



**US Army Corps  
of Engineers**  
Hydrologic Engineering Center

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# **HEC-WAT**

# **Watershed Analysis Tool**

## **User's Manual**

Version 1.0  
September 2017

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<p>14. ABSTRACT</p> <p>The HEC-WAT (Watershed Analysis Tool) software provides an interface that will streamline and integrate the analytical process using the tools commonly applied by the multi-disciplinary teams of USACE offices so that more efficient and coordinated modeling and planning may be performed. HEC-WAT is a tool that will help USACE offices perform water resources studies and/or system-wide studies, it can also be used for smaller studies as well, like a CAP (Continuing Authorities Program) study.</p> <p>The HEC-WAT graphical user interface (GUI) streamlines and integrates a water resources study using software commonly applied by multi-disciplinary teams in USACE. HEC-WAT is not replacing existing software but rather it's an interface that allows unique pieces of software to work together (i.e., HEC-HMS, HEC-SSP, HEC-RAS, HEC-ResSim, HEC-DSSVue, HEC-FIA, etc.). Software is incorporated in HEC-WAT through the use of a plug-in. The plug-in concept means that HEC-WAT does not "know" anything about the software application code; the individual pieces of software provide the analytical computations, while HEC-WAT provides the framework to coordinate the study. The graphical user interface is illustrated and described in detail in this manual.</p>					
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## **Watershed Analysis Tool, HEC-WAT, User's Manual**

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# Foreword

United States Army Corps of Engineers (USACE) policy states that USACE will analyze water resources projects, including flood risk management projects, using a risk framework that incorporates watershed and systems approaches. USACE's Hydrologic Engineering Center (HEC) developed the Watershed Analysis Tool (HEC-WAT) to provide software to the field that supports these requirements.

HEC-WAT helps a study team perform the necessary hydrologic, hydraulic, and consequence planning analyses by integrating water resources software that is commonly applied by a multi-disciplinary study team when conducting a water resources study. Many pieces of software within the HEC suite of tools are implemented within HEC-WAT, thus allowing a study team to perform many of the necessary hydrologic, hydraulic, and planning/ consequence analyses from a single interface. The HEC software currently incorporated in HEC-WAT includes HEC-HMS (hydrology), HEC-ResSim (reservoir operations), HEC-RAS (hydraulics), and HEC-FIA (flood consequences).

The development of the Flood Risk Analysis (FRA) compute option within HEC-WAT software allows a watershed or study area to be analyzed in a systems context using risk analysis and also supports risk-based analyses and risk-informed decision-making. FRA uses event-based Monte Carlo-style uncertainty sampling to evaluate the full range of possible conditions across a watershed or within a system, which in turn provides a more complete picture of flood risk in a watershed.

The goal of HEC-WAT is to help USACE offices perform all types of water resources studies in a coordinated and comprehensive fashion. HEC-WAT accomplishes this goal through an interface that allows the user to: load GIS based layers; establish stream networks and schematics; identify locations where models would share information; define the modeling software applications and their sequence order; import and edit existing models; develop new models; organize and develop alternatives, analysis periods, and simulations; run modeling software applications directly; and, view and compare alternative results.

HEC-WAT has been implemented following software guidelines that have been established at HEC. The guidelines facilitate a common graphical user interface and look-and-feel for HEC software in the PC environment. Recent HEC software implemented under these guidelines include rainfall-runoff analysis (HEC-HMS), river hydraulics (HEC-RAS), reservoir system analysis (HEC-ResSim), flood damage analysis (HEC-FDA), flood impact analysis (HEC-FIA), statistical analysis (HEC-SSP), and, ecosystem function analysis (HEC-EFM). HEC software implementation is under the guidance of Christopher N. Dunn, Director, Hydrologic Engineering Center.

Design and development of the HEC-WAT software has been a team effort. The initial design and concepts of HEC-WAT were done by Messrs. Christopher Dunn, Gary Brunner, Jeff Harris, and William Charley. This group also included John DeGeorge of Resources Management Associates (RMA). Once a draft design document was created, the formal design process started and several other individuals joined the team: Michael Deering, Beth Faber, William Lehman, Mark Jensen, William Scharffenberg, Joan Klipsch, Matthew Fleming, and Penni Baker. The above personnel have also been involved in the development and implementation of the FRA compute option. Development and testing of the final release was led by Lea Adams, Chief, Water Resource System Division, Hydrologic Engineering Center.

Mark Ackerman, Ben Chacon, Ryan Ripken, John DeGeorge, and Shannon Newbold of RMA developed the graphical user interface, developed the concept of plug-ins, implemented and assisted HEC in the development of the plug-ins, and assisted with debugging and the overall design of the program.

# CHAPTER 1

## Introduction

### 1.1 Overview

The U.S. Army Corps of Engineers (USACE) conducts water resources management studies to fulfill USACE's Civil Works mission. These studies begin with the definition of problems, issues, and opportunities and continue through the planning process by formulating, evaluating, and comparing alternatives. Various analyses are used to determine alternative performance and related impacts so that appropriate decisions may be made. The studies often require hydrologic/hydraulic, economic, environmental, and social performance and impact analyses. In most cases, varying sections within a district office or through a Project Delivery Team (PDT), perform these analyses independently with the reporting and visualization of modeling results using independent models. For the project study, coordination, file/data sharing, logistics, reporting of modeling results, and status reporting are often a problem for the PDT and modeling teams as well as project management.

USACE determined that there was a need to streamline and integrate the tools commonly applied by the district and division offices to perform water resources analyses so that more efficient, transparent, and coordinated modeling and planning can be performed. The Hydrologic Engineering Center (HEC) developed the Watershed Analysis Tool (HEC-WAT) to meet USACE requirements for performing water resources studies in a comprehensive, systems based approach. Modeling teams benefit because teams will be able to develop models in a closely coordinated manner using a shared schematic; track progress of other models; and, automatically retrieve results from previous model runs through the shared schematic, thus assuring a more efficient and coordinated result. A graphical user interface (GUI) allows for data and results sharing, facilitates the assembly of a common schematic; definition and representation of alternatives; model setup; editing and implementation; and, direct data and results visualization. The management team will benefit through the use of a tool that employs a common interface to track project status through each modeling component and to display results during public and project status meetings.

### Flood Risk Management

USACE flood risk management (FRM) policy requires that USACE analytical processes include methods and tools that employ integrated, comprehensive, systems and life-cycle based approaches and risk-based concepts in planning, design, construction, operations and major maintenance. These USACE methods need to incorporate systems response of projects when considering load distribution and failure possibilities. USACE policy also states that project performance needs to consider the system reaction to flood loading and how those loadings are distributed across the watershed. A new capability was needed to focus on sustainability and to employ adaptive planning and engineering capabilities. This new capability was also needed to incorporate new information and knowledge about a project throughout its life to ensure project

safety and performance requirements are addressed. From within USACE there is very little guidance and few tools to support these requirements. Also, limitations of the current process include difficulty in performing a system-wide risk assessment and incorporating a life-cycle approach.

HEC-WAT includes an option that analyzes complex riverine systems while implementing the flood risk management and systems requirements. Life-cycle analysis will be addressed in a later version of HEC-WAT. The compute option, Flood Risk Analysis (FRA), allows a user to perform plan formulation or system performance analyses while incorporating risk and uncertainty analyses.

The terminology, analysis procedures, and output for the FRA compute option are consistent with the following USACE guidance and requirements:

- ER 1105-2-100, "Planning Guidance Notebook" (22 Apr 2000), requires systems and life-cycle approaches
- ER 1105-2-101, "Risk Analysis for Flood Damage Reduction Studies" (11 July 2017), requires risk analysis for all flood damage reduction studies
- EM 1110-2-1619, "Risk-Based Analysis for Flood Damage Reduction Studies" (1 August 1996), specifies how to conduct risk analysis
- ER 1110-2-8159, "Life Cycle Design and Performance" (31 Oct 1997)
- ETL 1110-2-573, "Construction Cost Estimating Guide for Civil Works" (30 Sep 2008)

## 1.2 Purpose

The purpose of the HEC-WAT software is to help USACE study teams perform the necessary hydrologic, hydraulic, and consequence planning analyses that are required for water resource studies. The HEC-WAT framework allows a multi-disciplinary PDT to perform water resources studies in a comprehensive, systems based approach by building, editing and running models commonly applied by multi-disciplinary teams and saving and displaying data and results in a coordinated fashion. The terminology, analysis procedures, and output used by HEC-WAT are consistent with the requirements of USACE guidance and policy. HEC-WAT is designed to facilitate:

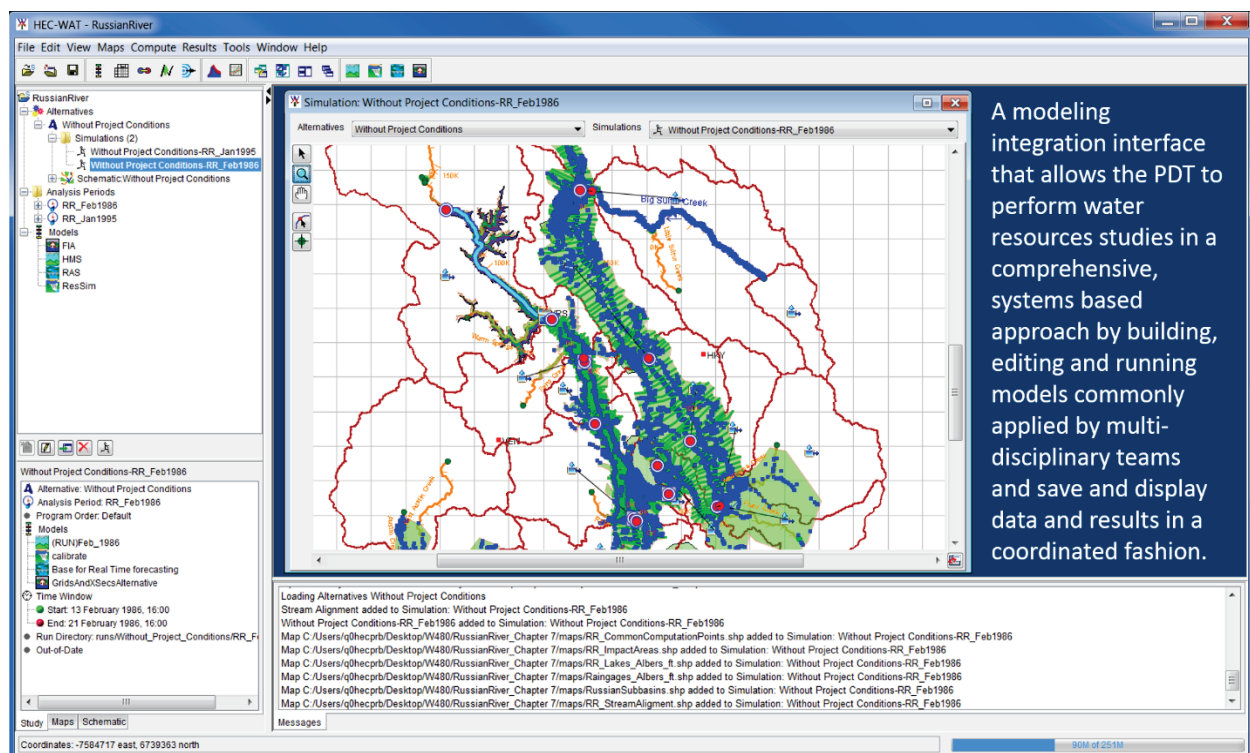
- Entry of the appropriate data into each of the modeling programs is incorporated into the HEC-WAT framework.
- Trade-off analyses among all study alternatives will eventually be a capability within HEC-WAT through the use of consistent schematics, data, and tools. Results will be easier to compare and contrast making the trade-off analysis easier to perform.
- The analytical process and enhanced coordination among study team members, while producing more consistent results, and displays.



- The definition of alternatives through schematic representations, model identification and sequencing, and tabular formatting.
- The assessment of study status by reviewing HEC-WAT outputs and reports.
- The review of modeling results at all modeled locations without the direct knowledge of how the individual models generate those results. Those attending meetings can view the results system-wide rather than reading the results for a few locations in a hard copy report or poster.

### 1.3 Overview of HEC-WAT

HEC-WAT is software that orchestrates the building, editing, and running of a series of models to help perform water resources studies while addressing the requirements prescribed by ER 1105-2-101. The software provides flexibility to offices in the performance of water resources studies (Figure 1.1). The software can be used to perform small CAP (Continuing Authorities Program) studies or large comprehensive studies. The HEC-WAT interface streamlines and integrates the analytical process of water resource studies by using the software tools commonly applied by multi-disciplinary teams. These software tools include hydrologic, hydraulic, economic, and social impact assessment models.



**Figure 1.1** HEC-WAT Study

The HEC-WAT tool allows USACE, partners, and stakeholders to conduct studies in a coordinated fashion. Coordination begins as each model uses the common schematic that is built within the HEC-WAT interface. The common schematic is a "road map" of the study area that provides each team with the agreed upon nomenclature for the study area which should be used

for each model and alternative. The individual models can be built and edited inside or outside HEC-WAT, or imported from CWMS (Corps Water Management System) or HEC-RTS (Real-Time Simulation) watersheds. Model results can be viewed from HEC-WAT by selecting elements found on the schematic. Once the models are located (i.e., importing models, building models) within an HEC-WAT study, the models can be run in a user defined sequence. The storage of data is organized by DSS (HEC's Data Storage System) and a simple DSS linking device is used to connect the models. The models, the input data, and the results are all stored in the HEC-WAT's directory structure. Therefore, all data and files used to make decisions are easily retrieved. Alternative analyses can be performed, and output from multiple alternatives can be viewed concurrently making alternative analyses and alternative selection more efficient.

### 1.3.1 Identifying a Study

An issue at the beginning of any project feasibility study is the definition of study extent, the without-base year alternative and the array of potential project alternatives. HEC-WAT helps to alleviate these issues by allowing the project study team to jointly define extents and alternatives through schematic representations, model identification and sequencing, and tabular formats.

The study team, under the direction of a Project Manager (PM), conducts an initiation meeting to introduce the team to the project and study objectives. The PM will also define the problems and identify opportunities within the study area. A typical study team could be composed of a PM, GIS (geographic information system) specialist, hydrologist, hydraulic engineer, geotechnical engineer, water manager (reservoir), economist (flood damage and other consequence such as life loss), biologist (water quality), and planner.

After locating the watershed boundary and identifying the problems and opportunities of the study, the team starts the analytical process by determining what data or models already exist and what data and models need to be developed. Other HEC software performs data management functions so that all required data is available in one location (DSS file) before a simulation is computed. HEC-WAT does not perform these data management functions (i.e., extracting, copying), therefore, if the study requires the use of observed, historical, or other model data, this data needs to be stored in DSS files. This requirement is based on the way HEC-WAT links model alternatives together and simulations are computed.

With a map in hand, the PM leads the study team on choosing the study boundaries, identifying gage locations, sub-basin delineations, locations where models can share data (common computation points), damage area centers, and location of measures (reservoirs, levees, etc.). Once this information has been identified, someone from the study team will be chosen to setup the base alternative (*Without Project Conditions*). This person should be someone with knowledge of the study area.

With the study area defined, the study team needs to identify any models that may already exist, what data is available, and what is the time window (analysis period) of the available data for the base alternative (*Without Project Conditions*). Once the base alternative is set the study team identifies names and gathers information for the additional alternatives. These alternatives could include the use of additional flood risk management measures, environmental features, or represent future conditions. The benefit of HEC-WAT is that each of the modeling teams is able

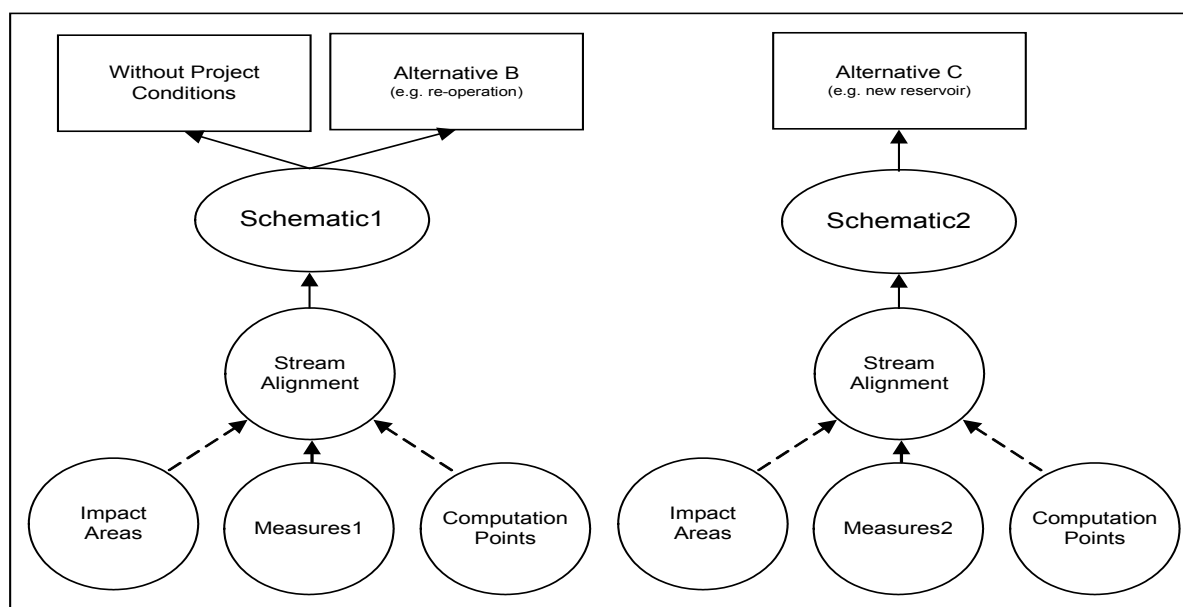
to use the identical schematic to perform their modeling with naming and other schematic elements (e.g., stream alignment) being consistent across all models. Each alternative is tied to a given schematic. Therefore, the alternative definitions are fully coordinated making for more consistent modeling and modeling results.

### 1.3.2 Creating a Study

After the PDT has identified the study area, an HEC-WAT study needs to be created (Figure 1.1). A **study**, in HEC-WAT is a combination of data, models, and events required to analyze a specific geographic area. The first step is to define the schematic for the base alternative, and then schematics for other defined alternatives.

A **schematic** is a physical representation of a watershed boundary, stream alignment, and the flood risk management and environmental measures to be modeled. One individual from the study team builds the schematic for the base alternative. The first basic item of an HEC-WAT schematic is the stream alignment, which is usually created by importing information from a map layer (shapefile) or alternatively constructed within HEC-WAT (Appendix F). Once a stream alignment has been constructed, and using the drawing tools available from within HEC-WAT or importing information from a map layer (shapefile), common computation points (Appendix H) and existing flood control or restoration measures (Appendix G) can be added to the schematic and is available across all models. To aid in the placement of elements on the schematic, background maps of gage locations, reservoir locations, sub-basin delineations, study boundary areas, etc. can be added to the study.

By default, HEC-WAT creates the base alternative – ***Without Project Conditions*** first. The study team has probably defined other alternatives that can be created, as well (Figure 1.2). An **alternative** in HEC-WAT is a way to group a schematic with different operations and model parameters. Once an alternative is created, the next step is to create analysis periods. **Analysis periods** define the time window (events) that could be associated with an alternative. An **event**



**Figure 1.2** Relationship of Alternatives and Schematics

is an occurrence of precipitation/snowmelt that leads to some sort of hydrologic response normally associated with a specific time period. The event can be historical or hypothetical or represent the upper limit of a precipitation runoff response.

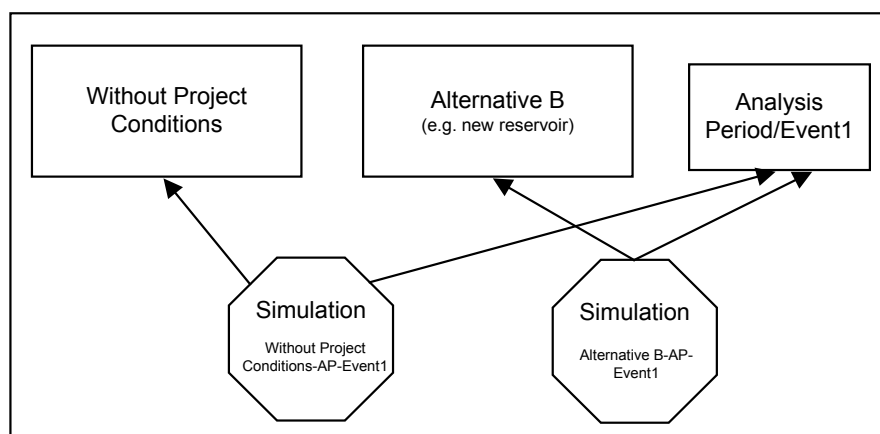
Now that analysis periods and alternatives have been defined (Chapters 9 and 10), existing models that have been identified for the study can be brought into the HEC-WAT study either by importing (Chapter 8) or copying the files into the HEC-WAT directory structure. If models are to be built, HEC-WAT provides two options. One is the ability to create the models through HEC-WAT by accessing the individual pieces of software directly from within HEC-WAT. The other option is to copy the files created by HEC-WAT to a computer, and then return the files to the HEC-WAT study once the models are calibrated and validated. For example, if the HEC-RAS (River Analysis System) model for a study needs to be built, within the HEC-WAT directory structure, an HEC-RAS folder exists which contains the default HEC-RAS project files. The user can copy these files to another computer, develop the HEC-RAS model, and then copy the files back to the HEC-WAT study.

From the individual models, HEC-WAT is interested in the individual model alternatives that have been defined. Each model has their own nomenclature for "alternative":

- HEC-HMS – run, simulation
- HEC-RAS – plan
- HEC-ResSim – alternative
- HEC-FIA - alternative

Throughout the rest of this User's Manual, all of the above will be referred to as "model alternative". For example, a RAS plan, from within HEC-WAT, is referred to as "RAS model alternative"

Once all the model alternatives have been added to the HEC-WAT study, simulations (Figure 1.3) can be created (Chapter 11). A **simulation** is a combination of an analysis period associated with an alternative. For each of these combinations, model alternatives need to be selected, a simulation computed, and results reviewed. The process is then repeated for the other identified alternatives, and after several HEC-WAT simulations, alternative result comparison can be reviewed.



**Figure 1.3** Relationship of Alternatives and Analysis Periods to Simulations

## 1.4 Starting HEC-WAT

When starting HEC-WAT, double-click the **HEC-WAT** icon on a user's desktop, or from the taskbar click **Start**, point to **All Programs**, point to **HEC**, point to **HEC-WAT**, and then click **HEC-WAT**. The splash dialog box for HEC-WAT opens (Figure 1.4).



The splash dialog box (Figure 1.4) appears for a few seconds, and then the main window of HEC-WAT appears. The user is now ready to start using HEC-WAT.



**Figure 1.4** HEC-WAT Splash Dialog Box

## 1.5 Organization of Manual

The organization of this manual is shown in Table 1.1. A description of the HEC-WAT framework and interface are provided in Chapters 2 and 3. Chapters 4 through 14 cover creating and computing a basic (deterministic) HEC-WAT study. Chapters 15 through 21 provide details on the HEC-WAT flood risk analysis (FRA) compute option. Appendix A contains the list of references for this manual. Appendices B through N provide more detailed information on specific items within the HEC-WAT framework. Appendix O is a glossary of terms used in this manual.

**Table 1.1**  
**Summary of Contents of User's Manual**

<b>If the user wants to find out...</b>	<b>Refer to...</b>
HEC-WAT Framework	Chapter 2
HEC-WAT Interface	Chapter 3
How to create and manage studies	Chapter 4
How to work with layers	Chapter 5
Building the base schematic	Chapter 6
Creating a basic HEC-WAT study	Chapter 7
Importing models	Chapter 8
Time Window – Analysis Periods	Chapter 9
Creating and managing alternatives	Chapter 10
Creating and managing simulations	Chapter 11
Model Linking	Chapter 12
Final Basic HEC-WAT Study Setup	Chapter 13
Computes and Alternative Analysis	Chapter 14
Flood Risk Analysis (FRA) Compute Option Overview	Chapter 15
Output Variable Editor	Chapter 16
Fragility Curve Sampler	Chapter 17
Models Skip Rules Editor	Chapter 18
Performance Metrics	Chapter 19
FRA Simulation Setup	Chapter 20
FRA Results	Chapter 21
Tools available from HEC-WAT	Appendix B
How to setup the coordinate system for map layers	Appendix C
Map editors	Appendix D
Using the Color Chooser	Appendix E
Stream Alignment	Appendix F
Measures	Appendix G
Common Computation Points	Appendix H
Impact Areas	Appendix I
How to use HEC-DSSVue	Appendix J
Model Integration Tools	Appendix K
How to edit model data	Appendix L
Plots	Appendix M
Printing and Copying Data	Appendix N
Glossary	Appendix O

# CHAPTER 2

## HEC-WAT Framework

A framework is a basic structure underlying a system or concept. In the case of HEC-WAT, the framework allows for linkage of stand-alone modeling software, orchestration of modeling inputs, and visualization of modeling outputs. The HEC-WAT framework and associated linked components allows for the various PDT disciplines to work together in a flexible and transparent environment to achieve a common goal. The HEC-WAT overarching framework allows a multi-disciplinary study team to perform water resources studies in a comprehensive, systems based approach. The HEC-WAT framework promotes the building, editing and running of models commonly applied by multi-disciplinary teams including the saving and displaying of data and results in a coordinated fashion. Performing a risk analysis in a systems approach is an underpinning of the HEC-WAT framework including the Flood Risk Analysis (FRA) compute option. The FRA compute option will analyze complex riverine systems while implementing the flood risk and uncertainty analysis and systems requirements. The HEC-WAT software will also allow a user to perform plan comparisons or system performance analyses while incorporating risk analysis methods.

### 2.1 Overview

The HEC-WAT software allows USACE to meet its primary mission of managing the nation's water resources in a holistic and comprehensive approach. HEC-WAT meets the planning perspective for a PDT by allowing the team to perform an alternative analysis in an intuitive and collaborative manner. This ease of use is provided by the HEC-WAT framework which improves a study team's ability to facilitate transfer of information, convene as a team, provide advice to stakeholders, and work collaboratively. The basic premise of HEC-WAT is to involve modelers early in the process, thus encouraging a collaborative team approach to conducting a water resources study. This coordination allows a study team to perform many of the necessary hydrologic, hydraulic, consequence, environmental, and planning analyses orchestrated from a single interface.

This central framework will allow study team members to: load GIS based layers shapefiles and DEMs (digital elevation model); establish stream networks and schematics; identify locations (common computation points) where models would share information; define the modeling software applications and their compute sequence order; import existing models; and, develop new models. The HEC-WAT framework will also aid in organizing and developing alternatives; provide the ability to access and execute modeling software applications directly; and, view and compare alternative results.

### 2.2 Plug-In Concept

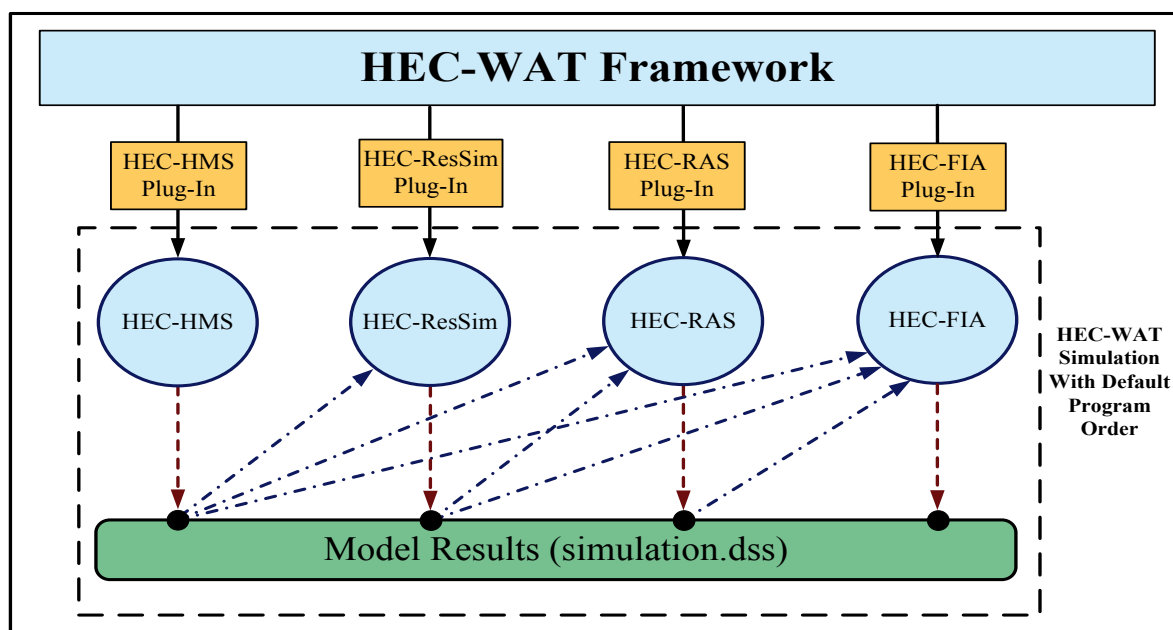
HEC-WAT is not replacing existing software but rather the framework allows unique and existing software to work together. The integration of the individual pieces of software within the HEC-WAT framework is achieved through the concept of a "plug-in". The plug-in is what

allows the individual pieces of software to integrate without requiring special code in HEC-WAT to support the individual pieces of software. There are numerous ways to implement plug-ins; therefore, the plug-in concept should not preclude a plug-in being developed for software that might be included in the HEC-WAT framework in the future. HEC-WAT provides the analysis framework but does not know anything about the individual pieces of software used. The individual pieces of software provide the technical mechanics within the framework (i.e., editing, reporting capability, computational analyses, etc.) and are not intended to contain any HEC-WAT specific code. Further details about the plug-in concept will be detailed in the HEC-WAT Technical Reference Manual (not available for Version 1.0).

## 2.3 HEC Software Integrated into HEC-WAT

The primary set of initial software to be used during the analytical process in HEC-WAT is shown in Figure 2.1. The set of software available is:

- HEC-HMS (Hydrologic Modeling System)
- HEC-RAS (River Analysis System)
- HEC-ResSim (Reservoir System Simulation)
- HEC-FIA (Flood Impact Analysis)



**Figure 2.1** HEC-WAT Framework - Basic

Other software and tools that are available with the HEC-WAT software include HEC-SSP (Statistical Software Package) and HEC-DSSVue (Data Storage System Visual Utility Engine).

### 2.3.1 Hydrologic - HEC-HMS

HEC-HMS (<http://www.hec.usace.army.mil/software/hec-hms/>) is a standalone software application that is designed to simulate the precipitation-runoff processes of dendritic watershed systems. The software is designed to be applicable in a wide range of geographic areas and is a



generalized hydrologic modeling system capable of representing many different watersheds to simulate either a single flood event or a continuous simulation that spans a couple of weeks or multiple decades. A model of the watershed is constructed by selected modeling methods for different components of the hydrologic cycle defining meteorologic boundary conditions. HEC-HMS in the HEC-WAT compute sequence is a hydrologic precipitation rainfall-runoff model that generally provides simulated flow at multiple locations within a watershed.

### 2.3.2 Reservoirs - HEC-ResSim

HEC-ResSim (<http://www.hec.usace.army.mil/software/hec-ressim/>) is a standalone software application that is used to model reservoir operations at one or more reservoirs whose rule-based operations are defined by a variety of operational goals and constraints. The software simulates reservoir operations for flood management, low flow augmentation and water supply for planning studies, detailed reservoir regulation plan investigations, and real-time decision support. HEC-ResSim in the HEC-WAT compute sequence is a reservoir simulation model that provides regulated flow hydrographs. Results from both HEC-HMS and HEC-ResSim can be used by the hydraulics model.

### 2.3.3 Hydraulics - HEC-RAS

HEC-RAS (<http://www.hec.usace.army.mil/software/hec-ras/>) is a standalone software application that allows the user to perform one- dimensional steady and unsteady flow and two-dimensional unsteady flow simulations. HEC-RAS also includes sediment transport/mobile bed computations and water temperature modeling. HEC-RAS contains four one-dimensional river analysis components for: (1) steady flow water surface profile computations; (2) unsteady flow simulation; (3) movable boundary sediment transport computations; and (4) water quality analysis. The HEC-RAS Mapper tool that is available from the HEC-RAS interface, calculates inundation boundary and water depth maps. HEC-RAS in the HEC-WAT compute sequence is a river hydraulic model that computes the river stages, water surface profiles, and levee breach information that is used to compute consequences by HEC-FIA.

### 2.3.4 Consequences - HEC-FIA

HEC-FIA (<http://www.hec.usace.army.mil/software/hec-fia/>) is a standalone software application that evaluates consequences using either continuously observed or simulated stage hydrographs (hydrograph-based) or depth grids (GIS-based). For a specified analysis, the software evaluates urban and agricultural flood damage, area inundated, number of structures inundated, and consequences. Consequences include economic and life loss. HEC-FIA also provides information to flood managers and emergency managers for emergency response activities.

## 2.4 Other Software

The plug-in concept allows study teams to add to the HEC-WAT framework other application software that may be required for a study. These additions can be made with minimal changes to HEC-WAT. Examples of additional software applications to HEC-WAT in the past are listed below:

- URC (Upper Rule Curve) - software used by CENWD for developing upper rule curves for storage reservoirs in the Columbia River Basin watershed.
- ECC (Energy Content Curve) - software used by CENWD for developing the guide curves (target pool elevations) for storage reservoirs in the Columbia River Basin watershed.
- Hydrologic Sampling - when an FRA compute is being performed, the hydrologic sampling will generate system-wide flood event samples for a Monte Carlo simulation. The data produced by the plug-in can take the form of hydrographs or hyetographs spanning the life-cycle of the system, usually fifty years (*USACE, CEIWR-HEC*).
- Fragility Curve Sampling – when an FRA compute is being performed and the HEC-RAS model alternative (plan) is setup for levee breaching, sampling of levee failure elevations from fragility curves is accomplished through the fragility curve sampling. This plug-in defines the probability and elevation of failure at each levee that is part of the system. Sampling is conducted and the result is an evaluation of the full range of levee failure possibilities for each pre-defined location in the entire system (*USACE, CEIWR-HEC*).
- Performance Metrics - risk for USACE is the measure of the probability and severity of undesirable consequences (ER 1105-2-101). From these analyses, the performance of a system's reaction to a flood must be reported. Performance and economic metrics describe the capability of the system to accommodate a single event (Assurance); the full range of events (Annual Exceedance Probability and Long-Term Exceedance Probability); and, the average or mean of all annual damage (Expected Annual Damage). These metrics assist in communicating risk and the Performance Metrics plug-in generates these metrics. Not all FRA studies require performance metrics (*USACE, CEIWR-HEC*).

The following sections detail the additional CEIWR-HEC software that has also been added to the HEC-WAT framework.

## 2.5 Tools

Tools are CEIWR-HEC software applications that are not part of the HEC-WAT compute sequence but are used by a PDT team during a water resources study. HEC-DSSVue (HEC Data Storage System Visual Utility Engine) is used to view the DSS files where each software application stores data. HEC-SSP (Statistical Software Package) might be used for statistically analyzing data in a water resources study.

### 2.5.1 HEC-DSSVue

HEC-DSSVue (<http://www.hec.usace.army.mil/software/hec-dssvue/>) graphs and tabulates data that is stored in a DSS file. Over sixty mathematical manipulation functions are available for operations on datasets within a DSS file, as well as data entry functions, and several utility and database maintenance functions. Data can be displayed from a selection of dataset names or

from spatially referenced locations with a map background. Common data stored in a DSS file includes time series data, such as hourly or daily flow, stages, precipitation, elevation, and storage data; curve data, such as rating tables and frequency curves; gridded data, such as NexRAD (Next-Generation Radar) data; and a variety of other data types.

## 2.5.2 HEC-SSP

HEC-SSP (<http://www.hec.usace.army.mil/software/hec-ssp/>) allows a user to perform statistical analyses of hydrologic data. The flood flow frequency analysis capability is based on Bulletin 17B, "Guidelines for Determining Flood Flow Frequency" (1982) and Bulletin 17C (England, et. al., 2015). The analysis includes a generalized frequency analysis on not only flow data but other hydrologic data as well, a volume frequency analysis on high and low flows, a duration analysis, a coincident frequency analysis, and a balanced hydrograph analysis.

## 2.6 How Does It All Work

The HEC-WAT framework allows for the linked application of the software commonly used by multi-disciplinary teams in a water resources study. Individual models are built for the study. For example, a PDT is conducting a water resources study and is using the following software - HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA. Section 2.6.1 describes the traditional approach to conducting a water resources study. Section 2.6.2 describes conducting a water resource study using HEC-WAT.

### 2.6.1 Traditional Approach

A PDT is conducting a water resources study and is using the following software - HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA. The HEC-HMS model for the study is built and run, which provides data about uncontrolled flows into and downstream of reservoirs. This information is stored to a DSS file.

Next an HEC-ResSim model is built and some of the required input would be results from an HEC-HMS model. The modeler will find the appropriate data in a DSS file and will link that DSS file to the HEC-ResSim model. The HEC-ResSim model is used to generate regulated flow/stages, flow hydrographs, or stage hydrographs which are stored to a DSS file.

The hydraulics model, built using HEC-RAS requires input that has been created by HEC-HMS and HEC-ResSim. The modeler will find the appropriate data in a DSS file and will link that DSS file to the HEC-RAS model. During an HEC-RAS compute, river stages, water surface profiles, hydrographs (unsteady analysis), and levee breach information, is stored to a DSS file. Also, RAS Mapper (a tool in HEC-RAS) calculates inundation boundary and water depth maps.

The last model required for this study is an HEC-FIA model which computes economic and life loss consequences. Depending on input requirements, HEC-FIA could require data from all of the upstream models. The modeler will need to find the appropriate data (possibly from multiple DSS files) and link the HEC-FIA model to the DSS files. HEC-FIA will evaluate urban and agricultural flood damages, area inundated, number of structures inundated, and life loss consequences.

With the traditional approach, there is typically insufficient coordination across the PDT as the individual models are constructed and simulated. Lack of coordination among the PDT can make data management of the study files difficult. Reporting and visualization of modeling results is also difficult because it is likely the individual models would have different naming conventions, could be built to different datum and extents, and may not provide results at locations needed by each model.

## 2.6.2 HEC-WAT Approach

A PDT is conducting a water resources study and is using the following software - HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA. An HEC-WAT study has been created with a schematic built by the PDT that will be used by most of the models. The models are brought in to the HEC-WAT study and all models files are imported or copied into the HEC-WAT data management system that is based on the HEC-WAT study name.

Now that all the models have been imported, simulations are created. For each simulation, the individual models are selected for a defined alternative. After the simulations are setup, "linking" between the models will need to be defined. Linking is the process within the HEC-WAT framework that allows the individual models to communicate with each other and how data is handed-off from model to model. The majority of linking in HEC-WAT is accomplished through DSS mapping and the use of simulation names. Additional linking capabilities include inundation boundary maps, water depth maps, and other DSS files.

For example, the HEC-ResSim model requires information from an HEC-HMS model. From the **Model Linking Editor** (Chapter 12), based on a particular simulation, the modeler will link the models. From a table that lists the available locations that were defined by the HEC-ResSim model, the modeler will select HEC-HMS as the model that has the information needed. Then the modeler will select the appropriate location/results from the HEC-HMS simulation to pass to

the HEC-ResSim model. Once completed, the linkage will be saved for the HEC-ResSim model. All of the software that was included within the HEC-WAT alternative simulation will need to be linked. Once all of the linking has been completed the simulation can be run.

The first model is an HEC-HMS model. The model is run and unregulated flows are saved to a DSS file (*simulation.dss*). The unregulated flow from HEC-HMS now becomes inflow to the HEC-ResSim model. Because of the linking that was defined earlier in the process, HEC-HMS information stored in *simulation.dss* is used by the HEC-ResSim model during the compute. At the same time the HEC-ResSim model is saving peak regulated flows/stages, flow hydrographs or stage hydrographs to the *simulation.dss* file. Once the HEC-ResSim model compute is complete, the HEC-RAS model begins running using HEC-HMS and HEC-ResSim information from the *simulation.dss* file. HEC-RAS is saving river stages, water surface profiles, hydrographs (unsteady analysis), and levee breach information to the *simulation.dss* file. HEC-RAS (through the RAS Mapper tool) is also creating inundation boundary and water depth maps, which are saved in the HEC-WAT study data management structure.

After the HEC-RAS model compute is complete the HEC-FIA model compute begins. Based on the linking, HEC-FIA will retrieve HEC-ResSim and/or HEC-RAS results from the

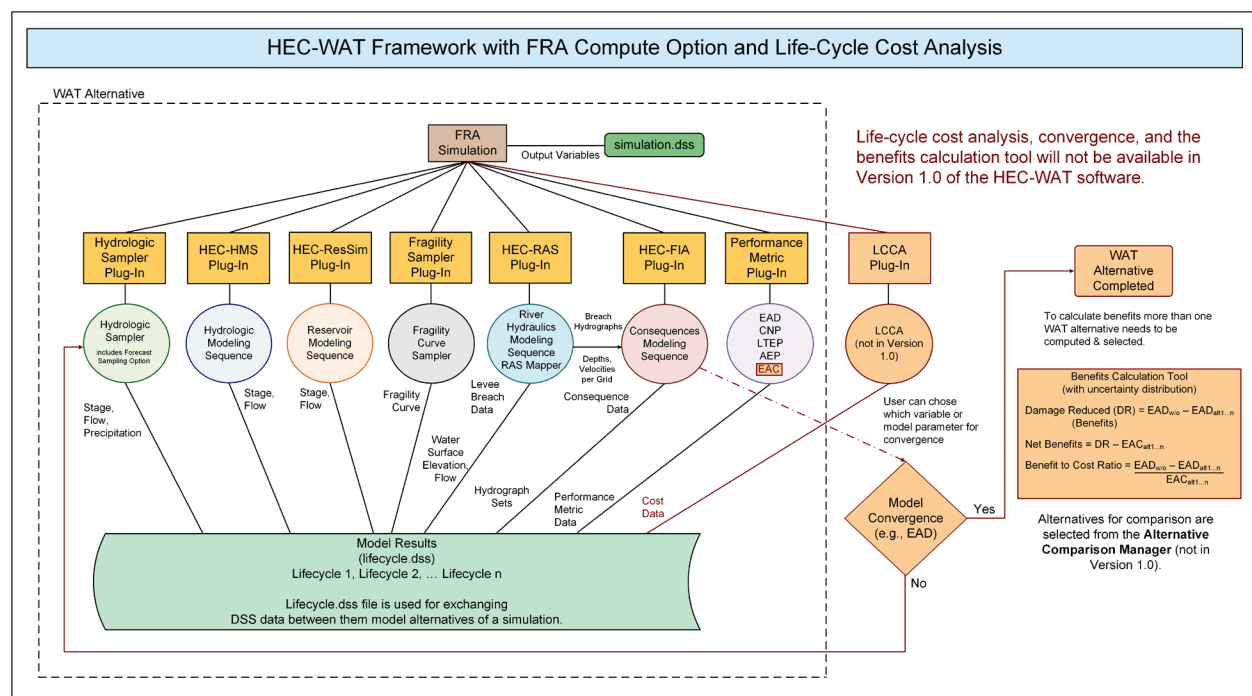
*simulation.dss* file and also will use the inundation boundary maps generated by HEC-RAS. Once the HEC-FIA model compute is complete the HEC-WAT simulation is complete and results can be reviewed from within the HEC-WAT framework.

With the HEC-WAT approach there is flexibility in the performance of water resources studies, the PDT is able to perform the study in a coordinated fashion, the data management of study files is centrally located within the HEC-WAT directory structure, alternative analyses can be performed easily and review of analyses results is from a central location.

## 2.7 Flood Risk Management

The HEC-WAT framework also includes a flood risk analysis (FRA) compute option (Figure 2.2), which provides tools that will help a planner address the issues faced during a USACE planning study, and specifically the requirement for systems, watershed, and uncertainty analyses. The FRA compute builds on the HEC-WAT framework to provide a convenient method of implementing a Monte Carlo analysis across multiple models for flood risk management. With the initial HEC-WAT framework providing all the initial software that would meet the needs of a performing a system-wide analysis, the FRA compute option allows a user to perform plan formulation or system performance analyses while incorporating risk and uncertainty capabilities. Chapter 15 provides further details on the flood risk analysis compute option.

**Note:** Not all the models shown in Figure 2.2 are required to run an FRA compute. An FRA compute could be configured with the Hydrologic Sampler and HEC-HMS only in the compute sequence. This shortened compute sequence could be used to simply evaluate how uncertainty around meteorologic information might impact flow frequency at locations within a watershed.



**Figure 2.2** HEC-WAT Framework - Flood Risk Analysis (FRA) Compute Option





# CHAPTER 3

## HEC-WAT Interface

The HEC-WAT main window (Figure 3.1) displays the framework for HEC-WAT that allows users to enter data, review data, create alternatives, run simulations, and view results. The **Title Bar** (Figure 3.1) displays the HEC-WAT study title. After a study is opened, the name of the study will appear in the **Title Bar**.

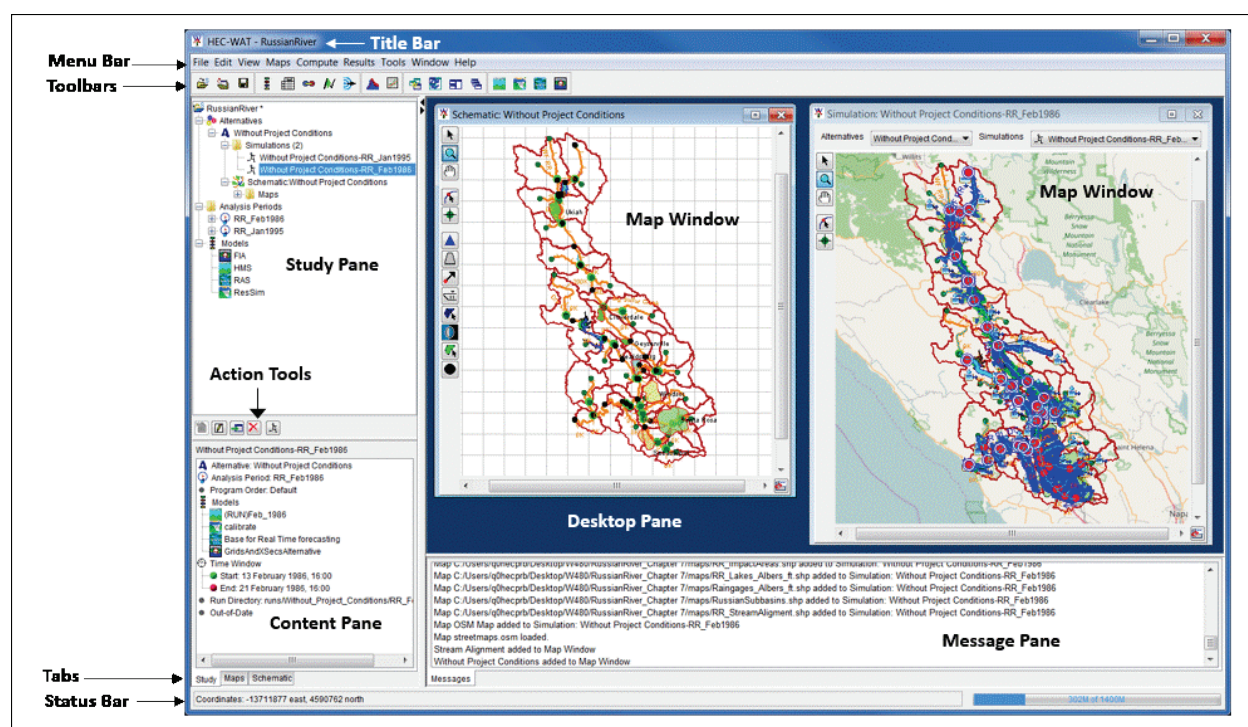
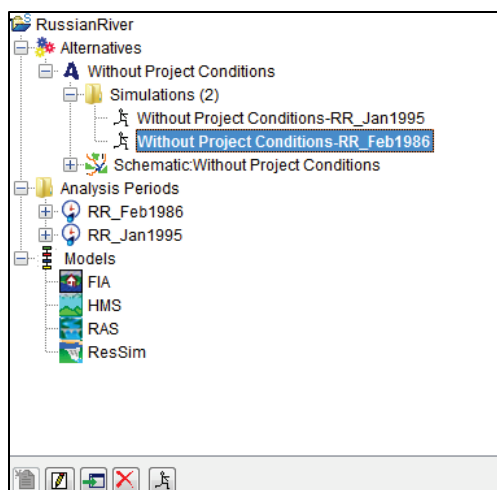


Figure 3.1 HEC-WAT Main Window

### 3.1 Panes

The HEC-WAT main window (Figure 3.1) is laid out in panes that allow the user to view HEC-WAT study components at the same time or to display different, yet simultaneous, views of study components. The HEC-WAT main window has four main panes. The panes are:

- Study Pane** Provides an overview of items that have been defined for an HEC-WAT study (Figure 3.2). Based on the view (see Section 3.2), the **Study Pane** can display information about alternatives; simulations; analysis periods; models that have been defined for the study; what map windows are actively open; the available schematics; stream alignments; measures; common computation points; and, impact areas.



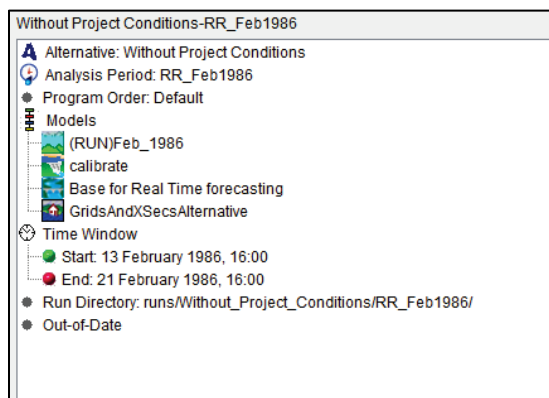
**Figure 3.2** Study Pane - Study View

The **Study Pane** contains a toolbar of action tools (Figure 3.3), that will allow the user to create, edit, display in a map window, delete, and, compute an item that has been selected in the **Study Tree** (Figure 3.2). For example, in Figure 3.2 a simulation has been selected and the available action tools (Figure 3.2) are edit, display in map window, delete, and compute the simulation.



**Figure 3.3** Action Toolbar

**Content Pane** This pane provides details on selected HEC-WAT components (Figure 3.3) in the **Study Pane** (see Section 3.2). For example, in Figure 3.4, for a study view, an HEC-WAT simulation has been selected – *Without Project Conditions-RR\_Feb\_1986*. The **Content Pane** displays the elements of that simulation. Information includes the alternative; the analysis period; the program order; the model alternatives that were run; the time window; the directory where the results from the simulation were written; and, the status of the simulation. For a map view, the **Content Pane** displays the layers associated with the selected map windows listed in the **Study Pane**.



**Figure 3.4** Content Pane - Study View



**Desktop Pane** The **Desktop Pane** (Figure 3.5) is where the different map windows that are available from HEC-WAT will display. For example, in Figure 3.5, the **Desktop Pane** contains a map window of a selected simulation and a map window of a selected schematic. These two map windows provide the user with a graphical representation of a simulation and a schematic.

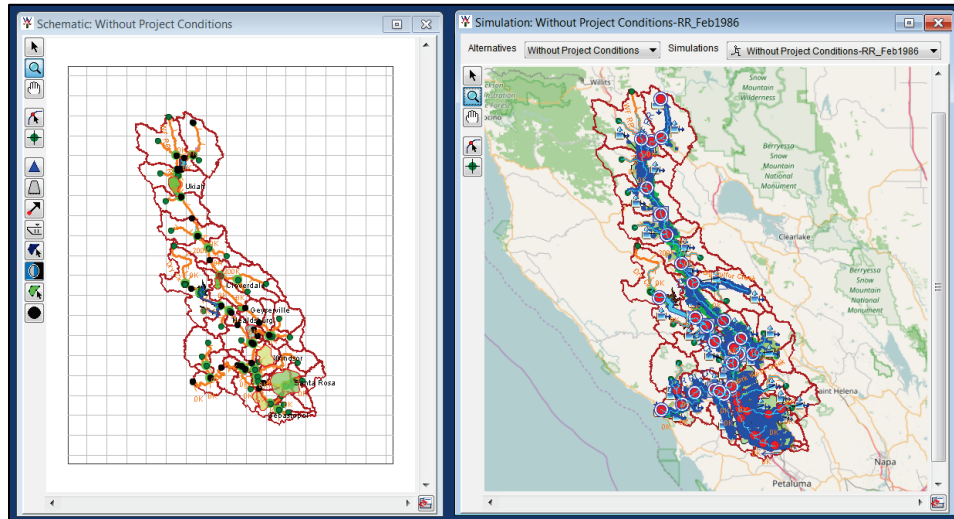


Figure 3.5 Desktop Pane

**Message Pane** The **Message Pane** (Figure 3.6) contains messages that the HEC-WAT software is providing for informational purposes as a simulation progresses. The information in the **Message Pane** is a record of HEC-WAT software activities, records the opening of a study, opening map windows, accessing DSS, and many other HEC-WAT activities.

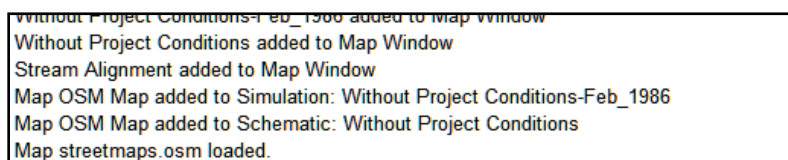
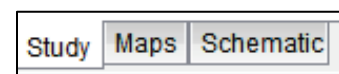


Figure 3.6 Message Pane

## 3.2 Tabs

HEC-WAT tabs provide different views of the available components of a study and users can perform certain operations for a study from the tabs. The tabs can change the layout of the menu bar and available information in the **Study** and the **Content** panes can be changed. There are three tabs:



**Study** The default tab (Figure 3.2) which provides a view of the study components in a tree (study tree) in the **Study Pane**. Also, from the **Study Tree** a user can create, edit, and delete alternatives, analysis periods, and simulations. From the **Content Pane** (Figure 3.4) the user can view detailed information about items listed in the **Study Tree**. This view also affects the HEC-WAT menu bar (see Section 3.3).

## Maps

This tab (Figure 3.7) provides a view (maps view) of the available map windows currently active in the **Desktop Pane** (Figure 3.5). The maps windows are displayed by type in the **Currently Opened Maps** pane (Figure 3.7). In the **Map Layers Tree** (Figure 3.7) information about the layers for a selected map window are displayed. From the **Map Layers Tree**, the user can turn map layers on/off, adjust properties of the map layers, and order the map layers for viewing in the associated map window. When the user switches to the **Maps** tab the HEC-WAT menu bar options will change.

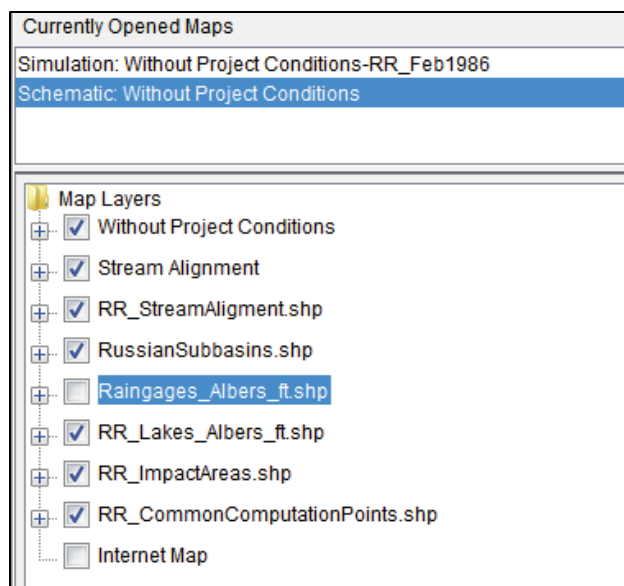


Figure 3.7 Maps Tab

## Schematic

From this tab (Figure 3.8), the user is provided with a view (a tree) in the **Study Pane** of the map layers that are available in the study, schematics that have been defined for the study, and available components - stream alignments, measures (levees, reservoirs), common computation points, and impact areas that have been defined for the study. Also, from the study tree, the user can create, edit, delete, and modify the elements in the **Schematic View**. In the **Content Pane** portion (Figure 3.8) further information is provided about elements in the **Schematic View**. When the user switches to the **Schematic View** the HEC-WAT menu bar options will change.

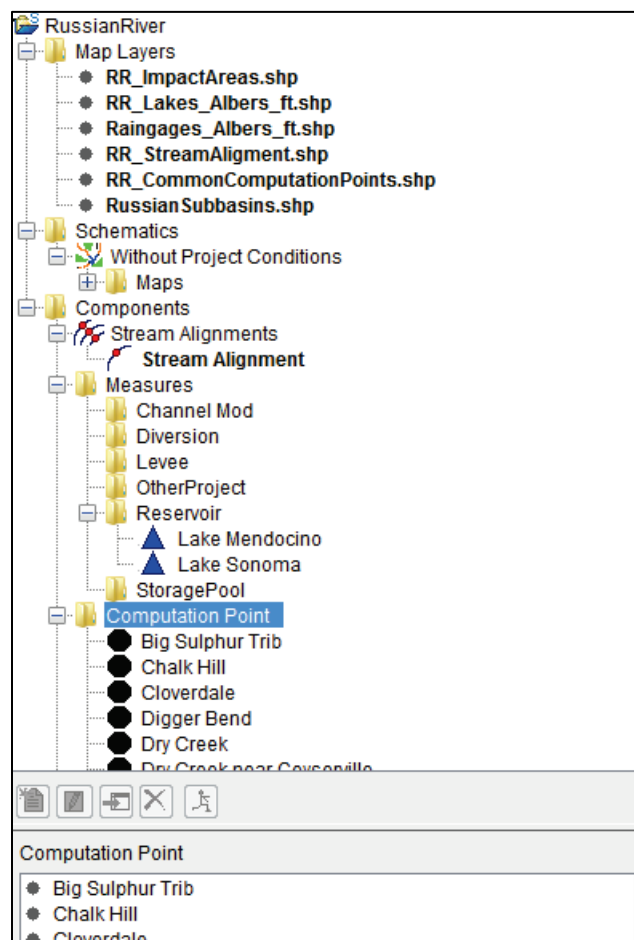


Figure 3.8 Schematic Tab

### 3.3 Menu Bar

The menu bar of HEC-WAT provides the user with many commands to perform various activities/functions.

The **File** menu (Table 3.1) allows the user to perform study management functions such as creating, opening, closing, and saving an HEC-WAT study. The **File** menu also provides commands that will allow users to provide information about the study team; select the software applications or tools (plug-ins) that are needed for the study; import a CWMS watershed; import other HEC software application's model alternatives (HEC-HMS, HEC-ResSim, HEC-RAS, HEC-FIA); open recently viewed HEC-WAT studies; and, exit the HEC-WAT software. The **File** menu is available in all HEC-WAT views.

**Table 3.1** HEC-WAT File Menu Commands

Commands	Description
New Study	Creates a new HEC-WAT study; opens the <b>Create New Study</b> dialog box.
Open Study	Open an HEC-WAT study; open the <b>Open Study Browser</b> .
Close Study	Closes the current HEC-WAT study.
Save Study	Saves the current HEC-WAT study.
Study Details	Opens the <b>Study Details</b> dialog box, has four tabs – <b>Map Properties, Contacts, Model Info, Simulations, Plugins</b> . Provides general information about the HEC-WAT study; user can turn on/off map window grids; and, change background color. The user can also add information about the study team; list the models and what study team member is responsible for a model's development; information about simulations; and, disable/enable the plug-ins that are needed for the HEC-WAT study.
Import	Menu items for importing into HEC-WAT: CWMS Watershed ; FIA; HMS; ResSim; RAS
Recent Studies	List the studies (last five) that have been opened.
Exit	Exit the HEC-WAT software.

From the **Edit** menu (Table 3.2) the HEC-WAT user can create/modify/edit items that are the building blocks of an HEC-WAT study. A user can manipulate alternatives and simulations; establish the program order for a study; link the individual models of a study; modify the look and feel of the common computation point layers (CCPs); provide aliases for the defined stream segments in the HEC-WAT study; available FRA editors; and, access editors from application software that are part of a study. The FRA specific editors allow the user to skip models during an FRA compute, and select variables to save to the simulation DSS file. The above description is available when in the **Study View**, the **Edit** menu in the other views is limited.

**Table 3.2** HEC-WAT Edit Menu Commands

Commands	Description
Alternative and Simulation Manager	Opens the <b>Alternative and Simulation Manager</b> dialog box.
Program Order	Opens the <b>Program Order</b> dialog box.
Model Linking Editor	Open the <b>Model Linking Editor</b> .
Edit Computation Point Layers	Opens the <b>Computation Point Layer Editor</b> .
Stream Reach Alias Editor	Opens the <b>Stream Reach Alias Editor</b> .
FRA	Menu items for FRA compute: <b>Model Skip Rules Editor; Output Variable Editor</b>

HMS	From this menu item the user can open the HEC-HMS software and also access individual HEC-HMS editors.
ResSim	From this menu item the user can open the HEC-ResSim software and also access individual HEC-ResSim editors.
RAS	From this menu item the user can open the HEC-RAS software and also access individual HEC-RAS editors.
FIA	From this menu item the user can open the HEC-FIA software and also access individual HEC-FIA editors.

The **View** menu (Table 3.3) is where an HEC-WAT user can setup the HEC-WAT main window. The user can select which toolbars and panes to display and not display; set display units for plotting and tabulating (English, SI); create and use layouts of the main window; manage layouts; which common computation point layer to display (Default, Fragility Curve); and, a report of the common computations point available for the study. The **View** menu is available in all HEC-WAT views.

**Table 3.3** HEC-WAT View Menu Commands

Commands	Description
Toolbars	From this menu item the user can toggles on/off the following toolbars that are available in the HEC-WAT framework: Standard, WAT Tools, Tools, Maps, Programs
Study Pane	Menu item that toggles on/off the <b>Study Pane</b> in the HEC-WAT main window.
Message Pane	Menu item that toggles on/off the <b>Message Pane</b> in the HEC-WAT main window.
Status Bar	Menu item that toggles on/off the <b>Status Bar</b> in the HEC-WAT main window.
Set Display Units	The user can set the display units for the HEC-WAT study - English (default) or SI.
Save Layout	Opens the <b>Create Layout</b> dialog box.
Restore Layout	This menu item provides a list of layouts that a user can choose from.
Layout Manager	Opens the <b>Layout Manager</b> dialog box.
Computation Point Layer	From this menu item the user can choose which common computation point layer is to be displayed - Default or Fragility Curve. The user can also select both layers.
Computation Point Layer Report	Opens the <b>List of Computation Point Layers</b> dialog box.

The **Maps** menu (Table 3.4), can be used by an HEC-WAT user to setup map layers and map windows for an HEC-WAT study. The user can set spatial properties; zoom the active map window out to its full extents; add and remove map layers; open a new map window; adjust the active map window's properties; save the contents of the active map window as a graphics file; and, synchronize the current open map windows. The user can also add an Internet map to the active map window, and view the map windows in either the watershed coordinate system or the coordinate system of the Internet map. Other available commands include the ability to print a copy of the active map window in the **Desktop Pane** (Figure 3.5); import various schematic elements (stream alignment, impact areas, reservoirs, levees, computation points) from a shapefile; and, export various schematic elements (stream alignment, impacts areas, schematic elements) to a shapefile. The **Maps** menu is available in all HEC-WAT views.

**Table 3.4** HEC-WAT Maps Menu Commands

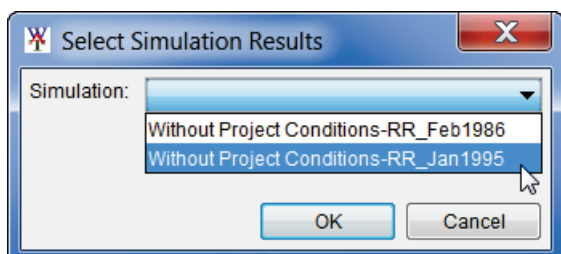
Commands	Description
Default Map Properties	Opens the <b>Default Map Properties</b> for dialog box.
Zoom to All	Menu item zooms to the full extents of the current map window.
Add Map Layers	Opens the <b>Select Map to Add Browser</b> .
Remove Map Layers	Opens the <b>Remove Map Layers from Study</b> dialog box.
New Map Window	Opens a map window that displays the map layers selected for the HEC-WAT study.
Map Window Properties	Opens the <b>Map Window Settings</b> dialog box.
Save Map Image	Opens a <b>Save Browser</b> that allows the user to save the active map window as a graphic (*.wmf, *.jpg, *.png).
Sync Map Windows	Menu item syncs the open map windows in the Display Area.
Add Internet Map	Menu item provides a list of available Internet maps that can be included as a layer in the HEC-WAT study: Google Street Map                      Bing Satellite Map Google Satellite Map                  Open Street Map Google Terrain Map                    No Internet Map
Display Map Coordinates	Menu item allows the user to toggle on/off the map coordinates for the map window. Can be based either on a selected Internet map or the study projection (default).
Print Map	Opens a <b>Print</b> window that allows the user to make a printed copy of the active map window.
Import	Menu item that allows the user to import schematic elements from shapefiles: Stream Alignment, Computation Points, Reservoirs, Levees, Impact Areas
Export	Menu item that allows the user to export define schematic elements to shapefiles: Stream Alignment, Impact Areas, Schematic Elements (opens the <b>Export Schematic Layers</b> dialog box)

The **Compute** (Table 3.5) menu is used to compute individual HEC-WAT simulations; compute multiple simulations; view a list of simulations for the watershed that have been computed; compute the active simulation or compute the individual models of the active simulation; and, view the compute log for the active simulation. For an HEC-WAT study with multiple FRA simulations there is an item for simulation failures. The **Compute** menu is only available in the **Study View**.

**Table 3.5** HEC-WAT Compute Menu Commands

Commands	Description
Compute " <i>simulation name</i> "	Menu item that computes the active HEC-WAT simulation.
Compute Manager	Opens the <b>Compute Manager</b> dialog box.
Recent Simulations	Menu item that list HEC-WAT simulations that have been computed; opens the <b>Run FRA Simulation – "<i>simulation name</i>"</b> dialog box.
Simulation Failures	Opens the <b>Compute Failures for "<i>simulation name</i>"</b> dialog box; FRA compute only
Compute	Menu item that allows the user to compute the active simulation or compute the individual models of the active simulation.
View Compute Log	Opens the compute log for the active simulation dialog box.

An HEC-WAT simulation must be selected for the **Results** menu to be active. If a simulation has not been selected, from the **Results** menu, click **Select Simulation**, the **Select Simulation Results** dialog box will open (Figure 3.9). From the **Simulation** list, select the simulation that will be active. Click **OK**, the **Select Simulation Results** dialog box will close (Figure 3.9), and a simulation **Map Window** will display in the **Desktop Pane**. The user will now be able to select results items from the **Results** menu.



**Figure 3.9** Select Simulation Results Dialog Box

The **Results** menu can be different based on the simulation type – deterministic or an FRA simulation. For a deterministic simulation (Table 3.6) the user can view the *simulation.dss* file and view results available from the individual models that were part of the simulation.

**Table 3.6** HEC-WAT Results Menu Commands – Deterministic Simulation

Commands	Description
Simulation DSS File	Opens a <b>DSS Viewer</b> dialog box.
HMS	Menu items that lists available HEC-HMS reports.
ResSim	Menu items that lists available HEC-ResSim reports.
RAS	Menu items that lists available HEC-RAS reports.
FIA	Menu items that lists available HEC-FIA reports.

When an FRA simulation (Table 3.7) has been run, the user selects what results will be shown based on realization, lifecycle, and event; view the *simulation.dss* file for the FRA simulation; view (Histogram, Scalar, or Frequency) the various model output variables that the user selected (Output Variable Editor); results from the hydrologic sampling (if part of the FRA simulation); results from the fragility curve sampling (if part of the FRA simulation); results from the individual models that are part of the simulation; and, performance metric results (i.e., EAD, AEP, LTEP) if part of the FRA simulation.

**Table 3.7** HEC-WAT Results Menu Commands – FRA Simulation

Commands	Description
Select Results ( <i>realization, lifecycle, event</i> )	Opens the <b>Select Event Results</b> dialog box.
Simulation DSS File	Opens a <b>DSS Viewer</b> dialog box.
Output Variables	User can view the various model output variables that were selected; view either by the <b>Histogram Viewer</b> , <b>Scalar Viewer</b> , or <b>Frequency Viewer</b> .
Hydrologic Sampling	Available hydrologic sampling results are: <b>Plot Hydrographs</b> , <b>Plot Event Distribution</b> , <b>Plot Maximum Flows</b> , <b>Correlation Table</b> , <b>Plot Shape Set Frequency</b> , <b>Output Report</b>
Fragility Curve	Available fragility curve sampling results are: <b>Plot</b> , <b>Output Report</b>

HMS	Menu items that lists available HEC-HMS reports.
ResSim	Menu items that lists available HEC-ResSim reports.
RAS	Menu items that lists available HEC-RAS reports.
FIA	Menu items that lists available HEC-FIA reports.
Performance Metrics	Depending on what the user has selected in the performance metrics alternatives, available results are: a series of EAD plot/reports ( <b>Plot EAD, EAD Output Report</b> ); <b>AEP Histogram</b> ; <b>LTEP Histogram</b> ; <b>Performance Metrics Output Report</b>

The **Tools** menu (Table 3.8) provides access to DSS data (HEC-DSSVue); access to the Statistical Software Package (HEC-SSP); provides options for HEC-WAT (Appendix F); view the log for HEC-WAT, view logs for DSS files and the individual models that are part of a simulation; monitor memory usage; what graphic elements HEC-WAT knows about from the other applications; information on how the different model alternatives are used for the study; setup for distributed computing; and, if a simulation is running slowly, setup compute timings to locate where slow down is occurring. The **Tools** menu is available in all HEC-WAT views.

**Table 3.8** HEC-WAT Tools Menu Commands

Commands	Description
HEC-DSSVue	Opens the HEC-DSSVue application.
HEC-SSP	Opens the HEC-SSP application.
Options	Open the <b>Options</b> dialog box.
Console Output	Opens the <b>Console Window</b> which contains the HEC-WAT log for the study.
Logs	Opens the <b>DSS.log</b> dialog box and the log files for the individual models that are part of simulation.
Memory Monitor	Opens the <b>Memory Monitor</b> window.
Graphic Elements	Opens the <b>Graphic Element Report</b> .
Model Alternative Usage	Opens the <b>Model Alternative Usage</b> dialog box.
Simulation Compute Engine Manager	Opens the <b>Simulation Compute Engine Manager</b> dialog box.
Compute Timings	Opens the Compute Timings dialog box.

The **Window** menu (Table 3.9) is where the HEC-WAT user can control the appearance of the map windows in the **Desktop Pane** (Figure 3.1) of the HEC-WAT main window. The **Window** menu is available in all HEC-WAT views.

**Table 3.9** HEC-WAT Window Menu Commands

Commands	Description
Tile	Menu item that allows the user to organize all of the currently opened map windows in either a vertical or horizontal tile.
Cascade	Menu item that allows the user to place one map window on top of the next in a cascading fashion.
Next Window	Menu item that brings the next map window in the list of currently opened map windows to the top.
Previous Window	Menu item that brings the previous map window that was on top to the top.
Window Selector	Menu item that provides a list of the currently opened map windows.
Window	Menu item that lists the currently opened map windows.

The **Help** menu (Table 3.10) allows the user access to HEC-WAT documentation; install the example study; connect to the HEC-WAT web page; connect to the HEC website; and, display current version information about HEC-WAT.

**Table 3.10** HEC-WAT Help Menu Commands

Commands	Description
HEC-WAT Quick Start Guide	Opens the HEC-WAT Quick Start Guide.
HEC-WAT User's Manual	Opens the HEC-WAT User's Manual.
Hydrologic Sampling User's Manual	Opens the Hydrologic Sampling User's Manual.
Install Example Study	Opens the <b>Select Folder for Installing Example Study Browser</b> .
HEC-WAT Website	Goes to the HEC-WAT web page.
HEC Website	Goes to the HEC website.
About HEC-WAT	Opens the About Box for HEC-WAT.

## 3.4 Toolbar

The toolbar area of the HEC-WAT main window (Figure 3.1) provides quick access to the most frequently used options from the HEC-WAT menu bar. There are six available toolbars from the main toolbar:

**Standard** There are three tools available from the **Standard** toolbar (Figure 3.10). The tools allow the HEC-WAT user to open a study, close a study, and save a study. These tools have the same function as items under the **File** menu (see Table 3.1).



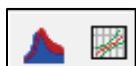
**Figure 3.10** Standard Toolbar

**WAT Tools** There are several tools available from the **WAT Tools** toolbar (Figure 3.11). The tools allow the user to set the program order for HEC-WAT; to manipulate alternatives, analysis periods, and simulations; link the individual model alternatives; set up rules to skip models during an HEC-WAT compute; and, select results from the individual models (output variables) that will be saved.



**Figure 3.11** WAT Tools Toolbar

**Tools** The tools available from the **Tools** toolbar (Figure 3.12) are variable depending on what plug-ins are loaded. Two tools that are always available are: access DSS data (HEC-DSS) and the Statistical Software Package (HEC-SSP).



**Figure 3.12** Tools Toolbar



**Maps** There are four tools available from the **Maps** toolbar (Figure 3.13). The tools allow the HEC-WAT user to control the appearance of map windows in the **Desktop Pane** (Figure 3.5) - create a new map window; synchronize active map windows; tile; and, cascade. These tools have the same function as items under the **Window** menu (see Table 3.9).



**Figure 3.13** Maps Toolbar

**Programs** There are usually four tools available from the **Programs** toolbar (Figure 3.14) that represent the individual software applications available from HEC-WAT: HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA. These tools allow the user to directly open the selected software application's user interface from within HEC-WAT. The tools available from the **Programs** toolbar are dependent on which plug-ins are loaded.



**Figure 3.14** Programs Toolbar

To toggle these toolbars on and off, from the HEC-WAT menu bar, from the **View** menu, point to **Toolbars**, and select the toolbar the user wishes to toggle on and off.

## 3.5 Map Windows

Map windows (Figure 3.15) are used to graphically display stream alignments, schematics, alternatives, and simulations. From an alternative map window the user can make adjustments to the stream alignment. A schematic map window allows the user to edit, modify, and delete measures, CCPs, impact areas, and make adjustments to the stream alignment. The simulation map window is where the HEC-WAT user can edit individual model parameters and view results.

### 3.5.1 Open a Map Window

There are a couple of ways to open map windows: from the **Study Pane** (Figure 3.2), double-click on a stream alignment, schematic, alternative, or simulation; or, from the shortcut menu of a stream alignment, schematic, alternative, or simulation.

To open a map window by double-clicking:

1. From the **Study** and **Schematic** tabs the user can double-click on stream alignments, schematics, alternatives, or simulations to open map windows in the **Desktop Pane**.
2. For example, in Figure 3.16, from the **Study** tab, double-click on the *Without Project Conditions-RR\_Feb1986* simulation. A map window will open and display the model elements for the simulation *Without Project Conditions-RR\_Feb1986*.

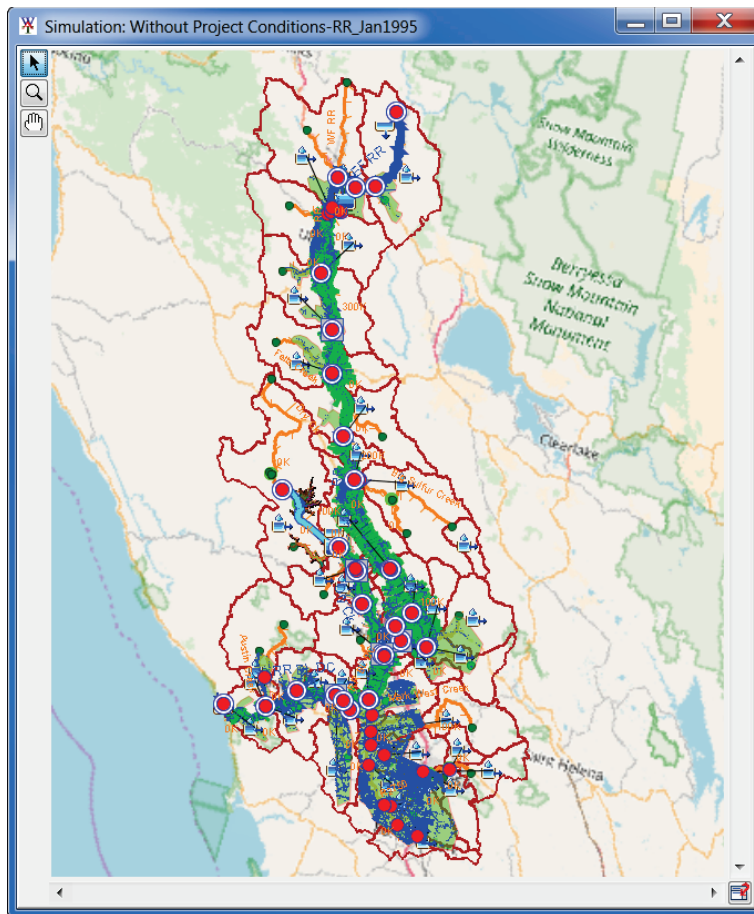


Figure 3.15 Map Window

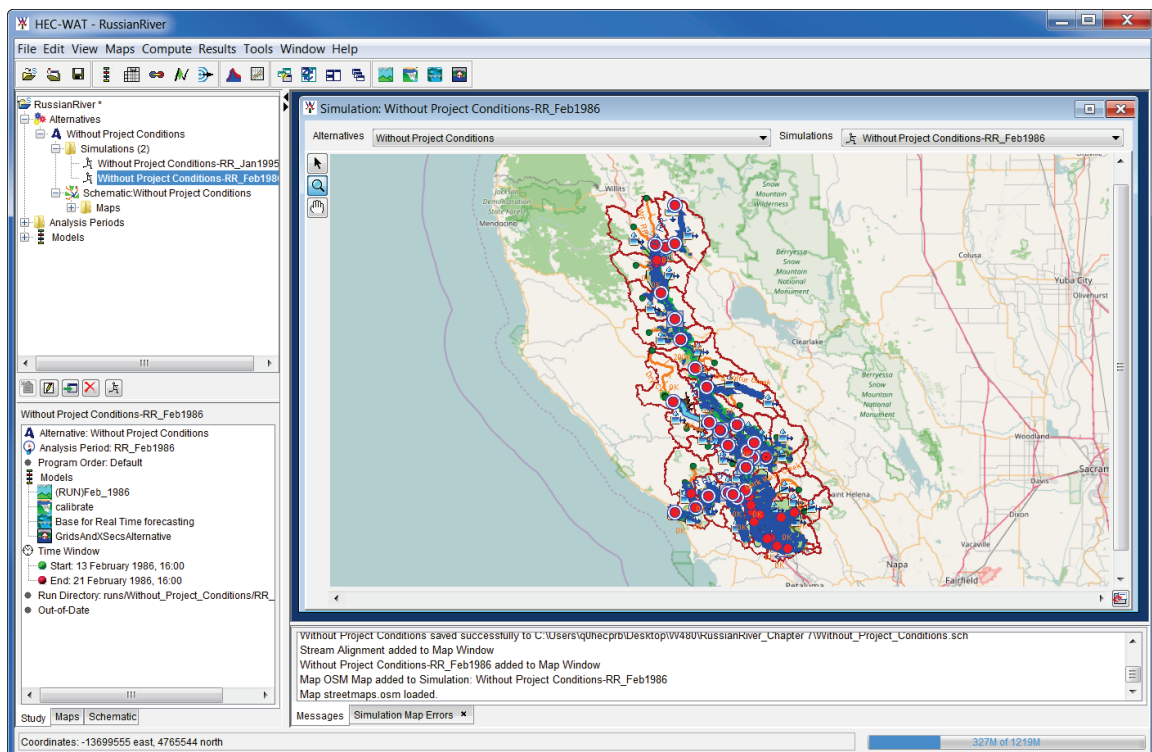


Figure 3.16 Display Simulation Map Window from Study Pane

To open a map window from a shortcut menu:

1. From the **Study** and **Schematic** tabs, from the shortcut menus available for stream alignments, schematics, alternatives, or simulations the **Display in Map Window** command will open map windows in the **Desktop Pane**.
2. For example, in Figure 3.17, from the **Schematics** tab, right-click on *Stream Alignment*. From the shortcut menu, click **Display in Map Window** and a map window will open displaying the elements for the stream alignment.

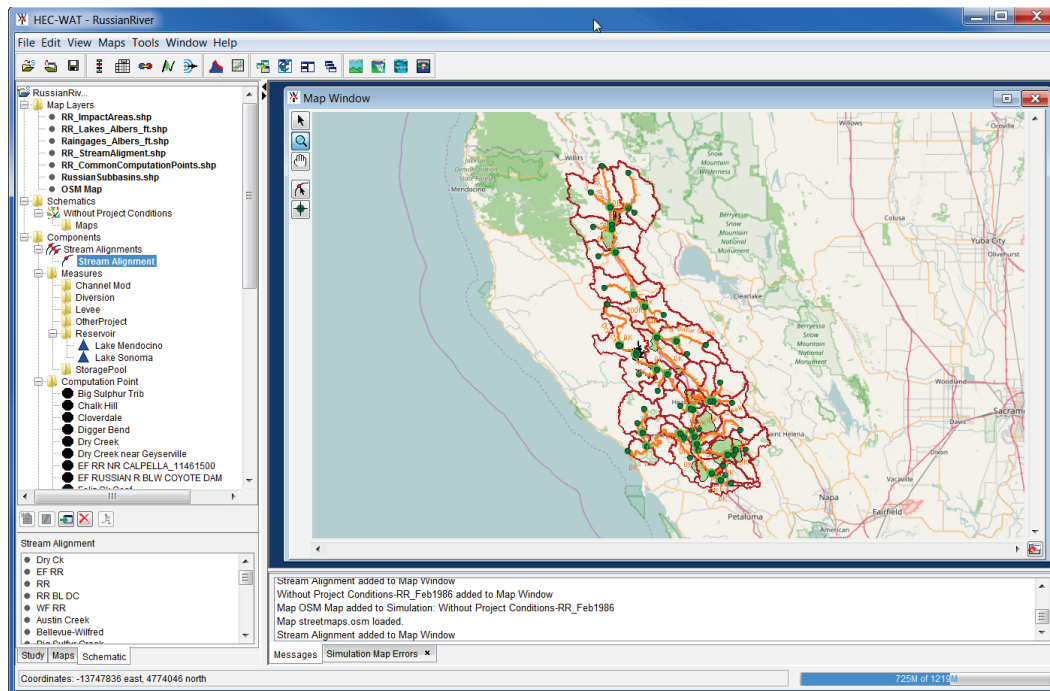


Figure 3.17 Display Stream Alignment Map Window from Schematic Tab

### 3.5.2 New Map Window

HEC-WAT provides a mechanism for the user to build a map window. Instead of double-clicking on a simulation, alternative or schematic the user can build a new map window.

To create a map window:

1. From the **Maps** menu, click **New Map Window**, in the **Desktop Pane** a **Map Window** will open (Figure 3.18), with the map layers for the study loaded.
2. From the **Study** and **Schematic** tabs the user can drag-n-drop stream alignments, schematics, alternatives, and simulations on to a new map window. For example, in Figure 3.18, from the **Schematic** tab on the **Study Pane**, click on the *Without Project Conditions* schematic. Holding down the left mouse button, drag the schematic to the map window. Release the mouse key, and the schematic for the *Without Project Conditions* is displayed in the new map window, and the map window will now be a schematic map window (Figure 3.19).

