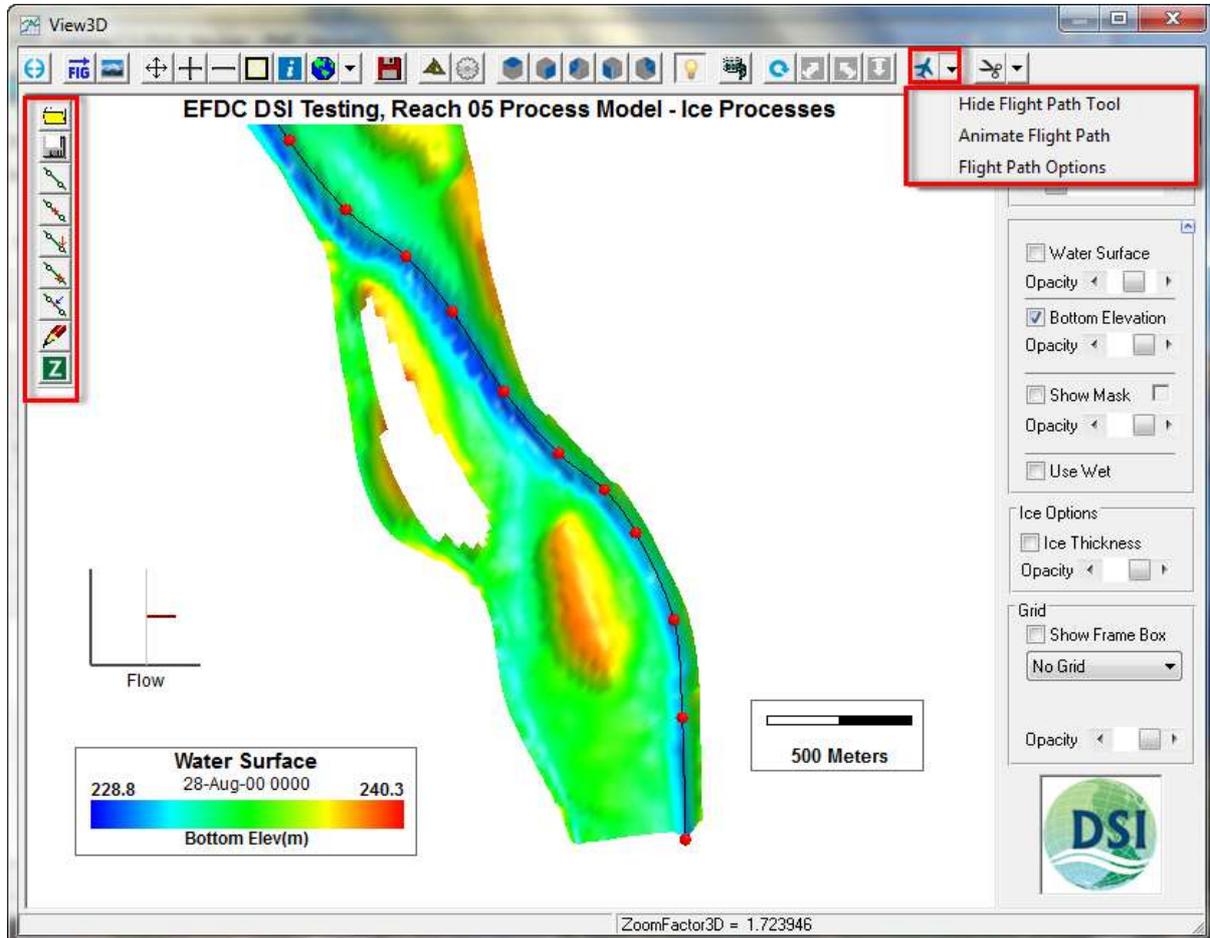


Figure 10-5 View3D: Flight Path Animation.

Controls for the flight path are used to draw a spline that can be either a straight line or a curved line and must contain at least two points. In the main toolbar there are a number of icons that may be used to define the flight path that are explained in Table 10-2.

Table 10-2 Flight Path Polyline Tool Buttons.

	Open an existing flight path polyline.
	Save a flight path polyline. It is necessary to select this icon for the polyline to be saved.
	Define a new flight path. LMC in the workspace creates a point. Moving the mouse and LMC in another location creates another point with a line joining the two points. RMC to end drawing the polyline.
	Delete previously created line. When this icon is selected, clicking on a line will delete it.
	Insert points on an already created line. Once a point is inserted it can be moved to reshape the line.
	Move points on a polyline.
	Delete points on a polyline.
	Edit a point. Edit the x, y, z location of a point as well as the roll.
	Assign a constant elevation to the flight path. Sets all the vertical elevations of the flight path at one time as opposed to editing it point by point.

The process for creating a flight path are as follows:

1. Select the flight path tool drop down *Show Flight Path Tool*
2. EE will reset to plan view to draw the flight path in the horizontal plan view
3. LMC on the first point of the path and LMC for each subsequent point on the path
4. RMC to end the line
5. Move or delete points as required using the *Move* and *Delete* buttons. Note that it is not possible to pan in this mode except by using the arrow keys
6. Select the *Z* button to set the vertical position of the flight path
7. Use the *Edit Point* button to further adjust the vertical position or roll of any point
8. Rotate the model to ensure the flight path is vertically and horizontally correct
9. Save the flight path

A number of options are available to user to define the flight path. These options are available from the *Animate Flight Path* from the dropdown on the toolbar and shown in Figure 10-6. The user can first decide whether or not to display the flight path polygon using the *Show* check box. It is also possible to adjust the animation steps to provide a smoother visualization. Camera height and angle may also be set. *FovY* is field-of-view in the y dimension i.e. vertical angle, which may be set to maximize the image size on the screen.

The user may select various options for the path color when editing the lines as well as colors displayed when a line is selected or dragged.

The user can select the spline type to be used for the flight path. The default is the *Catmull-Rom spline* in which the original set of points make up the control points for the spline curve. “B spline” may also be selected, in which the curve does not remain on the original control points. The user may also select the spline checkbox to switch on or off the use of splines.

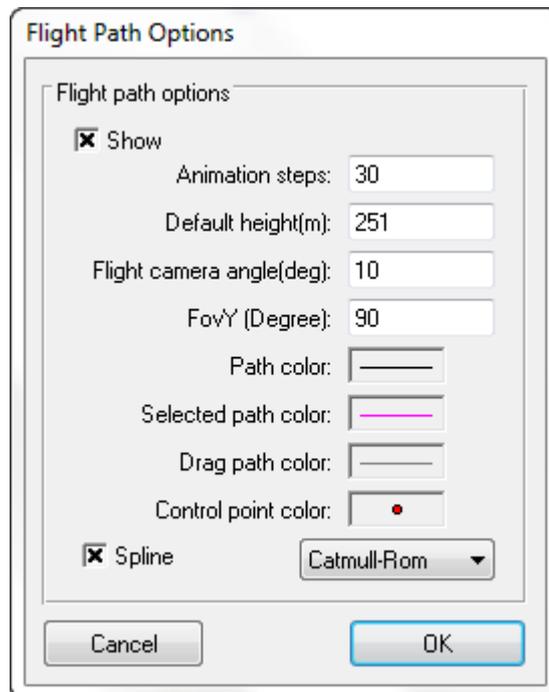


Figure 10-6 View3D: Flight Path Options

To animate a flight path load the existing flight path from the *Show Flight Path* tool. Then select the *Animate Flight Path* from the dropdown on the toolbar. It is possible to animate to an AVI or just animate to screen. For either option the parameters show in Figure 10-7 should be set.

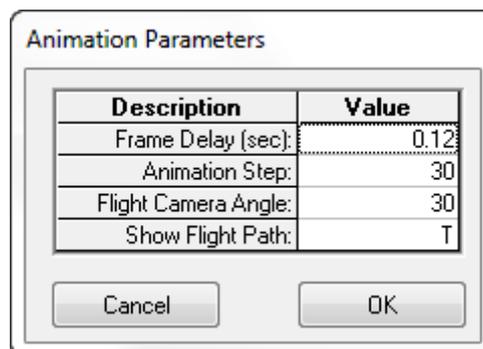


Figure 10-7 View3D: Flight Path Animation Parameters.

Selecting OK will animate the flight path as shown in Figure 10-8

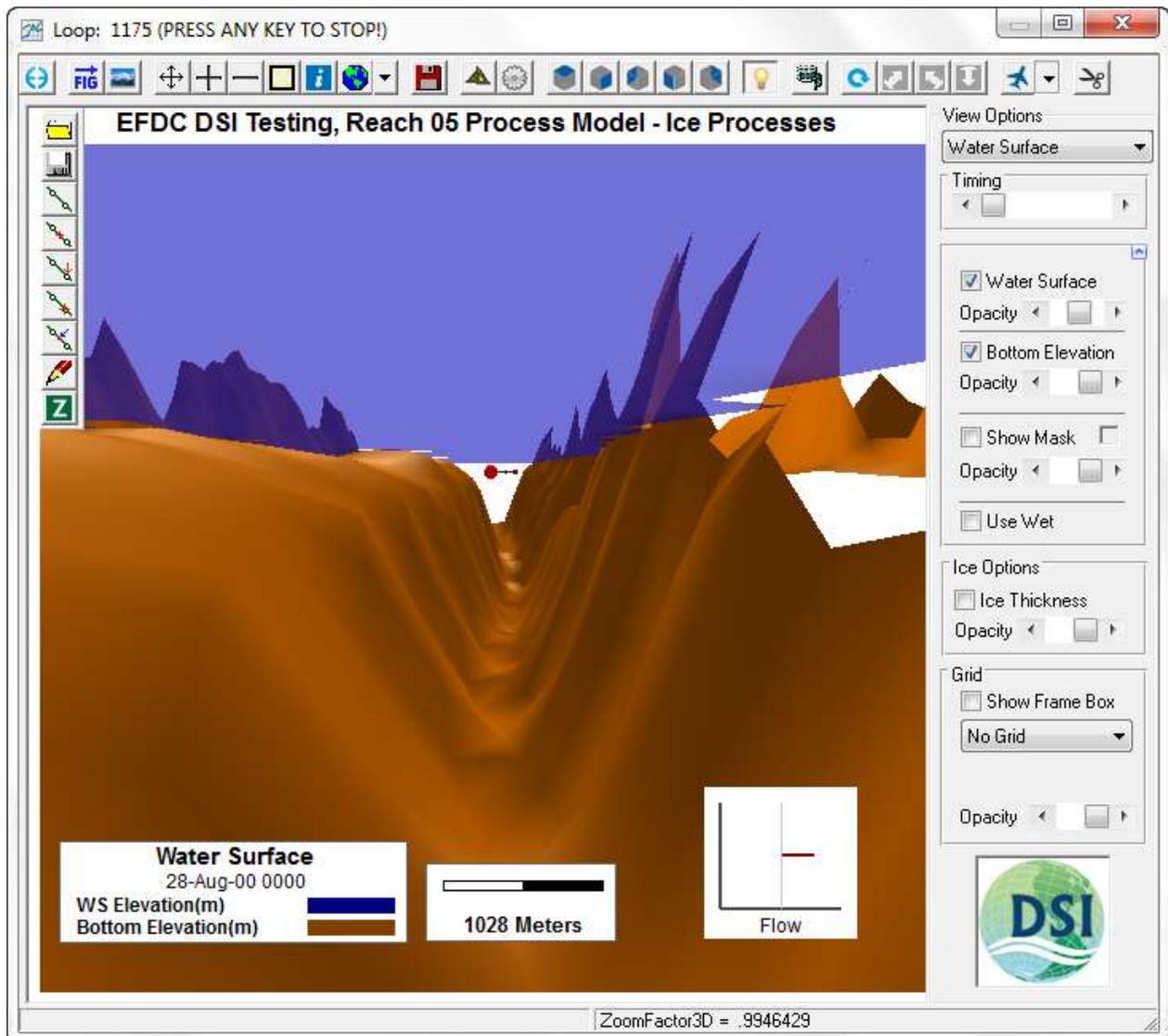


Figure 10-8 View3D: Flight Path Animation.

10.1.3. 3D Blanking and Clipping

The user may view certain cells along the I, J index by using the blanking option in *View3D*. This is accessed by the *Show Blanking* check box on *Water Column* frame. This allows the user to blank between certain I and J indices to see inside the model domain as shown in Figure 10-9. In this case the model is only being viewed between 2 and 73 on the I index, and between 2 and 23 on the J index.

Clipping may also be applied in much the same way with the *By C* option. This value is the same as that set for the color ramp which will only display the parameter selected between certain values. However, if the user selected the *Clipped by Value* checkbox then those cells will be blanked or clipped from the display. This function now clips the cell corners whereas previously it clipped the whole cell based on the cell centroid value.