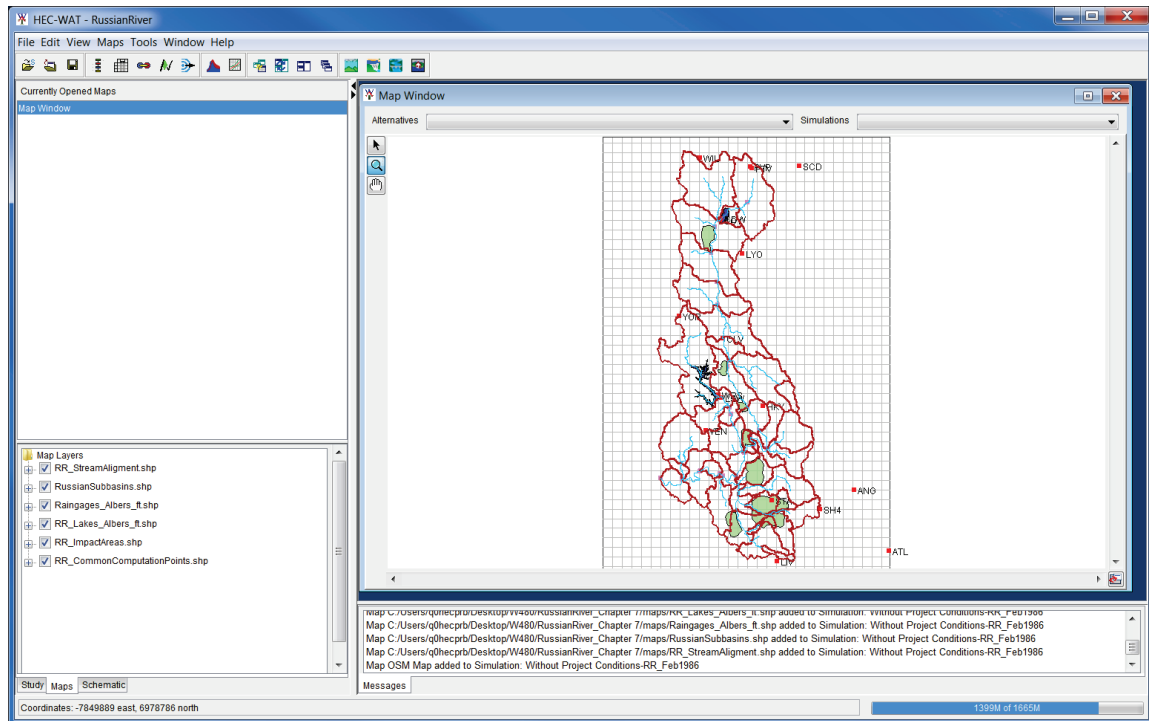


Figure 3.18 New Map Window

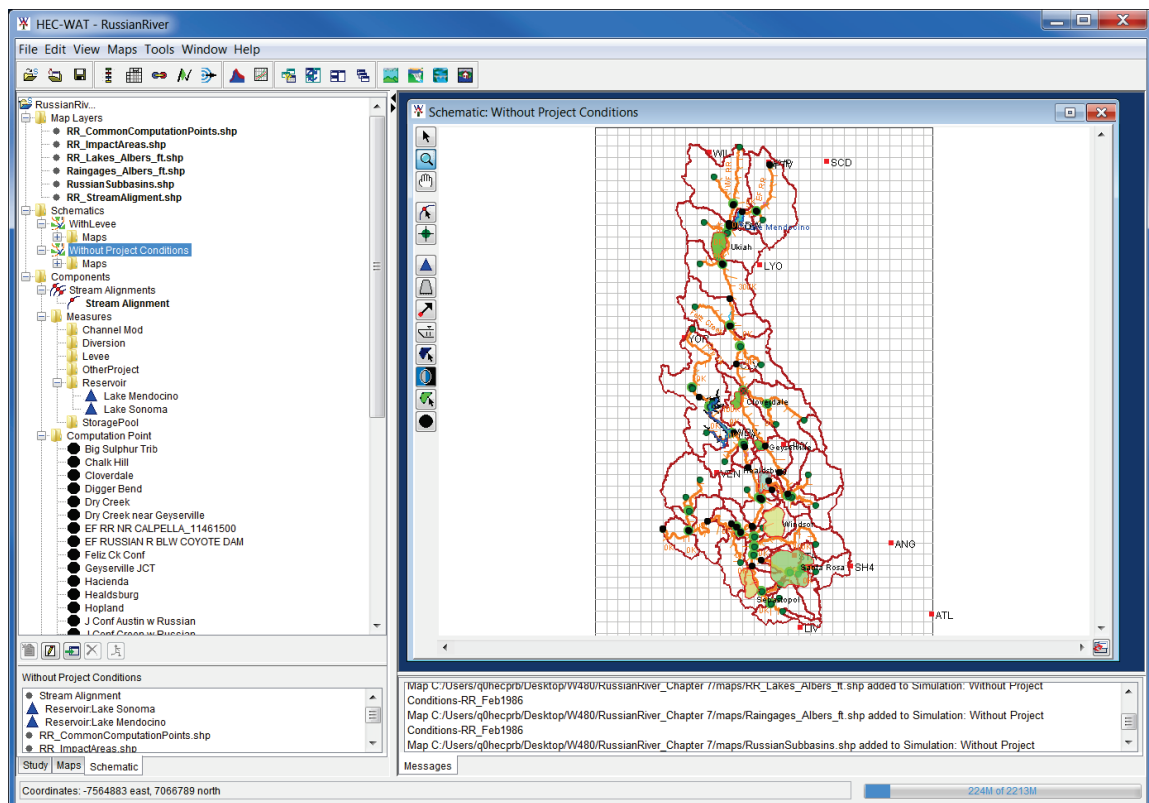


Figure 3.19 New Map Window with Schematic Added

3. To add an alternative to the **Map Window**, from the **Study** tab, on the **Study Pane**, from the **Alternatives** list, select an alternative. Holding down the left mouse button, drag the alternative to the map window. The elements that make-up the selected alternative will now display in the new map window and the map window will now be an alternative map window.
4. The user can save the map window by saving the study. This means that the next time the user opens the study, the map window created will display.

### 3.5.3 Tools

The **Tools** appear in a toolbar on the left side of a **Map Window** (Figure 3.18). The tools change the appearance of the mouse, as well as the functionality of the mouse.



#### Pointer/Selector Tool

The **Pointer/Selector Tool** is available on all HEC-WAT map windows. For a **Simulation Map Window** (Figure 3.16), with this tool selected the user can right-click on model graphical elements from the schematic displayed in the **Simulation Map Window** and from the shortcut menu view results or edit model elements. When a **New Map Window** (Figure 3.18), an **Alternative Map Window**, or a **Schematic Map Window** (Figure 3.19) are selected, with this tool selected the user can right-click on the map window and from the shortcut menu edit the properties of the map window; zoom to the full extents; duplicate the map window; and, detach the map window.



#### Zoom Tool

The **Zoom Tool** is available on all HEC-WAT map windows and allows the user to view data closely. To zoom in, with the **Zoom Tool** selected, hold the mouse button down and outline the area the user wants to enlarge. To zoom out, click the right mouse button (right-click). The zoom out is done by a factor of two and positions the clicked location at the center of the display area.



The **Pan Tool** is available on all HEC-WAT map windows and allows the user to move in map windows while zoomed in.

All of the other tools available from a **Schematic Map Window** (Figure 3.19) are described in Chapter 6, Sections 6.3 and 6.4



### 3.5.4 Zoom with Mouse

In HEC-WAT map windows, if the user has a mouse with a wheel, the user can zoom in and out on a map window by manipulating the mouse wheel.



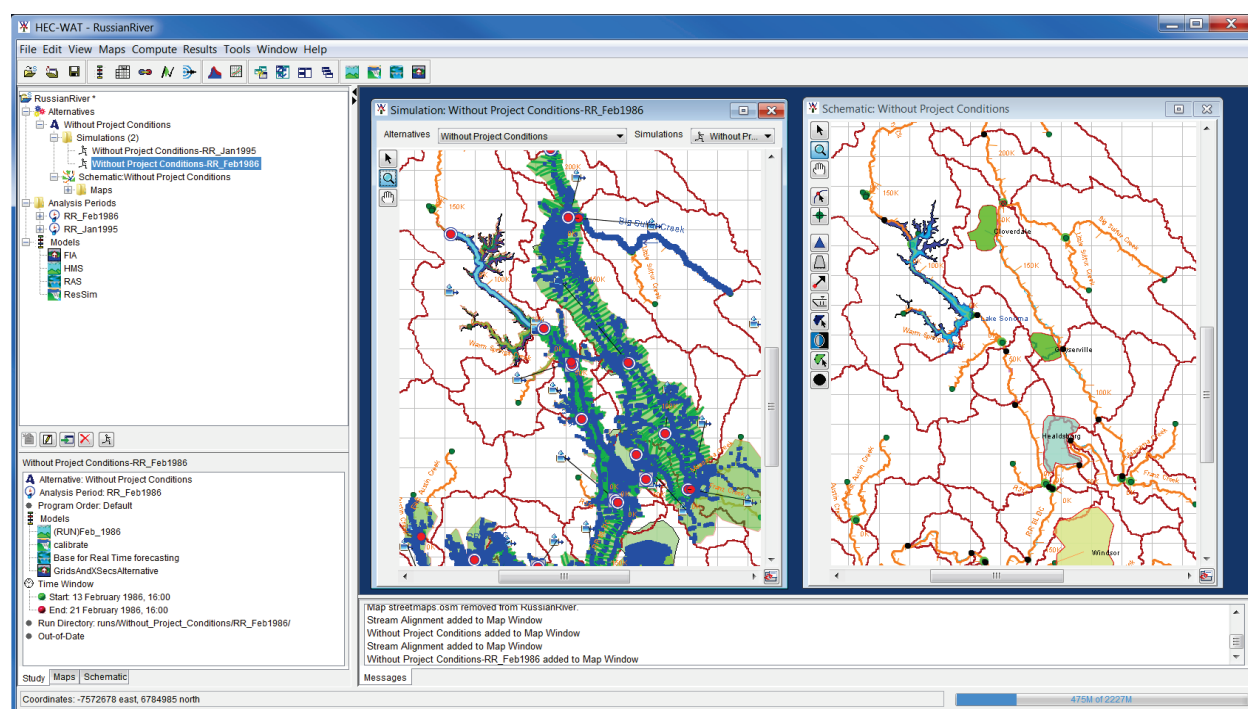
### 3.5.5 Detaching a Map Window from the Desktop Pane

When a map window is opened, the map window is confined to the **Desktop Pane** of the HEC-WAT main window. When several map windows are open, the user can use commands (Section 3.2) to arrange the map windows, but being able to view several map windows for comparison and presentation becomes difficult.

HEC-WAT allows the user to detach a map window from the **Desktop Pane**, and then the user can manipulate the map window outside of the HEC-WAT framework. This gives the user the ability to manipulate the map window as needed for better presentation and communication. From a map window (Figure 3.19), in the bottom right corner, there is a **Detach Map Window** tool , click the **Detach Map Window** tool, and the tool changes to , now the user can move the map window anywhere in the available display area. Clicking the **Detach Map Window** tool will return the map window to the **Desktop Pane** on the HEC-WAT main window.

### 3.5.6 Synchronous Map Windows

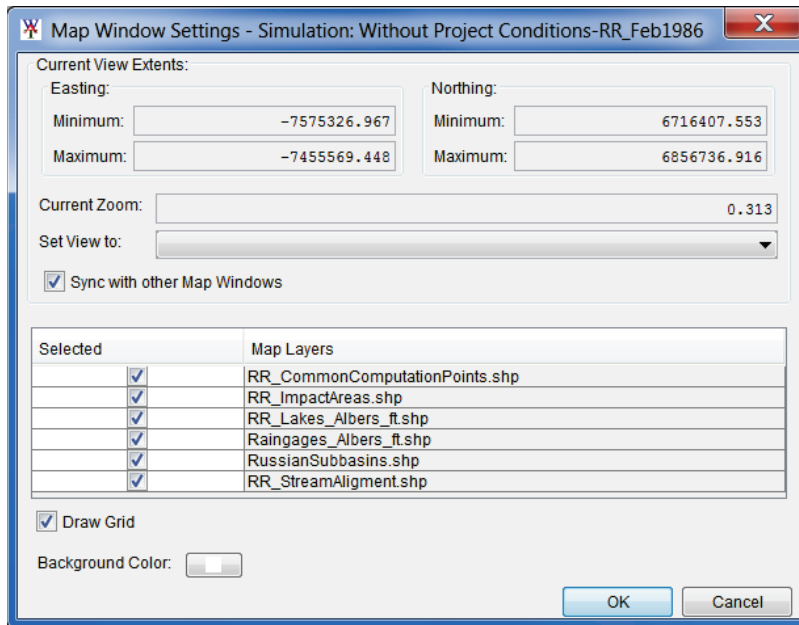
The user can synchronize multiple map windows, which allows a user to review items in one map window and then be able to view the same area of the watershed in another map window. Open multiple map windows (Figure 3.19), for this example, a **Simulation Map Window** and a **Schematic Map Window** have been opened. From the HEC-WAT main window and from the **Window** menu, select **Tile**, the map windows should appear side-by-side as displayed in Figure 3.20. Using the **Zoom** tool in the **Simulation Map Window**, zoom-in on an area of the watershed. From the **Maps** menu, click **Sync Map Windows**. Now the two map windows are synchronized, so any action done by the user in one map window will also happen in the other map windows.



**Figure 3.20** Synchronized Map Windows

### 3.5.7 Properties of a Map Window

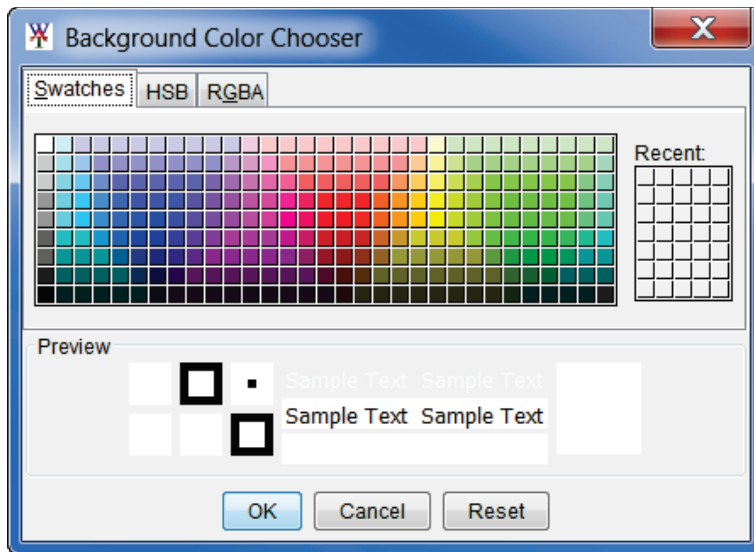
The properties of a map window basically are the geographic extents (Chapter 5, Section 5.2.5), the zoom factor, the available map layers, the grid, and the background color. The **Map Window Settings** dialog box (Figure 3.21) provides this information and allows the user to edit some of the map window's properties.



**Figure 3.21** Map Window Settings Dialog Box

To edit and view map window properties:

1. From the **Maps** menu, click **Map Window Properties**, the **Map Window Settings** dialog box will open (Figure 3.21).
2. From the **Current View Extents** box, the user can view the extents of the map window and the current zoom factor.
3. The map layers associated with the active map window are listed in the table on the **Map Window Settings** dialog box (Figure 3.21). The user can remove a map layer from the active map window by clicking in the **Selected** column. For example, in Figure 3.19, if the user does not want to display the map layer associated with the impact areas, click the cell in the **Selected** column associated with *RR\_ImpactAreas.shp*. Click **OK**, the **Map Windows Settings** dialog box will close (Figure 3.21), and the map layer will no longer display in the active map window.
4. By clicking **Draw Grid** (Figure 3.21) the grid that is displayed in the active map window is turned off and on.
5. The default background color for the active map window is white. By clicking **Background Color** (Figure 3.21); a **Background Color Chooser** will open (Figure 3.22). From the **Swatches Tab** click on a color, click **OK**, the **Background Color**



**Figure 3.22** Background Color Chooser

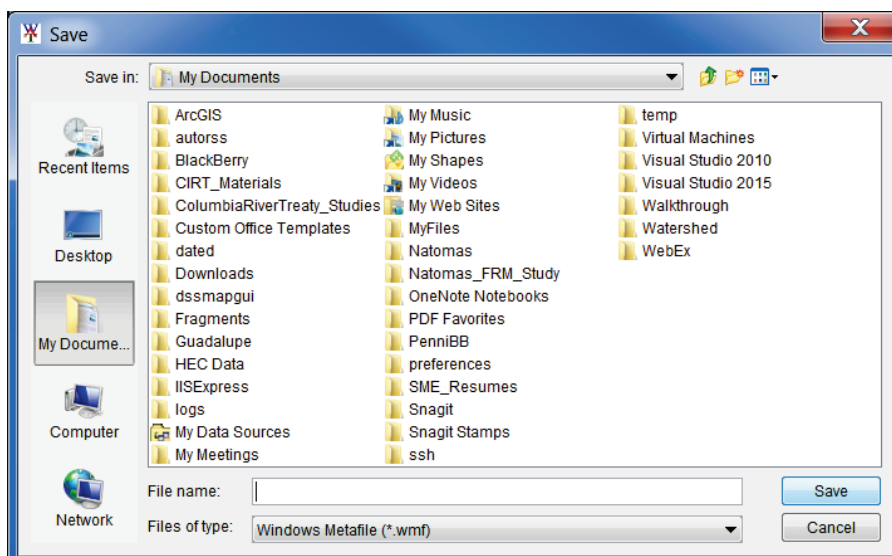
**Chooser** (Figure 3.22) will close. See Appendix F for further details on the color chooser. From the **Map Windows Setting** dialog box (Figure 3.20), click **OK**. The **Map Windows Setting** dialog box will close and the background color of the active map window will change.

### 3.5.8 Create a Graphics File of a Map Window

HEC-WAT allows the user to save the active map window to a graphics file for inclusion in reports and presentations. HEC-WAT has three possible formats: Windows Metafile (\*.wmf), JPEG (\*.jpg, \*.jpeg) and Portable Network Graphics (\*.png) which is the default.

To create a graphics file of the active map window:

1. From the **Maps** menu, click **Save Map Image**, a **Save Browser** will open (Figure 3.23).



**Figure 3.23** Save Browser

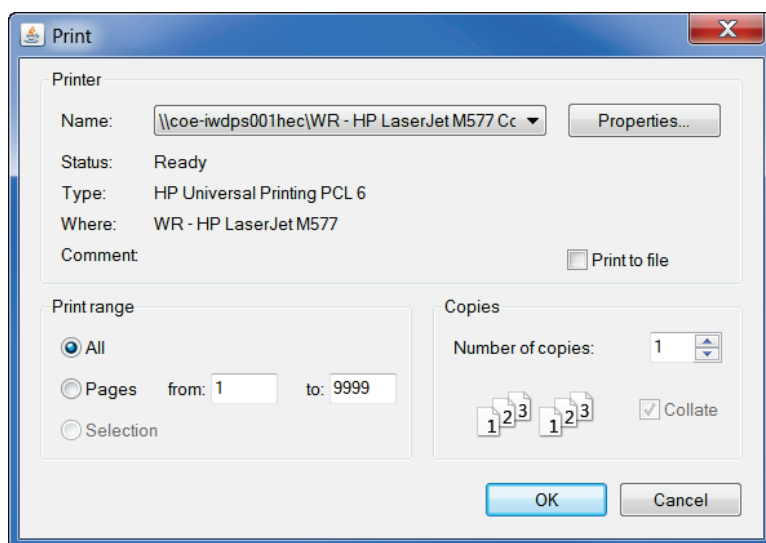


2. Browse to a location where the file will be saved, in the **File name** box type a name. From the **Files of type** list select the graphics file type to create.
3. Click **Save**, the **Save Browser** will close (Figure 3.23), and a file with the appropriate extension will be created in the selected location. The file will contain an image of the active map window.

### 3.5.9 Print a Map Window

From HEC-WAT a user can print the contents of the active map window. Make sure that the correct map window that the user wants to print is active before executing the following steps:

1. From the **Maps** menu, click **Print Map**, a standard system **Print** dialog box will open (Figure 3.24).



**Figure 3.24** Print Dialog Box

2. Choose a printer from the **Name** list (list of system printers), set options for the selected printer (click **Properties**), print to a file, select number of copies, and enter a print range.
3. Click **OK**, the **Print** dialog box will close (Figure 3.24) and output of the map window will print on the selected printer. See Appendix N for further details on printing from the HEC-WAT



# CHAPTER 4

## Manage Studies

Data management by HEC-WAT is largely done behind the scenes. Files are automatically created and named by HEC-WAT, and the active software application utilized within the HEC-WAT framework, to store information. Simulation information is stored in various DSS files (dependent on the type of simulation), while HEC-WAT general information, alternative descriptions, and simulation descriptions are all stored in ASCII text files.

### 4.1 Manage Studies

In HEC-WAT, the set of files associated with a particular water resources study is called a **study**. HEC-WAT creates a directory (folder) with the study name specified, and stores all the files associated with the study in that directory.

Commands available from the **File** menu (Figure 4.1) allow the user to create a new study; open an existing study; close the current study; save the current study; provide details about a study; import models into a study; select a study from the most recently opened studies; and, exit HEC-WAT.

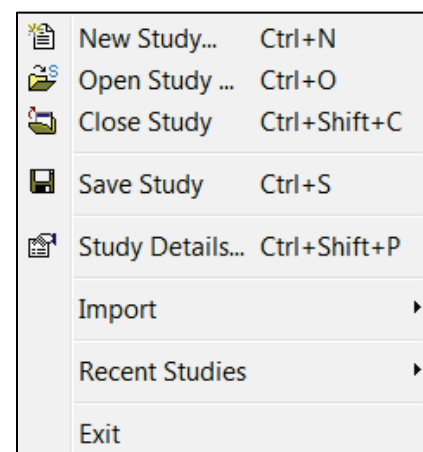


Figure 4.1 File Menu Commands

#### 4.1.1 Create a New Study

1. From the HEC-WAT main window, from the **File** menu, click **New Study**. The **Create New Study** dialog box (Figure 4.2) will open.

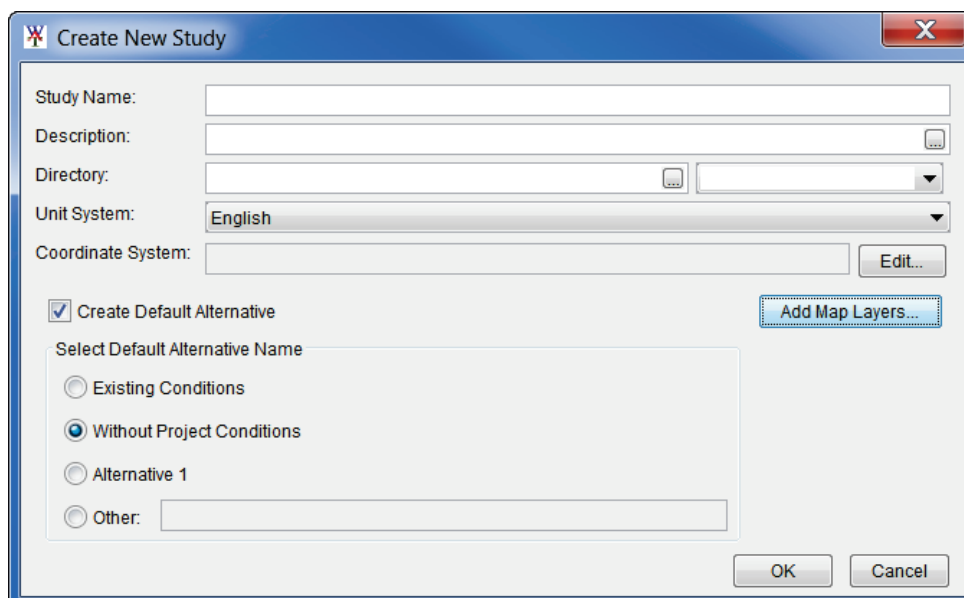

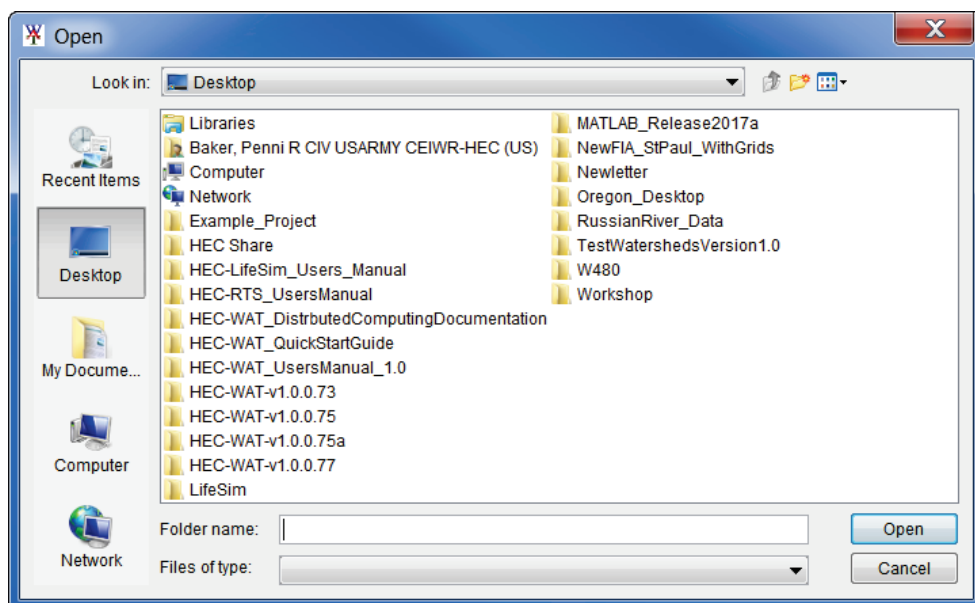


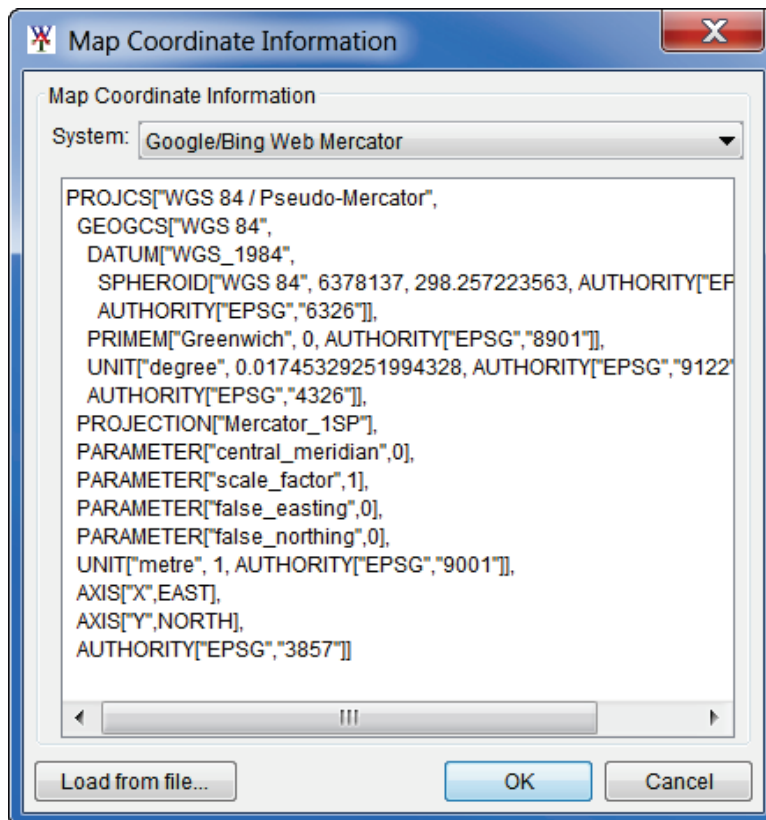
Figure 4.2 Create New Study Dialog Box

2. In the **Study Name** box (Figure 4.2), enter a name and in the **Description** box, enter a description of the new study.
3. In the **Directory** box (Figure 4.2), either enter the name of the directory where to store the HEC-WAT study, or click , and an **Open** browser (Figure 4.3) will open. Navigate to the directory where the HEC-WAT study will be stored, click **Open**. The **Open** browser (Figure 4.3) will close. On the **Create New Study** dialog box (Figure 4.2) in the **Directory** box the location will display.



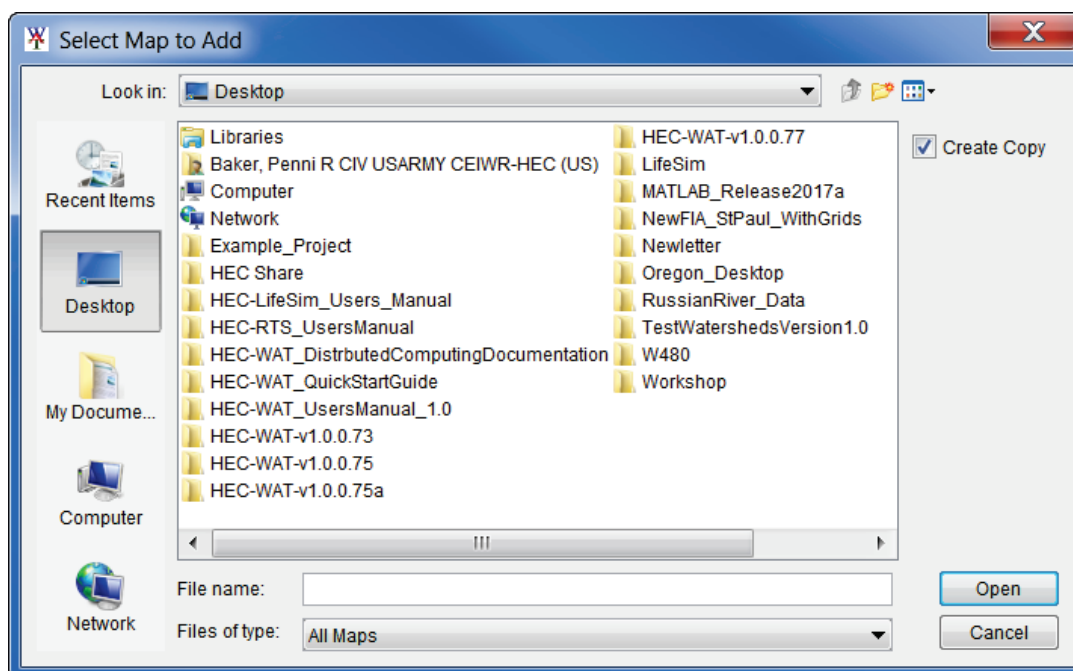
**Figure 4.3** Open Browser

4. The **Unit System** (Figure 4.2) for the study defaults to **English** (which is correct for the *RussianRiver* study). The other choice from the list is **SI** (metric).
5. Next, the projected coordinate system of the study needs to be set. A map projection is required to view locations from a curved surface on to a flat map. HEC-WAT will re-project on-the-fly, but it is a good idea to have all the layers in the same projection. From the **Create New Study** dialog box (Figure 4.2), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure 4.4).
6. If the study has at least one associated map layer that has the correct projected coordinate system for the study, that map layer can be used to set the projected coordinate system for the study. From the **Map Coordinate Information** dialog box (Figure 4.4), click **Load from file** (lower left corner of dialog box); an **Open** browser (Figure 4.3) will open. Browse to where the map layer containing the correct projection is stored. Click **Open**, now the **Map Coordinate Information** dialog box will contain information about the projected coordinate system (Figure 4.4). Click **OK**, the **Map Coordinate Information** dialog box will close (Figure 4.4). Now on the **Create New Study** dialog box the **Coordinate System** box (Figure 4.2) contains the name of the projected coordinate system (i.e., *USA\_Contiguous\_Albers\_Equal\_Area\_Conic\_USGS\_version*) for the study.



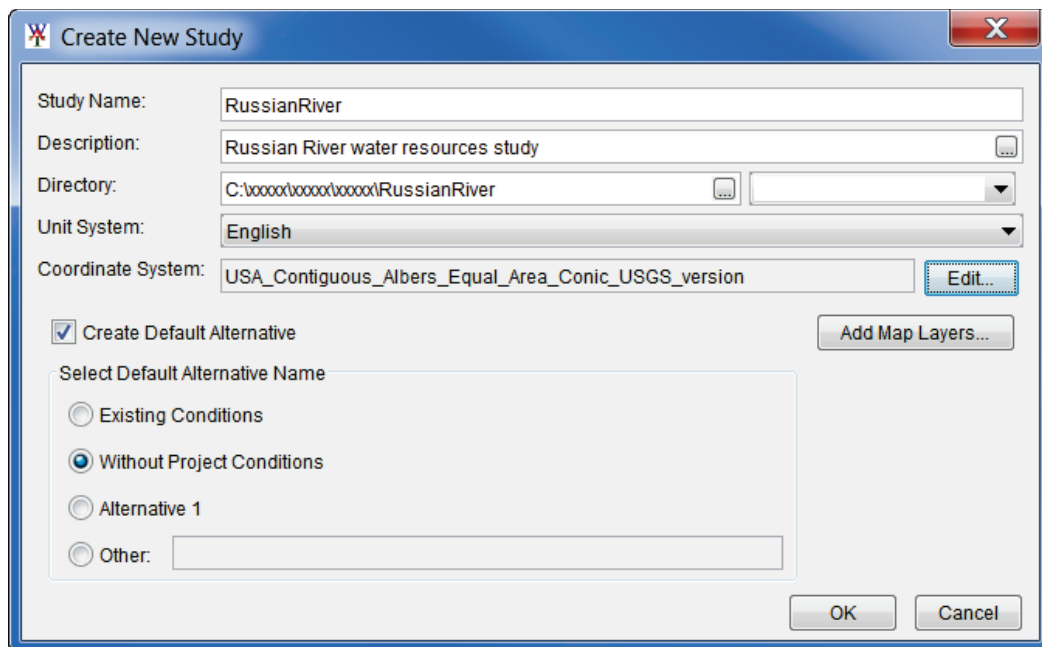
**Figure 4.4** Map Coordinate Information Dialog Box with Study Projection Information

7. When creating the study the user can add map layers that the PDT has gathered for defining the study area. From the **Create New Study** dialog box (Figure 4.2), click **Add Map Layers**. The **Select Map to Add** browser will open (Figure 4.5).



**Figure 4.5** Select Map to Add Browser

To copy map layers to the study directory area, from the **Select Map to Add** browser (Figure 4.5), select **Create Copy**. Browse to where the map layers are located. Select the map layers for the study. Click **Open**, the **Select Map to Add** browser will close (Figure 4.5). The **Create New Study** dialog box (Figure 4.6) appears.



**Figure 4.6** Create New Study Dialog Box - Completed

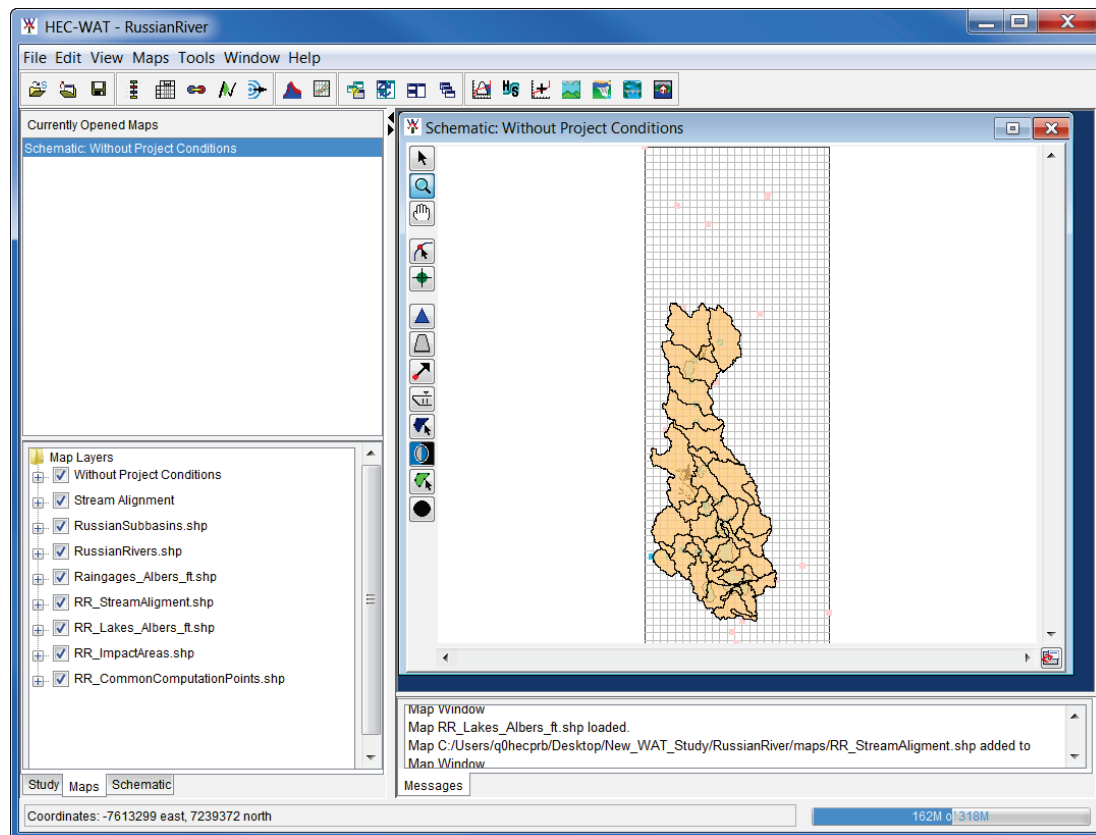
8. HEC-WAT creates a default alternative - *Without Project Conditions*. If the user wants the default alternative to have a different name, several choices are available, including **Other** which allows the user to name the default alternative.
9. Click **OK**, the **Create New Study** dialog box will close (Figure 4.5). The HEC-WAT main window will now have the name of the study (i.e., *RussianRiver*) on the title bar (Figure 4.7). A **Schematic Map Window** opens, which contains the map layers that were added to the study in Step 7.
10. An HEC-WAT study has been created.

### 4.1.2 Open an Existing Study

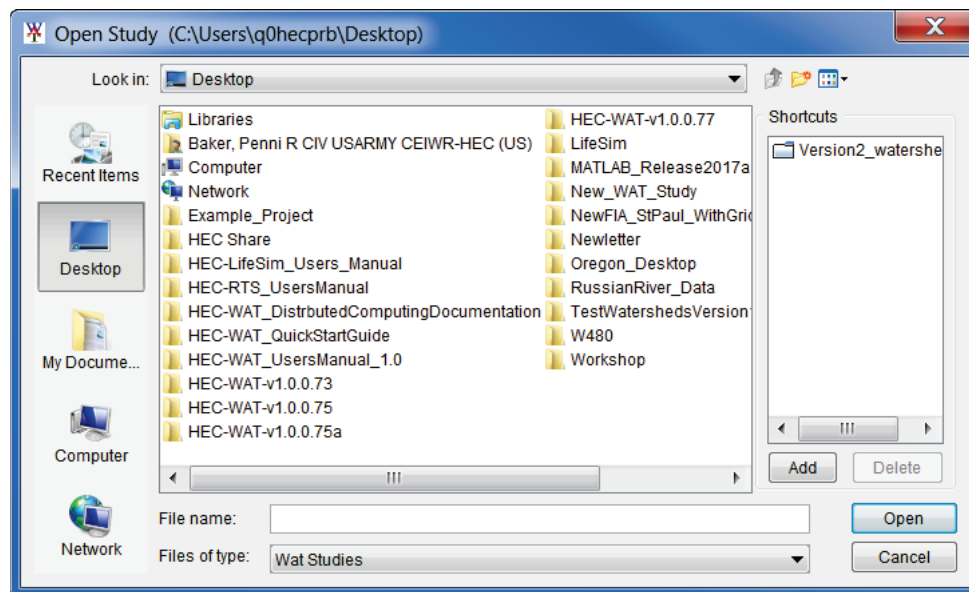
There are two ways to open existing studies in HEC-WAT. One way is to open a study by selecting it from the list of recently opened studies. On the **File** menu (Figure 4.1), point to **Recent Studies**, from the list of the five most recently opened studies, click on the name of the study to open, and HEC-WAT will automatically load the selected study. The second way to open an existing study is described below.

To open an existing study:

1. From the HEC-WAT main window (Figure 4.7), from the **File** menu, click **Open Study**, an **Open Study** browser (Figure 4.8) will open.



**Figure 4.7** HEC-WAT Main Window - Maps Tab



**Figure 4.8** Open Study Browser

2. From the **Open Study** browser (Figure 4.8), browse to the location of an existing HEC-WAT study. By default, HEC-WAT is looking for a file with the extension *\*.sty*.
3. Select the study name, click **Open**, the **Open Study** browser will close (Figure 4.8), and the selected study will open in the HEC-WAT main window.

### 4.1.3 Close a Study

To close an active study:

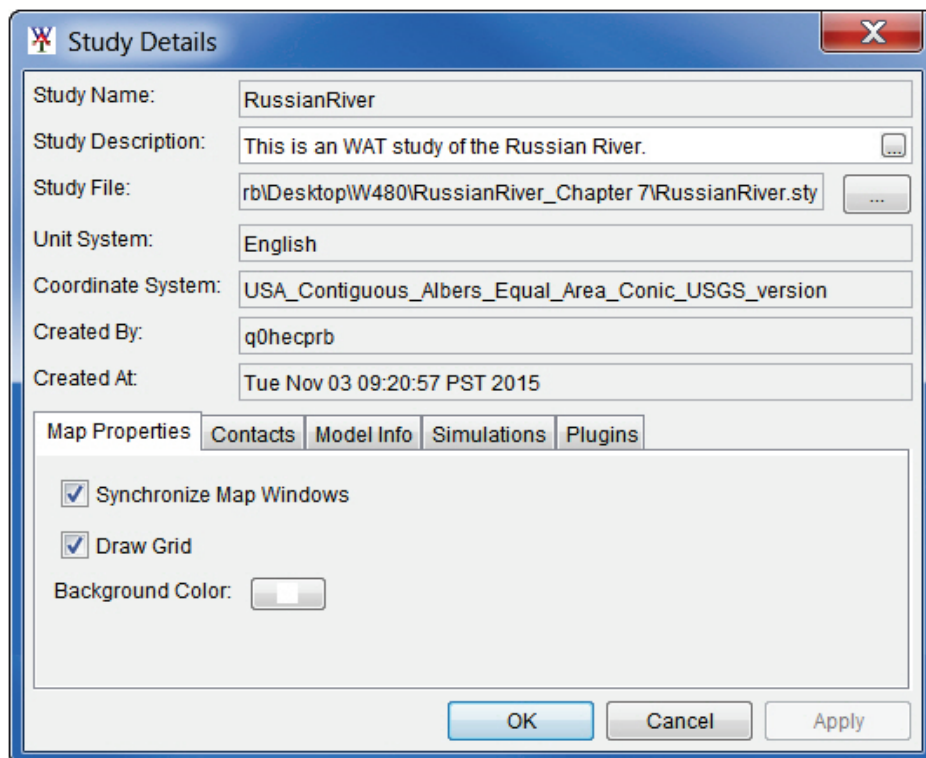
1. From the HEC-WAT main window (Figure 4.7), from the **File** menu, click **Close Study**.
2. HEC-WAT keeps track of changes being made to a study by the major study components – alternatives, analysis periods, and simulations. HEC-WAT will save the study, which includes all the files associated with the individual software applications that are part of the study (e.g., HEC-RAS, HEC-FIA).

### 4.1.4 Save a Study

To save a study, from the HEC-WAT main window (Figure 4.7), from the **File** menu (Figure 4.1), click **Save Study**. HEC-WAT will save the study, which includes all the files associated with the individual software applications that are part of the study (e.g., HEC-RAS, HEC-FIA).

### 4.1.5 Study Details

One of the objectives of HEC-WAT is to provide information regarding the status of the study to the manager or any other member of the PDT. Some of the information needs to be entered by the study team. From the HEC-WAT main window (Figure 4.7), from the **File** menu (Figure 4.1), click **Study Details**, the **Study Details** dialog box (Figure 4.9) will open. This dialog box has five tabs – **Map Properties**, **Contacts**, **Model Info**, **Simulations**, and **Plugins**.



**Figure 4.9** Study Details Dialog Box – Map Properties Tab



The **Study Details** dialog box (Figure 4.9) displays the name of the study; the study description (which the user can edit); location of the study file (\*.sty); the selected unit system; the selected coordinate system; the user name of the team member that created the study; and, the date and time the study was created.

## Map Properties

From the **Map Properties** worksheet, the user can set the synchronizing of map windows; choose to have or not have a grid display on map windows (default is to have a grid); and, set the background color of map windows (default is white). The **Map Properties** worksheet is the default tab for the **Study Details** dialog box (Figure 4.9).

## Contacts

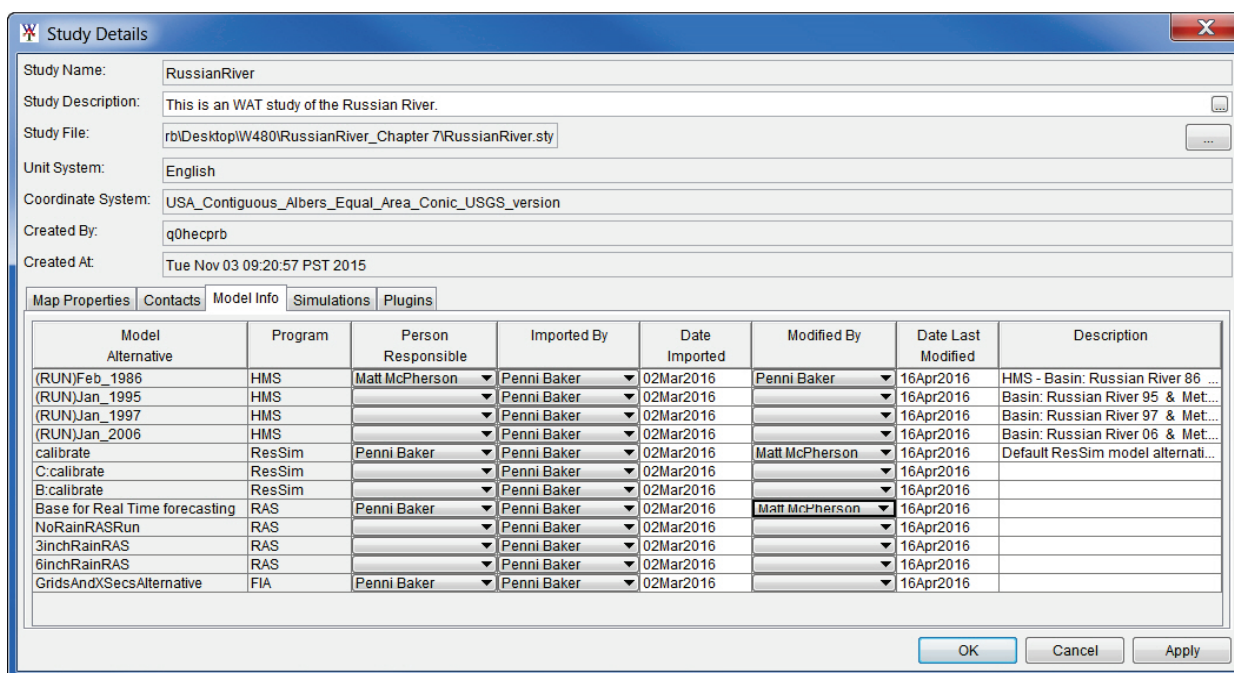
The **Contacts** worksheet is where information regarding the study team is entered (Figure 4.10). Information includes the team member's name; the user name of the team member; the team member's responsibility on the study team; phone number; office symbol; and, the assignment (i.e., specific model, creation of stream alignment, etc.) given to the team member.

Team Member	User Name	Responsibility	Phone Number	Office Symbol	Team Member Assignment
Matt McPherson	q0hecyy	PM for Russian Ri...	530 756-1104	CEIWR-HEC-WMS	PM
Penni Baker	q0hecxx	Create Russian Ri...	530 756-1104	CEIWR-HEC-WRS	Default schematic

**Figure 4.10** Study Details Dialog Box – Contacts Tab

## Model Info

Information from the **Model Info** worksheet (Figure 4.11) is related to the model alternatives that have been defined for a study. HEC-WAT knows all model alternatives that have been identified and to what software applications each alternative belongs. From the information



The dialog box shows the following information:

- Study Name: RussianRiver
- Study Description: This is an WAT study of the Russian River.
- Study File: r:\Desktop\W480\RussianRiver\_Chapter 7\RussianRiver.sty
- Unit System: English
- Coordinate System: USA\_Contiguous\_Albers\_Equal\_Area\_Conic\_USGS\_version
- Created By: q0hecpb
- Created At: Tue Nov 03 09:20:57 PST 2015

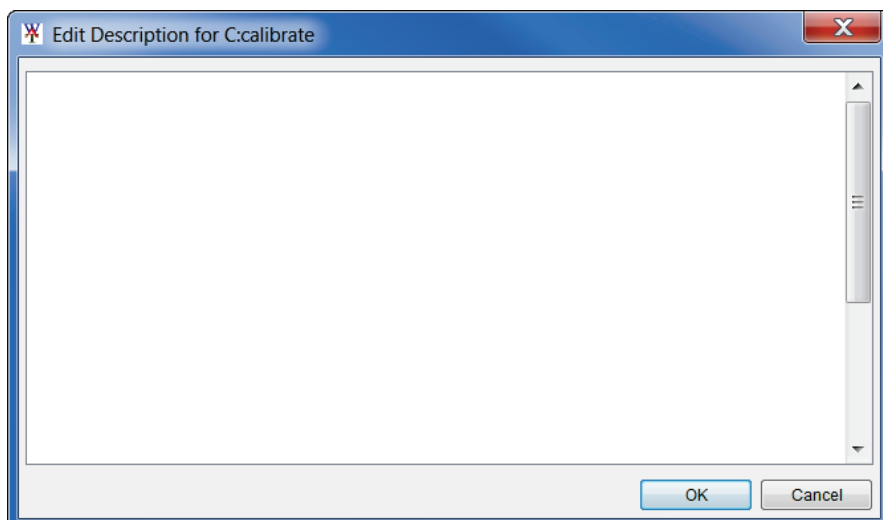
The **Model Info** tab is selected, displaying a table of model alternatives:

Model Alternative	Program	Person Responsible	Imported By	Date Imported	Modified By	Date Last Modified	Description
(RUN)Feb_1986	HMS	Matt McPherson	Penni Baker	02Mar2016	Penni Baker	16Apr2016	HMS - Basin: Russian River 86 ...
(RUN)Jan_1995	HMS		Penni Baker	02Mar2016		16Apr2016	Basin: Russian River 95 & Met...
(RUN)Jan_1997	HMS		Penni Baker	02Mar2016		16Apr2016	Basin: Russian River 97 & Met...
(RUN)Jan_2006	HMS		Penni Baker	02Mar2016		16Apr2016	Basin: Russian River 06 & Met...
calibrate	ResSim	Penni Baker	Penni Baker	02Mar2016	Matt McPherson	16Apr2016	Default ResSim model alternati...
C:calibrate	ResSim		Penni Baker	02Mar2016		16Apr2016	
B:calibrate	ResSim		Penni Baker	02Mar2016		16Apr2016	
Base for Real Time forecasting	RAS	Penni Baker	Penni Baker	02Mar2016	Matt McPherson	16Apr2016	
NoRainRASRun	RAS		Penni Baker	02Mar2016		16Apr2016	
3inchRainRAS	RAS		Penni Baker	02Mar2016		16Apr2016	
6inchRainRAS	RAS		Penni Baker	02Mar2016		16Apr2016	
GridsAndXSecsAlternative	FIA	Penni Baker	Penni Baker	02Mar2016		16Apr2016	

**Figure 4.11** Study Details Dialog Box – Model Info Tab

identified on the **Contacts** worksheet (Figure 4.10), from the **Model Info** worksheet a user can now identify the team member responsible for an individual model alternative; what team member imported the model alternative; the date the model alternative was imported; what team member modified the model alternative; the date the model alternative was modified; and, the description of the model alternative.

If the model has a description, the **Description** column will display the description of the model alternative. If there is no description, click in a **Description** cell, the **Edit Description for "model alternative"** dialog box will open (Figure 4.12). Enter a description, click **OK**. The **Edit Description for "model alternative"** dialog box will close and the entered description will appear in the selected **Description** cell.



The dialog box is titled "Edit Description for C:calibrate" and contains a large text area for entering a description. At the bottom, there are **OK** and **Cancel** buttons.

**Figure 4.12** Edit Description for "model alternative" Dialog Box

## Simulations

From the **Simulations** worksheet (Figure 4.13) a user can view information regarding simulations. The information on this worksheet is gathered by HEC-WAT based on dates and times, and the user name which was entered on the **Contacts** worksheet (Figure 4.10).

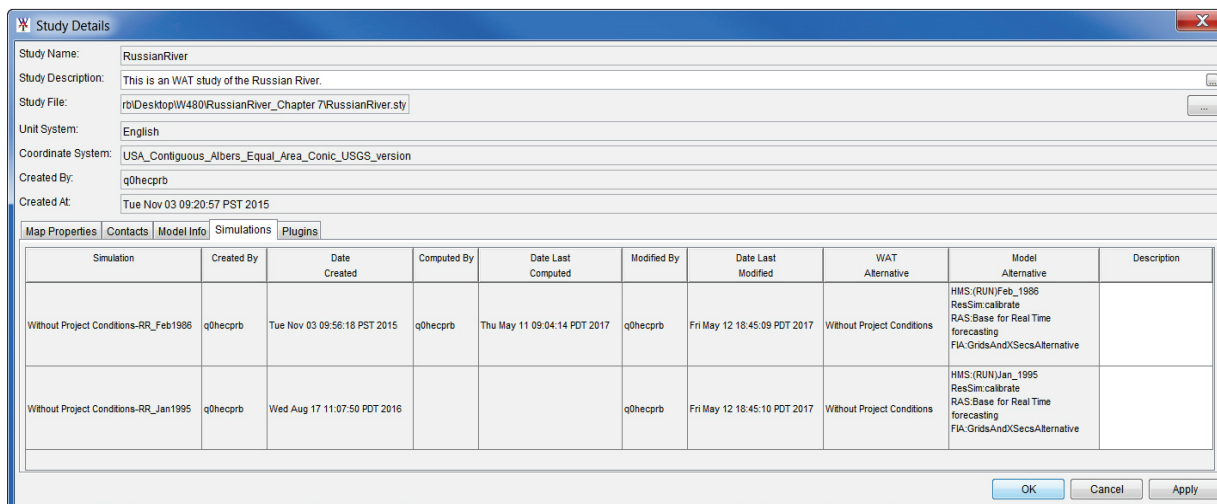


Figure 4.13 Study Details Dialog Box – Simulations Tab

## Plugins

From the **Plugins** worksheet (Figure 4.14) the user can define what plug-ins are being used by the study. By enabling or disabling the plug-ins listed, the user will define what plug-ins will be used for the active study.

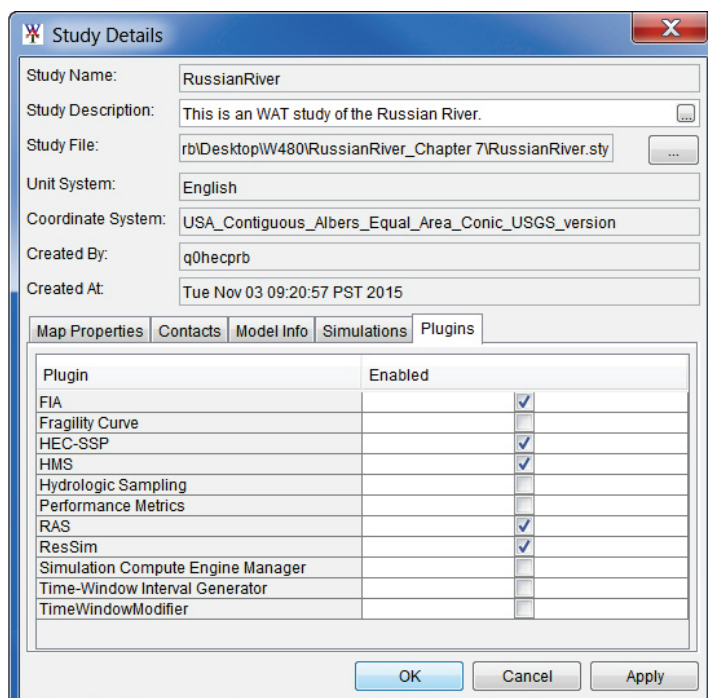


Figure 4.14 Study Details Dialog Box – Plugins Tab





















## 4.2 Study Directories and Files
















Figure 4.15 shows an example of how HEC-WAT organizes the directories and files that it creates in the study directory. In this example, the study directory is */RussianRiver*. As data is entered, other files and subdirectories are created. Table 4.1 describes each directory and file that is shown in Figure 4.15.

Name	Date modified	Type	Size
autorss	2/22/2016 5:37 PM	File folder	
fia	8/4/2016 9:05 AM	File folder	
hms	8/4/2016 9:05 AM	File folder	
layouts	8/4/2016 9:03 AM	File folder	
maps	8/3/2016 2:01 PM	File folder	
ras	5/2/2016 7:52 PM	File folder	
rrlayers	11/3/2015 9:34 AM	File folder	
rss	8/4/2016 9:03 AM	File folder	
runs	8/3/2016 8:20 AM	File folder	
scripts	11/3/2015 9:22 AM	File folder	
shared	6/27/2016 5:10 PM	File folder	
ssp	11/3/2015 9:48 AM	File folder	
study	7/8/2016 1:46 PM	File folder	
w2	7/17/2016 8:51 AM	File folder	
wat	5/13/2016 4:09 PM	File folder	
.forecast	11/3/2015 9:22 AM	FORECAST File	2 KB
.forecast.bak	11/3/2015 9:22 AM	BAK File	0 KB
contacts.xml	6/24/2016 6:23 PM	XML Document	1 KB
contacts.xml.bak	4/16/2016 8:31 PM	BAK File	1 KB
Correct_stream.align	11/3/2015 9:22 AM	ALIGN File	775 KB
Default.ag	11/3/2015 9:23 AM	AG File	1 KB
Default.ag.bak	11/3/2015 9:22 AM	BAK File	1 KB
modelAltInfo.xml	6/24/2016 6:23 PM	XML Document	3 KB
modelAltInfo.xml.bak	4/16/2016 8:31 PM	BAK File	2 KB
PrecipGrids.xml	11/3/2015 9:22 AM	XML Document	2 KB
PrecipGrids.xml.bak	11/3/2015 9:22 AM	BAK File	2 KB
RR_PrecipGrids.xml	11/3/2015 9:22 AM	XML Document	2 KB
RR_PrecipGrids.xml.bak	11/3/2015 9:22 AM	BAK File	2 KB
RR_ResSim_Model.wksp	11/3/2015 9:22 AM	WKSP File	4 KB
RR_ResSim_Model.wksp.bak	11/3/2015 9:22 AM	BAK File	4 KB
Russian_River.wksp	11/3/2015 9:22 AM	WKSP File	4 KB
Russian_River.wksp.bak	11/3/2015 9:22 AM	BAK File	4 KB
RussianRiver.log	8/4/2016 9:05 AM	Text Document	380 KB
RussianRiver.log.bak	8/4/2016 9:05 AM	BAK File	380 KB
RussianRiver.projection	8/3/2016 2:01 PM	PROJECTION File	1 KB
RussianRiver.projection.bak	8/3/2016 12:50 PM	BAK File	1 KB
RussianRiver.sty	8/3/2016 2:01 PM	STY File	9 KB
RussianRiver.sty.bak	8/3/2016 12:50 PM	BAK File	9 KB
RussianRiver.sty.projection	6/24/2016 5:52 PM	PROJECTION File	1 KB
RussianRiver.sty.projection.bak	6/24/2016 5:52 PM	BAK File	0 KB
RussianRiver.sty.sa.bak	6/24/2016 5:52 PM	BAK File	0 KB
RussianRiver.wksp	8/4/2016 9:03 AM	WKSP File	5 KB













**Figure 4.15** Example HEC-WAT Study Directory Structure

**Table 4.1** Example HEC-WAT Directories and Files

File or Directory Name	Contents
 RussianRiver	Study folder that is created when a user creates a new study (Section 4.1.1).
 RussianRiver.sty  RussianRiver.sty.bak	ASCII text file created by HEC-WAT when a study is created. Contains the name and description of the study, what user created the study, map coordinate information, and references to the stream alignment and the schematic data. The *.bak file is an automatic backup file of the *.sty file.
 RussianRiver.wksp  RussianRiver.wksp.bak	ASCII text file created by HEC-ResSim when an HEC-WAT study is created. The file is specifically used by the HEC-ResSim model. Contains the name and description of the study, location of stream alignment file, and location of any map layers that have been added to the study. The *.bak file is an automatic backup file of the *.wksp file.
 RussianRiver.projection  RussianRiver.projection.bak	ASCII text file created by HEC-WAT when a study is created. Contains the projection information for an HEC-WAT study that was identified in the <b>Map Coordinate Information</b> dialog box. The *.bak file is an automatic backup file of the *.projection file.
 RussianRiver.log  RussianRiver.log.bak	ASCII text file created by HEC-WAT when a study is created. Contains the basic information creation/modification of a study. The *.bak file is an automatic backup file of the *.log file.
 Default.ag  Default.ag.bak	ASCIISerializer text file created by HEC-WAT when a study is created. Contains information for a default analysis group. The *.bak file is an automatic backup file of the *.ag file.
 stream.align  stream.align.bak  stream.prj	ASCII text file created by HEC-WAT when a study is created. Contains the name, description, and other information that define the stream alignment (stream nodes, vertex points, stream element(s), etc.). The *.bak file is an automatic backup file of the *.sty file. The stream.prj file (created when importing a stream alignment from a shapefile) contains the projection information for the stream alignment.
 Without_Project_Conditions.walt  Without_Project_Conditions.walt.bak	ASCII text file created by HEC-WAT when a study is created; contains information on the default alternative. Contains the name, associated stream alignment, and other information. The *.bak file is an automatic backup file of the *.walt file.
 Without_Project_Conditions.sch  Without_Project_Conditions.sch.bak	An XML file created by HEC-WAT when a study is created; contains information on the schematic associated with an alternative. The *.bak file is an automatic backup file of the *.walt file.
 contacts.xml  contact.xml.bak	An XML file created by HEC-WAT when information is entered on the <b>Contacts</b> worksheet from the <b>Study Details</b> dialog box. Contains information on the study team that is entered: team member names, user name of team member, software responsibility, phone number, office assignment, and, team member assignment. The *.bak file is an automatic backup file of the *.xml file.

File or Directory Name	Contents
 modelAltInfo.xml  modelAltInfo.xml.bak	An XML file created by HEC-WAT when information is entered on the <b>Model Info</b> worksheet from the <b>Study Details</b> dialog box. Contains information on the study team that can be linked to the individual model alternatives. Information includes: team member responsible for model alternative, who imported the model alternative, date model alternative was imported, team member who modified the model alternative, date the model alternative was modified, and the description of the model alternative. The *.bak file is an automatic backup file of the *.xml file.
 fia	Sub-folder created by HEC-WAT when a study is created. This folder contains all HEC-FIA model files.
 hms	Sub-folder created by HEC-WAT when a study is created. This folder contains all HEC-HMS model files.
 layouts	Sub-folder created by HEC-WAT when a study is created. This folder contains the saved layouts for the <b>WAT Desktop Pane</b> . Layouts also contain information in regards to the divider locations; what has been expanded and selected in the various panes; and, other information.
 maps	Sub-folder created by HEC-WAT when a study is created. Used to store map layers and GIS coverages associated with a study.
 ras	Sub-folder created by HEC-WAT when a study is created. This folder contains all HEC-RAS model files.
 rss	Sub-folder created by HEC-WAT when a study is created. This folder contains all HEC-ResSim model files.
 ssp	Sub-folder created by HEC-WAT when a study is created. This folder contains all HEC-SSP model files.
 w2	Sub-folder created by HEC-WAT when a study is created. This folder contains all CEQUAL-W2 model files.
 shared	Sub-folder created by HEC-WAT when a study is created. This folder contains the default HEC-WAT program order; contains the file that has information from the <b>Stream Reach Alias Editor</b> ; and, any other files that might be shared for the study.
 watProgramOrder.xml  watProgramOrder.xml.bak	An XML file created by HEC-WAT when a study is created and stored in the shared folder. Contains information on the program order that can be defined by HEC-WAT. Initially, contains the default program order: HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA. The *.bak file is an automatic backup file of the *.xml file.
 StreamAlignAliasMgr.sam  StreamAlignAliasMgr.sam.bak	An XML file created by HEC-WAT when a study is created and stored in the shared folder. Contains information from the <b>Stream Reach Alias Editor</b> . The *.bak file is an automatic backup file of the *.sam file.



File or Directory Name	Contents
 study	Sub-folder created by HEC-WAT when a study is created. This folder contains the information created from the <b>Schematic Tab</b> . Contains database files (*.dbf, *.dbt, *.mdx) that contain the data when creating measures, impact areas, and common computation points.
 runs	Sub-folder created when an HEC-WAT simulation (deterministic or FRA) is computed.
 wat	Sub-folder created by HEC-WAT when either an alternative, analysis period, or simulation is created. Contains the sub-folders for alternatives, analysis periods, and simulations.
 alts	Sub-folder of the <i>wat</i> folder that contains the information about HEC-WAT alternatives that have been created for the study.
 AlternativeA.walt  AlternativeA.walt.bak	ASCII text file created by HEC-WAT when an alternative is created and stored in the <i>alts</i> folder. Contains information on an HEC-WAT alternative. Information includes: the name, associated stream alignment, and other information. The *.bak file is an automatic backup file of the *.walt file.
 aps	Sub-folder of the <i>wat</i> folder that contains the information about HEC-WAT analysis periods that have been created for the study.
 RR_1986.wap  RR_1986_wap.bak	ASCII text file created by HEC-WAT when an analysis period is created and stored in the <i>aps</i> folder. Contains information on an HEC-WAT analysis period. Information includes: the name, start date and time; and the end date and time. The *.bak file is an automatic backup file of the *.wap file.
 sims	Sub-folder of the <i>wat</i> folder that contains the information about HEC-WAT simulations that have been created for the study.
 Without_Project_Conditions-RR_1986.simulation  Without_Project_Conditions-RR_1986.simulation.bak	An XML file created by HEC-WAT when a simulation is created and stored in the <i>sims</i> folder. Contains information on an HEC-WAT simulation. Information includes: the name; name of the associated analysis period; and the names of the selected model alternatives. The *.bak file is an automatic backup file of the *.simulation file.

### 4.3 Automatic Backup Files

As elements are added to the study, such as a stream alignment, map layers, and data; the files and directories displayed in Figure 4.15 are created, along with automatic backup files. For example, a *RussianRiver.sty* file and a *RussianRiver.sty.bak* file are created when the study is created. If a map layer is added for example, the .bak file would not have any reference to the added map layer, the backup file reflects the state previous to the current changes. So every time the study is saved, the \*.bak file is updated to the previous state.

Automatic backup files are created for all study files, alternative files, analysis period files, simulation files, and results files. DSS files are not automatically backed up. Since the .bak file reflects the previous state of that file, the user can go back to the previous state by eliminating

the *.bak* extension. This would allow the information for that previous state to become the current state. The overall effect would be "undoing" all changes the user made before saving the HEC-WAT study.

For example, if for some reason the *stream.align* file became corrupt, the user could retrieve the stream alignment from the *stream.align.bak* file. The user would need to close HEC-WAT, browse to the correct HEC-WAT study directory, delete the *stream.align* file, and rename the *stream.align.bak* file to *stream.align*. Open HEC-WAT, open the correct HEC-WAT study, and the stream alignment will be visible again.



# CHAPTER 5

## GIS Layers

In the construction of a study, the PDT meets to determine what data or models already exist and what data is yet to be collected and what models need to be constructed. The team must decide on the study boundaries, identify gage locations, determine sub-basin delineations, damage area centers (impact areas), locations of measures (reservoirs, levees, etc.), and points (locations) where models could share data (common computation points). From these discussion the PDT must decide on the projected coordinate system for the study area and create layers based on the projection. HEC-WAT will set the projection for the HEC-WAT study based on the projection defined by the user.

### 5.1 Concept of Layers

There are several types of layers available in the HEC-WAT software. The **Stream Alignment Layer** is specifically for the stream alignment. Map layers (GIS layers) are used in HEC-WAT to visualize a system layout and or a flood inundation map. Map layers identify the projection for the HEC-WAT study. HEC-WAT creates primary layers when a stream alignment, schematic, alternatives and a simulation are created. This chapter covers map and primary layers.

### 5.2 Map Layers

To help visualize a study area, HEC-WAT has the capability to display maps of study features. Sub-basin boundaries, watershed boundary, and stream gage locations, are just a few of the digital maps of study features that can be displayed in HEC-WAT.

#### 5.2.1 Map Layer Formats

Digital maps (GIS layers) are referred to as **map layers** in HEC-WAT. When a map layer is included in a watershed, the software displays the map layer as GIS features, points, lines, and polygons. In Version 1.0, the map layers are used for visual purposes only. In future versions, depending on the type of map layer, the program will interact with map layers as data sources. The map layer formats that HEC-WAT can display are listed in Table 5.1.

#### USGS Digital Line Graph (.dlg)

U.S. Geological Survey (USGS) Digital Line Graphs (DLG) are created from two sources using manual and automated digitizing methods. The two sources are aerial photographs or cartographic sources. DLG files are vector representations of the data. When HEC-WAT interacts with a *.dlg* file a *.dlgbin* file is automatically generated for use.

**Table 5.1** Map Layer Formats Supported by HEC-WAT

Description	Common Filename Extension
USGS digital line graph	.dlg
AutoCAD® DXF	.dxf
Arc Shapefile	.shp
GeoTIFF	.tif
Raster image	.img, .jpg, .gif
USGS DEM	.dem
ArcInfo® DEM	.asc
SMRMP	.smrmp
Ascii NetTin	*.net
Mr SID	*.sid
Virtual Format	*.vrt
Open Street Maps	*.osm

## AutoCAD® DXF (.dxf)

A Drawing Interchange File (.dxf) is created by a Computer-Aided Design (CAD) package, AutoCAD®. This format is a tagged data representation of an AutoCad® drawing file. **Tagged data** is where each data element is preceded by a group code. A **group code** is an integer indicating the type of data element. The file created is a vector-based graphic. The DXF format is commonly used for data export from other CAD and GIS programs.

## Arc Shapefile (.shp)

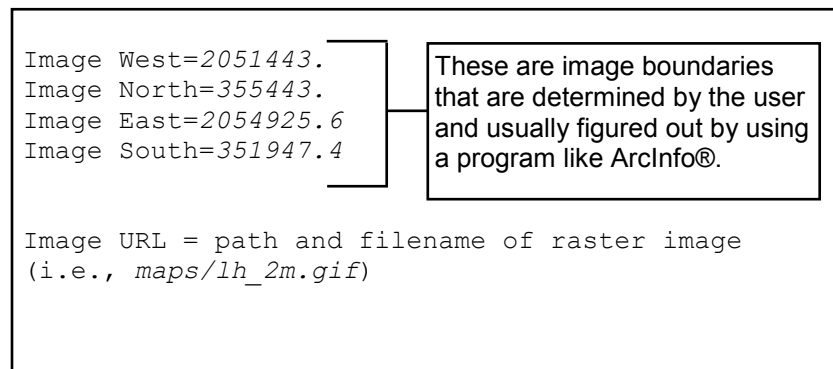
Shapefiles are the native data structure for the ArcGIS® program. Shapefiles store non-topological geometry and attribute information for the spatial features of a dataset. Usually there are four files associated with a shapefile: \*.dbf, \*.shp, \*.prj, and \*.shx. The .shp file contains the shapes (point, polylines, or polygons) that are displayed in the layer. Each shape has a record in the .dbf file containing descriptive data called "attributes." The .prj file contains the projection information for the shapefile. The .shx file contains an index that links each shape to its record in the .dbf file. For more information on shapefiles, see the *ESRI Shapefile Technical Description* available here: <http://www.esri.com/library/whitepapers/pdfs/shapefile.pdf>.

## GeoTIFF (.tif)

A metadata standard which allows geo-referencing information to be embedded into a TIF (Tagged Image File Format) file. The added metadata could be map projection datums, coordinate systems, and any other information that will establish spatial references. A TIF file stores raster graphic images and data within a single file.

## Raster Image

The raster image formats supported by HEC-WAT are JPEG format (\*.jpg) and Graphics Interchange Format (\*.gif). To access these file types, an \*.img (ASCII text) file must be created by the user outside of HEC-WAT. The file needs to contain the information shown in Figure 5.1, and this information needs to match the easting and northing parameters stated in the **Map Default Properties for StudyName** dialog box (Section 5.2.5).



**Figure 5.1** Raster Image File

## USGS DEM (.dem)

USGS publishes the file format USGS DEM (as of 2006 USGS no longer directly distributes elevation data in the DEM format). A raster file format, .dem files usually contain terrain elevations, but the file format can be used for representing any surface. The format, published by the USGS, allows internal documentation of coordinate system, date of publication, etc. These values are referenced horizontally, either to a Universal Transverse Mercator (UTM) projection or to a geographic coordinate system.

## ArcInfo® DEM (.asc)

An ArcInfo® DEM file is an ASCII file format representation of a grid generated by ArcInfo®. The file consists of keywords followed by values defining the number of columns, number of rows, lower left corner, cell size, no data value, and each cell value.

## SMRMP (.smrmp)

The Segmented Multi-Resolution Multi-Parameter (SMRMP) file was created to incorporate gridded data (namely, digital terrain grids, inundation depth grids, and arrival time grids) more efficiently in HEC-FIA. When users add terrain and inundation data, the user is prompted to convert to SMRMP format. The conversion is not required, but is recommended for higher efficiency. The SMRMP file type is not recommended, and is only being maintained for existing HEC-WAT studies which have used the SMRMP format. A conversion tool to export to any another file format is not available.

## ASCII NetTin (.net)

An ASCII NetTin is an ASCII file format used to represent a triangulated irregular network (TIN). TIN data are stored in a simple format that defines the nodes, edges, and triangles contained in the TIN. This format is common for transferring TIN data between software.

## LizardTech® MrSID® (.sid)

The MrSID® (multi-resolution seamless image database) is a proprietary geo-referenced image file format developed by LizardTech® for use with Geographic Information Systems (GIS). This format compresses large raster image files like aerial photographs or satellite imagery for easier viewing. Some MrSID images contain geo-referencing and positioning information and can be placed in the watershed.

## Virtual Format (.vrt)

The *.vrt* format is a format driver for GDAL (Geospatial Data Abstraction Library) and allows for a virtual GDAL dataset to be composed of other GDAL datasets. The primary use of this format is to group together a series of grids that should be associated together. This file format allows multiple depth grids for the same event to create a mosaic single grid. Relative file paths are saved in an XML format, as well as a histogram describing the frequency of cell values across all grids within the *vrt*.

## Open Street Maps (.osm)

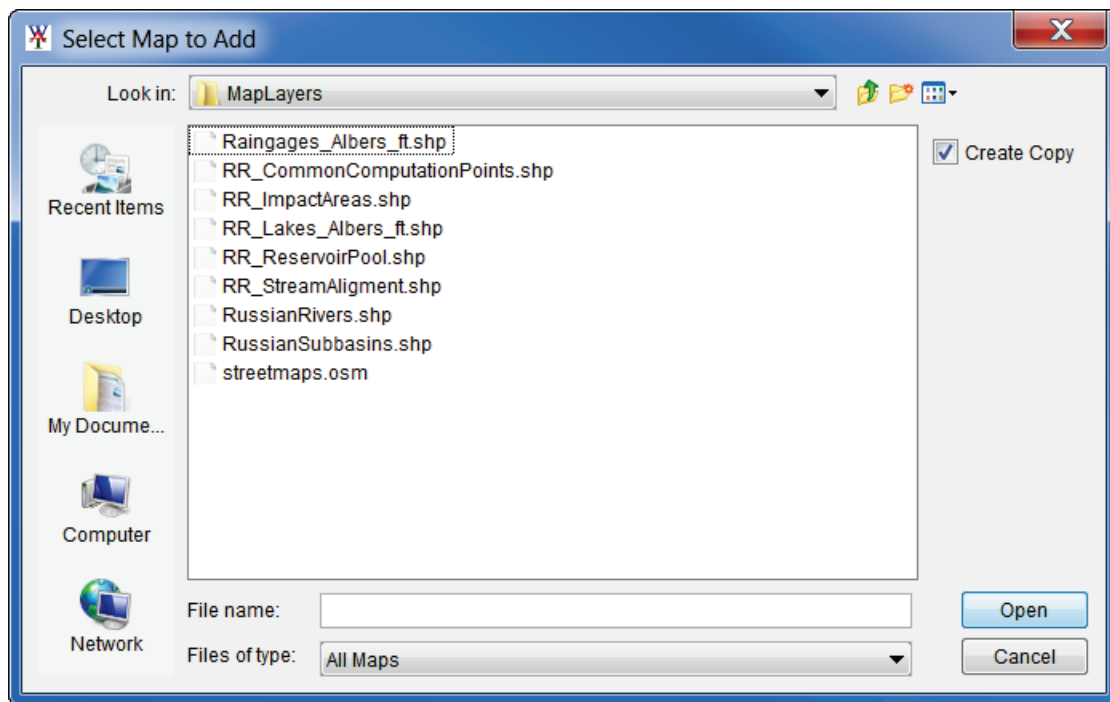
An XML file created to store user preferences regarding streaming services. This file is generated by HEC-WAT and is stored in the study's *maps* folder. This file should not be edited by the user.

### 5.2.2 Add Map Layers

When a map layer is added to a study, HEC-WAT reads the coordinates of points, lines, and polygons on the map layer and resets the geographic extents of the study to the smallest rectangle that will contain all objects in a map layer. A map projection uses mathematical models that transform spherical coordinates (latitude, longitude) to planar coordinates in a map projection (X- and Y-coordinates). Data is projected onto a flat plane (surface) that can be converted without stretching, and features will be referenced by a planar coordinate system. If a map layer is not in the same projection as the study, HEC-WAT can "on-the-fly" re-project the map layer in question.

To add map layers:

1. From the **Maps** menu, click **Add Map Layers**, the **Select Map to Add** browser will open (Figure 5.2).



**Figure 5.2** Select Map to Add Browser

2. The browser defaults to the study directory, but map layers can be retrieved from anywhere on a computer. From the study directory is a *maps* directory, which is the location where it is recommended that users copy various map layers. Using the project's maps directory ensures the map layers are maintained within the project directory when the project is opened on other computers.
3. To copy the selected map layer to the study directory, click **Create Copy** on the **Select Map to Add** browser (Figure 5.2).
4. From the **Select Map to Add** browser, select the desired map layer format from the **Files of type** list, locate the file of the desired map layer format, select filename, and click **Open**. The **Select Map to Add** browser will close (Figure 5.2) and the map layer will appear in the active map window. Also, if the user has chosen to have HEC-WAT copy the map layer to the study directory, under the *maps* folder, the map layer file (s) will appear.
5. From the HEC-WAT main window (Figure 5.3), select the **Maps** tab, there will now be an entry for the added map layers.

### 5.2.3 Remove Map Layers

To remove map layers:

1. From the **Maps** menu, click **Remove Map Layers**.
2. The **Remove Map Layers from Study** dialog box will open (Figure 5.4).

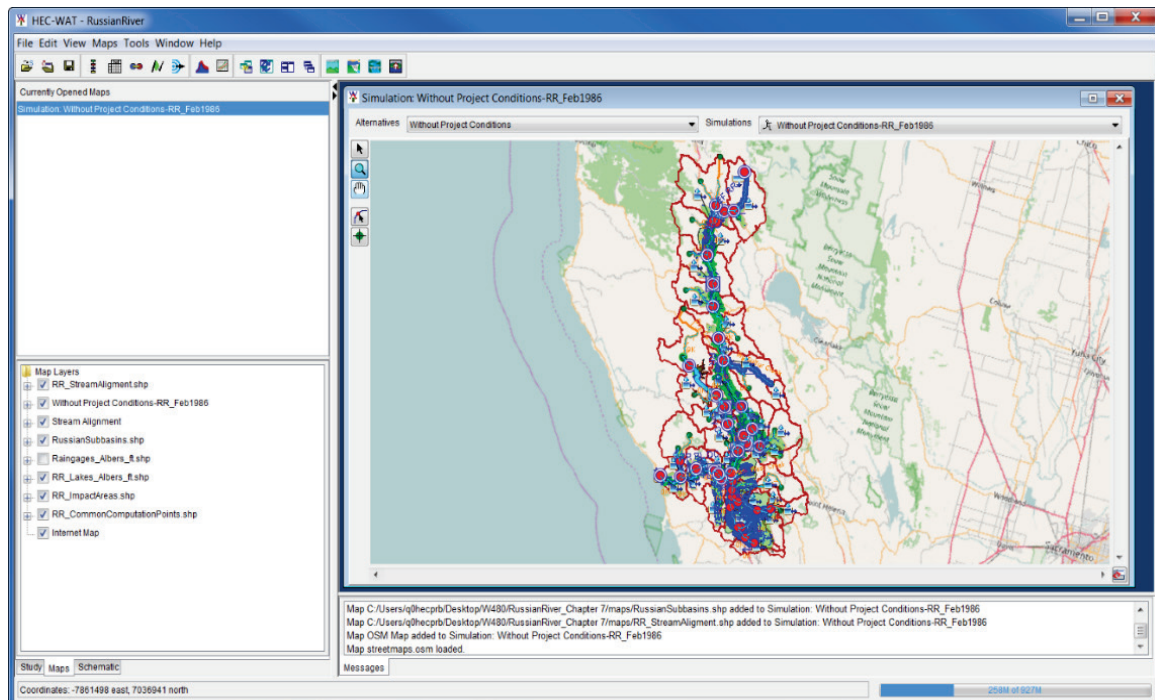


Figure 5.3 HEC-WAT Main Window – Maps Tab

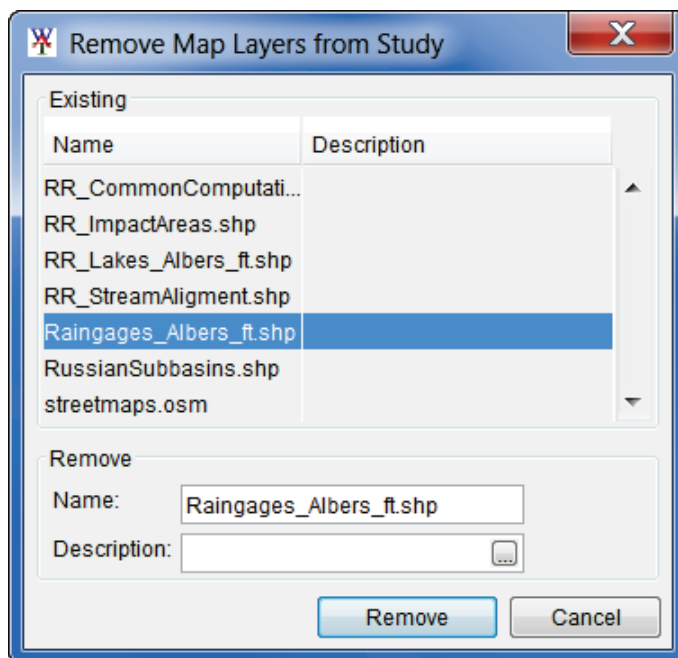


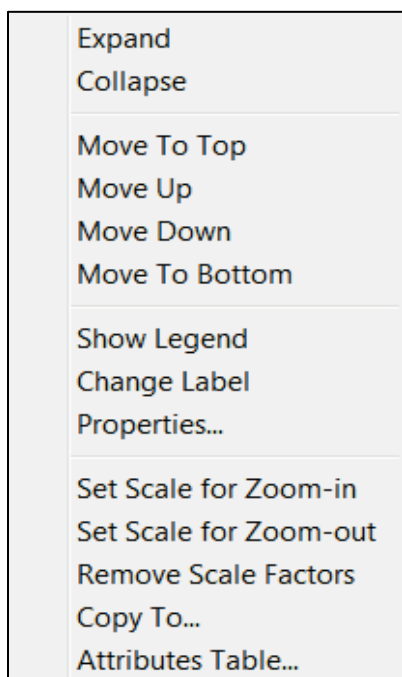
Figure 5.4 Remove Map Layers from Study Dialog Box

- From the **Existing** box there is list of map layers, select a map layer by clicking on the name.
- In the **Remove** box, the name of the selected map layer will appear in the **Name** box.
- Click **Remove**, a warning message will appear, asking the user if you really want to remove the map layer from the study, click **Yes**.

6. The warning message will close, the **Remove Map Layers from Study** dialog box (Figure 5.4) will close, and the map layer will be eliminated from the active map window.

## 5.2.4 Shortcut Menu for Map Layers

The shortcut menu (Figure 5.5) for map layers is accessed by right-clicking on any map layer that is listed in the **Maps** tab (Figure 5.3). This list of map layers refers to the currently active map window that is open in the **Desktop Pane** (Figure 5.3). The shortcut menu provides several ways to manipulate map layers. This ability to manipulate depends on the type of map layer (Figure 5.5), since HEC-WAT does not provide the same capabilities to all recognized map layer formats (Table 5.1). The available commands are:



**Figure 5.5** Map Layer Shortcut Menu

**Expand** – expands the selected map layer's tree; the tree provides information on the available elements of a map layer, and details provided are based on what HEC-WAT recognizes for the individual map layer format.

**Collapse** – collapses the selected map layer's tree; the tree provides information on the available elements of a map layer, and details provided are based on what HEC-WAT recognizes for the individual map layer format.

**Move to Top** – moves the selected map layer to the top of the tree

**Move Up** – moves the selected map layer up the tree one position

**Move Down** – moves the selected map layer down the tree one position

**Move to Bottom** – moves the active map layer to the bottom of the tree

**Show Legend** – displays the legend for the active map layer in the tree structure.

**Change Label** – allows the user to change the label of the map layer in the **Maps** tab. This does not change the filename of the map layer.

**Properties** – displays the properties of the selected map layer. See Appendix D for further details on the available map layer editors.

**Set Scale for Zoom-in** – set the zoom-in visualization scale for the selected map layer

**Set Scale for Zoom-out** – set the zoom-out visualization scale for the selected map layer

**Remove Scale Factors** – disable or clear all scale settings for the selected map layer

**Copy To** – allows the user to make a copy of the **Internet Map** layer. A **Save** browser will open (Figure 5.6), browse to the location on the computer where the map layer is to be copied. Click **Save**, the **Save** browser will close and the file (\*.osm) that contains the **Internet Map** layer is saved.

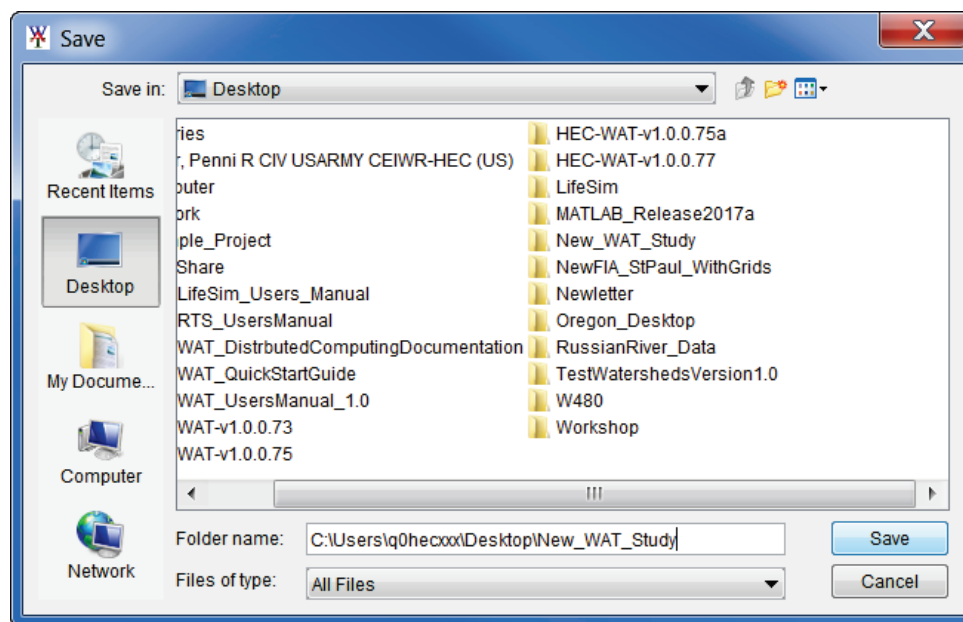


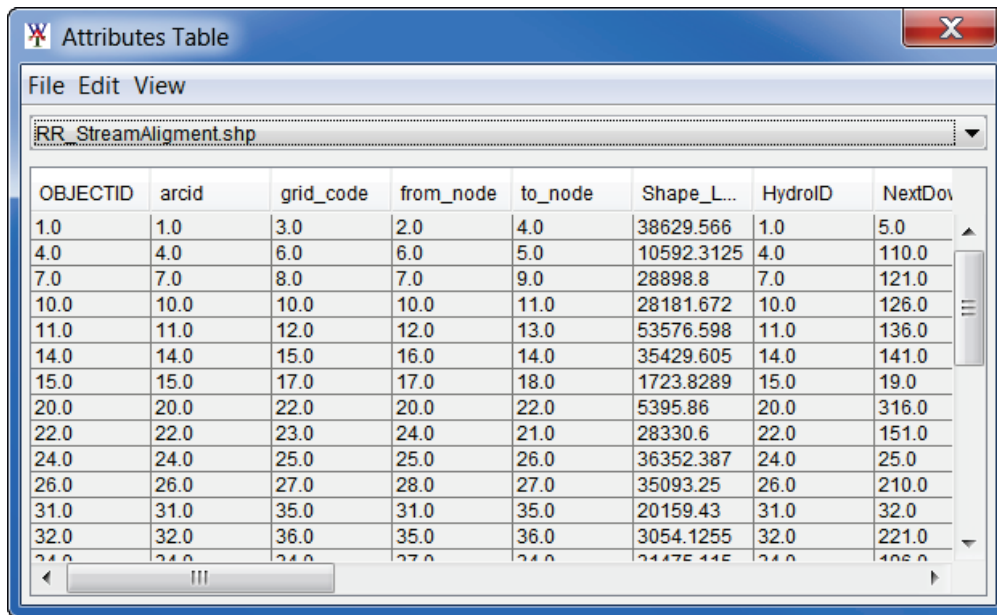
Figure 5.6 Save Browser

**Attributes Table** – if the selected map layer is a shapefile, click **Attributes Table**, the **Attributes Table** dialog box will open (Figure 5.7). Each shapefile contains a separate file that provides information on the attributes of that shape file. The **Attributes Table** dialog box provides the user with the attributes of the selected map layer (shapefile).

## 5.2.5 Geographic Reference for Map Layers

Map projections have been developed because the true image of places on earth would have to be a three-dimensional solid (spherical globes). The sets of mathematical models that transform spherical coordinates (latitude, longitude) to planar coordinates are contained within a map



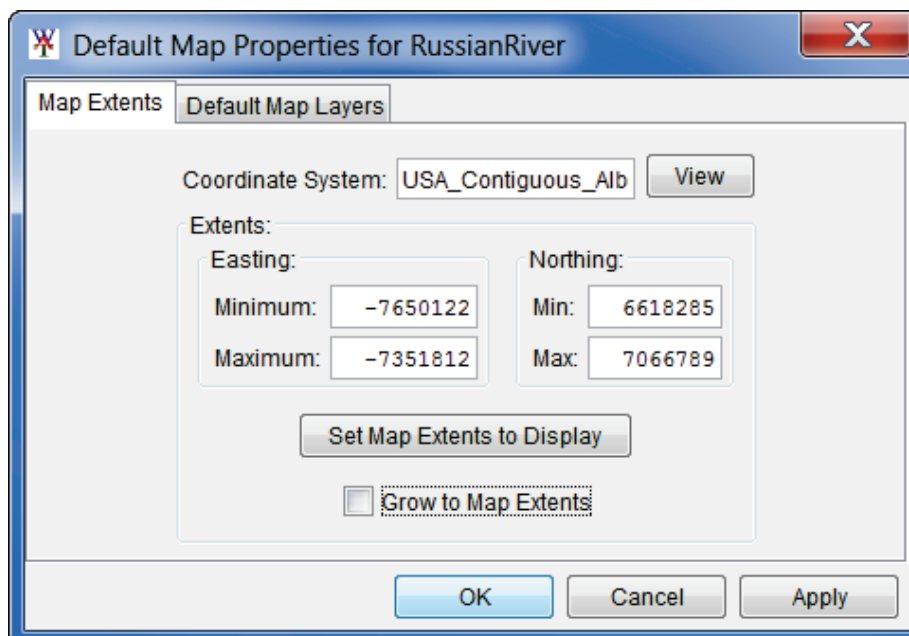


OBJECTID	arcid	grid_code	from_node	to_node	Shape_L...	HydrolID	NextDov
1.0	1.0	3.0	2.0	4.0	38629.566	1.0	5.0
4.0	4.0	6.0	6.0	5.0	10592.3125	4.0	110.0
7.0	7.0	8.0	7.0	9.0	28898.8	7.0	121.0
10.0	10.0	10.0	10.0	11.0	28181.672	10.0	126.0
11.0	11.0	12.0	12.0	13.0	53576.598	11.0	136.0
14.0	14.0	15.0	16.0	14.0	35429.605	14.0	141.0
15.0	15.0	17.0	17.0	18.0	1723.8289	15.0	19.0
20.0	20.0	22.0	20.0	22.0	5395.86	20.0	316.0
22.0	22.0	23.0	24.0	21.0	28330.6	22.0	151.0
24.0	24.0	25.0	25.0	26.0	36352.387	24.0	25.0
26.0	26.0	27.0	28.0	27.0	35093.25	26.0	210.0
31.0	31.0	35.0	31.0	35.0	20159.43	31.0	32.0
32.0	32.0	36.0	35.0	36.0	3054.1255	32.0	221.0
34.0	34.0	34.0	37.0	34.0	34475.145	34.0	105.0

**Figure 5.7** Attributes Table Dialog Box

projection (X- and Y-coordinates). Data is projected onto a flat plane (surface) that can be converted without stretching, and features will be referenced by a planar coordinate system. The x-coordinate is referred to as "easting" and the y-coordinate is referred to as "northing". The user can select the extent of this grid, the dimensions of the grid's cells, the units of measurement of the grid, and even the location of the grid's origin. Because of this flexibility, a user can specify and use virtually any grid coordinates convenient for water resources studies. To do so:

1. From the **Maps** menu, click **Default Map Properties**, the **Map Default Properties for StudyName** dialog box will open (Figure 5.8). By default, the **Map Extents** tab is selected.



**Default Map Properties for RussianRiver**

Map Extents | Default Map Layers

Coordinate System: USA\_Contiguous\_Alb View

Extents:

Easting:

Minimum: -7650122

Maximum: -7351812

Northing:

Min: 6618285

Max: 7066789

Set Map Extents to Display

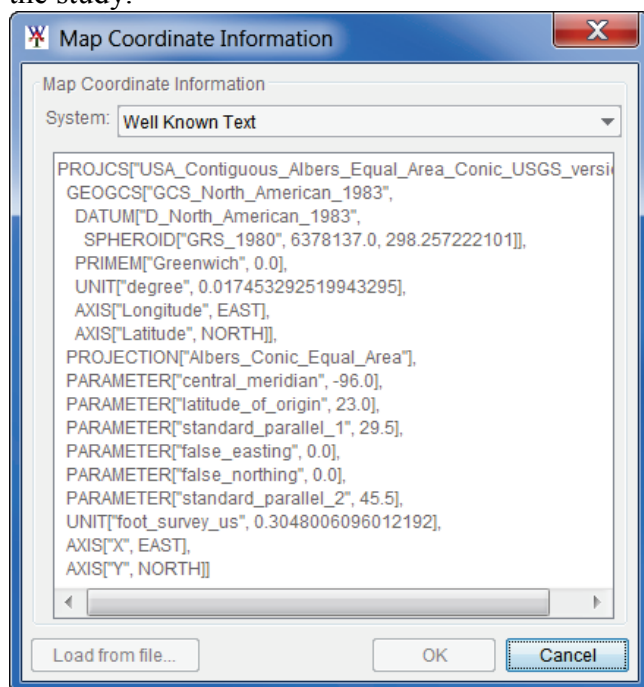
☐ Grow to Map Extents

OK Cancel Apply

**Figure 5.8** Map Default Properties for *StudyName* Dialog Box

2. The information in the **Map Extents** tab includes:

- **Coordinate System.** This box identifies the established coordinate system for a study. To view the coordinate system, click **View**, and the **Map Coordinate Information** dialog box (Figure 5.9) will open.
- **Extents – Easting Minimum, Maximum, Northing Minimum, and Maximum.** These values (Figure 5.8) indicate the location of the left, right, bottom and top borders (respectively) of the grid in the map window.
- **Grow to Map Extents.** When selected, HEC-WAT automatically sets the geographic extents to define the smallest rectangle that encompasses all the objects in the study.



**Figure 5.9** Map Coordinate Information Dialog Box

- **Set Map Extents to Display.** This will set the limits of the map window. If the user zooms in on an area, and clicks **Set Map Extents to Display** (Figure 5.8), the **Map Default Properties for StudyName** dialog box (Figure 5.8) extents will change to the zoomed area.

Note that the geographic extents of map layers must be selected carefully to ensure that the entire study is included. Further, the extents specified and the coordinate system used must be consistent with the projection of the study.

## 5.2.6 Set Visualization Scales - Map Layer

The easy way to set the visualization scale for map layers is outlined in the following steps:

1. From a map window, the user can zoom-in to the point at which a map layer becomes visible.
2. From the **Maps** tab, in the **Content Pane**, right-click on the map layer. From the shortcut menu, click **Set Scale for Zoom-in**, the visualization scale is set automatically for that map layer.
3. From the map window zoom-out, the selected map layer no longer displays. Inversely, if the user wants the map layer to become visible as the user zooms-out, from the shortcut menu click **Set Scale for Zoom-out**.
4. Visualization scale settings can be cleared or disabled for a map layer. From the shortcut menu, click **Remove Scale Factors**, the current visualization scale for that particular map layer is cleared.

## 5.3 Primary Layers

HEC-WAT creates primary layers when a user creates a stream alignment, schematics, alternatives, and simulations. These primary layers appear in the **Maps** tab. Depending on which type of map window that is open, the user will be able to access different primary layers.

### 5.3.1 Stream Alignment Layer

The **Stream Alignment Layer** contains the stream alignment that was imported or digitized and is visible on the active map window. Access for the **Stream Alignment Layer** is from the **Maps** tab, and is available from all map window types. This layer has sub-layers for each stream alignment element, and can be accessed by expanding the tree for the **Stream Alignment Layer** (Figure 5.10). To expand the tree, click the plus sign; to collapse the tree, click the minus sign.

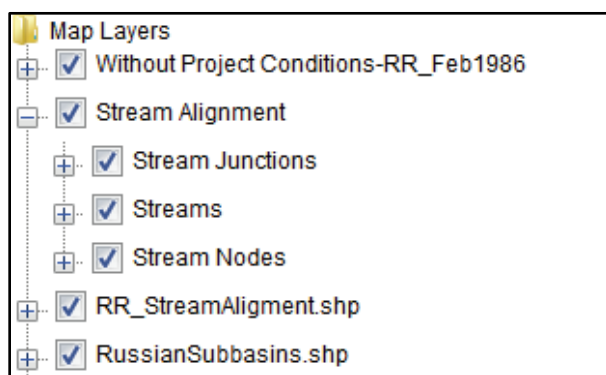


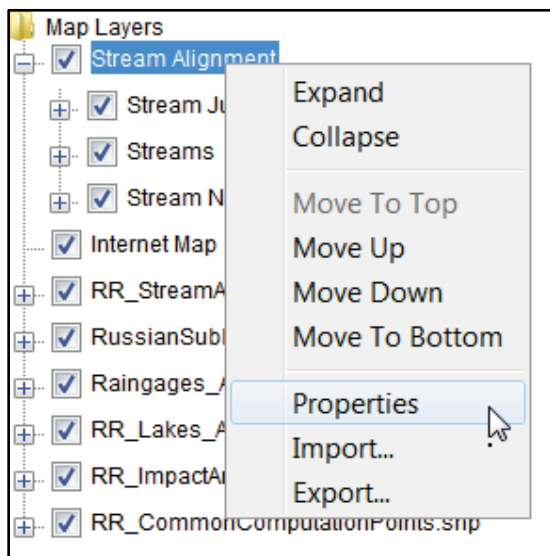
Figure 5.10 Maps Tab - Stream Alignment Layer

When the tree is expanded, different sub-layers (Figure 5.10) for the stream alignment layer are visible. There are three – **Stream Junctions**, **Streams**, and **Stream Nodes**. A **stream junction** is where two streams connect, and is represented by a bright green circle on the stream alignment. A **stream node** is a location (a dark green circle) on a stream that provides stream stationing information. By default, HEC-WAT creates two automatically, and a user can add stream nodes to a stream. A **stream** in a stream alignment is a multi-segmented line with

beginning and ending stream nodes. If the user does not want to see the stream junctions for the entire stream alignment, clear **Stream Junctions**, and the stream junctions no longer are visible in the active map window. To view the stream junctions, click **Stream Junctions**. This procedure applies to all of the sub-layers.

## Shortcut Menu

The shortcut menu (Figure 5.11) for the **Stream Alignment Layer** is accessed by right-clicking on the stream alignment layer in the **Maps** tab (Figure 5.10). The shortcut menu provides several ways to manipulate the **Stream Alignment Layer**. The available commands are:



**Figure 5.11** Stream Alignment Layer – Shortcut Menu

**Expand** – expands the **Stream Alignment Layer's** tree; the tree provides information on the available elements of the stream alignment.

**Collapse** – collapses the **Stream Alignment Layer's** tree; the tree provides information on the available elements of the stream alignment.

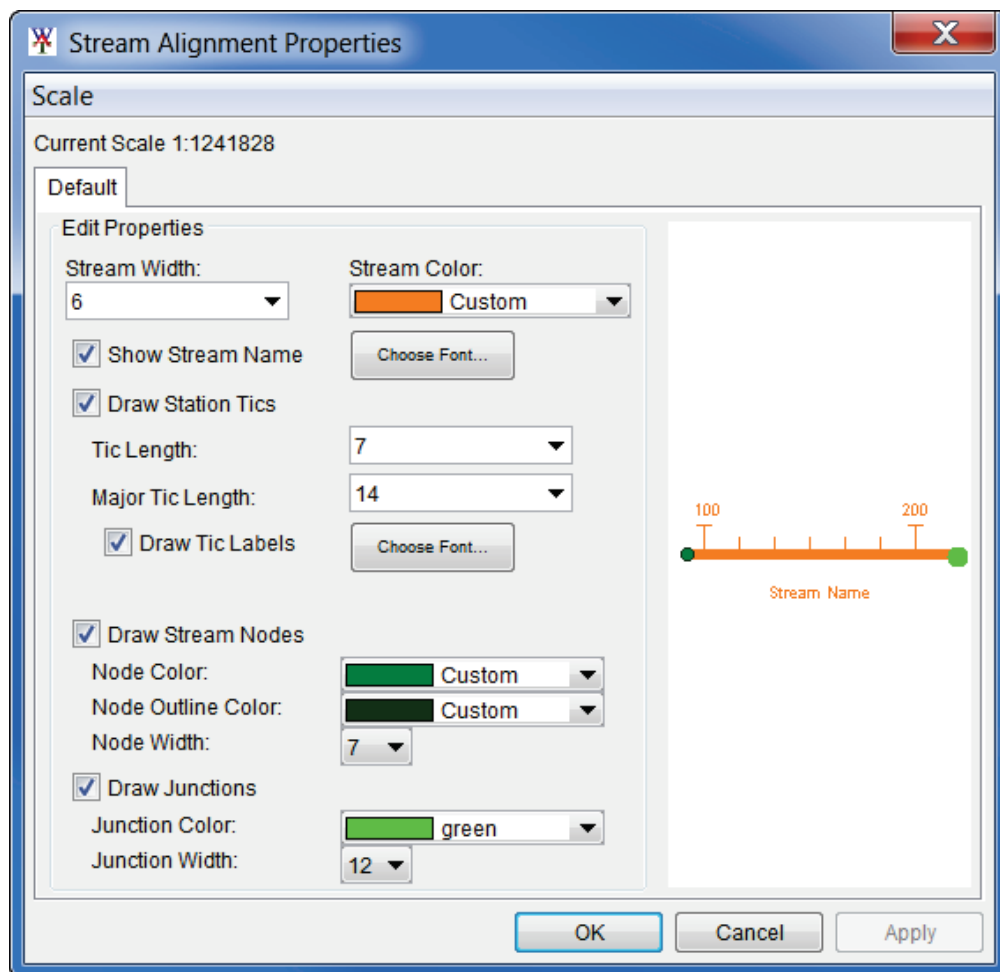
**Move to Top** – moves the **Stream Alignment Layer** to the top of the tree

**Move Up** – moves the **Stream Alignment Layer** up the tree one position

**Move Down** – moves the **Stream Alignment Layer** down the tree one position

**Move to Bottom** – moves the **Stream Alignment Layer** to the bottom of the tree

**Properties** – opens the **Stream Alignment Properties** dialog box (Figure 5.12) which allows the user to edit properties of the elements that are part of the **Stream Alignment Layer**.



**Figure 5.12** Stream Alignment Properties Dialog Box

**Import** – allows the user to import a stream alignment from a shapefile that has already been added to the project. From the **Import Stream Alignment** dialog box (Figure 5.13), the user will select a shapefile (polyline) and then import that shapefile, creating a stream alignment.

**Export** – allows the user to export the stream alignment to a shapefile. A **Save** browser will open (Figure 5.6), browse to the location on the computer where the shapefile is to be copied. Click **Save**, the **Save** browser will close and a shapefile of the stream alignment will be saved.

## Stream Alignment Properties

For the **Stream Alignment Layer**, the user can configure the appearance of the streams and their labels, configure the appearance of the stream junctions and stream nodes, and set the visualization scaling for the **Stream Alignment Layer**. To configure these properties, from the **Maps** tab, right-click on **Stream Alignment**. From the shortcut menu (Figure 5.11), click **Properties**, and the **Stream Alignment Properties** dialog box will open (Figure 5.12).

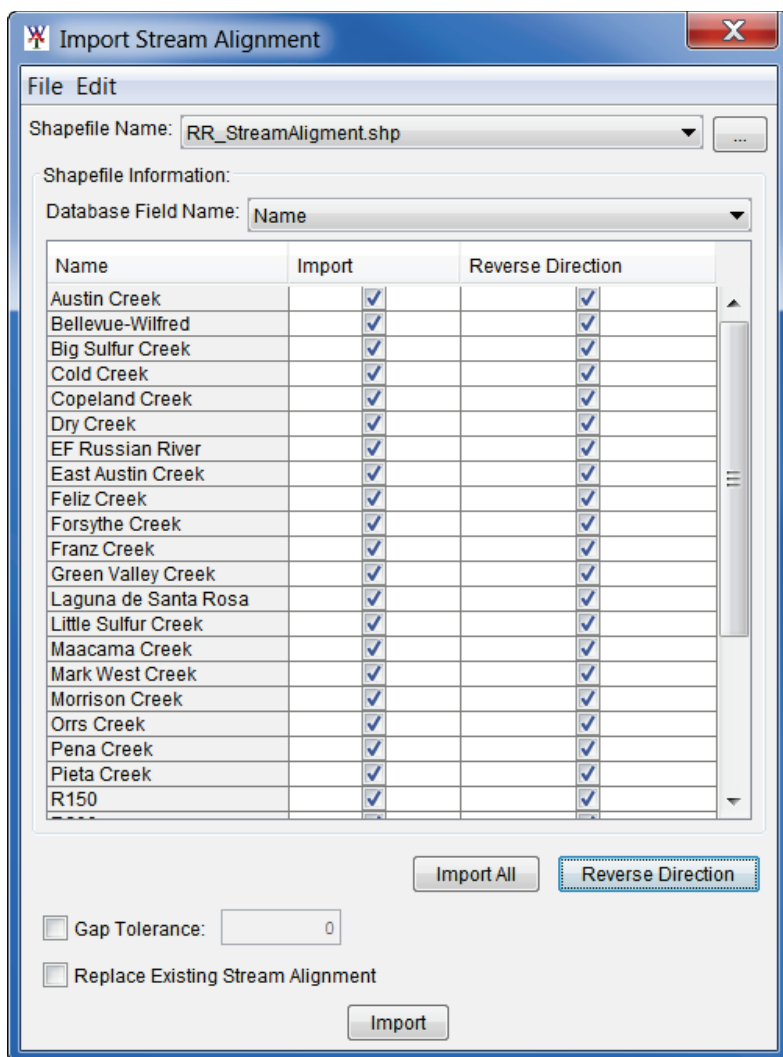


Figure 5.13 Import Stream Alignment Dialog Box

## Streams

To change the appearance of all streams in the map window:

1. The user can set the width of the lines that represent the streams in the stream alignment from the **Stream Alignment Properties** dialog box (Figure 5.12) from the **Stream Width** list (Figure 5.14).

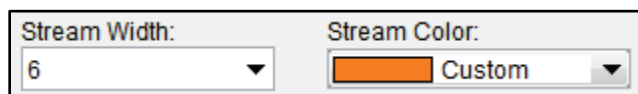
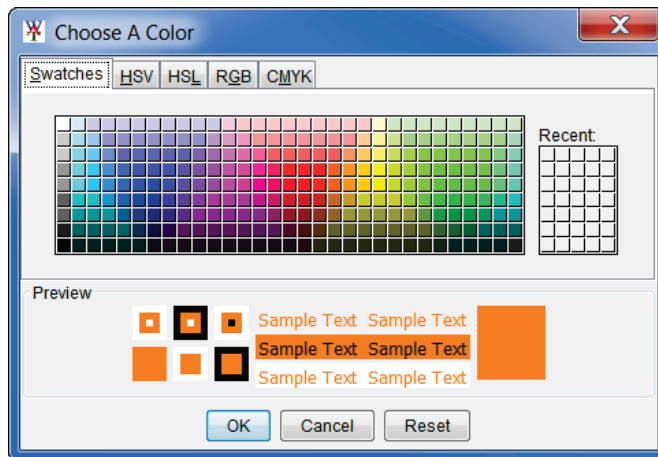


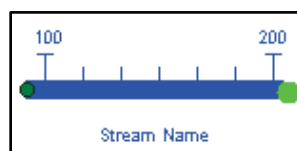
Figure 5.14 Stream Alignment Properties - Streams

2. The color of the lines that represent the streams in the stream alignment can be changed from the **Stream Color** list (Figure 5.14). The default color is orange, there are several colors to choose from, plus the user has the ability to create colors. From the **Stream Color** list, click **Custom**, the **Choose A Color** dialog box (Figure 5.15) will open. See Appendix E for further details on the color chooser.



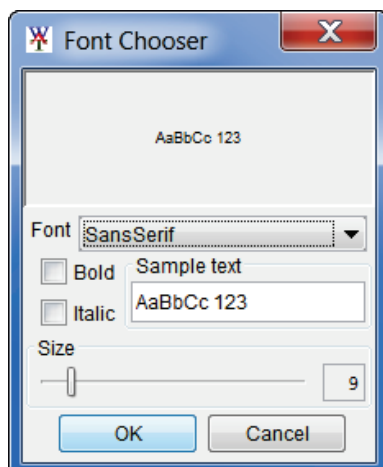
**Figure 5.15** Choose A Color Dialog Box

3. Either changing the width or color of the streams, can be previewed in the example to the right of the **Edit Properties** box (Figure 5.16). For the changes to appear in the map window, click **Apply** (Figure 5.12), and the map window will update.



**Figure 5.16** Preview Changes

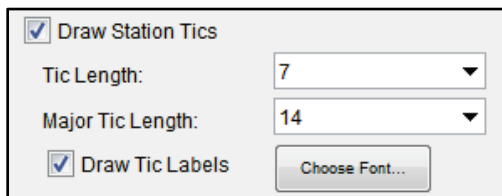
4. By default, the labels for the streams appear in the active map window. If the user does not want the labels displayed, clear **Show Stream Name** (Figure 5.12); click **Apply**, stream labels no longer display in the map window.
5. To change the font of the stream labels, click **Choose Font** (Figure 5.12), next to **Show Stream Name**. A **Font Chooser** opens (Figure 5.17), select the font type from the **Type** list, and select a size using the **Size** slider. Click **OK**, the **Font Chooser** closes, from the **Stream Alignment Properties** dialog box (Figure 5.12), click **Apply**, the stream labels display in the font and size chosen.



**Figure 5.17** Font Chooser

Tic marks appear on a stream representing the stream stationing of the stream. There are two types of tic marks – minor and major. To change the appearance of tic marks in the stream alignment:

1. By default, tic marks display on the stream alignment. If the user does not want tic marks to display, clear **Draw Station Tics** (Figure 5.18). Click **Apply** (Figure 5.12), tic marks no longer display in the active map window.



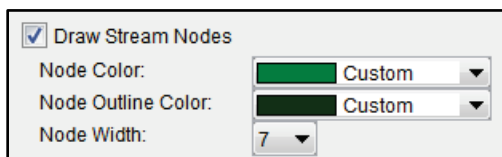
**Figure 5.18** Stream Alignment Properties - Tic Marks

2. From the **Tic Length** list, the user can set the length of the minor tic marks. To change the length of the major tic marks, from the **Major Tic Length** list (Figure 5.18), select the length of the major tic marks. For the changes to appear in the active map window, from the **Stream Alignment Properties** dialog box (Figure 5.12) click **Apply**, and the map window will update.
3. By default, the labels for tic marks appear in the active map window. If the user does not want the labels to display, clear **Draw Tic Labels** (Figure 5.18). To change the font of the tic mark labels, click **Choose Font**, a **Font Chooser** opens (Figure 5.17), select the font type from the **Type** list, and select a size using the **Size** slider. Click **OK**, the **Font Chooser** closes, from the **Stream Alignment Properties** dialog box (Figure 5.12), click **Apply**. Now all of the tic mark labels will appear in the font and size chosen.

## Stream Nodes

To change the appearance of all stream nodes in the map window:

1. By default stream nodes display, if the user does not want to display stream nodes clear **Draw Stream Nodes** (Figure 5.19), from the **Stream Alignment Properties** dialog box (Figure 5.12) click **Apply**, the stream nodes no longer display in the active map window.



**Figure 5.19** Stream Alignment Properties - Stream Nodes

2. The user can select the color of the stream nodes in the stream alignment from the **Node Color** list (Figure 5.19). The default color is green, there are several colors to choose from, plus the user has the ability to create colors. From the **Node Color** list, click **Custom**, the **Choose A Color** dialog box (Figure 5.15) will open. Appendix E provides further details on the color chooser.



3. The user can select the color of the outline of stream nodes in the stream alignment from the **Node Outline Color** list (Figure 5.19). The default color is dark green, there are several colors to choose from, plus the user has the ability to create colors. From the **Node Outline Color** list, click **Custom**, the **Choose A Color** dialog box (Figure 5.15) will open. Appendix E provides further details on the color chooser.
4. The user can set the width of the stream nodes in the stream alignment from the **Node Width** list (Figure 5.18).

## Stream Junctions

To change the appearance of all stream junctions in the active map window:

1. By default the stream junctions display, if the user does not want to display the stream junctions clear **Draw Junctions** (Figure 5.20), from the **Stream Alignment Properties** dialog box (Figure 5. 12) click **Apply**, stream junctions no longer display in the active map window.



**Figure 5.20** Stream Alignment Properties - Stream Junctions

2. The user can select the color of the stream junctions in the stream alignment from the **Junction Color** list (Figure 5.20). The default color is *darkgreen*, there are several colors to choose from, plus the user has the ability to create colors. From the **Junction Color** list, click **Custom**, the **Choose A Color** dialog box (see Figure 5.15) will open. Appendix E provides further details on the color chooser.
3. The user can set the width of the stream junctions in the stream alignment from the **Junction Width** list (Figure 5.20).

## Scale

Visualization scale can be set for the **Stream Alignment Layer**:

1. To set the visualization scale for the stream alignment to a default, from the **Stream Alignment Properties** dialog box (Figure 5.12), from the **Scale** menu, click **Set to Defaults**. The visualization scale is set automatically.
2. To enter a scale factor, from the **Scale** menu, click **New**. The **Create New Scale** dialog box opens (Figure 5.21), in the **Scale** box, enter values for the scale factor.
3. Click **OK**, the **Create New Scale** dialog box closes (Figure 5.21), and the visualization scale is set for the stream alignment.

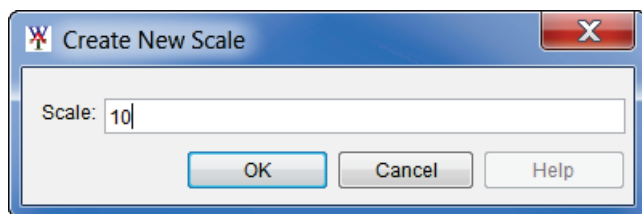


Figure 5.21 Create New Scale Dialog Box

### 5.3.2 Simulation Layer

When a simulation map window is open, the **Simulation Layer** for that map window is available. In Figure 5.22, the **Simulation Layer** is *Without Project Conditions-RR\_Feb1986*, which is the active simulation. When the tree expands, the different sub-layers that represent each model in the simulation is displayed. Therefore, if the user did not want to display the impact areas, clear *FIA:GridsAndXSecsAlternative* (Figure 5.22). The impact areas will no longer be visible in the simulation map window. To view the impact areas, click *FIA:GridsAndXSecsAlternative*. This procedure applies to all of the sub-layers of the simulation layer.

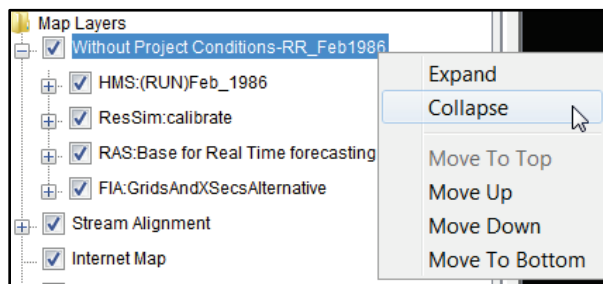


Figure 5.22 Simulation Layer – Shortcut Menu

### Shortcut Menu

The shortcut menu (Figure 5.22) for the **Simulation Layer** is accessed by right-clicking on the simulation layer (i.e., *Without Project Conditions-RR\_Feb1986*) in the **Maps Tab**. The shortcut menu provides several ways to manipulate the **Simulation Layer**. The available commands are:

**Expand** – expands the **Simulation Layer's** tree; the tree provides information on the available elements of the simulation.

**Collapse** – collapses the **Simulation Layer's** tree; the tree provides information on the available elements of the simulation.

**Move to Top** – moves the **Simulation Layer** to the top of the tree

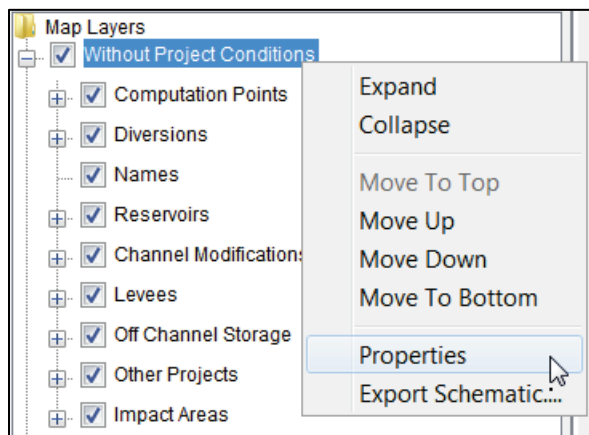
**Move Up** – moves the **Simulation Layer** up the tree one position

**Move Down** – moves the **Simulation** down the tree one position

**Move to Bottom** – the **Simulation** to the bottom of the tree

### 5.3.3 Schematic Layer

When a schematic map window is open, the **Schematic Layer** for that map window is available. In Figure 5.23, the **Schematic Layer** is *Without Project Conditions*. The **Schematic Layer** contains the graphical representations of the measures, common computation points, and impact



**Figure 5.23** Schematic Layer - Shortcut Menu

areas. When the tree expands, the different sub-layers that represent each element are displayed. Therefore, if the user did not want the impact areas displayed in the schematic map window, clear **Impact Areas**. The impact areas will no longer display in the schematic map window. To view the impact areas, click **Impact Areas**. This procedure applies to all of the sub-layers of the schematic layer.

### Shortcut Menu

The shortcut menu (Figure 5.23) for the **Schematic Layer** is accessed by right-clicking on the schematic layer (i.e., *Without Project Conditions*) in the **Maps Tab**. The shortcut menu provides several ways to manipulate the **Schematic Layer**. The available commands are:

**Expand** – expands the **Schematic Layer's** tree; the tree provides information on the available elements of the schematic.

**Collapse** – collapses the **Schematic Layer's** tree; the tree provides information on the available elements of the schematic.

**Move to Top** – moves the **Schematic Layer** to the top of the tree

**Move Up** – moves the **Schematic Layer** up the tree one position

**Move Down** – moves the **Schematic Layer** down the tree one position

**Move to Bottom** – moves the **Schematic Layer** to the bottom of the tree

**Properties** – opens the **Drawing Properties Editor** (Figure 5.24) which allows the user to edit properties of the elements that are part of the **Schematic Layer**.

**Export Schematic** – opens the **Export Schematic Layers** dialog box (Figure 5.25) which allows the user to export the selected elements for the active **Schematic Layer** to shapefiles.

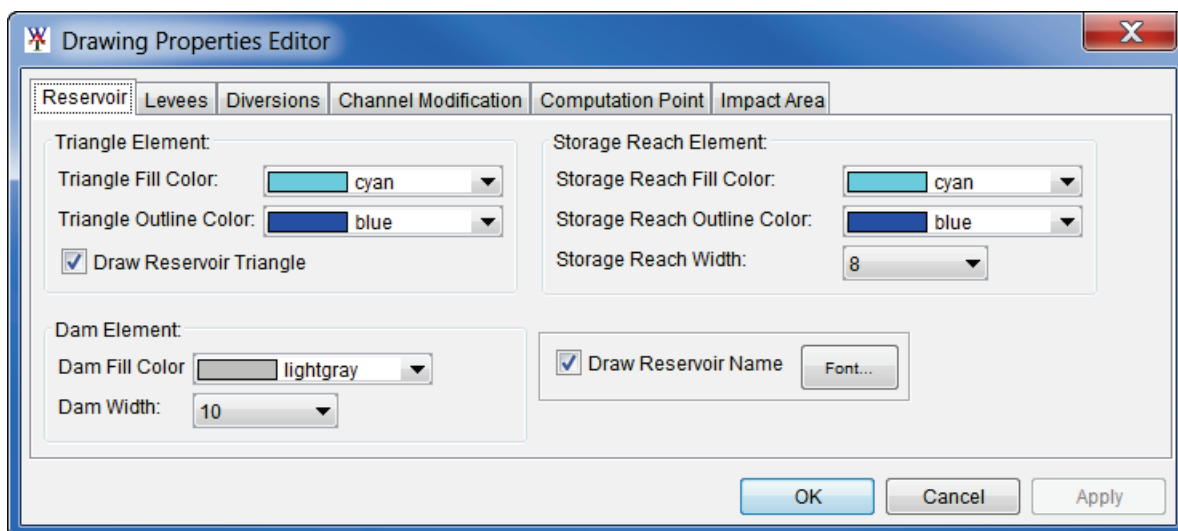


Figure 5.24 Drawing Properties Editor

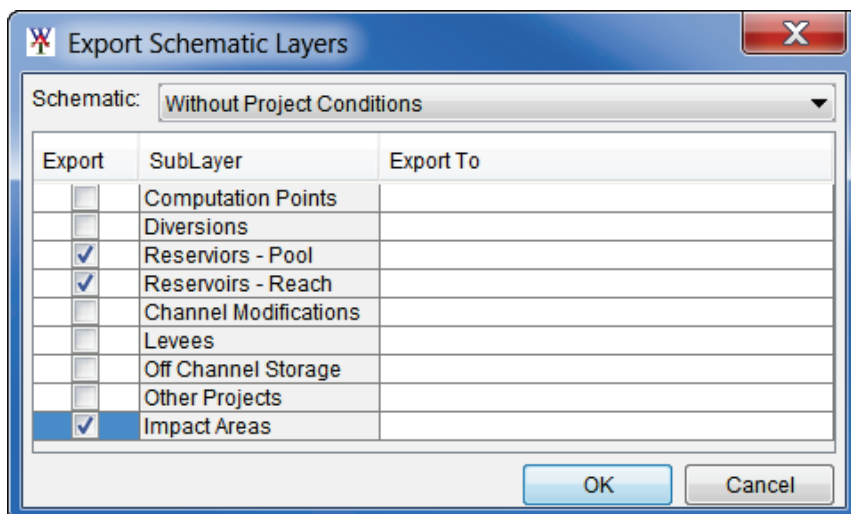


Figure 5.25 Export Schematic Layers Dialog Box

## Schematic Properties

For the **Schematic Layer**, the user can configure the appearance of the measures, common computation points, and impact areas. To configure:

1. From the **Maps** tab, right-click on a **Schematic Layer**. From the shortcut menu, click **Properties**, the **Drawing Properties Editor** will open (Figure 5.24). The **Drawing Properties Editor** has six tabs, which represent the elements available in the study.

2. Depending on the element (i.e., reservoirs, levees, etc.), the user can change the color of the element, the size of the element, whether the element is drawn or not, whether the label of the element is drawn or not, and what font and size of font the label of the element is displayed in.
3. For example, from the **Reservoir** tab (Figure 5.24) the user can set the width and colors of the different elements that make up a reservoir, whether to draw the reservoir polygon (triangle), whether to draw the reservoir label, and set the font for the reservoir label. The **Triangle Fill Color**, **Triangle Outline Color**, and **Draw Reservoir Triangle** affect the polygon (triangle) of a reservoir. The **Storage Reach Fill Color**, **Storage Reach Outline Color**, and **Storage Reach Width** affect the storage reach of a reservoir. The **Dam Fill Color** and the **Dam Width** affect the dam of a reservoir.
4. By default, the labels for the reservoirs appear in the display area. If the user does not want to display the labels, clear **Draw Reservoir Name**; click **Apply** (Figure 5.24), and the reservoir labels no longer appear in the display area. To change the font of the reservoir labels, click **Font**. A **Font Chooser** opens (Figure 5.17), select the font type from the **Type** list, and either select a size from the **Size** slider or enter a size. Click **OK**, the **Font Chooser** closes, from the **Drawing Properties Editor** (Figure 5.24), click **Apply**. Now all of the reservoir labels will display in the font and size chosen. The other elements in the **Drawing Properties Editor** have similar properties.

## 5.4 Layer Visualization Scaling

Layers may be set to become visible or invisible as users zoom-in or zoom-out on the active map window. Generally, this capability allows the user to display finer levels of detail as users zoom-in on regions in the map window and avoid clutter when displaying the full area. This might include detailed map layers to become visible, and raster or other images to appear that are not as distinguishable at a courser zoom level.



# CHAPTER 6

## Building the Base Schematic

### 6.1 Concepts

Once a study has been created and background maps have been collected, the next step is the development of the common schematic. A **schematic** is a physical representation of a stream alignment, and the flood damage reduction and environmental measures that will be modeled. The schematic also provides a common starting point for construction of compatible model data sets. A common schematic assures the naming convention, measure identification and location for the study is consistent throughout the modeling disciplines. The individual models can be edited and those individual model results can be viewed from HEC-WAT by selecting the elements found on the common schematic.

The common schematic will provide geo-referencing, stream referencing (stream alignment), common physical features (measures), data exchange locations (common computation points) and a set of features present for a particular modeling scenario (schematics).

### 6.2 Elements of a Schematic

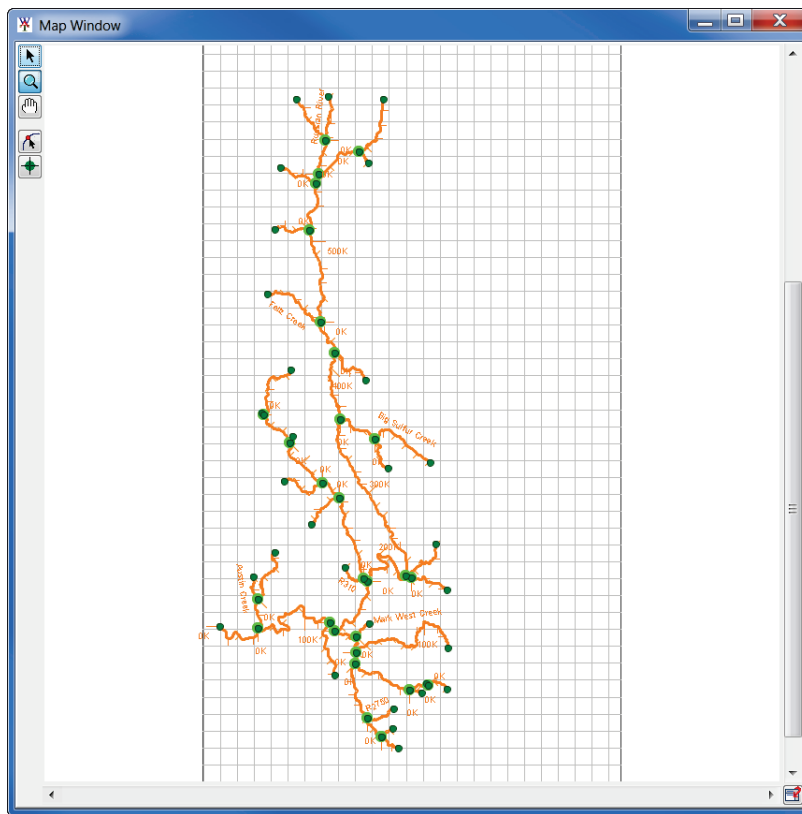
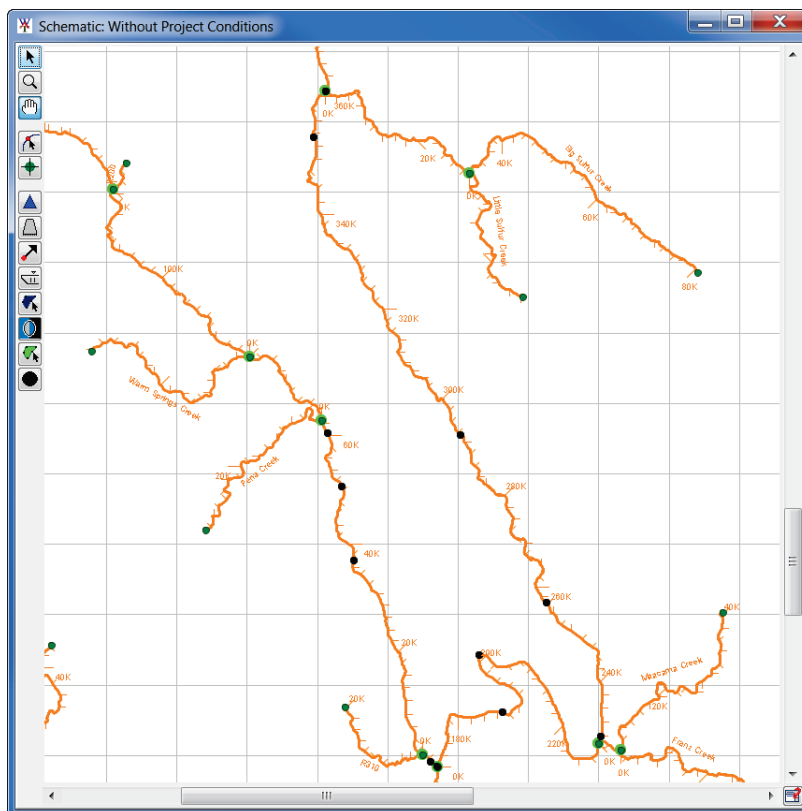
The following sections describe in general terms the main elements of a schematic and the tools provided by HEC-WAT to create schematics. Also, further details on each element are provided in the appendices of this User's Manual

#### 6.2.1 Stream Alignment

The backbone of any schematic is the stream alignment (Figure 6.1), and is the starting point in creating a schematic. A **stream alignment** is a one-dimensional river coordinate system, which defines the flow network. Also, from the stream centerline, stationing will be provided relative to its global location and specific to the study. See Section 6.5.1 and Appendix F for further details on stream alignments.

#### 6.2.2 Common Computation Points (CCP)

**Common computation points** (Figure 6.2) are locations where one model transfers model results to another model, where results are needed for model development or alternative analysis, or where input boundary conditions are to be defined. The common computation points need to be consistent for all models and should be placed on the stream alignment based on knowledge of possible study alternatives. The entire study team should be involved in the definition of the common computation points. For further details on common computation points see Section 6.5.2 and Appendix H.

**Figure 6.1** Stream Alignment**Figure 6.2** Common Computation Points (CCPs)



### 6.2.3 Measures

Measures (Figure 6.3) for HEC-WAT include structural/non-structural measures (flood damage reduction), and/or ecosystem measures. **Structural measures** are physical modifications designed to reduce the frequency of damaging levels of flood inundation, and include dams with reservoirs, levees, channelization measures, walls, diversion channels, pumps, bridge modifications, and ice-control structures. **Non-structural measures** are activities that reduce flood damage without significantly altering the nature or extent of flooding (e.g., flood proofing, relocation of structures, raising structures). **Ecosystem restoration measures** are physical modifications or other actions that improve the value and function of an ecosystem (e.g., channel restoration, removal of drainage structures or levees). There are various measures that can be defined for HEC-WAT, but this User's Manual will only focus on reservoirs (Section 6.5.3) and levees (Appendix G). Other measures available in HEC-WAT are diversions, channel improvements, off-channel storage, and other projects. Measures are not required for an HEC-WAT study.

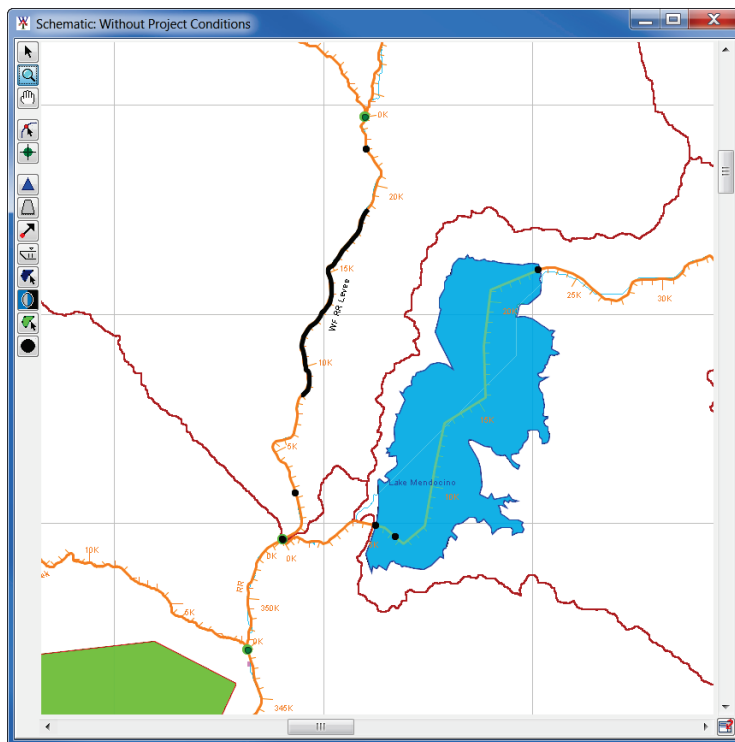


Figure 6.3 Measures

### 6.2.4 Impact Areas

An **impact area** (Figure 6.4) is any distinct portion of a study that is affected by rising or falling stage in a stream, river, lake, or reservoir. The boundaries of an impact area are defined by a closed polygon, and the user can characterize the effects of rising or falling stage by describing the property, project, and/or population at risk in the area bounded by the polygon. Impact areas are an optional element, and are only required when a user wants to compute impacts at damage area centers in the study area, and an HEC-FIA model is part of the HEC-WAT modeling effort. For further details on impact areas see Section 6.5.4 and Appendix I.

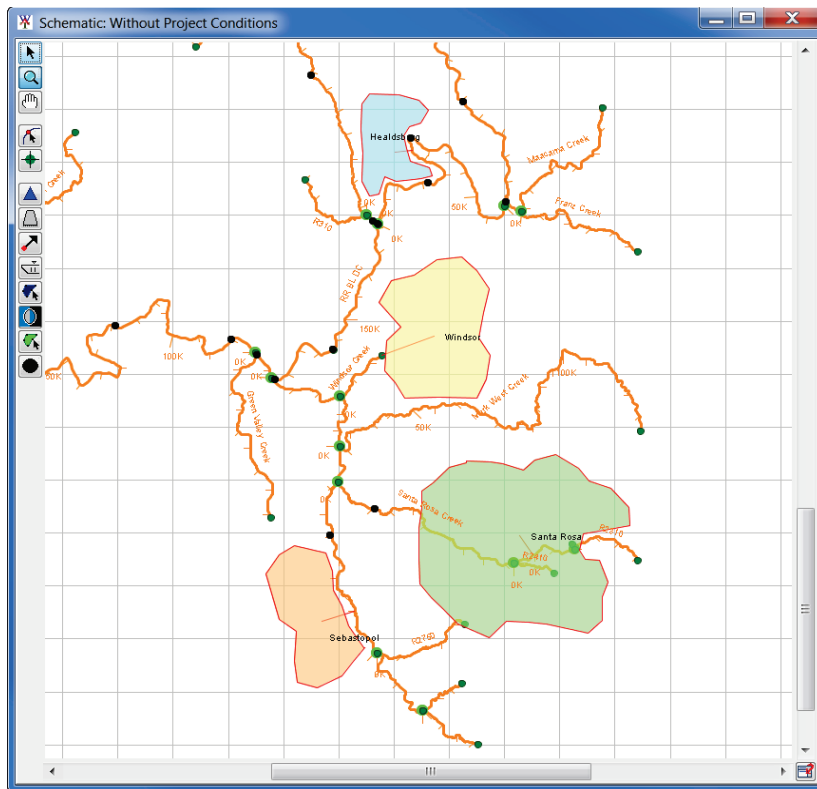


Figure 6.4 Impact Areas

## 6.3 Study Element Tools

There are tools available to view and create the study elements from the schematic map window. These tools are as follows:



**Pointer/Selector Tool** – use this tool to edit, rename, and delete elements (does not include stream alignment elements). Commands for editing existing study elements are available by selecting the **Pointer/Selector** tool, and right-clicking on a study element.



**Zoom Tool** - use this tool to zoom in and out of map windows. To zoom in, hold the left mouse button down and outline the area that will be enlarged. To zoom out, click the right mouse button (right-click). The zoom out is done by a factor of two and positions the clicked location at the center of the map window.



**Pan Tool** – use this tool to move the map window while zoomed in.



**Impact Area Tool** - use this tool to create, delete, rename, and edit impact areas. See Appendix I for further details on impact areas.



**Computation Point Tool** - use this tool to create, delete, rename, and edit common computation points. Common computation points are locations where one model transfers data to another model, where results are needed for model development, or where input boundary conditions are to be defined. Appendix H provides further details on common computation points.



**Stream Alignment Tool** - use this tool to create, delete, and edit streams that make up the stream alignment (Appendix F).



**Stream Node Tool** - use this tool to create, delete, and edit stream nodes and stream junctions (Appendix F) on the stream alignment.

## 6.4 Measure Tools



**Reservoir Tool** - use this tool to create, delete, rename, and edit reservoirs. Appendix G provides further details on reservoirs.



**Levee Tool** - use this tool to create, delete, rename, and edit levees. Appendix G provides further details on levees.



**Diversion Tool** - use this tool to create, delete, rename, and edit diversions. A diversion has to be started on the stream alignment. To create a diversion, select the **Diversion** tool, hold down the **CTRL** key, and click on the stream alignment. Each click creates a vertex point along the diversion. When reaching the end point of the diversion, release the **CTRL** key, and click. The user will be asked to name the diversion. After naming the diversion, the diversion will appear on the active map window. Commands available for editing an existing diversion are available by selecting the **Diversion** tool, and right-clicking on a diversion.



**Channel Modification Tool** - use this tool to create, delete, rename, and edit channel modifications. A channel modification has to be created on the stream alignment. To create a channel modification, select the **Channel Modification** tool, hold down the **CTRL** key, click on the upstream end of the channel modification, release the **CTRL** key, and drag along the stream alignment to the downstream end of the channel modification and click. The user will be asked to name the channel modification. After naming the channel modification, the channel modification will appear on the active map window. Commands available for editing an existing channel modification are available by selecting the **Channel Modification** tool, and right-clicking on a channel modification.



**Off-Channel Storage Area Tool** - use this tool to create, delete, rename, and edit off-channel storage areas. To create an off-channel storage area, select the **Off-Channel Storage Area** tool and hold down the **CTRL** key while clicking the mouse button. Each click creates a vertex point, which is the boundary of the polygon. When reaching the end point, release the **CTRL** key and click. The user will be asked to name the off-channel storage area. After naming the off-channel storage area, the off-channel storage area will appear on the active map window. Commands available for editing an existing off-channel storage area are available by selecting the **Off-Channel Storage Area** tool, and right-clicking on an off-channel storage area.



**Other Project Tool** - use this tool to create, delete, rename, and edit other projects. This tool enables the placement of elements that represent "other" projects, such as pump stations. To create an "other" project, select the **Other Project** tool and hold down the

**CTRL** key and click. The user will be asked to name the "other" project. After naming the "other" project, the "other" project will appear on the active map window. Commands available for editing an existing "other" projects are available by selecting the **Other Project** tool, and right-clicking on an "other" project.

## 6.5 Create the Default Schematic

When a new study is created in HEC-WAT, a default (base) alternative is created with either an HEC-WAT default name (*Without Project Conditions*) or a user-defined name. After the alternative has been created, the default schematic needs to be defined, this will have the same name as the default alternative. The first step in defining the default schematic is to add the basic schematic elements to the schematic - stream alignment, common computation points, measures (reservoirs, levees), and impact areas.

The steps to define the default schematic are:

1. Once a study is created, the default schematic map window will open in the **Desktop Pane** (Chapter 3, Section 3.1).
2. Add a map layer (Chapter 5) that will guide in creating the stream alignment. The user can either digitize the stream alignment by hand or import a stream alignment using a stream shapefile layer that has already been added to the HEC-WAT study. Section 6.5.1 provides further details on creating a stream alignment.
3. After the stream alignment has been defined, common computation points should be added (Section 6.5.2) to the default schematic. Common computation points are locations where the models associated with the alternative will hand off data to each other, the user can view results, or locations where input boundary conditions are defined.
3. Now measures that describe the default alternative need to be added to the schematic. There are several types of optional measures that can be added, this manual will concentrate on reservoirs (Section 6.5.3) and levees (Appendix G).
5. An optional element to add to the default schematic is impact areas. Impact areas are required if computation of impacts at damage area centers in the study area are required, and an HEC-FIA model is part of HEC-WAT modeling alternatives. Section 6.5.4 provides further details on defining impact areas.
6. Once the default schematic is complete, be sure to save the schematic data. The user can now create other alternatives and schematics based on the default schematic.

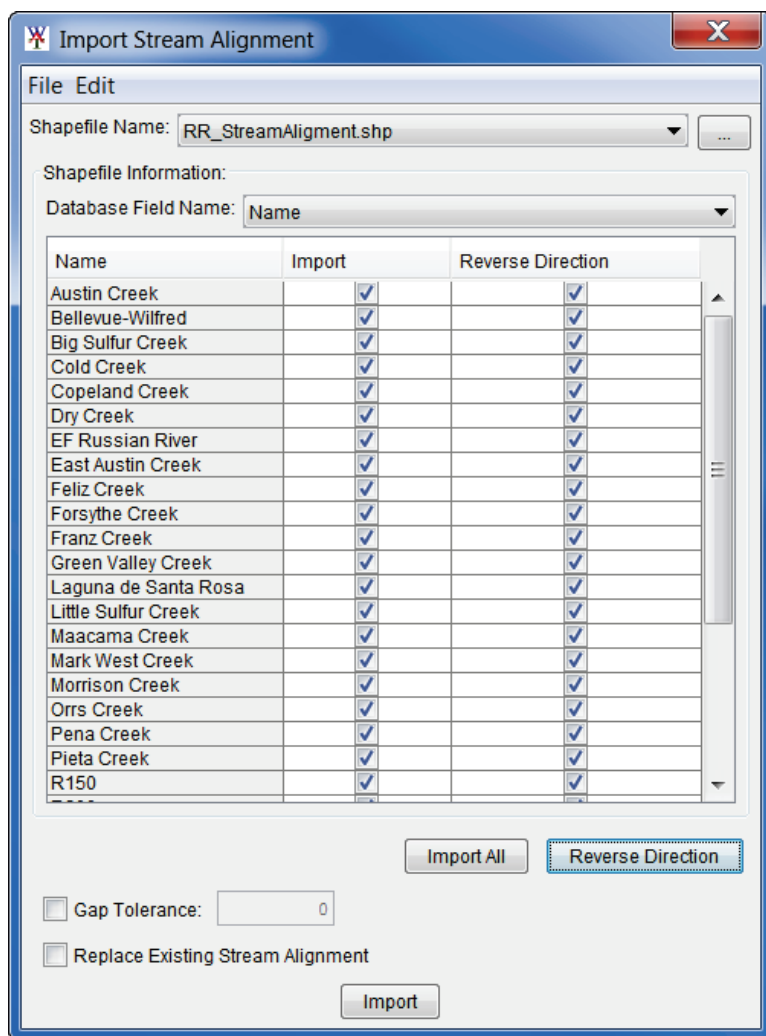
### 6.5.1 Create a Stream Alignment

The backbone of any schematic is the stream alignment, and is the starting point in creating a schematic. A **stream alignment** is a one-dimensional river coordinate system, which defines the natural downstream flow network. Also, from the stream centerline, stationing will be provided relative to its global location and specific to the study. The alignment indicates where

confluences and bifurcations occur and provides a sense of distance and scale. Stream alignments are composed of a series of streams, stream nodes, and stream junctions.

To import a stream alignment:

1. From the HEC-WAT main window, click the **Maps** tab, from the **Map Layers** tree, right-click on **Stream Alignment**. From the shortcut menu, click **Import**. The **Import Stream Alignment** dialog box will open (Figure 6.5). The **Shapefile Name** list defaults to the first line shapefile that HEC-WAT can find in the *maps* directory of a study; which for this example (Figure 6.5) happens to be the shapefile that represents the stream alignment for the *RussianRiver* study - *RR\_StreamAlignment.shp*.



**Figure 6.5** Import Stream Alignment Dialog Box

2. From the **Database Field Name** list (Figure 6.5), the user needs to select the field name in the attribute file that contains the names of the streams - **Name**. Once a field name is selected, the table below the **Database Field Name** list (Figure 6.5) will populate with the streams contained in the shapefile. If there is an issue with any of the stream segments the checkbox in the **Import** column (Figure 6.11) will not be selected. This means the stream segment is not continuous and will not be imported.

- Click **Import**, the **Import Stream Alignment** dialog box will close (Figure 6.5). Once the import of the stream alignment is completed, a message window will appear letting the user know that the stream alignment imported successfully. In the active **Map Window** the stream alignment appears (orange stream segments; green stream nodes and stream junctions).

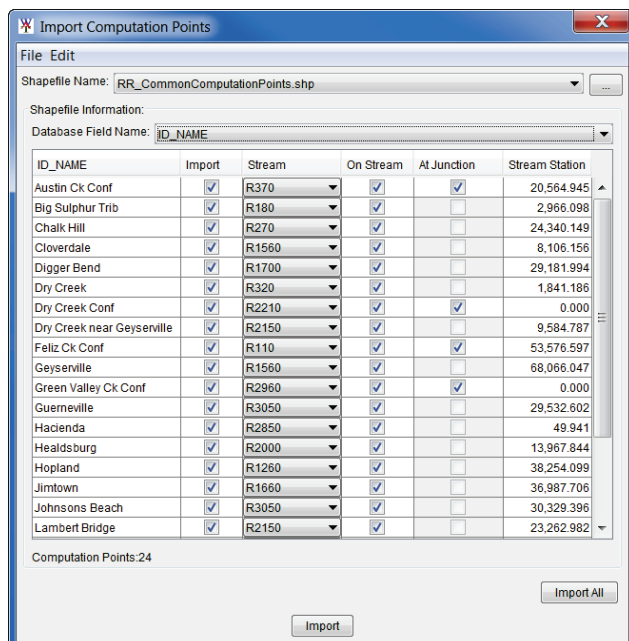
Sometimes the streams in a shapefile are not in the right flow direction. Instead, of fixing this issue outside of HEC-WAT, and if the user is aware of this issue before an import. From the **Import Stream Alignment** dialog box (Figure 6.5), from the table, make sure the under the **Reverse Direction** column, all of the streams are selected where the flow direction is not correct. When, the stream alignment is imported, the flow direction will be corrected automatically. For further information on **Reverse Direction** see Appendix F.

## 6.5.2 Add Common Computation Points (CCPs)

**Common computation points (CCPs)** are locations where one model can transfer data to another model, where results are needed for model development or alternative analysis, or where input boundary conditions are to be defined. CCPs need to be consistent for all models and should be placed on the stream alignment based on the knowledge of possible study alternatives. The entire study team should be involved in the definition of the CCPs.

To import CCPs from a shapefile:


- From the HEC-WAT main window, from **Maps** menu, point to **Import**, click **Computation Points**. The **Import Computation Points** dialog box will open (Figure 6.6). The **Shapefile Name** list defaults to the first point shapefile that HEC-WAT can find in the *maps* directory of a study; which happens to be the shapefile that represents the CCPs for the *Russian River* study - *RR\_CommonComputationPoints.shp*.

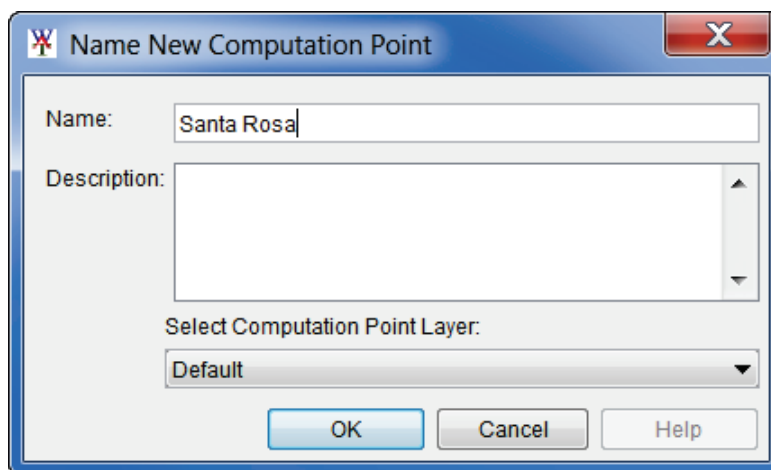


**Figure 6.6** Import Computation Points Dialog Box

2. From the **Database Field Name** list (Figure 6.6), select the field name in the attribute file that contains the names of the CCPs - **ID\_Name**. Once a field name is selected, the table below the **Database Field Name** list (Figure 6.6) will populate with the CCPs contained in the shapefile. If there is an issue with any of the CCPs, the checkbox in the Import column will not be selected.
3. Click **Import**, the **Import Computation Points** dialog box will close (Figure 6.6). Once the import of the CCPs is completed, a message window will appear letting you know that the CCPs have been imported successfully. In the active **Map Window** the CCPs appear as black circles.

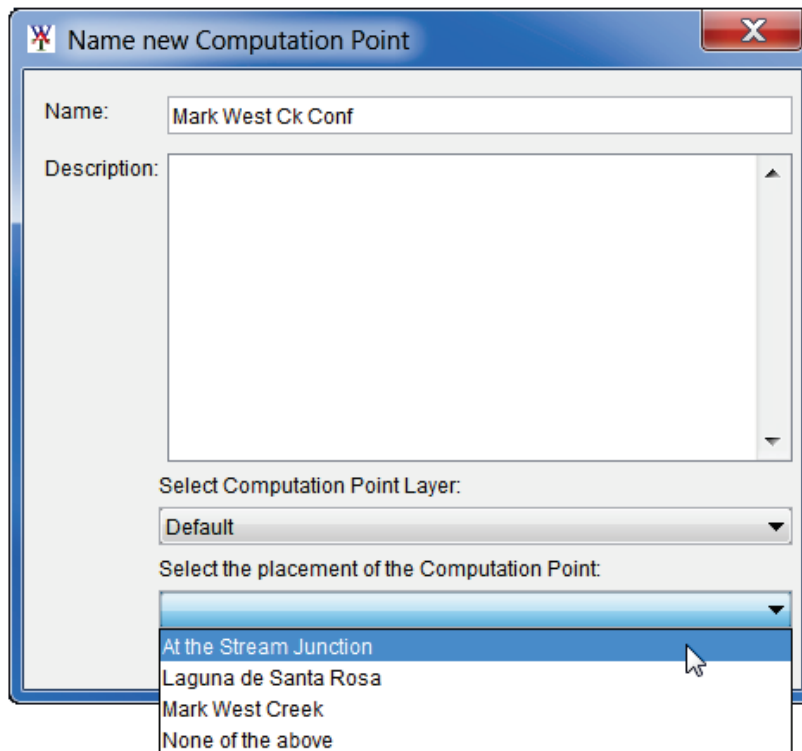
A user can also add CCPs to the schematic manually by performing the following steps:

1. From the **Schematic Map Window**, find the location where a CCP needs to be added, press the **Computation Point** tool .
2. Hold down the **CTRL** key and click on the stream alignment to place the common computation point.
3. The **Name New Computation Point** dialog box will open (Figure 6.7). Enter the new **Name** (required) and **Description** (optional, but recommended). Click **OK**, the **Name New Computation Point** dialog box will close.



**Figure 6.7** Name New Computation Point Dialog Box

4. The CCP will now appear in the map window as a black circle.
5. If a CCP is added at a stream junction, a slightly different **Name New Computation Point** dialog box will open (Figure 6.8). Enter the new **Name** (required) and **Description** (optional, but recommended).
6. From the **Select the Placement of the Computation Point** list (Figure 6.8), determine exactly where the CCP will be placed. Choices are to have the CCP placed on the stream junction, along one of the streams that form the stream junction, or none of the above. For example, in Figure 6.8, the CCP will be placed on the stream junction.




**Figure 6.8** Name new Computation Point Dialog Box at a Stream Junction

7. Click **OK**, the **Name New Computation Point** dialog box (Figure 6.8) will close. The CCP will now appear in the display area as a black circle.

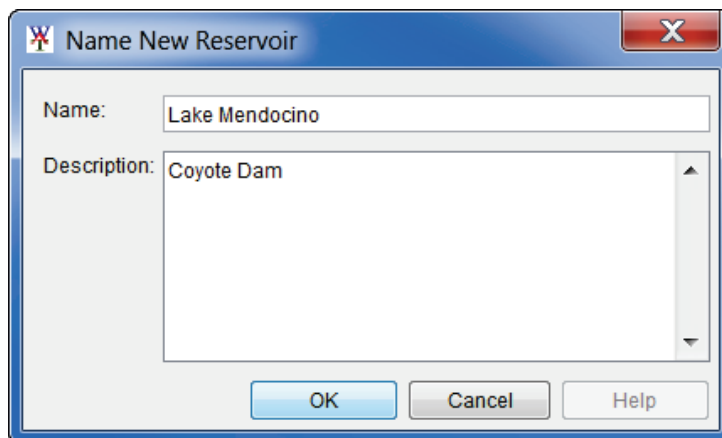
### 6.5.3 Add a Reservoir

A **reservoir** is the impoundment created behind dams, or behind navigation locks and dams. For HEC-WAT a reservoir also includes the dam built on a stream to store water for uses such as flood risk management, hydroelectric power generation, recreation use, and water supply, etc.

To add a reservoir:

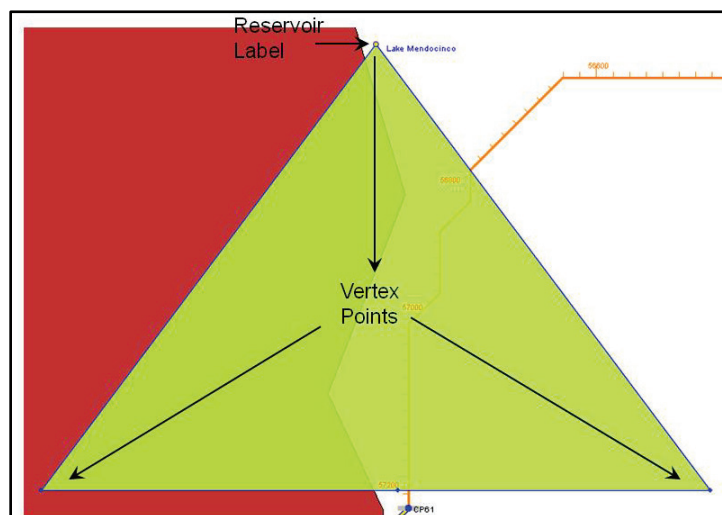
1. From the **Schematic Map Window**, find the location where a reservoir needs to be added, press the **Reservoir** tool .
2. Hold down the **CTRL** key and click on the stream alignment to place the upstream end of the reservoir. Release the **CTRL** key; drag the mouse to the downstream end of the reservoir and click.
3. The **Name New Reservoir** dialog box will open (Figure 6.9). Enter a **Name** (*Lake Mendocino*) and **Description** (optional, but recommended) for the reservoir. Click **OK**, the **Name New Reservoir** dialog box will close.
4. The reservoir will now appear on the schematic as a cyan triangle (reservoir pool), a blue line (storage reach), a gray rectangle (dam), and two CCPs that represent the upstream and downstream ends of the reservoir.






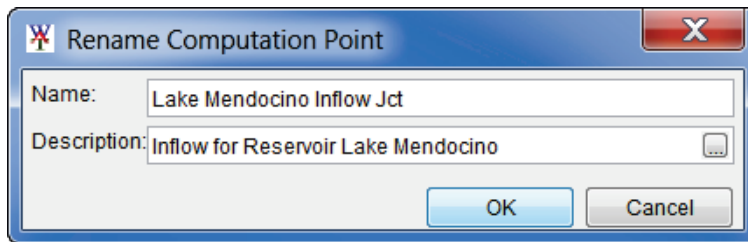
**Figure 6.9** Name New Reservoir Dialog Box

5. The default representation of the reservoir pool is a triangle; the user can edit this triangle if a more detailed representation of the pool is desired. With the **Reservoir** tool pressed, double-click on the reservoir. The triangle (Figure 6.10) will now be green with a blue outline color. Also, there are three vertex points (blue), and at the apex of the triangle is the reservoir label, which is represented by a yellow circle.



**Figure 6.10** Reservoir Pool

6. When a reservoir is created there are two CCPs that are created with default names. It is recommended that the names of the two CCPs be changed. These two CCPs represent the inflow and outflow junctions of the reservoir and should be renamed accordingly.
7. To change the name of a CCP, press the **Computation Point** tool , right-click on one of the CCPs. From the shortcut menu, click **Rename Computation Point**; the **Rename Computation Point** dialog box will open (Figure 6.11). In the **Name** box, enter the new name, and in the **Description** box enter a description (optional, but recommended). For example, in Figure 6.11, the inflow junction for *Lake Mendocino* has been labeled *Lake Mendocino Inflow Jct*, and the outflow junction should be labeled *Lake Mendocino Outflow Jct*.



**Figure 6.11** Rename Computation Point Dialog Box

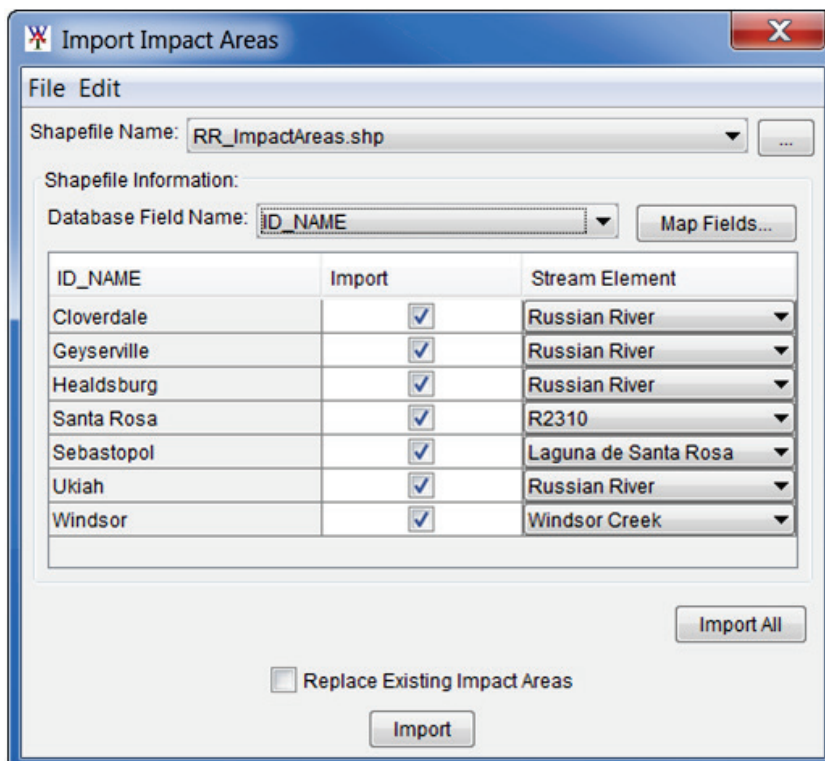
8. Click **OK**, a **Confirm Rename** window will open, asking the user to be sure that the CCP is to be renamed. Click **Yes**, the **Rename Computation Point** dialog box will close (Figure 6.11) and the new name for the CCP will appear in the map window.

## 6.5.4 Add Impact Areas

An **impact area** is any distinct portion of a study that is affected by rising or falling stage in a stream, river, lake, or reservoir. Impact areas are an optional element, and are only required when the user wants to aggregate impacts at damage area centers in the study area

To import impact areas from a shapefile:

1. From the HEC-WAT main window, from **Maps** menu, point to **Import**, click **Impact Areas**. The **Import Impact Areas** dialog box will open (Figure 6.12). The **Shapefile Name** list figures out whether there are any polygon shapefiles available in the **maps** directory (e.g., *RR\_ImpactAreas.shp*).



**Figure 6.12** Import Impact Areas Dialog Box

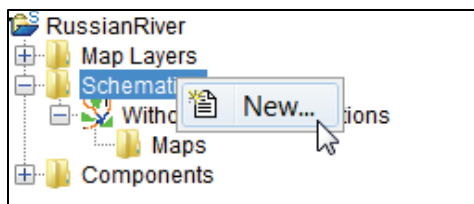
- From the **Database Field Name** list (Figure 6.12), the user needs to select the field name in the attribute file that contains the names of the impact areas - **ID\_Name** (Figure 6.12). Once a field name is selected, the table below the **Database Field Name** list will populate with the impact areas contained in the shapefile. If there is an issue with any of the impact areas the checkbox in the **Import** column will not be selected.
- Click **Import**, the **Import Impact Areas** dialog box will close (Figure 6.12). Once the import of the impact areas is completed, a message window will appear letting the user know that the impact areas have been imported successfully. In the active **Map Window** the impact areas appear as green polygons.

## 6.6 Create Additional Schematics

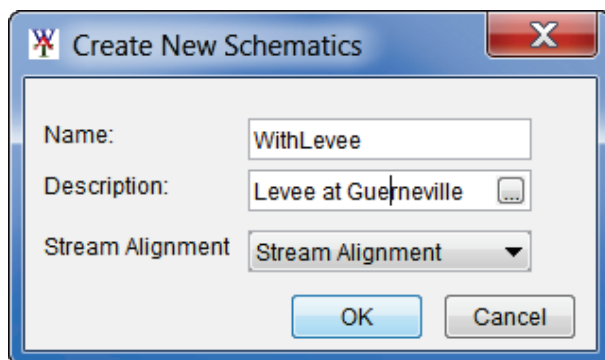
Section 6.5 described the steps for creating the schematic for the default HEC-WAT alternative (i.e., *Without Project Conditions*). Additional schematics can be created if the HEC-WAT study has other alternatives where something might be different, like adding a new project, or removing a project from the study area. There are two ways to create a schematic, one is from the **Schematic Tab**, and the other is when an alternative is created.

To create a schematic from the **Schematic** tab:

- From the **Schematic** tab, on the **Study Pane** (Figure 6.13), right-click on the **Schematics** folder, from the shortcut menu click **New**. The **Create New Schematics** dialog box will open (Figure 6.14).



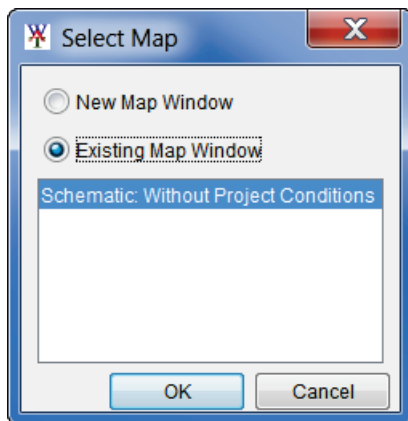
**Figure 6.13** Creating a New Schematic



**Figure 6.14** Create New Schematics Dialog Box

- In the **Name** box enter the name (required), and in the **Description** box, enter a description (optional, but recommended).

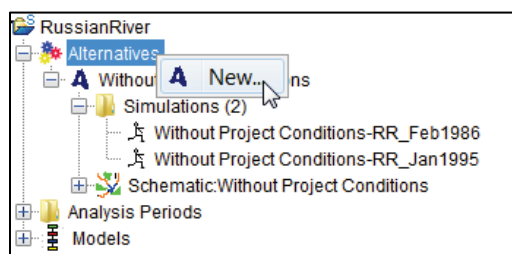
3. Select a stream alignment that the schematic will be built around. HEC-WAT allows for multiple stream alignments in a study. From the **Stream Alignment** list (Figure 6.14) select a stream alignment.
4. Click **OK**, the **Create New Schematics** dialog box will close (Figure 6.14). In the **Study Pane** (Figure 6.13), the **Schematics** folder will now contain the new schematic.
5. A map window will open in the **Desktop Pane** representing the schematic. Now the user needs to review the new schematic to see if any adjustment need to be made to the stream alignment; add/edit/delete measures; add/edit/delete CCPs; and, add/edit/delete impact areas.
6. If a map window is open in the **Desktop Pane**, the **Select Map** dialog box will open (Figure 6.15). The user can choose whether to open the schematic in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 6.15) and the **Create New Schematics** dialog box (Figure 6.14) will both close, and the map window for the new schematic will appear in the **Desktop pane**. Now the user needs to review the new schematic to see if any adjustment need to be made to the stream alignment; add/edit/ delete measures; add/edit/delete CCPs; and, add/edit/delete impact areas.



**Figure 6.15** Select Map Dialog Box

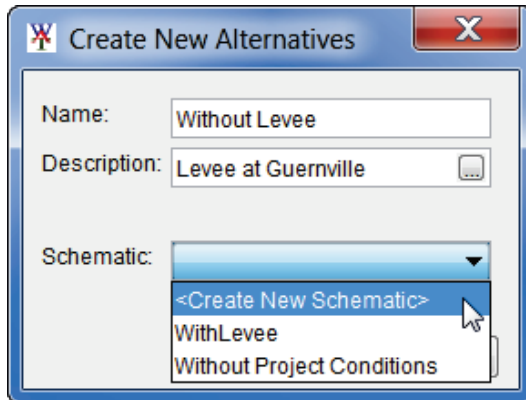
To create a schematic when creating an alternative:

1. From the **Study** tab, on the **Study Pane** (Figure 6.16), right-click on the **Alternatives** folder, from the shortcut menu click **New**. The **Create New Alternatives** dialog box will open (Figure 6.17).



**Figure 6.16** Creating a New Alternative

2. Enter the alternative name in the **Name** box (required), and an optional (recommended) description in the **Description** box (Figure 6.17).



**Figure 6.17** Create New Alternatives Dialog Box

3. Each alternative requires a schematic to provide the layout of the study area measures and components. Select a previously defined schematic, or create a schematic for the alternative from the **Schematic** list (see Step 6).
4. Click **OK**, the **Create New Schematics** dialog box will close (Figure 6.12). If there is not a map window open in the **Desktop Pane**, the **Create New Alternatives** dialog box will close (Figure 6.17) and a map window will open in the **Desktop Pane** representing the alternative.
5. If a map window is open in the **Desktop Pane** (Chapter 3, Section 3.1), the **Select Map** dialog box will open (Figure 6.15). The user can choose whether to open the alternative in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 6.15) and the **Create New Alternatives** dialog box (Figure 6.17) will both close, and the map window for the new alternative will appear in the **Desktop Pane**.
6. If a new schematic for the alternative needs to be created, from the **Schematic** list (Figure 6.17), click **<Create New Schematic>**. Click **OK**, a **No schematic was selected** warning window will open. The window is asking the user if a schematic needs to be created, click **Yes**. The **Create New Schematics** dialog box will open (Figure 6.14). A name for the schematic is automatically generated based on the name of the alternative. Review Steps 4 and 5.
7. The schematic name will now appear on the **Schematic Tab**, under the **Schematics** folder (Figure 6.13). Now the user needs to review the new schematic to see if any adjustment need to be made to the stream alignment; add/edit/delete measures; add/edit/delete CCPs; and, add/edit/delete impact areas.

## 6.7 Existing Schematics

After creating a schematic, the user can view the schematic; edit certain properties of a schematic; save the active schematic; create a copy of an existing schematic; delete a schematic that is not associated with an alternative; and, view an existing schematic's properties. All of

these tasks are accomplished through the schematic shortcut menu (Figure 6.18). To access the schematic shortcut menu, from the **Schematic** tab, right-click on an existing schematic under the **Schematics** folder, and the schematic shortcut menu will appear.