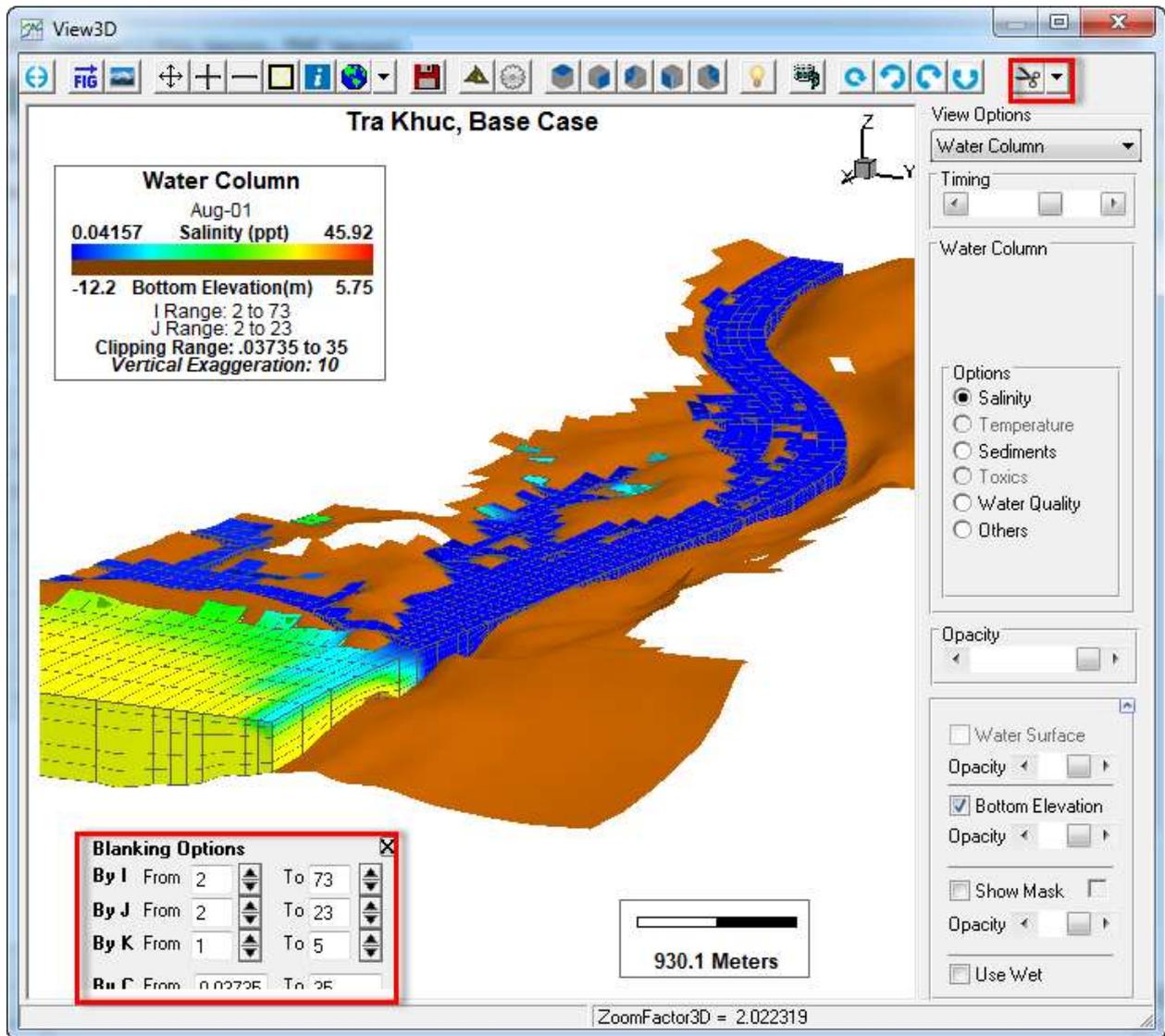


Figure 10-9 View3D: Blanking and Clipping.

10.1.4. Background Images in 3D

Several options are available to provide backgrounds for models in EE. If the user has a 3D surface of the area surrounding the model domain, this may be loaded to provide a land surface background. Alternatively, the user may simply use an automatically generated flat terrain as described below.

10.1.4.1 *Loading Digital Elevation Models*

RMC the *Legend* or select the *Display Options* button to show the *Display Options* and select *3D View | DEM Options* as shown in Figure 10-10. If the user has a polyline P2D file or any comma or tab delimited X, Y, Z file then they should first create an overlay file from this with the *Interpolate DEM from Polyline* button. This interpolation process can be quite slow, but once the DEM is generated it loads quickly. The native DEM file is *.TB2 format and should be loaded with *Browse* button. The user must also select *View* from the DEM Option frame. Clicking OK will then display the background file.

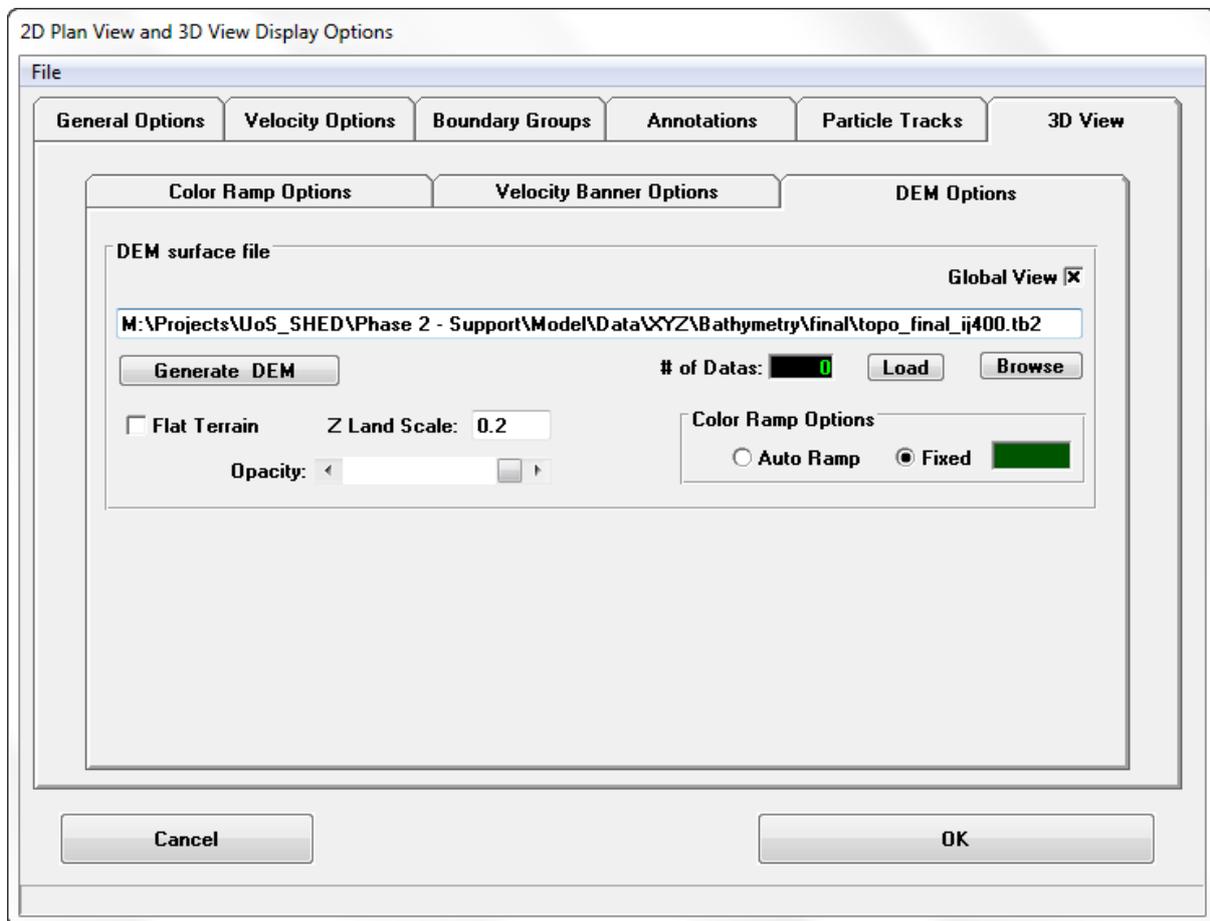


Figure 10-10 View3D: DEM Options.

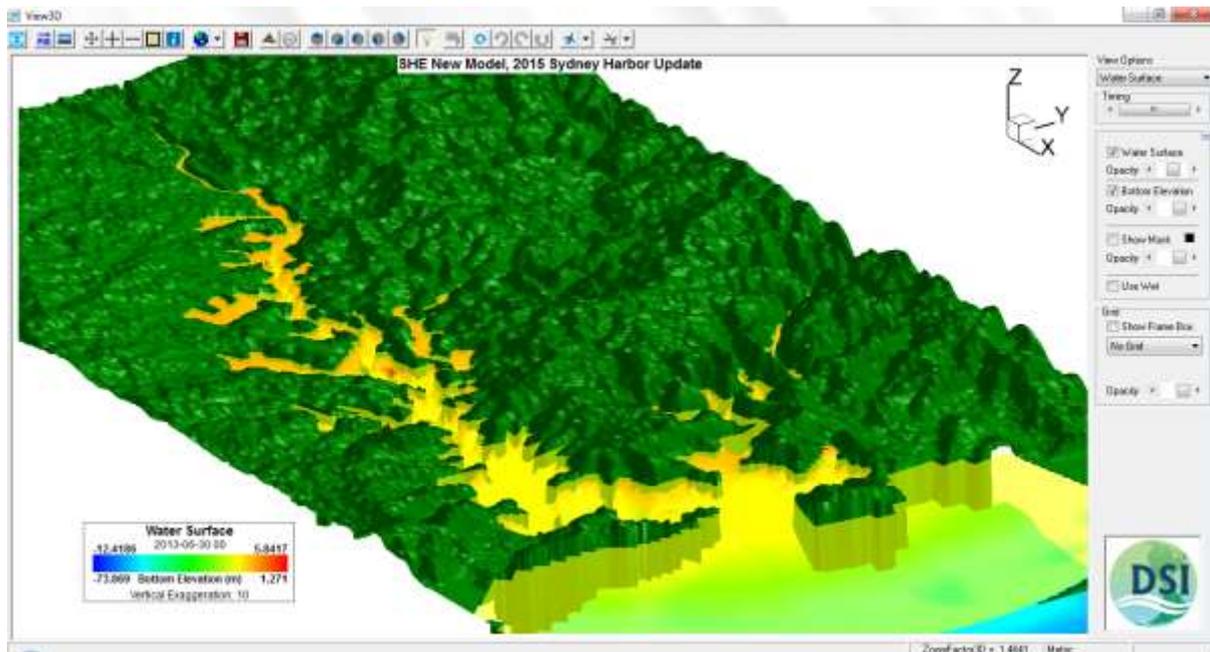


Figure 10-11 View3D: DEM display.

10.1.4.2 Flat Terrains

If the user does not have a XYZ file they can use the flat terrain option and change the fixed color.

Viewing options are managed in the *DEM Options* frame shown in Figure 10-10. Select the *View* checkbox to display the DEM. When OK pressed the user is prompted for the *Generate Flat Surface Options* as shown in Figure 10-12. Here the resolution and dimensions of the flat terrain may be set. These may need to be adjusted when working with a coastal domain that has an open boundary.

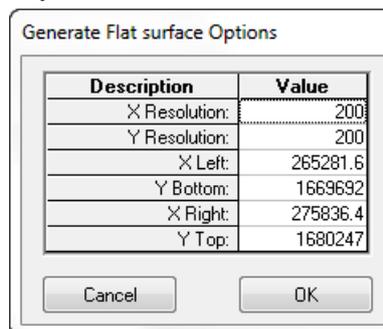


Figure 10-12 View3D: DEM Terrain – Generate Flat Surface Options.

The flat terrain generated is shown in Figure 10-13.

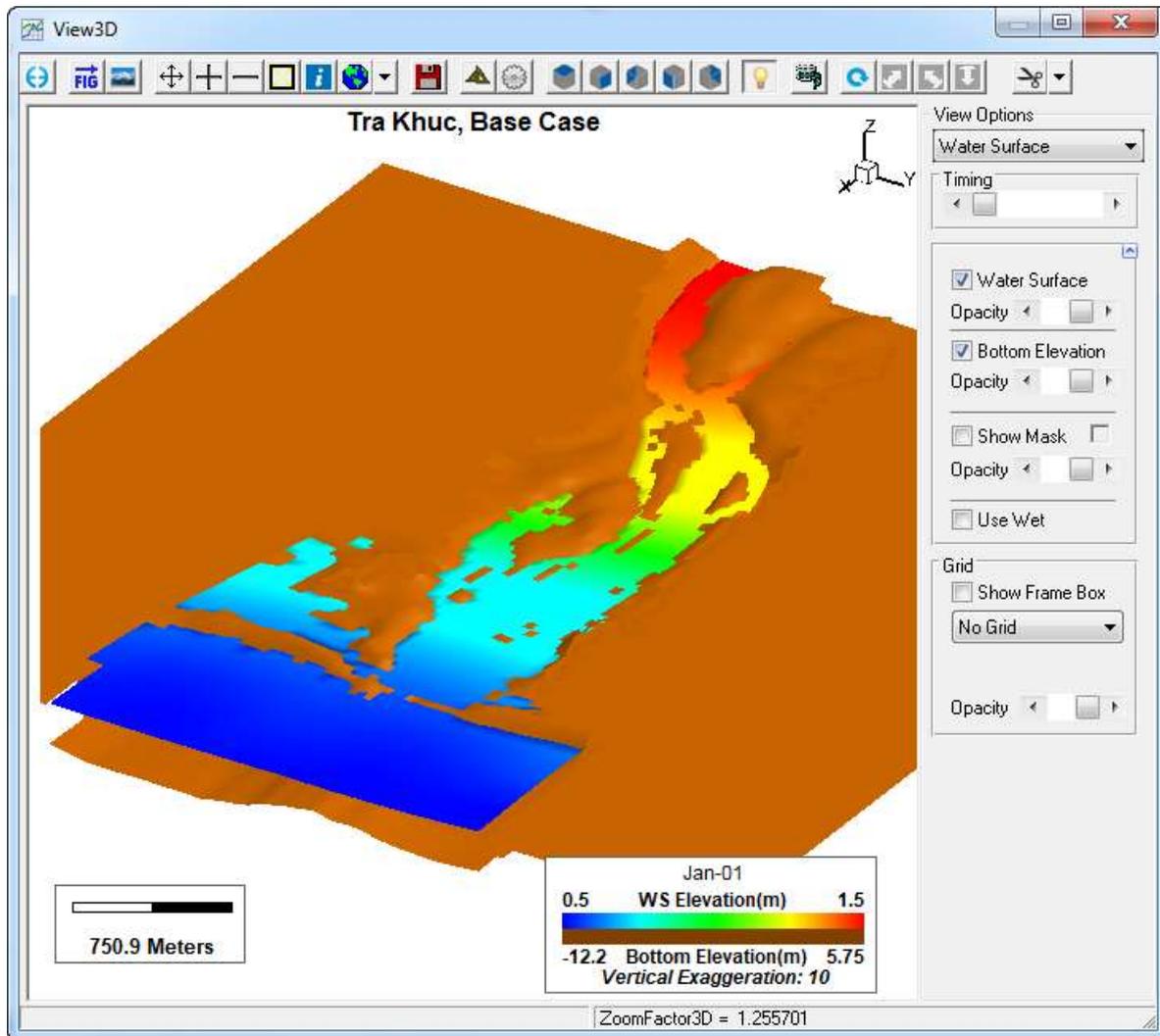


Figure 10-13 View3D: DEM Terrain.