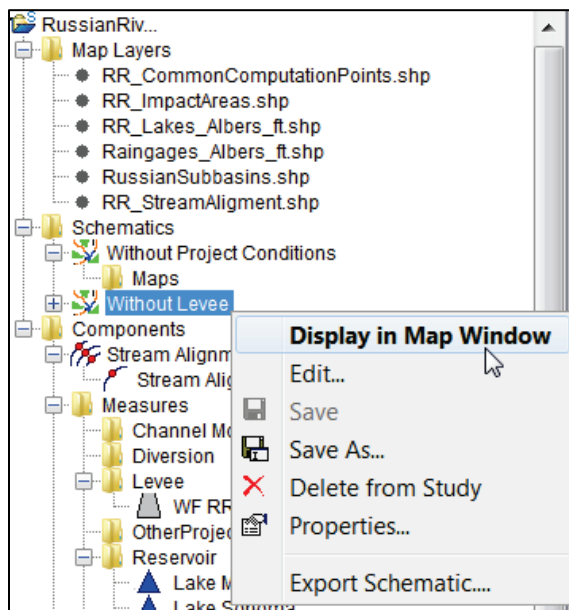


Figure 6.18 Schematic Shortcut Menu

## 6.7.1 View a Schematic

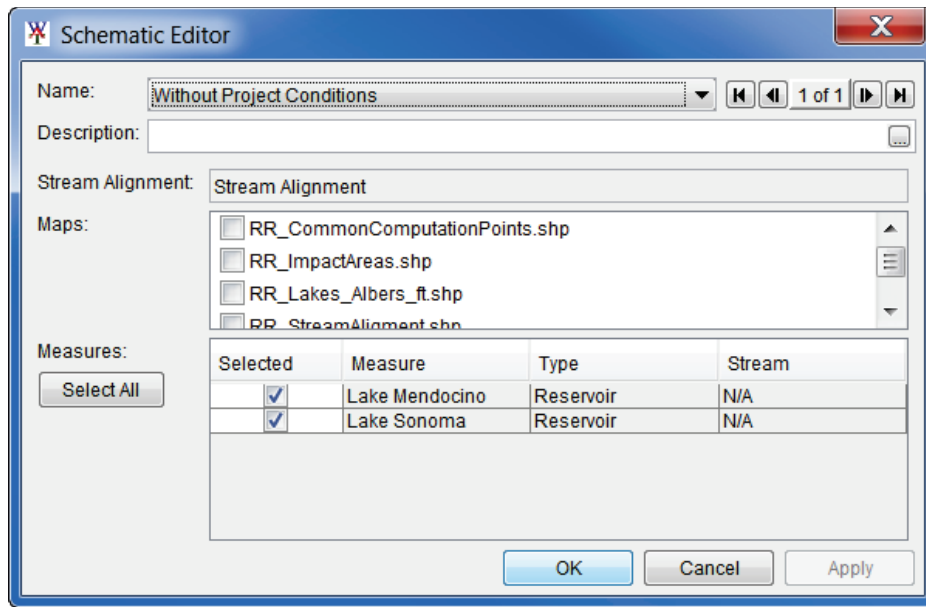
To view a schematic in a map window:

1. From the schematics shortcut menu (Figure 6.18) click **Display in Map Window**.
2. If there is not a map window open in the **Desktop Pane** (Chapter 3, Section 3.1), the map window for the selected schematic will open in the **Desktop Pane**. From the map window the user needs to review the new schematic to see if any adjustment needs to be made to the stream alignment; add/edit/delete measures; add/edit/delete CCPs; and, add/edit/delete impact areas.
3. If a map window is open in the **Desktop Pane** (Chapter 3, Section 3.1), the **Select Map** dialog box (Figure 6.15) will open. Now the user needs to review the new schematic to see if any adjustment need to be made to the stream alignment; add/edit/delete measures; add/edit/delete CCPs; and, add/edit/delete impact areas., Click **OK**, the **Select Map** dialog box (Figure 6.15) will close, and the map window for the selected schematic will appear in the **Desktop Pane**.





## 6.7.2 Edit an Existing Schematic

To edit the description, or to add and remove measures from an existing schematic:

1. From the schematics shortcut menu (Figure 6.18) click **Edit**. The **Schematic Editor** will open (Figure 6.19).



**Figure 6.19** Schematic Editor

2. In the **Description** box the user can edit the description of schematic.
3. From the **Measures** box the user can add or remove measures from a schematic by selecting the measures. For example (Figure 6.19), if the user decides for this schematic not to include the *Lake Sonoma*, clear **Lake Sonoma**. *Lake Sonoma* will now be removed from the schematic.
4. From the **Schematic Editor** (Figure 6.19), there is the ability to edit other schematics by using the **Navigator Button** in the upper right-hand corner of the editor. Clicking  places the user at the first schematic, while clicking  places the user at the last schematic. Clicking  or  moves the user back (previous) one schematic and forward (next) one schematic, respectively. The center of the navigator button indicates the number of schematics and which schematic the user is presently accessing.
5. Click **OK**, the **Schematic Editor** will close (Figure 6.19), and if the map window associated with the schematic is open, the measure will no longer display in the map window.

### 6.7.3 Save a Schematic

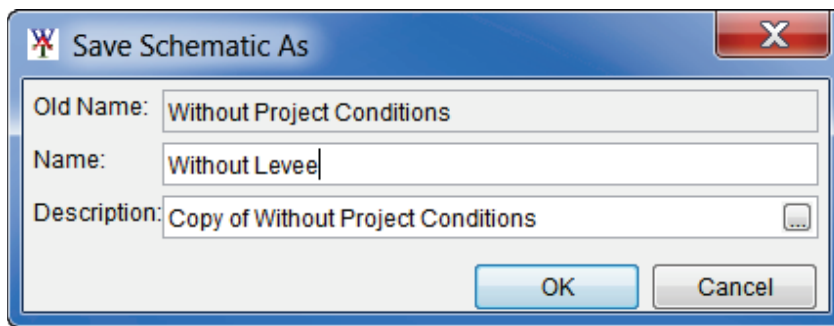
To save the active schematic, from the schematic shortcut menu (Figure 6.18), click **Save**. Any changes that have occurred to the selected schematic will be saved by HEC-WAT.

### 6.7.4 Make a Copy of an Existing Schematic

To make a copy of an existing schematic:

1. From the schematics shortcut menu (Figure 6.18), click **Save As**. The **Save Schematic As** dialog box will open (Figure 6.20).





**Figure 6.20** Save Schematic As Dialog Box

2. The information displayed in the dialog box represents the schematic the user has chosen to make a copy of.
3. In the **Name** box, enter the name (required) of the new schematic, and in the **Description** box, enter a description (optional, but recommended).
4. Click **OK**, the **Save Schematic As** dialog box (Figure 6.20) will close, and in the **Study Pane**; under the **Schematics** folder the new schematic name will appear.

### 6.7.5 Delete a Schematic

A schematic can only be deleted as long as it is not associated with an alternative. For example, in Figure 6.18, the *Without Project Conditions* schematic is associated with an alternative, so the **Delete from Study** command does not display on the schematic shortcut menu. To delete a schematic not associated with an alternative:

1. From the **Schematic** tab, on the **Study Pane**, from the **Schematics** folder, right-click on a schematic that is not associated with an alternative. From the **Schematics** shortcut menu (Figure 6.18), click **Delete from Study**.
2. A **Confirm Manager Delete** message window will open, asking the user do you really want to delete the selected schematic. Click **Yes**, the schematic name will no longer appear under the **Schematics** folder on the **Study Pane**.

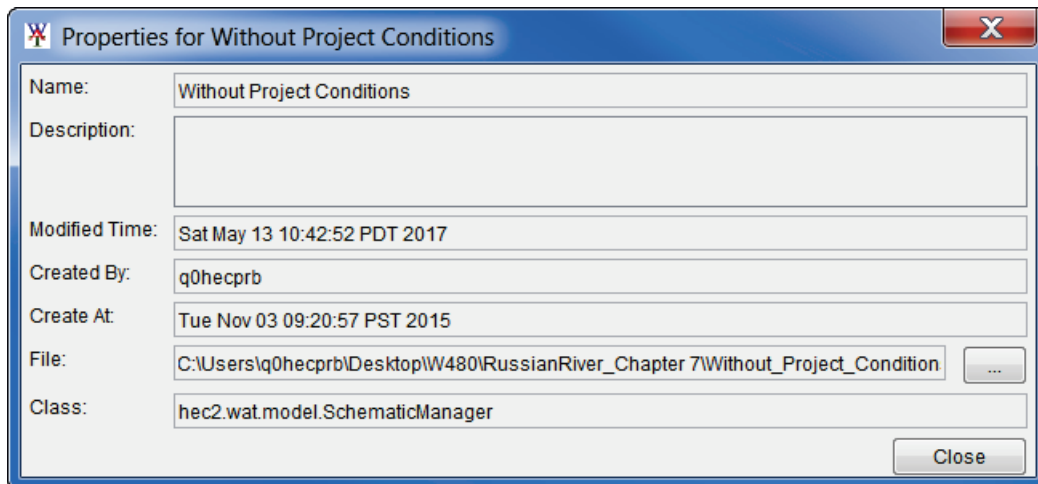
### 6.7.6 Schematic Properties

The properties of a schematic include the name; description; when the schematic was modified; who created the schematic; when the schematic was created; and, the file that contains the schematic data. To view the properties of a schematic, from the schematics shortcut menu (Figure 6.18), click **Properties**. The **Properties for SchematicName** dialog box will open (Figure 6.21).


### 6.7.7 Export Schematic Layers

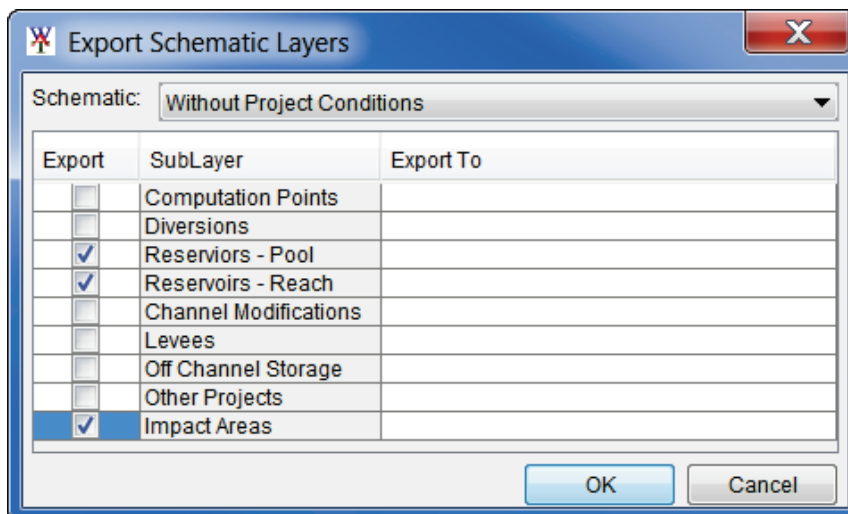
The user can export schematic sub-layers:





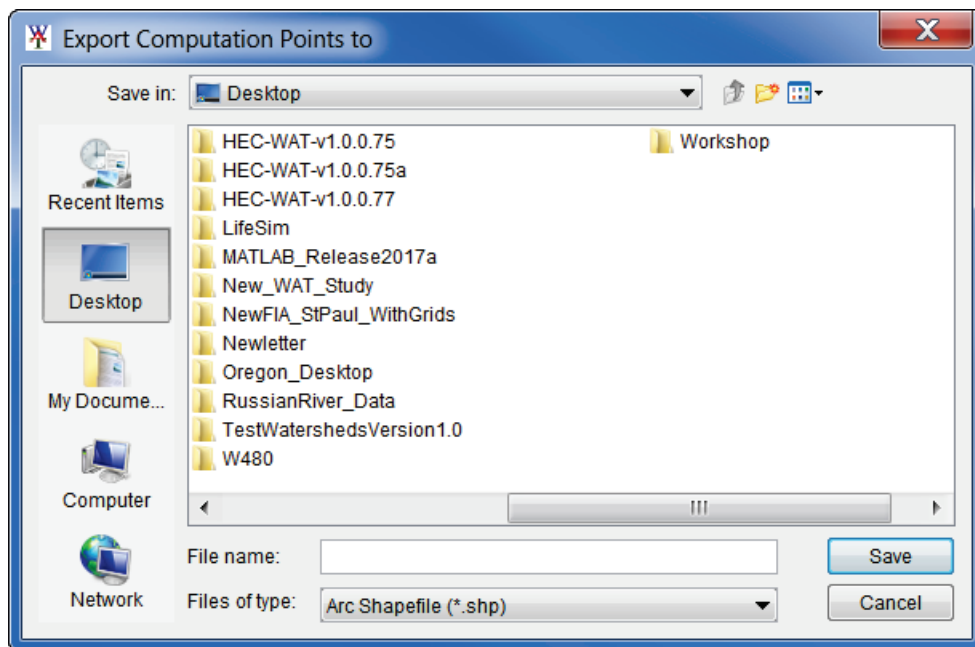
**Figure 6.21** Properties for *SchematicName* Dialog Box

1. From the **Schematic** tab, on the **Study Pane**, from the **Schematics** folder, right-click on a schematic. From the **Schematics** shortcut menu (Figure 6.18), click **Export Schematic**.
2. The **Export Schematic Layers** dialog box will open (Figure 6.22).
3. From the **Export** column (Figure 6.22) select the individual sub-layers that need to be exported to a shapefile. Double-click in the associated cell for a sub-layer, under the **Export To** column (Figure 6.22). In that cell (Figure 6.22), either enter the name of the directory where to store the shapefile, or click , and an **Export** browser (Figure 6.23) will open.



**Figure 6.22** Export Schematic Layers Dialog Box

4. The browser name will be based on the schematic sub-layer that the user has chosen, for example in Figure 6.23, the user has selected to export the common computation point sub-layer. Navigate to the directory where the shapefile will be stored, enter a name in the **File name** box (Figure 6.23), click **Save**. The **Export** browser (Figure 6.23) will close.



**Figure 6.23** Export Browser – Common Computation Points

5. From the **Export Schematic Layers** dialog box (Figure 6.22), click **OK**. The **Export Schematic Layers** dialog box will close (Figure 6.22) and the shapefile (all necessary files) will be created in the selected location.

# CHAPTER 7

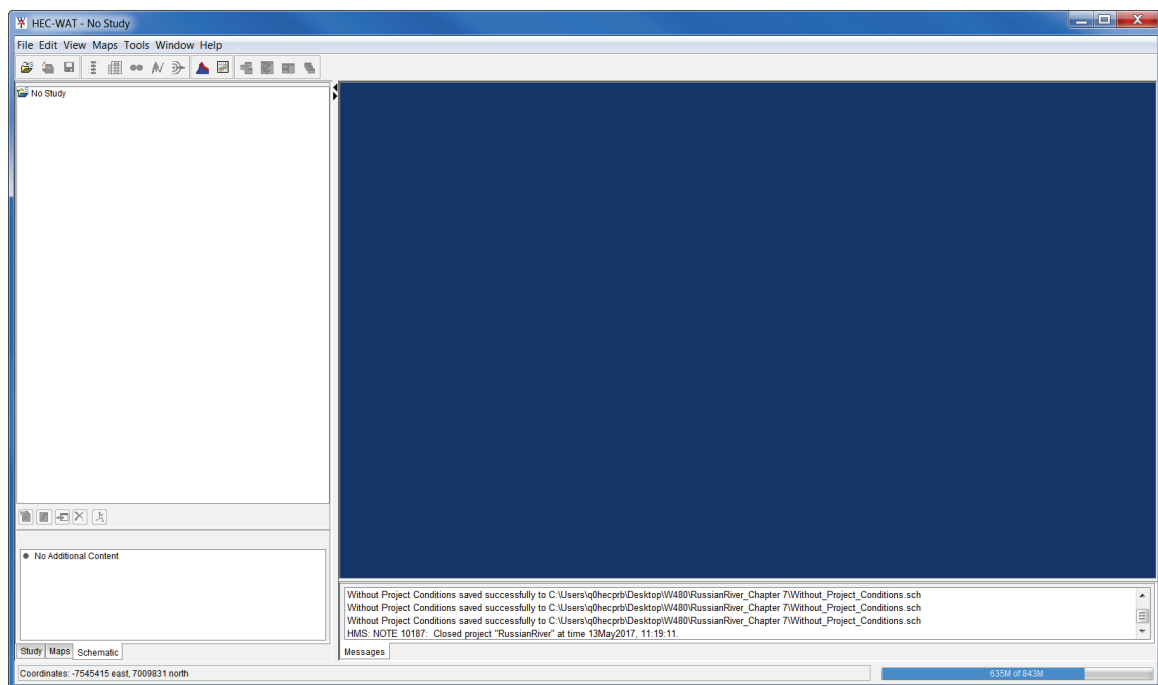
## Create a Basic HEC-WAT Study

Now that the user has an understanding about the basic building blocks of what an HEC-WAT study requires, the following chapter walks the user through the steps of creating a basic HEC-WAT study.


### 7.1 Create an HEC-WAT Study

To create a new study:

1. From the HEC-WAT main window (Figure 7.1), on the **File** menu, click **New Study**. The **Create New Study** dialog box (Figure 7.2) will open.



**Figure 7.1** HEC-WAT Main Window

2. In the **Study Name** box (Figure 7.2), enter a name, and in the **Description** box, enter a description for the new study.
3. In the **Directory** box (Figure 7.2), either enter the name of the directory where to store the HEC-WAT study, or click , and an **Open** browser (Figure 7.3) will open. Navigate to the directory where the HEC-WAT study will be stored, click **Open**. The **Open** browser (Figure 7.3) will close. On the **Create New Study** dialog box (Figure 7.2) in the **Directory** box the location will display.

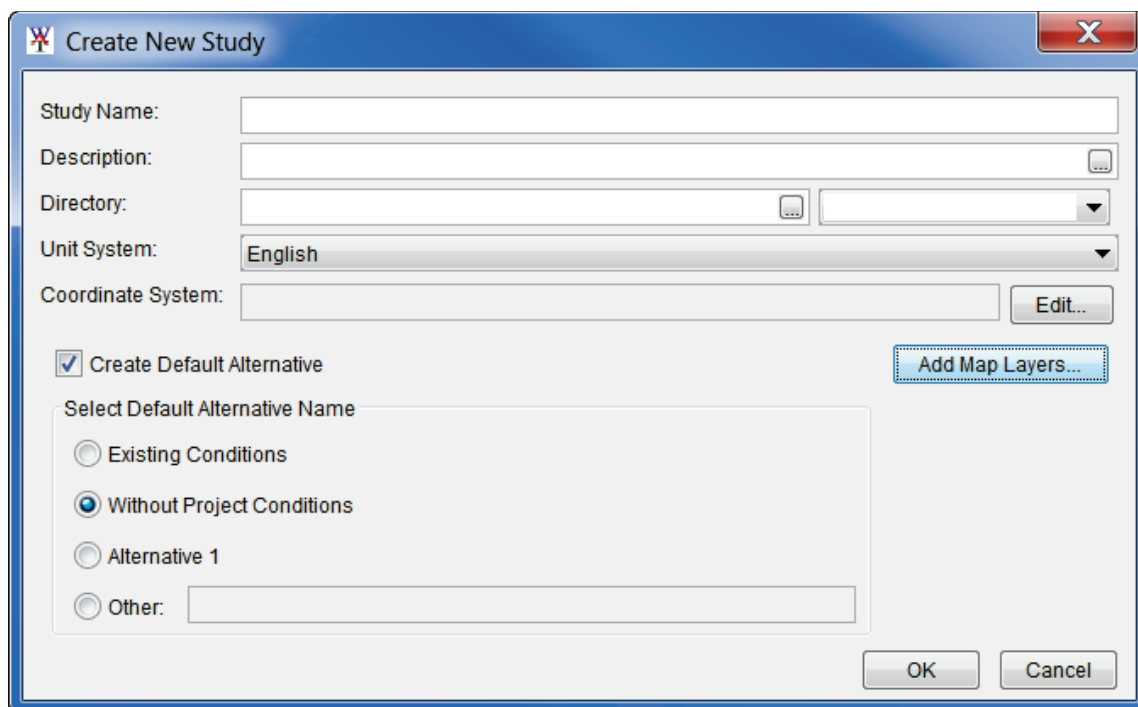


Figure 7.2 Create New Study Dialog Box

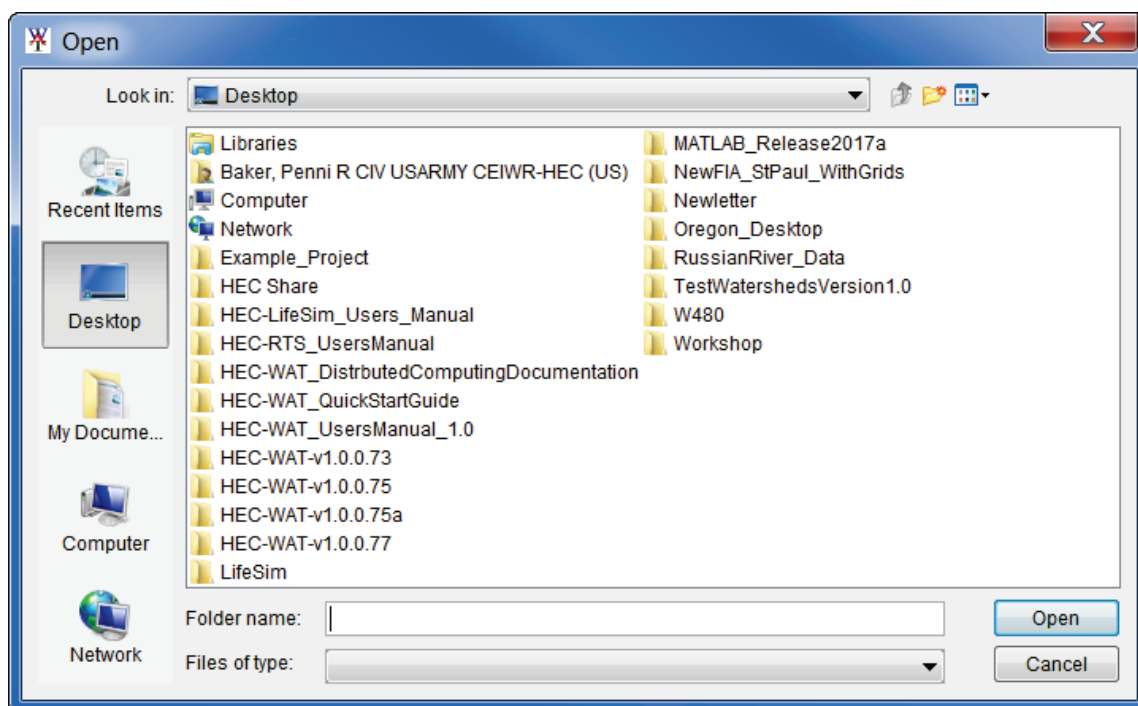
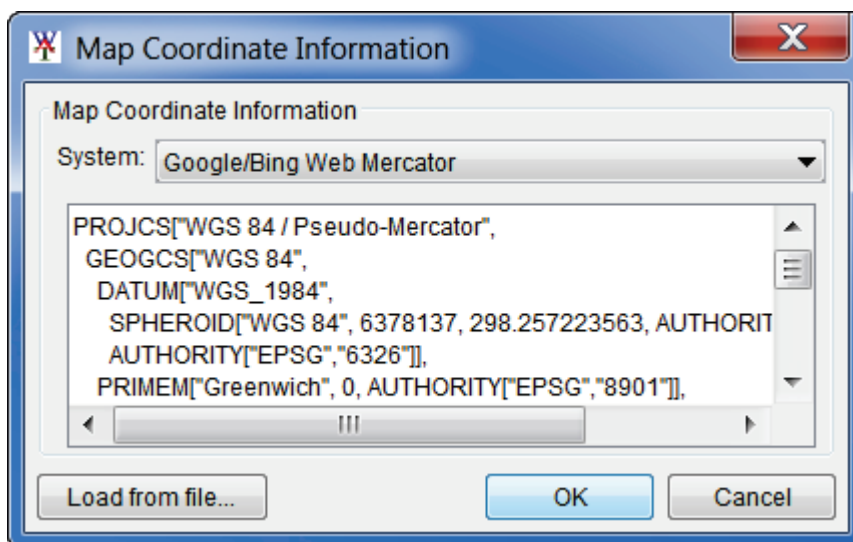


Figure 7.3 Open Browser

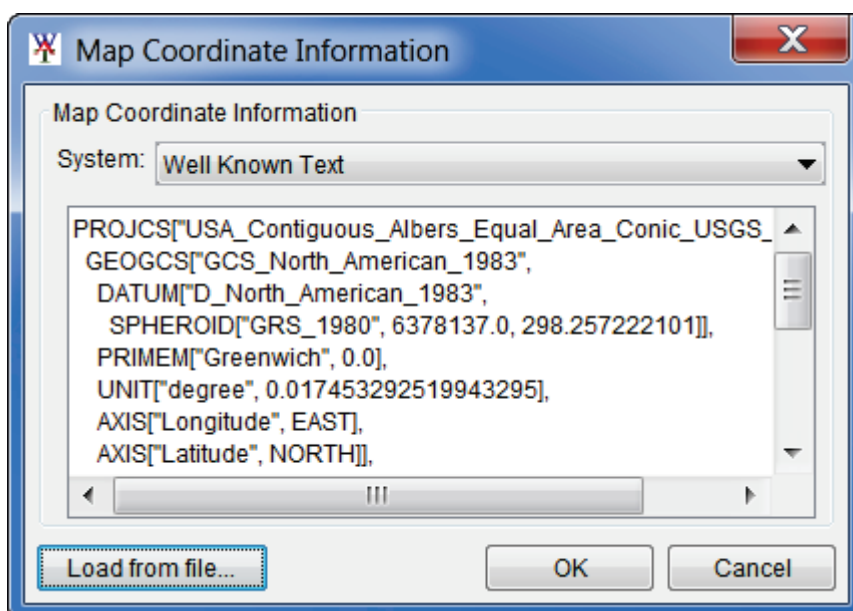
4. The **Unit System** (Figure 7.2) for the study defaults to **English**. The other choice from the list is **SI** (metric).
5. Next, the projected coordinate system of the study needs to be set. For this example study, the study map layers are in the projected coordinate system, and that information will be imported from one of the map layers (i.e., shapefile).

6. From the **Create New Study** dialog box (Figure 7.2), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure 7.4). The dialog box opens with a default coordinate system (*Google/Bing Web Mercator*).



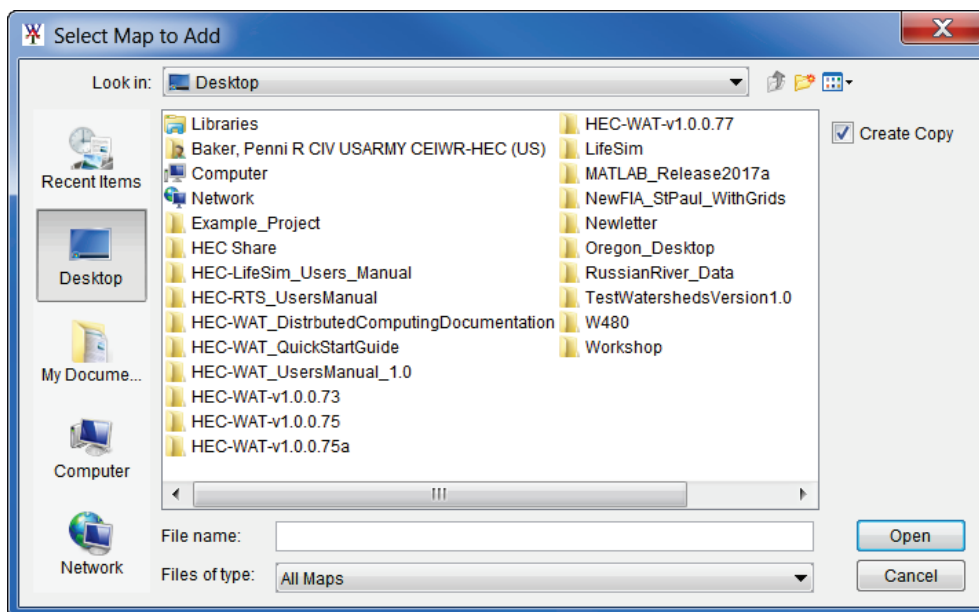
**Figure 7.4** Map Coordinate Information Dialog Box – Default Coordinate System

7. From the **Map Coordinate Information** dialog box (Figure 7.4), click **Load from file** (lower left corner of dialog box); an **Open** browser (Figure 7.3) will open. Browse to the location of the map layer (i.e., *RR\_StreamAlignment.prj*) that has the correct projection for the study area. Click on that map layer, click **Open**, now the **Map Coordinate Information** dialog box will contain information about the projected coordinate system (Figure 7.5). Click **OK**, the **Map Coordinate Information** dialog box will close (Figure 7.5). Now on the **Create New Study** dialog box the **Coordinate System** box (Figure 7.2) contains the name of the projected coordinate system (i.e., *USA\_Contiguous\_Albers\_Equal\_Area\_Conic\_USGS\_version*) for the study.

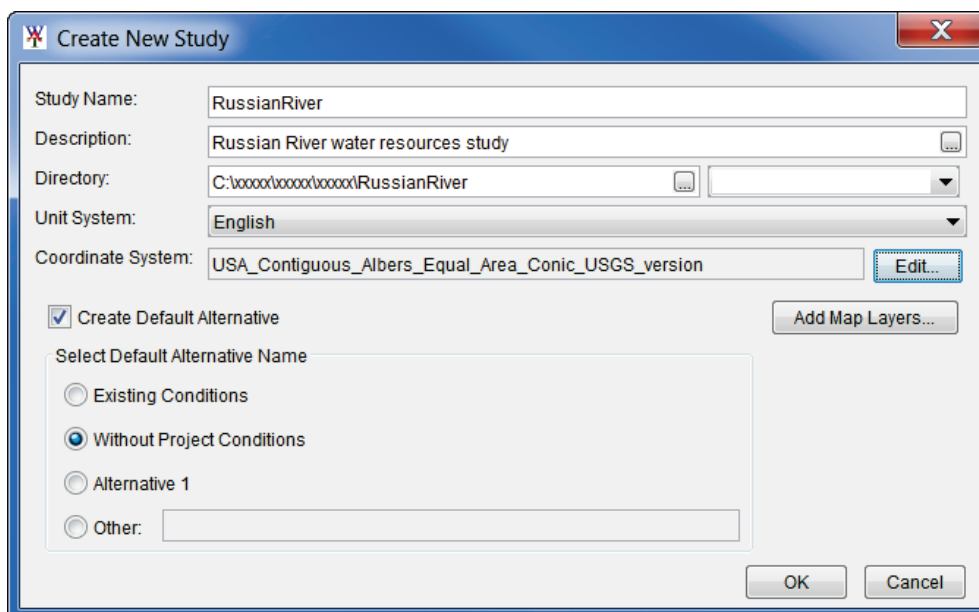


**Figure 7.5** Map Coordinate Information Dialog Box

8. When creating the study, the user can add map layers that the PDT has gathered for defining the watershed area. From the **Create New Study** dialog box (Figure 7.2), click **Add Map Layers**. The **Select Map to Add** browser will open (Figure 7.6). To copy the map layers to the study directory area, from the **Select Map to Add** browser (Figure 7.6), select **Create Copy**. Browse to where the map layers are located, select the appropriate map layers, click **Open**, the **Select Map to Add** browser will close (Figure 7.6). The **Create New Study** dialog box (Figure 7.7) appears.



**Figure 7.6** Select Map to Add Browser



**Figure 7.7** Create New Study Dialog Box - Completed

9. HEC-WAT creates a default alternative - *Without Project Conditions*. If the user wants the default alternative to have a different name, several choices are available, including **Other** which allows the user to name the default alternative.

- Click **OK**, the **Create New Study** dialog box will close (Figure 7.7). The HEC-WAT main window will now have the name of the study on the title bar (Figure 7.8). A **Schematic Map Window** opens, which contains the map layers that were added to the study.

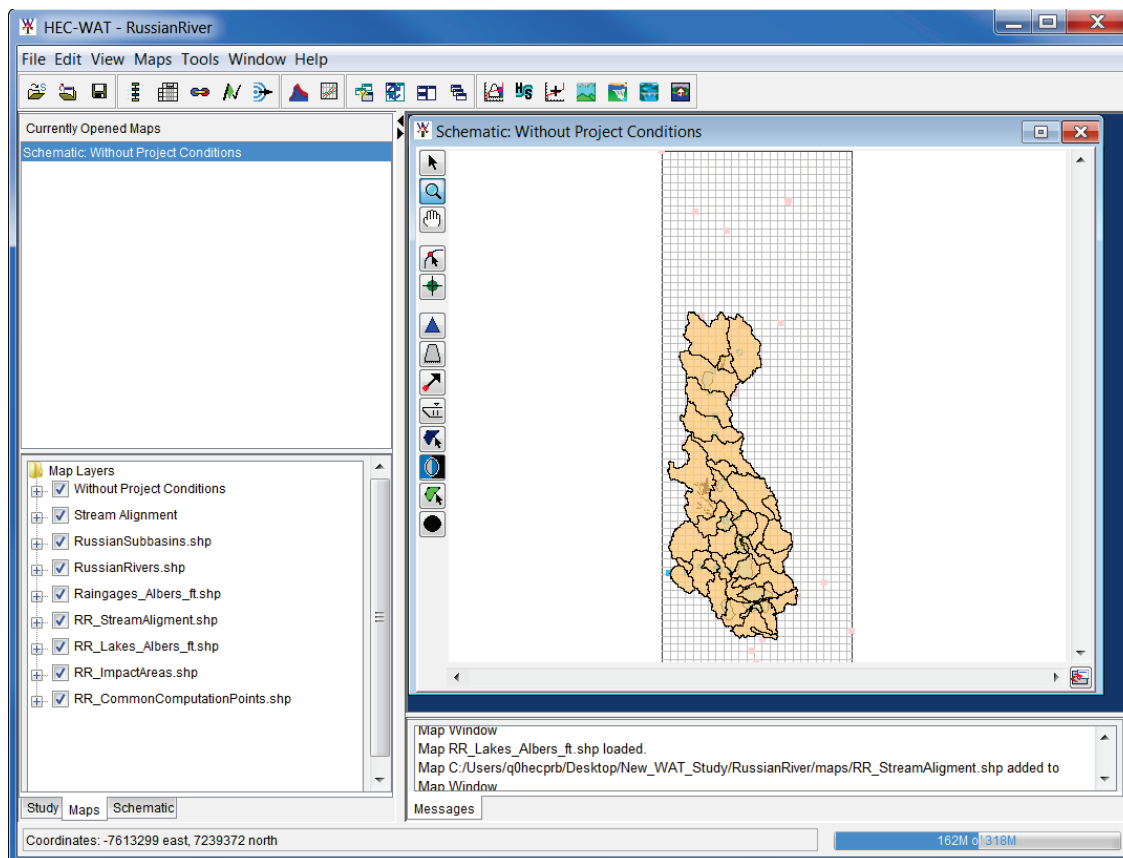


Figure 7.8 HEC-WAT Main Window – New Study Created

## 7.2 Build the Without Project Conditions Schematic

HEC-WAT by default will create a default alternative *Without Project Conditions* (see Section 6.1, Step 8). From the HEC-WAT main window (Figure 7.8), the **Schematic Map Window**, will contain the initial schematic for the *Without Project Conditions*. The next step is to build the schematic for the default alternative.

### 7.2.1 Adjust Map Layers

Once map layers are in an HEC-WAT study, the user can make adjustments to those map layers. From the HEC-WAT main window, click the **Maps** tab (Figure 7.8). Now the user can see which **Map Window** is currently active and what layers make up that **Map Window**. To change the color and the fill aspects of a shapefile do the following:

- From the **Map Layers** tree (Figure 7.9), right click on a map layer, which happens to be a shapefile. The shortcut menu that appears is for shapefiles. This shortcut menu allows the user to expand/collapse the selected map layer; move the shapefile to different

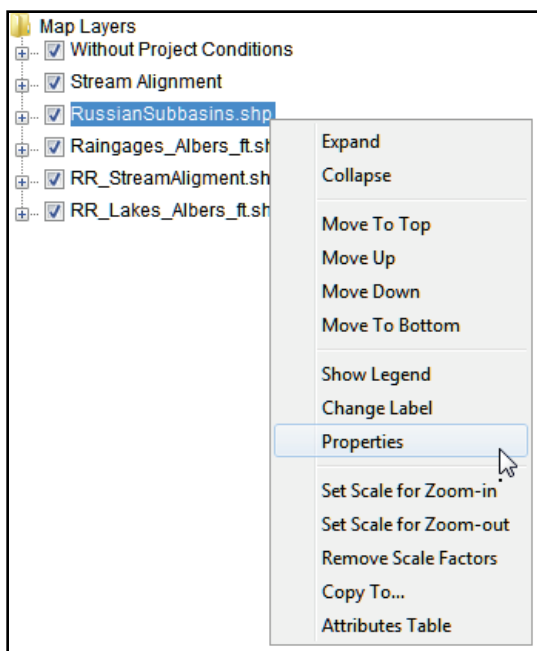


Figure 7.9 Map Layers Tree - Shortcut Menu

positions in the tree (**Move To Top/Move To Bottom, Move up/Move Down**); show the legend of the shapefile; change the label of the shapefile; edit the properties of the shapefile; set/remove scale factors; copy the map layer to another location; and open the attribute table of the shapefile.

2. From the shapefile shortcut menu (Figure 7.9), click **Properties**, the **Edit Polygon Properties** dialog box will open (Figure 7.10). The selected shapefile is a polygon shapefile. To edit the fill of the active map layer, from the **Fill** tab, change the color or turn off the fill. For the example in Figure 7.10, the fill will be turned off. Click **Display Fill**, the check mark will clear, meaning that fill is turned off.

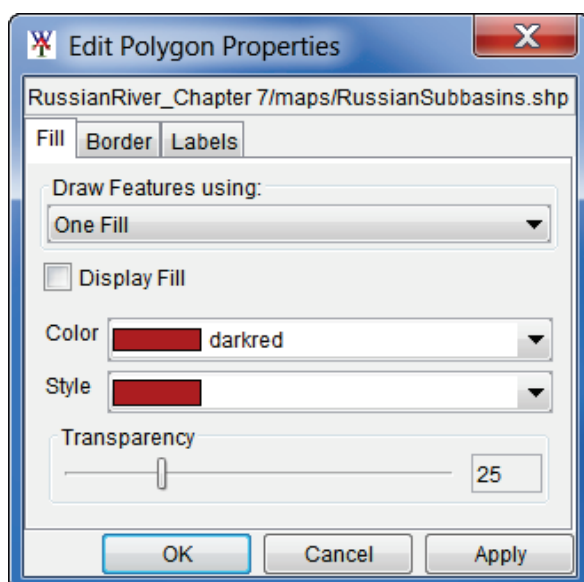

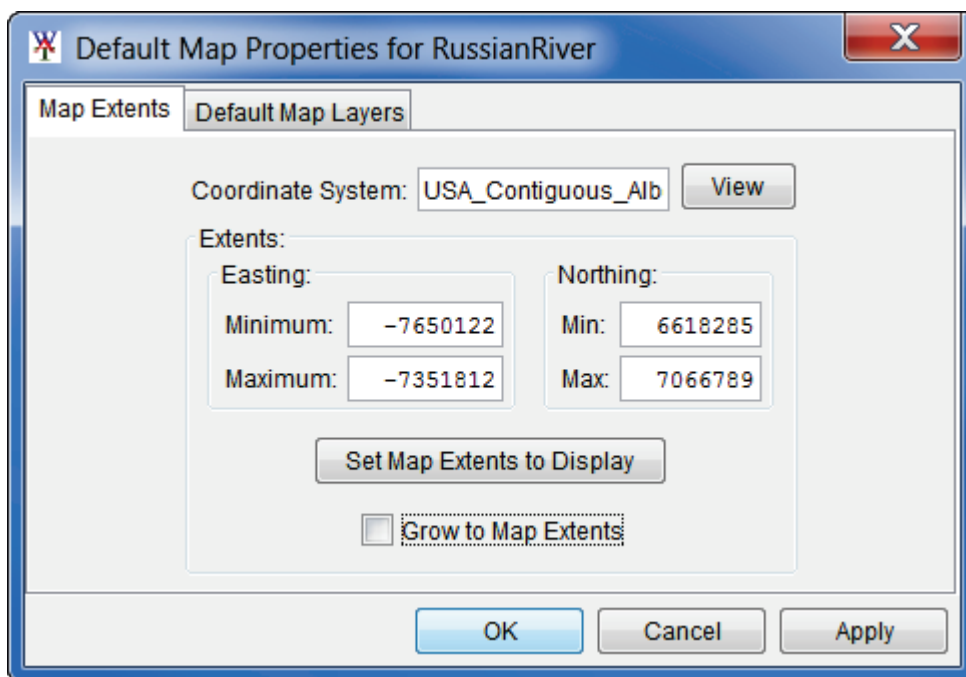


Figure 7.10 Edit Polygon Properties Dialog Box



3. To change the outline color of the shapefile layer, from the **Edit Polygon Properties** dialog box (Figure 7.10), click the **Border** tab. From the **Color** list, select a color ("darkred"). Click **OK**, the **Edit Polygon Properties** dialog box (Figure 7.10) will close and the changes will appear in dark red in the **Map Window**.
4. To turn off a map layer - click in the checkbox by a map layer, that map layer no longer displays in the map window.
5. To display the map window zoomed in, select the **Zoom** tool . Draw a box around the map layers that are displayed in the **Map Window**. From the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for** dialog box will open (Figure 7.11). Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for** dialog box will close.



**Figure 7.11** Default Map Properties for Dialog Box

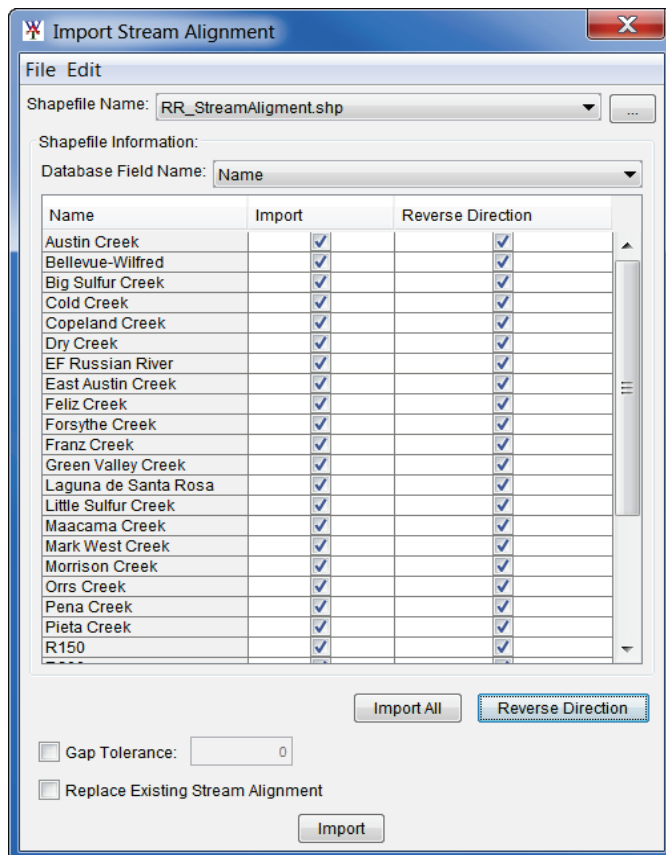
This sets the extents for the **Map Window** so that when the study is opened the next time the **Map Window** will be zoomed in to the tighter area.

## 7.2.2 Create a Stream Alignment

The backbone of any schematic is the stream alignment, and is the starting point in creating a schematic. A **stream alignment** is a one-dimensional river coordinate system, which defines the natural downstream flow network. Also, from the stream centerline, stationing will be provided relative to its global location and specific to the study. The alignment indicates where confluences and bifurcations occur and provides a sense of distance and scale. Stream alignments are composed of a series of streams, stream nodes, and stream junctions. The stream alignment can be digitized or imported from a map layer. This section provides the steps for importing a stream alignment from a shapefile.

To import a stream alignment:

1. From the **Map Layers** tree (Figure 7.9), right-click on *StreamAlignment*. From the shortcut menu, click **Import**. The **Import Stream Alignment** dialog box will open (Figure 7.12). The **Shapefile Name** list defaults to the first line shapefile it can find in the *maps* directory of a study; if that is not the correct shapefile, the user can choose the correct shapefile from the **Shapefile Name** list (Figure 7.12).



**Figure 7.12** Import Stream Alignment Dialog Box

2. From the **Database Field Name** list (Figure 7.12), the user needs to select the field name in the attribute file that contains the names of the streams (default is **Name**). Once a field name is selected, the table below the **Database Field Name** list (Figure 7.12) will populate with the streams contained in the shapefile. If there is an issue with any of the stream segments the checkbox in the **Import** column (Figure 7.12) will not be selected. This means the stream segment is not continuous and will not be imported.
3. If the flow direction in the shapefile is not correct, click **Reverse Direction** (Figure 7.12). and the system of streams will have the correct flow direction.
4. Click **Import**, the **Import Stream Alignment** dialog box will close (Figure 7.12). Once the import of the stream alignment is completed, a message window will appear letting the user know that the stream alignment imported successfully. In the active **Map Window** the stream alignment appears (orange stream segments; green stream nodes and stream junctions).

## 7.2.3 Add the Background Internet Map

Knowing where the watershed is located in reference to known locations can be quite helpful when communicating with the PDT and stakeholders. From the **Maps** menu (Figure 7.13), point to **Add Internet Map**, from the available list select the internet map that would be a good background (*Open Street Map*) map for the watershed. The selected internet map will load and appear in the active **Map Window**.

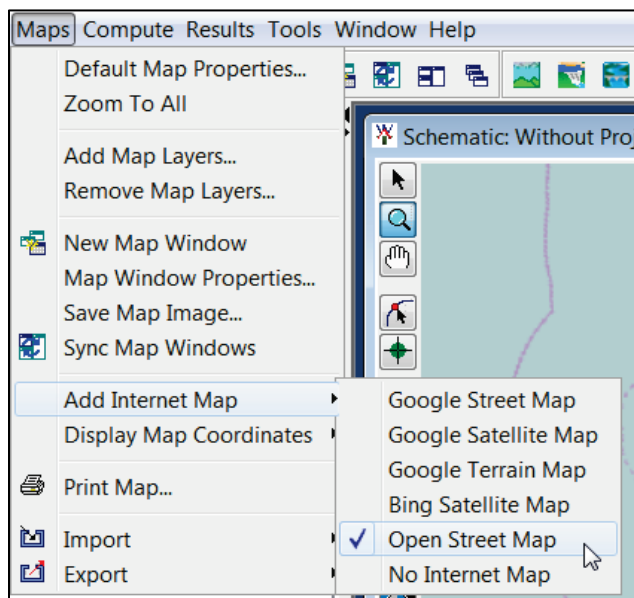


Figure 7.13 Maps Menu - Add Internet Map

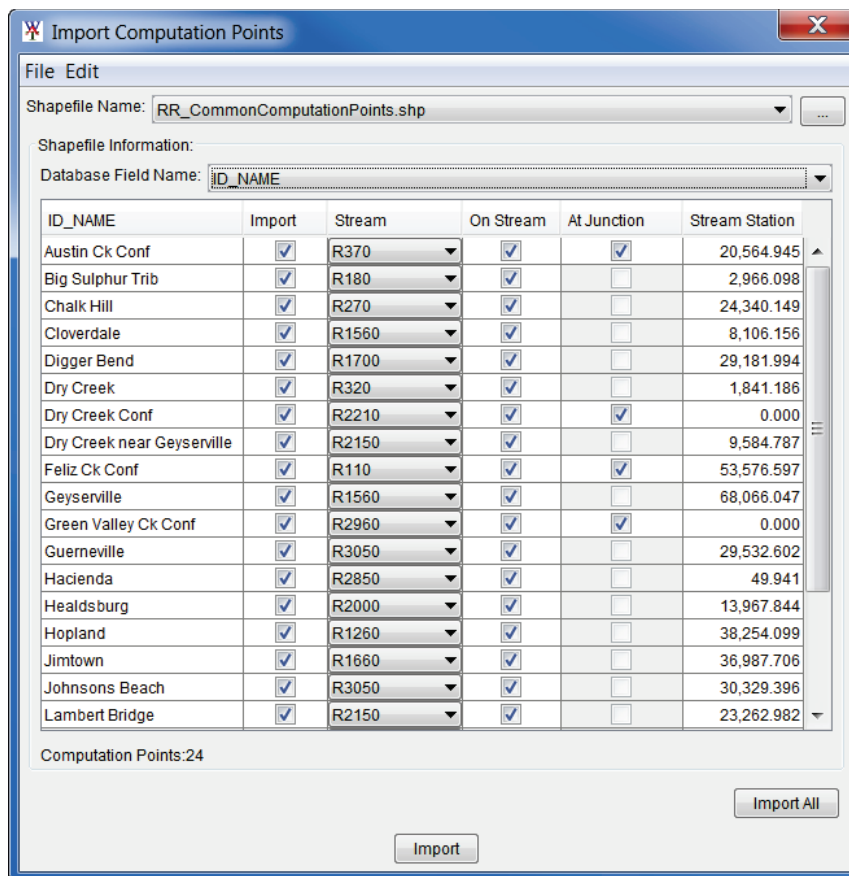
This layer in the background might help with adding additional streams to the stream alignment; locations of reservoirs; levees, other measures; impact areas; and, common computation points (CCPs). Based on the known extents of the study area, the layer provides a view of the watershed and surrounding area.

## 7.2.4 Add Common Computation Points (CCPs)

**Common computation points (CCPs)** are locations where one model can transfer data to another model, where results are needed for model development or alternative analysis, or where input boundary conditions are to be defined. CCPs need to be consistent for all models and should be placed on the stream alignment based on knowledge of possible study alternatives. The entire study team should be involved in the definition of the CCPs.

To import CCPs from a shapefile:

1. From **Maps** menu (Figure 7.13), point to **Import**, click **Computation Points**. The **Import Computation Points** dialog box will open (Figure 7.14). The **Shapefile Name** list defaults to the first point shapefile it can find in the *maps* directory of a study; if that is not the correct shapefile, the user can choose the correct shapefile from the **Shapefile Name** list.

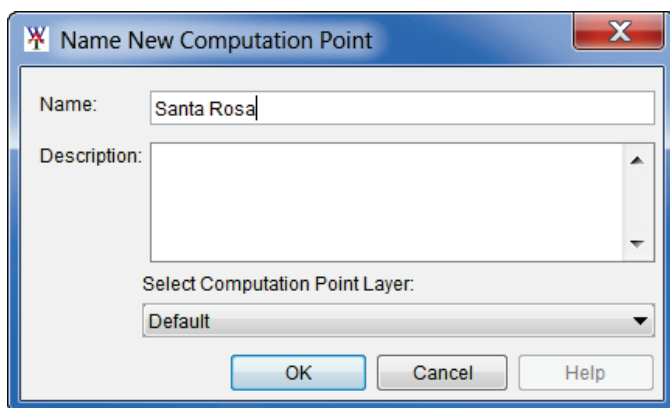


**Figure 7.14** Import Computation Points Dialog Box

- From the **Database Field Name** list (Figure 7.14), select the field name in the attribute file that contains the names of the CCPs (for the example in Figure 7.14 that name is **ID\_Name**). Once a field name is selected, the table below the **Database Field Name** list (Figure 7.14) will populate with the CCPs contained in the shapefile. If there is an issue with any of the CCPs the checkbox in the **Import** column will not be selected.
- Click **Import**, the **Import Computation Points** dialog box will close (Figure 7.14). Once the import of the CCPs is completed, a message window will appear letting you know that the CCPs have been imported successfully. In the active **Map Window** the CCPs appear as black circles.

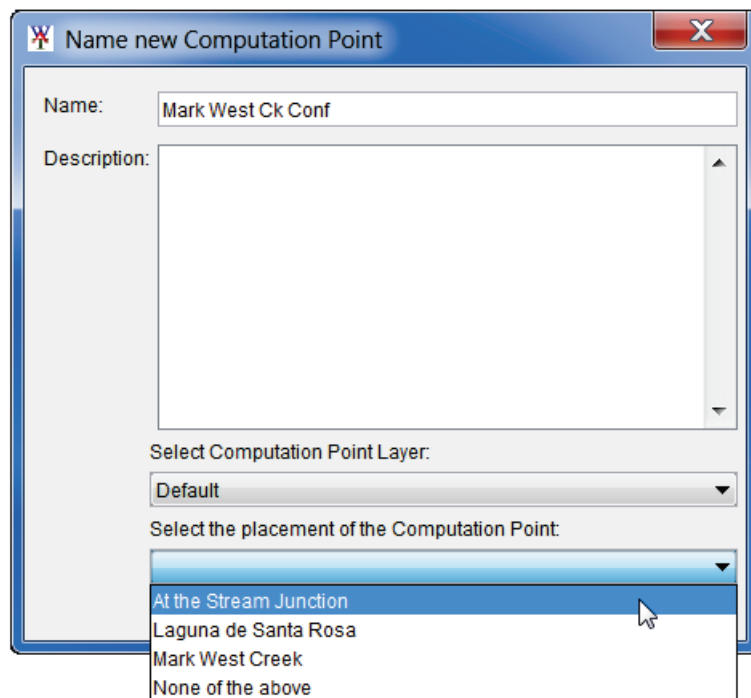
A user can also add CCPs to the schematic manually by performing the following steps:

- From the **Schematic Map Window**, find the location where a CCP needs to be added, press the **Computation Point** tool
- Hold down the **CTRL** key and click on the stream alignment to place the common computation point.
- The **Name New Computation Point** dialog box will open (Figure 7.15). Enter the new **Name** (required) and **Description** (optional, but recommended). Click **OK**, the **Name New Computation Point** dialog box will close.



**Figure 7.15** Name New Computation Point

4. The CCP will now appear in the map window as a black circle.
5. If a CCP is added at a stream junction, a slightly different **Name New Computation Point** dialog box will open (Figure 7.16). Enter the new **Name** (required) and **Description** (optional, but recommended).




**Figure 7.16** Name new Computation Point Dialog Box at a Stream Junction

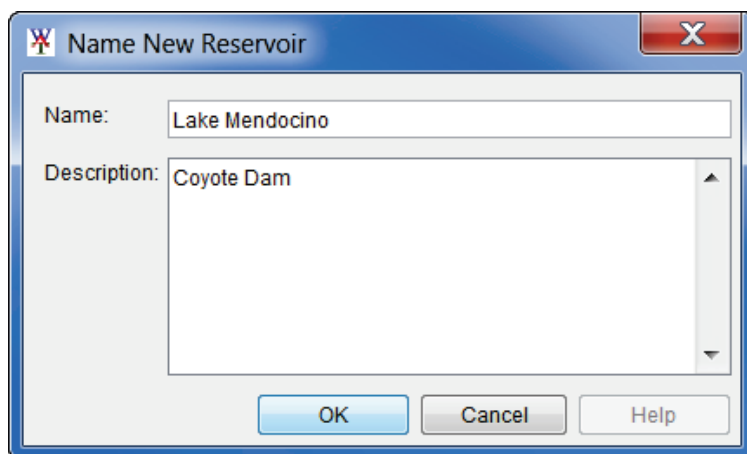
6. From the **Select the Placement of the Computation Point** list (Figure 7.16), determine exactly where the CCP will be placed. Choices are to have the CCP placed on the stream junction, along one of the streams that form the stream junction, or none of the above. For example, in Figure 7.16, the CCP will be placed on the stream junction.
7. Click **OK**, the **Name New Computation Point** dialog box (Figure 7.16) will close. The common computation point will now appear in the display area as a black circle.

## 7.2.5 Add a Reservoir

A **reservoir** is the impoundment created behind dams, or behind navigation locks and dams. For HEC-WAT a reservoir also includes the dam built on a stream to store water for uses such as flood risk management, hydroelectric power generation, recreation use, and water supply, etc.

To add a reservoir:

1. From the **Schematic Map Window**, find the location where a reservoir needs to be added, press the **Reservoir** tool .
2. Hold down the **CTRL** key and click on the stream alignment to place the upstream end of the reservoir. Release the **CTRL** key; drag the mouse to the downstream end of the reservoir and click.
3. The **Name New Reservoir** dialog box will open (Figure 7.17). Enter the new **Name** and **Description** (optional, but recommended). Click **OK**, the **Name New Reservoir** dialog box will close.



**Figure 7.17** Name New Reservoir Dialog Box

4. The reservoir will now appear on the schematic as a cyan triangle (reservoir pool), a blue line (storage reach), a gray rectangle (dam), and two CCPS that represent the upstream and downstream ends of the reservoir.
5. The default representation of the reservoir pool is a triangle; the user can edit this triangle if a more detailed representation of the pool is desired. With the **Reservoir Tool** pressed, double-click on the reservoir. The triangle (Figure 7.18) will now be green with a blue outline color. Also, there are three vertex points (blue), and at the apex of the triangle is the reservoir label, which is represented by a yellow circle.
6. When a reservoir is created there are two CCPs that are created with default names. It is recommended that the names of the two CCPs be changed. These two CCPs represent the inflow and outflow junctions of the reservoir and should be renamed accordingly.

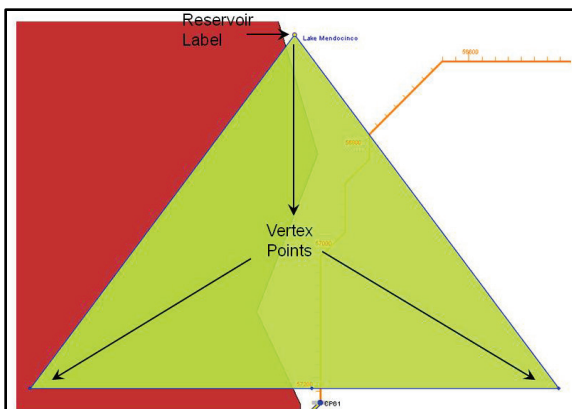



Figure 7.18 Reservoir Pool

- To change the name of a common computation point, press the **Computation Point** tool , right-click on one of the common computation points. From the shortcut menu, click **Rename Computation Point**; the **Rename Computation Point** dialog box will open (Figure 7.19). In the **Name** box, enter the new name, and in the **Description** box enter a description (optional, but recommended). For example, in Figure 7.19, the inflow junction for *Lake Mendocino* has been labeled *Lake Mendocino Inflow Jct*, and the outflow junction should be labeled *Lake Mendocino Outflow Jct*.

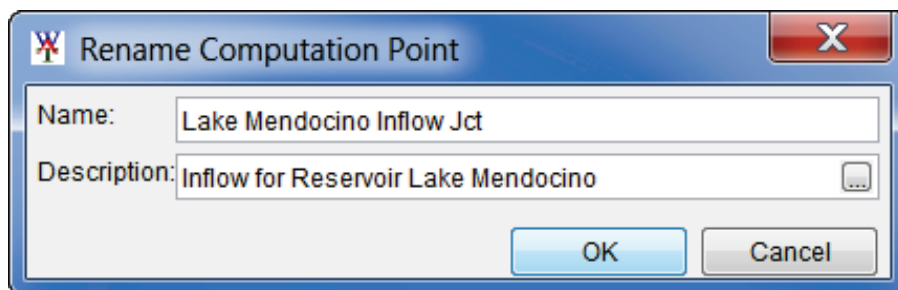


Figure 7.19 Rename Computation Point Dialog Box

- Click **OK**, a **Confirm Rename** window will open, asking the user to be sure that the CCP is to be renamed. Click **Yes**, the **Rename Computation Point** dialog box will close (Figure 7.19) and the new name for the CCP will appear in the map window.

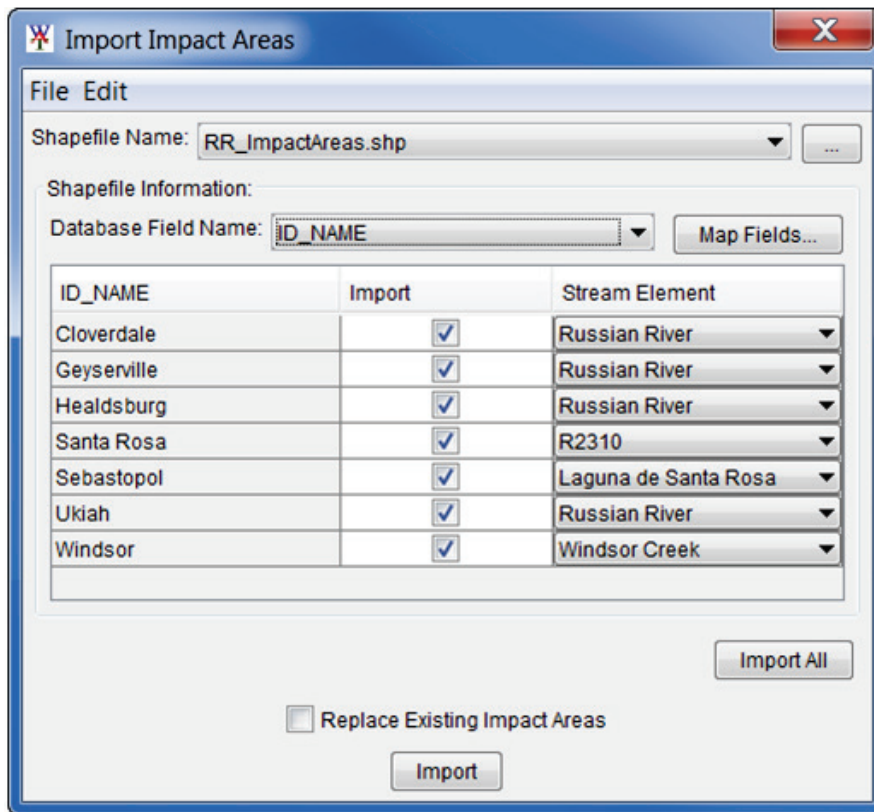
## 7.2.6 Add Impact Areas

An **impact area** is any distinct portion of a study that is affected by rising or falling stage in a stream, river, lake, or reservoir. Impact areas are an optional element, and are only required when the user wants to compute impacts at damage area centers in the study area

To import impact areas from a shapefile:

- From the **Maps** menu (Figure 7.13), point to **Import**, click **Impact Areas**. The **Import Impact Areas** dialog box will open (Figure 7.20). The **Shapefile Name** list figures out whether there are any polygon shapefiles available in the *maps* directory of a study; if the correct shapefile is not selected, the user can choose the correct shapefile from the **Shapefile Name** list.






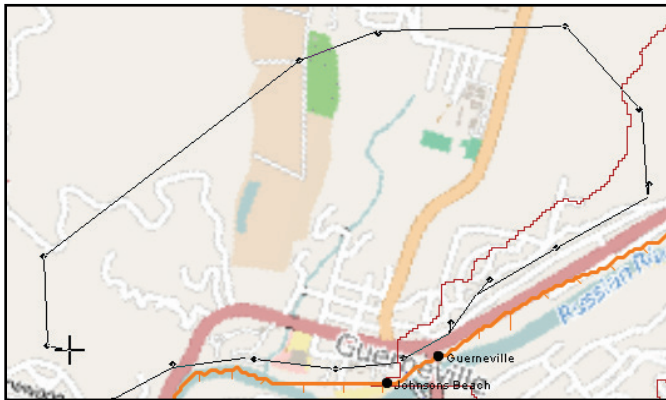
**Figure 7.20** Import Impact Areas Dialog Box

- From the **Database Field Name** list (Figure 7.20), the user needs to select the field name in the attribute file that contains the names of the impact areas (for the example in Figure 7.20 that name is **ID\_Name**). Once a field name is selected, the table below the **Database Field Name** list (Figure 7.20) will populate with the impact areas contained in the shapefile. If there is an issue with any of the impact areas the checkbox in the **Import** column will not be selected.
- Click **Import**, the **Import Impact Areas** dialog box will close (Figure 7.20). Once the import of the impact areas is completed, a message window will appear letting the user know that the impact areas have been imported successfully. In the active **Map Window** the impact areas appear as green polygons.

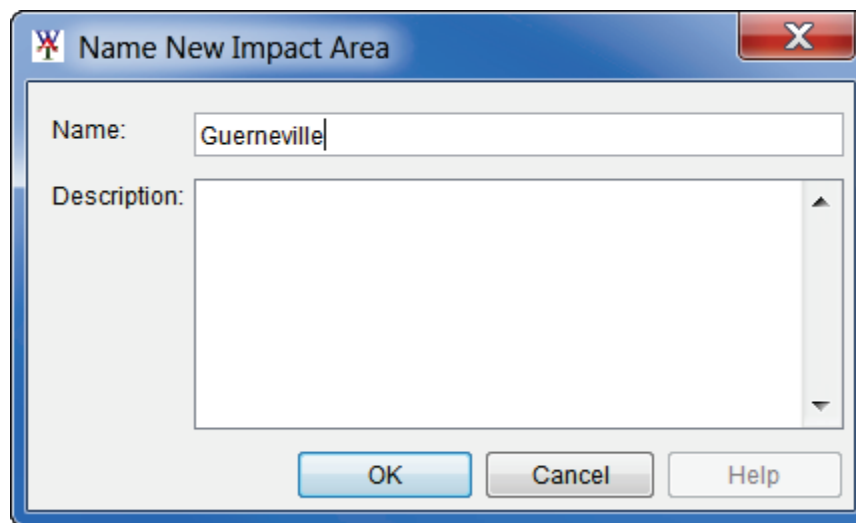
A user can also add impact areas to the schematic manually by performing the following steps:

- From the **Schematic Map Window**, find the location where an impact area needs to be added, press the **Impact Area** tool .
- Hold down the **CTRL** key while clicking the mouse button. Each click creates a vertex point (Figure 7.21), which is the boundary of the polygon. When reaching the end point, release the **CTRL** key and click.
- The **Name New Impact Area** dialog box will open (Figure 7.22). Enter a name, and if needed, enter a description. Click **OK**, the **Name New Impact Area** dialog box will close.





**Figure 7.21** Draw an Impact Area



**Figure 7.22** Name New Impact Area Dialog Box

4. The impact area will now appear in the display area as a green polygon with a name.

Following the steps in this chapter creates the basic schematic elements for an HEC-WAT watershed - stream alignment, common computation points, impact areas, and projects (reservoirs, levees). Now this basic schematic can be used by the models that are required for the watershed. The user will have choices at this point - to either build the individual models in HEC-WAT or build individual models outside of HEC-WAT.



# CHAPTER 8

## Importing Models

Besides building the models directly from the HEC-WAT framework, the PDT can chose to import individual models or models from a Corps Water Management Study (CWMS) or an HEC-RTS (Real-Time Simulation) watershed. This chapter will layout the steps for both import mechanisms.

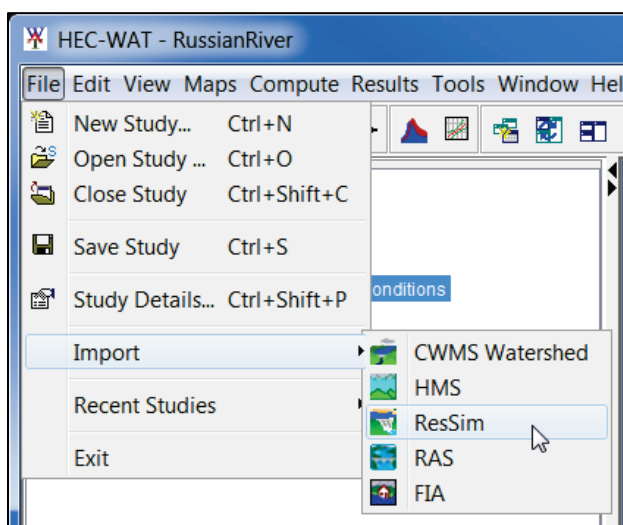
### 8.1 Importing Individual Models

When importing from individual models, it is recommended that the models have been created in the individual application software and have been successfully computed. Calibrated and validated models are even better. Also, it is recommended that all of the models being imported into a study have the same projection coordinate system, so that everything displays correctly on the schematic. The first step is to create a basic HEC-WAT study, in Chapter 7, Section 7.1, follow those steps to create a new HEC-WAT study

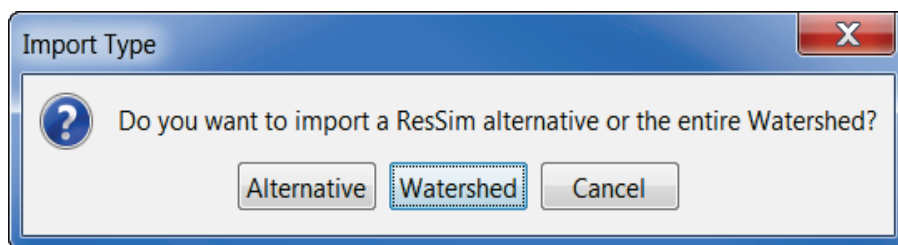
#### 8.1.1 Import an HEC-ResSim Model

If the HEC-WAT study contains an HEC-ResSim model, it is recommended that the user import the HEC-ResSim model first. The HEC-ResSim model usually contains the basic building block elements for an HEC-WAT study - a stream alignment, common computation points (CCPs), and the reservoirs necessary to model the study area. HEC-ResSim models are very much tied to the stream alignment, any slight changes to the stream alignment can cause an HEC-ResSim model to become very unhappy.

1. From the HEC-WAT main window, from the **File** menu, point to **Import** (Figure 8.1), and click **ResSim**, an **Import Type** window (Figure 8.2) will open.

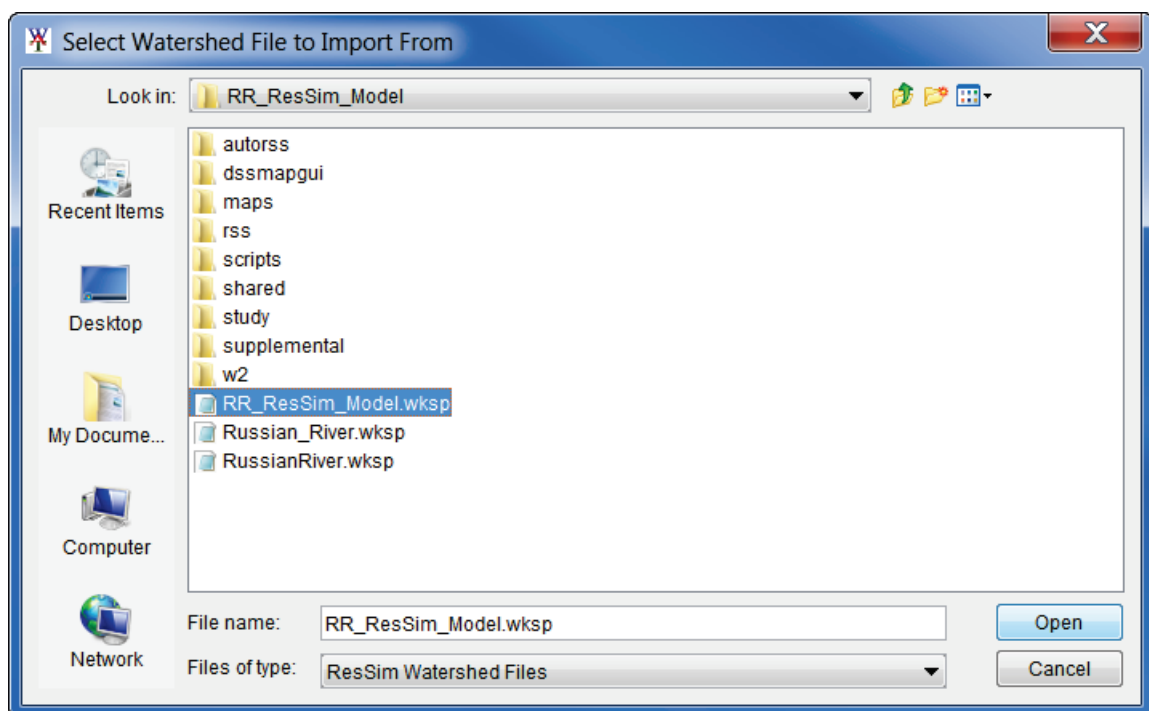


**Figure 8.1** HEC-WAT Main Window- File Menu - Import Menu Options



**Figure 8.2** Import Type Window

2. There are two import options for the HEC-ResSim import. If the HEC-WAT study does not have any of the basic information (i.e., stream alignment, CCPs, etc.), then the choice should be **Watershed** (this will import everything from the HEC-ResSim model, which includes the basic information). On the other hand, if the HEC-WAT study already has the basic information built (i.e., stream alignment, CCPs, etc.), then the user only wants to import by **Alternative**.
3. For this example, the user will be clicking **Watershed**. The **Import Type Window** will close (Figure 8.2), and the **Select Watershed File to Import From** browser will open (Figure 8.3). Browse to the folder that contains the HEC-ResSim model to be imported. Once the correct location has been found, the **Files of Type** list should display the HEC-ResSim watershed file (\*.wksp). Click on the "wksp" file, click **Open**, the **Select Watershed File to Import From** browser will close.



**Figure 8.3** Select Watershed File to Import From Browser

4. A **ResSim Import** window will open (Figure 8.4) showing the progress of the HEC-ResSim import.

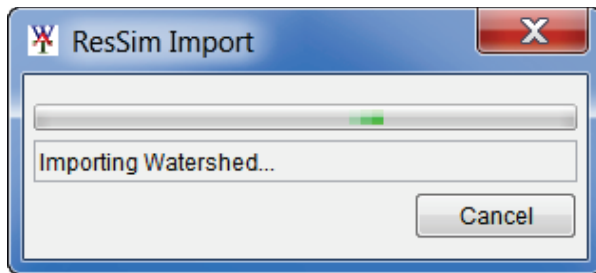


Figure 8.4 ResSim Import Window

5. The HEC-WAT **Schematic Editor** will open (Figure 8.5), from the **Measures** area of the **Schematic Editor**, click **Select All**. All of the reservoirs listed in the table are now selected. Click **OK**, the **Schematic Editor** will close (Figure 8.5).

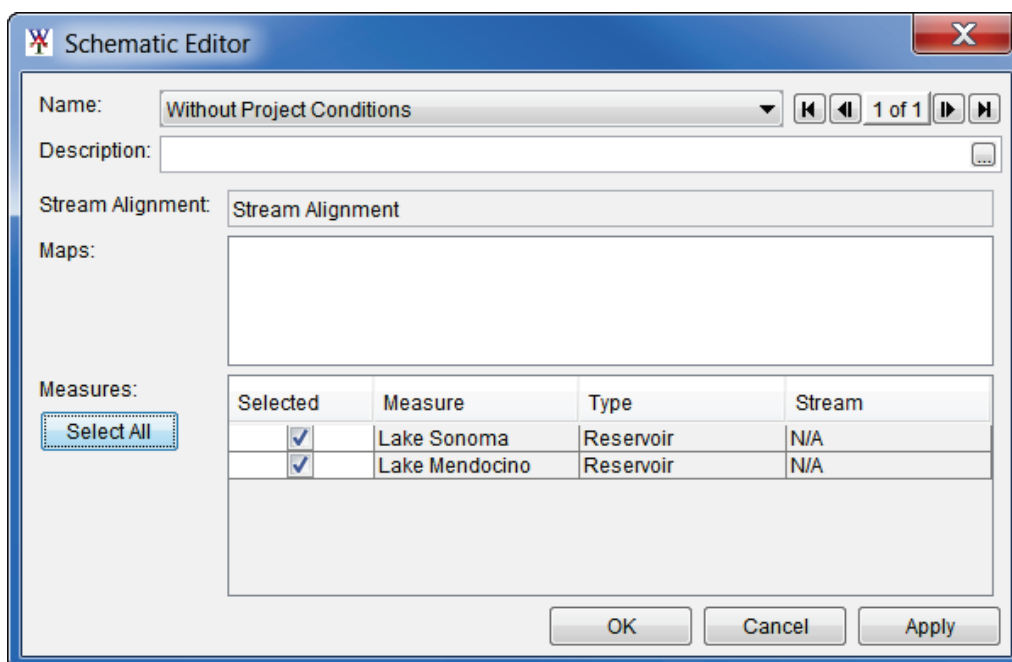
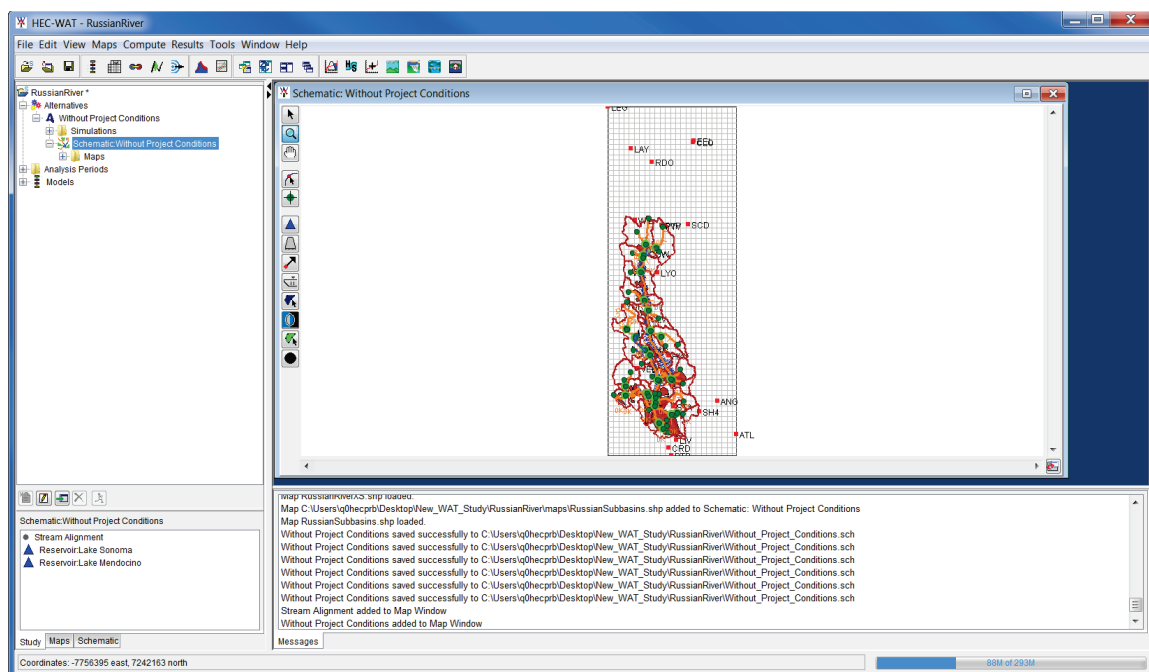


Figure 8.5 Schematic Editor

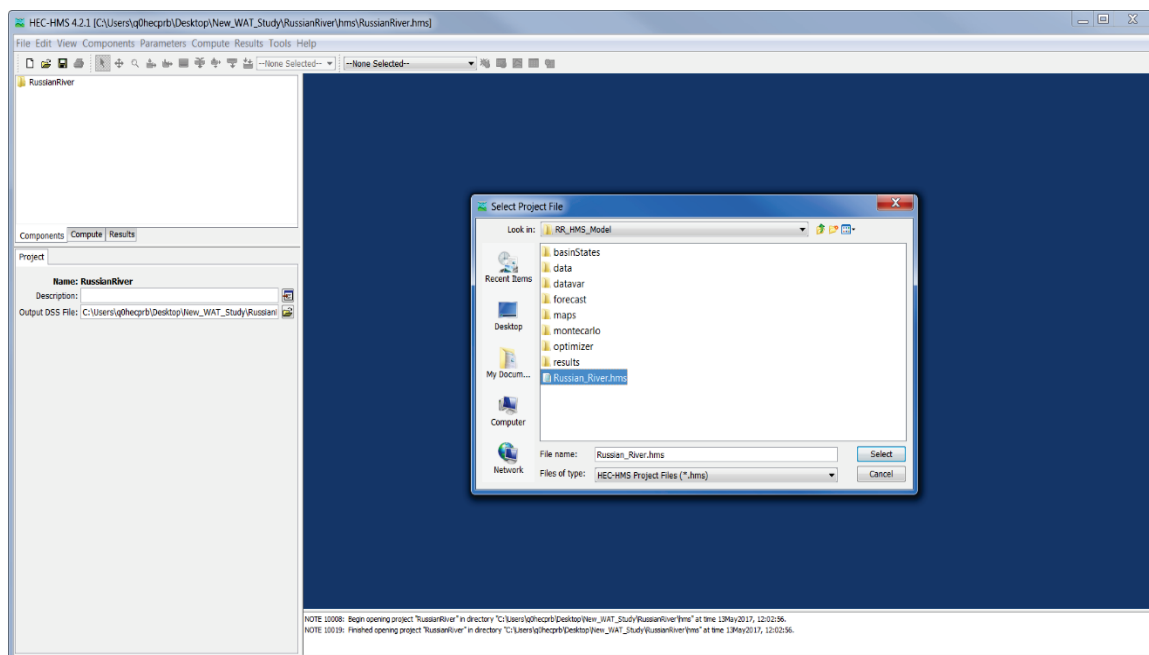
6. The imported stream alignment, common computation points, reservoirs, and any available map layers from the HEC-ResSim model display in the HEC-WAT **Schematic Map Window** (Figure 8.6). For all of the map layers to appear, close the **Schematic Map Window**. To re-open the **Schematic Map Window**, from the **Study Tree**, from an **Alternative** folder (i.e., *Without Project Conditions*), double-click on a schematic (i.e., *Schematic:Without Project Conditions*), the **Schematic Map Window** will appear in the **Desktop Area** of the HEC-WAT main window (Figure 8.6). The importing of an HEC-ResSim model has completed.

## 8.1.2 Import an HEC-HMS Model

1. From the HEC-WAT main window, from the **File** menu, point to **Import** (Figure 8.1), and click **HMS**. The HEC-HMS application will open with the **Select Project File** browser already open (Figure 8.7).

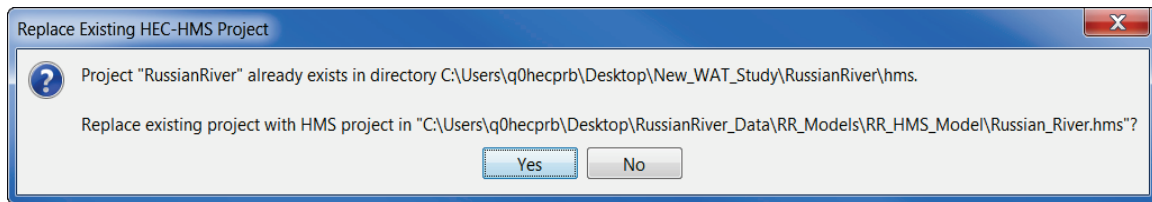


**Figure 8.6** HEC-WAT Schematic Map Window after HEC-ResSim Import



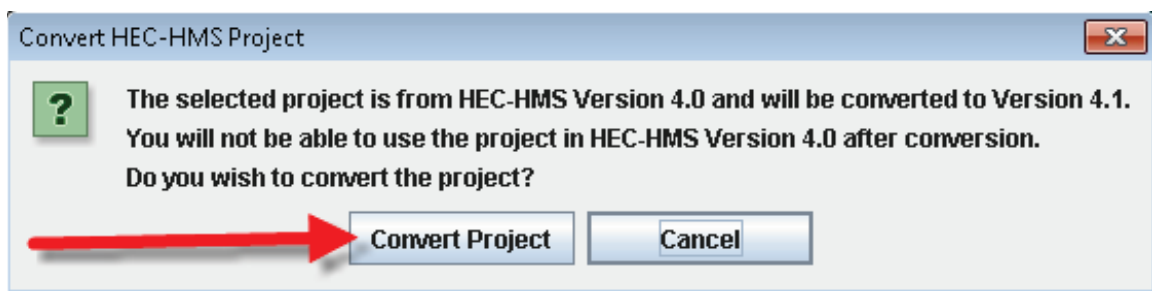
**Figure 8.7** HEC-HMS Main Window and Select Project File Browser

2. Browse to the folder that contains the HEC-HMS model to be imported. Once the right location has been found, select the HEC-HMS project file (\*.hms). The HEC-HMS project filename will appear in the **File name** box (Figure 8.7), click **Select**.
3. When the HEC-WAT study is created an *hms* subfolder is created. In that subfolder are the default files that are generated when creating an HEC-HMS project. When the HEC-HMS import process finds that a project already exists, a warning window will appear (Figure 8.8). From the warning window, click **Yes**, the warning window will close.



**Figure 8.8** HEC-HMS Warning Window about HEC-HMS Project

4. If the HEC-HMS model was created using a previous version of HEC-HMS, a **Convert HEC-HMS Project** window (Figure 8.9) will open. This window is letting the user know that the HEC-HMS model will be converted to a Version 4.2.1 HEC-HMS model. Click **Convert Project**, the **Convert HEC-HMS Project** window (Figure 8.9) will close, and the import of the HEC-HMS model will continue.