Scale may be adjusted as well as the background color. In order to move the level of the flat terrain up or down to an appropriate level, the user may set the *Land Elevation*. In this case it is set to 1, which will move the land up by one meter.

10.1.5. Sediment Bed Viewing

The sediment bed in the 3D Viewer can be viewed in EE7.2 and later releases. This displays the sediment volume similar to the way the water column is viewed. The user may select from the same display options in terms of top layer, thickness, sediment mass, sediment fraction, porosity, d50 and delta (change in thickness) as in *ViewPlan* as shown in Figure 10-13.

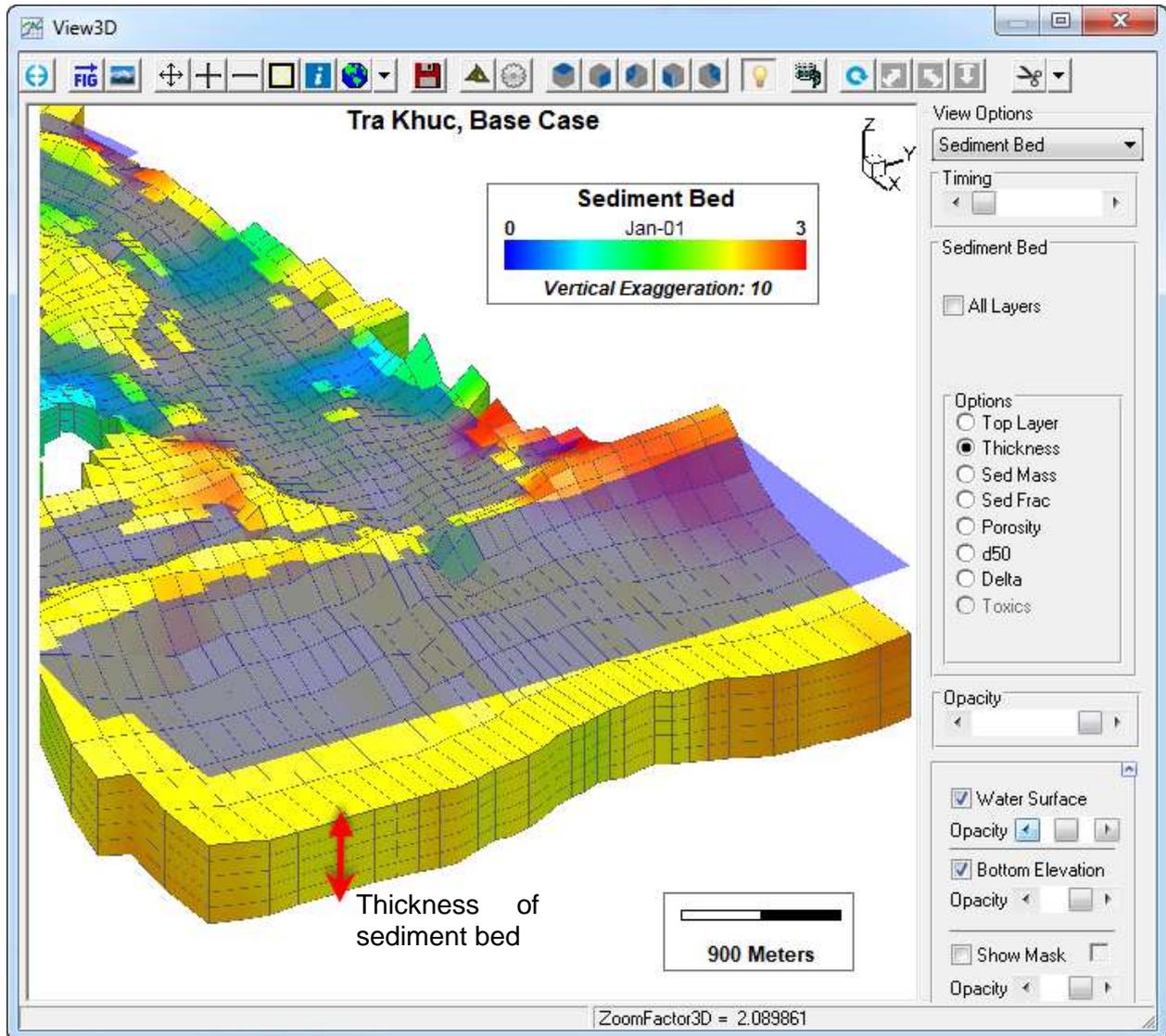


Figure 10-13 View3D: Sediment Bed View.

10.1.6. Mouse Inquire Information

Use mouse to click to see the cell information for each layer is now available much as it is in the *ViewPlan* mode. This function is accessed with the enquire button as shown in Figure 10-14.

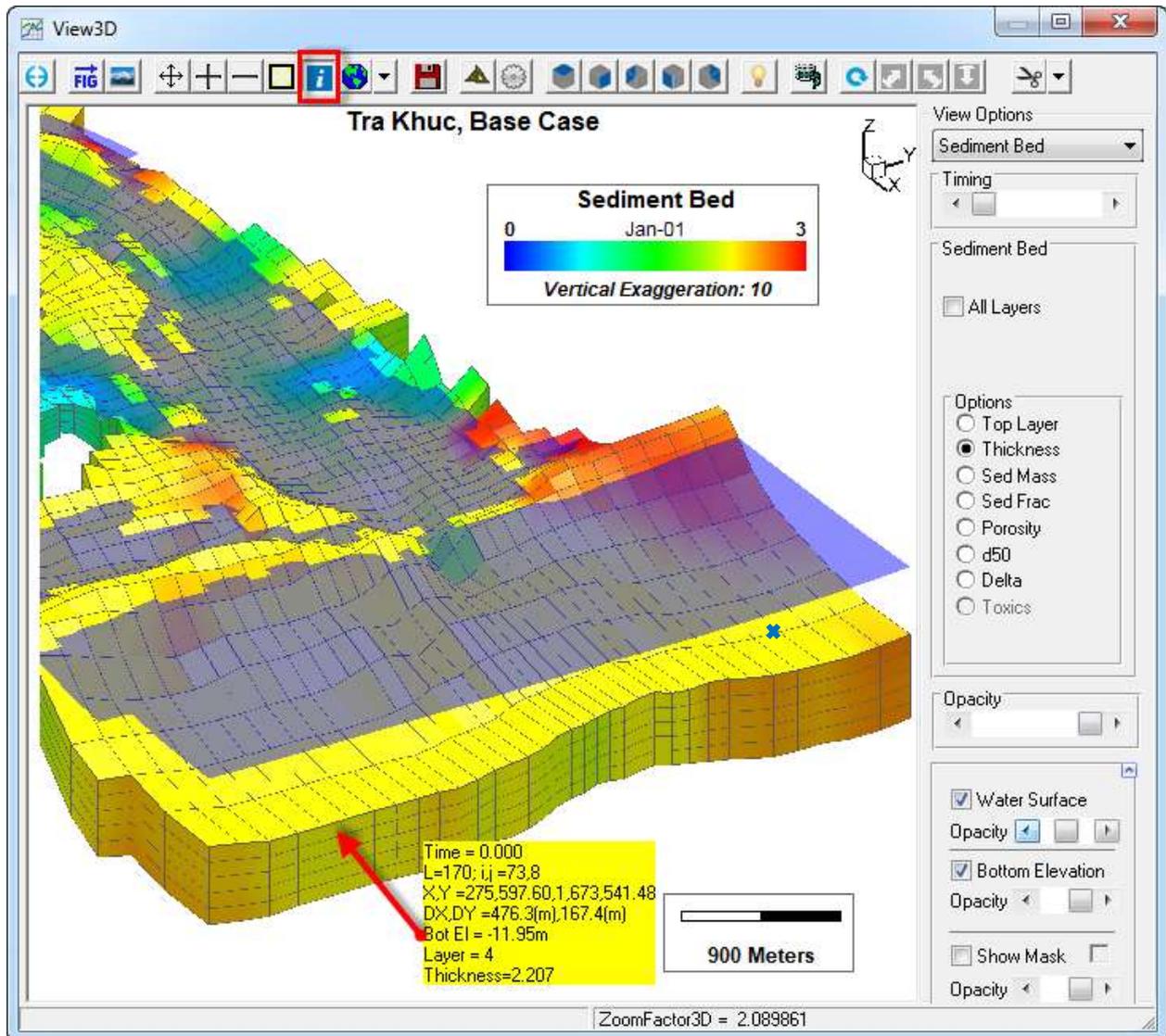


Figure 10-14 View3D: Mouse Enquire Button.

10.1.7. Particle Tracks and Oil Spill Viewing Options

Display options for particles in *View3D* are similar to those in *ViewPlan*, including display by elevation or group. In the particle tracking submodel of prior to EE7.3, particles that reach the model boundary stick to the edge of the boundary as shown in Figure 10-15. This is to show that the particles have left the model domain and are no longer being calculated. Another method now provides the user the option of allowing the particles to disappear if the *Hide After Exit* check box is selected as shown in Figure 10-16.

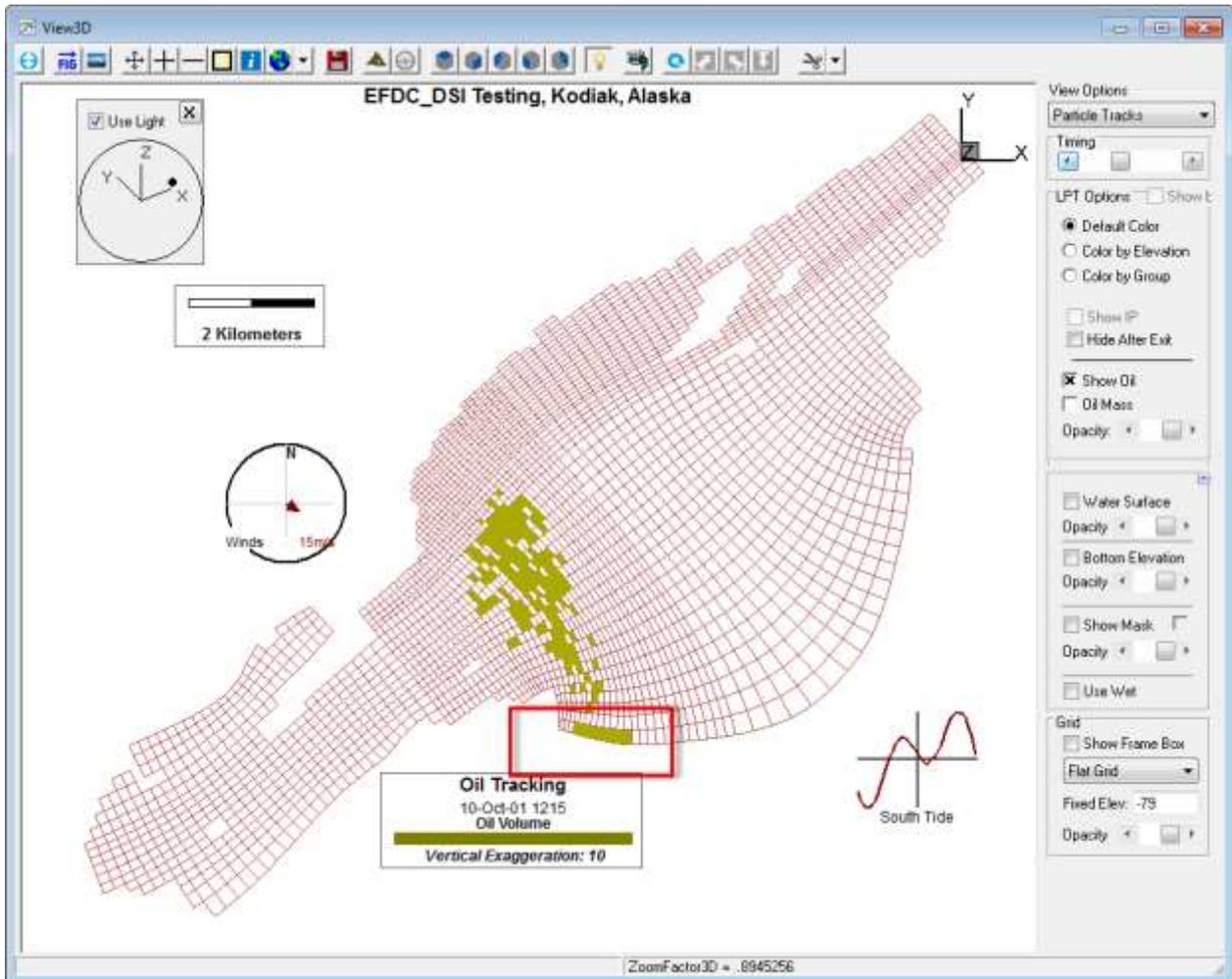


Figure 10-15 View3D: Oil spill still displayed after exiting model domain.

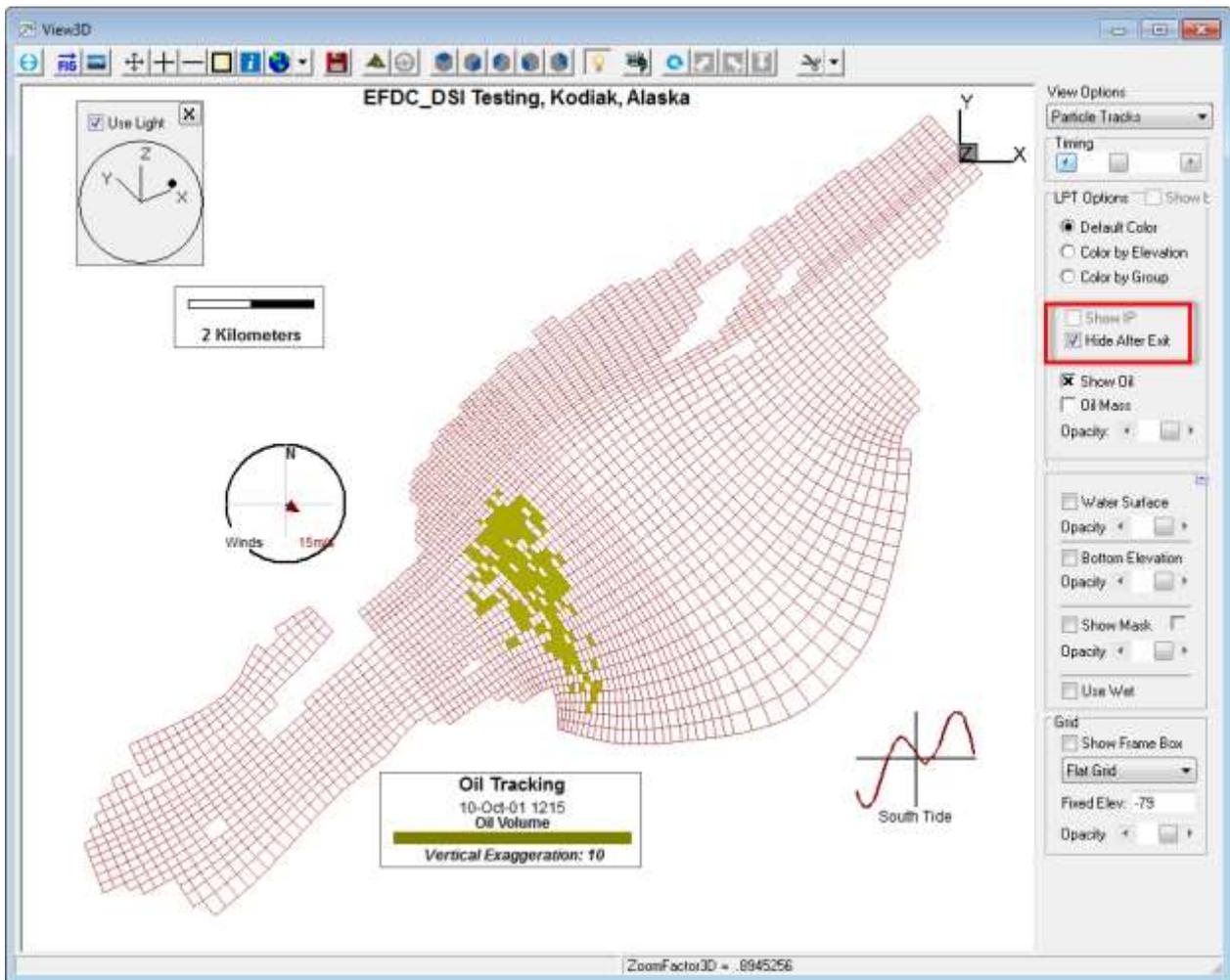


Figure 10-16 View3D: Oil spill hidden after exiting model domain.

If the the checkboxes *Show Oil* and *Oil Mass* are both selected then the mass of the oil is displayed using a color profile as shown in Figure 10-17.

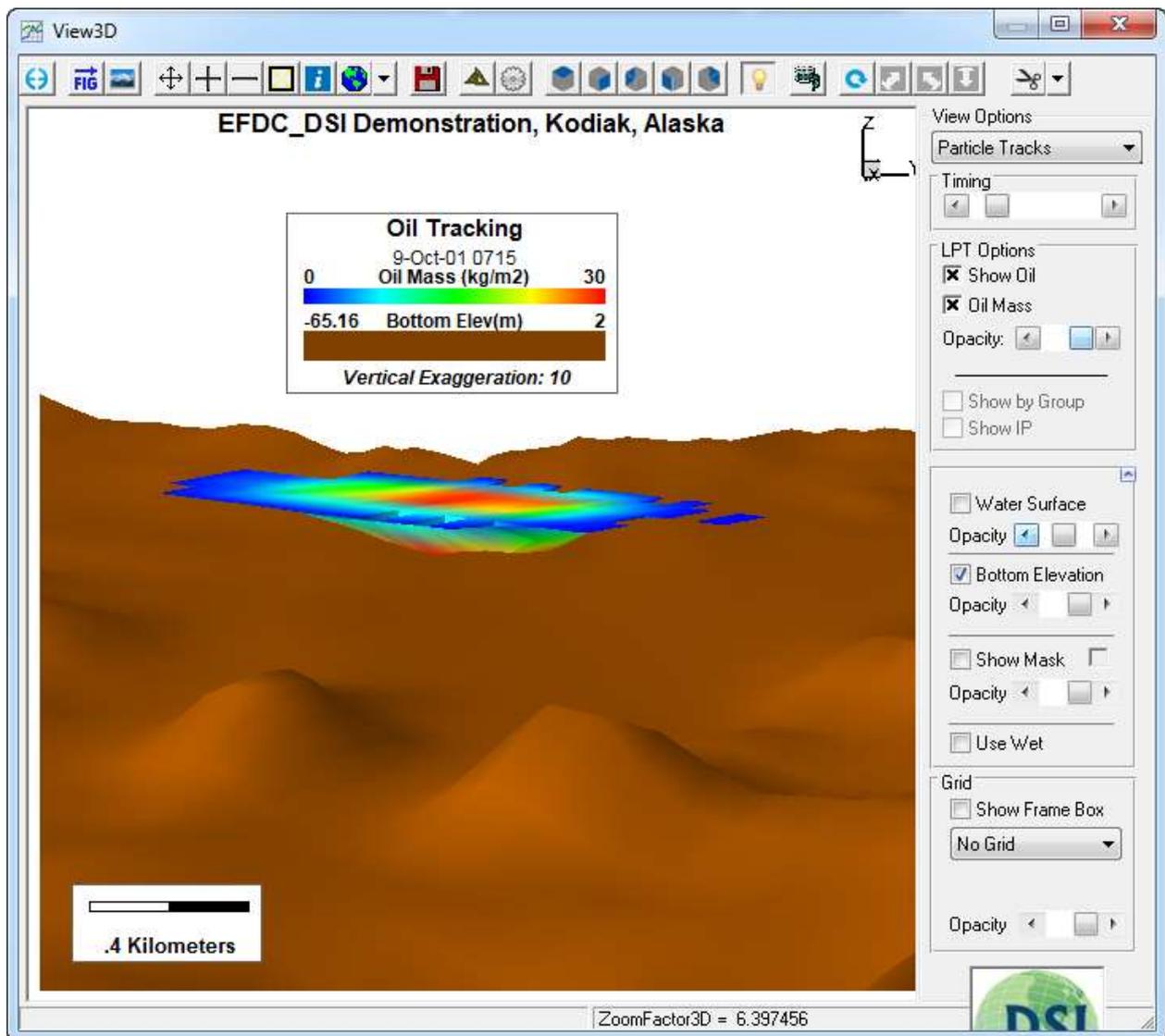


Figure 10-17 Oil Spill Tracking in View3D.

10.1.8. Import Structures in 3D

EE8 allows users to import pre-defined structures for visualization using *View3D* tool. This allows users to get a better feel for the model domain by displaying significant engineering structures in the model domain. Any COLLADA file can now be imported to 3D View as an overlay file. COLLADA stands for “COLLABorative Design Activity” and is an interchange file format for interactive 3D applications. It has a .DAE extension (digital asset exchange) and defines an open standard XML schema for exchanging digital assets among various graphics. COLLADA has been adopted by ISO as a publicly available specification, ISO/PAS 17506.

EE handles the COLLADA file as an overlay file which can be accessed in the *Display Options* menu shown in Figure 10-18. To add the 3D structure to *View3D* the user can either *Browse* to the file, or use more convenient “drag and drop” function to import *.DAE file directly to intended location in *ViewPlan* or *View3D*.

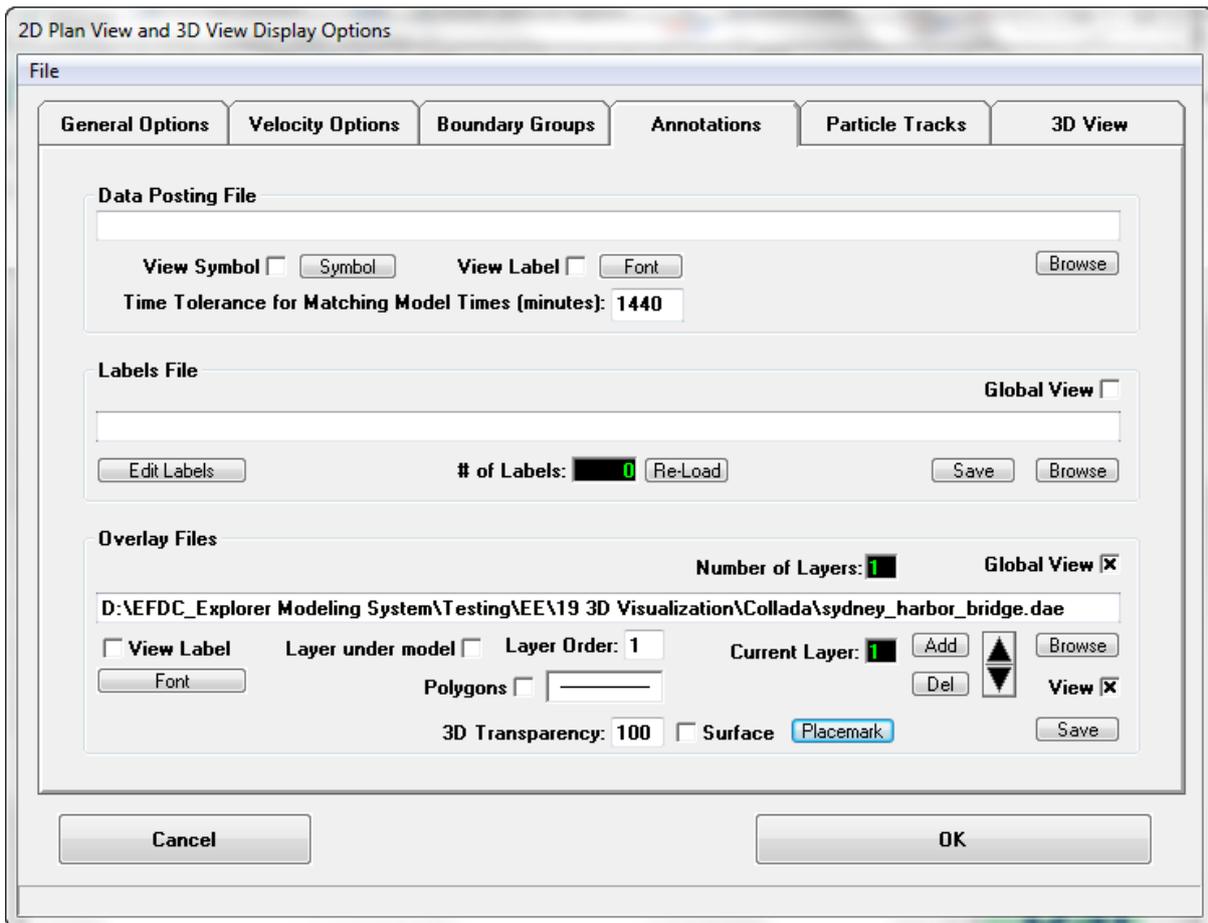


Figure 10-18 3D Structure: Setting overlay file.

Once loaded in, the users have extra flexibility such as adjusting X,Y,Z co-ordinates, re-scaling the object in three dimensions as well as changing the angle of rotation using the *Placemark* button as shown in Figure 10-19. This button may also be accessed with the Alt U key stroke from *ViewPlan* or *View3D*. In *View3D* the user may select the *Move* checkbox to allow the object to be dragged on the screen by the cursor to place it more exactly. An example of a complex structure that can be loaded into *View3D* is shown in Figure 10-20.

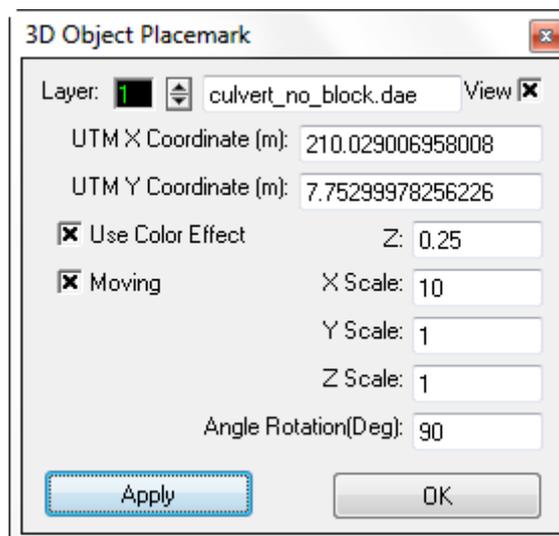


Figure 10-19 3D Structure: Setting place marks.