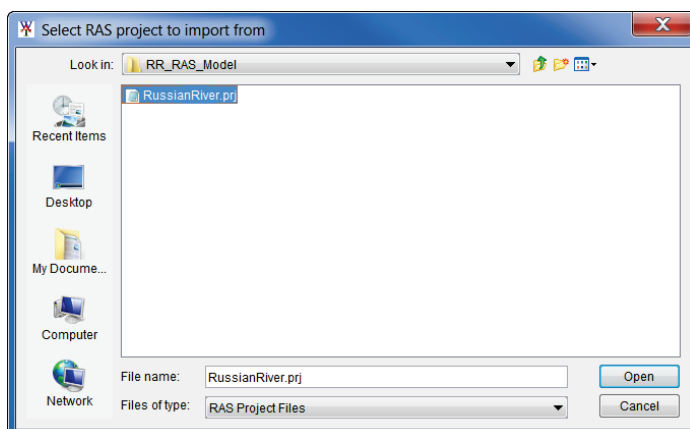


**Figure 8.9** Convert HEC-HMS Project Window

5. The import process begins (the import this could take a few seconds and depends on the number of files being copied to the HEC-WAT project directory and the size of the files). The import is finished when the study tree pane in the HEC-HMS main window contains a study tree. From the HEC-HMS main window (Figure 8.7), from the **File** menu, click **Exit**. The HEC-HMS model import is completed.

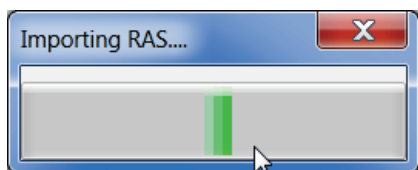
### 8.1.3 Import an HEC-RAS Model

1. From the HEC-WAT main window, from the **File** menu, point to **Import** (Figure 8.1), and click **RAS**. The **Select RAS project to import from** browser will open (Figure 8.10).



**Figure 8.10** Select RAS project to import from Browser

2. Browse to the folder that contains the HEC-RAS model to be imported. Once the correct location has been found, select the HEC-RAS project file (\*.prj). The HEC-RAS project filename will appear in the **File name** box (Figure 8.10), click **Open**.
3. The **Select RAS project to import from** browser will close (Figure 8.10). An **Importing** window (Figure 8.11) will open; when the HEC-RAS model import is complete this window will close. The HEC-RAS model import is completed.

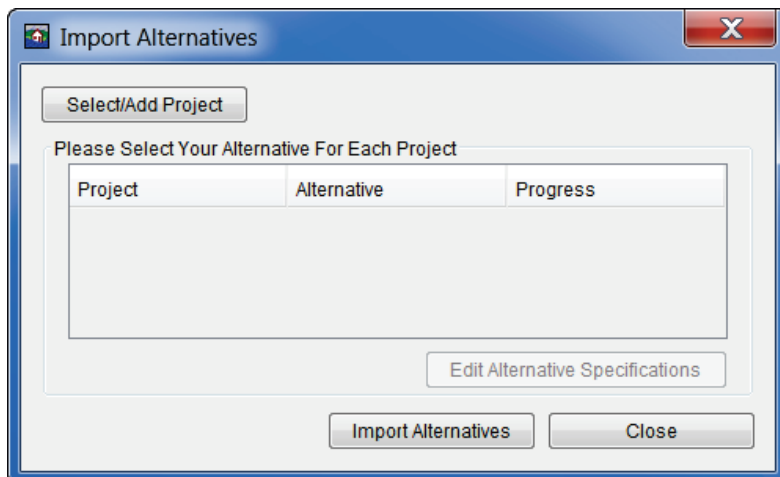


**Figure 8.11** HEC-RAS Importing Window

The HEC-RAS import does not include copying external files, like terrain files and HEC-DSS files containing boundary conditions, to the "ras" folder within the HEC-WAT study directory. The user will need to determine how to manage these files, including whether to make them local to the HEC-WAT study directory in order to easily copy the study from one computer to another.

### 8.1.4 Import an HEC-FIA Model

1. From the HEC-WAT main window, from the **File** menu, point to **Import** (Figure 8.1), and click **FIA**. The **Import Alternatives** dialog box will open (Figure 8.12).



**Figure 8.12** Import Alternatives Dialog Box

2. Click **Select/Add Project**, an **Open** browser will open (Figure 8.13). Browse to the folder that contains the HEC-FIA model to be imported. Once the correct location has been found, select the HEC-FIA project file (\*.prj). The HEC-FIA project filename will appear in the **File name** box (Figure 8.13), click **Open**, the **Open** browser will close.
3. From the **Import Alternatives** dialog box (Figure 8.14), the table will now contain the name of the **Project** (i.e., *RussianRiver*). From the **Alternative** column (Figure 8.14), from the list select the HEC-FIA alternative that will be imported (i.e., *GridsAndXSecsAlternative*).



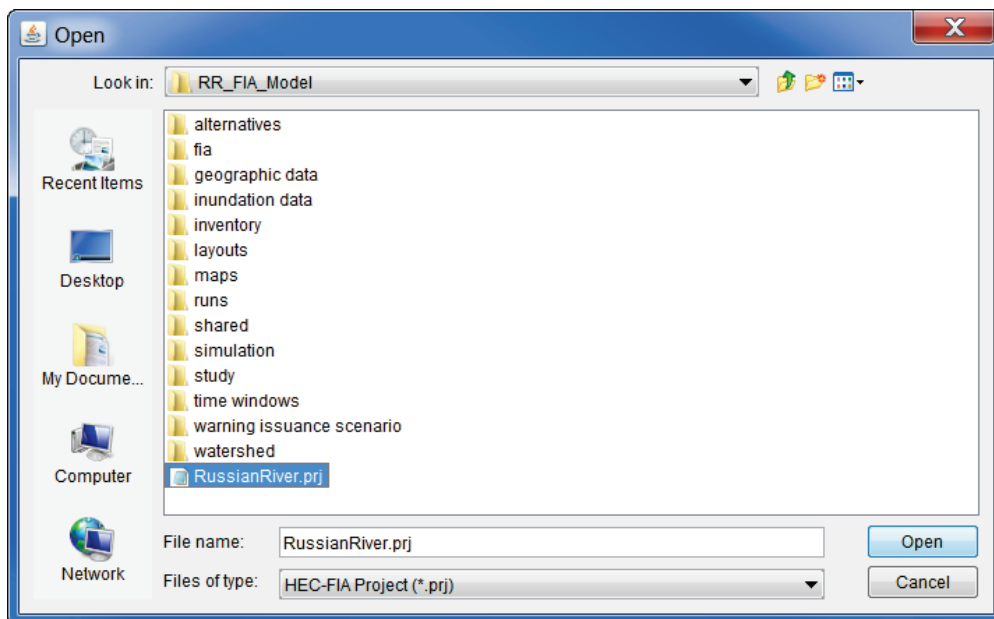


Figure 8.13 Open Browser

Please Select Your Alternative For Each Project

Project	Alternative	Progress
RussianRiver	GridsAndXSecsAlter...	<div style="width: 100%; height: 10px; background-color: green;"></div>

Figure 8.14 HEC-FIA Import Alternative Table

- From the **Import Alternatives** dialog box (Figure 8.12), click **Edit Alternative Specifications**, the **Alternative Specification** dialog box will open (Figure 8.15). **Copy Projection from project** should by default be clicked, click **OK**.

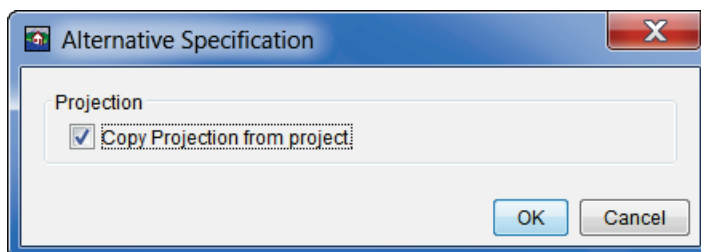


Figure 8.15 Alternative Specification Dialog Box

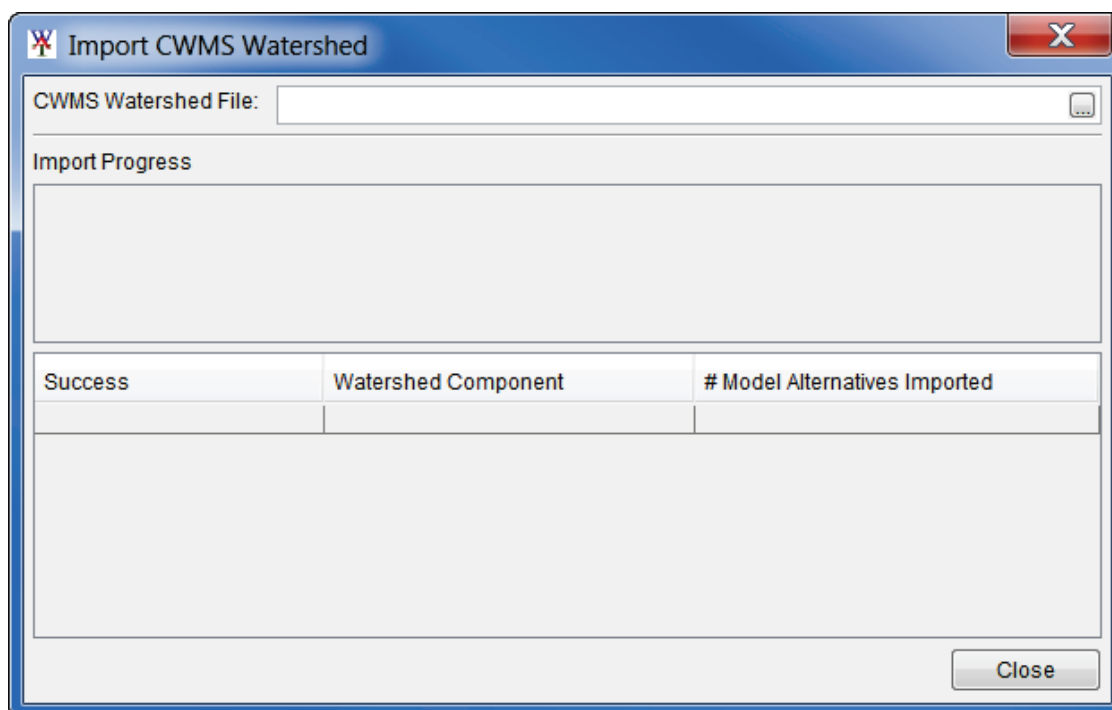
- From the **Import Alternatives** dialog box (Figure 8.12), click **Import Alternatives**, in the **Progress** column of the table (Figure 8.14) the cell will display the progress of the import with a green bar. When the import is complete an **Information** window will open, click **OK**.
- From the **Import Alternatives** dialog box (Figure 8.15) click **Close**. The HEC-FIA model alternative has been imported.

## 8.2 Importing a CWMS/HEC-RTS Watershed


A CWMS (Corps Water Management System) or an HEC-RTS watershed has been built for forecasting in the same watershed area that a PDT wants to build an HEC-WAT study. The HEC-WAT software has the capability to import a CWMS/HEC-RTS watershed. Once the import is finished, the study team will need to review the models and make adjustments as needed. The first step is to create a basic HEC-WAT study, in Chapter 7, Section 7.1, follow those steps to create a new HEC-WAT study

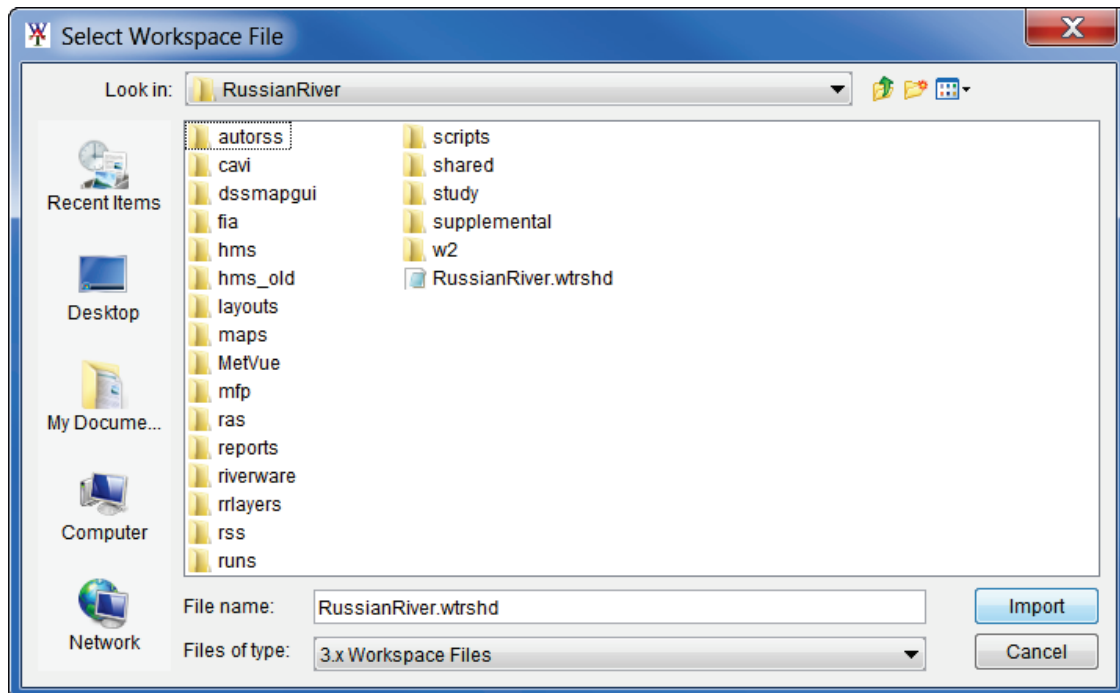
To import a CWMS/HEC-RTS watershed:

1. From the HEC-WAT main window (Figure 8.1), from the **File** menu, point to **Import**, click **CWMS Watershed**. The **Import CWMS Watershed** dialog box will open (Figure 8.16).

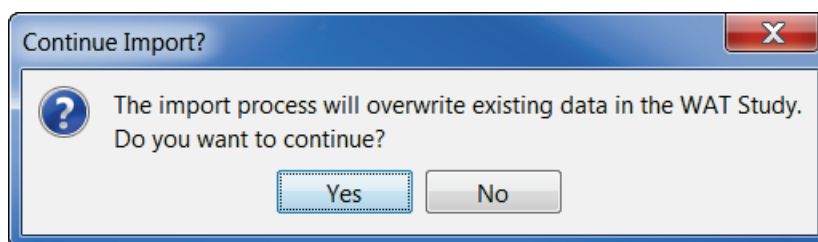


**Figure 8.16** Import CWMS Watershed Dialog Box

2. Now select the CWMS/HEC-RTS watershed, from the **CWMS Watershed File** box, click , and the **Select Workspace File** browser (Figure 8.17) will open. Browse to the directory where the CWMS/HEC-RTS watershed is located and select the CWMS/HEC-RTS watershed file (\*.wtrshd). The watershed filename will appear in the **File name** box (Figure 8.17), click **Import**, the **Select Workspace File** browser will close (Figure 8.17).
3. A **Continue Import?** window will open (Figure 8.18). This window is warning the user that the import process will overwrite any existing data in the HEC-WAT study. Click **Yes**, the **Continue Import?** window will close (Figure 8.18)



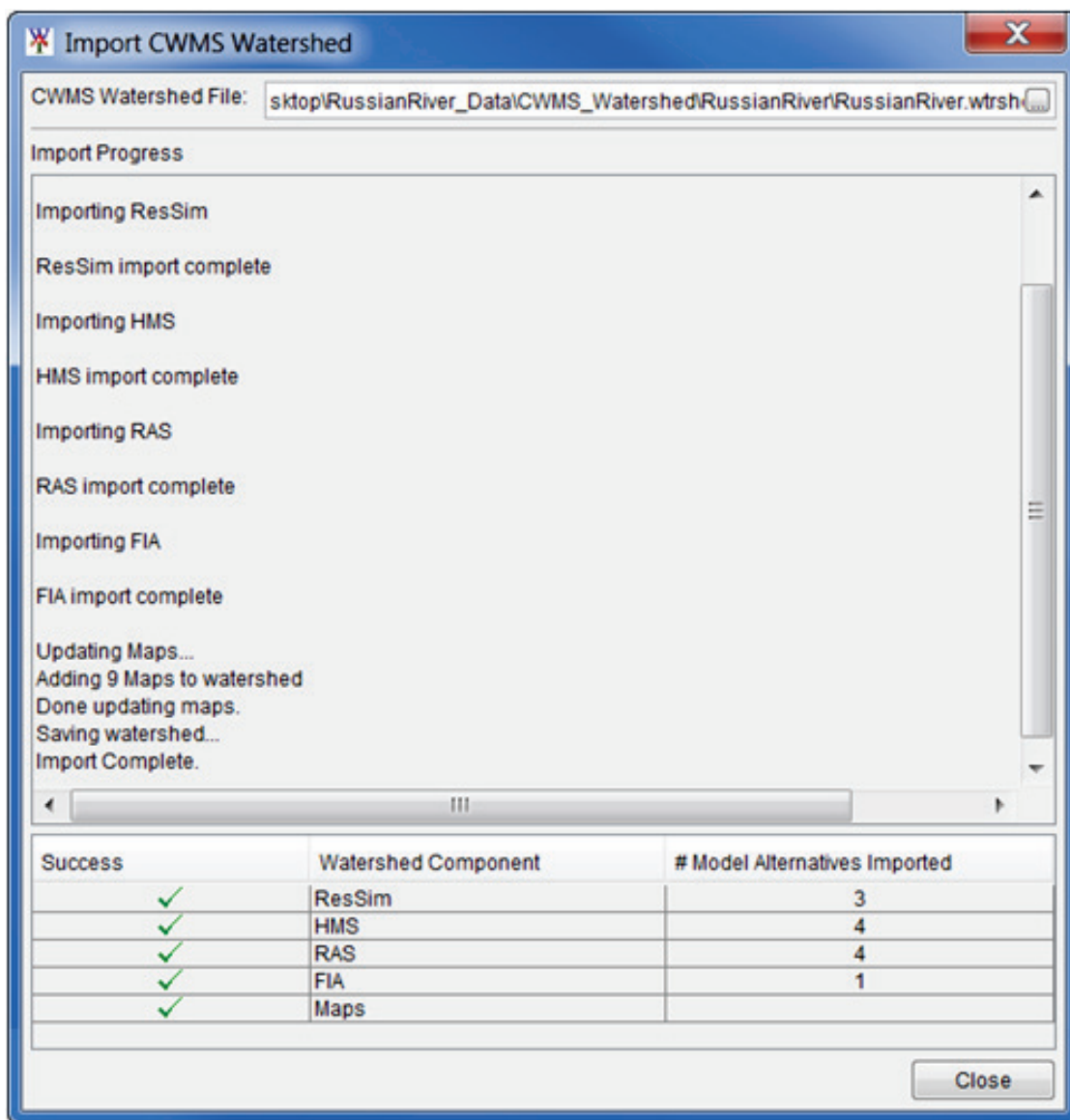
**Figure 8.17** Select Workspace File Browser



**Figure 8.18** Continue Import? Window

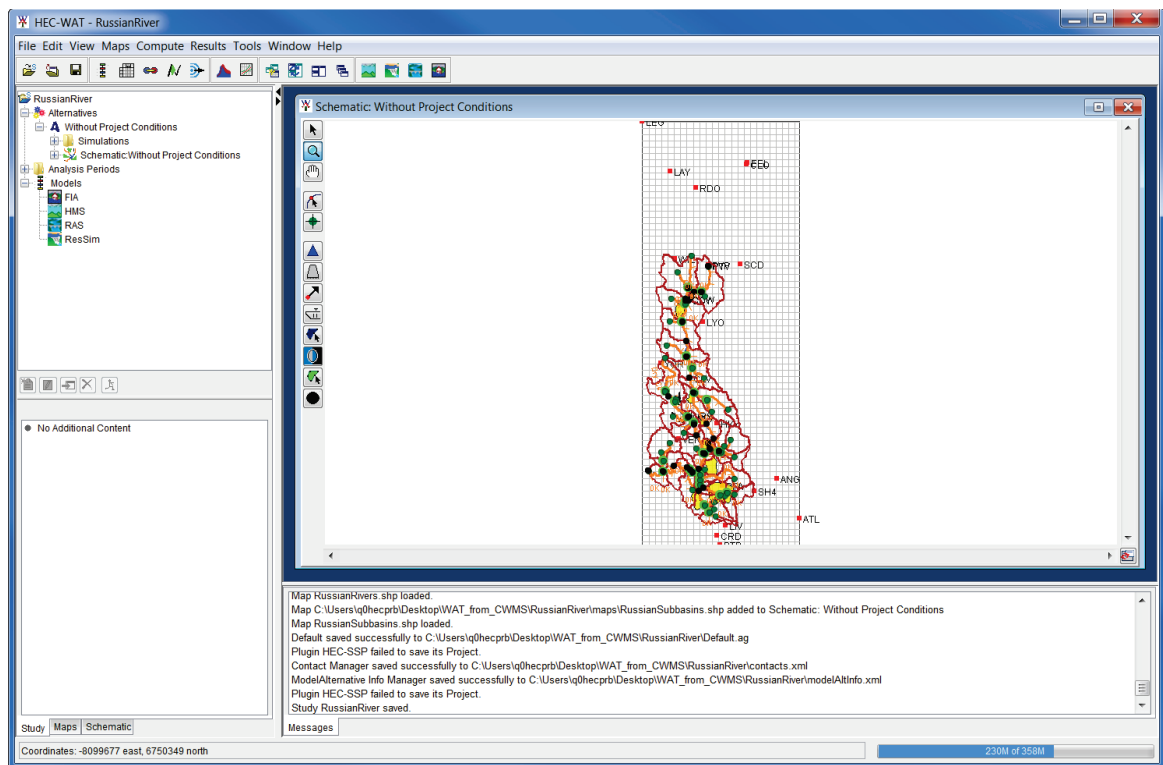
4. The **Import CWMS Watershed** dialog box (Figure 8.19) will now display the name of the CWMS/HEC-RTS watershed file in the **CWMS Watershed File** box (Figure 8.19). As the import proceeds, the **Import Progress** box on the **Import CWMS Watershed** dialog box (Figure 8.10) will display what is happening during the import. The table on the **Import CWMS Watershed** dialog box (Figure 8.19) will display which CWMS/HEC-RTS watershed components have finished, whether the import was successful or not, and the number of model alternatives that were imported.
5. When the HEC-WAT study is created an *hms* subfolder is created. In that subfolder are the default files that are generated when creating an HEC-HMS project. When the HEC-HMS import process finds that a project already exists, a warning window will appear (Figure 8.8; this warning window can open behind the HEC-WAT main window). Click **Yes**, the warning window will close.
6. If the HEC-HMS model was created using a previous version of HEC-HMS, a **Convert HEC-HMS Project** window (Figure 8.9) will open. This window is letting the user know that the HEC-HMS model will be converted to a Version 4.2.1 HEC-HMS model. Click **Convert Project**, the **Convert HEC-HMS Project** window (Figure 8.9) will close, and the import of the watershed will continue.

7. Once the import process is finished from the **Import CWMS Watershed** dialog box (Figure 8.19) click **Close**. The **Import CWMS Watershed** dialog box (Figure 8.19) will close, and the HEC-WAT main window (Figure 8.20) will display the map layers and the stream alignment of the imported CWMS/HEC-RTS watershed.



**Figure 8.19** Importing CWMS Watershed Dialog Box

8. The CWMS/HEC-RTS watershed has been imported into an HEC-WAT study. From the HEC-WAT main window (Figure 8.20), from the **File** menu, click **Save**.



**Figure 8.20** HEC-WAT Main Window after a CWMS/HEC-RTS Import



# CHAPTER 9

## Time Window – Analysis Period

An **analysis period** defines the simulation time window that is used by all the model alternatives in an HEC-WAT simulation. An analysis period can span single or multiple historical events or can be used to define the lifecycle length within a Flood Risk Analysis (FRA) simulation. For example, an analysis period for a historic event, such as the 1986 flood, should be defined so that the start and end time spanned the 1986 event, i.e., the start time captures the precipitation that drove the flood event and the end time captures the flood wave and resulting damage. An analysis period for multiple events, or a continuous simulation, would be defined by creating one analysis period (start and end times) that captures all the flood events within the continuous record.

An analysis period for an FRA simulation is different than when modeling historic events. The analysis period for an FRA simulation is used to set the length of each lifecycle within the FRA compute. Typically, lifecycles are fifty-years in length. If the FRA compute does not analyze damages and lifecycles are not required, then the analysis period can be an arbitrary length; however, 100 or 500 year lifecycles are optimal for results management.

Options that modify the analysis period (time window) are available and are described in Section 9.2. Once the user has defined an alternative (such as the *Without Project Conditions* alternative), the next step is to create analysis periods. Analysis periods are required to create simulations runs, and an analysis period can only be used once per HEC-WAT alternative.

### 9.1 Analysis Periods – Study Tree

Analysis periods can be managed from different areas in the HEC-WAT framework (Figure 9.1). This sections covers the **Study Tree**, which is in the **Study Pane** (Figure 9.1) of the HEC-WAT main window. Analysis periods can also be managed from the **Alternative and Simulation Manager**, which is covered in Section 9.3.

#### 9.1.1 Create an Analysis Period

1. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, right-click on the **Analysis Periods** folder. From the shortcut menu (Figure 9.2) click **New**.
2. The **Create New Analysis Periods** dialog box will open (Figure 9.3).
3. In the **Name** box, enter a name (required) for the analysis period. Optionally (but recommended), the user can enter a description in the **Description** box.

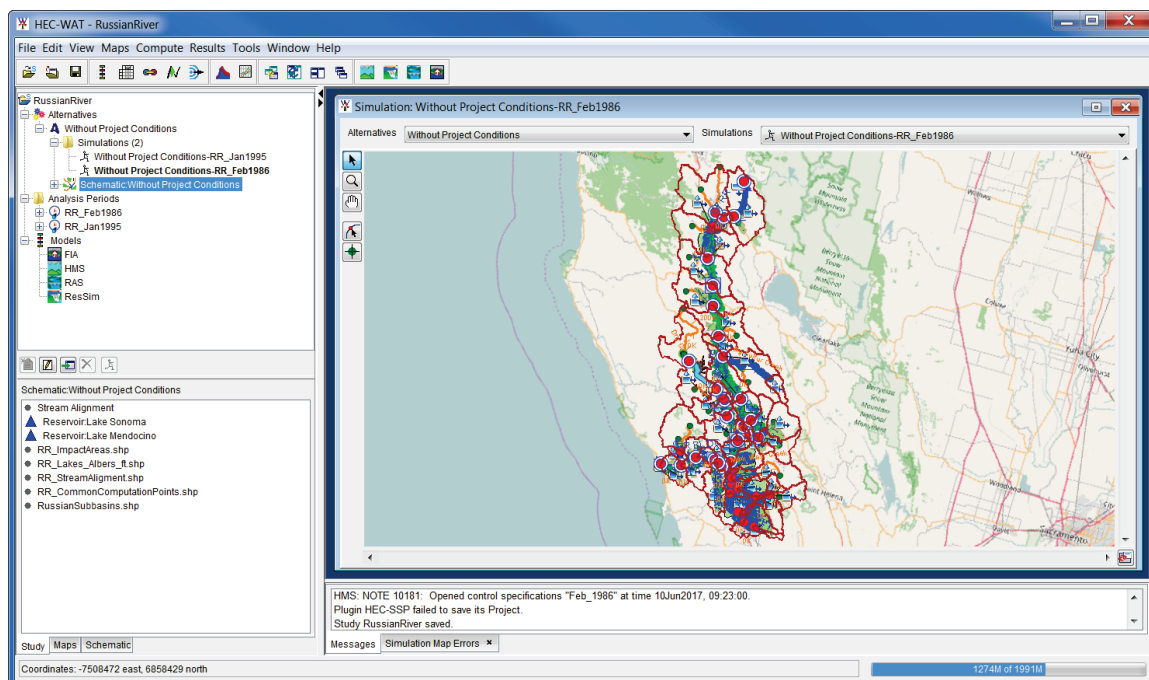


Figure 9.1 HEC-WAT Main Window

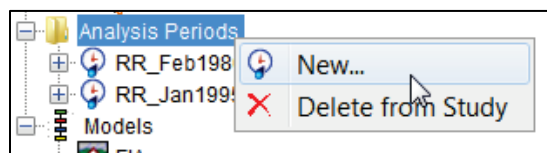


Figure 9.2 Study Tree- Analysis Periods Folder – Shortcut Menu

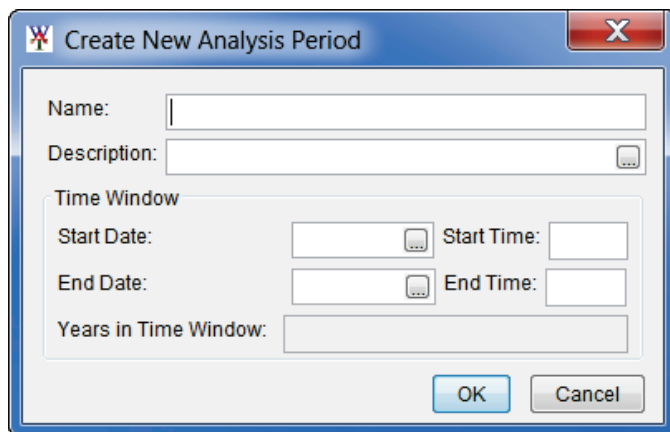


Figure 9.3 Create New Analysis Period Dialog Box

4. In the **Time Window** box (Figure 9.3), the user will enter a start date in the **Start Date** box, and a start time in the **Start Time** box. For the end date of the time window the user will enter that in the **End Date** box, and the end time in the **End Time** box. The **Years in Time Window** box will automatically update based on the start date/time and end date/time specified by the user. This feedback was added to help users enter standard lifecycle lengths for the FRA simulation. An analysis period of 50.05 years can lead to 51 flood events within an FRA lifecycle, which may be unwanted. A **Years in Time Window** of exactly 50 years will result in fifty events within a lifecycle.



5. Click **OK**. The **Create New Analysis Period** dialog box (Figure 9.3) will close. On the **Study Tree**, under the **Analysis Period** folder (Figure 9.1), the name of the analysis period that was just created is displayed.

### 9.1.2 Delete Analysis Period(s)

1. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, right-click on the **Analysis Periods** folder. From the shortcut menu (Figure 9.2) click **Delete from Study**.
2. The **Delete Analysis Period(s)** dialog box will open (Figure 9.4). This dialog box allows the user to delete single or multiple analysis period(s) at one time. From the **Existing** box select the analysis periods to be deleted. The name(s) selected will display in the **Name** field of the **Delete Object** box. Click **Delete**, a warning message box will appear, checking to see if the user really wants to delete the selected analysis period(s), click **Yes**.

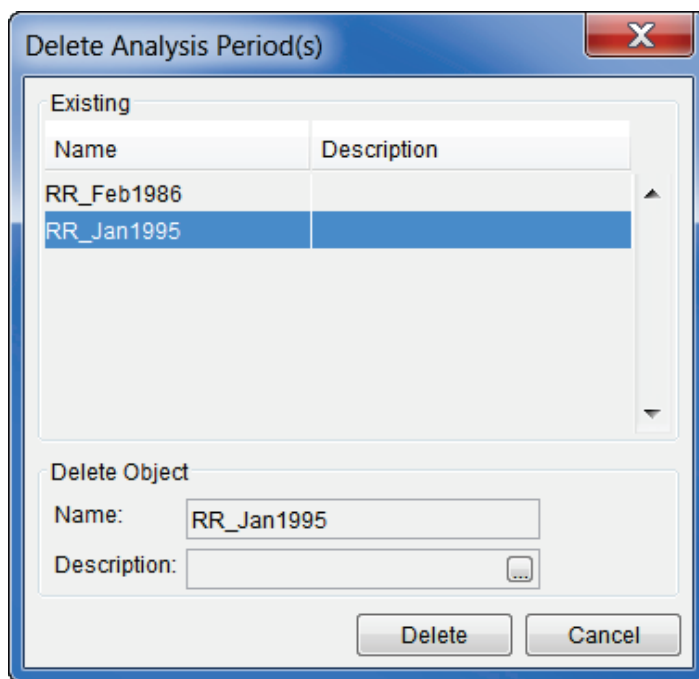
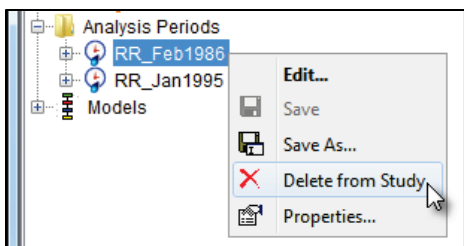


Figure 9.4 Delete Analysis Period(s) Dialog Box

3. The **Delete Analysis Period(s)** dialog box will close (Figure 9.4) and the name(s) of the selected analysis period(s) are no longer displayed under the **Analysis Period** folder in the **Study Tree**.

### 9.1.3 Individual Analysis Periods

When an analysis period has been created, from the **Study Tree**, under the **Analysis Periods** folder, the analysis periods defined for the HEC-WAT study are displayed. By right-clicking on an analysis period, a shortcut menu (Figure 9.5) becomes available. From the shortcut menu the user can perform various functions on individual analysis periods. These options include editing the existing analysis period; save as (which is used to copy an existing analysis period); and, deleting the existing analysis period.

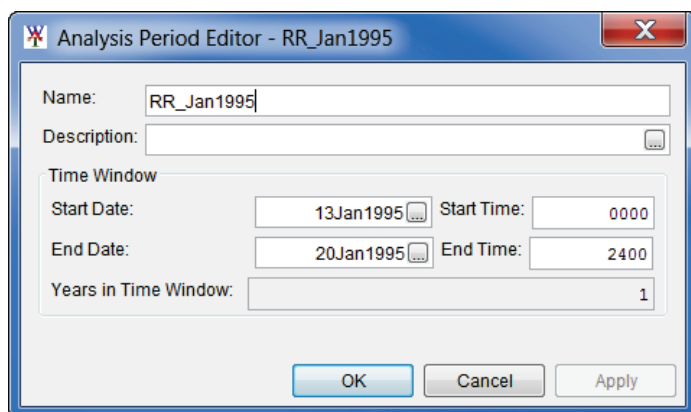


**Figure 9.5** Study Tree - Individual Analysis Period Shortcut Menu

## Edit

To edit an analysis period:

1. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, from the **Analysis Periods** folder, right-click on an analysis period. From the shortcut menu (Figure 9.5), click **Edit**. The **Analysis Period Editor** will open (Figure 9.6).



**Figure 9.6** Analysis Period Editor

2. The user can edit any of the analysis period data from the editor. Once the edits are complete, click **OK**. The **Analysis Period Editor** will close (Figure 9.6).

## Save

When an analysis period has been changed and the **Analysis Period Editor** has been closed, the user can save the analysis period information from the **Study Tree**. From the **Analysis Periods** folder, right-click on an analysis period. From the shortcut menu (Figure 9.5) click **Save**.

## Save As

To make a copy of an analysis period:

1. The user can make a copy of an individual analysis period by using the **Save As** option. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, from the **Analysis Periods** folder, right-click on an analysis period. From the shortcut menu (Figure 9.5), click **Save As**.

2. The **Save Analysis Period As** dialog box will open (Figure 9.7). In the **Name** box, enter a name for the new analysis period. Click **OK**, the **Save Analysis Period As** dialog box will close (Figure 9.7). The new analysis period will appear on the **Study Tree**, under the **Analysis Periods** folder.

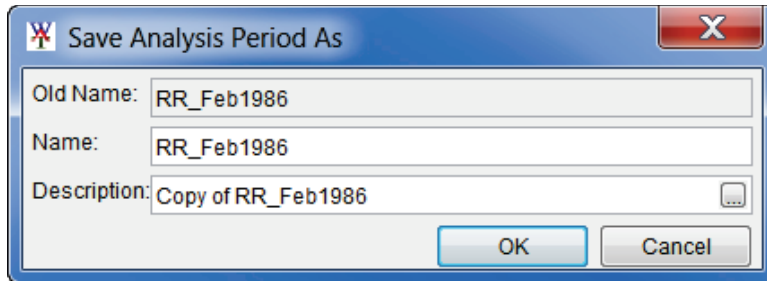


Figure 9.7 Save Analysis Period As Dialog Box

## Delete from Study

To delete an analysis period study:

1. The user can delete an individual analysis period by using the **Delete from Study** option. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, from the **Analysis Periods** folder, right-click on an analysis period. From the shortcut menu (Figure 9.5), click **Delete from Study**.
2. A **Confirm Manager Delete** message window will appear, checking to see if the user really wants to delete the selected analysis period. Click **Yes** to delete the analysis period. The message window will close and the name of the selected analysis period is no longer displayed under the **Analysis Period** folder in the **Study Tree**.

## Analysis Period Properties

The properties of an analysis period include the name, description, when the analysis period was modified, who created the analysis period, when the analysis period was created, and the file that contains the analysis period data. To view the properties of an analysis period, from the individual analysis period shortcut menu (Figure 9.5), click **Properties**. The **Properties for AnalysisPeriodName** dialog box will open (Figure 9.8).

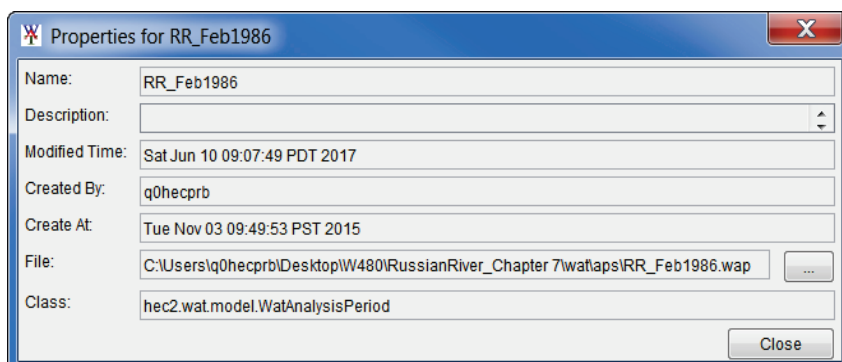


Figure 9.8 Properties for *AnalysisPeriodName* Dialog Box

## 9.2 Analysis Period - Modifiers

Now that the user has created an analysis period for an HEC-WAT simulation, HEC-WAT provides several methods for modifying the analysis period time window within a simulation. Modifying the simulation time window is a way to make a simulation run faster or help make simulations more stable by adjusting the time window for each model that is part of an HEC-WAT simulation. For example, a reservoir model may need to run for the entire time window, but a hydraulic model may only need to run for a shorter time around the peak flow in order to capture maximum flow and inundation.

There are three options available for modifying the simulation time window: **Time Window Adjustment** (Section 9.2.1), **Time Window Modifier** (Section 9.2.2), and **Time Window Interval Generator** (Section 9.2.3). The **Time Window Adjustment** and **Time Window Modifier** options are available in both a deterministic and FRA compute, while the **Time Window Interval Generator** option is only available in a deterministic compute.

### 9.2.1 Time Window Adjustment

The **Time Window Adjustment** option (Figure 9.9) provides the user with simple methods to adjust the simulation time window for a specific model. The user can independently adjust the start and end dates and times of a simulation time window using one of two options: *No Change* and *Relative*. The time window adjustment modifies the simulation time window based on date shifts. The time window adjustment feature is available for both deterministic and FRA compute types, and can be used in conjunction with the **Time Window Modifier** (Section 9.2.2). The **Time Window Modifier** allows users to also alter the simulation time window, but based on model alternative results (e.g., adding or subtracting days relative to the date and time of a peak flow or stage) instead of date shifts. From the **Simulation Editor** (Figure 9.9), the user can apply time window adjustment options as follows:

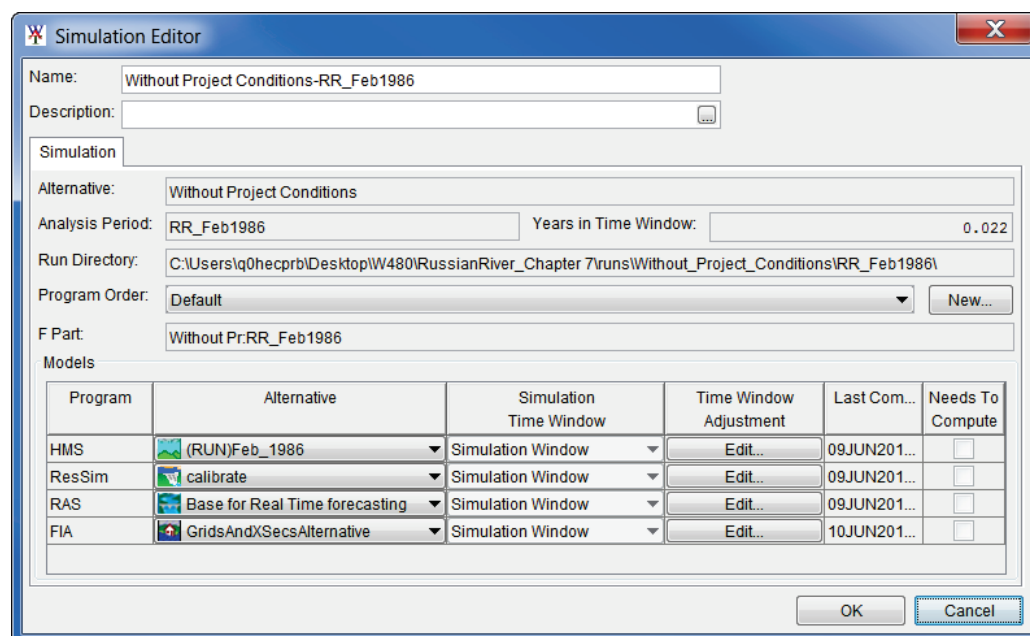
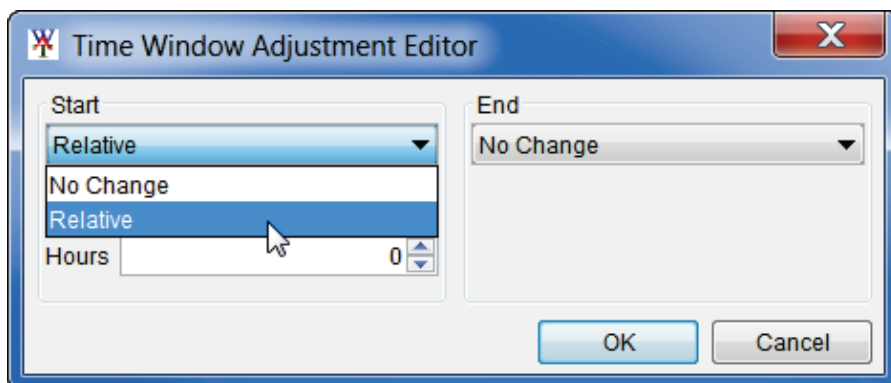


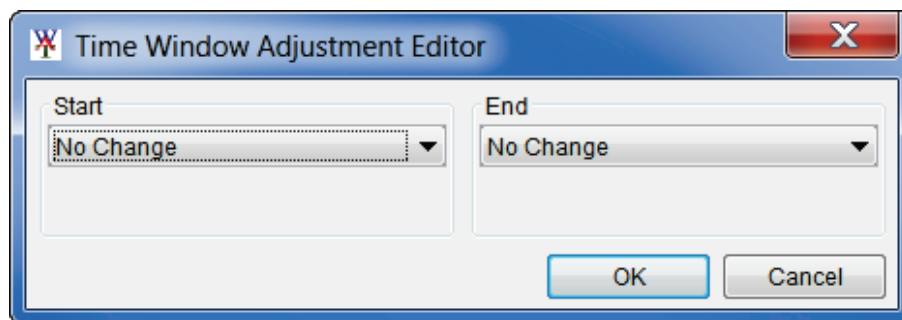
Figure 9.9 Simulation Editor – Time Window Adjustment

1. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, from the **Alternatives** node, from the **Simulation** folder, right-click on a simulation. From the shortcut menu click **Edit Simulation**.
2. The **Simulation Editor** will open (Figure 9.9). From the **Models** table, from the **Time Window Adjustment** column, click **Edit**. The **Time Window Adjustment Editor** (Figure 9.10) will open.



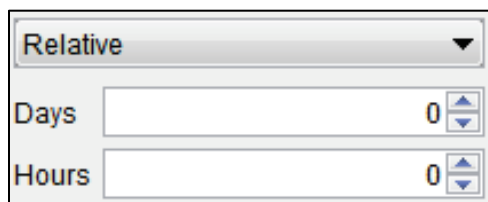
**Figure 9.10** Time Window Adjustment Editor

3. For the **Start** and **End** of the time window, there are two options – **No Change** and **Relative**. These options can be selected independently for the **Start** and **End** times. For example, the user could select **Relative** for **Start** and **No Change** for **End**.
  - **No Change** (Default) – The start or end of the simulation time window will not be adjusted (Figure 9.11).



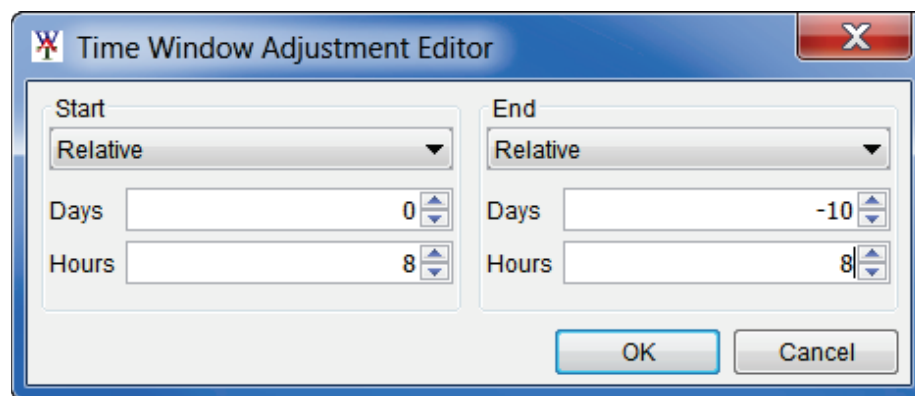
**Figure 9.11** Time Window Adjustment Editor – No Change

- **Relative** – The start or end of the simulation time window can be adjusted by adding or subtracting days and hours (Figure 9.12).



**Figure 9.12** Time Window Adjustment Editor – Relative

The start and end times of the **Simulation Time Window** can be adjusted independently (Figure 9.13). Negative values for the number of days and hours will move a date backward in time. For example, a value of minus one day will shift the date from *May 15* to *May 14*. Positive values for the number of days and hours will move a date forward in time. For example, a value of plus one day will shift the date from *May 15* to *May 16*.



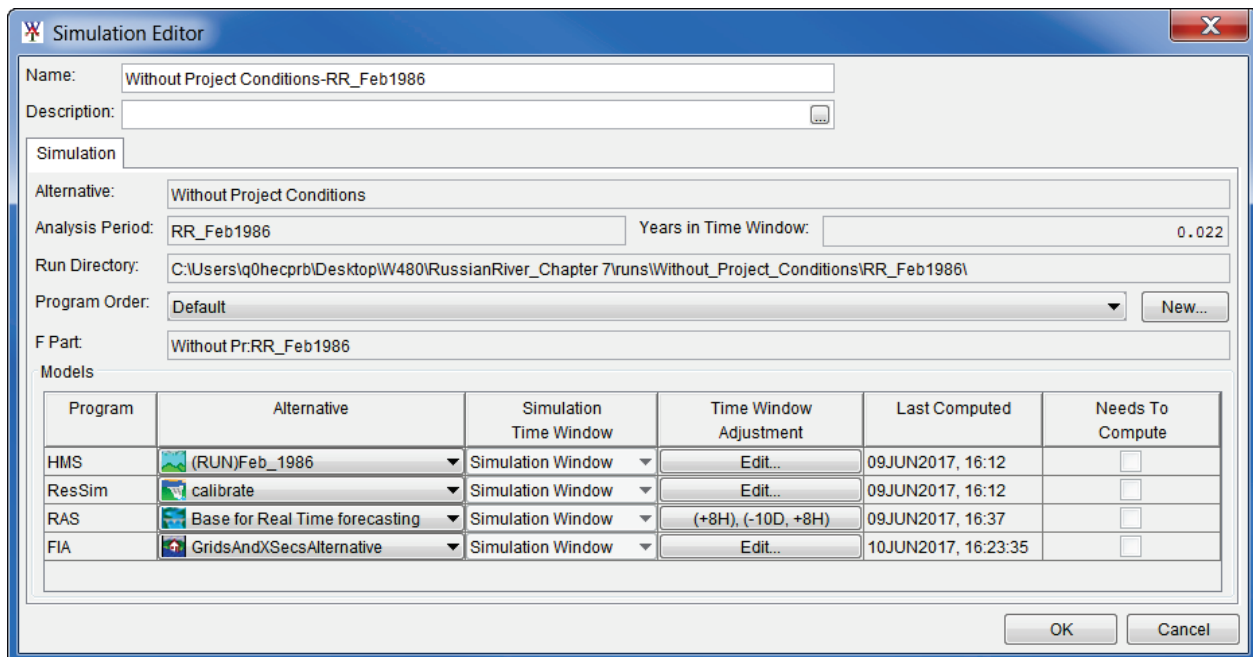
**Figure 9.13** Time Window Modifier Editor - Relative -Example

**Important:** The time window can be shortened or lengthened using the **Relative** option. If the time window is lengthened, however, there is a risk that subsequent model alternatives in the compute sequence will not have data for the entire time window and may fail to compute. The user should also be aware that it is possible to generate overlapping start and end times, through either an incorrect selection of dates for the relative **Time Window Adjustment** option or through a combination of a **Time Window Modifier** alternative (Section 9.2.2) and a **Time Window Adjustment**. A simulation will fail if the start and end times overlap.

4. An example application of a time window adjustment follows. From the **Time Window Adjustment Editor** the user has selected the *Relative* option to adjust the time window (Figure 9.13). In the **Start** box, the user selected **Relative** from the list, entered the number of hours to add to the simulation time window in the **Hours** box. In the **End** box, the user selected **Relative** from the list, entered the number of days and hours to adjust the simulation time window in the **Days** and **Hours** boxes. Click **OK**, the **Time Window Adjustment Editor** (Figure 9.13) closes, and now on the **Simulation Editor**, from the **Models** box, the **Time Window Adjustment** cell for the RAS model alternative displays the new simulation time window for the RAS model alternative (Figure 9.14). When the simulation computes, only HEC-RAS will have a modified simulation time window.
5. Click **OK**, the **Simulation Editor** (Figure 9.14) will close.

## 9.2.2 Time Window Modifier

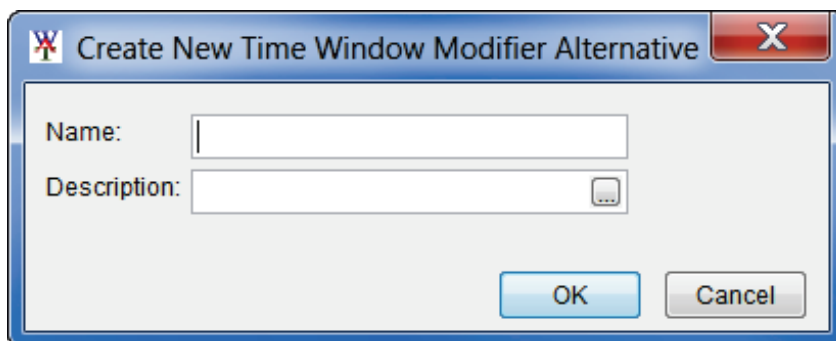
The **Time Window Modifier** has greater flexibility than the time window adjustment and can be used to modify the simulation time window based on flow, stage, or elevation. The modification can be relative to a threshold, a peak value, or through a script. If a time window modifier



**Figure 9.14** Simulation Editor – Example Time Window Adjustment – Relative

alternative is used for the study, make sure the time window modifier plug-in has been enabled for the study (Chapter 4, Section 4.1.5). The user creates a **Time Window Modifier**

**Alternative** (Figure 9.15) and sets up the options. To use a time window modifier alternative in an HEC-WAT simulation, the program order (Chapter 11, Section 11.1) for the simulation **must** include a time window modifier in the compute sequence.



**Figure 9.15** Create New Time Window Modifier Alternative Dialog Box

One or more time window modifier alternatives can be used in a simulation, and each time window modifier alternative must be linked to an output time-series from a model alternative that is part of a simulation. For example, a time window modifier alternative could be inserted between an HMS model alternative and an RAS model alternative in a simulation to shorten the RAS model alternative's runtime. The time window modifier would be linked to a flow time-series from the HMS model alternative, which runs for the entire analysis period and comes before the time window modifier in the simulation. Based on user-specified criteria and HMS flow results, the time window modifier would then determine and pass a shortened run time window to the RAS model alternative. The time window modifier feature is available for both deterministic and FRA compute types, and can be used in conjunction with the time window adjustment feature.



Create a time window modifier alternative:

1. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, from the **Models** node, right-click on **TimeWindowModifier** (if *TimeWindowModifier* does not display, the time window modifier plug-in (Chapter 4, Section 4.1.5) has not been enabled for the study). From the shortcut menu click **New**.
2. The **Create New Time Window Modifier Alternative** dialog box will open (Figure 9.15). In the **Name** box, enter a name (required) for the time window modifier alternative. Optionally (but recommended), the user can enter a description in the **Description** box.
3. Click **OK**, the **Create New Time Window Modifier Alternative** dialog box will close (Figure 9.15) and the **Time Window Modifier Alternative Editor** will open (Figure 9.16).

**Figure 9.16** Time Window Modifier Alternative Editor

4. By default, the **Time Window Modifier Alternative Editor** opens with the **Model** tab selected. From the **Model** tab, the user is given choices to adjust the simulation time window by either a flow threshold or a time window relative to the peak of a time-series.



The **Input Data Parameter** box (Figure 9.16) contains three options: **Flow**, **Stage**, and **Elevation**. **Flow** is selected by default when a new time window modifier alternative is created, but the user can also select either **Stage** or **Elevation**. The parameter type is used to filter the list of model results in the **Model Linking Editor** (Chapter 12) to only those specified here in the **Time Window Modifier Alternative Editor**.

There are four options for modifying the time window: **Threshold Crossing**, **Minimum Time Window**, **Maximum Time Window** and **Script**. Input information for the first three options is organized in separate boxes on the **Model** tab, and the **Script** option is a tab. The time window modifier checks for input and applies each option in the order that the options are displayed, meaning the threshold crossing is checked first, then minimum time window, maximum time window and finally script. As each option is applied, the time window is modified further. If input data has not been provided for one of the options, the time window modifier carries the existing time window forward to the next option without modification. The next option in the sequence is then checked for input data, and if data is available, the time window is modified accordingly. This process continues until all four options have been checked for input data and a final modified time window is produced.

- The **Threshold Crossing** option (Figure 9.17) *shortens* the analysis period time window based on user-defined thresholds relative to the peak value of a time-series. The user can define both a pre- and post-peak threshold using either absolute values or a percentage of the peak value. The user can also choose to define only one threshold, either pre- or post-peak. If percentage-based thresholds are desired, the user must select **Threshold is percentage of value at peak** (Figure 9.17). A **Search Method** (Figure 9.17) is also specified, with a default of **Out from Peak**, which searches backwards in time from the peak when a pre-peak threshold is set, and

**Figure 9.17** Time Window Modifier Alternative Editor – Threshold Crossing

searches forward in time from the peak when a post-peak threshold is set. The **In from Edges** search method (Figure 9.17) searches forward in time from the start of a time-series when a pre-peak threshold is set, and searches backwards in time from the end of a time-series when a post-peak threshold is set. In all cases, the time window is modified to match the time at which the designated threshold(s) are first crossed. If the user-specified threshold(s) are never crossed, the original time window is passed forward without modification.

- The **Minimum Time Window** option (Figure 9.18) is applied next, and can be used to set a minimum time window based on the peak value from the linked time-series. The user can enter **Minimum Time Window** values in a combination of **Days** and **Hours**. This option *expands* the current time window, based on user inputs. For

Minimum Time Window	
Start Relative to Peak	
Days	6
Hours	0
End Relative to Peak	
Days	1
Hours	0

**Figure 9.18** Time Window Modifier Alternative Editor – Minimum Time Window

example (Figure 9.18), a user may specify a start relative to peak of six days and an end relative to peak of four days. If the time window passed to the **Minimum Time Window** option includes six or more days before the peak and four or more days after the peak, no adjustment will be made. However, if the initial time window includes only three days before the peak and one day after the peak, the time window would be expanded to include six days before the peak and four days after the peak to match the requirements specified in the **Minimum Time Window** option.

**Important:** Because the **Minimum Time Window** option can expand a previously defined time window, there is a risk that subsequent model alternatives in the simulation that come after a time window modifier alternative in an HEC-WAT compute sequence will be passed a time window that is larger than the input data of those model alternative and the simulation will not complete. The user must carefully check the logic defined for this option to ensure that it does not result in a modified time window that extends beyond the data limits of the following model alternatives in a compute sequence.

- The **Maximum Time Window** option (Figure 9.19) is applied next and works in the opposite way of the **Minimum Time Window** option. It *shortens* the time window based on user-defined values for start and end times relative to the peak. The user can enter **Maximum Time Window** values in a combination of **Days** and **Hours**. For example, a user may specify a start relative to peak of four days and an end relative to peak of two days. If the time window passed to the **Maximum Time Window** option includes four or less days before the peak and two or less days after the peak, no adjustment will be made. However, if the initial time window includes ten days before the peak and five days after the peak, the time window would be shortened to include four days before the peak and two days after the peak to match the requirements specified in the **Maximum Time Window** option.

Maximum Time Window	
Start Relative to Peak	
Days	6
Hours	0
End Relative to Peak	
Days	1
Hours	0

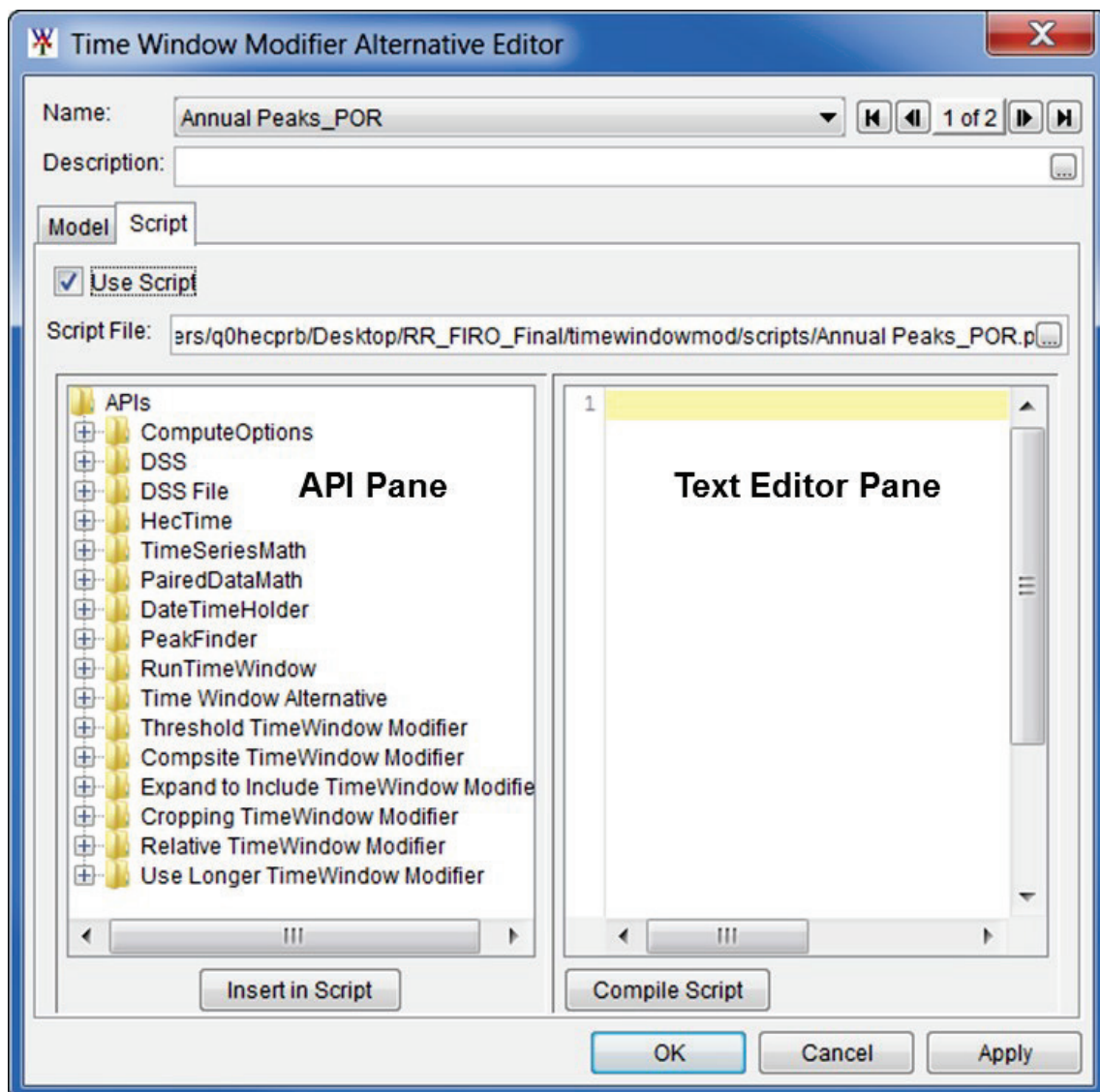
**Figure 9.19** Time Window Modifier Alternative Editor – Maximum Time Window

5. The script option (available from the **Script** tab) runs last and is described in the following section. If the user is not applying the script option and the time window modifier setup is complete, click **OK**, and the **Time Window Modifier Alternative Editor** closes (Figure 9.16).

## Script Tab

HEC-WAT provides a built-in scripting interface for defining a more complex time window modifier. The user can create a Python script that will adjust the simulation time window based on parameters and conditions the user selects. An example script is available for download from the HEC-WAT webpage.

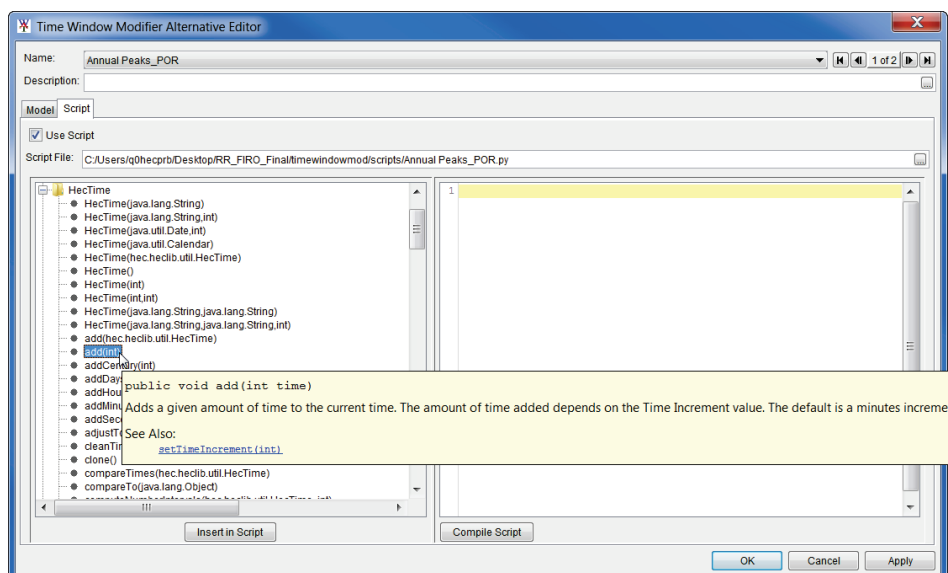
1. From the **Time Window Modifier Alternative Editor**, click the **Scripts** tab (Figure 9.20).



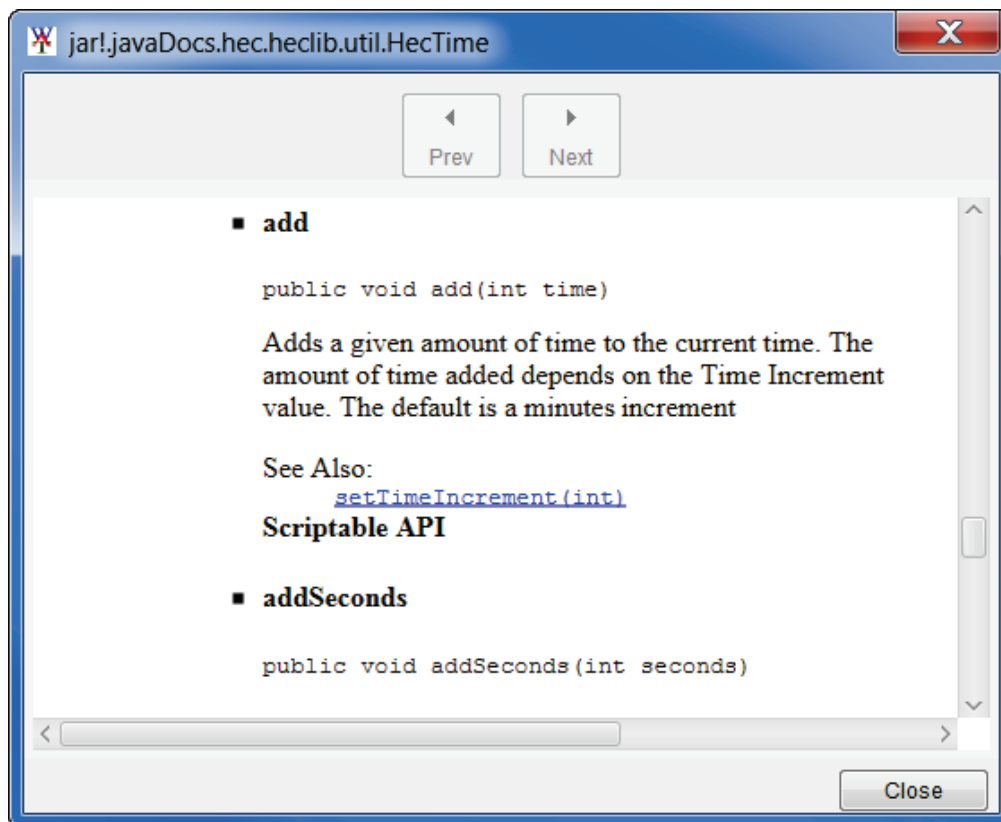
**Figure 9.20** Time Window Modifier Alternative Editor – Script Tab

2. The name of the script (displays in the **Name** box, Figure 9.20) is the same as the time window modifier alternative. Optionally, the user can enter a description in the **Description** box (Figure 9. 20). To create a script, click **Use Script**, the **Script File** box (Figure 9. 20) displays the location of where the file is stored.

3. From the **API (Application Programming Interface) Pane** (Figure 9. 20), is a list of the available APIs that a user can insert into a script. The user will decide which API needs to be included in the script, expand the folder for that API (click the plus sign). From the expanded list, the user will select the appropriate item that needs to be included in the script. Once an item is selected, click **Insert in Script**, and the format for the selected item will appear in the **Text Editor Pane** (Figure 9. 20).
4. The **Text Editor Pane** (Figure 9. 20) is a basic editor where the user can create and edit a script. The editor supports the standard Windows® keys for **Select All** (Ctrl-A), **Cut** (Ctrl-X), **Copy** (Ctrl-C) and **Paste** (Ctrl-V) operations. By right-clicking in the **Text Editor Pane**, a shortcut menu is available, that also supports the previously listed operations, plus **Undo** and **Redo**. Below the **Text Editor Pane**, by clicking **Compile Script**, the user can check the script for Python code syntax errors.
5. When editing a script, from the **Text Editor Pane** (Figure 9. 20), the user will need to select the appropriate text in the script where revisions might be made. Then, using the **API Pane** (Figure 9. 20), the user can add items to the script in several ways. One way is described in Step 3 by clicking **Insert in Script**. The user can also double-click on an item in the **API Pane**, the format for the selected item will be inserted at the current cursor position in the text editor. Another way is by dragging an API item to a position in the **Text Editor Pane**, this also causes the format for the selected item to be inserted into the current cursor position in the text editor.
6. Arguments are placeholders for variables that the user must supply in the script. The user needs to replace the placeholders (red parentheses) with an argument of appropriate variables/objects that the user has created within the script. General information about an API item can be viewed by hovering over an item in the **API Pane**, a yellow callout box will display (Figure 9.21). More detailed information can be viewed by selecting an API item and then pressing the **F1** key, which displays a **JavaDoc window** (Figure 9.22).



**Figure 9.21** API Pane – Displaying Information about an API Item



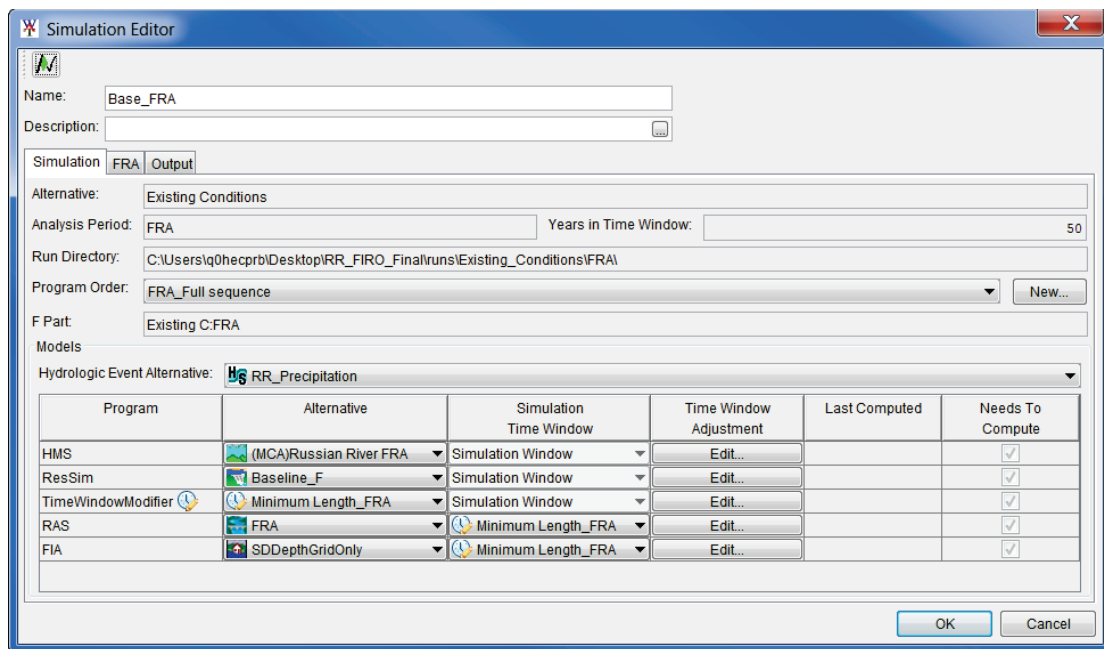
**Figure 9.22** JavaDoc Window – Displaying More Detailed Information about an API Item

5. When the script has been completed, click **OK**, the **Time Window Modifier Alternative Editor** will close (Figure 9.20).

## Simulation Editor

Now that a time window modifier alternative has been created, the user will decide on which model alternatives to apply the time window modification. Note that multiple time window modifier alternatives can be defined within one simulation, and conversely, multiple model alternatives can reference the same time window modifier alternative.

1. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, from the **Alternatives** node, from the **Simulation** folder, right-click on a simulation. From the shortcut menu click **Edit Simulation**.
2. The **Simulation Editor** will open (Figure 9.23), in the table, the **Program** column (Figure 9.23) will contain the names of the software applications. The software applications that display are determined by the selected program order (e.g., *FRA\_Full sequence*) from the **Program Order** list (Figure 9.23). If **TimeWindowModifier** is not listed in the **Program** column, the selected program order does not include *TimeWindowModifier* (Chapter 11, Section 11.1). The **Alternative** column will contain the time window modifier alternative name (i.e., *Minimum Length\_FRA*) used in the compute sequence for the selected simulation.



**Figure 9.23** Simulation Editor – Simulation with Time Window Modifier Alternative

- For a model alternative to use a time window modifier alternative, from the **Simulation Time Window** column (Figure 9.23), from a cell associated with a software application (e.g., *RAS*) that is located below the *TimeWindowModifier* in the table (Figure 9.23), click the cell, a list of available time window modifier alternatives will display, select the name for the appropriate time window modifier alternative (i.e., *Minimum Length\_FRA*).

**Important:** Connecting a model alternative to a time window modifier alternative in the **Simulation Editor** modifies the simulation time window for that model alternative, either by shortening or expanding it. As a best practice, subsequent model alternatives in the simulation should generally be connected to the same time window modifier alternative to ensure that those model alternatives simulation time windows match that of prior model alternatives. If the simulation time windows of the subsequent model alternatives are not modified, there is a risk that those model alternatives time windows will be larger than the previous model alternative. This could mean that adequate input data might be unavailable for those model alternatives and the simulation will not complete.

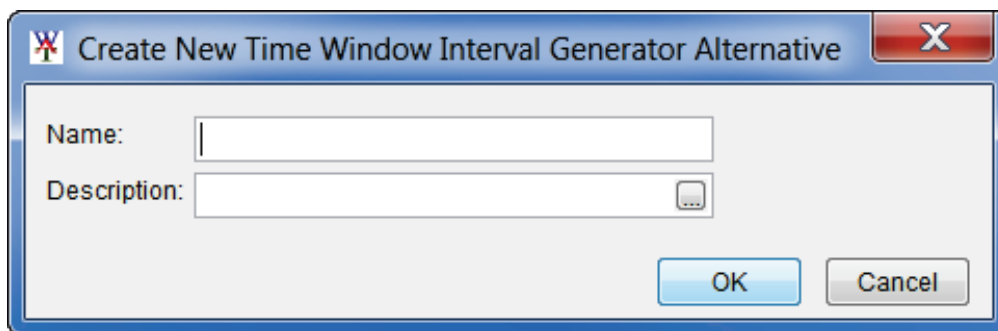
- When this example simulation computes, the simulation time window will be modified for the model alternatives connected to the time window modifier alternative (i.e., *Minimum Length\_FRA*) in the **Simulation Editor** (Figure 9.23).
- Click **OK**, the **Simulation Editor** (Figure 9.23) will close.

### 9.2.3 Time Window Interval Generator

Models can run on a continuous basis in a deterministic simulation. An analysis period can be one year or one hundred or more years, based on the boundary condition data available for model simulations and the type of analysis. HEC-FIA is an event based software application, and when



HEC-FIA is used within a multi-year deterministic simulation, damage and life loss are only computed for the maximum flood event within the analysis period. If the user is interested in average annual damage (damage computed for each year and then averaged) within a deterministic compute that spans multiple years, the **time window interval generator** must be used to create annual time windows within an analysis period. The time window interval generator feature is only available for the deterministic compute type. The user creates a **Time Window Interval Generator Alternative** (Figure 9.24) and adds the alternative to the user created program order for an HEC-WAT simulation. To use a time window interval generator alternative in an HEC-WAT simulation, the program order (Chapter 11, Section 11.1) for the simulation **must** include a time window interval generator in the compute sequence.



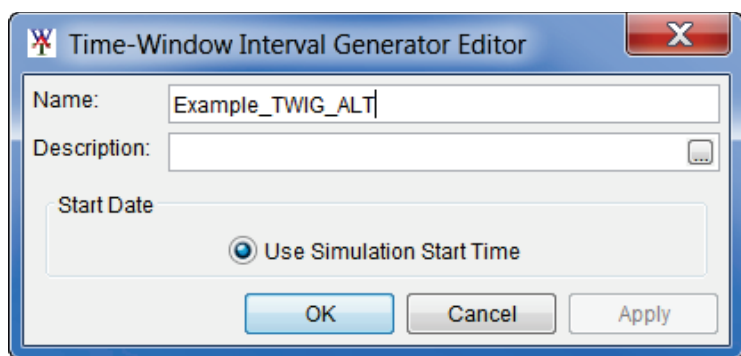
**Figure 9.24** Create New Time Window Interval Generator Alternative Dialog Box

The time window interval generator alternative sets the simulation start time equal to the analysis period start time included in the simulation. During the simulation compute, any model alternatives listed above the time window interval generator alternative in the compute sequence for the simulation will run continuously for the entire analysis period. However, any model alternatives listed after the time window interval generator alternative in the compute sequence will run independent simulations that are broken up by years. Results are stored for each individual year within the analysis period in the results DSS file. The time window modifier model alternative (Section 9.3.2) can be used following a time window interval generator alternative in a program order to further shorten the time window parameters (e.g., shorten the time window to ten days before the peak flow and three days after the peak flow) within each year.

For example, the time window interval generator alternative can be used so that the user could compute average annual damage within a deterministic simulation that spans fifty-years. The program order would consist of the time window interval generator alternative (if *Time-Window Interval Generator* does not display, the time-window interval generator plug-in (Chapter 4, Section 4.1.5) has not been enabled for the study), followed by the HEC-RAS and HEC-FIA software applications. If a fifty-year analysis period was selected, from *01 Jan 1950* to *31 Dec 1999*, then the time window interval generator alternative would create fifty separate time windows within the overall analysis period. The RAS and FIA model alternatives would run independently for each of the fifty years, with results reported in separate *event* folders for each year. Time window adjustment(s) or time window modifier alternative(s) could be used within each year to further shorten the model simulation time windows.

To create a new time window interval generator alternative:

1. From the HEC-WAT main window (Figure 9.1), from the **Study Pane**, expand the **Models** folder. Right-click on **Time-Window Interval Generator** (if *Time-Window Interval Generator* does not display, the time-window interval generator plug-in (Chapter 4, Section 4.1.5) has not been enabled for the study), and from the shortcut menu, click **New**. The **Create New Time Window Interval Generator Alternative** dialog box will open (Figure 9.24).
2. In the **Name** box (Figure 9.24), enter a name for the time window interval generator alternative. Enter a description (optional, but recommended) in the **Description** box.
3. Click **OK**. The **Create New Time Window Interval Generator Alternative** dialog box will close (Figure 9.24), and the **Time-Window Interval Generator Editor** will open (Figure 9.25). The newly created time window interval generator alternative will be listed in the **Content Pane** of the HEC-WAT main window (Figure 9.1).



**Figure 9.25** Time-Window Interval Generator Editor

4. In the **Time-Window Interval Generator Editor** (Figure 9.25) there is currently only one option available for the **Start Date**, **Use Simulation Start Time**, which is automatically selected. If the analysis period begins on *October 1*, then the event time windows would line up with the standard water year. If the analysis period begins on *January 1*, then the event windows would line up with the calendar year. When a time window interval generator alternative is included in a simulation, the simulation time window passed to subsequent model alternatives in the compute sequence is discretized into a series of annual events, with the start date of the first event set equal to the **Start Date** of the analysis period associated with the simulation. If using a time window modifier alternative to further shorten the annual time windows is being considered, place the time window modifier alternative after the time window interval generator alternative in the compute sequence.
5. Click **OK**, the **Time-Window Interval Generator Editor** (Figure 9.25) will close. A time window interval generator alternative has now been created.

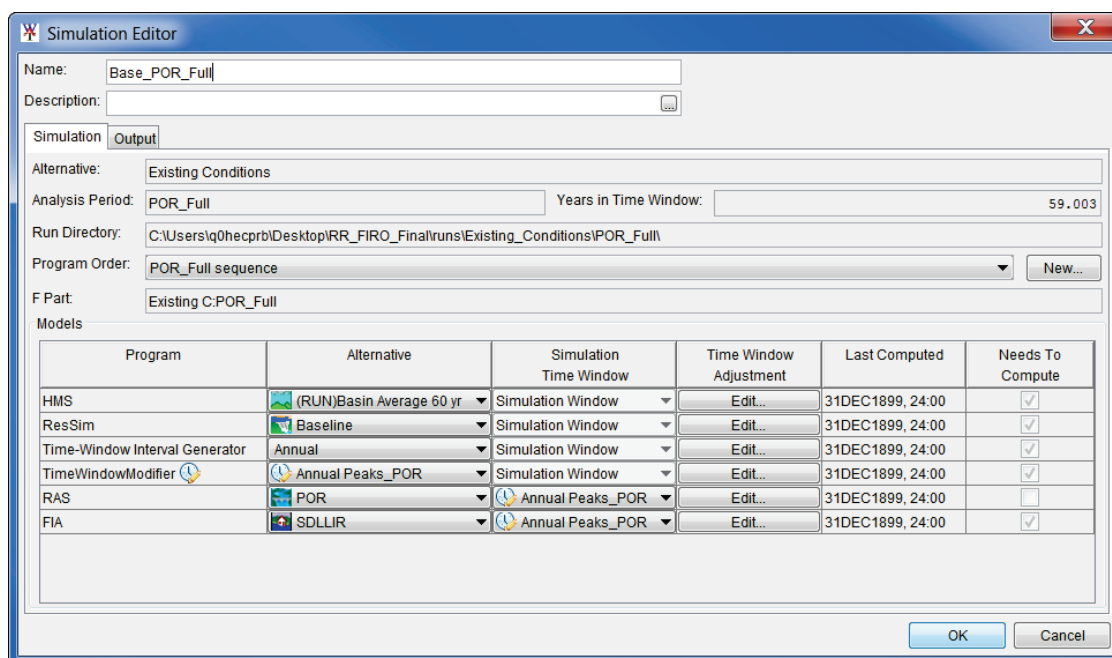
## Simulation Editor

Now that a time window interval generator alternative has been created, the user will decide on which model alternatives to apply the time window interval generator alternative. Note that multiple time window interval generator alternatives can be defined within one simulation, and



conversely, multiple model alternatives can reference the same time window interval generator alternative.

1. From the HEC-WAT main window (Figure 9.1), from the **Study Tree**, from the **Alternatives** node, from the **Simulation** folder, right-click on a simulation. From the shortcut menu click **Edit Simulation**.
2. The **Simulation Editor** will open (Figure 9.26). In the table, the **Program** column (Figure 9.26) will contain the names of the software applications. The software applications that display are determined by the selected program order (e.g., *POR\_Full sequence*) from the **Program Order** list (Figure 9.26). If *Time-Window Interval Generator* is not listed in the **Program** column, the selected program order does not include *Time-Window Interval Generator* (Chapter 11, Section 11.1). The **Alternative** column will contain the time-window interval generator alternative name (i.e., *Annual*) used in the compute sequence for the selected simulation.



**Figure 9.26** Simulation Editor – Simulation with Time Window Interval Generator Alternative

3. When this example (Figure 9.26) simulation computes, once the HMS and ResSim model alternatives have run using the defined simulation time window, the time window interval generator alternative (i.e., *Annual*) will create annual time windows (events) within the simulation time window. The time window modifier alternative (i.e., *AnnualPeaks\_POR*) will modify the simulation time window for the model alternatives below the time window modifier alternative in the **Simulation Editor** (Figure 9.26).


**Note:** When using a time window interval generator alternative and a time window modifier alternative, the sequence should be the time window interval generator alternative first and the time window modifier alternative second (Figure 9.26).

5. Click **OK**, the **Simulation Editor** (Figure 9.26) will close.

## 9.3 Analysis Periods – Alternative and Simulation Manager

Analysis periods can also be managed from the **Alternative and Simulation Manager**, which is covered in the following sections.

### 9.3.1 Create an Analysis Period

1. From the HEC-WAT main window (Figure 9.1), from the **WAT Tools** toolbar, click . The **Alternative and Simulation Manager** will open (Figure 9.27).

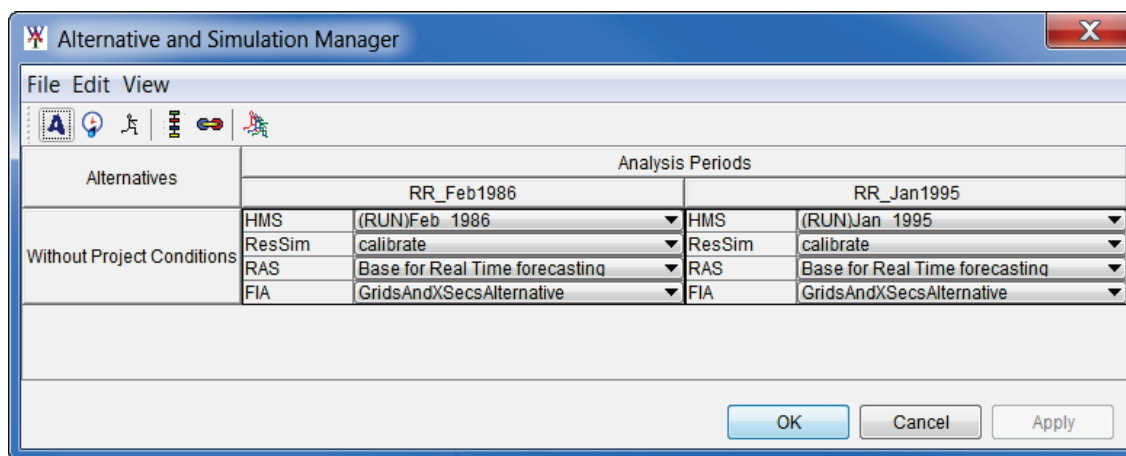



Figure 9.27 Alternative and Simulation Manager

2. From the **Alternative and Simulation Manager** toolbar, click ; or from the **File** menu, point to **Analysis Periods**, click **New**; or, from the table (Figure 9.27), right-click on the **Analysis Periods** header, from the shortcut menu (Figure 9.2), click **New**. The **Create New Analysis Period** dialog box will open (Figure 9.3).
3. In the **Name** box (Figure 9.3), enter a name (required) for the analysis period. Optionally (but recommended), the user can enter a description in the **Description** box (Figure 9.3).
4. In the **Time Window** box (Figure 9.3), enter a start date in the **Start Date** box and a start time in the **Start Time** box. Enter the end date of the time window in the **End Date** box, and enter the end time in the **End Time** box.
5. Click **OK**. The **Create New Analysis Period** dialog box (Figure 9.3) will close. The new analysis period is now displayed on the **Study Tree**, under the **Analysis Period** folder (Figure 9.1).