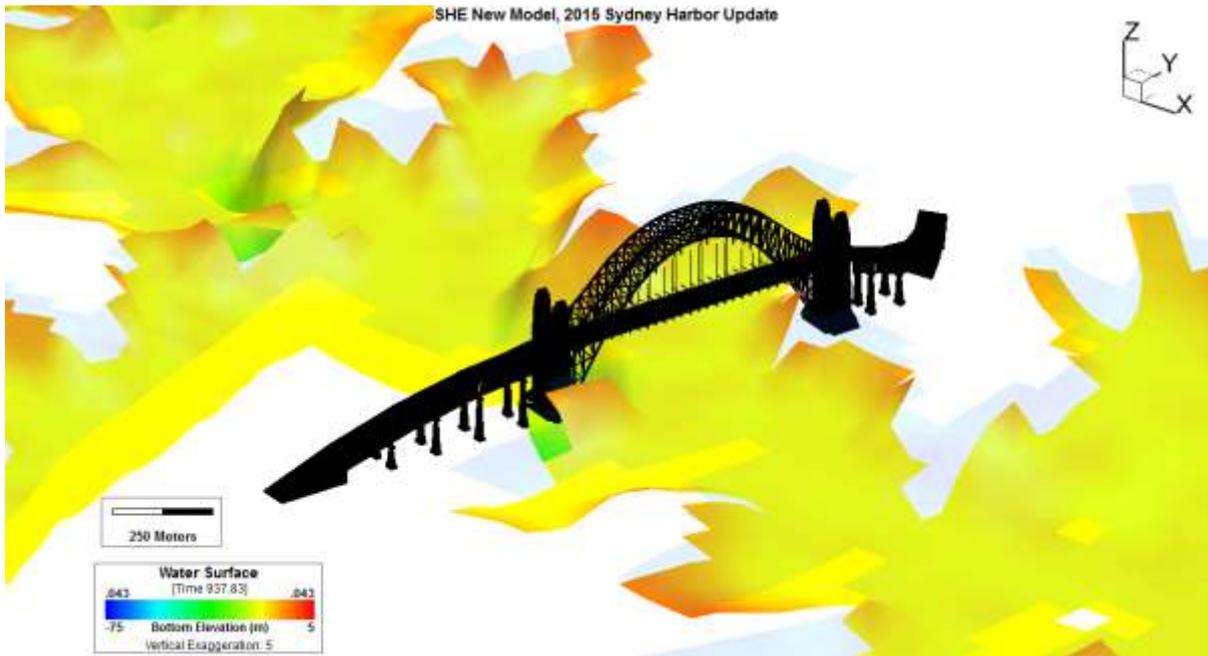


Figure 10-20 COLLADA file in View3D.

10.1.9. 3D Symbols

It is possible to display symbols as 3D images. These are selected in the normal way from *Display Options | Annotations | Edit Labels | Edit (Selected Labels)* as shown in Figure 10-21 and Figure 10-22.

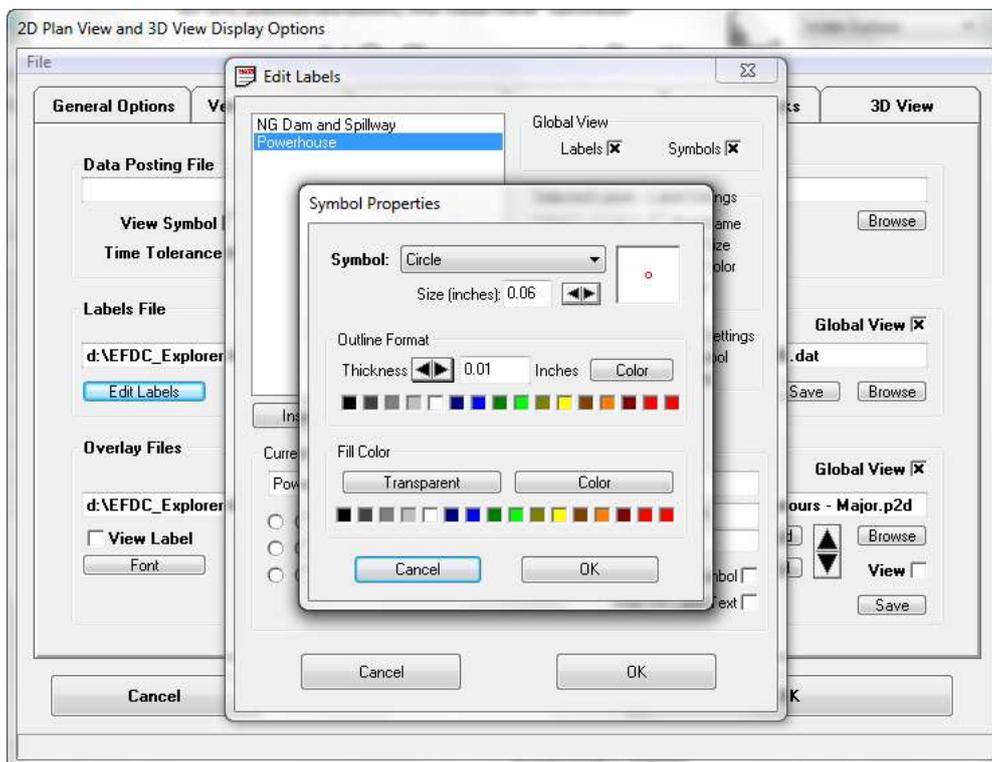


Figure 10-21 View3D Display Options: Configuring 3D symbols.

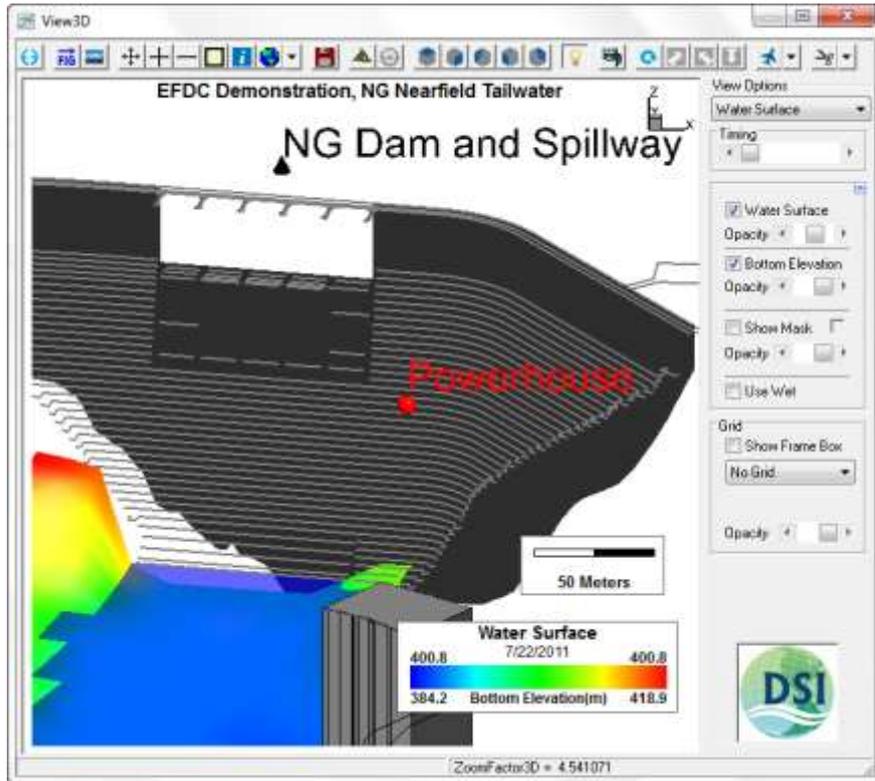


Figure 10-22 View3D Display Options: 3D triangle symbol.

10.1.10. Light Effects

Light effect in the View 3D form may be toggled on and off with the light bulb icon shown in Figure 10-23. This function allows the user to define the direction and intensity of the light source. The user may click the black dot in x, y, z sphere to move the source of light. The light color may also be set for both ambient light and diffuse light by clicking on the color box to the right of these options.

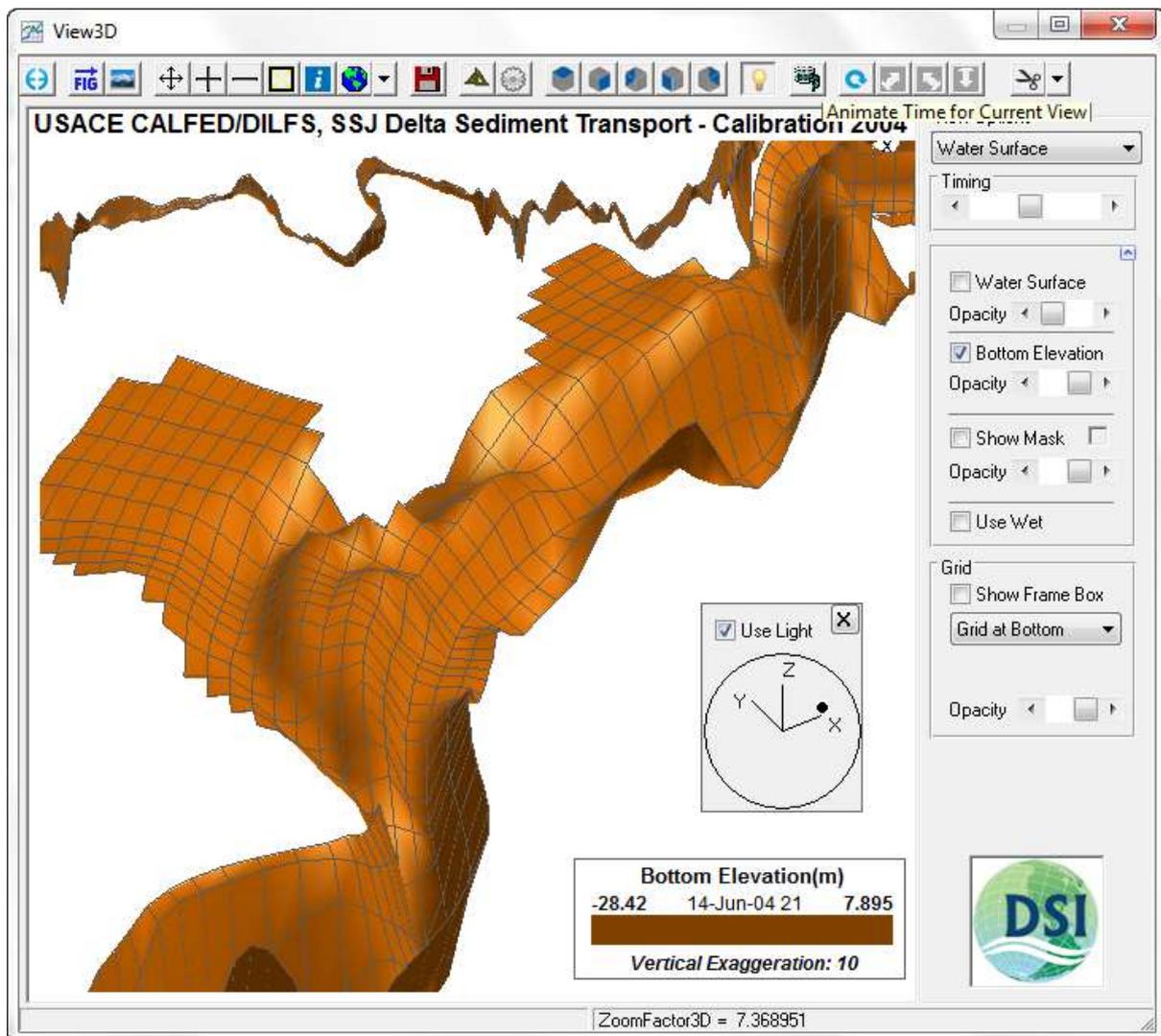


Figure 10-23 View 3D: Light Effects \

11 Open Multi-Processing Functionality

EFDC code has been upgraded to allow multi - threading capabilities for vastly improved model run times. Depending on the machine topology, application, and operating system, thread affinity can have a dramatic effect on the application speed. The OpenMP capability of EFDCPlus was formerly an optional extra for users of EFDC_DSI. From EE8 and EFDC+ it is the default option. In order to use it effectively it is important to note the following features. The OMP option is only required to be set when the user runs the model. In the *Run Options* frame shown in Figure 11-1 below, the user is able to set the number of OMP threads for the model run. This will rewrite the EFDC.INP file.

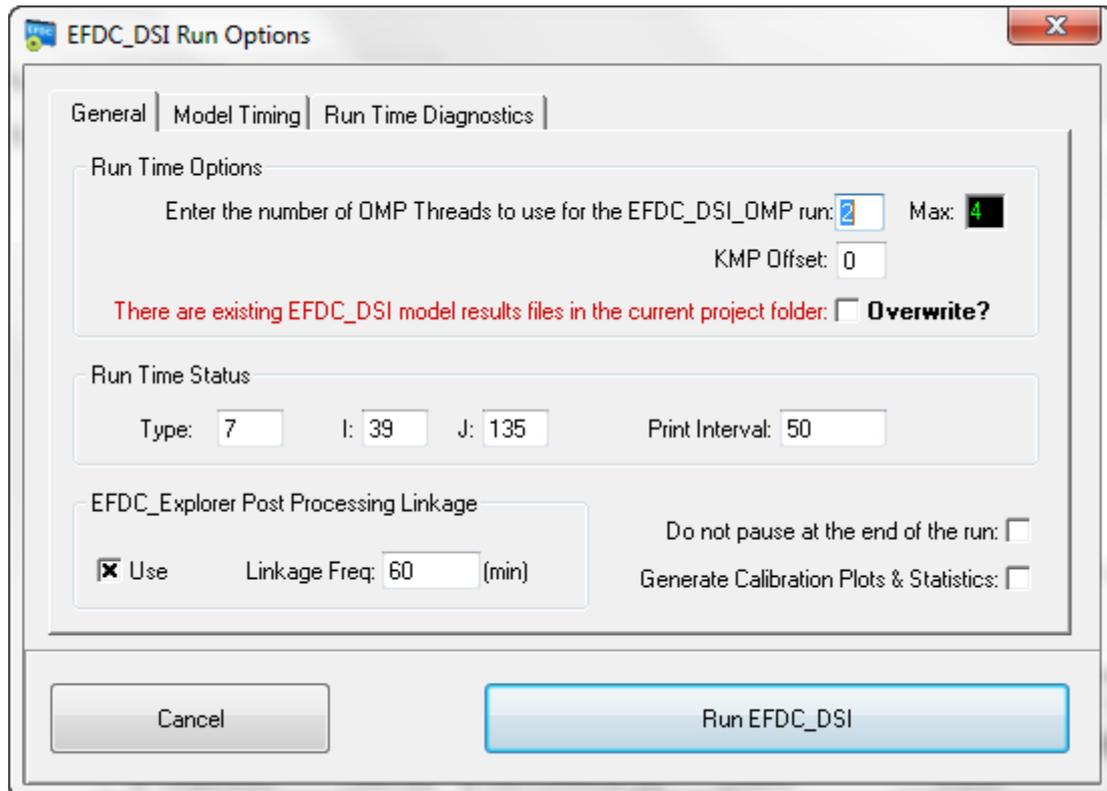


Figure 11-1 Run Options for OpenMP model runs.

11.1.1.1. KMP Offset

The user may also set the *KMP Offset*, which is the core offset for the current run. The *KMP Offset* relates to the number of cores already being used by the system, and is therefore usually set to zero. The *KMP Offset* should only be adjusted if the user wishes to run more than one model on the same machine. In order to run second model the *KMP Offset* should be set to the number of cores being used in the already running model. For example, assume a system comprising a Xeon Processor with 6 cores (12 threads), is already running a model on 2 cores (where *KMP Offset* had been set to 0). If the user wishes to run a second model, they then should set the *KMP Offset* to 2 and the OMP threads to 4.

A typical Intel I7 computer had from has 4 to 6 cores. The way these cores are handled in the EFDC code is with the *KMP_AFFINITY* variable, defined as:

```
KMP_AFFINITY=[<modifier>,...]<type>[,<permute>][,<offset>]
```

For example, to list a machine topology map, specify “KMP_AFFINITY=verbose,none” to use a modifier of verbose and a type of none.

“KMP_AFFINITY = granular = fine, compact, 1,0”, will assign individual threads to different cores. When it assigns the threads it also spreads them out. If the modifier is set to verbose, then a map of threads will also be produced.

Note that a “0_RunEFDC” file is created in the model folder each time the EFDCPlus model is run. This file tells EE whether the model ran to completion or not as it is deleted on successful model completion.. If the user opens that file then they can see these parameters.

Figure 11-2 illustrates the binding of OpenMP thread to hardware thread contexts when specifying “KMP_AFFINITY=granularity=fine,compact”.

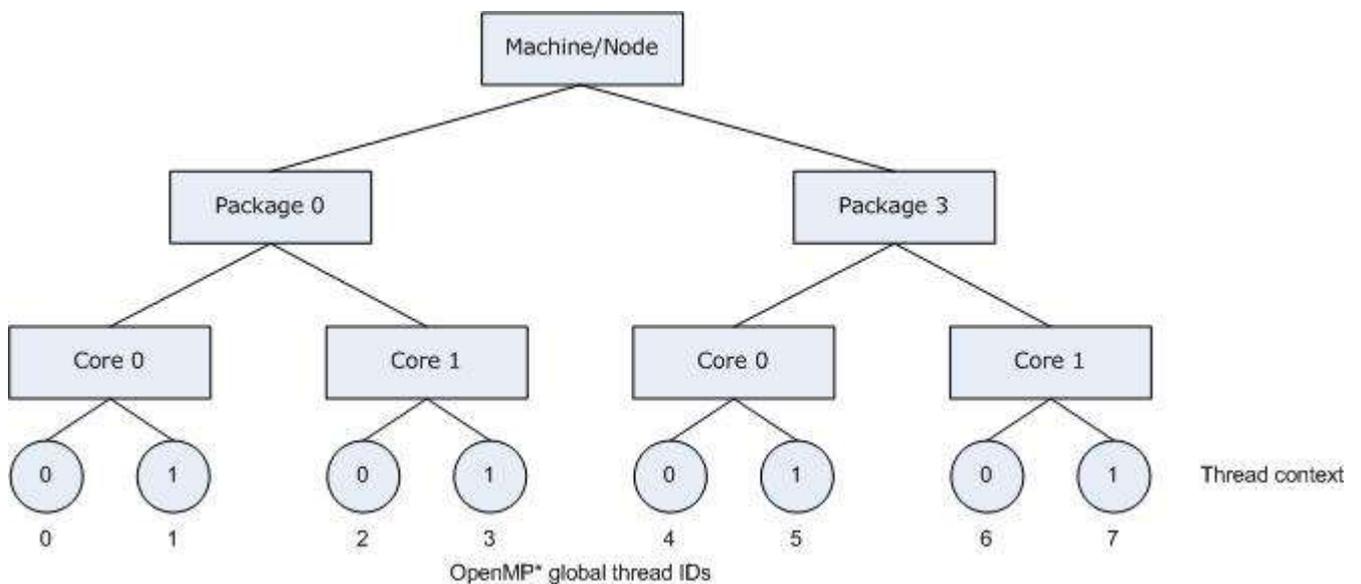


Figure 11-2 Open MP thread IDs (graphic courtesy of Intel).

To learn more about the KMP_AFFINITY environment and the specific syntax which must be used please visit the following website:

http://software.intel.com/sites/products/documentation/hpc/composerxe/en-us/cpp/mac/optaps/common/optaps_openmp_thread_affinity.htm

11.1.2. Three Time Level Solution

The Three Time Level (3TL) solutions subroutines in EFDCPlus have now been updated to allow for Open Multi-processing, thereby providing significant speed up in model run time for users running the 3TL solution.

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Appendix A

EFDC Internal Array Visualization Instructions

The only thing the user need to do to use EFDC_Explorer to plot and otherwise visualize arrays from within EFDC is to modify the EEXPORT subroutine in the section of code listed in the following textbox. To turn on the feature, use the following statement:

```
IF (.TRUE..AND.JSEXPLORER.EQ.0) THEN
```

To turn off the feature, use

```
IF (.FALSE..AND.JSEXPLORER.EQ.0) THEN
```

There are basic two types of output, one for time static arrays and one for those that vary as the model progresses (the standard case). Depending on the temporal nature of the array, the user must code the loops inside the IF/THEN block for time static arrays and outside/below the IF/THEN block for time variable arrays. The basic code for outputting the arrays is very simple and examples for both are shown in the text box. The user must make sure the flags are set right in order for EFDC_Explorer to correctly handle the arrays. The EFDC_INT.OUT file is a binary file for efficient reads and disk storage. The following is the basic structure:

DimFlag, TimeFlag	Two Integer*4 flags
ArrayName	One Character*8 name to identify the array
The array	Loop over the appropriate dimensions
andoutput	the array.

Remember to recompile after any changes to the source code.

A section of code from the EEXPOUT subroutine in EFDC.

```

INTEGER*4 VER
CHARACTER*8 ARRAYNAME

C*****C
C
! *** INTERNAL ARRAYS
IF (.TRUE..AND.JSEXPLORER.EQ.0) THEN

! *** TIME STATIC ARRAYS
IF (N.LT.(2*NTSPTC/NPSPH(8))) THEN
OPEN(97,FILE='EFDC_INT.OUT',STATUS='UNKNOWN')
CLOSE(97,STATUS='DELETE')
OPEN(97,FILE='EFDC_INT.OUT',STATUS='UNKNOWN',
& ACCESS='SEQUENTIAL',FORM='BINARY')
WRITE(97)VER ! FILE FORMAT VERSION #
WRITE(97)1 ! # OF TIME VARYING ARRAYS

! FLAGS: ARRAY TYPE, TIME VARIABLE
! ARRAY TYPE: 0 = L DIM'D
! 1 = L,KC DIM'D
! 2 = L,0:KC DIM'D
! 3 = L,KB DIM'D
! 4 = L,KC,NCLASS DIM'D
! TIME VARIABLE: 0 = NOT CHANGING
! 1 = TIME VARYING

WRITE(97)0,0
ARRAYNAME='WVKHV'
WRITE(97)ARRAYNAME
DO L=2,LA
WRITE(97)WVKHV(L)
ENDDO

ENDIF

! *** TIME VARYING ARRAYS
WRITE(97)2,1
ARRAYNAME='QQ'
WRITE(97)ARRAYNAME
DO L=2,LA
DO K=0,KC
WRITE(97)QQ(L,K) ! Turbulent Intensity (
ENDDO
ENDDO

ENDIF
C

```

Appendix B

Data Formats

Data Format B-1 P2D Polyline/Polygon File.

Any number of polylines/polygons can reside in the same file. Each one begins with a single line header that is used as the "ID" of the polyline/polygon. Next comes the data in either 2D or 3D format, the importing automatically handles either. Finally the polyline/polygon is finished (not necessarily "closed") by an "*" in column 1. There is no difference between polyline and polygon in a P2D file, only how the data are treated by the application reading the file.

Example

```

-----
Polyline
609115.69390674          3643612.72035394          Test
608828.057738002          3642922.39387814          0
608569.186338242          3642232.06904821          0
608396.604307826          3640908.94563456          0
...
...
...
601493.350247946          3628713.19503985          0
601464.586301899          3627763.99747289          0
601522.11337106          3627016.14485373          0
601522 11337106          3626642 21854415          0

```

Data Format B-2 TB2 XYZ Gridded Data.

This format is a compact way to store regular grid X, Y and Z data. It contains three lists, each with the number of data points as the first value in the list. The file contains a list of the X coordinates, a list Y coordinates and a list of the Z's.

Example

```

-----
195          Nx
-97516.6484
-96511.4938
-95506.3391
-94501.1845
...
...
...
113          Ny
656865
657873.929
658882.857
659891.786
...
...
...
22035          Nz
-28.337
-28.346999
-28.1060000

```

Data Format B-3 DX Polyline/Polygon File.

The DX format is described by the following outline. The vertical bar "|" indicates the actual left side of the file.

```
Notes          |Contents of line beginning
               |\Column 1 of the actual file
-----
Line01         |Description Line          ] Header lines (1st line in the file)
Line02         |#Polylines                ]
Line01p1       |Index,nPts,branch,type,angle,deltax ] Header lines for each polyline
Line02p1       |PolyLine ID                } branch,angle,deltax are only used
Line03p1       |PolyLine Desc              } for special cases but must be input.
Line01p1n1     |X,Y or X,Y,Z ] Data Points } Type = 0 Undefined (defaults to open)
Line02p1n2     |X,Y or X,Y,Z ] Loop over nPts } Type = 1 Polyline (Open)
Line03p1n3     |X,Y or X,Y,Z ]           } Type = 2 Polygon (Closed)
...
Linennp2nn    |X,Y or X,Y,Z ]           }End of Polyline Block
Line01p2       |Index,nPts,branch,type,angle,deltax ] Header lines for each polyline
Line02p2       |PolyLine ID                }
Line03p2       |PolyLine Desc              }
Line01p2n1     |X,Y or X,Y,Z ] Data Points }
Line02p2n2     |X,Y or X,Y,Z ] Loop over nPts }
Line03p2n3     |X,Y or X,Y,Z ]           }
...
Linennp2nn    |X,Y or X,Y,Z ]           }End of Polyline Block
```

Example

```
-----
HR Test Sections
2
1,10,0,1,0,0
XS022
Geomorph XS022
55907.8741026827,910678.007703451,956.594
55907.2507413484,910678.789637365,956.594
55906.6273800142,910679.57157128,956.604
55906.0040186799,910680.353505195,956.574
55905.3806573456,910681.135439109,956.404
55904.7572960113,910681.917373024,956.884
55904.1339346771,910682.699306939,957.434
55903.5105733428,910683.481240853,956.954
55902.8872120085,910684.263174768,956.764
55902.2638506742,910685.45108683,957.564
2,22,0,1,0,0
XS023
Geomorph Transect XS023
55867.0383902119,910642.619457468,964.856
55866.7836519141,910643.049699725,961.236
55866.6308089354,910643.307845079,959.236
55866.2741753184,910643.910184238,957.346
55865.7646987227,910644.770668752,957.116
55865.255222127,910645.631153266,957.146
55864.7457455313,910646.49163778,957.146
55864.2362689356,910647.352122294,957.106
55863.7267923399,910648.212606807,956.976
55863.2173157442,910649.073091321,957.126
55862.7078391485,910649.933575835,956.716
55862.1983625528,910650.794060349,956.606
55861.688885957,910651.654544862,956.646
55861.1794093613,910652.515029376,956.696
55860.6699327656,910653.37551389,957.206
55860.1604561699,910654.235998404,957.606
55859.6509795742,910655.096482917,957.836
55859.1415029785,910655.956967431,957.716
```

Data Format B-4 Measured 3D Velocity Point Data (TecPlot).

```
TITLE = "ADCP IJK Data"
VARIABLES = "X", "Y", "Z", "V_E_W", "V_N_S", "V_U_D"
ZONE I= 257, J=1, K=1, F=POINT, T="Avg Vel"
56730.14 906511.90 288.38 -0.0443 -0.1582 -0.0001
56731.96 906530.90 288.42 -0.0570 -0.1482 -0.0001
56730.98 906533.00 288.45 -0.0599 -0.1219 -0.0001
56731.46 906535.70 288.49 -0.0578 -0.1042 -0.0001
56733.52 906512.90 288.39 -0.0548 -0.1524 -0.0001
...
...
...
```

Data Format B-5 I, J, K Formatted Measured 3D Velocity Data (TecPlot).

```
TITLE = "ADCP IJK Data"
VARIABLES = "X", "Y", "Z", "V_E_W", "V_N_S", "V_U_D"
ZONE I=40, J=26, K=1, F=POINT, T="Velocity"
56728.00 906511.00 288.54 -0.0457 -0.1574 0.00000
56732.00 906511.00 288.51 -0.0492 -0.1563 0.00000
56736.00 906511.00 288.52 -0.0549 -0.1551 0.00000
56740.00 906511.00 288.73 -0.0530 -0.1438 0.00000
...
...
...
```


Data Format B-8 Vertical Profile for Calibration/Validation Profiles.