### 9.3.2 Delete Analysis Period(s)

1. From the **Alternative and Simulation Manager** (Figure 9.27), from the **File** menu, point to **Analysis Periods**, click **Delete from Study**.

2. The **Delete Analysis Period(s)** dialog box will open (Figure 9.4). This dialog box allows the user to delete one or more analysis periods at one time. From the **Existing** box select the analysis periods to be deleted. To select more than one, hold down the Shift key before selecting the analysis periods. The names selected will display in the **Name** field of the **Delete Object** box. Click **Delete**, a warning message box will appear, checking to see if the user really wants to delete the selected analysis periods, click **Yes**.
3. The **Delete Analysis Period(s)** dialog box will close (Figure 9.4) and the selected analysis periods are no longer displayed under the **Analysis Period** folder in the **Study Tree**.

### 9.3.3 Individual Analysis Periods

When an analysis period has been created, from the **Alternative Simulation Manager** (Figure 9.27), from the table, right-click on the header that contains the name of the individual analysis period(s). By right-clicking on an analysis period, a shortcut menu (Figure 9.5) becomes available. From the shortcut menu the user can perform various functions on individual analysis periods.

#### Edit

To edit an analysis period:

1. From the **Alternative and Simulation Manager** (Figure 9.27), from the table, right-click on the header that contains the name of the individual analysis period. From the shortcut menu (Figure 9.5), click **Edit**. Alternatively, from the **Alternative and Simulation Manager** (Figure 9.27), from the **Edit** menu, click **Analysis Periods**. Either way, the **Analysis Period Editor** will open (Figure 9.6).
2. The user can edit any of the analysis period data from the editor. Once the edits are done, click **OK**. The **Analysis Period Editor** will close (Figure 9.5).

#### Save

When an analysis period has been changed and the **Analysis Period Editor** has been closed, the user can save the analysis period information. From the **Alternative and Simulation Manager** (Figure 9.27), from the table, right-click on the header that contains the name of the individual analysis period. From the shortcut menu (Figure 9.5) click **Save**.

#### Save As

To make a copy of an analysis period:

1. From the **Alternative and Simulation Manager** (Figure 9.27), from the table, right-click on the header that contains the name of the individual analysis period. From the shortcut menu (Figure 9.5) click **Save As**.

2. The **Save Analysis Period As** dialog box will open (Figure 9.7). In the **Name** box, enter a name for new analysis period. Click **OK**, the **Save Analysis Period As** dialog box will close (Figure 9.8). The new analysis period will appear on the **Study Tree**, under the **Analysis Periods** folder.

## Delete From Study

To delete an individual analysis period:

1. From the **Alternative and Simulation Manager** (Figure 9.27), from the table, right-click on the header that contains the name of the individual analysis period. From the shortcut menu (Figure 9.5) click **Delete from Study**.
2. A **Confirm Manager Delete** message window will appear, checking to see if the user really wants to delete the selected analysis period, click **Yes**. The message window will close and the name of the selected analysis period is no longer displayed under the **Analysis Period** folder in the **Study Tree**.

## Analysis Period Properties

The properties of an analysis period include the name, description, when the analysis period was modified, who created the analysis period, when it was created, and the file that contains the analysis period data. From the **Alternative and Simulation Manager** (Figure 9.27), from the table, right-click on the header that contains the name of the individual analysis period, from the shortcut menu (Figure 9.5), click **Properties**. The **Properties for AnalysisPeriodName** dialog box will open (Figure 9.8).

# CHAPTER 10

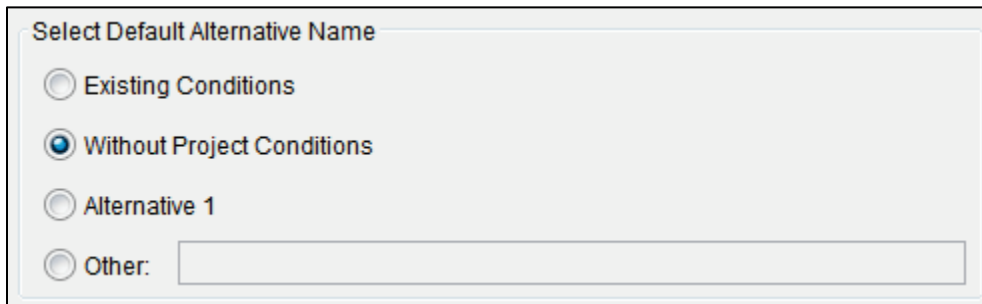
## Create and Manage Alternatives

### 10.1 Overview

The start of most studies involves defining the problem, establishing the scope, and formulating alternative solutions to be evaluated. HEC-WAT will help define alternatives through schematic representations, model alternative identification, and compute sequencing. An **alternative** in HEC-WAT is a representation of the physical and operational system, and groups a schematic with different measures, operations, and model alternatives. For example, one alternative could be a "current conditions" alternative that represents the current condition in the study area, including the current reservoir operational scheme. Additional alternatives could be some future condition, which represents changes to land use, and alternatives representing differing reservoir operational schemes or flood damage reduction measures. The alternative framework within HEC-WAT facilitates creation of simulations across all defined alternatives (using the same analysis period for each), and comparison of model alternative results.

### 10.2 Default Alternative – Without Project Conditions

When an HEC-WAT study is created (Chapter 4, Section 4.1.1), a default alternative is generated (Figure 10.1). By default, this alternative is given the name *Without Project Conditions*, the user can select several other name choices, or, a user can provide a name for the default alternative.

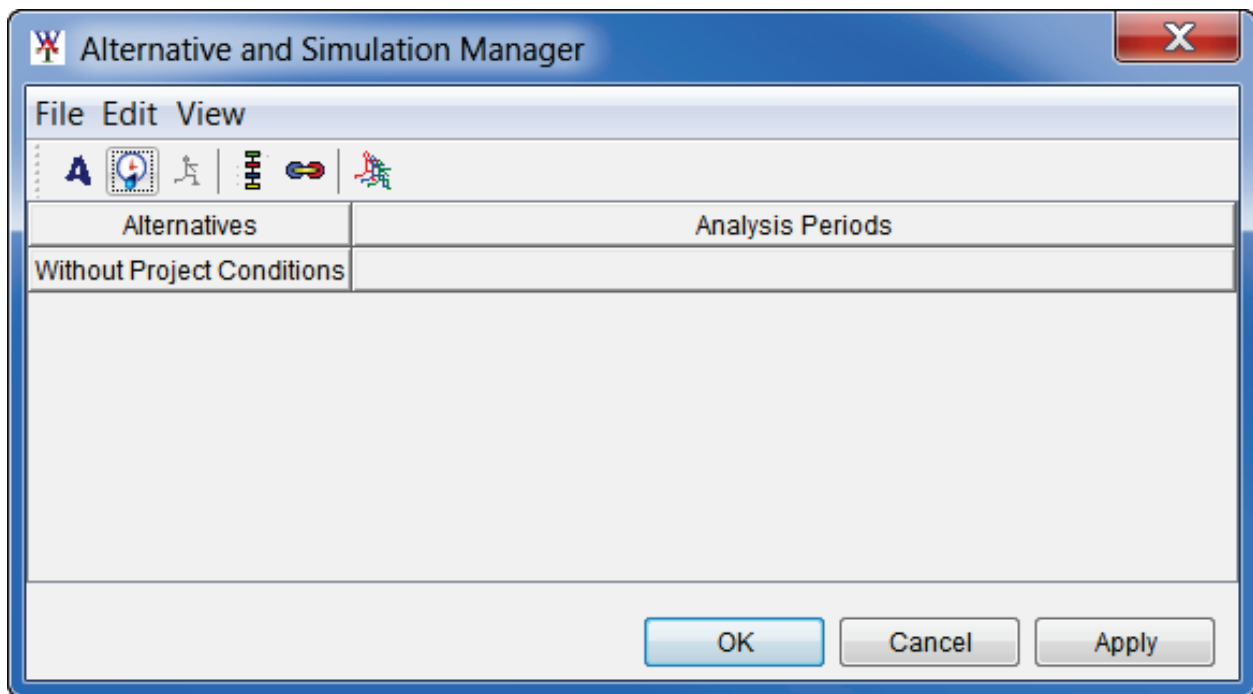


**Figure 10.1** Default Alternative Name

Once the study is created, a schematic map window opens in the **Desktop Pane** (Chapter 3). The first action following the creation of the default alternative should be to define the default schematic (Chapter 6). After defining the default schematic, analysis periods and simulations can then be created for the default alternative.


### 10.3 Alternatives - Alternative and Simulation Manager

After the default alternative has been created, the remaining alternatives that have been identified by the study team need to be developed. The **Alternative and Simulation Manager** (Figure 10.2) can be used for organizing and developing alternatives. The **Alternative and Simulation**




**Figure 10.2** Alternative and Simulation Manager

**Manager** (Figure 10.2) provides a convenient way to organize and develop the main components for an HEC-WAT study – alternatives, analysis period (time window), and simulations. The **Alternative and Simulation Manager** has three areas where the user can access commands that will allow the user to create, delete, and rename alternatives. These areas are the **Table**, **Toolbar**, and **Menu Bar**. The **Table** allows organization of a study's alternatives; a way to track the state of datasets needed for each model, create analysis periods, and create simulations.

To access the **Alternative and Simulation Manager**, from the HEC-WAT main window (Figure 10.3), from the **WAT Tools** toolbar, click . Alternatively, from the **Edit** menu, click **Alternative and Simulation Manager**. From either method the **Alternative and Simulation Manager** will open (Figure 10.2).

### 10.3.1 Create an Alternative

To create an alternative:

1. From the **Alternative and Simulation Manager** (Figure 10.2), right-click on the **Alternatives** header in the table, from the shortcut menu (Figure 10.4); or from the toolbar click ; or from the **File** menu, point to **Alternatives**, click **New**.
2. The **Create New Alternative** dialog box will open (Figure 10.5). In the **Name** box enter the name (required), and in the **Description** box, enter a description (optional, but recommended).

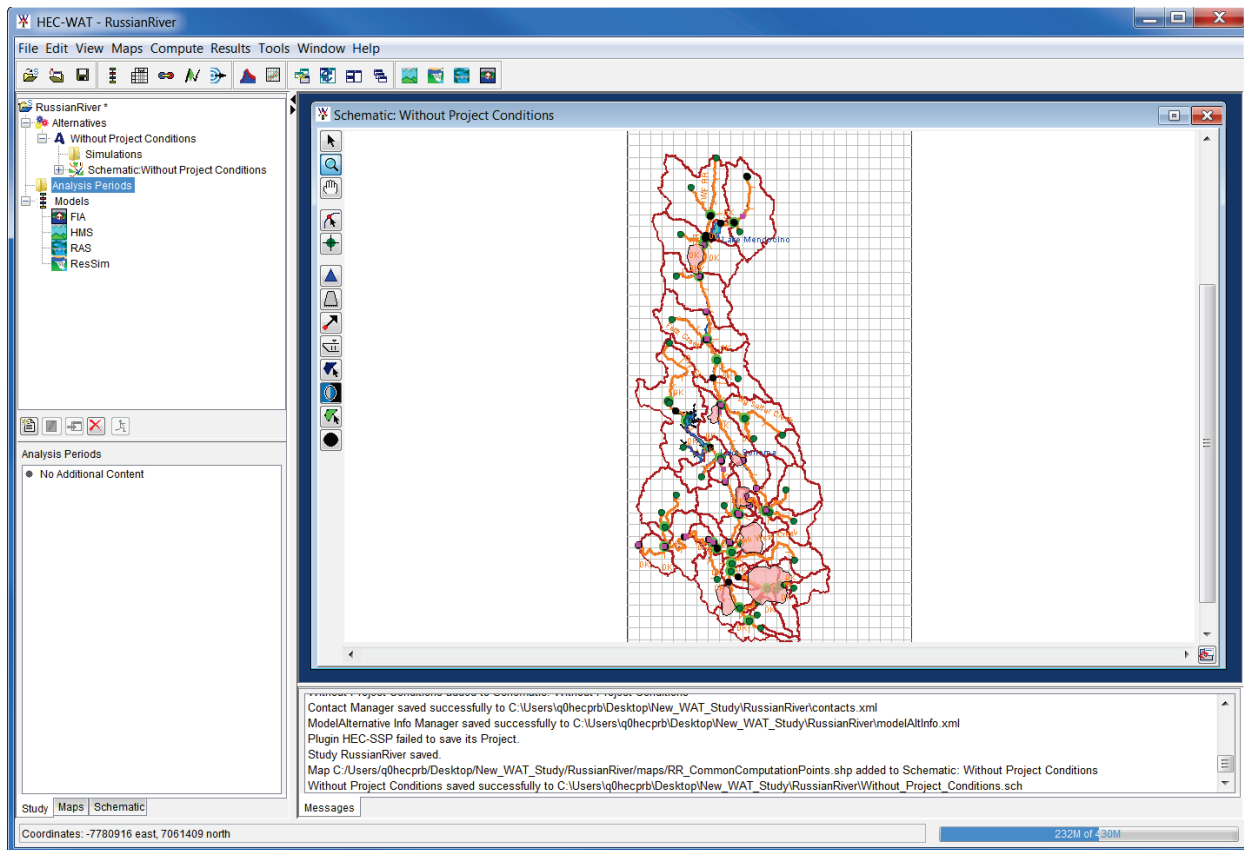


Figure 10.3 HEC-WAT Main Window

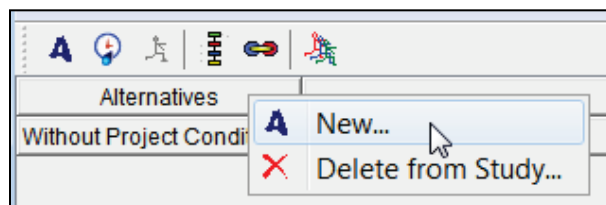
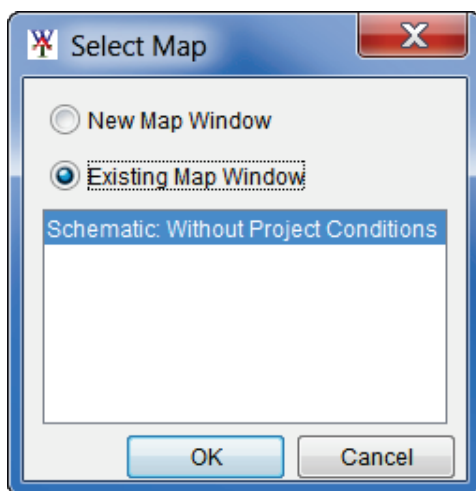


Figure 10.4 Alternatives Shortcut Menu



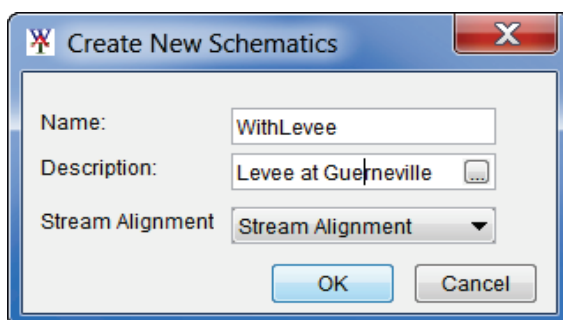
Figure 10.5 Create New Alternative Dialog Box

3. Each alternative requires a schematic to provide the layout of the study area measures and components (Chapter 6). From the **Schematic** list, select a previously defined schematic (proceed to Step 4), or create a schematic for the alternative (see Step 6).
4. Click **OK**, if there is no map window open in the **Desktop Pane**, the **Create New Alternative** dialog box (Figure 10.5) will close and an alternative map window will open in the **Desktop Pane**.
5. If a map window is open in the **Desktop Pane**, the **Select Map** dialog box will open (Figure 10.6). The user can choose whether to open the alternative map window in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 10.6) and the **Create New Alternative** dialog box (Figure 10.5) will both close, and the map window for the new alternative will appear in the **Desktop Pane**.



**Figure 10.6** Select Map Dialog Box

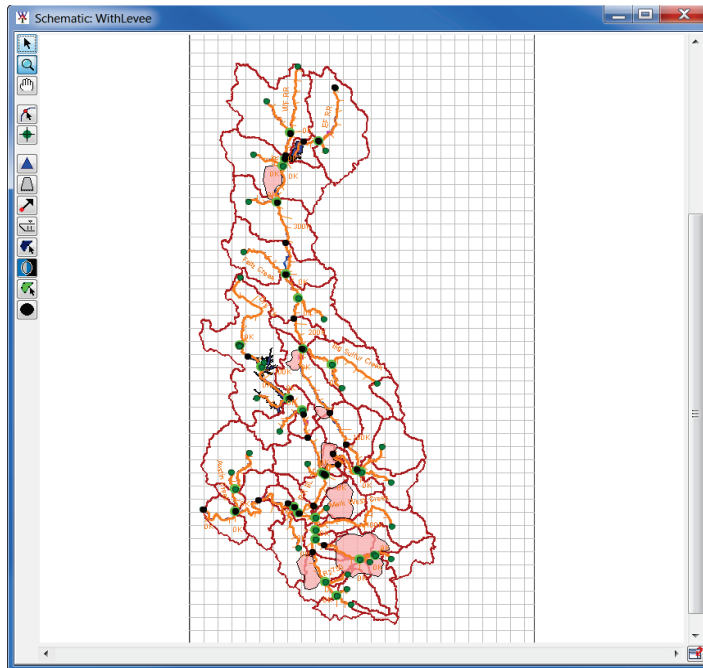
6. If a schematic needs to be created for the alternative, from the **Schematic** list (Figure 10.5), click **<Create New Schematic>**. Click **OK**, a warning message appears letting the user know that a schematic was not selected, and asks the user to create a new schematic, click **Yes**. The **Create New Schematics** dialog box will open (Figure 10.7). The name of the alternative will appear in the **Name** box for the new schematic. The user can accept this name or enter a name for the schematic in the **Name** box. The user can also enter a description in the **Description** box (optional, but recommended).



**Figure 10.7** Create New Schematics Dialog Box

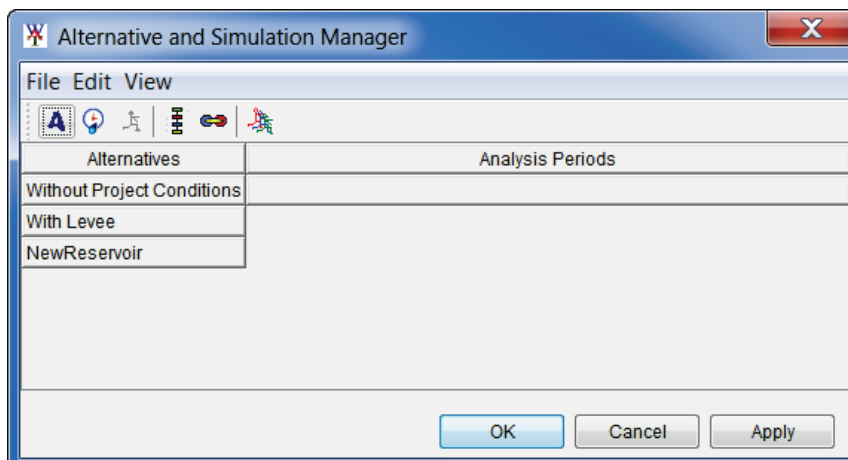


7. Click **OK**, if there is no map window open in the **Desktop Pane**, the **Create New Schematics** dialog box (Figure 10.7) will close and an alternative map window will open in the **Desktop Pane** (Figure 10.8). The user will need to add measures for the new schematic (Chapter 6).



**Figure 10.8** Alternative Map Window

8. If a map window is open in the **Desktop Pane**, the **Select Map** dialog box will open (Figure 10.6). The user can choose whether to open the alternative map window in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 10.6) and the **Create New Schematics** dialog box (Figure 10.7) will both close, and the map window for the new alternative will appear in the **Desktop Pane**.
9. The alternative name will now appear in the table on the **Alternative and Simulation Manager**, under the **Alternatives** column header (Figure 10.9).

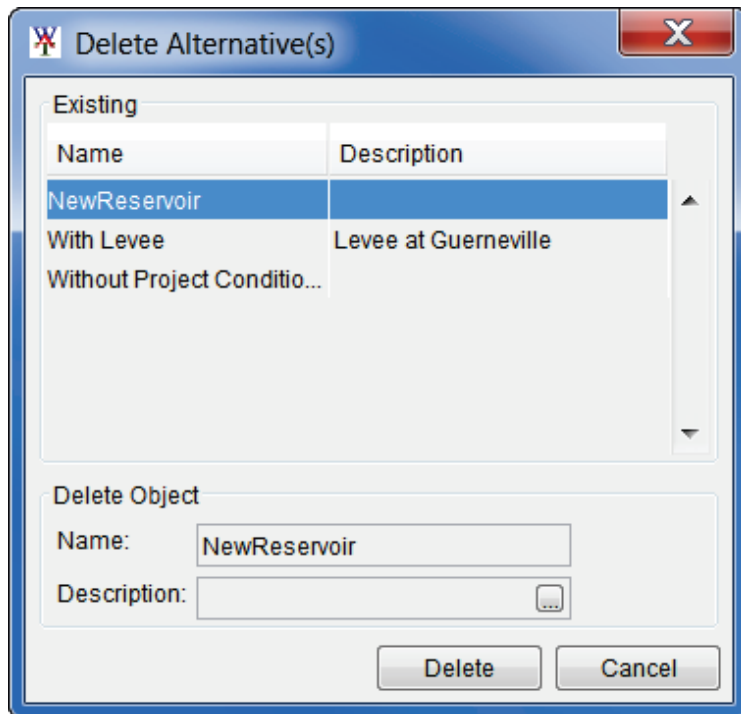


**Figure 10.9** Alternative and Simulation Manager – Additional Alternatives

### 10.3.2 Delete Alternatives

To delete alternatives from a study:

1. From the **Alternative and Simulation Manager** (Figure 10.9), right-click on the **Alternatives** header in the table, from the shortcut menu (Figure 10.4); or from the **File** menu, point to **Alternatives**, click **Delete from Study**, the **Delete Alternative(s)** dialog box will open (Figure 10.10).

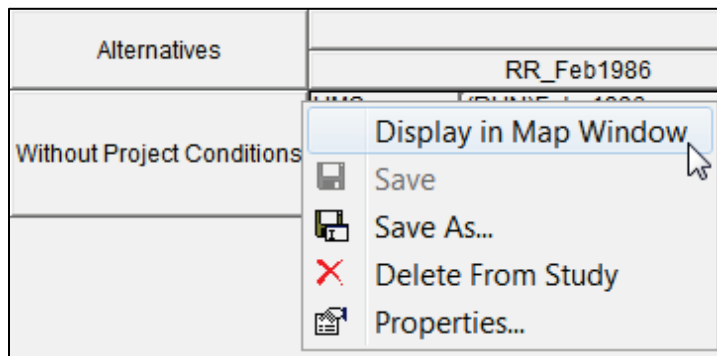


**Figure 10.10** Delete Alternative(s) Dialog Box

2. From the **Existing** list select alternative(s), in the **Delete Object** box (Figure 10.10) the name(s) and descriptions of the selected alternative(s) will appear.
3. Click **Delete**, a warning message will appear asking the user if the user really wants to delete the selected alternative(s). Click **Yes**, the warning message will close, the **Delete Alternative(s)** dialog box will close (Figure 10.10), and the selected alternative(s) will no longer appear under the **Alternatives** column of the **Alternative and Simulation Manager** (Figure 10.9).

### 10.3.3 Individual Alternatives

The individual alternative shortcut menu (Figure 10.11) is available from the **Alternative and Simulation Manager** (Figure 10.9), by right-clicking on an alternative name in the table. This shortcut menu allows the user to view the selected alternative in a map window, save, make a copy, delete from the study, and view the properties of the alternative. The following sections provide further details.



**Figure 10.11** Alternative and Simulation Manager – Individual Alternative Shortcut Menu

## View

To view an alternative in a map window:

1. From the **Alternative and Simulation Manager** (Figure 10.9), right-click on an alternative in the table. From the individual alternative shortcut menu (Figure 10.11), click **Display in Map Window**.
2. If there is not a map window open in the **Desktop Pane**, the alternative map window for the alternative will open in the **Desktop Pane**. From the alternative map window the user can edit the stream alignment, measures, impact areas, and adjust background maps associated with the alternative.
3. If a map window is open in the **Desktop Pane**, the **Select Map** dialog box (Figure 10.6) will open. The user can choose whether to open the alternative map window in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 10.6) will close, and the alternative map window for the selected alternative will appear in the **Desktop Pane**.

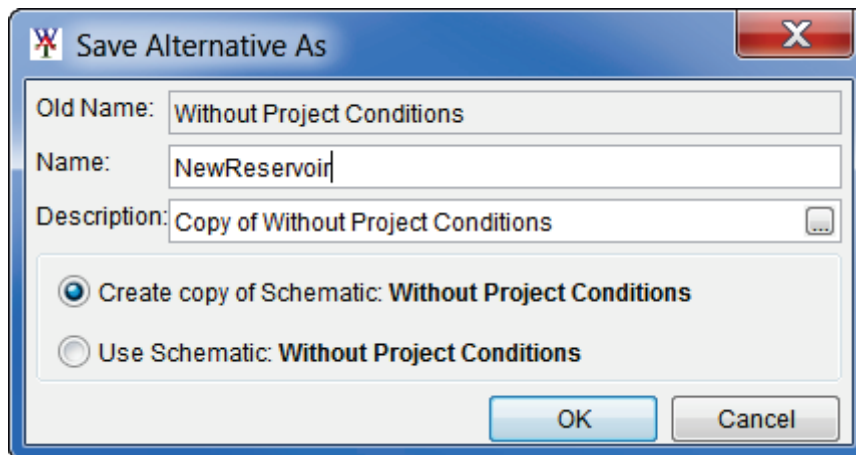
## Save

To save an alternative, from the individual alternative shortcut menu (Figure 10.11), click **Save**. Any changes that have occurred to the selected alternative will be saved by HEC-WAT.

## Save As

To make a copy from an existing alternative:

1. From the individual alternative shortcut menu (Figure 10.11), click **Save As**. The **Save Alternative As** dialog box will open (Figure 10.12). The information displayed in the dialog box represents the alternative has been selected for copying.
2. In the **Name** box, enter the name (required) of the new alternative, and in the **Description** box, enter a description (optional, but recommended).



**Figure 10.12** Save Alternative As Dialog Box

3. The user can also choose to create a copy of the associated schematic (will create a new schematic with the new alternative name) or use the associated schematic of the existing alternative the user has selected to make a copy of.
4. The alternative name will now appear in the table on the **Alternative and Simulation Manager**, under the **Alternatives** column header (Figure 10.9).

## Delete from Study

To delete an alternative, right-click on an alternative in the table on the **Alternative and Simulation Manager** (Figure 10.9), from the individual alternative shortcut menu (Figure 10.11), click **Delete From Study**. A **Confirm Manager Delete** warning message will appear asking the user if you really want to delete the selected alternative. Click **Yes**, the warning message will close. The alternative will no longer appear on the table in the **Alternative and Simulation Manager** (Figure 10.9).

## Alternative Properties

The properties of an alternative include the name, description, when the alternative was modified, who created the alternative, when the alternative was created, and the file that contains the alternative data. To view the properties of an alternative:

1. From the individual alternative shortcut menu (Figure 10.11), click **Properties**. The **Properties for AlternativeName** dialog box will open (Figure 10.13).
2. For HEC-WAT Version 1.0, the properties for viewing are the name and description of the selected alternative; the date and time the alternative was last modified (not the date and time that individual models making up the simulation were last modified); the location of the alternative file; and, the name of the file which contains information about the alternative.

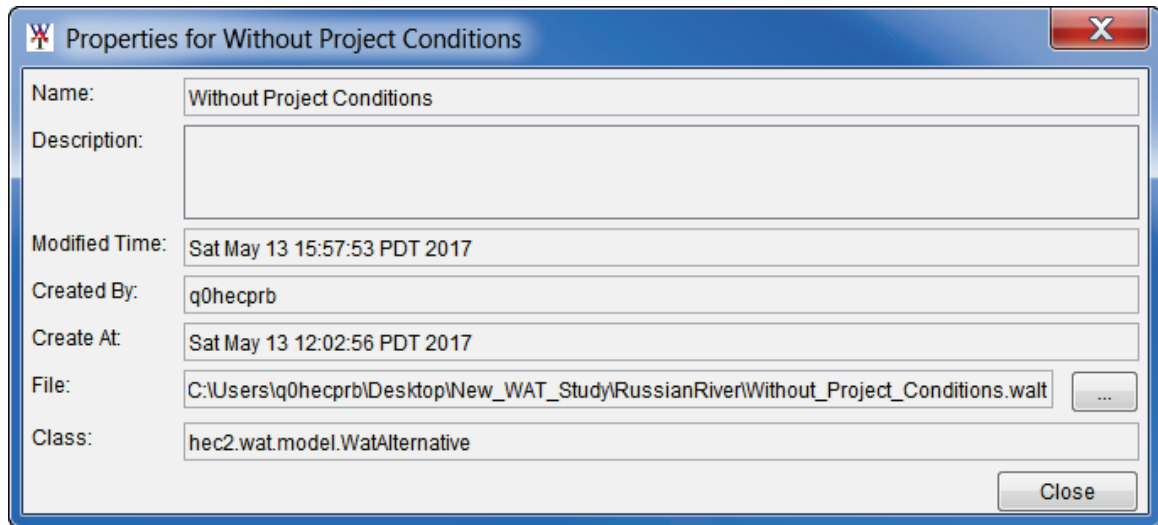



Figure 10.13 Properties for *AlternativeName* Dialog Box

### 10.3.4 Toolbar

From the toolbar of the **Alternative and Simulation Manager** (Figure 10.9), the user can create an alternative. Click , the **Create New Alternative** dialog box will open (Figure 10.5). The steps for creating an alternative are the same as in **Creating an Alternative** Section 10.3.1.

### 10.3.5 Menu Bar

From the **Menu Bar** of the **Alternative and Simulation Manager** (Figure 10.9), the user can create and delete alternatives (Sections 10.3.1 and 10.3.2).

### 10.3.6 ToolTips

From the **Alternative and Simulation Manager** (Figure 10.14) the user can review information regarding the status of certain elements of the study. For example, in Figure 10.14, hover the mouse over the alternative *Without Project Conditions*, a small box will appear, this is a tooltip. This tooltip provides the name and description of the alternative. Chapter 4, Section 4.1.5 provide details on how information is entered that a tooltip displays. By default tooltips in HEC-WAT are displayed, if the user does not want tooltips displayed, Appendix B, Section B.2.1 will provide further information.

## 10.4 Alternatives – Study Tree

The user can also create, view, save, save as, delete, and view properties of alternatives from the **Study Pane** (Study Tree). This section of the chapter describes how to perform these operations directly from the **Study Tree**.

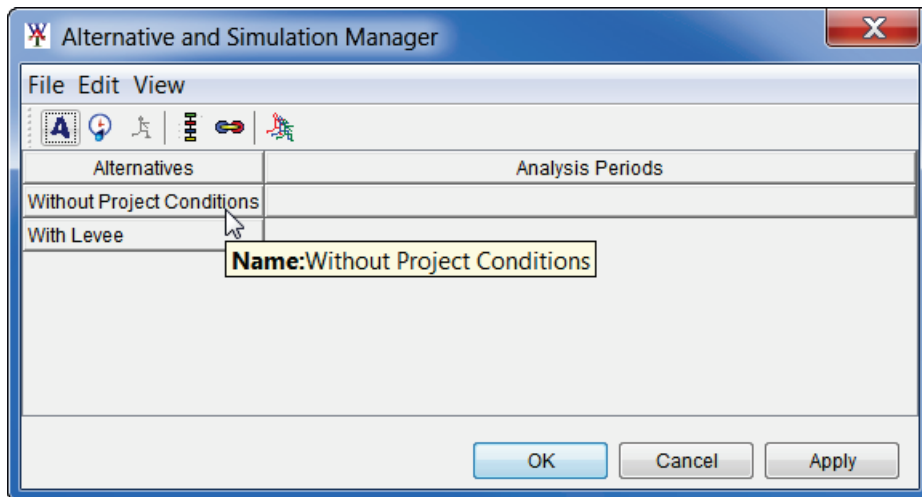


Figure 10.14 Alternative and Simulation Manager - Tooltip

### 10.4.1 Create an Alternative

1. From the HEC-WAT main window (Figure 10.3), from the **Study Tree**, right-click on the **Alternatives** folder. From the shortcut menu click **New**, the **Create New Alternative** dialog box will open (Figure 10.4).
2. The steps for creating an alternative are the same as in the **Creating an Alternative**, Section 10.3.1.

### 10.4.2 Individual Alternatives

When an alternative has been created, from the **Study Tree**, under the **Alternatives** folder, the alternatives defined for the HEC-WAT study are displayed. By right-clicking on an alternative, a shortcut menu (Figure 10.15) becomes available. From the shortcut menu the user can perform various functions on individual alternatives.

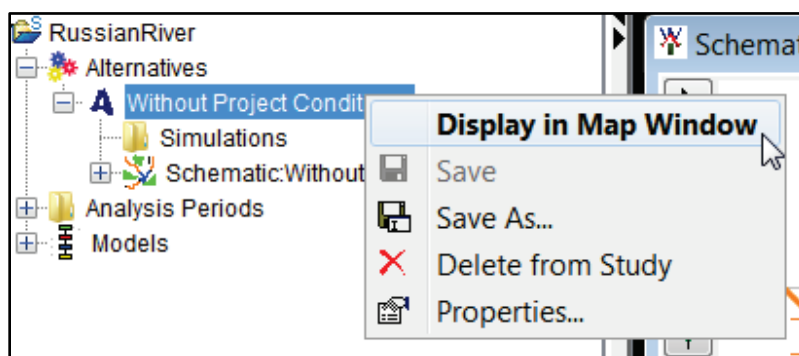


Figure 10.15 Study Tree – Individual Alternative Shortcut Menu

## View

To view an alternative in a map window:

1. From the HEC-WAT main window (Figure 10.3), from the **Study Tree**, under the **Alternatives** node, right-click an individual alternative. From the individual alternative shortcut menu (Figure 10.15), click **Display in Map Window**.
2. If there is not a map window open in the **Desktop Pane**, the alternative map window for the alternative will open in the **Desktop Pane**. From the alternative map window the user can edit the stream alignment, measures, impact areas, and adjust background maps associated with the alternative.
3. If a map window is open in the **Desktop Pane**, the **Select Map** dialog box (Figure 10.6) will open. The user can choose whether to open the alternative map window in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 10.6) will close, and the alternative map window for the selected alternative will appear in the **Desktop Pane**.

## Save

To save an alternative, from the individual alternative shortcut menu (Figure 10.15), click **Save**. Any changes that have occurred to the selected alternative will be saved by HEC-WAT.

## Save As

To make a copy from an existing alternative:

1. From the individual alternative shortcut menu (Figure 10.15), click **Save As**. The **Save Alternative As** dialog box will open (Figure 10.12). The information displayed in the dialog box represents the alternative has been selected for copying.
2. In the **Name** box, enter the name (required) of the new alternative, and in the **Description** box, enter a description (optional, but recommended).
3. The user can also choose to create a copy of the associated schematic (will create a new schematic with the new alternative name) or use the associated schematic of the alternative the user has selected to make a copy of.
4. The alternative name will now appear on the **Study Tree**, under the **Alternatives** folder (Figure 10.3).

## Delete from Study

To delete an alternative, from the individual alternative shortcut menu (Figure 10.15), click **Delete From Study**. A **Confirm Manager Delete** warning message will appear asking the user does the user really want to delete the selected alternative. Click **Yes**, the warning message will close. The alternative will no longer appear on the **Study Tree** under the **Alternatives** folder (Figure 10.3).

## Alternative Properties

The properties of an alternative include the name, description, when the alternative was modified, who created the alternative, when the alternative was created, and the file that contains the alternative data. To view the properties of an individual alternative, from the individual alternative shortcut menu (Figure 10.15), click **Properties**. The **Properties for *AlternativeName*** dialog box will open (Figure 10.13). See Section 10.3.3 for further details about alternative properties.



# CHAPTER 11


## Create and Manage Simulations

Once model alternatives have been imported, and HEC-WAT alternatives and analysis periods have been defined, the user can create an HEC-WAT simulation. A **simulation** in HEC-WAT is a combination of an analysis period and an alternative. A program order (sequence of software applications) will also need to be established. This chapter covers creating a program order (if necessary), and how to create, edit, and manage simulations.

### 11.1 Program Order

HEC-WAT provides a flexible set of software applications, computation sequence, and data flow for individual simulations. The user can establish several different program orders for one HEC-WAT study. HEC-WAT has a default program order named **Default**, which consists of HEC-HMS, HEC-ResSim, HEC-RAS and HEC-FIA.

#### 11.1.1 HEC-WAT Main Window

From the HEC-WAT main window (Figure 11.1), the user can manipulate program orders either from the **Toolbar**, click , or from the **Edit** menu, click **Program Order**. From either method, the **Program Order** dialog box will open (Figure 11.2).

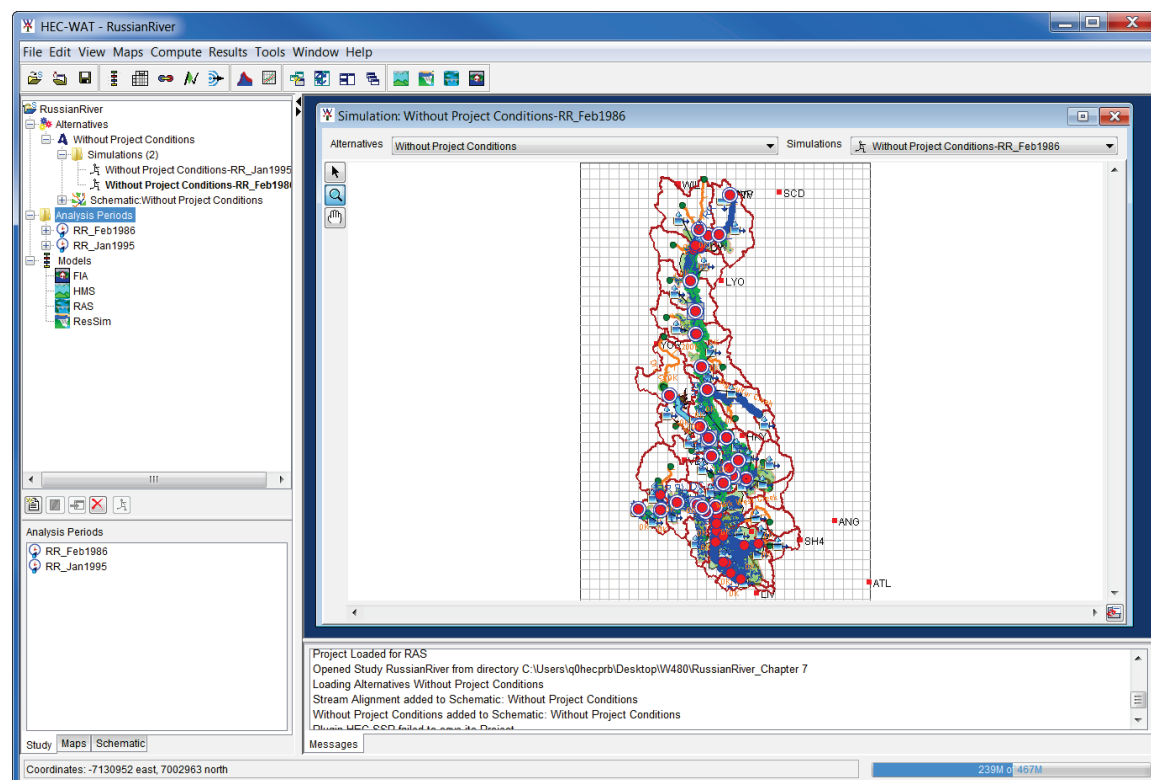


Figure 11.1 HEC-WAT Main Window

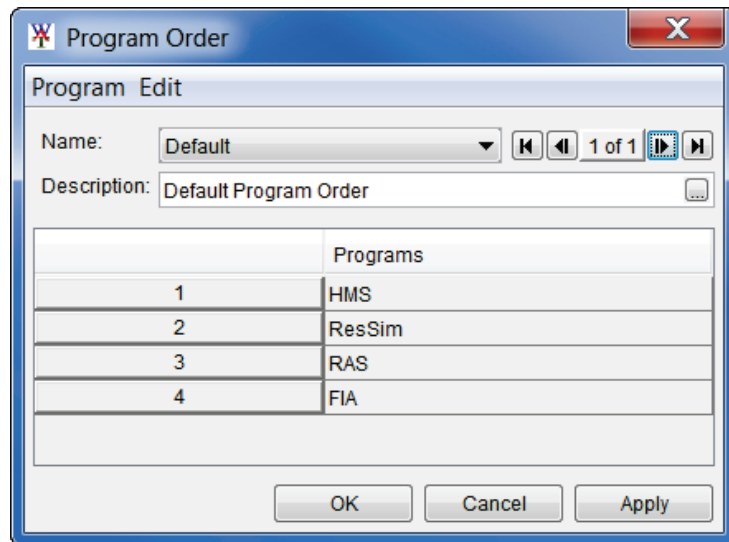


Figure 11.2 Program Order Dialog Box

### 11.1.2 Alternative and Simulation Manager

From the **Alternative and Simulation Manager** (Figure 11.3), the user can define or edit a program order either from the **Toolbar**, by clicking , or from the **Edit** menu, by clicking **Program Order**. From either method, the **Program Order** dialog box will open (Figure 11.2).

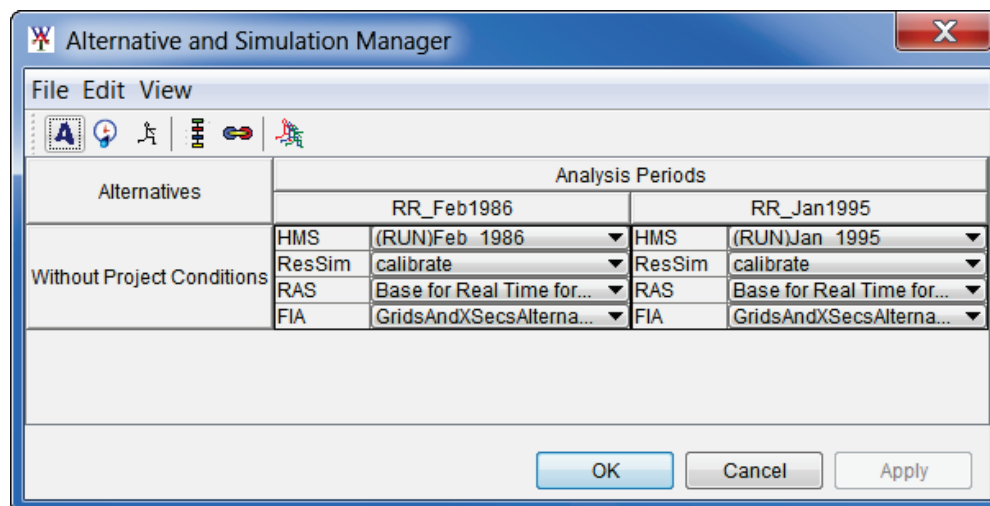
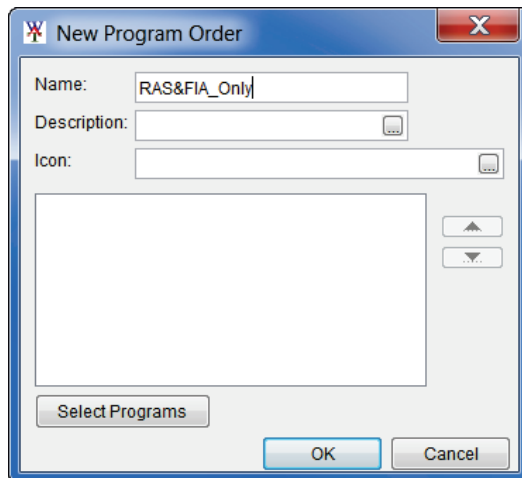


Figure 11.3 Alternative and Simulation Manager


### 11.1.3 Create a Program Order

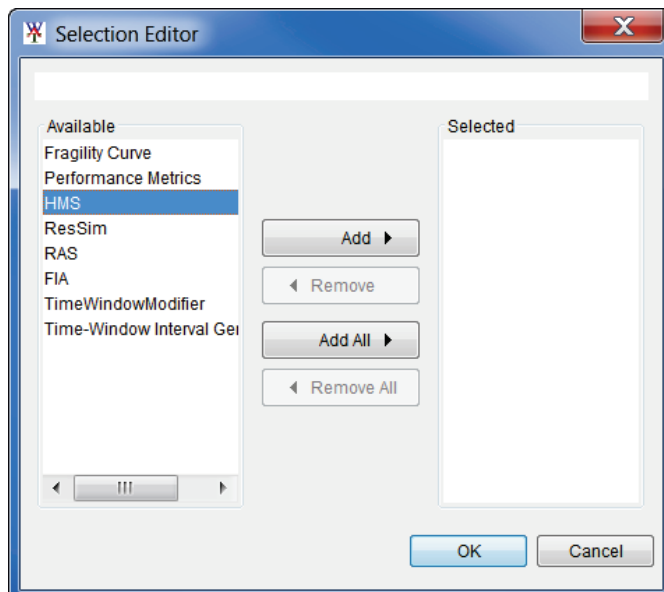
To create a program order:

1. By default, the **Default** program order is displayed in the **Program Order** dialog box (Figure 11.2). To create a new program order, from the **Program Order** dialog box, from the **Program** menu, click **New**. The **New Program Order** dialog box will open (Figure 11.4).



**Figure 11.4** New Program Order Dialog Box

2. In the **Name** box (Figure 11.4) enter a name for the program order. Optionally (but recommended), the user can provide a description in the **Description** box, and if the software application has an icon that represents the software, the user can enter the location of the icon file in the **Icon** box (Figure 11.4). The user can also browse to the location of the icon file by clicking , an **Open** browser will open. Navigate to the directory where the icon file is stored, click **Open**. The **Open** browser will close and the location of the icon file will display in the **Icon** box (Figure 11.4).
3. To select the software applications that are wanted in the program order, click **Select Programs**, the **Selection Editor** will open (Figure 11.5). From the **Available** list, select the software applications that are required for the program order. Click **Add**, the name of the selected software applications will move to the **Selected** list (Figure 11.5). Make sure to add the software applications in the order that the software applications will appear within the compute sequence. HEC-WAT will direct the applications to compute in the defined order.



**Figure 11.5** Selection Editor

4. Once all the software applications have been selected, click **OK**, the **Selection Editor** will close (Figure 11.5). On the **New Program Order** dialog box (Figure 11.4) the names of the selected software applications will appear. Click **OK**, the **New Program Order** dialog box (Figure 11.4) will close.
5. On the **Program Order** dialog box (Figure 11.2) the name of the new program order will appear in the **Name** list, and the table will display the software applications selected.

### 11.1.4 Delete a Program Order

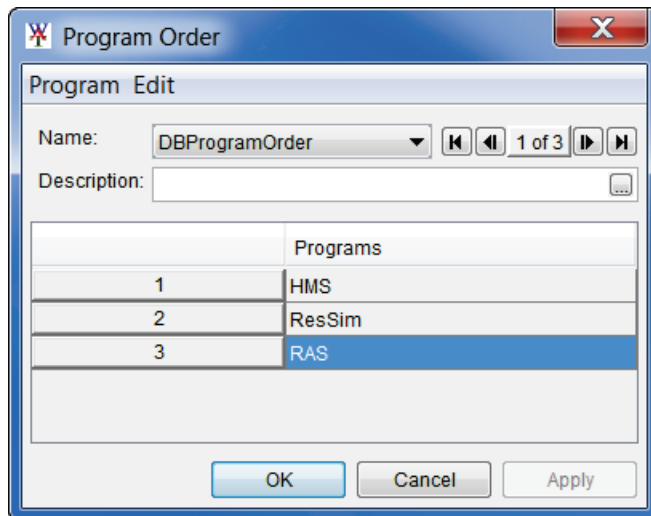
Deleting or editing a program order that is part of a simulation is not recommended. A new program order should be created and then the simulation should be edited to use the new program order. If a program order is deleted or edited that is part of a simulation, the simulation associated with that program order should be deleted and then re-created.

1. From the **Program Order** dialog box (Figure 11.2), from the **Name** list, select the program order that is to be deleted.
2. From the **Program** menu, click **Delete**. A **Confirm Deletion** window will open asking the user if the user really wants to delete this program order. Click **Yes**, the **Confirm Deletion** window will close and the selected program order is deleted.

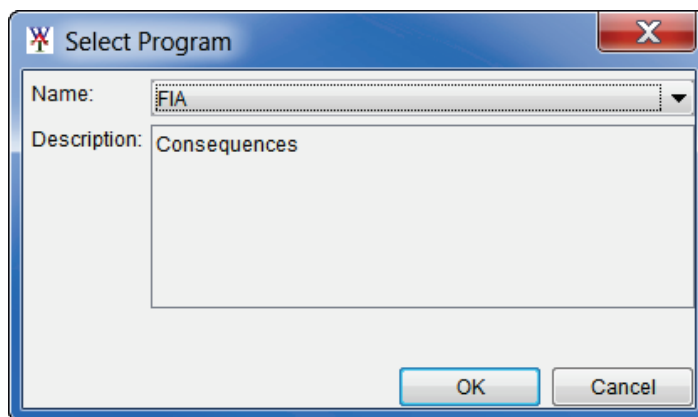
### 11.1.5 Edit a Program Order

Editing or deleting a program order that is part of a simulation is not recommended. A new program order should be created and then the simulation should be edited to use the new program order. If a program order is edited or deleted that is part of a simulation, the simulation associated with that program order should be deleted and then re-created.

1. From the **Program Order** dialog box (Figure 11.2), from the **Edit** menu, the user can insert a new software application into a program order or remove a software application from a program order.
2. To add a software application to the selected program order, select a row in the table on the **Program Order** dialog box (Figure 11.6). From the **Edit** menu, click either **Insert Before** or **Insert After**, the **Select Program** dialog box will open (Figure 11.7).
3. From the **Name** list select the software application that is to be added to the program order, click **OK**. The **Select Program** dialog box will close (Figure 11.7) and the selected software application will be added to the program order displayed on the **Program Order** dialog box (Figure 11.6). Click **Apply** to save the change.
4. To remove a software application from the program order, select a row in the table on the **Program Order** dialog box (11.6). From the **Edit** menu, click **Remove**. A **Confirm Removal** window will open, checking with the user to be sure that the selected software application is to be removed, click **Yes**. The **Confirm Removal** window will close, the



**Figure 11.6** Program Order Dialog Box – Software Application Selected




**Figure 11.7** Select Program Dialog Box

selected software application no longer is displayed in the table. Click **Apply** (Figure 11.6) to save the change.

5. A **Confirm Save** window will open, letting the user know that making a change to a program order that is already being used in an existing simulation will affect that simulation, click **Yes**. The **Confirm Save** window closes, and the change is saved to the selected program order.

## 11.2 Simulations – Alternative and Simulation Manager

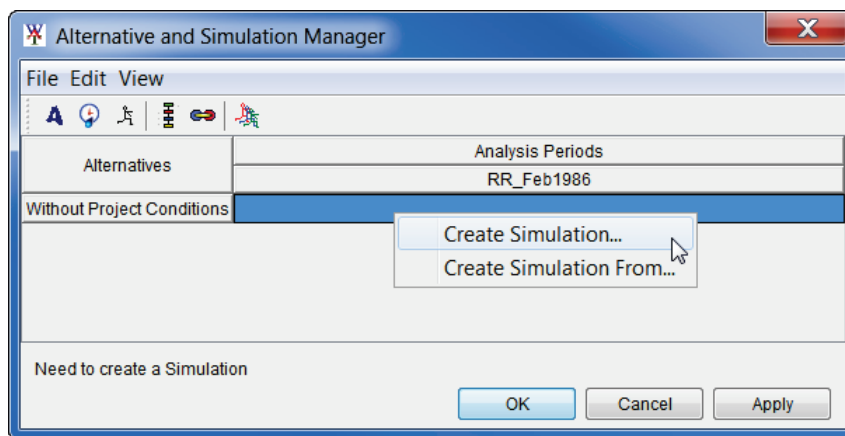
In HEC-WAT, the **Alternative and Simulation Manager** (Figure 11. 3) provides a convenient way to organize and develop the main components for an HEC-WAT study – alternatives, analysis period (time window), and simulations. From the table on the **Alternative and Simulation Manager** (Figure 11.3) the user can organize a study's alternatives; a way to track the state of datasets needed for each model alternative; create analysis periods (time windows; Chapter 9); and, create simulations. Since the focus of this chapter is simulations, the focus of this section will only be on the available commands from the table to develop and organize simulations.

To access the **Alternative and Simulation Manager**, from the HEC-WAT main window (Figure 11.1), from the **WAT Tools** toolbar (Chapter 3, Section 3.2.1), click ; or, from the **Edit** menu, click **Alternative and Simulation Manager**. From either method the **Alternative and Simulation Manager** will open (Figure 11.3).

### 11.2.1 Create a Simulation - Table

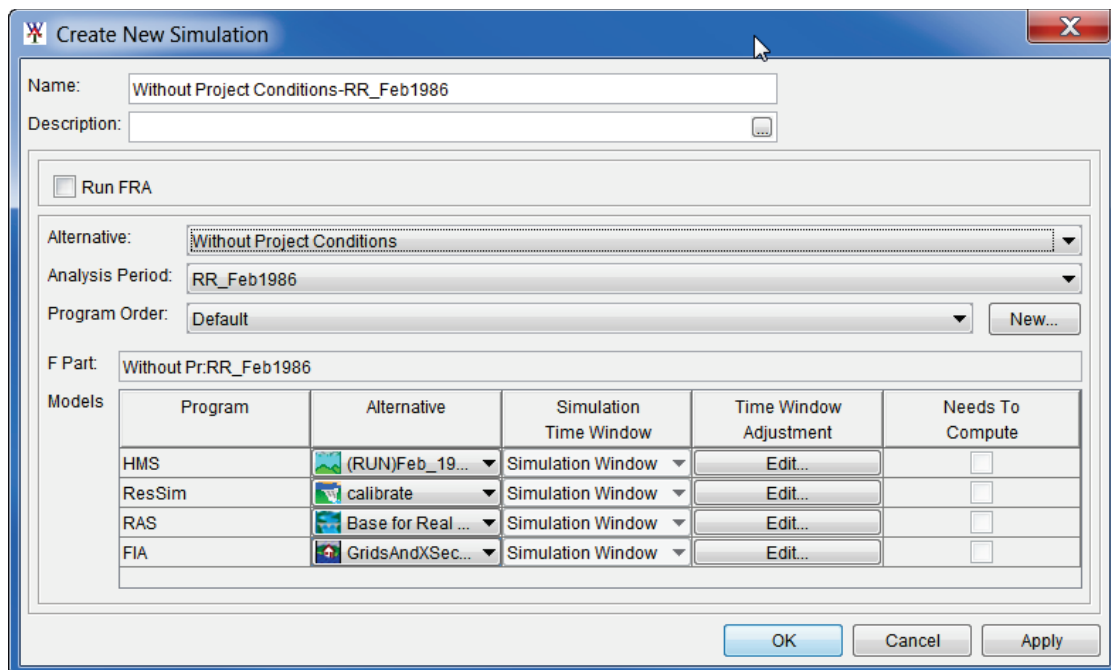
In the table, when an intersection is blank, the user can create a simulation:

1. From the **Alternative and Simulation Manager** (Figure 11.8), from the table, right-click on the intersection of an alternative and analysis period (blank). From the shortcut menu click **Create Simulation**. The **Create New Simulation** dialog box will open (Figure 11.9).







**Figure 11.8** Alternative and Simulation Manager - Table

2. HEC-WAT has defined a default name for the simulation (e.g., *Without Project Conditions-RR\_Feb1986*) in the **Name** box (Figure 11.9). The name is a combination of the HEC-WAT alternative name and analysis period name, where the intersection was in the table (name can be changed). Also, in the **Alternative** and **Analysis Period** lists (Figure 11.9) the selections have already been made based on the intersection in the table. The selected **Alternative** cannot be changed, but the selected **Analysis Period** can be changed.
3. The program order is *Default*.
4. In the **F Part** box (Figure 11.9), a DSS F-Part is displayed that was generated by HEC-WAT based on the alternative and analysis period names.
5. In the **Programs** table (Figure 11.9), the software applications that were defined in the program order appear in the order the software applications were selected. Now the user must select the appropriate alternative (i.e., plan, run) for each software application. From the **Alternative** column, for example, from the list for **HMS** (Figure 11.10), select the appropriate HEC-HMS run (*(RUN)Feb\_1986*). Repeat the process for the other software applications.

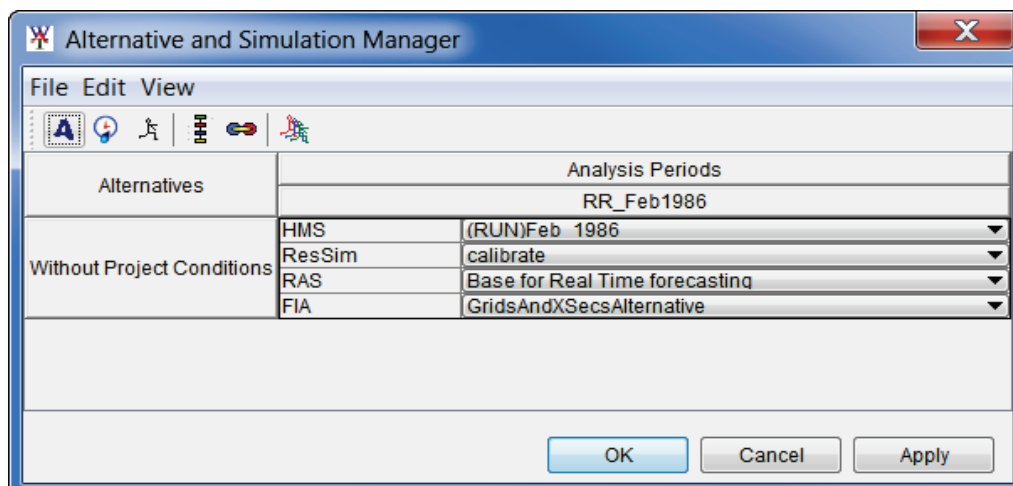


**Figure 11.9** Create New Simulation Dialog Box

Models	Program	Alternative	Simulation Time Window	Time Window Adjustment	Needs To Compute
	HMS	 (RUN)Feb_1986 ▾	Simulation Window ▾	<input type="button" value="Edit..."/>	
	ResSim	 calibrate ▾	Simulation Window ▾	<input type="button" value="Edit..."/>	
	RAS	 Base for Real Time forecasting ▾	Simulation Window ▾	<input type="button" value="Edit..."/>	
	FIA	 GridsAndXSecsAlternative ▾	Simulation Window ▾	<input type="button" value="Edit..."/>	

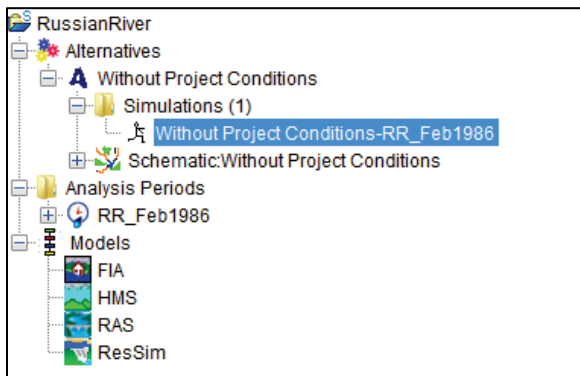
**Figure 11.10** Selection of Model Alternatives - Create New Simulation Dialog Box

- Now that all of the alternatives have been selected, click **OK**. The **Create New Simulation** dialog box will close (Figure 11.9). On the **Alternative and Simulation Manager** (Figure 11.11), the intersection of the alternative and analysis period now provides information about the simulation.



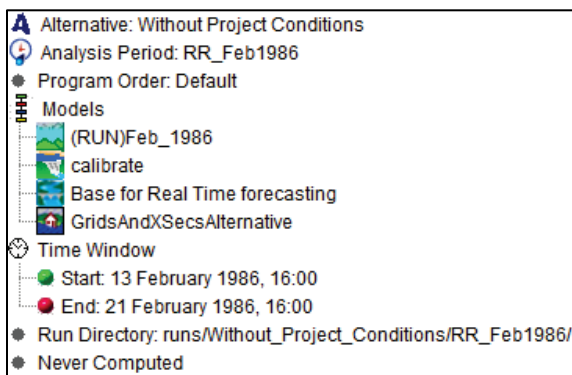
**Figure 11.11** Alternative and Simulation Manager - Completed Simulation

- Click **OK**; the **Alternative and Simulation Manager** will close (Figure 11.11). From the HEC-WAT main window (Figure 11.1), the created simulation appears on the **Study Tree**, under the **Simulations** folder (Figure 11.12).



**Figure 11.12** Study Tree with Created Simulation

- The **Content Pane** (Figure 11.13) displays information about the selected simulation.



**Figure 11.13** Content Pane

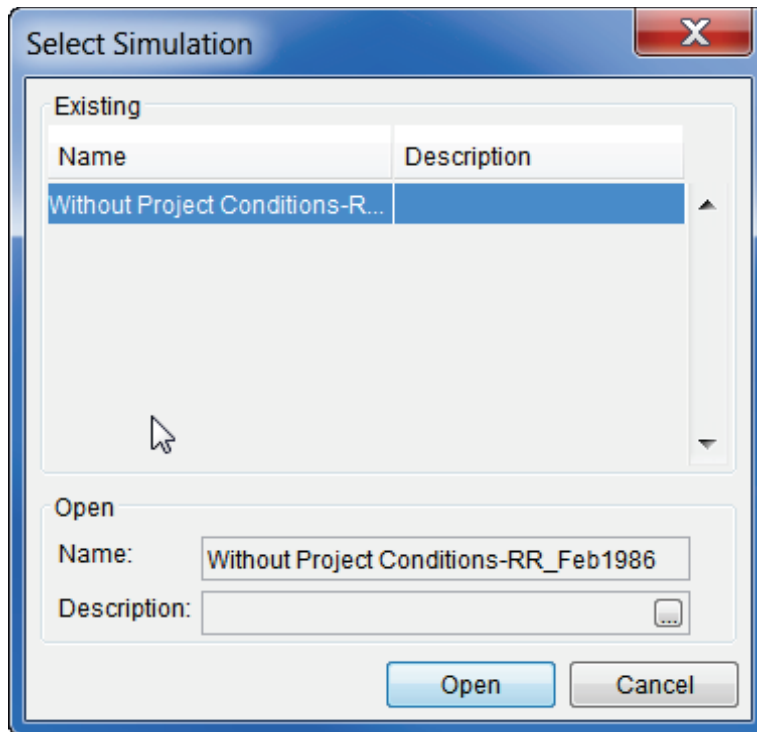
- Double click on the simulation name (e.g., *Without Project Conditions-RR\_Feb1986*), a **Select Map** dialog box will open. Click **New Map Window**, click **OK**. The **Select Map** dialog box will close. The new map window will contain the schematic elements that represent the simulation (Figure 11.1).

## 11.2.2 Create a Simulation - From another Simulation - Table

In the table, when an intersection is blank, the user can create a simulation from another simulation:

- From the **Alternative and Simulation Manager** (Figure 11.8), from the table, right-click on the intersection of an alternative and analysis period (blank). From the shortcut menu click **Create Simulation From**.
- The **Select Simulation** selector will open (Figure 11.14). From the **Existing** box, select a simulation, the name of the simulation will appear in the **Name** box. Click **Open**, the






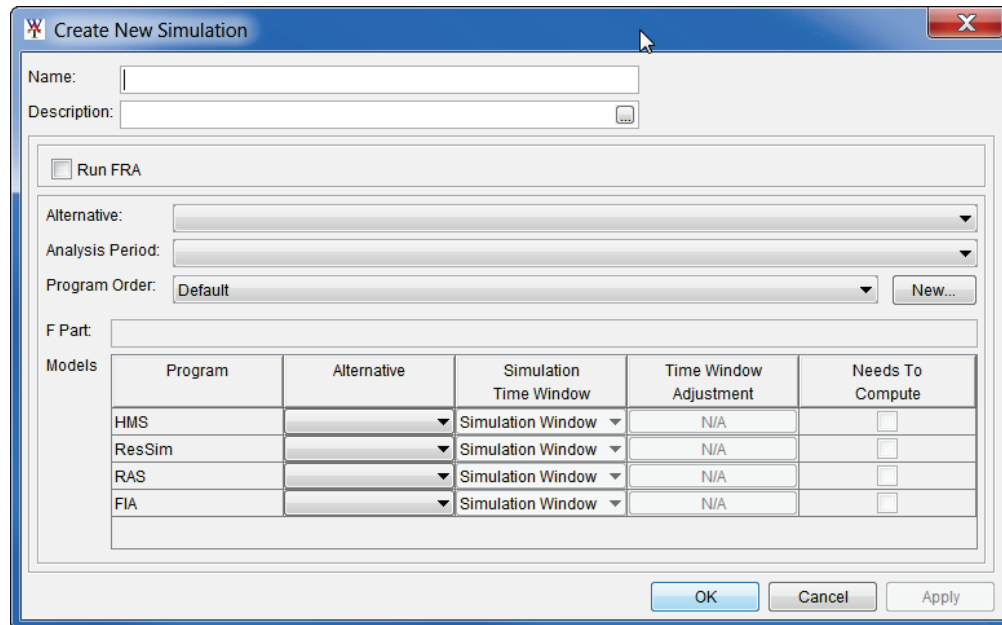
**Figure 11.14** Select Simulation Selector

**Select Simulation** selector will close (Figure 11.14) and the **Create New Simulation** dialog box will open (Figure 11.9).

3. HEC-WAT has defined a default name for the simulation (e.g., *Without Project Conditions-RR\_Jan1986*) in the **Name** box (Figure 11.9). The name is a combination of the HEC-WAT alternative name and analysis period name, where the intersection was in the table (name can be changed). Also, in the **Alternative** and **Analysis Period** lists (Figure 11.9) the selections have already been made based on the intersection in the table. The selected **Alternative** cannot be changed, but the selected **Analysis Period** can be changed.
4. The program order is *Default*.
5. In the **F Part** box (Figure 11.9), a DSS F-Part is displayed that was generated by HEC-WAT based on the alternative and analysis period names.
6. In the **Programs** table (Figure 11.9), the software applications that were defined in the program order appear in the order the software applications were selected. The model alternative (i.e., plan, run) for each software application that was created for the simulation that was being copied from is displayed. The user can make adjustments if warranted for this new simulation.
7. Now that all of the model alternatives have been selected, click **OK**. The **Create New Simulation** dialog box will close (Figure 11.9). On the **Alternative and Simulation Manager** (Figure 11.11), the intersection of the alternative and analysis period now provides information about the simulation.

### 11.2.3 Create a Simulation - Toolbar

From the **Alternative and Simulation Manager** (Figure 11.11), from the **Toolbar**, click , the **Create New Simulation** dialog box will open (Figure 11.15).



The dialog box titled "Create New Simulation" contains the following fields and controls:

- Name:** A text input field.
- Description:** A text input field with a help icon.
- Run FRA:** A checkbox.
- Alternative:** A dropdown menu.
- Analysis Period:** A dropdown menu.
- Program Order:** A dropdown menu set to "Default" and a "New..." button.
- F Part:** A text input field.
- Models Table:**

Program	Alternative	Simulation Time Window	Time Window Adjustment	Needs To Compute
HMS	▼	Simulation Window ▼	N/A	<input type="checkbox"/>
ResSim	▼	Simulation Window ▼	N/A	<input type="checkbox"/>
RAS	▼	Simulation Window ▼	N/A	<input type="checkbox"/>
FIA	▼	Simulation Window ▼	N/A	<input type="checkbox"/>
- Buttons:** OK, Cancel, and Apply.

**Figure 11.15** Create New Simulation Dialog Box - Blank

1. The **Create New Simulation** dialog box (Figure 11.15) is blank (when created from the table most of the information about a simulation is known). The user must enter a name in the **Name** box. The user can enter an optional description in the **Description** box.
2. From the **Alternative** list (Figure 11.15) select the HEC-WAT alternative that the user wants to analyze.
3. From the **Analysis Period** list select the analysis period that represents the time window for the analysis.
4. From the **Program Order** list, *Default* has already been selected. If there is another program order that the user wants to use, then from the **Program Order** list, select the appropriate program order. The user can also create a new program order by clicking **New** (Figure 11.15). The **New Program Order** dialog box will open (Figure 11.4); follow the instructions in Section 11.1.3 for creating a program order.
5. Once an analysis period is selected, HEC-WAT builds a default DSS F-Part based on the alternative and analysis period selected.
6. In the **Programs** table (Figure 11.15), the software applications that were defined in the program order appear in the order the software applications were selected. Now the user must select the appropriate model alternative (i.e., plan, run) for each program. From the **Alternative** column, for example, from the list for **HMS** (Figure 11.10), select the

appropriate HEC-HMS run ((*RUN*)Feb\_1986). Repeat the process for the other software applications.

7. Now that all of the model alternatives have been selected, click **OK**. The **Create New Simulation** dialog box will close (Figure 11.15). On the **Alternative and Simulation Manager** (Figure 11.11), the intersection of the alternative and analysis period now provides information about the simulation.
8. Click **OK**; the **Alternative and Simulation Manager** will close (Figure 11.11). From the HEC-WAT main window (Figure 11.1), the created simulation appears on the **Study Tree**, under the **Simulations** folder (Figure 11.12).
9. The **Content Pane** (Figure 11.13) displays information about the selected simulation.
10. Double click on the simulation name (*Without Project Conditions-RR\_Feb1986*), a **Select Map** dialog box will open. Click **New Map Window**, click **OK**. The **Select Map** dialog box will close. The new map window will contain the schematic elements that represent the simulation (Figure 11.1).

## 11.2.4 Create a Simulation – File Menu

From the **Alternative and Simulation Manager** (Figure 11.3), from the **File** menu, point to **Simulation**, click **New**, the **Create New Simulation** dialog box will open (Figure 11.15). The instructions for creating a simulation are the same as described in Section 11.2.2.

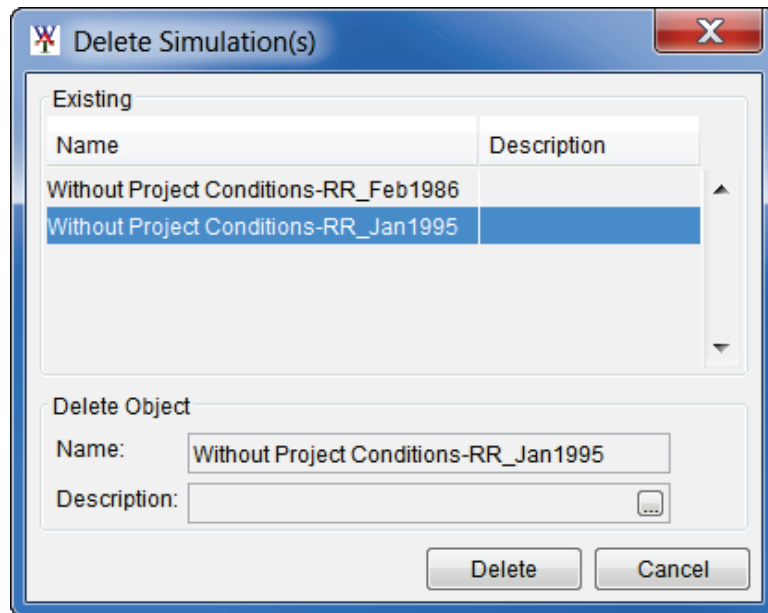
## 11.2.5 Delete Simulation(s)

To delete simulation(s) from a study:

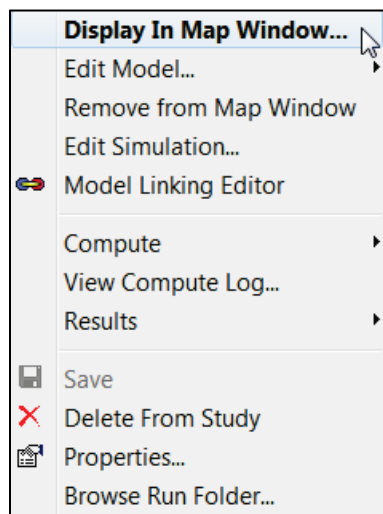
1. From the **Alternative and Simulation Manager** (Figure 11.3), from the **File** menu, point to **Simulation**, click **Delete from Study**, the **Delete Simulation(s)** dialog box will open (Figure 11.16).
2. From the **Existing** list select simulation(s), in the **Delete** box the name(s) and descriptions of the selected simulation(s) will appear.
3. Click **Delete**, a warning message will appear asking the user if the user really wants to delete the selected simulation(s). Click **Yes**, the warning message will close and the **Delete Simulations(s)** dialog box will close (Figure 11.16) and the simulation(s) will no longer appear under the **Simulation** column of the table (Figure 11.11).

## 11.2.6 Individual Simulation Shortcut Menu - Table

The individual simulation shortcut menu (Figure 11.17) is available from the **Alternative and Simulation Manager** (Figure 11.11) by right-clicking on a simulation in the table. This shortcut menu will allow the user to view the selected simulation in a map window; edit the model alternatives associated with the selected simulation; remove the simulation map window; edit the



**Figure 11.16** Delete Simulation(s) Dialog Box



**Figure 11.17** Individual Simulation Shortcut Menu

active simulation; open the **Model Linking Editor** (Chapter 12); compute; view the log of the compute; view results; save changes to the simulation; delete the simulation from the study; view the properties of the simulation; and, browse the run folder associated with the active simulation. The following sections provide further details on these capabilities from the individual simulation shortcut menu (Figure 11.17).

## View a Simulation

To view a simulation in a map window:

1. From the individual simulation shortcut menu (Figure 11.17), click **Display in Map Window**.

2. If there is not a map window open in the **Desktop Pane** (Chapter 3, Section 3.2.2), the simulation map window for the simulation will open in the **Desktop Pane**. From the simulation map window the user can edit the stream alignment, view model alternative results, and edit model alternatives that are associated with a simulation.
3. If a map window is open in the **Desktop Pane** (Chapter 3, Section 3.2.2), the **Select Map** dialog box (Figure 11.18) will open. The user can choose whether to open the simulation map window in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 11.18) will close, and the simulation map window for the selected simulation will appear in the **Desktop Pane**.

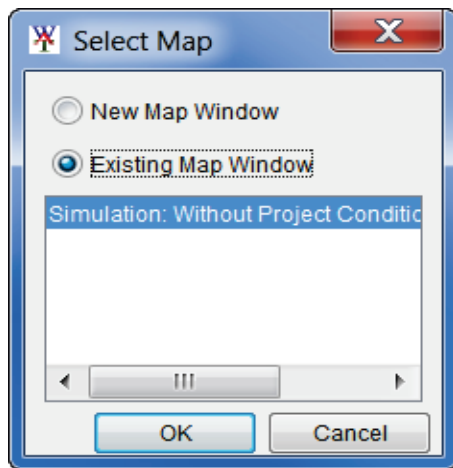


Figure 11.18 Select Map Dialog Box

## Edit the Model Alternatives of a Simulation

To edit the model alternatives associated with a simulation:

1. From the individual simulation shortcut menu (Figure 11.17), point to **Edit Model**, from the sub-menu (Figure 11.19) click on the model alternative that needs to be edited.

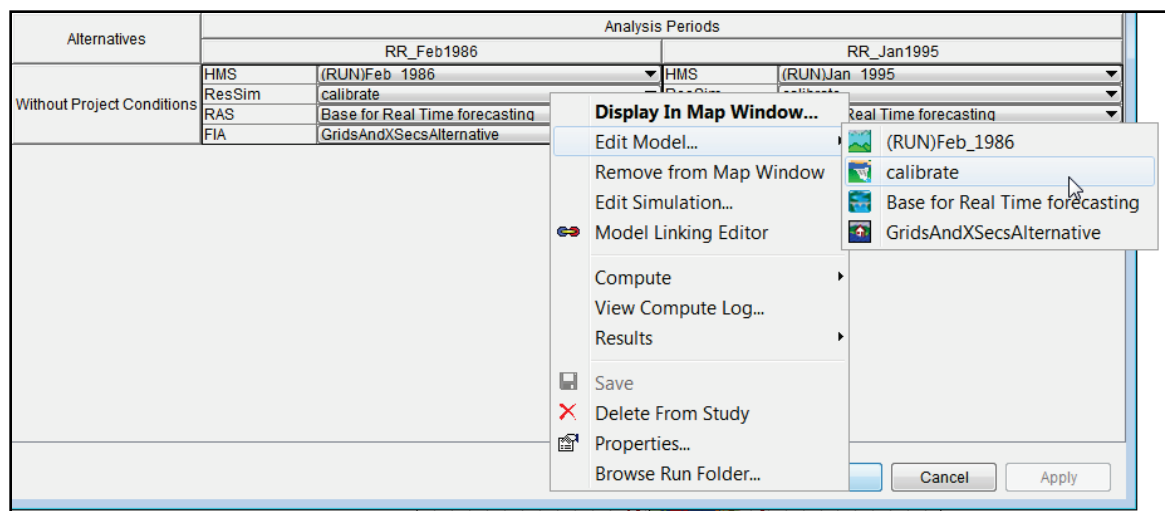


Figure 11.19 Editing a Model Alternative

2. The user must expand the **Alternative and Simulation Manager** (Figure 11.8) so that the length of the individual simulation shortcut menu fits within the manager.
3. The program associated with the model alternative that was selected will open. For example, in Figure 11.19, if the model alternative *calibrate* is selected, the HEC-ResSim software will open with the *calibrate* alternative selected.
4. The user can now make changes to the selected model alternative, save, and close the program associated with the model alternative. For further details on the individual program editors, see Appendix L.

## Remove a Simulation from the Active Map Window

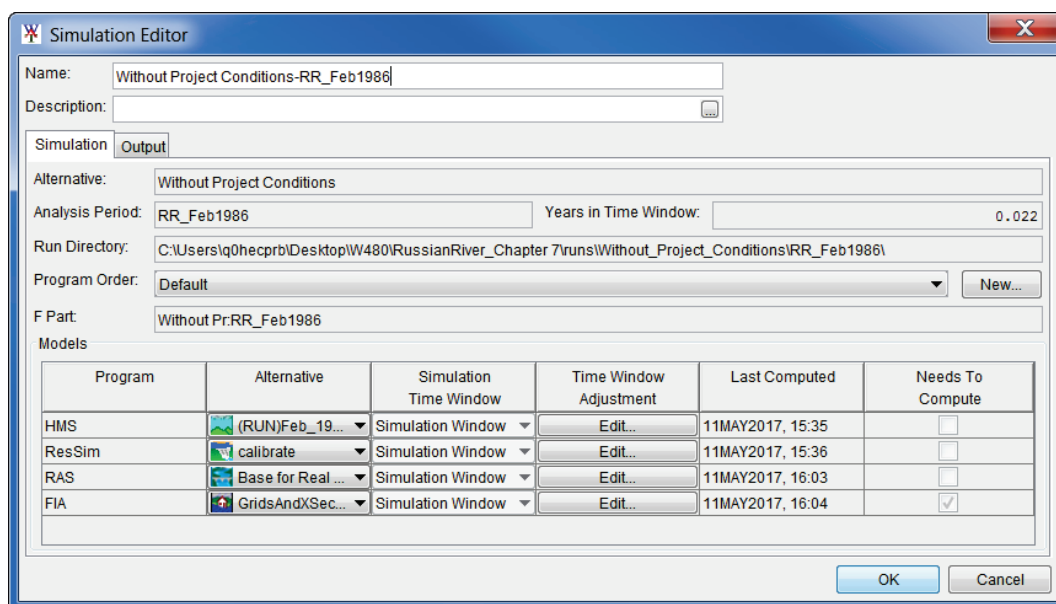
To remove a simulation from the active map window:

1. From the individual simulation shortcut menu (Figure 11.17), click **Remove from Map Window**.
2. The **Remove from Map?** message box will open asking the user if the user really wants to remove the simulation from the active map window, click **Yes**. The message box will close, and the map window will no longer display the simulation.

## Edit a Simulation

To edit a simulation:

1. From the individual simulation shortcut menu (Figure 11.17), click **Edit Simulation**. The **Simulation Editor** will open (Figure 11.20).



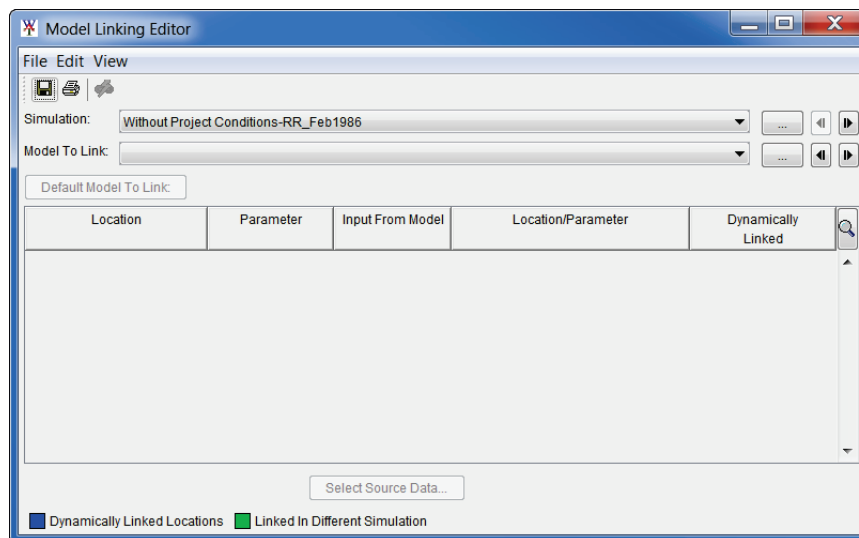
**Figure 11.20** Simulation Editor

2. The user can edit the name and the description of the simulation. The editor also provides the user with information on what HEC-WAT alternative and analysis period are associated with the simulation. The editor also provides information on what model alternatives are currently being computed for the simulation. The user can change the model alternatives and setup time window adjustments (Chapter 9) for each model alternative.
3. Click **OK**, the **Simulation Editor** will close (Figure 11.20) and the information changed will be saved.

## Model Linking Editor

Opening the **Model Linking Editor** (Chapter 12):

1. From the individual simulation shortcut menu (Figure 11.17), click **Model Linking Editor**. The **Model Linking Editor** will open (Figure 11.21).



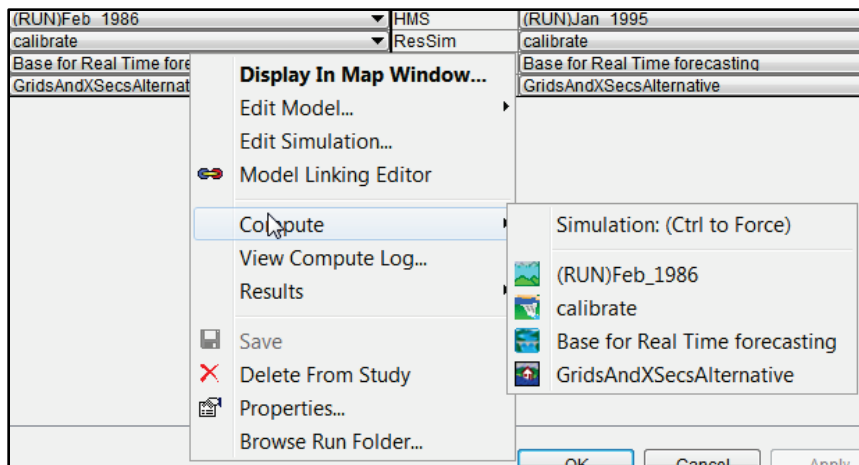
**Figure 11.21** Model Linking Editor

2. The **Model Linking Editor** provides the user with the capability of setting up or changing the linking between the model alternatives of the selected simulation. Further details on the **Model Linking Editor** are provided in Chapter 12.
3. From the **File** menu (Figure 11.21), click **Close**. The **Model Linking Editor** will close (Figure 11.21) and the information changed will be saved.

## Compute a Simulation

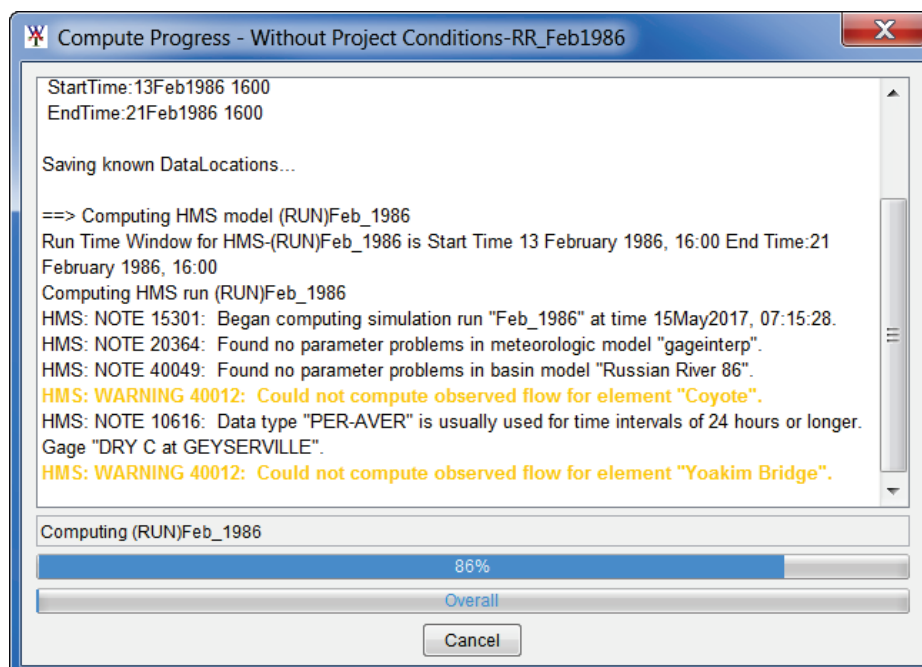
To compute a simulation (deterministic):

1. From the individual simulation shortcut menu (Figure 11.17), point to **Compute**, from the sub-menu (Figure 11.22) the user can compute the entire simulation or compute individual models.



**Figure 11.22** Individual Simulation Shortcut Menu - Compute

2. The user must expand the **Alternative and Simulation Manager** (Figure 11.8) so that the length of the individual simulation shortcut menu fits within the manager.
3. To compute the simulation, hold down the **CTRL** key, click **Simulation** (Figure 11.22)
4. The **Compute Progress** dialog box will open (Figure 11.23) and the compute will begin. From this dialog box the user can view which model alternative is computing for the simulation and information from each model is displayed in the **Compute Progress** dialog box.



**Figure 11.23** Compute Progress Dialog Box

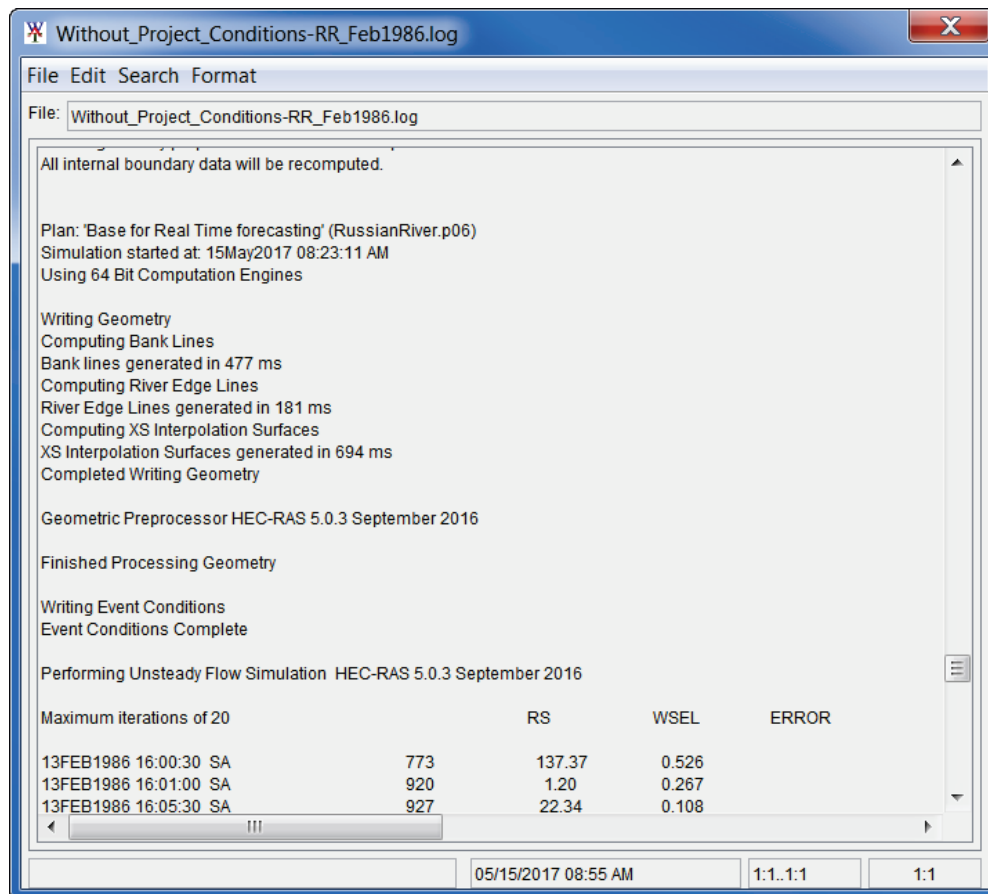
5. When the compute is finished click **Close**, the **Compute Progress** dialog box (Figure 11.23) will close.



## View the Compute Log of a Simulation

To view the compute log of a simulation:

1. From the individual simulation shortcut menu (Figure 11.17), click **View Compute Log**. The *SimulationName.log Editor* will open (Figure 11.24).



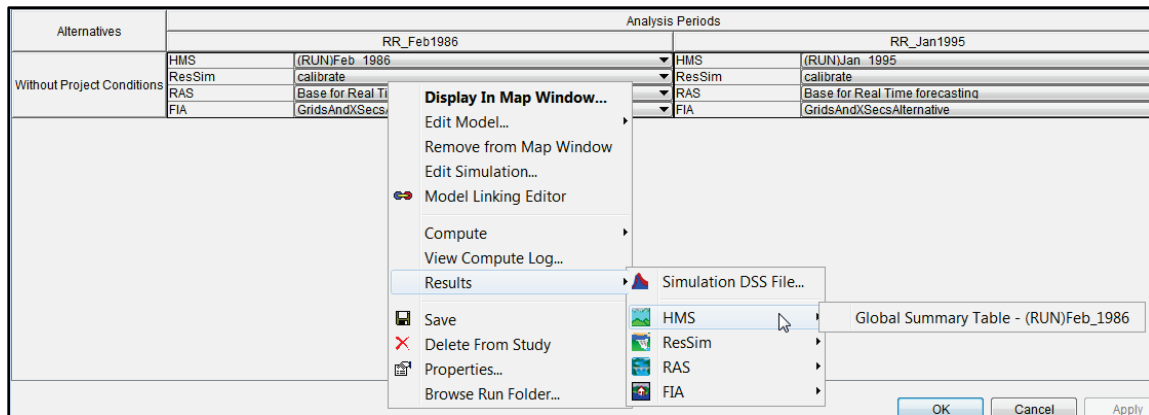
**Figure 11.24** *SimulationName.log* Editor

2. This editor contains information regarding the compute for the selected simulation. This information is provided by each individual software application that was part of the compute.
3. When the compute is finished click **Close**, the *SimulationName.log Editor* (Figure 11.24) will close.

## Simulation Results

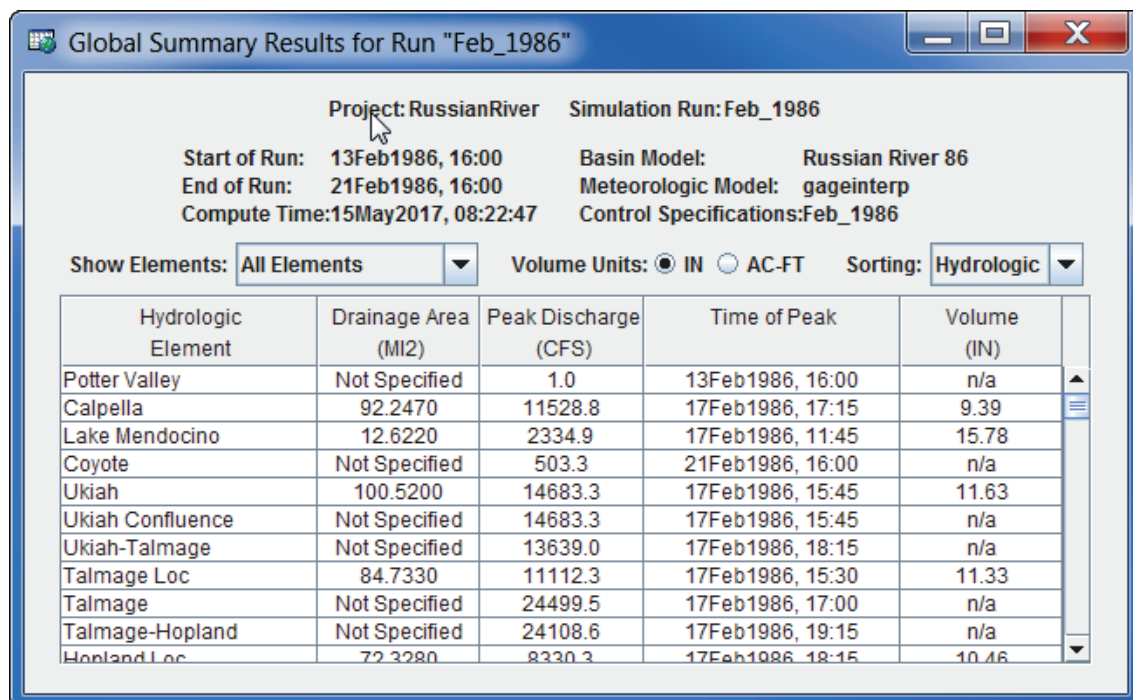
To view results for a simulation (deterministic):

1. From the individual simulation shortcut menu (Figure 11.17), point to **Results**, from the sub-menu (Figure 11.25) the user can view results from the individual models and review the DSS file associated with the simulation.



**Figure 11.25** Individual Simulation Shortcut Menu – Results

2. The user must expand the **Alternative and Simulation Manager** (Figure 11.8) so that the length of the individual simulation shortcut menu fits within the manager.
3. Point to the individual software application that the user wants to display results. For example, in Figure 11.25, if the software application **HMS** is selected, a list of available outputs from the HEC-HMS software are listed. Click **Global Summary Table**, the **Global Summary Results** dialog box will open (Figure 11.26).



**Figure 11.26** HEC-HMS Results – Global Summary Results

## Save a Simulation

To save a simulation, from the individual simulation shortcut menu (Figure 11. 17), click **Save**. Any changes that have occurred to the selected simulation will be saved by HEC-WAT.

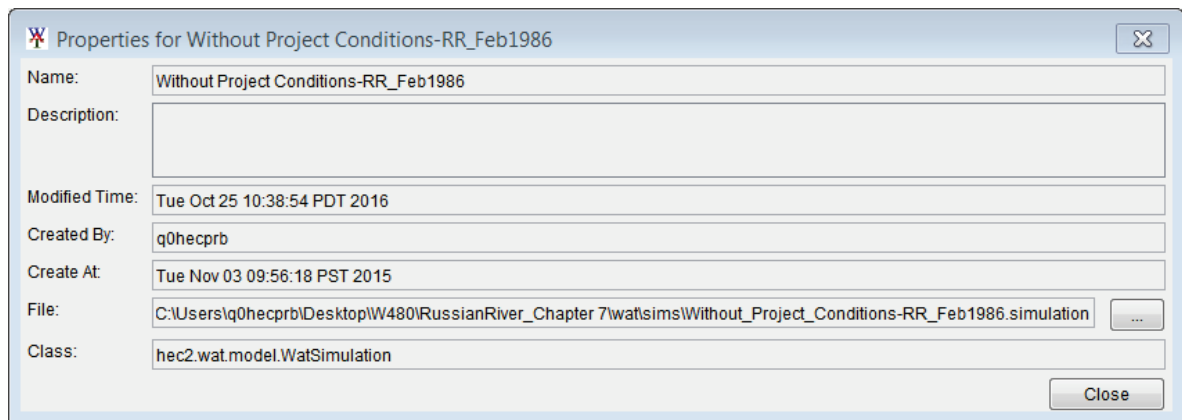
## Delete a Simulation

To delete a simulation, right-click on a simulation in the table, from the individual simulation shortcut menu (Figure 11. 17), click **Delete From Study**. A warning message will appear asking the user if the user really wants to delete the selected simulation. Click **Yes**, the intersection of the alternative and analysis period/event that the simulation was associated with will now be blank in table in the **Alternative and Simulation Manager** (Figure 11.11).

## Simulation Information

To view information about a simulation:

1. From the individual simulation shortcut menu (Figure 11. 17), click **Properties**. The **Properties for SimulationName** dialog box will open (Figure 11.27).



**Figure 11.27** Properties for *SimulationName* Dialog Box

2. From this dialog box the user can view information about the selected simulation – name of simulation; description; date simulation was last modified; who created the simulation; date simulation was created; and the location of the simulation file.
3. Click **Close**, the **Properties for SimulationName** dialog box (Figure 11.27) will close.

## Browse Run Folder

This command takes the user to the location of the results that are generated by HEC-WAT when a simulation is computed. The user can view the *simulation.dss* file using HEC-DSSVue from this location; and, if the model folders have been saved the user can view results for the individual models from HEC-RAS, HEC-ResSim, or HEC-FIA if necessary from this location.

## 11.3 Simulations – Study Tree

The user can also create simulations; delete individual and multiple simulations; save, view, edit, and compute simulations. This section of the chapter describes how to perform these operations directly from the **Study Tree**.

### 11.3.1 Create a Simulation

If there are no simulations in the study, from the HEC-WAT main window (Figure 11.1), from the **Study Tree**, right-click on the **Simulations** folder. From the shortcut menu click **New**, the **Create New Simulation** dialog box will open (Figure 11.15). The instructions for creating a simulation are the same as described in Section 11.2.2.

### 11.3.2 Delete Simulation(s)

To delete simulation(s) from a study:

1. From the HEC-WAT main window (Figure 11.1), from the **Study Tree**, right-click on the **Simulations** folder. From the shortcut menu click **Delete from Study**, the **Delete Simulation(s)** dialog box will open (Figure 11.16).
2. From the **Existing** list select simulation(s), in the **Delete** box the name(s) and descriptions of the selected simulation(s) will appear.
3. Click **Delete**, a warning message will appear asking the user if the user really wants to delete the selected simulation(s). Click **Yes**, the warning message will close and the **Delete Simulations(s)** dialog box will close (Figure 11.16) and the simulation(s) will no longer appear under the **Simulation** folder of the **Study Tree**.

### 11.3.3 Individual Simulation Shortcut Menu

The individual simulation shortcut menu (Figure 11.14) is available from the **Study Tree** (Figure 11.11), by right-clicking on a simulation under the **Simulations** folder. This shortcut menu will allow the user to view the selected simulation in a map window; edit the model alternatives associated with the selected simulation; remove the simulation map window; edit the active simulation; open the **Model Linking Editor** (Chapter 12); compute; view the log of the compute; view results; save changes to the simulation; delete the simulation from the study; view the properties of the simulation; and, browse the run folder associated with the active simulation. The following sections provide further details on these capabilities from the individual simulation shortcut menu (Figure 11.17).

#### View a Simulation

To view a simulation in a map window:

1. From the individual simulation shortcut menu (Figure 11.17), click **Display in Map Window**.
2. If there is not a map window open in the **Desktop Pane** (Chapter 3, Section 3.2.2), the simulation map window for the simulation will open in the **Desktop Pane**. From the

simulation map window the user can edit the stream alignment, view model alternative results, and edit model alternatives that are associated with a simulation.

3. If a map window is open in the **Desktop Pane** (Chapter 3, Section 3.2.2), the **Select Map** dialog box (Figure 11.18) will open. The user can choose whether to open the simulation map window in the current map window or in a new map window, click **OK**. The **Select Map** dialog box (Figure 11.18) will close, and the simulation map window for the selected simulation will appear in the **Desktop Pane**.

## Edit the Model Alternatives of a Simulation

To edit the model alternatives associated with a simulation:

1. From the individual simulation shortcut menu (Figure 11.17), point to **Edit Model**, from the sub-menu (Figure 11.20) click on the model alternative that needs to be edited.
2. The user must expand the **Alternative and Simulation Manager** (Figure 11.8) so that the length of the individual simulation shortcut menu fits within the manager.
3. The program associated with the model alternative that was selected will open. For example, in Figure 11.19, if the model alternative *calibrate* is selected, the HEC-ResSim software will open with the *calibrate* alternative selected.
4. The user can now make changes to the selected model alternative, save, and close the program associated with the model alternative. For further details on the individual program editors, see Appendix L.

## Remove a Simulation from the Active Map Window

To remove a simulation from the active map window:

1. From the individual simulation shortcut menu (Figure 11.17), click **Remove from Map Window**.
2. The **Remove from Map?** message box will open asking the user if the user really wants to remove the simulation from the active map window, click **Yes**. The message box will close, and the map window will no longer display the simulation.

## Edit a Simulation

To edit a simulation:

1. From the individual simulation shortcut menu (Figure 11.17), click **Edit Simulation**. The **Simulation Editor** will open (Figure 11.20).
2. The user can edit the name and the description of the simulation. The editor also provides the user with information on what HEC-WAT alternative and analysis period are

associated with the simulation. The editor also provides information on what model alternatives are currently being computed for the simulation. The user can change the model alternatives and setup time window adjustments (Chapter 9) for each model alternative.

3. Click **OK**, the **Simulation Editor** will close (Figure 11.20) and the information changed will be saved.

## Model Linking Editor

Opening the **Model Linking Editor** (Chapter 12):

1. From the individual simulation shortcut menu (Figure 11.17), click **Model Linking Editor**. The **Model Linking Editor** will open (Figure 11.21).
2. The **Model Linking Editor** provides the user with the capability of setting up or changing the linking between the model alternatives of the selected simulation. Further details on the **Model Linking Editor** are provided in Chapter 12.
3. From the **File** menu (Figure 11.21), click **Close**. The **Model Linking Editor** will close (Figure 11.21) and the information changed will be saved.

## Compute a Simulation

To compute a simulation (deterministic):

1. From the individual simulation shortcut menu (Figure 11.17), point to **Compute**, from the sub-menu (Figure 11.22) the user can compute the entire simulation or compute individual models.
2. The user must expand the **Alternative and Simulation Manager** (Figure 11.8) so that the length of the individual simulation shortcut menu fits within the manager.
3. To compute the simulation, hold down the **CTRL** key, click **Simulation** (Figure 11.17)
4. The **Compute Progress** dialog box will open (Figure 11.23) and the compute will begin. From this dialog box the user can view which model alternative is computing for the simulation and information from each model is displayed in the **Compute Progress** dialog box.
5. When the compute is finished click **Close**, the **Compute Progress** dialog box (Figure 11.23) will close.

## View the Compute Log of a Simulation

To view the compute log of a simulation:

1. From the individual simulation shortcut menu (Figure 11.17), click **View Compute Log**. The *SimulationName.log Editor* will open (Figure 11.24).
2. This editor contains information regarding the compute for the selected simulation. This information is provided by each individual software application that was part of the compute.
3. When the compute is finished click **Close**, the *SimulationName.log Editor* (Figure 11.24) will close.

## Simulation Results

To view results for a simulation (deterministic):

1. From the individual simulation shortcut menu (Figure 11.17), point to **Results**, from the sub-menu (Figure 11.25) the user can view results from the individual models and review the DSS file associated with the simulation.
2. The user must expand the **Alternative and Simulation Manager** (Figure 11.8) so that the length of the individual simulation shortcut menu fits within the manager.
3. Point to the individual software application that the user wants to display results, for example, in Figure 11.25, if the software application **HMS** is selected, a list of available outputs from the HEC-HMS software are listed. Click **Global Summary Table**, the **Global Summary Results** dialog box will open (Figure 11.26).

## Save a Simulation

To save a simulation, from the individual simulation shortcut menu (Figure 11. 17), click **Save**. Any changes that have occurred to the selected simulation will be saved by HEC-WAT.

## Delete a Simulation

To delete a simulation, right-click on a simulation in the table, from the individual simulation shortcut menu (Figure 11. 17), click **Delete From Study**. A warning message will appear asking the user if the user really wants to delete the selected simulation. Click **Yes**, the intersection of the alternative and analysis period/event that the simulation was associated with will now be blank in table in the **Alternative and Simulation Manager** (Figure 11.11).

## Simulation Information

To view information about a simulation:

1. From the individual simulation shortcut menu (Figure 11. 17), click **Properties**. The **Properties for SimulationName** dialog box will open (Figure 11.27).

2. From this dialog box the user can view information about the selected simulation – name of simulation; description; date simulation was last modified; who created the simulation; date simulation was created; and the location of the simulation file.
3. Click **Close**, the **Properties for *SimulationName*** dialog box (Figure 11.27) will close.

## Browse Run Folder

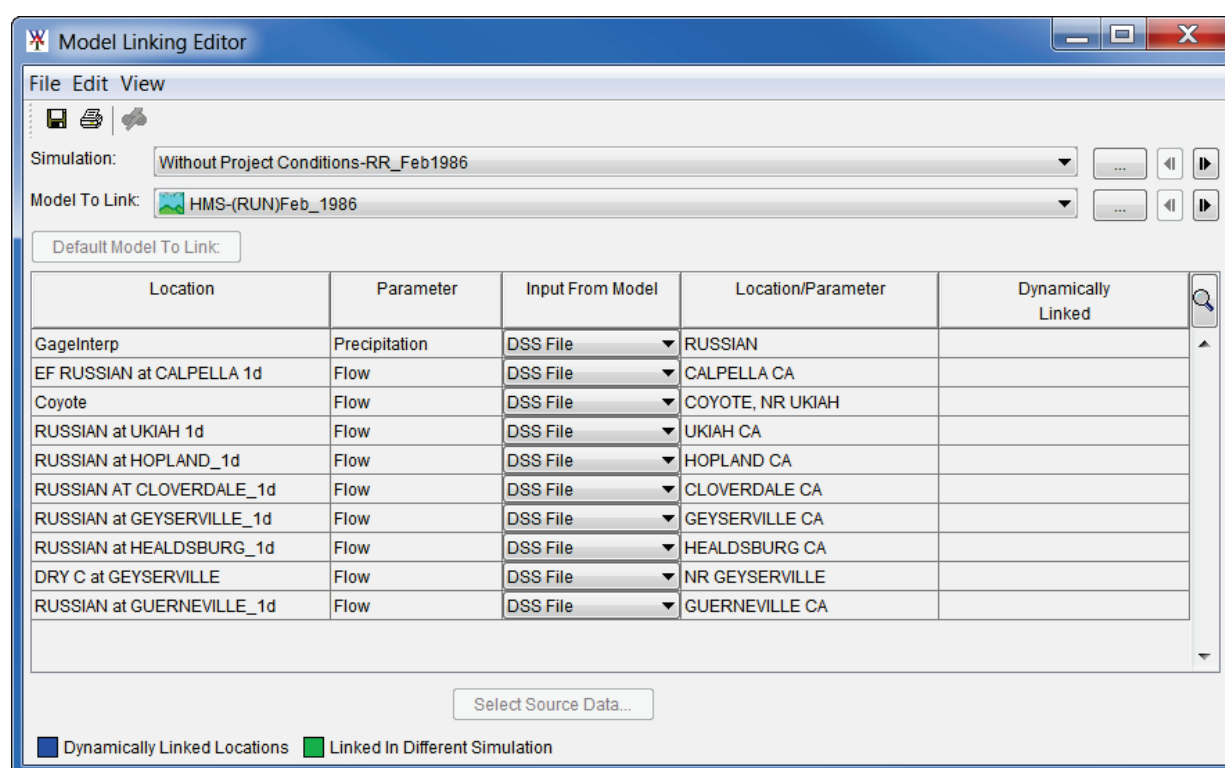
This command takes the user to the location of the data that is generated by HEC-WAT when a simulation is computed. The user can view the *simulation.dss* file using HEC-DSSVue from this location; and, if the model folders have been saved the user can view results for the individual models from HEC-RAS, HEC-ResSim, or HEC-FIA if necessary from this location.



# CHAPTER 12

## Model Linking

The next step is to have the model alternatives within a simulation communicate with each other, by sharing data. This is accomplished by linking (DSS mapping, grid files) the model alternatives through DSS and using a simulation name. From HEC-WAT, the **Model Linking Editor** (Figure 12.1) provides an easy way to link model alternatives including observed data, and provides a mechanism where the linking will have to be done once per model alternative.




**Figure 12.1** Model Linking Editor

Model linking is the mechanism that allows the model alternatives involved in an HEC-WAT simulation to share data. The available software applications are defined through a program order (Chapter 11) that is defined by the user. This program order defines the software applications that will be used and the order in which the software applications will be run in a simulation.

From the **Model Linking Editor** (Figure 12.1), a model alternative is selected as the **Model To Link**, the current linkage of the selected model alternative displays in the table of the **Model Linking Editor** (Figure 12.1). From the **Input From Model** column, the model alternative that contains the correct data that needs to be linked is selected. HEC-WAT facilitates this linking from one model alternative to the next in an HEC-WAT simulation, with the linking information being saved by the software application (e.g., linkage for an FIA model alternative is saved to an HEC-FIA \*.fits file) of the selected **Model to Link** alternative.

## 12.1 Model Linking Editor

To access the **Model Linking Editor** (Figure 12.1), from the HEC-WAT main window (Figure 12.2), from the **WAT Tools** toolbar, click . Alternatively, from the HEC-WAT main window, from the **Edit** menu, click **Model Linking Editor**. From either method the **Model Linking Editor** will open (Figure 12.1).

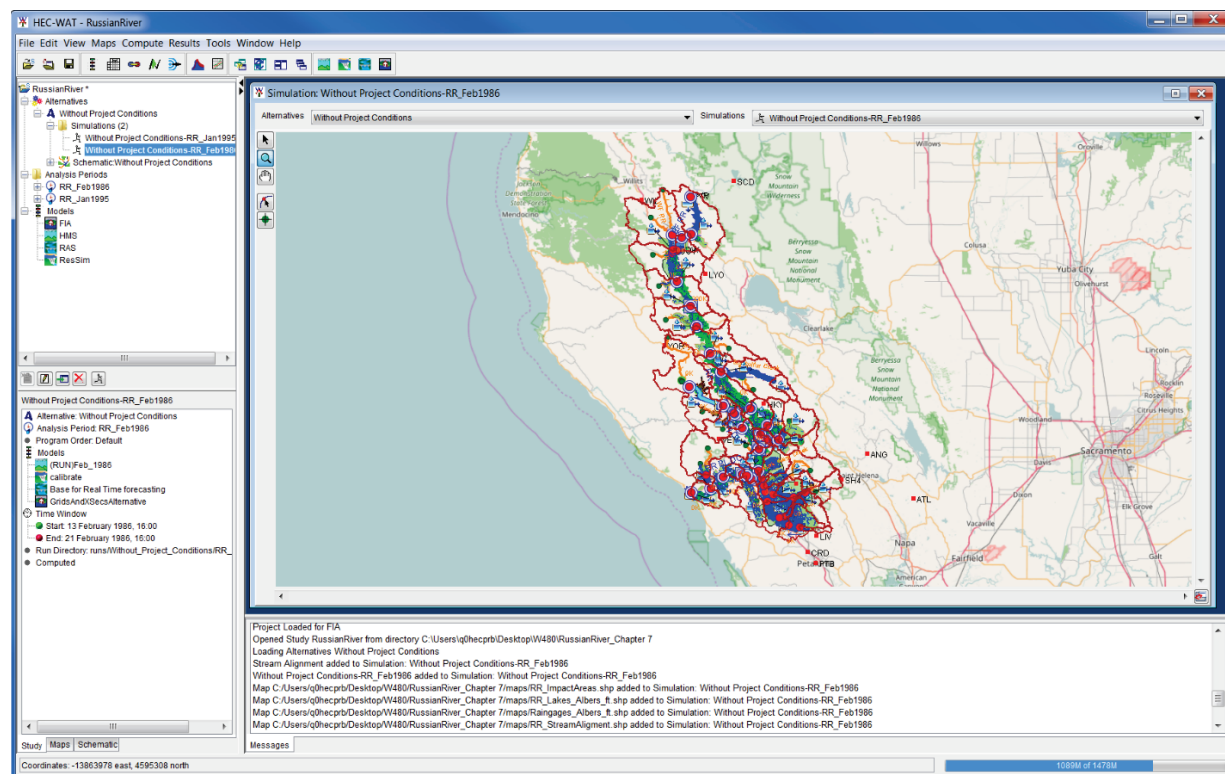



Figure 12.2 HEC-WAT Main Window

An example basic model linking scenario is described in the following steps.

1. From the HEC-WAT main window (Figure 12.2), from the **WAT Tools** toolbar, click , the **Model Linking Editor** will open (Figure 12.1).
2. A program order (Chapter 11) of HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA has been selected for the study. For these software applications, model alternatives (i.e., HEC-HMS (simulations/runs), HEC-ResSim (alternatives), HEC-FIA (alternatives), HEC-RAS (plans)) have been imported into the HEC-WAT study.
3. From the **Model Linking Editor** (Figure 12.1), the user selects an HEC-WAT simulation from the **Simulation** list (Figure 12.3).

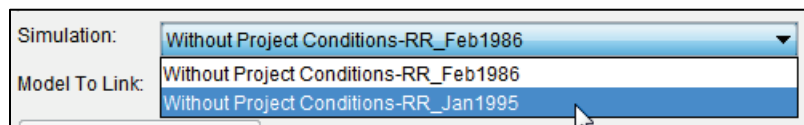
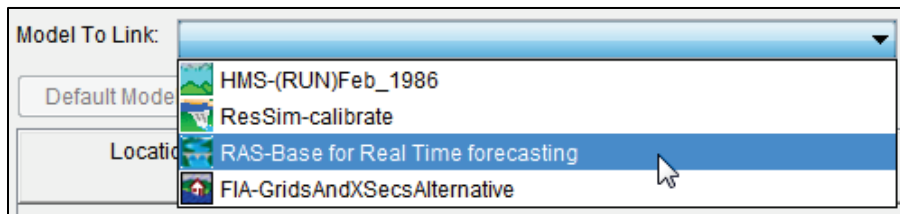


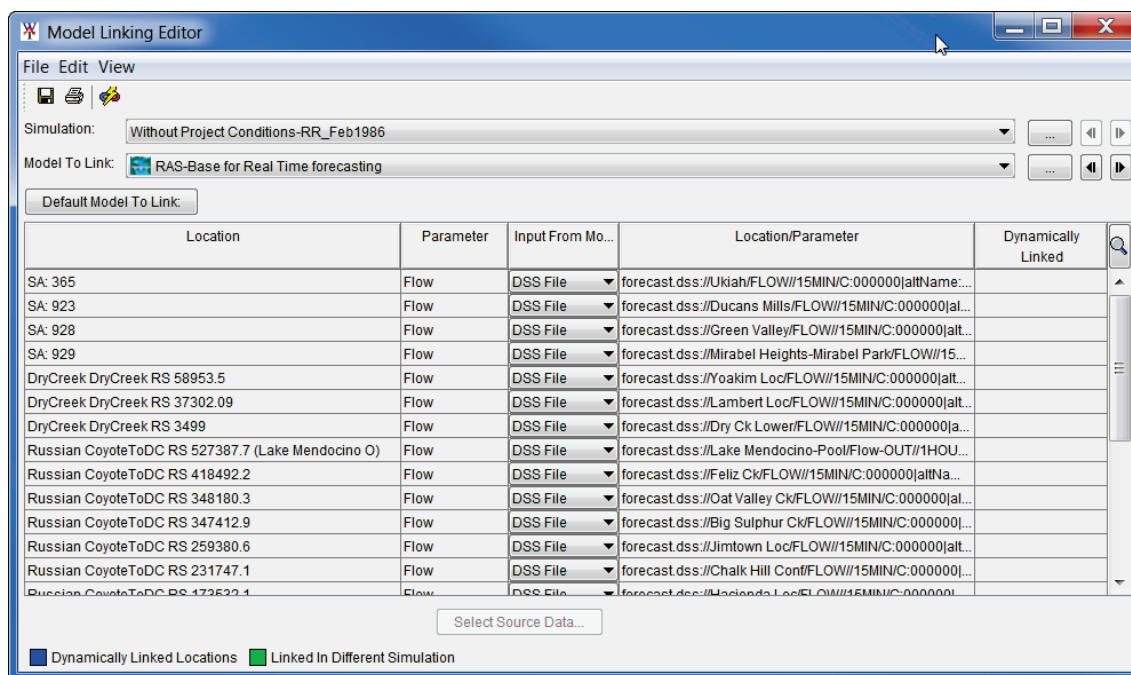
Figure 12.3 Model Linking Editor – Simulation List

4. For example, in Figure 12.3, a simulation has already been selected – *Without Project Conditions-RR\_Feb1986*. Since the HEC-WAT study has an active simulation (simulation is bold in the **Study Tree**; a **Simulation Map Window** is open in the **Desktop Pane**) the **Model Linking Editor** (Figure 12.1) has already selected that simulation.
5. Once a simulation has been selected, the user now must select a model alternative for linking. From the **Model Linking Editor** (Figure 12.1) from the **Model To Link** list (Figure 12.4).



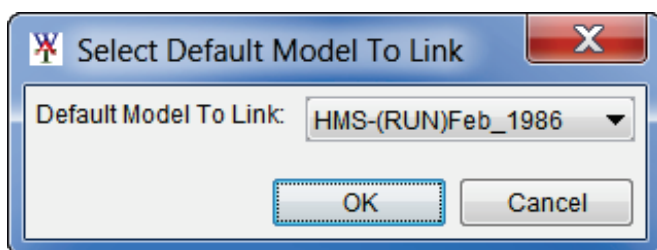
**Figure 12.4** Model Linking Editor – Model To Link List

6. For example, in Figure 12.4, from the **Model to Link** list, the user is selecting a RAS model alternative – *RAS-Base for Real Time forecasting*.
7. The **Model Linking Editor** table (Figure 12.5) now displays all of the locations from the RAS model alternative that will require information (e.g., time-series or levee failure elevations) from other model alternatives in the HEC-WAT simulation. The initial linking (Figure 12.5) displayed in the **Model Linking Editor** (Figure 12.5) will be what is defined in the base HEC-RAS model. For example, Figure 12.5 shows the RAS model alternative is linked to DSS files.



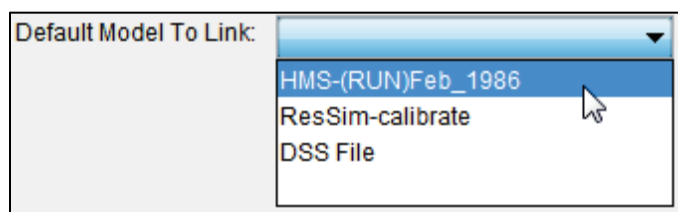
**Figure 12.5** Model Linking Editor - RAS Model Alternative Unlinked

8. For this example (Figure 12.5), the user knows that the RAS model alternative linking will be results from the HMS and ResSim model alternatives. Most of the locations will be linked with an HMS model alternative, and a couple of the locations will be linked to a ResSim model alternative.
9. From the table the user can link each location individually (which will be described in Step 12); but since most of the locations in the table will be linked to an HMS model alternative, for this example the user will link all locations to an HMS model alternative. From the **Model Linking Editor** (Figure 12.5), click **Default Model to Link**, the **Select Default Model to Link** dialog box will open (Figure 12.6).



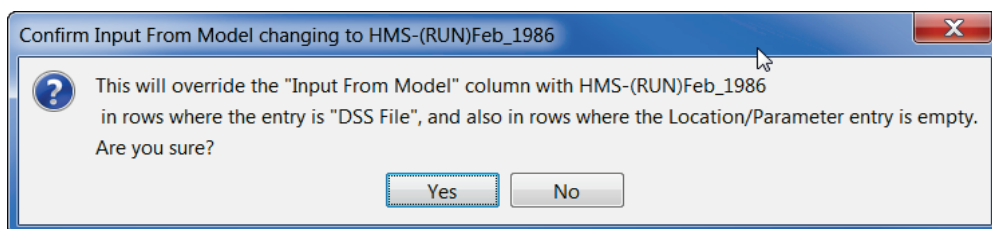
**Figure 12.6** Select Default Model To Link Dialog Box

10. From the **Default Model to Link** list (Figure 12.7), there are three choices. This list is based on the program order that was selected for this simulation. In that program order, the HEC-HMS and HEC-ResSim software application were selected to compute before the HEC-RAS software application. The **DSS File** option allows the user to link locations to a DSS file. For this example, the user will select the HMS model alternative *HMS-(RUN)Feb\_1986*. Click **OK**, the **Select Default Model to Link** dialog box will close (Figure 12.6).

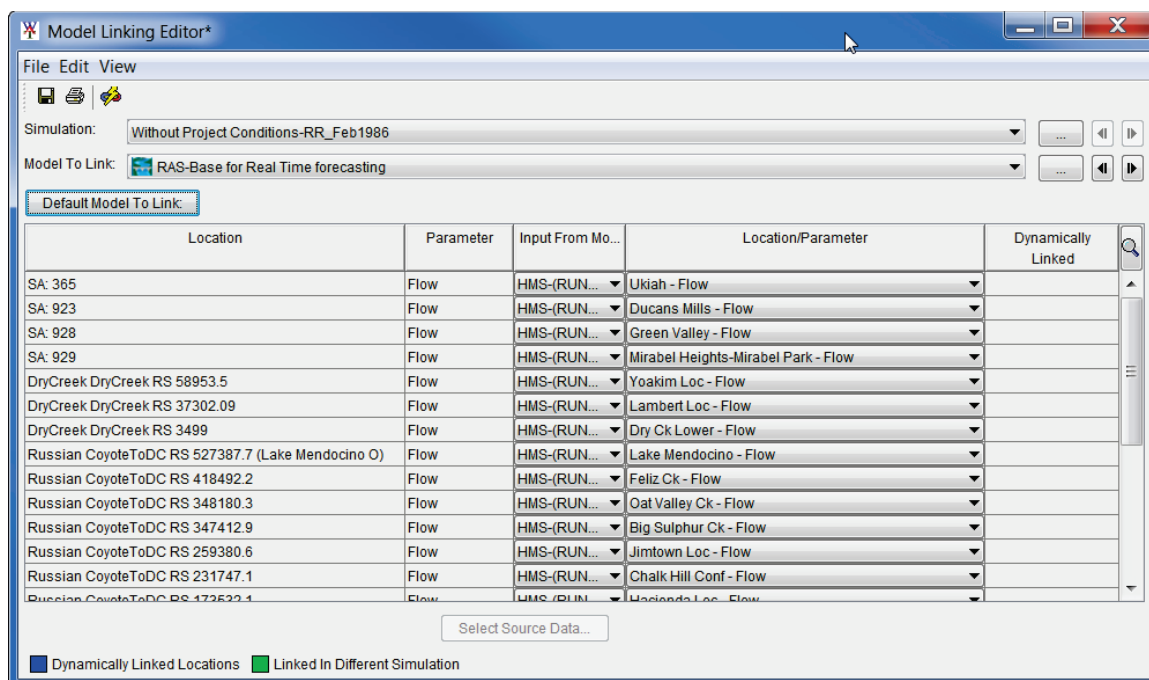


**Figure 12.7** Default Model To Link List

11. A **Confirm Input from From Model changing to** window (Figure 12.8) will appear prompting the user about whether or not to proceed, click **Yes**. The **Confirm Input from From Model changing to** window closes, and the **Model Linking Editor** now displays the linking for the RAS model alternative (Figure 12.9).

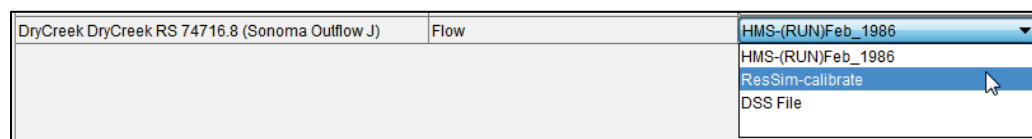


**Figure 12.8** Confirm Input from Model changing to Window




**Figure 12.9** Model Linking Editor - RAS Model Alternative to HMS Model Alternative

- For this example, there are locations in the RAS model alternative linking that need to be linked to a ResSim model alternative. From the **Model Linking Editor** table (Figure 12.10) the user will locate one of the locations (*DryCreek DryCreek RS 74716.8 (Sonoma Outflow J)*). From the row, from the **Input Model** column (Figure 12.10), the user will select the ResSim model alternative - *ResSim-calibrate*.



**Figure 12.10** Model Linking Editor – Individual Locations

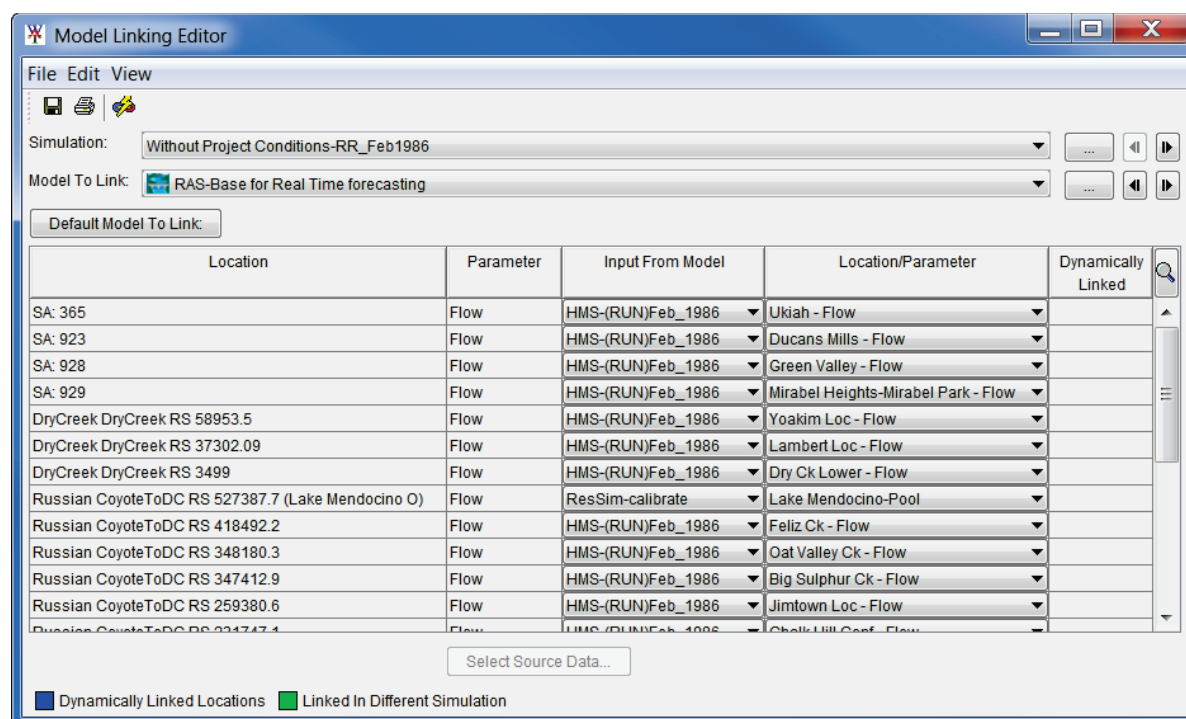
- Once the linking is finished for the RAS model alternative, from the **Model Linking Editor** (Figure 12.11) click  to save the linking.

This example completes the linking for the RAS model alternative. From the above steps the user should be able to perform the linking for the other model alternatives associated with the selected simulation. HEC-WAT attempts to choose the correct linking based on information from the individual model alternatives and locations that have been identified (i.e., element names, common computation points). The user should carefully review all linkages to make sure the right choices have been made.

## 12.2 Dynamic Linking

The example in Section 12.1 addressed modeling linking for one simulation, what happens when the HEC-WAT study contains many HEC-WAT simulations? If the same model alternatives are used in other simulations, there could be an issue when a model alternative in one simulation





**Figure 12.11** Model Linking Editor - Completed RAS Model Alternative Linking

needs to be linked to a different model alternative in another simulation. One example is where RAS model alternative Plan A needs to be linked to HMS model alternative Simulation A in one HEC-WAT simulation and then HMS model alternative Simulation B in another HEC-WAT simulation. Dynamic linking can be used in this case to eliminate the need to create a new model alternative for each HEC-WAT simulation (in the example above, RAS model alternative Plan A would have to be duplicated) where the linking changes, dynamic linking can be used. Dynamic linking is not required, but can save the user time in instances like the above example.

Dynamic linking modifies the DSS pathname F-part such that a single model alternative can be applied to several HEC-WAT simulations. For example, in Figure 12.12, the same RAS model alternative *Base for Real Time forecasting*, is used in both the *Without Project Conditions\_Feb1986* and *Without Project Conditions\_Jan1995* simulations. The original linking for the *Base for Real Time forecasting* model alternative was done in the *Without Project Conditions\_Feb1986* simulation. This simulation is linked to the HMS model alternative, *(RUN)Feb\_1986*. The HEC-WAT simulation *Without Project Conditions-RR\_Jan1995* uses the *(RUN)Jan\_1995* HMS model alternative.

Alternatives	Analysis Periods			
	RR_Feb1986		RR_Jan1995	
Without Project Conditions	HMS	(RUN)Feb_1986	HMS	(RUN)Jan_1995
	ResSim	calibrate	ResSim	calibrate
	RAS	Base for Real Time forecasting	RAS	Base for Real Time forecasting
	FIA	GridsAndXSecsAlternative	FIA	GridsAndXSecsAlternative

**Figure 12.12** Multiple Simulations using the same RAS Model Alternative - *Base for Real Time forecasting*

If dynamic linking was not used for the *Without Project Conditions-RR\_Jan1995* simulation, the RAS model alternative would look for results from the *(RUN)Feb\_1986* HMS model alternative


during the *Without Project Conditions-RR\_Jan1995* compute. Dynamic linking allows the *Base for Real Time forecasting* RAS model alternative to be linked to additional HMS model alternatives with little additional effort. Without dynamic linking, a copy of *Base for Real Time forecasting* would have to be created in HEC-RAS for each simulation in the HEC-WAT study that used different HMS or ResSim model alternatives.

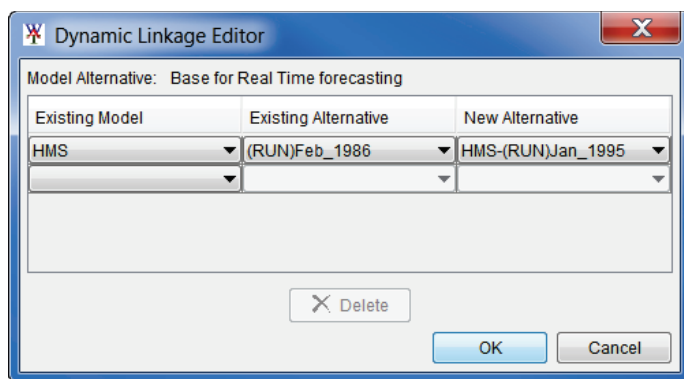
An example dynamic linking scenario is described in the following steps.

1. In Section 12.1, the user has set the linking for the RAS model alternative *Base for Real Time forecasting* for the simulation *Without Project Conditions\_Feb1986*. Now the user needs to do the linking for the RAS model alternative in the second HEC-WAT simulation *Without Project Conditions\_Jan1995*.
2. From the **Model Linking Editor** (Figure 12.1), the user selects *Without Project Conditions\_Jan1995* from the **Simulation** list (Figure 12.3).
3. From the **Model to Link** list (Figure 12.3), the user selects *Base for Real Time forecasting*.
4. The **Model Linking Editor** (Figure 12.13) now displays all of the locations for the RAS model alternative that need to be linked. As displayed in Figure 12.13, all of the locations are displayed in green (except for the two locations that are linked to the ResSim model alternative) indicating the model alternative has already been linked in a different HEC-WAT simulation.

Location	Parameter	Input From Model	Location/Parameter	Dynamically Linked
DryCreek DryCreek RS 37302.09	Flow	HMS-(RUN)Feb_1986	Camden Loc	
DryCreek DryCreek RS 3499	Flow	HMS-(RUN)Feb_1986	Dry Ck Lower	
Russian CoyoteToDC RS 527387.7 (Lake M...	Flow	ResSim-calibrate	Lake Mendocino-Pool	
Russian CoyoteToDC RS 418492.2	Flow	HMS-(RUN)Feb_1986	Feliz Ck	
Russian CoyoteToDC RS 348180.3	Flow	HMS-(RUN)Feb_1986	Oat Valley Ck	
Russian CoyoteToDC RS 347412.9	Flow	HMS-(RUN)Feb_1986	Big Sulphur Ck	
Russian CoyoteToDC RS 259380.6	Flow	HMS-(RUN)Feb_1986	Jimtown Loc	
Russian CoyoteToDC RS 231747.1	Flow	HMS-(RUN)Feb_1986	Chalk Hill Conf	
Russian CoyoteToDC RS 173532.1	Flow	HMS-(RUN)Feb_1986	Hacienda Loc	
Russian DCltoOcean RS 117632.2	Flow	HMS-(RUN)Feb_1986	Hacienda Loc	
Russian DCltoOcean RS 83985.54	Flow	HMS-(RUN)Feb_1986	Johnsons Loc	
Russian DCltoOcean RS 41890.00	Flow	HMS-(RUN)Feb_1986	Ducans Mills	
Russian CoyoteToDC RS 483712.3	Flow	HMS-(RUN)Feb_1986	Talmage Loc	
Russian CoyoteToDC RS 447460.5	Flow	HMS-(RUN)Feb_1986	Hopland Loc	
Russian CoyoteToDC RS 375961.5	Flow	HMS-(RUN)Feb_1986	Cloverdale Loc	
Russian CoyoteToDC RS 290472.6	Flow	HMS-(RUN)Feb_1986	Geyserville Loc	
Russian CoyoteToDC RS 202683.7	Flow	HMS-(RUN)Feb_1986	Digger Loc	
Russian CoyoteToDC RS 187494.*	Flow	HMS-(RUN)Feb_1986	Healdsburg East	
Russian DCltoOcean RS 144423.4	Flow	HMS-(RUN)Feb_1986	Windsor loc	
DryCreek DryCreek RS 74716.8 (Sonoma O...	Flow	ResSim-calibrate	Lake Sonoma-Pool	

**Figure 12.13** Model Linking Editor - RAS Model Alternative Already Linked

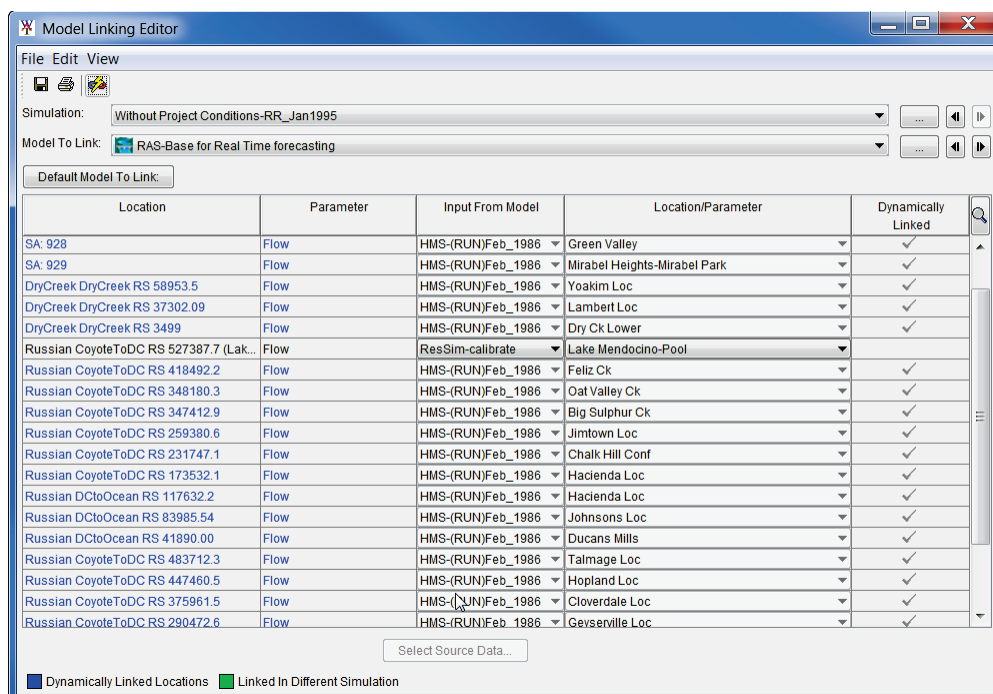
5. To dynamically link, from the toolbar on the **Model Linking Editor** (Figure 12.13), click , or from the **Edit** menu, click **Dynamic Linkage**. From either method, the **Dynamic Linkage Editor** will open (Figure 12.14).
6. Since the RAS model alternative *Base for Real Time forecasting* requires model results from multiple HMS model alternatives across multiple HEC-WAT simulations, dynamic linking needs to be applied for the RAS model alternative. The second simulation



**Figure 12.14** Dynamic Linkage Editor


*Without Project Conditions Jan1995* requires a different HMS model alternative to be used, but not a different ResSim model alternative. Therefore, dynamic linking is only required for the HMS model alternative.

7. To set dynamic linking for the HMS model alternative, from the table on the **Dynamic Linkage Editor** (Figure 12.14), in the **Existing Model** column, in the first cell, from the list, select *HMS*. In the **Existing Alternative** column, in the first cell, from the list, select *(RUN)Feb\_1986*. In the **New Alternative** column, in the first cell, from the list select *HMS-(RUN)Jan\_1995* (Figure 12.14).
8. Click **OK**, the **Dynamic Linkage Editor** closes (Figure 12.14) and on the **Model Linking Editor** (Figure 12.15), all of the locations linked to the HMS model alternative display in blue. This means all of those locations are dynamically linked, or linked to different model inputs in different HEC-WAT simulations. The **Dynamically Linked** column (Figure 12.15) will show a check mark for each row that is dynamically linked.



**Figure 12.15** Dynamic Linkage Editor – Dynamically Linked Locations



9. Once the linking is finished for the RAS model alternative, from the **Model Linking Editor** (Figure 12.15) click , this will save the linking.

This example illustrates the dynamic linking option for the RAS model alternative in two different HEC-WAT simulations. What did dynamic linking do? By using dynamic linking for the second simulation, during a compute of that simulation the dynamically linked DSS pathname F-parts will substitute the existing alternative name with the new alternative name when creating pathnames for the models to pass results. How? When a model alternative is linked within an HEC-WAT study, the software application specific files associated with that model alternative are changed. The model specific files are saved in the HEC-WAT study directory within the corresponding software application folders. For example, when the RAS model alternative (a plan in HEC-RAS) *Base for Real Time forecasting* was linked to other model alternatives in the HEC-WAT compute sequence, the selected information for that specific HEC-RAS model was saved to an HEC-RAS file with the extension *\*.p###.wcfLinks* in the *ras* folder of the HEC-WAT study directory. The other software applications, in the compute sequence use different file extensions to save information for each simulation, analysis, or alternative within those pieces of software. The main point is that files in the model specific folders are modified anytime an individual model is linked within an HEC-WAT simulation.

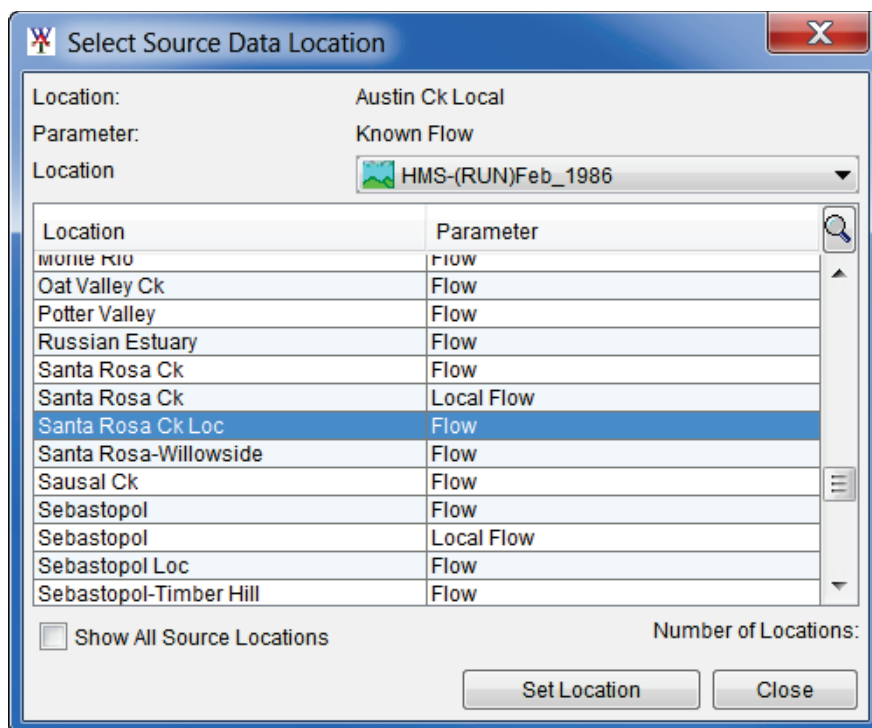
Dynamic linking also removes the user from having to create an additional HEC-RAS plan for the second HEC-WAT simulation. Could the user choose to perform the linking this way and choose not to use dynamic linking – yes. But if the study the user is analyzing will require a large amount of simulations for analysis, serious thought should be given on which approach to use.

Currently, HEC-HMS does not support dynamic linking in HEC-WAT Version 1.0. HEC-HMS is usually the first model in the compute sequence, where dynamic linking is used less often. For HEC-HMS, dynamic linking would be beneficial for linking hydrologic sampling alternatives with different precipitation information between hydrologic sampling alternatives. To work around this limitation the user must create duplicate copies of the HEC-HMS simulation (or Monte Carlo analysis), and link each one to the appropriate HEC-WAT alternative.

## 12.3 Select Source Data

Data listed in the **Model Linking Editor** (Figure 12.1) displays the type of results the location needs. In some cases the data type might not be recognized or the type of data is not what the user is expecting. For this reason, the user can specify a data type for a certain location.

1. Select a row in the **Model Linking Editor** table (e.g., *SantaRosa Cr*), click **Select Source Data** (Figure 12.1). If the **Input From Model** column (Figure 12.1) refers to a model alternative, the **Select Source Data Location** dialog box will open (Figure 12.16). If the **Input From Model** column (Figure 12.1) refers to a DSS file, then HEC-DSSVue opens to allow the user to select a DSS file.
2. To review a list of locations in the **Select Source Data Location** dialog box, from the **Location** (Figure 12.16) list, the user will select which model alternative's locations to review. The list is the known locations that were part of the original model alternative's



**Figure 12.16** Select Source Data Location Dialog Box

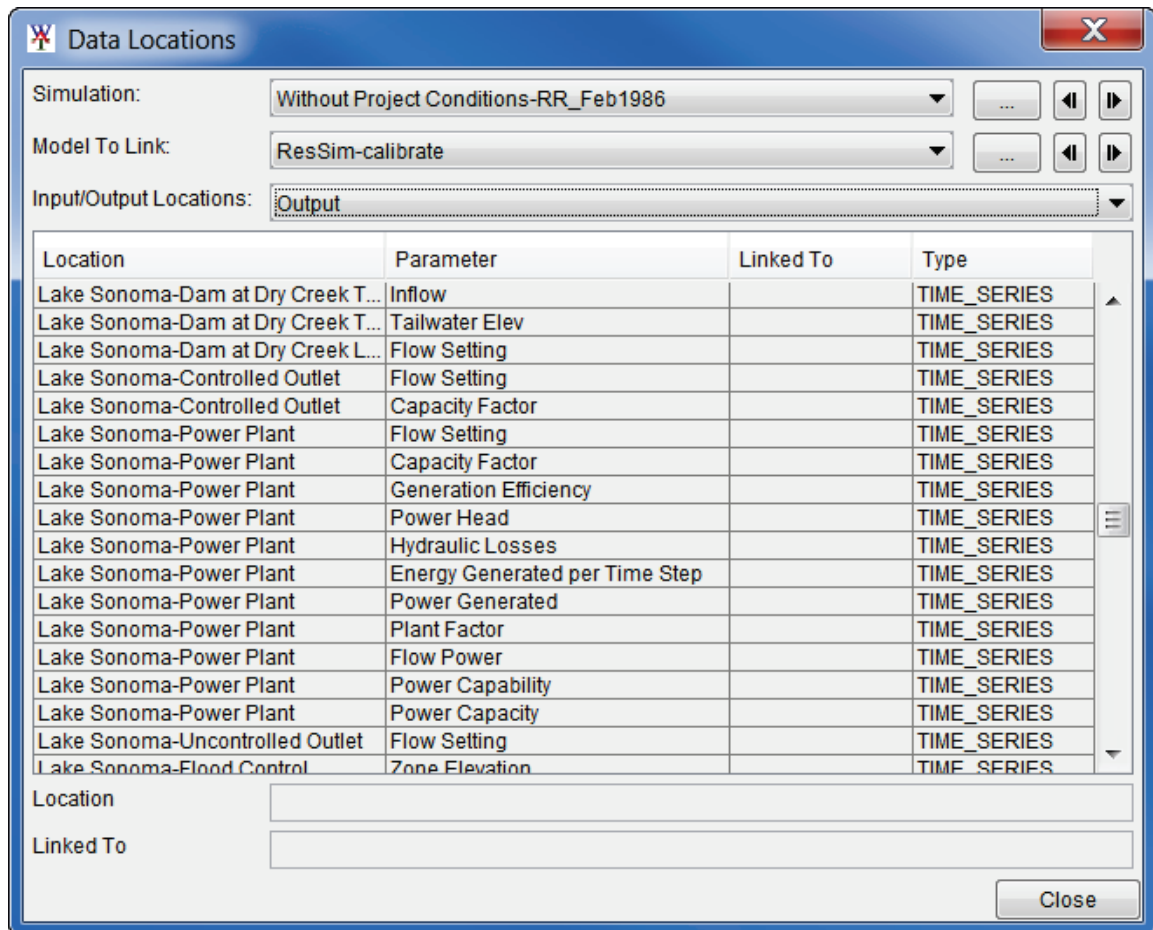
standalone model. To show all locations available, the user should select **Show All Source Locations**.

- From the **Location** column (Figure 12.16), select the row that contains the correct information (e.g., *Santa Rosa Ck Loc*). Click **Set Location**. The row selected in Step 1 will now contain the new location information selected from the **Select Source Data Location** dialog box. The **Select Source Data** dialog box (Figure 12.16) will remain open allowing the user to continue selecting source data for different rows in the Model Linking Editor (Figure 12.1).
- Click **Close**, the **Select Source Data Location** dialog box will close (Figure 12.16).

## 12.4 Data Locations

Data locations allow the user to view all available data at a particular location for each model alternative. This includes input data and results from model alternatives.

- From the **Model Linking Editor** (Figure 12.1), from the **View** menu, click **Locations**. The **Data Locations** dialog box will open (Figure 12.17).
- From the **Simulation** list (Figure 12.17) the user can select a simulation, and then select a model alternative from the **Model to Link** list (Figure 12.17). Next the user can select whether to view input or output locations that are available from the model selected.
- If the **Model Linking Editor** (Figure 12.1) does not have any locations for a particular model alternative and the **Data Locations** dialog box (Figure 12.17) does not have any




**Figure 12.17** Data Locations Dialog Box

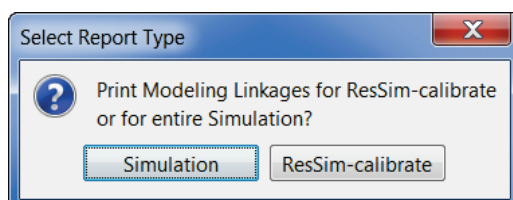
locations either, then something is not working between HEC-WAT and the selected model alternative. The output location list will give the user an idea of what results would be available from the model alternative after a compute.

4. Click **Close**, the **Data Locations** dialog box will close (Figure 12.17).

## 12.5 Model Linking Report

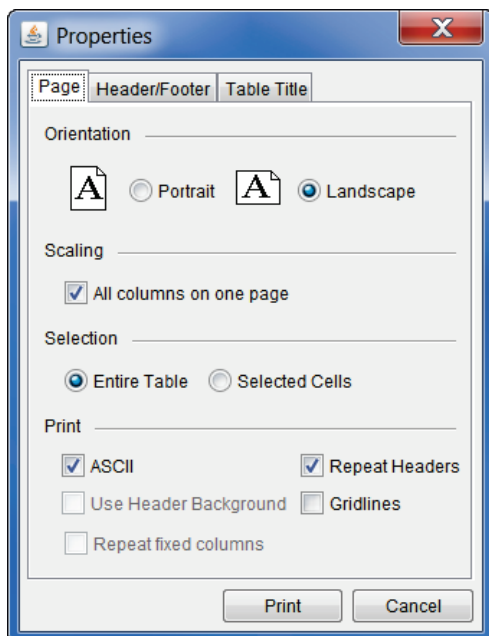
From the **Model Linking Editor** (Figure 12.1) the user can print the linking for a simulation or model alternative.

1. From the **Model Linking Editor** (Figure 12.1), from the **File** menu, click **Print**, or from the **Toolbar** click , a **Select Report Type** message window will open (Figure 12.18).



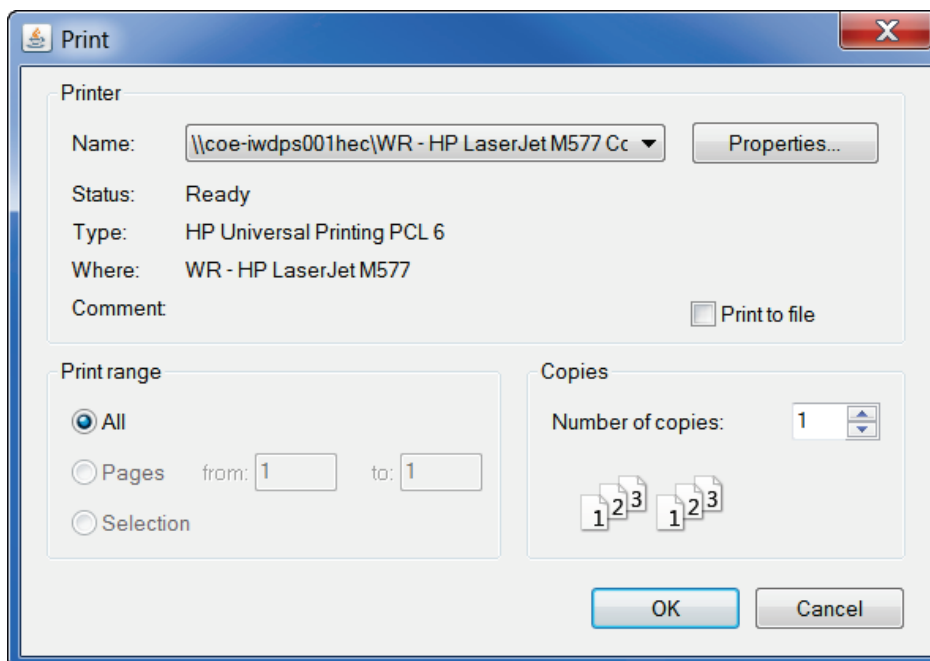
**Figure 12.18** Select Report Type Message Window

- The user is prompted to print the linkage for either the simulation or the model alternative. After making a selection, the **Select Report Type** message window will close, and a print **Properties** dialog box will open (Figure 12.19). The user can now format the **Model Linking Report**. When the user is done formatting, click **Print**.



**Figure 12.19** Print Properties Dialog Box

- A **Print** dialog box will open (Figure 12.20). From this dialog the user can choose which printer to print to and also setup other printer properties. Click **OK**, the **Print** dialog box will close and the **Model Linking Report** (Figure 12.21) will print.



**Figure 12.20** Print Dialog Box

Model Linking Report				
Date: 10/28/2016				
Study: RussianRiver				
Simulation:Without Project Conditions-RR_Feb1986				
Model Alternative:ResSim-calibrate				
Location	Parameter	Input From Model	Location/Parameter	Dynamically Linked
WF Russian	Known Flow	HMS-(RUN)Feb_1986	Ukiah	
Russian 10	Known Flow	HMS-(RUN)Feb_1986	Lake Mendocino	
Austin Ck Local	Known Flow	HMS-(RUN)Feb_1986	Austin Ck Loc	
Guerneville Local (Russian 20)	Known Flow	HMS-(RUN)Feb_1986	Hacienda Loc	
Green Valley	Known Flow	HMS-(RUN)Feb_1986	Green Valley	
Santa Rosa Cr	Known Flow	HMS-(RUN)Feb_1986	Mirabel Heights-Mirabel Park	
Dry Creek Local	Known Flow	HMS-(RUN)Feb_1986	Dry Ck Lower	
Geyserville Dry Creek Local	Known Flow	HMS-(RUN)Feb_1986	Yokim Loc	
Lake Sonoma Inflow	Known Flow	HMS-(RUN)Feb_1986	Lake Sonoma	
Healdsburg Local	Known Flow	HMS-(RUN)Feb_1986	Healdsburg Loc	
Geyserville Local	Known Flow	HMS-(RUN)Feb_1986	Geyserville Loc	
Big Sulphur Cr	Known Flow	HMS-(RUN)Feb_1986	Big Sulphur Ck	
Cloverdale Local	Known Flow	HMS-(RUN)Feb_1986	Cloverdale Loc	
Hopland Local (Russian 60)	Known Flow	HMS-(RUN)Feb_1986	Hopland Loc	
Talmage Local	Known Flow	HMS-(RUN)Feb_1986	Talmage Loc	
EF Russian 20	Known Flow	HMS-(RUN)Feb_1986	Calpella	
Butter Valley Release	Known Flow	HMS-(RUN)Feb_1986	Butter Valley	

Figure 12.21 Model Linking Report

## 12.6 Model Linking Editor – Study Tree

The user can also access the **Model Linking Editor** (Figure 12.1) from the **Study Tree** of an active HEC-WAT study (Figure 12.22). From the **Study Tree**, under the **Simulation** folder, right click on a simulation. From the shortcut menu, click **Model Linking Editor**, the **Model Linking Editor** will open (Figure 12.1).

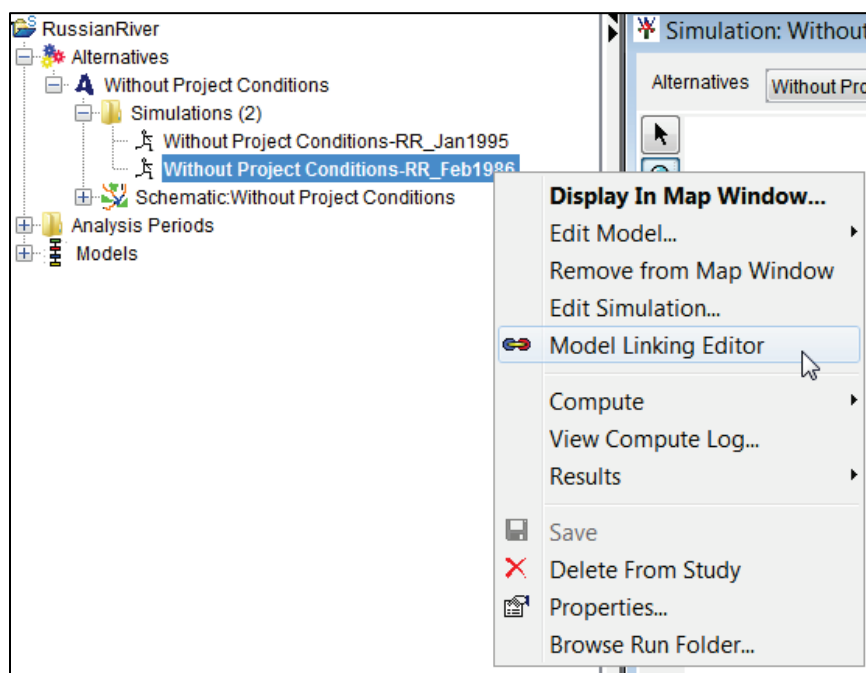


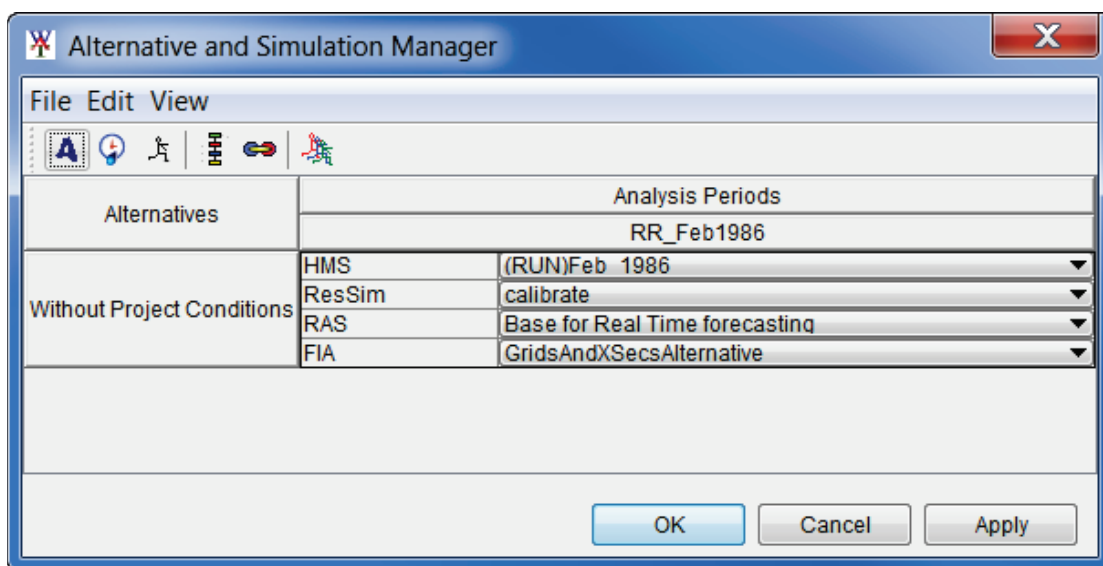


Figure 12.22 Study Tree – Model Linking Editor

## 12.7 Modeling Linking Editor – Alternative & Simulation Manager

The user can also access the **Model Linking Editor** (Figure 12.1) from the **Alternative and Simulation Manager** (Figure 12.23). From the HEC-WAT main window (Figure 12.2), from the **WAT Tools** toolbar, click , the **Alternative and Simulation Manager** will open (Figure 12.23). From the toolbar, click ; from the **Edit** menu, click **Model Linking Editor**; or from the table, right-click on a simulation, from the shortcut menu (Chapter 11, Section 11.2.6), click **Model Linking Editor**. Either method will open the **Model Linking Editor** (Figure 12.1).



**Figure 12.23** Alternative and Simulation Manager

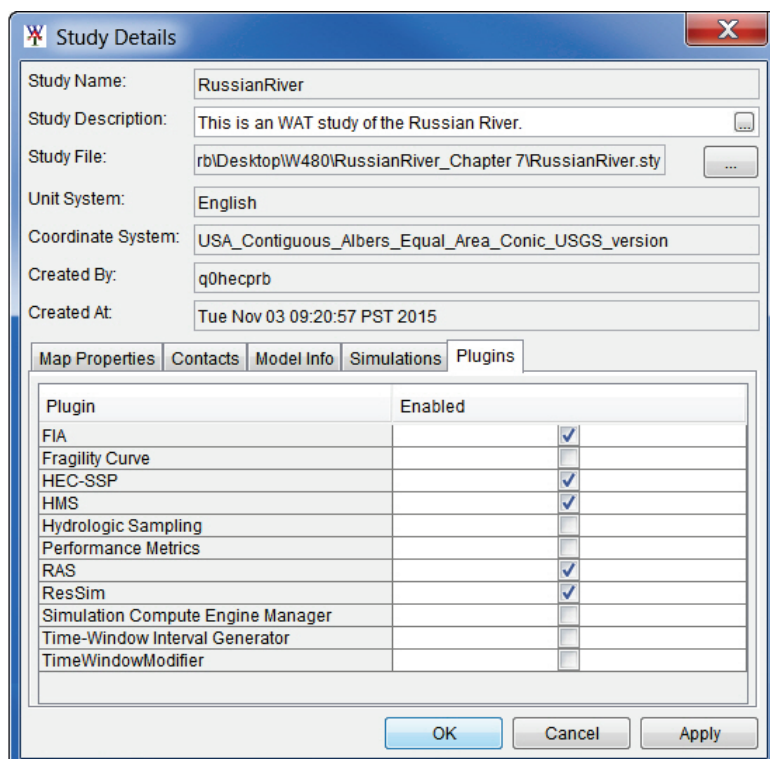
# CHAPTER 13

## Final Study Setup - Deterministic

The user now has an understanding of the HEC-WAT framework, knows how to create a study and has experience using map layers. The user has also created or imported model alternatives, created study alternatives and simulations, setup analysis periods, and defined model linking. There are a few final setup items that need to occur before a deterministic compute can happen: define plug-ins; adjust map layers; and, enter the correct lookback window for an HEC-ResSim model (if HEC-ResSim is part of the study).

### 13.1 Define Plug-Ins for a Study

Plug-ins (Chapter 2) allow HEC-WAT to integrate software applications into its framework without requiring special code in HEC-WAT to support the individual software applications. Currently there are nineteen plug-ins available (Appendix B provides further details), eight specifically for standalone software applications, and eleven specifically for HEC-WAT functions. While all of these plug-ins are available, the user should inform HEC-WAT which plug-ins are needed in the **Study Details** dialog box (Figure 13.1). Plug-ins can be enabled/disabled from the **Options** dialog box (Appendix B), but this should only be done to enable/disable specific plug-ins for specialized studies or when there is an issue with a plug-in.

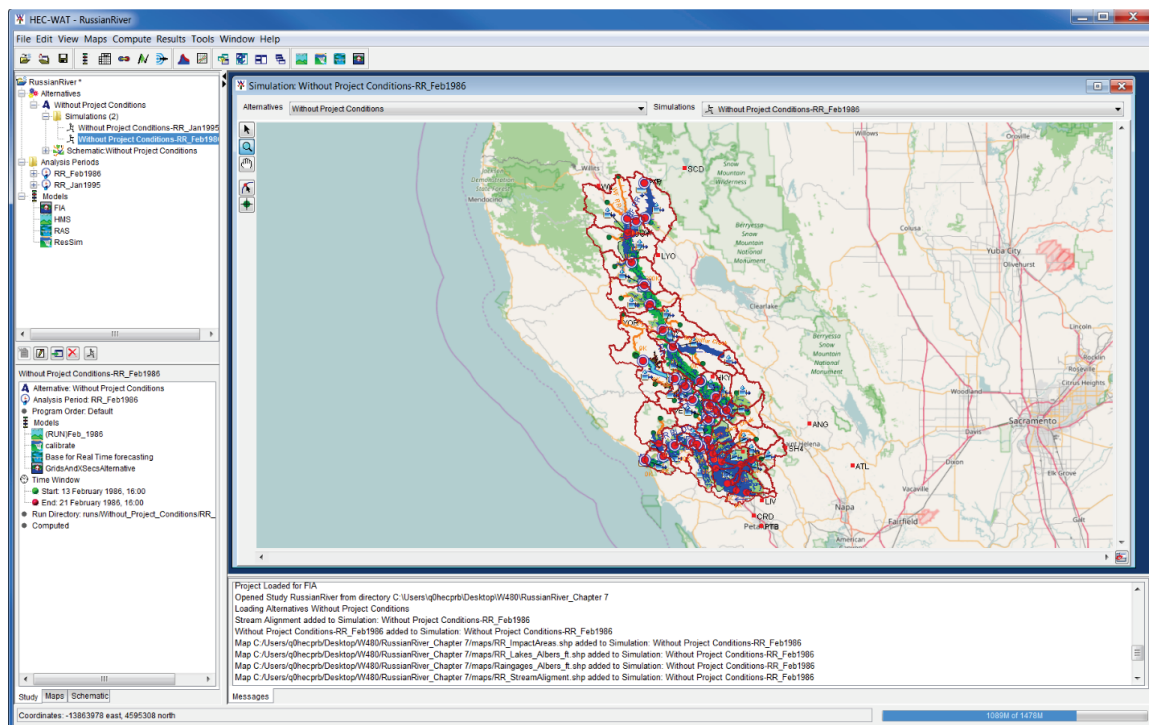


**Figure 13.1** Study Details Dialog Box – Plugins Tab – Deterministic



To set the specific plug-ins for the active study:

1. From the HEC-WAT main window (Figure 13.2), from the **File** menu, click **Study Details**, the **Study Details** dialog box (Figure 13.1) will open.



**Figure 13.2** HEC-WAT Main Window

2. The **Study Details** dialog box (Figure 13.1) displays the name of the study, the study description (which the user can edit), location of the study file (\*.sty), the selected unit system, the selected coordinate system, the user name of the team member that created the study, and the date and time the study was created.
3. Click the **Plugins** tab (Figure 13.1), by default, all plug-ins are enabled (Figure 13.3). Alternatively, in Figure 13.1, shows the active study in which the only plug-ins enabled are FIA, HEC-SSP, HMS, RAS, and ResSim.

Plugin	Enabled
FIA	<input checked="" type="checkbox"/>
Fragility Curve	<input checked="" type="checkbox"/>
HEC-SSP	<input checked="" type="checkbox"/>
HMS	<input checked="" type="checkbox"/>
Hydrologic Sampling	<input checked="" type="checkbox"/>
Performance Metrics	<input checked="" type="checkbox"/>
RAS	<input checked="" type="checkbox"/>
ResSim	<input checked="" type="checkbox"/>
Results Merge Tool	<input checked="" type="checkbox"/>
Simulation Compute Engine Manager	<input checked="" type="checkbox"/>
Stochastic Hydrologic Data Importer	<input checked="" type="checkbox"/>
Time-Window Interval Generator	<input checked="" type="checkbox"/>
TimeWindowModifier	<input checked="" type="checkbox"/>

**Figure 13.3** Study Plug-Ins Defaults

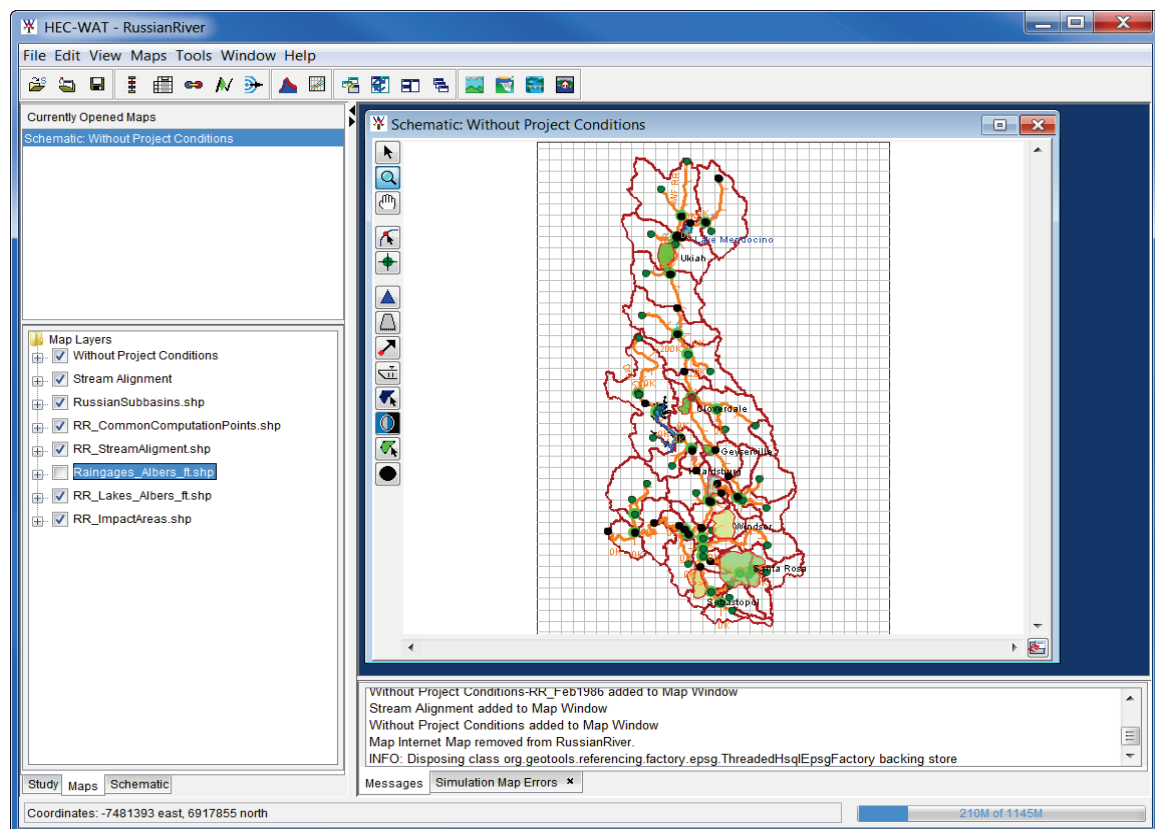


3. To disable a plug-in clear the check mark in the **Enabled** column of the table (Figure 13.1). When the user has the right plug-in configuration, click **OK**. The **Study Details** dialog box will close (Figure 13.1) and the plug-in configuration for the active study has been set.