SE 03, Unknown (Unknown) @ 573370.8125, 3009112														First line: Title for some meaning (here: station name, coordinate) This field is not used by EE.	
14	18-Aug-1999 11:25													Second line: number of data points on the vertical profile (i.e., 14); Date (Gregorian) (i.e., 18-Aug-1999) and time (i.e., 11:25) Third line: the water depths (from the water surface) of the points along the vertical profile (the depth unit must correspond to the model unit: meters) Fourth line: the observation water quality values of the points. Units – Must correspond to the model units. Repeat lines 2-4 for each profile.	
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500		6.000
	6.300	6.300	7.100	7.100	7.400	9.000	10.300	10.300	11.200	11.700	12.300	14.200	16.500		17.500
12	29-Sep-1999 10:15														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000			
	1.600	1.600	1.600	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700	1.700			
8	18-Oct-1999 12:05														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000							
	0.100	0.100	0.100	0.100	0.100	0.100	0.100	0.100							
13	29-Nov-1999 11:33														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500		
	6.300	6.700	7.500	8.400	10.600	12.100	12.700	12.700	16.700	17.000	17.100	17.200	18.400		
9	15-Dec-1999 11:00														
	0.000	0.500	1.000	1.500	2.000	2.000	2.500	3.000	3.500						
	8.500	8.600	8.600	8.800	9.300	9.700	9.900	10.700	11.480						
13	13-Jan-2000 10:54														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500		
	4.100	4.400	8.900	10.300	12.900	14.100	15.100	15.100	15.300	15.100	16.800	17.000	17.200		
13	24-Feb-2000 12:26														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500		
	23.800	24.000	24.000	24.200	24.200	24.200	24.200	24.300	24.300	24.300	24.300	24.300	24.400		
14	23-Mar-2000 10:52														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500	6.000	
	21.000	21.000	21.100	21.200	21.200	21.300	21.300	21.300	21.300	21.300	21.300	21.700	21.700	21.700	
14	10-Apr-2000 11:26														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500	6.000	
	21.600	21.700	21.800	21.800	21.900	22.600	22.700	22.700	22.900	23.000	23.200	23.300	23.500	23.600	
15	01-May-2000 12:00														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500	6.000	6.500
	1.800	1.800	2.200	4.000	5.100	6.300	7.200	7.200	8.700	9.400	9.600	9.700	9.800	9.900	9.900
13	08-May-2000 11:15														
	0.000	0.500	1.000	1.500	2.000	2.500	2.500	3.000	3.500	4.000	4.500	5.000	5.500		
	2.300	2.500	2.700	2.700	2.800	2.900	2.900	2.900	2.900	3.200	3.900	3.900	4.200		
11	25-May-2000 12:15														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500				
	6.100	6.100	6.100	8.200	10.900	13.700	16.100	16.100	18.700	21.200	21.600				
12	07-Jun-2000 11:30														
	0.000	0.500	1.000	1.500	2.000	2.500	2.500	3.000	3.500	4.000	4.500	5.000			
	18.400	18.700	19.100	19.300	20.100	20.600	20.600	21.100	21.700	22.500	23.100	23.500			
11	26-Jun-2000 13:20														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500				
	17.900	17.890	18.300	21.450	21.640	21.710	21.790	21.790	21.960	22.230	22.340				
14	06-Jul-2000 11:20														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500	6.000	
	30.900	20.300	21.500	21.800	22.200	22.600	23.100	23.100	23.600	23.700	24.000	24.000	24.000	24.000	
13	21-Aug-2000 11:55														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500		
	15.400	15.300	15.300	15.400	15.400	15.400	15.500	15.500	15.700	15.700	16.100	16.100	16.700		
14	18-Sep-2000 12:28														
	0.000	0.500	1.000	1.500	2.000	2.500	3.000	3.000	3.500	4.000	4.500	5.000	5.500	6.000	
	21.280	21.210	21.240	21.930	22.060	22.200	22.380	22.380	22.230	22.560	22.470	22.850	23.000	23.040	

Data Format B-9 Polygon DSM Format

The "Polygon" Digital Sediment Model (DSM) format is file that contains any number of polygons that define an area followed by a data block that contains the sediment data. The polygon ID and the data block ID's must match. The data block consists of a line for each depth (beginning at the surface or 0.0 depth) for which data exists. On each line the user must include the depth (m), thickness (m), porosity, and then the grain size. The number of grain size classes and the associated size breaks are determined by the space delimited data of the label line (see example). The number of grain size classes and their sizes must be the same for every sediment data block in the file. However, the size classes can vary from file to file or project to project to meet the project needs.

```
POLY ID1
X,Y
X,Y
X,Y
...
...
...
END
DATA ID1
depth thick density porosity Size1mm Size2mm Size3mm ... SizeNmm
Depth 1 data
Depth 2 data
...
...
...
END
```

Example

```
-----
POLY L125.01
56694.6 901917.7
56697.3 901937.2
56678.3 901944.2
56674.4 901924.5
END
DATA L125.01
depth thick density porosity 50mm 19mm 9.5mm 0.85mm 0.25mm 0.075mm 0.065mm 0.023mm 0.013mm 0.004mm 0.003mm
0.000 0.152 1749.3 0.500 1.00000 0.99998 0.99988 0.98257 0.90709 0.70847 0.67613 0.41642 0.28167 0.09082 0.06417
0.152 0.152 1787.6 0.490 1.00000 0.99996 0.99976 0.97702 0.89186 0.68776 0.65569 0.40369 0.27499 0.09192 0.06584
0.305 0.152 1826.7 0.479 0.99999 0.99991 0.99956 0.97004 0.87468 0.66569 0.63396 0.38991 0.26726 0.09230 0.06695
0.457 0.152 1866.7 0.469 0.99998 0.99982 0.99921 0.96138 0.85544 0.64229 0.61100 0.37518 0.25857 0.09199 0.06749
0.610 0.152 1907.6 0.459 0.99996 0.99964 0.99864 0.95077 0.83405 0.61762 0.58686 0.35958 0.24902 0.09101 0.06747
0.762 0.152 1949.4 0.449 0.99990 0.99933 0.99772 0.93794 0.81045 0.59174 0.56162 0.34323 0.23869 0.08941 0.06692
END
```

Data Format B-10 Sediment Cores with Grainsize DSM Format

The "Sediment Cores with Grainsize" Digital Sediment Model (DSM) format is file that contains any number of cores. Each core can have any number of samples at depths below the top of the core. For each core the user must locate the core in horizontal (XY) space. The "Z" requested is the top of the core elevation (i.e. the bottom elevation at the core location).

Title Line

"Discrete" Flag: Used to determine data file format

Loop over groupings of cores (Loop Terminated by the "END" statement)

ID, #Cores

X Y Z #Depths

Loop over #Depths

Thickness, Porosity, SpecGrav, nFractions

Loop over nFractions

Max Grainsizes (um)

EndLoop

Loop over nFractions

%Finer

EndLoop

EndLoop

END --> End Core Definitions with an "END"

Example -----

Tra Khuc Soil Sampling Results

Discrete

Core01 2

265814.3 1673167.4 5.90 4

0.25 56.00 2.66 9

20000 15000 7500 3500 1250 375 175 75 30

100.00 94.40 89.50 84.10 79.00 36.00 16.50 10.00 2.20

0.65 56.00 2.66 6

1250 375 175 75 30 8

100.00 90.80 70.20 33.00 17.80 9.00

5.00 56.00 2.65 7

7500 3500 1250 375 175 75 30

100.00 96.80 84.80 24.70 11.30 4.10 0.90

8.20 56.00 2.66 7

7500 3500 1250 375 175 75 30

100.00 97.60 87.60 29.30 13.90 5.20 1.00

! *** End of 1st Core

265808.1 1673613.9 0.13 2

0.25 56.00 2.66 9

20000 15000 7500 3500 1250 375 175 75 30

100.00 94.40 89.50 84.10 79.00 36.00 16.50 10.00 2.20

0.85 56.00 2.65 7

7500 3500 1250 375 175 75 30

100.00 96.50 83.10 27.70 17.10 4.20 0.00

! *** End of 2nd Core

Data Format B-11 Water Quality Point Source Loading Concentration Time Series File

```

C ** Caloosahatchee TMDL, WQPSLC Concentration Time Series FILE, DDD 5/27/2008 10:28:34 AM
C ** This file is only used by EE to generate mass loadings for EFDC
C ** INPUT UNITS (mg/l) EXCEPT: TAM(mol/l), FCB(MPN/l).
C **
C ** MWQPSR(NS) TCPSER(NS) TAPSER(NS) RMULADJ(NS) ADDADJ(NS)
C ** TWQPSESR(M,NS) WQPSSER(M,NWV= 1: 7,NS)
C ** WQPSSER(M,NWV= 8:14,NS)
C ** WQPSSER(M,NWV=15:22,NS)
C **
C ** Time CHC CHD CHG ROC LOC DOC ROP
C ** LOP DOP P4D RON LON DON NHX
C ** NOX SUU SAA COD DOX TAM FCB MAC
C **
732 86400 0 1 0 ! *** S79
2922.000 0.0000 0.0000 0.1958 1.3686 1.3686 10.9485 0.0096
0.0113 0.0113 0.0944 0.1130 0.4181 0.5989 0.0585
0.2984 0.0000 0.0000 0.0000 6.2596 0.0000 49.9881 0.0000
2923.500 0.0000 0.0000 0.1988 1.3360 1.3360 10.6880 0.0105
0.0123 0.0123 0.1139 0.1220 0.4514 0.6465 0.0612
0.3824 0.0000 0.0000 0.0000 6.5626 0.0000 49.9881 0.0000
2924.500 0.0000 0.0000 0.2007 1.3255 1.3255 10.6037 0.0104
0.0121 0.0121 0.1073 0.1214 0.4490 0.6432 0.0543
0.3633 0.0000 0.0000 0.0000 6.4734 0.0000 49.9881 0.0000
2925.500 0.0000 0.0000 0.2027 1.3934 1.3934 11.1468 0.0109
0.0127 0.0127 0.0994 0.1212 0.4484 0.6423 0.0554
0.3291 0.0000 0.0000 0.0000 6.3515 0.0000 49.9881 0.0000
2926.500 0.0000 0.0000 0.2047 1.4910 1.4910 11.9281 0.0118
0.0138 0.0138 0.0910 0.1234 0.4565 0.6538 0.0605
0.2974 0.0000 0.0000 0.0000 6.4037 0.0000 49.9881 0.0000

```

Data Format B-12 External Windwaves

```
C ** Tra Khuc, FILE: WAVE.INP
C ** Version: EFDC_Explorer7.1.1 : Ver 140606
C ** Specify Information For Wave-Current Boundary Layer and Wave Induced
Flow
C **
C ** I   J   WVHEI   WANGLE   WVPER   WVLEN   WVDISP
C **
C ** I,J Cell Indices
C **
C ** WVHEI = Wave Height (m)
C ** WANGLE = Wave Angle (Degrees from East)
C ** WVPER = Wave Period (seconds)
C ** WVLEN = Wave Length (meters)
C ** WVDISP = Wave Energy Dissipation In (m/s)**3
C **
   52   3   0.0000   0.0000   0.0000   0.0000   -0.0090
   53   3   0.0000   0.0000   0.0000   0.0000   0.0000
   54   3   0.0000   0.0000   0.0000   0.0000   0.0000
   55   3   0.0000   0.0000   0.0000   0.0000   0.0000
   56   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   57   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   58   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   59   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   60   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   61   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   62   3   0.0000   0.0000   0.0000   0.0000   0.0000
   63   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   64   3   0.0000   0.0000   0.0000   0.0000  -0.0090
   65   3   0.0000   0.0000   0.0000   0.0000   0.0000
```

Data Format B-13 External Windwaves

C ** JULIAN DAYS CORRESPONDING TO EXTR. WIND FILES

C ** FOR SWAN MODEL RUN IN CASE OF UNSTEADY WAVES

225.0000

225.0417

225.0833

225.1250

225.1667

225.2083

225.2500

225.2917

225.3333

225.3750

225.4167

225.4583

225.5000

Data Format B-14 Harmonic Constants (harcont.ee)

```
C ** NSTA = Number stations
C ** MTIDE = Number of tidal harmonic constants of this station
C ** xcoord = Longitude / X - coordinate
C ** ycoord = Latitude / Y - coordinate
C ** DATUM = Datum in meters
C ** TIMEZONE = Time zone
C ** AMPCON = Conversion factor to convert amplitude to meters
C ** PHACON = Conversion factor to convert amplitude to degrees
C ** NAME = Station name
C ** NSTA
C ** MTIDE XCOORD YCOORD DATUM TIMEZONE AMPCON PHACON NAME
C ** ID CONSTITUENT AMP (cm) PHA (deg)
    2 38 0 0 1.77799999713898 8 .01 1 Johor
92 M2 2232.0000 21.00
108 S2 2635.0000 48.90
80 N2 3275.0000 358.30
43 K1 3481.0000 204.30
150 M4 3661.0000 82.20
28 O1 2874.0000 209.20
184 M6 3884.0000 138.80
134 MK3 4096.0000 97.70
160 S4 3603.0000 258.50
146 MN4 4925.0000 192.70
83 NU2 2428.0000 351.20
197 S6 4315.0000 228.90
76 MU2 2168.0000 10.90
75 2N2 2165.0000 335.00
```

Data Format B-15 ISER.INP for ISICE = 1

```
C ** PROJECT NAME, ISER.INP TIME SERIES FILE
C **   FILE ISER.INP - EXTERNALLY SPECIFIED ICE COVER
C **   CONTROL AND TIME SERIES DATA REPEATING NISER TIMES.
C     **                               HEADER:                               MISER(NISER),
TCISER(NISER),TAISER(NISER),RMULADJC,RMULADJT
C **   MISER      = NUMBER OF DATA, TCISER=TIME CONVERSION TO SEC,
TAISER=ADDITIVE TIME ADJ
C **
      4   86400      0      1      0
240.001  0.3500
240.010  0.5500
240.020  0.7500
240.030  0.6000
      6   86400      0      1      0
 20.000  0.0000
238.000  0.4000
252.000  0.5700
283.000  0.7200
290.000  0.5500
320.000  0.3400
```

Data Format B-16 ICEMAP.INP for ISICE = 1

C ** , icemap.inp , Ice time series weightings for each cell and NISER Series

C **

C **

C I J Weighting Fraction by Series

1

5113.000 5478.000

2	107	3	0.000159	0.999672	0.000170
3	108	3	0.000159	0.999671	0.000170
4	109	3	0.000159	0.999671	0.000170
5	110	3	0.000160	0.999670	0.000170
6	107	4	0.000231	0.999520	0.000249
7	108	4	0.000232	0.999519	0.000249
8	109	4	0.000232	0.999518	0.000250
9	110	4	0.000233	0.999517	0.000250
10	107	5	0.000313	0.999346	0.000341
11	108	5	0.000315	0.999344	0.000341
12	109	5	0.000316	0.999342	0.000342
13	110	5	0.000317	0.999340	0.000343
14	107	6	0.000413	0.999135	0.000453

Data Format B-17 ISTAT.INP for ISICE = 2

```
C ** ISTAT FILE
C ** TIME SERIES ON THE STATUS OF ICE ON/OFF VIA ICECOVER
C ** FIRST DATA LINE: MISER(N),TCISER(N),TAISER(N),N=1 (only one)
C ** NEXT DATA LINES: TISER(M,N),RICECOVS(M,N), M=1:MISER
C ** TISER: TIME, RICECOVS = 1: ON/0:OFF
      5      86400      0
    0.000    0.0000
   240.000    1.0000
   242.000    0.0000
   243.000    1.0000
   300.000    0.0000
```

Data Format B-18 ICE.INP for ISICE = 3 & 4

* ICE THICKNESS INITIAL CONDITIONS

*

I	J	THICKNESS [M]
3	207	0.300
3	208	0.300
3	209	0.300
3	210	0.300
3	211	0.300
3	212	0.300
4	207	0.300
4	208	0.300
4	209	0.300
4	210	0.300
4	211	0.300
4	212	0.300
5	207	0.300
5	208	0.300

Data Format B-19 Windmap

```
C ** Ver=80
C ** Caloosahatchee TMDL, FILE: WNDMAP.INP
C ** 002
C ** 003
C ** 004
  6
2920.037 2921.000  1.000  0.000  0.000
2921.000 2922.000  1.000  1.000  0.000
2922.000 2924.037  1.000  1.000  1.000
2924.037 3276.328  0.900  1.000  1.000
3276.328 3368.787  0.900  1.000  0.000
3368.787 3654.996  0.900  0.000  0.000
  2  3  3 0.59541 0.23848 0.16611
  3  4  3 0.59704 0.23938 0.16359
  4  5  3 0.59775 0.24085 0.16140
  5  6  3 0.59741 0.24294 0.15965
  6  7  3 0.59610 0.24537 0.15853
  7  8  3 0.59448 0.24769 0.15783
  8  9  3 0.59233 0.25028 0.15739
  9 10  3 0.58954 0.25331 0.15715
```

Data Format B-20 East West Connectors

C FILE MAPPGEW.INP PROVIDES INFORMATION FOR MAKING MANUAL GRID CONNECTIONS

C IN THE EAST-WEST (I+1 AND I-1) DIRECTION

C

C NPEWBP = NUMBER OF EAST-WEST CONNECTIONS

C IWPEW,JWPEW = I,J INDICES OF THE CELL CONNECTED AT THE WEST FACE

C IEPEW,JEPEW = I,J INDICES OF THE CORRESPONDING CELL CONNECTED AT THE EAST FACE

C

C IWPEW JWPEW IEPEW JEPEW (REPEATED NPEWBP TIMES)

9

55 77 11 19

55 76 11 20

55 75 11 21

55 74 11 22

55 73 11 23

55 72 11 24

55 71 11 25

55 70 11 26

55 69 11 27

**Data Format B-21 SEDZLJ Input Files
BED.SDF**

```

# VAR_BED Bedload Nequil LAYMAX ISEDTIME IMORPH IFWAVE MAXDEPLIM#
  1      1      0      7      1      0      0      1.0
# ITBM NSICM Array Parameters #
  8      8
# ZBSKIN (>0 sets Zo in [um]) TAUCONST [dynes/cm^2] (> 0 to set constant) ISSLOPE #
 10.0  0.0  0
# D50 of Size Class D50(K) [um] #
 10.0  22.0  222.0  375.0  750.0  4000.0  22.0  222.0
# Critical Shear for Erosion TAU CRS(K) [dynes/cm^2] #
  1.0  2.2  1.6  2.4  3.8  30.8  2.2  1.6
# Critical Shear for Suspension TCRDPS(K) [dynes/cm^2] #
  1.0  2.2  2.4  3.5  12.5  98.8  2.2  2.4
# Sediment Bed Size (um) Tables #
  2.0  222.0  432.0  1020.0  2400.0  2600.0  3360.0  6000.0  8520.0
# Critical Shear for Erosion of Bed Surface [dynes/cm^2] #
  0.50  2.27  2.96  4.17  5.88  6.07  6.72  8.48  9.75
# Erosion rates for active and deposited Layers [cm/s] #
 1.00E-09 5.97E-05 5.97E-04 5.96E-03 5.95E-02 5.94E-01 5.94E+00 5.93E+01 ! 2 Micron
 1.00E-09 5.97E-05 5.97E-04 5.96E-03 5.95E-02 5.94E-01 5.94E+00 5.93E+01 ! 222 Micron
 1.00E-09 3.65E-04 2.16E-03 1.27E-02 7.49E-02 4.42E-01 2.61E+00 1.54E+01 ! 432 Micron
 1.00E-09 2.01E-04 1.14E-03 6.51E-03 3.71E-02 2.11E-01 1.20E+00 6.85E+00 ! 1020 Micron
 1.00E-09 1.12E-05 8.40E-05 6.28E-04 4.70E-03 3.51E-02 2.63E-01 1.96E+00 ! 2400 Micron
 1.00E-09 7.94E-06 6.01E-05 4.55E-04 3.45E-03 2.61E-02 1.98E-01 1.50E+00 ! 2600 Micron
 1.00E-09 2.11E-06 1.67E-05 1.31E-04 1.04E-03 8.17E-03 6.44E-02 5.08E-01 ! 3360 Micron
 1.00E-09 2.03E-08 1.67E-07 1.44E-06 1.24E-05 1.07E-04 9.28E-04 8.02E-03 ! 6000 Micron
 1.00E-09 1.19E-09 2.75E-09 1.69E-08 1.47E-07 1.33E-06 1.22E-05 1.11E-04 ! 8250 micron

```

**Data Format B-22 SEDZLJ Input Files
ERATE.SDF**

```

# Layer Thicknesses          #
  0.00 0.00 15.00 15.00 15.00    15.00 15.00
# Active layer thickness multiplier
  2.0
# Core 1 - Riverine Sediments - Critical Shear Stress (dynes/cm^2) #
  3.0 3.0 3.0 3.5 4.0 5.0 999.0
# Bulk Density (g/cm^3)      #
  1.35 1.40 1.45 1.50 1.55 1.60 1.60
# Water and sediment density (g/cm^3) #
  1.0 2.65
# Particle Size Distribution    #
  13. 57. 24. 5. 1. 0. 0. 0.
  13. 57. 24. 5. 1. 0. 0. 0.
  13. 57. 24. 5. 1. 0. 0. 0.
  13. 57. 24. 5. 1. 0. 0. 0.
  13. 57. 24. 5. 1. 0. 0. 0.
  13. 57. 24. 5. 1. 0. 0. 0.
  13. 57. 24. 5. 1. 0. 0. 0.
# Initial Bed Erosion Rates    #
  0.0
  1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09 1.000E-09
  1.000E-09 1.000E-09
  2.0
  2.460E-09 2.460E-09 2.460E-09 1.706E-04 8.020E-05 2.260E-05 3.700E-09 3.700E-09
  3.700E-09 3.700E-09
  4.0
  1.460E-03 1.460E-03 1.460E-03 5.790E-04 2.120E-04 7.980E-05 7.660E-08 7.660E-08
  7.660E-08 7.660E-08
  8.0
  8.680E-03 8.680E-03 8.680E-03 1.910E-03 5.580E-04 2.820E-04 1.580E-06 1.580E-06
  1.580E-06 1.580E-06
  16.0
  5.150E-02 5.150E-02 5.150E-02 6.280E-03 1.470E-03 9.950E-04 3.280E-05 3.280E-05
  3.280E-05 3.280E-05
  32.0
  3.060E-01 3.060E-01 3.060E-01 2.070E-02 3.890E-03 3.510E-03 6.770E-04 6.770E-04
  6.770E-04 6.770E-04
  64.0
  1.820E+00 1.820E+00 1.820E+00 6.820E-02 1.030E-02 1.240E-02 1.400E-02 1.400E-02
  1.400E-02 1.400E-02
  128.0
  1.080E+01 1.080E+01 1.080E+01 2.250E-01 2.710E-02 4.380E-02 2.900E-01 2.900E-01
  2.900E-01 2.900E-01

```

**Data Format B-23 SEDZLJ Input Files
ENSIGHT.SDF**

```

#
C Input file for Enight output
C values of 1 turns on the variable and 0 turns off the variable
C   1  U - X velocity
C   2  V - Y velocity
C   3  TAU - Shear Stress on active layer
C   4  D50 - Averaged particle size
C   5  CBL - Bedload concentration
C   6  SED - Suspended sediment concentration
C   7  CHC - cyanobacteria
C   8  CHG - diatom algae
C   9  CHD - green algae
C  10  ROC - refractory particulate organic carbon
C  11  LOC - labile particulate organic carbon
C  12  DOC - dissolved organic carbon
C  13  ROP - refractory particulate organic phosphorus
C  14  LOP - labile particulate organic phosphorus
C  15  DOP - dissolved organic phosphorus
C  16  P4D - total phosphate
C  17  RON - refractory particulate organic nitrogen
C  18  LON - labile particulate organic nitrogen
C  19  DON - dissolved organic nitrogen
C  20  NHX - ammonia nitrogen
C  21  NOX - nitrate nitrogen
C  22  SUU - particulate biogenic silica
C  23  SAA - dissolved available silica
C  24  COD - chemical oxygen demand
C  25  DOX - dissolved oxygen
C  26  TAM - total active metal
C  27  FCB - fecal coliform bacteria
C  28  CO2 - Dissolved Carbon Dioxide
C  29  MAC - macroalgae
C  30  HEAT- Heat Content
C   31  TEMP- Temperature (K)
C U  V  TAU  D50  CBL  SED
C CHC  CHD  CHG  ROC  LOC  DOC  ROP  LOP  DOP  P4D  RON  LON  DON
C NHX  NOX  SUU  SAA  COD  DOX  TAM  FCB  CO2  MAC  HEAT  TEMP
1  1  1  1  1  1
0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0  0  0

```


Appendix C

Derived Constituents for Water Quality

' *** Water Quality

' *** 1) CHC - cyanobacteria

' *** 2) CHG - diatom algae

' *** 3) CHD - green algae

' *** 4) ROC - refractory particulate organic carbon

' *** 5) LOC - labile particulate organic carbon

' *** 6) DOC - dissolved organic carbon

' *** 7) ROP - refractory particulate organic phosphorus

' *** 8) LOP - labile particulate organic phosphorus

' *** 9) DOP - dissolved organic phosphorus

' *** 10) P4D - total phosphate

' *** 11) RON - refractory particulate organic nitrogen

' *** 12) LON - labile particulate organic nitrogen

' *** 13) DON - dissolved organic nitrogen

' *** 14) NHX - ammonia nitrogen

' *** 15) NOX - nitrate nitrogen

' *** 16) SUU - particulate biogenic silica

' *** 17) SAA - dissolved available silica

' *** 18) COD - chemical oxygen demand

' *** 19) DOX - dissolved oxygen

' *** 20) TAM - total active metal

' *** 21) FCB - fecal coliform bacteria

' *** NWQV+1) MAC - fecal coliform bacteria

' *** Water Quality Derived Parameters

' *** 23 - Total Organic Carbon

$$\text{TOC} = \text{CHC} + \text{CHG} + \text{CHD} + \text{ROC} + \text{LOC} + \text{DOC}$$

' *** 24 - Total N

$$\text{TN} = \text{AlgaeRatio}(\text{N:C}) * (\text{CHC} + \text{CHG} + \text{CHD}) + \text{RON} + \text{LON} + \text{DON} + \text{NHX} + \text{NOX}$$

' *** 25 - Total P

$$\text{TP} = \text{AlgaeRatio}(\text{P:C}) * (\text{CHC} + \text{CHG} + \text{CHD}) + \text{ROP} + \text{LOP} + \text{DOP} + \text{P4D}$$

' *** 26 - Chlorophyll a

$$\text{Chl-a} = \text{AlgaeRatio}(\text{Chla:C}) * \text{CHC} + \text{AlgaeRatio}(\text{Chla:C}) * \text{CHG} + \text{AlgaeRatio}(\text{Chla:C}) * \text{CHD}$$

' *** 27 - Total Organic N

$$\text{TON} = \text{AlgaeRatio}(\text{N:C}) * (\text{CHC} + \text{CHG} + \text{CHD}) + \text{RON} + \text{LON} + \text{DON}$$

' *** 28 - Total Inorganic N

$$\text{TIN} = \text{NHX} + \text{NOX}$$

' *** 29 - Total Organic P

$$\text{TOP} = \text{AlgaeRatio}(\text{P:C}) * (\text{CHC} + \text{CHG} + \text{CHD}) + \text{ROP} + \text{LOP} + \text{DOP}$$

' *** 48 - Carlson's Trophic State Index

' *** 49 - Particulate Organic Carbon

$$\text{POC} = \text{CHC} + \text{CHG} + \text{CHD} + \text{ROC} + \text{LOC}$$

' *** 50 - Particulate Organic Phosphorus

$$\text{POP} = \text{AlgaeRatio}(\text{P:C}) * (\text{CHC} + \text{CHG} + \text{CHD}) + \text{ROP} + \text{LOP}$$

' *** 51 - Particulate Organic Nitrogen

PON = AlgaeRatio(N:C)*(CHC + CHG + CHD) + RON + LON

' *** 52 - Total Suspended Solids (Inorganic + Organic) TSS(io)

TSSio = TSED + TSND + CHC + CHG + CHD + ROC + LOC

' *** 53 - Total Kjeldahl Nitrogen (TKN)

TKN = PON + NHX

TKN = AlgaeRatio(N:C)*(CHC + CHG + CHD) + RON + LON + NHX

' *** 54 - Total Dissolved Phosphorous (DOP+PO4)

TDP = DOP + PO4

' *** 55 - Macroalgae per unit area ug Chl-a/m2

MAC/m2 = AlgaeRatio(Chla:C)*MAC/Thickness[Layer 1]