## 13.2 Adjust Map Layers

Whether models were built from HEC-WAT or imported, there could be map layers that define the study area. The user may need to adjust the map layers (not required) so that the schematic displays information to the study team and others.

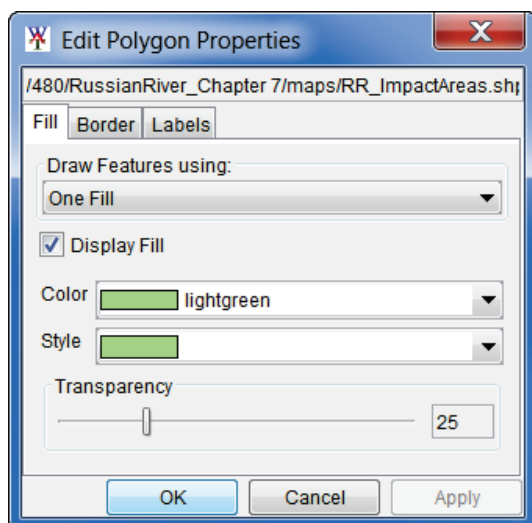
1. From the HEC-WAT main window, click the **Maps** tab (Figure 13.4). Now the user can see which **Map Window** is currently active and what layers make up that **Map Window**. The user can now make adjustments (changes to draw properties) to the map layers, from the **Map Layers** tree:



**Figure 13.4** HEC-WAT Main Window – Maps Tab

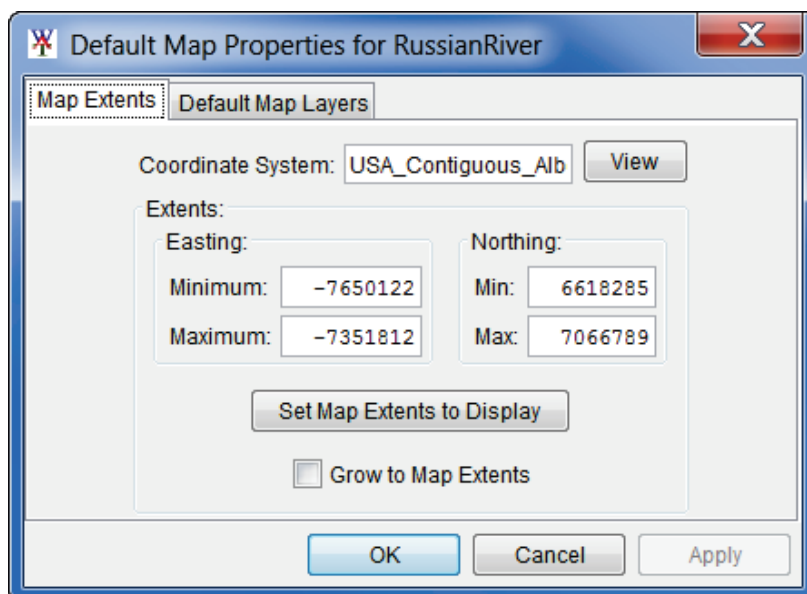
- Un-check a map layer so that it will no longer display in the active map window. For example in Figure 13.4, the *Raingages\_Albers\_ft.shp* map layer has been unchecked.
- For map layers, the user can change the display properties of the selected map layer. For example, in Figure 13.4, the user could right-click on the *RR\_ImpactAreas.shp* map layer, from the shortcut menu, click **Properties**. The **Edit Polygon Properties**

**Editor** will open (Figure 13.5). From the **Fill** tab, change the color to "lightgreen", click **OK**. The impact areas on the active map window will now display in "lightgreen".



**Figure 13.5** Edit Polygon Properties Editor

- Move layers to better display certain aspects of the schematic. For example, in Figure 13.4, right-click on **Stream Alignment**, from the shortcut menu click **Move To Top**. The **Stream Alignment** layer is now the top layer in the schematic.
2. The user can adjust the view of the study area in the active map window. Using the **Magnifier** tool, zoom the study area in the active map window to the appropriate area that the user would like displayed. From the HEC-WAT main window (Figure 13.4), from the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for** dialog box will open (Figure 13.6). Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for** dialog box will close.



**Figure 13.6** Default Map Properties for Dialog Box

This sets the extents for the **Map Window** so that when the study is opened the next time the **Map Window** will be zoomed in to the tighter area.

### 13.3 Lookback Window – HEC-ResSim (only)

The time window for an HEC-ResSim run has two parts, a "lookback period" and a "simulation or forecast period". The lookback period is used by HEC-ResSim to "warm up" a ResSim model alternative. During this period, routing of flows through the river and reservoir network are performed but no release decisions are made nor are any mass balance computations evaluated. The user should think of the lookback period as the time to establish the state of the river network and the starting conditions of the reservoirs. The simulation period is the portion of the time window during which HEC-ResSim simulates reservoir operations, and makes release decisions based on the operation logic defined by the user. Releases are then routed through the river network, combining with local inflows along the way.

HEC-WAT and most of the models treat the analysis period as a single, continuous time window. For this reason, a setup step is required for each ResSim model alternative in an HEC-WAT study. The setup step lets each ResSim model alternative know how much of the analysis period to use for the lookback period.

To setup the lookback period:

1. From the HEC-WAT main window (Figure 13.3), from the **Edit** menu, point to **ResSim**, click **Lookback Window** (Figure 13.7), the **Lookback Window** dialog box (Figure 13.8) will open.

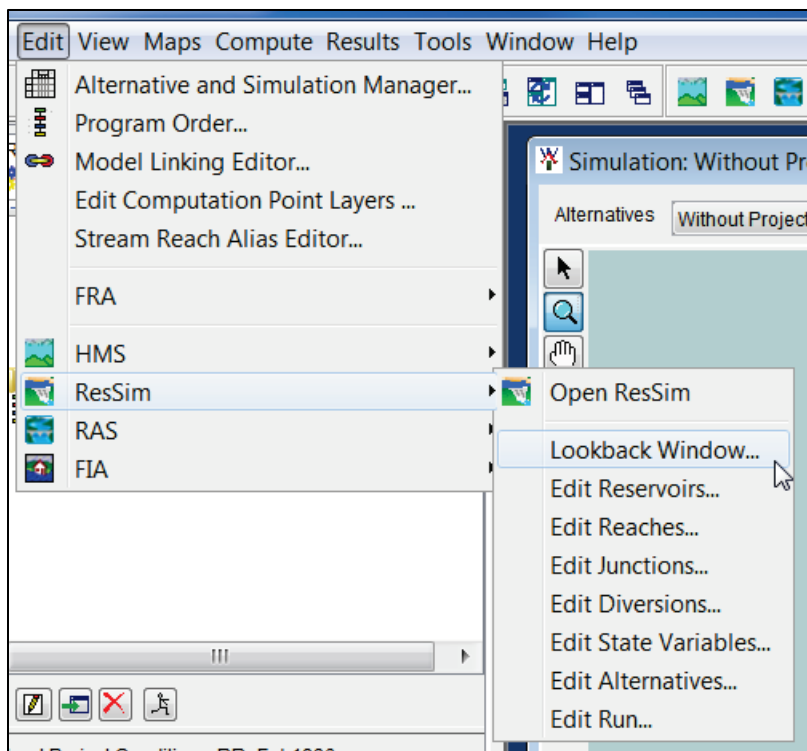
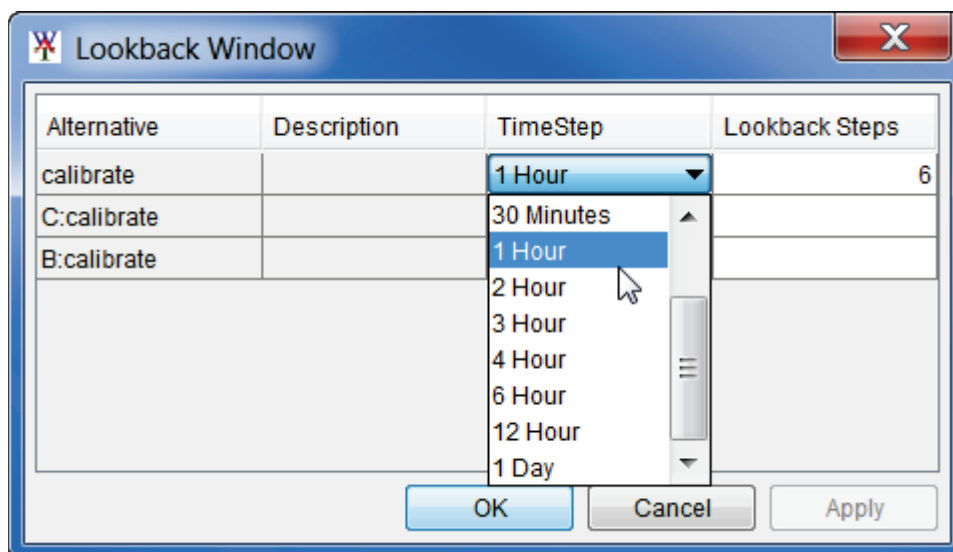


Figure 13.7 Edit Menu – ResSim – Lookback Window



**Figure 13.8** Lookback Window Dialog Box

- The table on the **Lookback Window** dialog box (Figure 13.8) displays the ResSim model alternatives that are available in the HEC-WAT study. Each model alternative that is being used in an HEC-WAT simulation will need to have a lookback window set. For example, in Figure 13.8, the ResSim model alternative *calibrate* has a **TimeStep** of one (1) hour and **Lookback Steps** of 6.
- For each **Alternative** listed, a **TimeStep** (compute interval) and number of **Lookback Steps** must be specified. The time step can be selected from the **TimeStep** column (Figure 13.8), in each cell there is a list of available time steps for the user to choose from. The selected time step has to match the time step that was specified for the ResSim model alternative as part of the alternative's original Run Control data (which is located in the HEC-ResSim Alternative Editor). The number of lookback steps must be entered in a cell in the **Lookback Steps** column (Figure 13.8). At least one lookback time step is required for a ResSim model alternative to compute, however more lookback steps may be needed, depending on a variety of factors in the ResSim model alternative's operating rules. The HEC-ResSim modeler should be consulted to determine the minimum lookback window needed by each ResSim model alternative. As mentioned, the lookback period takes place within the analysis period (time window) that HEC-WAT provides to the ResSim model alternative. No reservoir operations will be simulated during the lookback period, which could impact model results.
- Click **OK**, the **Lookback Window** dialog box (Figure 13.8) will close.

Now that all of the setup has been completed, the user is ready to compute HEC-WAT simulations.

# CHAPTER 14

## Compute/Results - Deterministic

Now that simulations have been defined and the linking of model alternatives has been completed for the simulations, the user is now ready to compute. Once again HEC-WAT provides the user with several ways to compute simulations. The user can compute a simulation individually, compute multiple simulations, compute individual model alternatives, or compute a simulation through a specific model alternative. For example if the user defined a compute sequence of HEC-HMS, HEC-ResSim, HEC-RAS, and HEC-FIA and only wanted to compute a simulation through the HEC-RAS model, HEC-WAT could request that the HEC-HMS, HEC-ResSim and HEC-RAS software applications compute their individual model alternatives (i.e., simulation, alternative, plan) for the HEC-WAT simulation alternative. The following sections describe in detail how to compute simulations in HEC-WAT.

### 14.1 Compute – Single Simulation

#### 14.1.1 Study Tree

Computing a simulation from the **Study Tree**:

1. From the HEC-WAT main window (Figure 14.1), from the **Study Tree**, from the **Simulations** folder, right-click on a simulation (e.g., *Without Project Conditions-RR\_Feb1986*). From the shortcut menu (Figure 14.1) point to **Compute**, hold down the **CTRL** key, click **Simulation**.

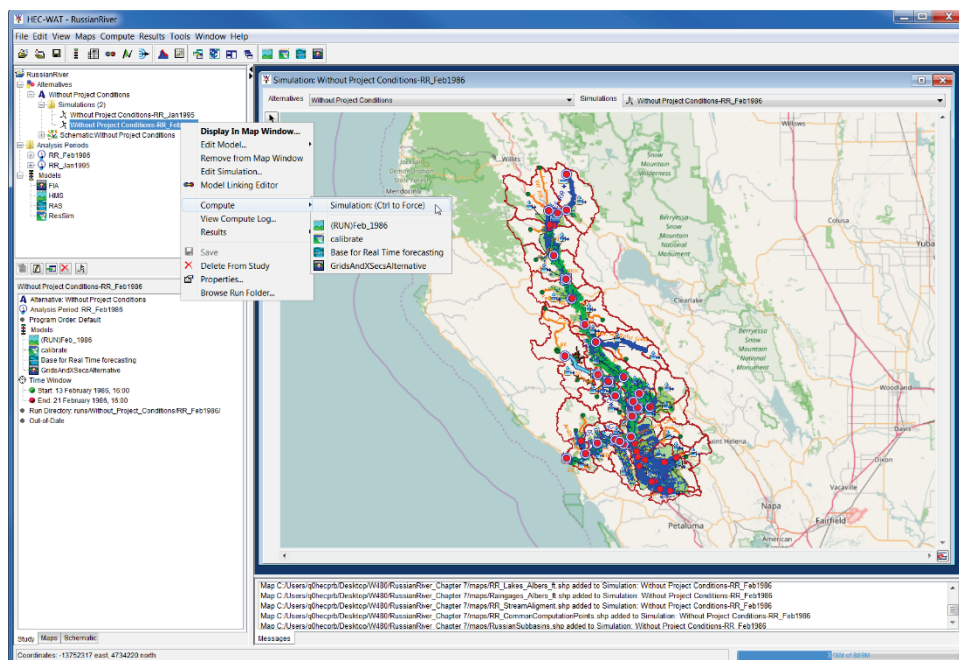


Figure 14.1 HEC-WAT Main Window

2. Holding down the **Ctrl** key forces all models alternatives in the compute sequence to compute, and is the recommended way to compute until additional coordination between HEC-WAT and software application teams has been completed.
3. The **Compute Progress** dialog box will open (Figure 14.2). When the compute is finished, click **Close**, the **Compute Progress** dialog box will close (Figure 14.2).

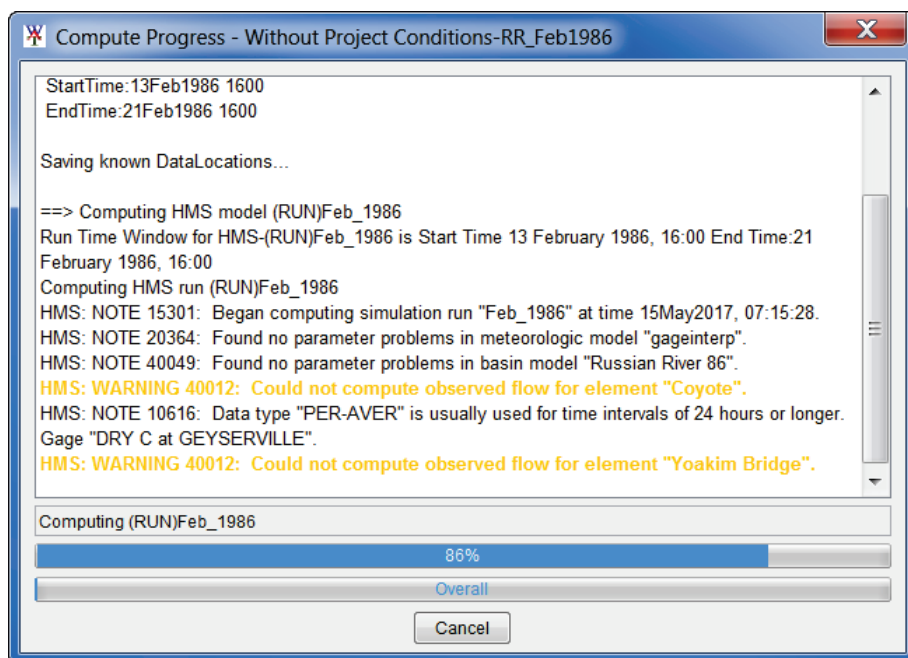


Figure 14.2 Compute Progress Dialog Box

## 14.1.2 Compute Menu

From the HEC-WAT main window (Figure 14.1) from the **Compute** menu (Figure 14.3), the user can compute a single simulation from different commands. If a simulation is active (displayed in a **Simulation Map Window** in the **Desktop Pane**), then the first item in the **Compute** menu will be that simulation's name (e.g., *Without Project Conditions-RR\_Feb1986*), hold down the **CTRL** key, click on the simulation, the **Compute Progress** dialog box will open (Figure 14.2) and the compute will start.

Alternately, from the **Compute** menu (Figure 14.3), point to **Recent Simulations**, a list of recently computed simulations will display. Hold down the **CTRL** key, click on the simulation that is to be computed. The **Compute Progress** dialog box will open (Figure 14.2) and the compute will start.

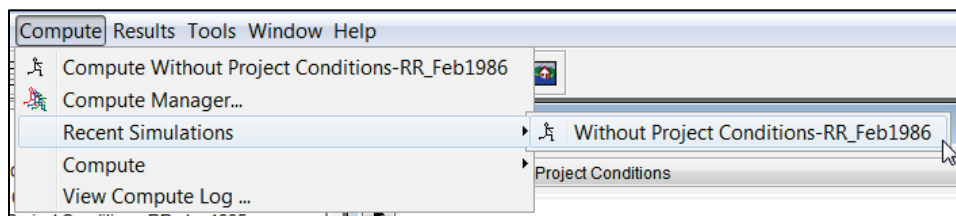


Figure 14.3 HEC-WAT Main Window – Compute Menu

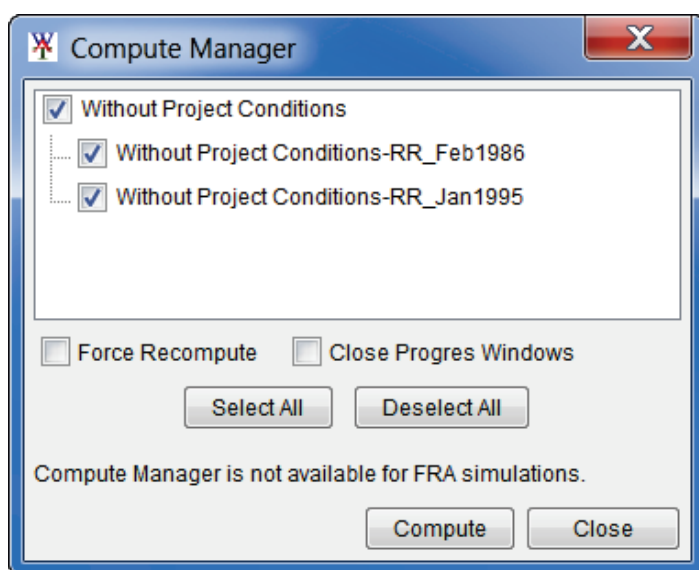


Finally, from the **Compute** menu (Figure 14.3), point to **Compute**, hold down the **CTRL** key, click **Simulation**, the **Compute Progress** dialog box will open (Figure 14.2), and the **Compute Progress** dialog box will open (Figure 14.2) and the compute will start. This will compute the active simulation (displayed in a **Simulation Map Window** in the **Desktop Pane**).

## 14.2 Compute – Multiple Simulations

To compute multiple simulations (non-FRA simulations):

1. From the **Compute** menu (Figure 14.3), click **Compute Manager**, the **Compute Manager** dialog box will open (Figure 14.4).



**Figure 14.4** Compute Manager Dialog Box

2. From the tree, simulations are organized by HEC-WAT alternatives (i.e., *Without Project Conditions*), with sub-nodes being the simulations (i.e., *Without Project Conditions-RRFeb1986*) that have been defined for an HEC-WAT alternative.
3. By default, the known simulations are all selected for computing. To un-select simulations, click the checkbox next to a simulation, the check mark will disappear and the simulation will not be computed. To easily de-select all simulations, click **Deselect All** (Figure 14.4); to select all simulations, click **Select All** (Figure 14.4).
4. **Force Recompute** (Figure 14.4) forces all models in the compute sequence to re-compute, and is the recommended way to re-compute until additional coordination between HEC-WAT and application teams has been completed.
5. For each simulation that is computed, a **Compute Progress** dialog box will open (Figure 14.2). When computing several simulations at once, many **Compute Progress** dialog boxes will be visible. The user can turn off the appearance of the **Compute Progress** dialog boxes by clicking **Close Progress Windows** (Figure 14.4).

6. Once the simulations have been selected in the **Computer Manager** dialog box (Figure 14.4), click **Compute**, a **Compute Progress** dialog box (Figure 14.2) will open for each simulation as that simulation starts to compute.
7. When done computing simulations, click **Close** (Figure 14.4), the **Computer Manager** dialog box will close (Figure 14.4).

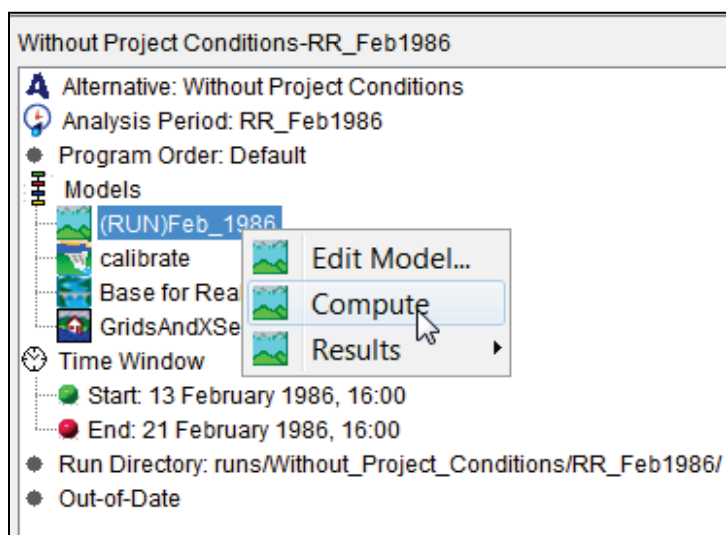
### 14.3 Compute – Individual Model Alternatives

Individual model alternatives (i.e., simulations, plans, alternatives) can be computed from within an HEC-WAT compute sequence. For example, within a compute sequence that includes HEC-HMS, HEC-ResSim, HEC-RAS and then HEC-FIA, the user can choose to run just the HMS model alternative within the compute sequence, or run only the HMS and ResSim model alternatives. The user can also choose to run the entire compute sequence.

The user can compute individual model alternatives from the HEC-WAT framework from several different places. From the HEC-WAT main window (Figure 14.1), from the **Study Tree**, from the **Simulations** folder, right-click on a simulation (e.g., *Without Project Conditions-RR\_Feb1986*). From the shortcut menu (Figure 14.1) point to **Compute**, from the sub-menu the user can choose which available model alternative to compute. The **Compute Progress** dialog box will open (Figure 14.2) and the compute will start.

From the HEC-WAT main window (Figure 14.1), from the **Compute** menu (Figure 14.3), point to **Compute**, from the sub-menu the user can choose which available model alternative to compute. The **Compute Progress** dialog box will open (Figure 14.2) and the compute will start.

From the HEC-WAT main window (Figure 14.1), the user needs to select a simulation from the **Study Tree**, under the **Simulation** folder. The **Content Pane** (Figure 14.5) contains information about the selected simulation, including what model alternatives are part of the simulation. From a model alternative, right-click, from the shortcut menu click **Compute**. The **Compute Progress** dialog box will open (Figure 14.2) and the compute will start.



**Figure 14.5** Content Pane – Individual Model Alternatives Shortcut Menu



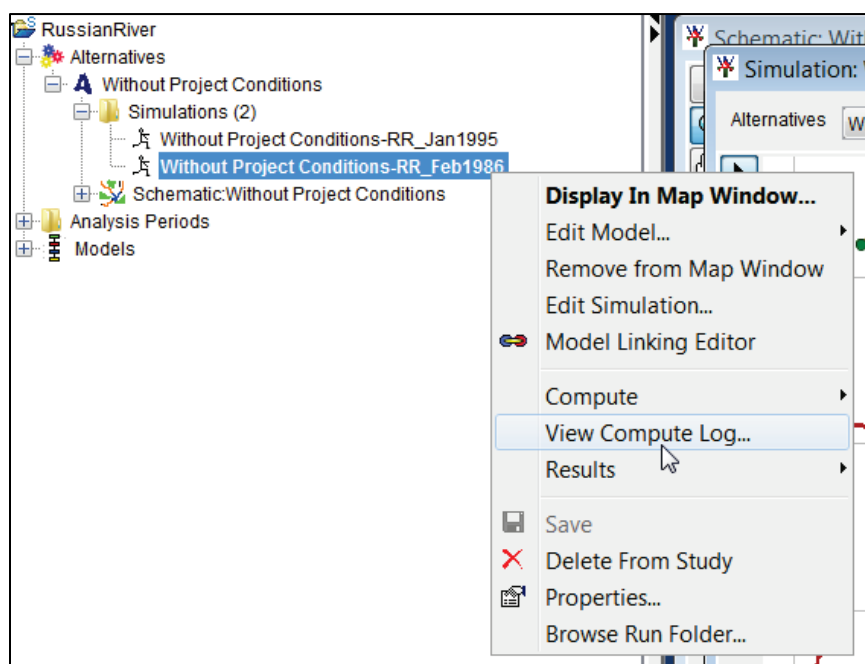
## 14.4 Compute through a Specific Model Alternative

The user can compute a simulation through an individual model alternative from the **Study Tree**, from the **Simulations** folder, right-click on a simulation (e.g., *Without Project Conditions-RR\_Feb1986*). From the shortcut menu (Figure 14.1) point to **Compute**, from the sub-menu, click on the model alternative where the compute will stop. The **Compute Progress** dialog box will open (Figure 14.2) and the compute will start. The user can perform the same function from the **Compute** menu (Figure 14.3). If previous model alternatives have been computed and not changed, those model alternatives will be skipped.

## 14.5 Compute Log

To view a simulation compute log:

1. From the HEC-WAT main window (Figure 14.1), from the **Study Tree**, from the **Simulations** folder, right-click on a simulation, from the shortcut menu (Figure 14.6), click **View Compute Log**. Also, from the **Compute Menu** (Figure 14.3), click **View Compute Log** – this command is only available when there is an active simulation (displayed in a **Simulation Map Window** in the **Desktop Pane**). Both methods open the **View Compute Log Editor** (Figure 14.7).



**Figure 14.6** Individual Simulation Shortcut Menu – View Compute Log

2. The compute log opens in an editor that allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot or review details regarding one of the software applications in the compute sequence.
3. From the **File** menu, click **Close**, the **Compute Log Editor** will close (Figure 14.7).

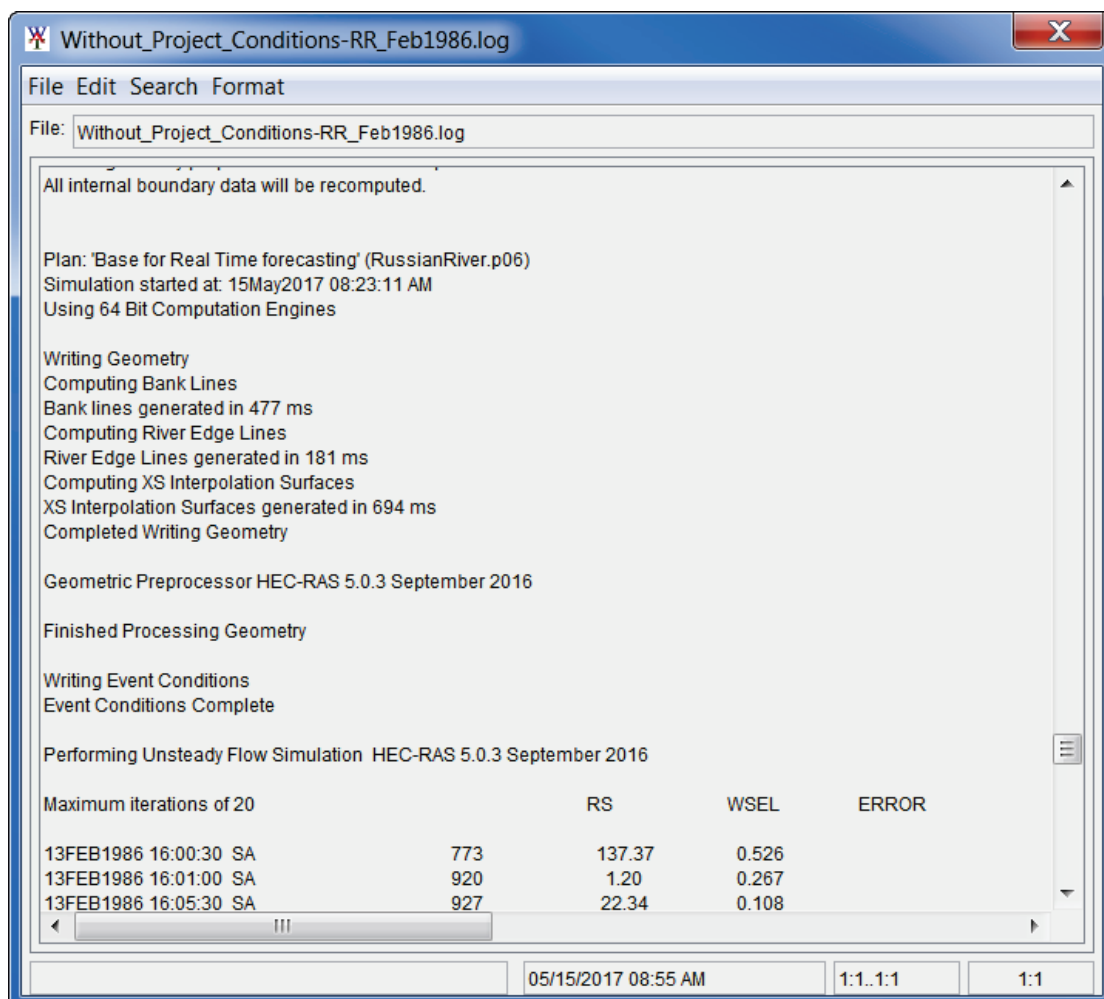


Figure 14.7 Compute Log Editor

## 14.6 Results Menu

From the HEC-WAT **Results** menu, the user can access results from the different software applications in a compute sequence. From the HEC-WAT main window (Figure 4.1), from the **Results** menu (Figure 14.8), the user will point to a software application from which the user wants to view results.

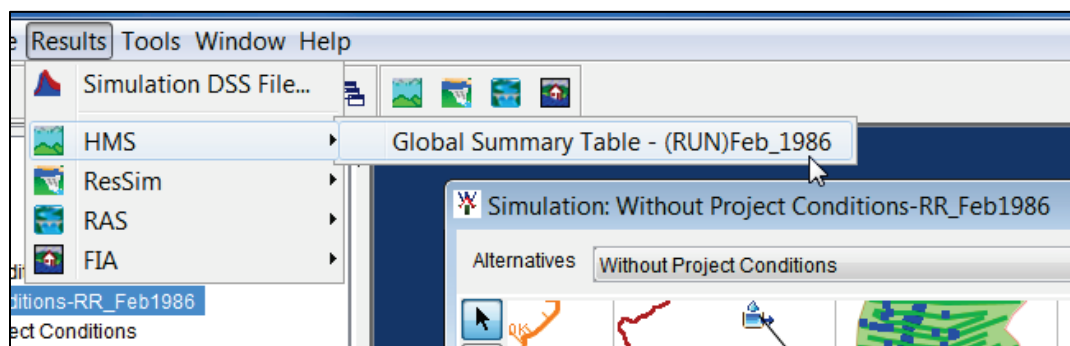
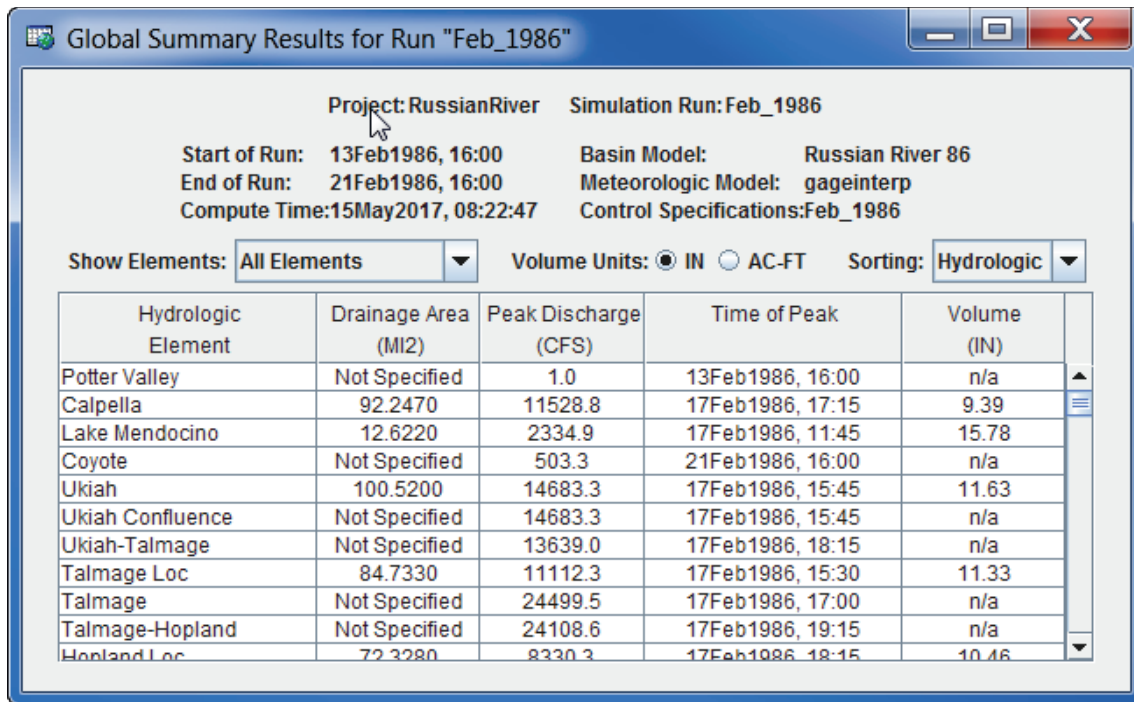


Figure 14.8 HEC-WAT Main Window – Results Menu - HMS

For example, in Figure 14.8, the user points to **HMS**, clicks **Global Summary Table**, the **Global Summary Results** for that particular HMS model alternative will display (Figure 14.9). The summary table is a native summary table that is generated by HEC-HMS; however, the summary table is accessed through HEC-WAT.



Project: RussianRiver Simulation Run: Feb\_1986

Start of Run: 13Feb1986, 16:00 Basin Model: Russian River 86  
 End of Run: 21Feb1986, 16:00 Meteorologic Model: gageinterp  
 Compute Time: 15May2017, 08:22:47 Control Specifications: Feb\_1986

Show Elements: All Elements Volume Units: ☒ IN ☐ AC-FT Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI <sup>2</sup> )	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Potter Valley	Not Specified	1.0	13Feb1986, 16:00	n/a
Calpella	92.2470	11528.8	17Feb1986, 17:15	9.39
Lake Mendocino	12.6220	2334.9	17Feb1986, 11:45	15.78
Coyote	Not Specified	503.3	21Feb1986, 16:00	n/a
Ukiah	100.5200	14683.3	17Feb1986, 15:45	11.63
Ukiah Confluence	Not Specified	14683.3	17Feb1986, 15:45	n/a
Ukiah-Talmage	Not Specified	13639.0	17Feb1986, 18:15	n/a
Talmage Loc	84.7330	11112.3	17Feb1986, 15:30	11.33
Talmage	Not Specified	24499.5	17Feb1986, 17:00	n/a
Talmage-Hopland	Not Specified	24108.6	17Feb1986, 19:15	n/a
Hopland Loc	72.3280	8330.3	17Feb1986, 18:15	10.46

Figure 14.9 HMS - Global Summary Report

For HEC-RAS, from the **Results** menu, point to **RAS**, the sub-menu (Figure 14.10) provides a list of available HEC-RAS results from which the user can select. For example, from the RAS results menu, click **Plot XYZ 3-D**, the **X-Y-Z Perspective Plot** dialog box will open (Figure 14.11). The plot is a native result that is generated by HEC-RAS; however, the plot is accessed through HEC-WAT.

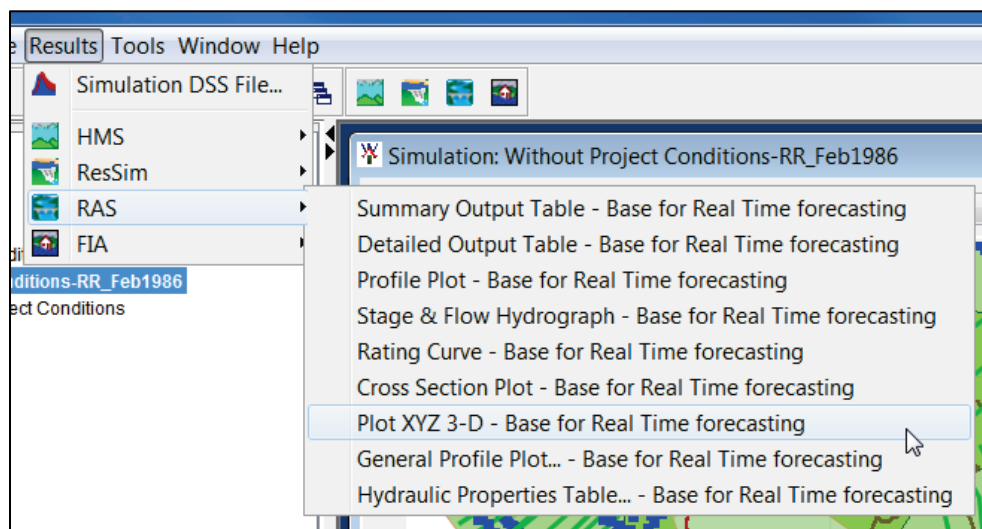


Figure 14.10 HEC-WAT Main Window – Results Menu - RAS

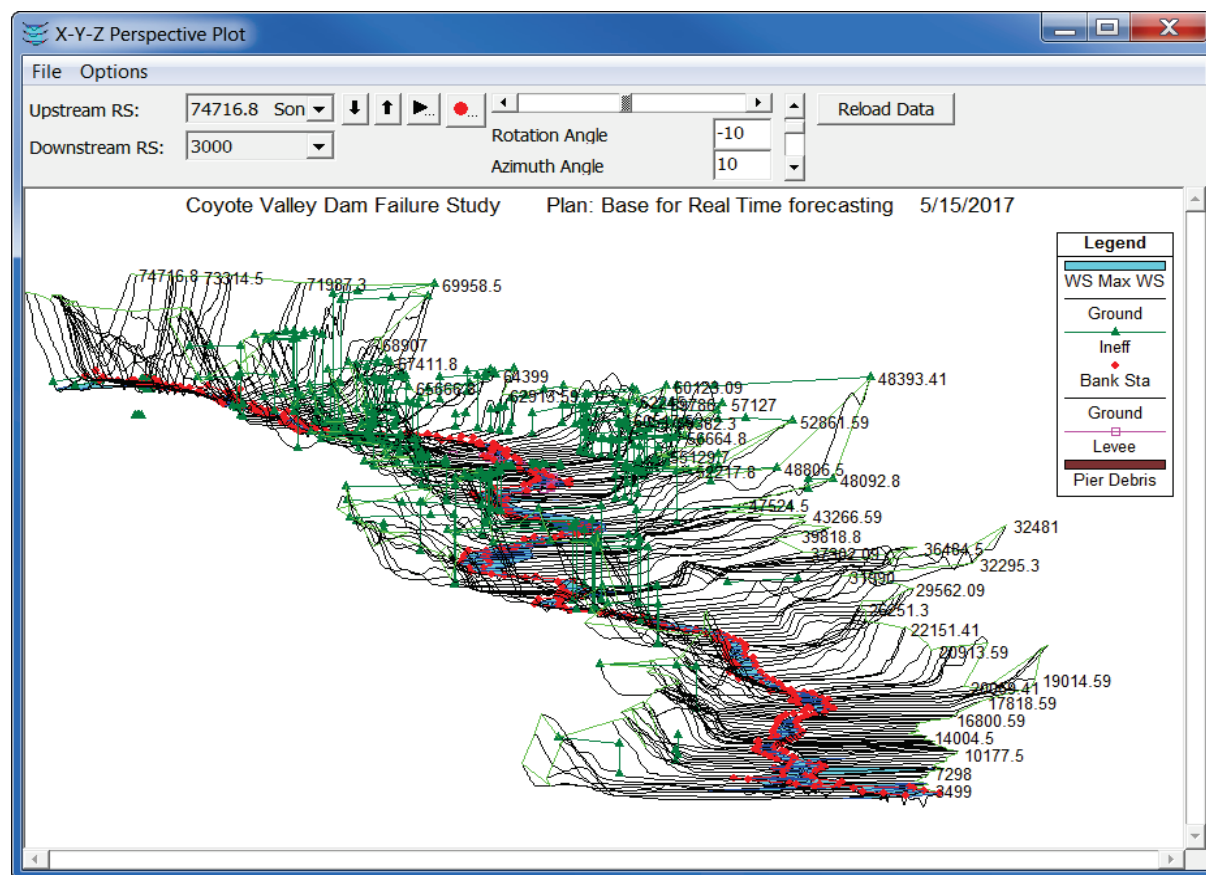


Figure 14.11 RAS - X-Y-Z Perspective Plot

## 14.7 Content Pane

Once a simulation has been computed, the user can review the same reports that are available from the **Results** menu from the **Content Pane**. From the **Content Pane**, right-click on one of the available model alternatives, from the shortcut menu (Figure 14.12), point to **Results**, click on the results that are available.

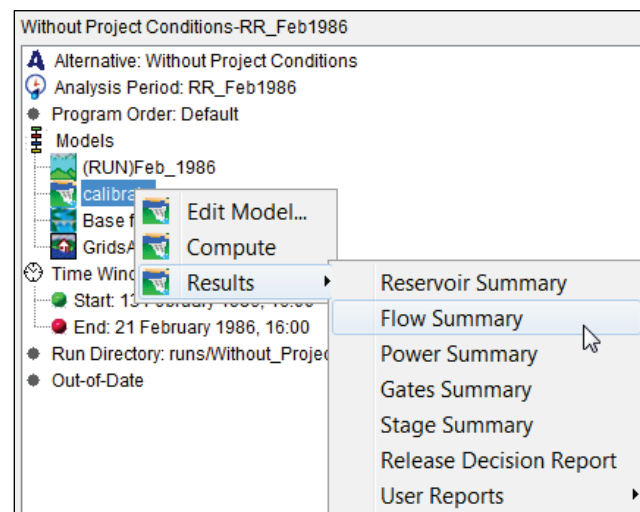
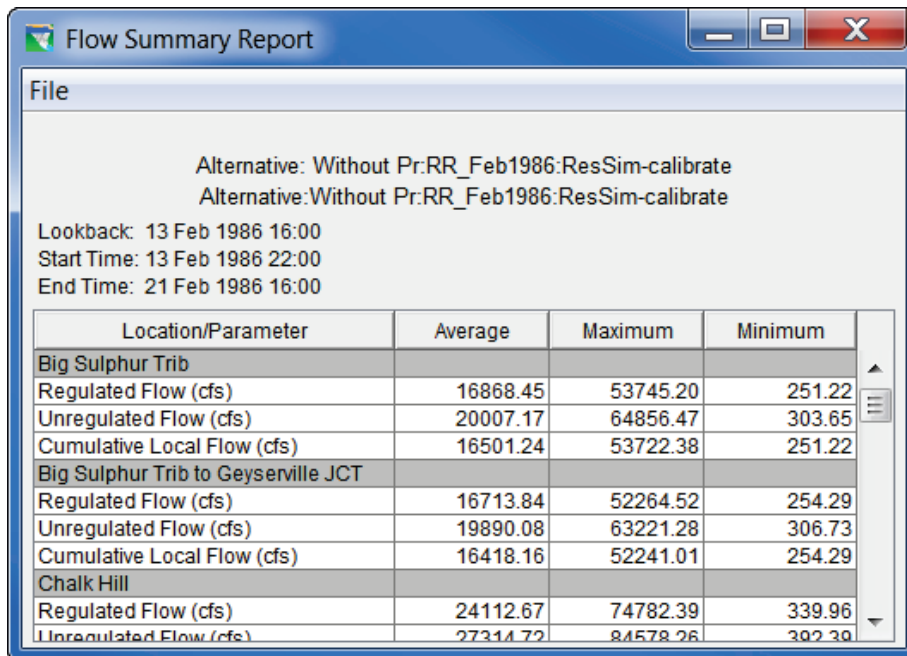


Figure 14.12 Content Pane - Shortcut Menu – Results - ResSim

For example, in Figure 14.12, from the **Content Pane**, right-click on the ResSim *calibrate* model alternative, point to **Results**. The sub-menu provides a list of available HEC-ResSim results from which the user can select. For example, point to **Results**, click **Flow Summary**, the **Flow Summary Report** dialog box will open (Figure 14.13). The report is a native result that is generated by HEC-ResSim; however, the report is accessed through HEC-WAT.



Flow Summary Report

File

Alternative: Without Pr:RR\_Feb1986:ResSim-calibrate  
Alternative:Without Pr:RR\_Feb1986:ResSim-calibrate

Lookback: 13 Feb 1986 16:00  
Start Time: 13 Feb 1986 22:00  
End Time: 21 Feb 1986 16:00

Location/Parameter	Average	Maximum	Minimum
<b>Big Sulphur Trib</b>			
Regulated Flow (cfs)	16868.45	53745.20	251.22
Unregulated Flow (cfs)	20007.17	64856.47	303.65
Cumulative Local Flow (cfs)	16501.24	53722.38	251.22
<b>Big Sulphur Trib to Geyserville JCT</b>			
Regulated Flow (cfs)	16713.84	52264.52	254.29
Unregulated Flow (cfs)	19890.08	63221.28	306.73
Cumulative Local Flow (cfs)	16418.16	52241.01	254.29
<b>Chalk Hill</b>			
Regulated Flow (cfs)	24112.67	74782.39	339.96
Unregulated Flow (cfs)	27314.72	84578.26	302.30

Figure 14.13 ResSim - Flow Summary Report

Another example, from the **Content Pane**, right-click on the FIA *GridsAndXSecsAlternative* model alternative, point to **Results**. The sub-menu (Figure 14.14) provides a list of available HEC-FIA results from which the user can select. For example, point to **Results**, click **Individual Structure Damage Report**, the **Individual Structure Damage Report** dialog box will open (Figure 14.15). The report is a native result that is generated by HEC-FIA; however, the report is accessed through HEC-WAT.

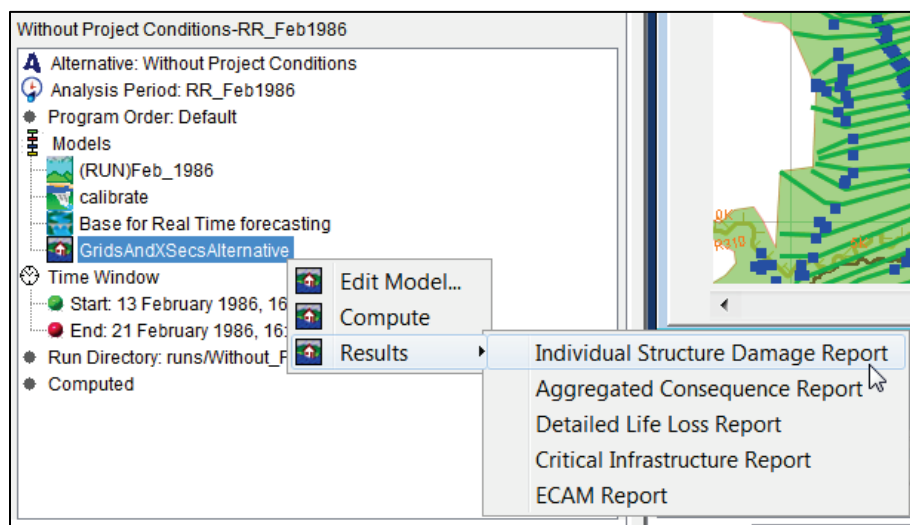



Figure 14.14 Content Pane - Shortcut Menu – Results - FIA



Structure Name	Damage				Total Damage	Depth of Flooding
	Struct Damage	Cont Damage	Car Damage	Other Damage		
RES1-1SNB 06097 64222	0.0	0.0	0.0	0.0	0.0	-3.81
RES1-1SNB 06097 64216	0.0	0.0	0.0	0.0	0.0	-3.34
RES1-2SWB 06097 64250	7651.58	3952.89	0.0	0.0	11604.47	-2.59
RES2 06097 64263	0.0	0.0	0.0	0.0	0.0	-2.41
RES2 06097 64256	1892.75	258.1	0.0	0.0	2150.86	-0.55
RES1-1SNB 06097 64218	0.0	0.0	0.0	0.0	0.0	-2.62
RES1-2SNB 06097 64248	15524.34	6286.51	490.56	0.0	22301.4	0.41
RES1-1SNB 06097 64217	0.0	0.0	0.0	0.0	0.0	-3.94
RES1-1SNB 06097 47282	0.0	0.0	0.0	0.0	0.0	-1.65
IND3 06097 24724	0.0	0.0	0.0	0.0	0.0	-2.89
RES1-1SNB 06097 47281	0.0	0.0	0.0	0.0	0.0	-2.61
RES2 06097 47260	30874.93	14867.47	11256.62	0.0	56999.01	6.25
RES1-2SNB 06097 47251	22786.22	26702.77	11256.62	0.0	70745.61	6.05

Figure 14.15 FIA - Individual Structure Damage Report

## 14.8 Schematic

Results from the schematic are available by right-clicking on schematic elements and from the shortcut menu select result items (zooming in on an area is a good idea). From the map window click the **Pointer Tool** , right-click on a schematic element, a shortcut menu will appear (Figure 14.16). For example, in Figure 14.16, from the shortcut menu, besides providing information about a junction, HEC-WAT also provides information on schematic elements that are around the junction, like impact areas, routing reaches, and cross sections.

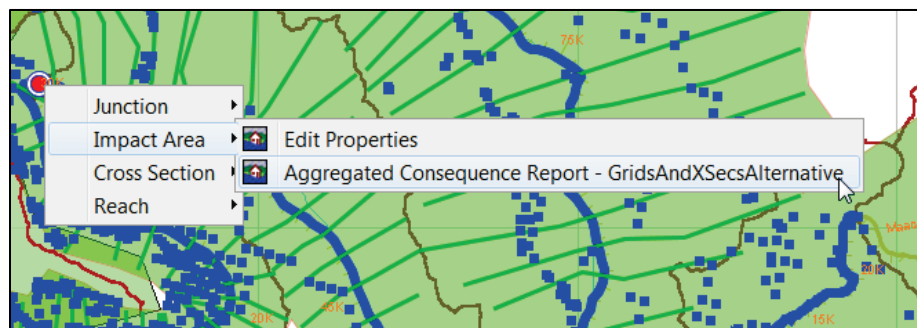
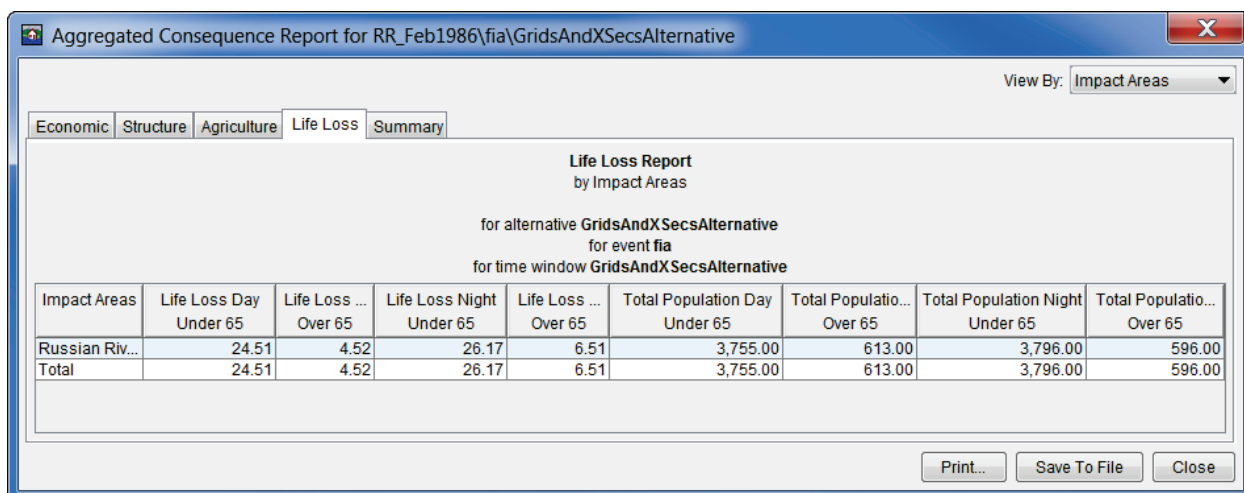


Figure 14.16 HEC-WAT Schematic Shortcut Menu – Impact Area

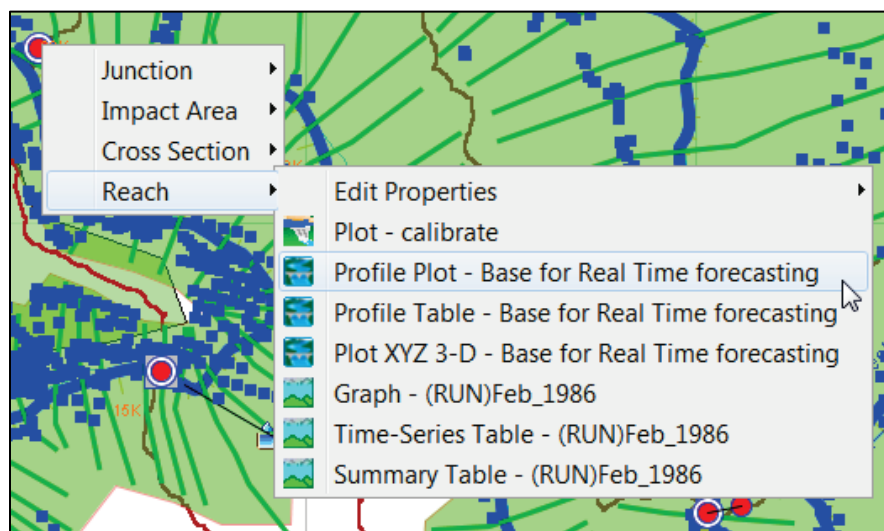
In the example (Figure 14.16), the user right-clicks on a junction from the schematic, from the shortcut menu (Figure 14.16), point to **Impact Area**, click **Aggregated Consequence Report**, the HEC-FIA **Aggregated Consequence Report** will open (Figure 14.17). Click the **Life Loss** tab to get a **Life Loss Report** by impact areas. The report is a native result that is generated by HEC-FIA; however, the report is accessed through HEC-WAT.



**Figure 14.17** FIA - Aggregated Consequence Report - Life Loss Report

From the same location in Figure 14.16, from the shortcut menu point to **Reach**. The sub-menu (Figure 14.18) lists all the available results from the models in the compute sequence that include routing reaches in their analysis (hydrologic, hydraulic). In Figure 14.18, each software application that has results is represented by the icon for each software application. For example, if the user wants to view the computed profile for a particular HEC-RAS hydraulic routing reach, click **Profile Plot** (Figure 14.18), the HEC-RAS **Profile Plot** (Figure 14.19) is displayed. The plot is a native result that is generated by HEC-RAS; however, the plot is accessed through HEC-WAT.

Another example, from the same location (Figure 14.16), from the shortcut menu (Figure 14.18) point to **Reach**. To view the computed hydrograph at that location along an HEC-HMS hydrologic routing reach, click **Graph**, and the **Graph for Reach** (Figure 14.20) is displayed. The plot is a native result that is generated by HEC-HMS; however, the plot is accessed through HEC-WAT.



**Figure 14.18** HEC-WAT Schematic Shortcut Menu - Reach

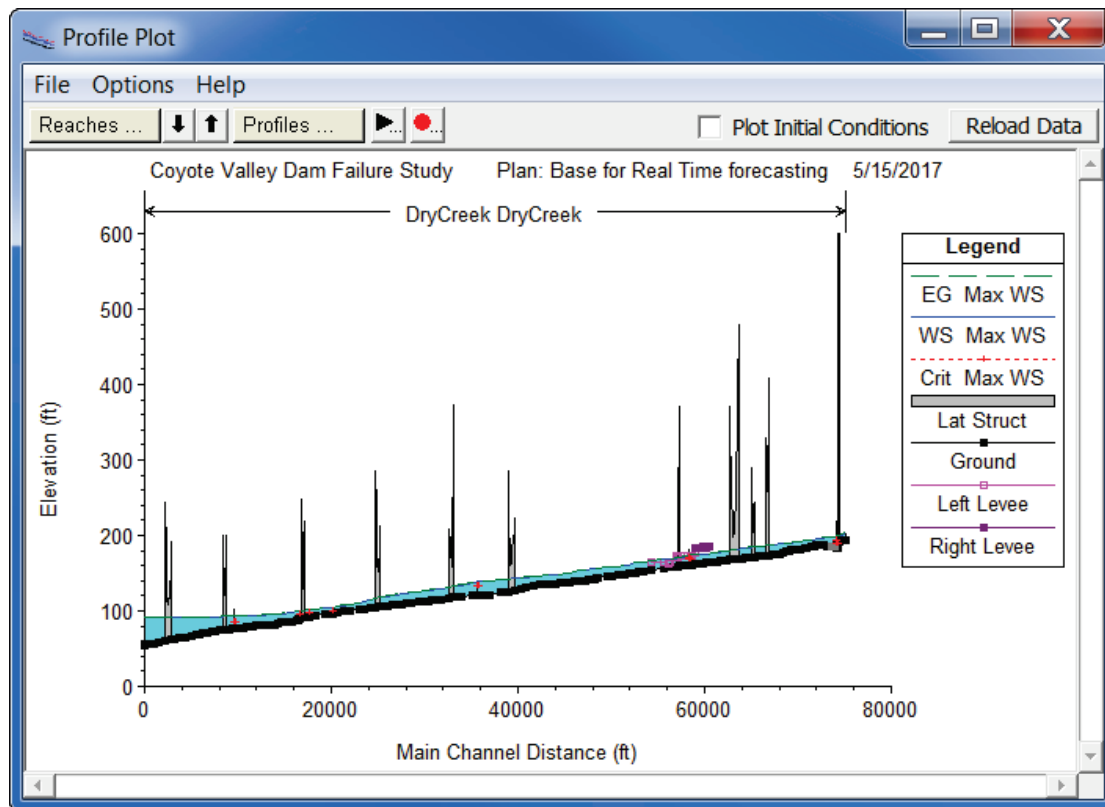


Figure 14.19 RAS - Profile Plot

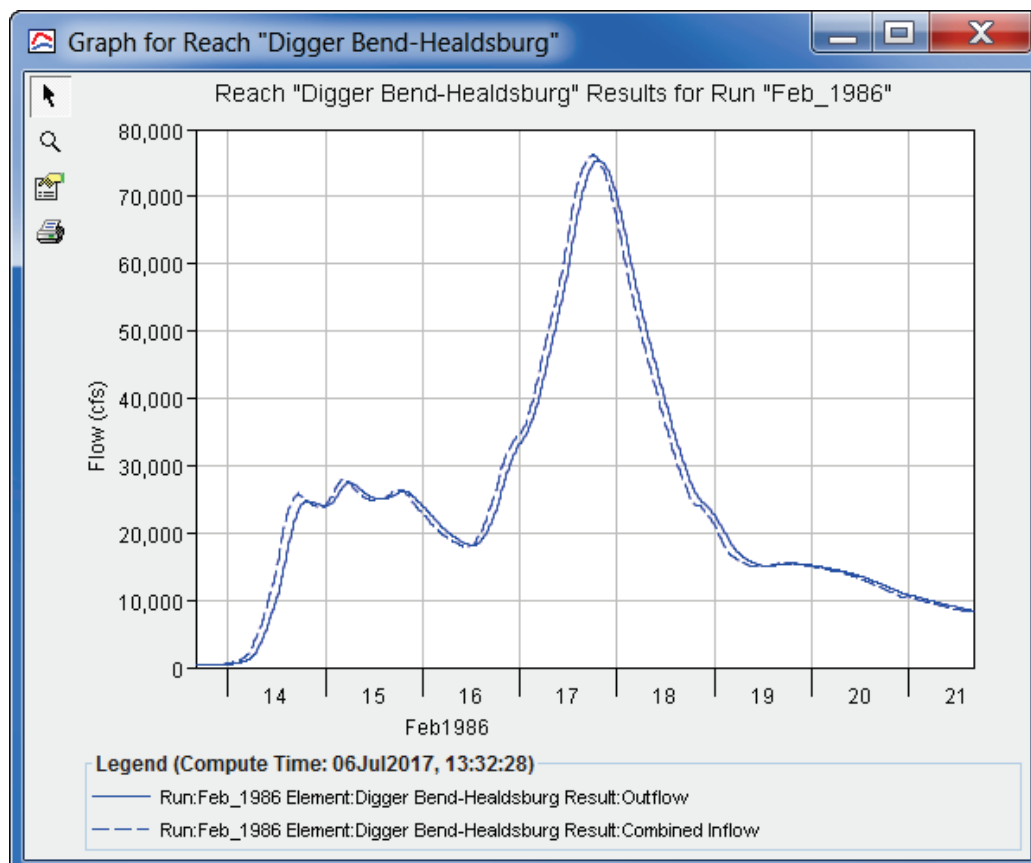


Figure 14.20 HMS - Graph of HEC-HMS Routing Reach

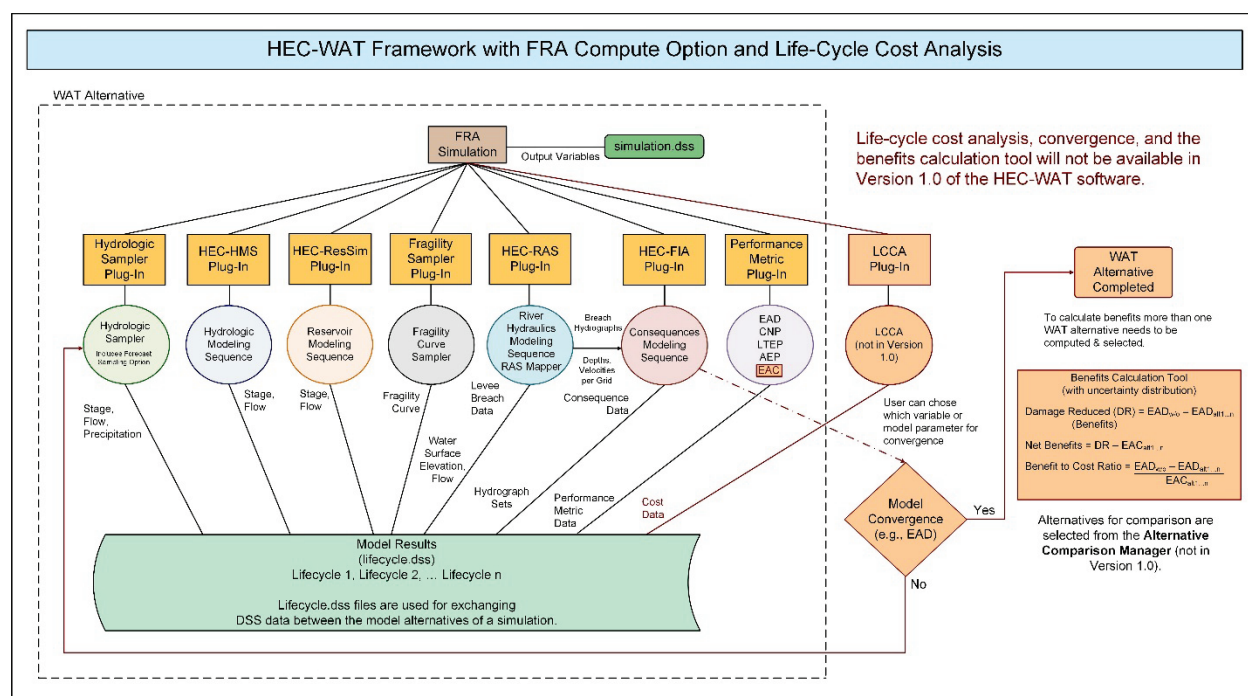


# CHAPTER 15

## Flood Risk Analysis (FRA) Compute Option

USACE flood risk management (FRM) policy requires that USACE analytical processes include methods and tools that employ integrated, comprehensive, systems and life-cycle based approaches and risk-based concepts in planning, design, construction, operations and major maintenance. These USACE methods need to incorporate systems response of projects when considering load distribution and failure possibilities. USACE policy also states that project performance needs to consider the system reaction to flood loading and how those loadings are distributed across the watershed.

HEC-WAT includes an option that will analyze complex riverine systems while implementing the flood risk management and systems requirements. Currently, life-cycle analysis in HEC-WAT is a period of analysis with no changes to measures (i.e., levees, reservoirs) being accounted for over that period of analysis. For levees, that period of analysis is fifty years, and for reservoirs/dams that period is 100 years. True life-cycle analysis is the tracking of how things (i.e., failure, re-build, maintenance) could change during the period of analysis for measures (i.e., levees, reservoirs), which HEC-WAT will address in a later version. The compute option, Flood Risk Analysis (FRA), allows a user to perform plan formulation or system performance analyses while incorporating risk analysis. FRA includes several plug-ins that provide sampling methodologies for hydrology and fragility curves (Figure 15.1). Also, a majority of the initial set of HEC software applications will include parameter sampling.



**Figure 15.1** HEC-WAT Framework - Flood Risk Analysis (FRA) Compute Option

## 15.1 Overview

The FRA compute option in HEC-WAT allows users to perform risk analysis using a Monte Carlo simulation approach. The Monte Carlo simulation provides a method for incorporating a probabilistic description of inputs (i.e., boundary conditions, initial conditions, model parameters) into an analysis while making use of detailed deterministic models. During a Monte Carlo simulation, the single-valued inputs (deterministic models) are replaced with randomly sampled values as defined by probability distributions. In turn, the sampled model information is repeated over and over to span the possible range of model inputs to quantify uncertainty in model results. During an FRA simulation input values are sampled, algorithmic decisions are performed, results are summarized, and convergence is reached (for Version 1.0, automatic convergence is not a feature, the user must define the total number of events).

The FRA compute option allows the model alternatives to evaluate a full range of flood scenarios based on reasonable probabilistic assumptions. The randomly sampled input values, the models involved in the simulation sequence, and the hydrologic loading are all executed iteratively according to the Monte Carlo analysis. At the beginning of each iteration, HEC-WAT generates random numbers which are used by each model alternative in the simulation, with the software application independently deciding if and how to use those random numbers.

An FRA compute requires a large amount of computation resources and a large amount of storage for results. HEC-WAT provides model skip flags (Chapter 18) that are developed based on user criteria that aid in the budgeting of simulation times. This is a very high-level overview of the FRA compute option, for further details on the Monte Carlo simulation, the HEC-WAT Technical Reference Guide will provide details (will not be available with Version 1.0 release).

This chapter provides an overview of the items that the user will need to create for an FRA simulation for a study area. This includes plug-ins; sampling of hydrologic data; possible sampling of levee fragility curves; analysis periods (time windows); alternatives; simulations; computations; and results. Chapters following this section will provide more details on certain items in an FRA study.

## 15.2 Random Numbers

When an FRA compute starts, HEC-WAT generates pseudo-random numbers. Pseudo random numbers allow for repeatability of the random sampling when an HEC-WAT alternative is re-computed or between multiple HEC-WAT alternatives. This means that the random values used to sample input variables are pseudo-random, which allows the same random value to be reproduced identically in a subsequent compute. Repeatability is important to support comparison of study alternatives or in case a simulation is stopped for some reason. Also, when an event is deemed interesting after the compute is complete, a user can re-run that particular event, saving detailed information for further analysis.

The pseudo-random numbers are generated by a random number generator, which uniquely determines the pseudo-random numbers that are created. Random numbers are generated for each software application (and plug-ins) listed in the program order of a simulation. Three sets of pseudo-random numbers are created, one set varies by realization (knowledge uncertainty),

another set varies by life cycle, and the third set varies by event (natural variability). Any software application (and plug-in) must be able to accept these pseudo-random numbers, but not necessarily do anything with the pseudo-random numbers. In Version 1.0, most of the current software applications and plug-ins will receive all of the pseudo-random numbers, but only use one of the pseudo-random numbers. Some of the software applications not doing anything with the pseudo-random number information. The fragility curve sampler and HEC-ResSim use two of the pseudo-random numbers.

Further details on the pseudo-random numbers and how this information is being used in the FRA compute and by the other software applications and plug-ins, are provided in the HEC-WAT Technical Reference Guide.

### 15.3 Realizations, Life Cycles, and Events

The Monte Carlo simulation in the FRA compute is implemented as a two-level nested process so that the uncertainty about the probability distributions can be captured, along with the nature of the uncertainty. Two kinds of uncertainty are distinguished in an FRA compute:

- Knowledge uncertainty (epistemic uncertainty) random variables are not known exactly and exist when it is not possible to make an accurate estimate of an input value. A few examples are flood likelihood, hydraulic coefficients, and channel capacities.
- Natural variability (aleatoric uncertainty) random variables vary spatially or event-to-event and exist when the outcome of a natural process is random, or the natural process is so complex it seems random when viewed in isolation. A few examples are flood magnitude and forecasts.

The FRA compute incorporates the two kinds of uncertainty separately, and all software applications (plug-ins) must distinguish between knowledge and natural variability random numbers. Iterations in the inner loop, **events**, randomly sample from natural variability uncertainties. When enough events (50, 100, 500, etc.) have been sampled to create frequency curves and compute probabilistic metrics, a **realization** is created. The outer loop randomly samples the knowledge uncertainty to define uncertainty parameters that are held for all the events in a realization.

Life-cycle analysis has been included at a very basic level, further changes to the life-cycle analysis procedures (including cost analysis) will be included in a later version of HEC-WAT. Further details on knowledge and natural variability uncertainty, realizations, life cycles, and events, are provided in the HEC-WAT Technical Reference Guide (not available for Version 1.0 release).

### 15.4 FRA Plug-Ins

The following sections provide information on the plug-ins in HEC-WAT that might be needed for an FRA compute. This covers plug-ins that provide hydrologic data sampling, fragility curve sampling, and performance metric results.

### 15.4.1 Hydrologic Sampling

The first step of the FRA compute is the sampling of the hydrology to create perhaps thousands of events in a hydrologic sequence. The hydrologic sampling will generate hydrologic information such as flow or precipitation frequency curves, cross correlations between curves, and hydrograph or hyetograph shapes, or instead, historical and synthetic event hydrographs. This hydrologic data will be sampled to generate as many realizations of the life-cycle hydrologic sequence as necessary, with each generated sequence provided to the other software applications available in the program sequence. For further details on the hydrologic sampling available in HEC-WAT, refer to the Hydrologic Sampler User's Manual.

### 15.4.2 Fragility Curve Sampler

The sampling of levee failure elevations from fragility curves is accomplished through the Fragility Curve Sampler. This plug-in defines the probability and elevation of failure at each levee that is part of the system. Sampling is conducted and the result is an evaluation of the full range of levee failure possibilities for each pre-defined location in the entire system. The fragility curve sampler is only needed for studies that model levee failures. For further details on the fragility curve sampling available in HEC-WAT, refer to Chapter 17 of this User's Manual.

### 15.4.3 Performance Metrics

USACE guidance and policy requires that risk and uncertainty analyses be performed for USACE planning studies. Risk for USACE is the measure of the probability and severity of undesirable consequences (ER 1105-2-101). From these analyses, the performance of a system's reaction to a flood must be commented. These metrics (Chapter 19) describe the capability of the system to accommodate a single event (Assurance) and the full range of events (Annual Exceedance Probability and Long-Term Exceedance Probability). These metrics assist in communicating risk and are defined in the following sections. Not all FRA studies require the metrics from the Performance Metrics plug-in. Therefore, this plug-in should only be included in the compute sequence when necessary.

#### Expected Annual Damage (EAD)

Expected Annual Damage (EAD) is the average or mean of all possible values of damage determined on an annual basis by a Monte Carlo (a numerical integration approach) analysis of various variables that contribute to EAD along with those variable's associated uncertainties. An HEC-FIA model is required in the FRA compute for EAD to be computed.

#### Annual Exceedance Probability (AEP)

Annual Exceedance Probability (AEP) is the probability that a specific capacity or target stage at a location of interest will be exceeded in a given year, based on the full range of possible flows. For levees (if applicable), AEP is the chance of failure or exceedance in any given year. AEP is calculated at every grid cell and structure, and reflects the probability of ground stage being equaled or exceeded.

## Assurance

Assurance (also known as Conditional Non-Exceedance Probability, CNP) is the probability that a specific target (e.g., the top of a levee) will not be exceeded, given the occurrence of a specific flood event.

## Long Term Exceedance Probability (LTEP)

Long Term Exceedance Probability (LTEP) is the probability that one or more flood events will occur within a specified time period or the likelihood that the target stage will be exceeded in a specified time period. The calculations are made directly by using the binomial distribution (EM 1110-2-1415).

### 15.4.4 Life-Cycle Cost Analysis (LCCA)

The FRA compute capability within the HEC-WAT framework is a computational option that a user can choose to perform plan formulation, system performance analyses or asset management studies using a life-cycle approach. Expected annual damage is computed based on a 50-year life-cycle in part to capture changes to the system through the project life. Net benefits (damage reduced less costs), will be an output from the FRA compute. Therefore, the FRA compute will include the initial and life-cycle costs through that 50 year project life. Life cycle costs include the initial project investment, costs for operation, maintenance, repair, rehabilitation, and replacement. Estimates for future rehabilitation or replacement will include the costs of all related work. For example, it may be necessary to construct temporary facilities to ensure continued project function during replacement. For comparison purposes, evaluation of life cycle costs should include a calculation of the present worth, based on constant dollar analysis, and using appropriate discount rates for future costs. This life-cycle capability will allow for investment decisions on risk management system components and for scenario testing of management options. Life cycle analysis including cost is not available in HEC-WAT Version 1.0.

### 15.4.5 Benefit Calculation Tool

This tool will calculate the benefit (damage reduced) and net benefit (damage reduced minus cost) if cost information is available. HEC-WAT computes the benefits (damage reduced) for each alternative. Damage reduced is the damage prevented because a project or projects (measures), or structural and/or non-structural, are part of an alternative analyses. First, HEC-WAT computes EAD for the Without Project Alternative and uses that EAD as a baseline to compare against all with-project alternatives. The Benefit Calculation Tool subtracts the with-project alternative's EAD from the Without Project Alternative EAD to obtain the damage reduced for that particular with-project alternative. The tool then computes Net Benefit for each with-project alternative by subtracting the EAC (Expected Annual Cost) for that particular with-project alternative from the damage reduced for that particular with-project alternative. If the Net Benefit is greater than zero that means the damage reduced from that with-project alternative exceed costs and therefore is an economically viable project; i.e., net benefits of the with-project alternative exceed the costs of that with-project alternative. To generate the Benefit to Cost ratio,

the Benefit Calculation Tool simply takes the benefits for the with-project alternative and divides by the costs. This tool will not be available in HEC-WAT Version 1.0.

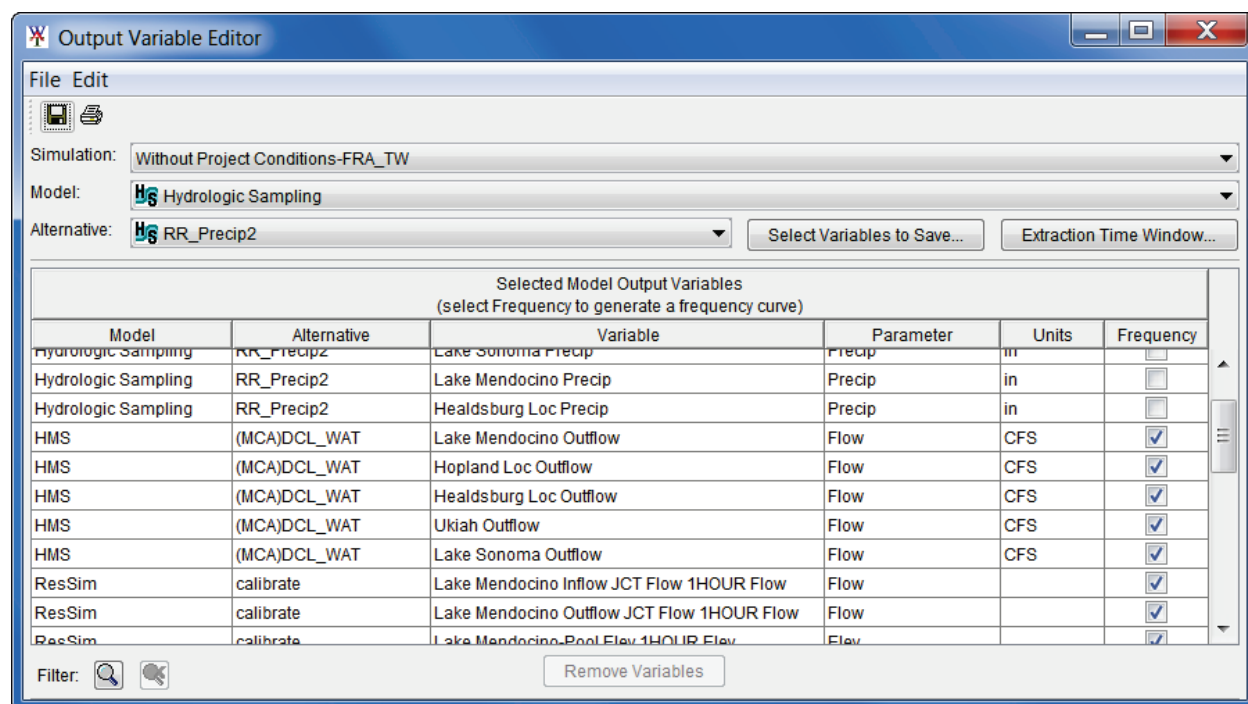
## **15.5 An FRA Study**

Now that the user has created a study (Chapter 7); has imported (Chapter 8) or created the appropriate model alternatives (including a hydrologic sampling alternative); created a program order (Chapter 11); created HEC-WAT alternative(s) (Chapter 10); created analysis period(s) (Chapter 9); and, if HEC-ResSim is included in the compute sequence, created an HEC-ResSim lookback window (Chapter 13, Section 13.3) – the user needs to decide if the study needs to include flood risk analysis. Chapters 16 through 21 provide details on selecting results for an FRA compute to view; setup fragility curve sampling if necessary; how to skip models in an FRA compute; setup the calculation of performance metrics if needed; and, outline the necessary steps for a user to create FRA simulations that will allow the user to perform a plan formulation of system performance analyses that incorporates risk and uncertainty.

# CHAPTER 16

## Output Variable Editor

The **Output Variable Editor** (Figure 16.1) provides an interface for selecting results from an HEC-WAT flood risk analysis (FRA) compute. Currently, only the maximum values from selected model alternative results and sampled parameters from some of the model alternatives are saved through output variables. There are multiple options for saving files and model alternative results from an FRA compute. All time-series information is saved in DSS files organized by life cycles. In many cases, saving and maintaining many thousands of time-series data records is not possible due to storage limitations. However, the maximum value from each time series is useful. For example, the peak flow or stage value from a hydrograph time-series can be used to compute a flow/stage frequency curve or these values can be plotted to quickly show if a flow or stage threshold was exceeded. Saving the sampled parameters or initial conditions is useful when evaluating the conditions that led to certain results (i.e., when a high reservoir stage is a result of sampling a high starting pool condition).

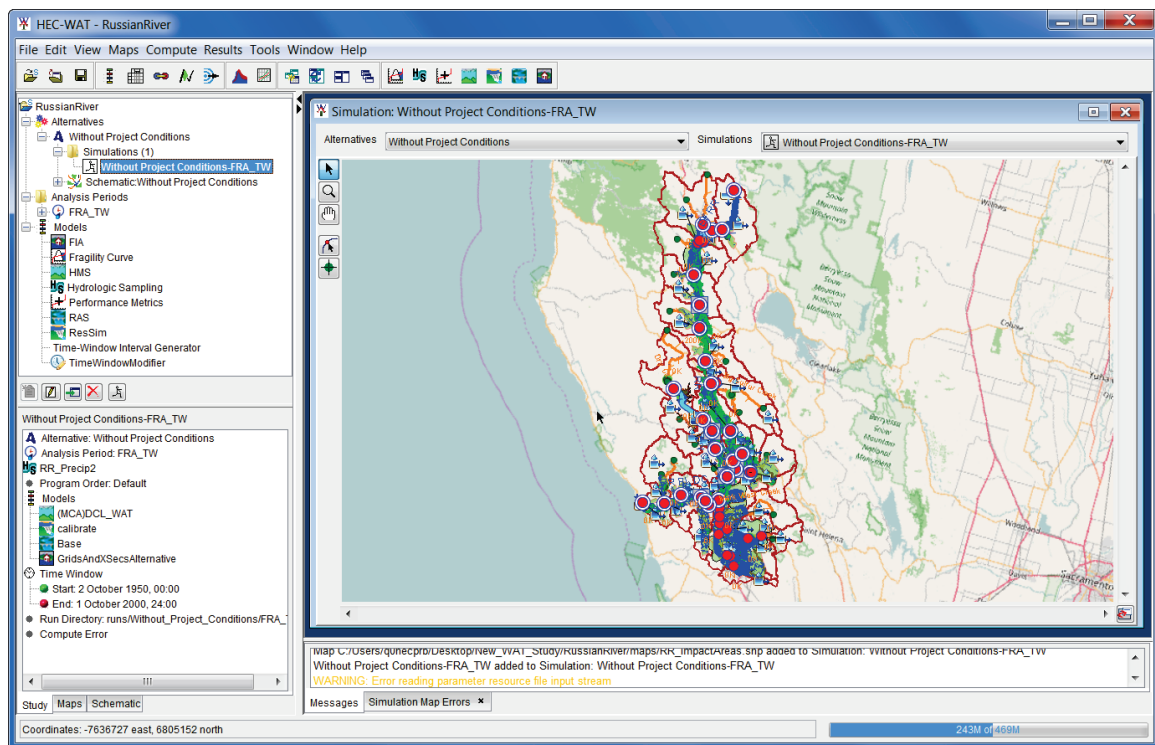


**Figure 16.1** Output Variable Editor

The **Output Variable Editor** has options for selecting an HEC-WAT simulation (only FRA simulations). First, select a model that is part of the selected HEC-WAT simulation program order and then select an available model alternative (a compute sequence can contain multiple instances of the same model) from the selected HEC-WAT simulation. Once those selections have been made, the user can select various variables (maximum values only), and, if wanted, create frequency curves.

The user must choose at least one output variable from the model alternatives in the compute sequence, or notify the FRA simulation to compute without an output variable. For a "production" simulation where results are required, the user should choose all appropriate output variables before running the simulation. Recommended and it is considered good practices for the user to choose at least one output variable. In most cases, the desired type of results from an FRA simulation will include the maximum (or minimum) value from a time-series record. For example, the maximum stage from a reservoir time-series could be extracted to build a reservoir stage frequency curve. Saving time-series information from many thousands of events, at many locations, for many model alternatives could overwhelm the available storage on a computer. However, maximum values (scalars) do not require much disk space. From the **Output Variable Editor** (Figure 16.1), a user can select any available output variables from the model alternatives that are part of a selected FRA simulation and get summary information (e.g., maximum flows, maximum stage, etc.) for each event in the FRA compute.

1. From the HEC-WAT main window (Figure 16.2), from the **WAT Tools** toolbar, click

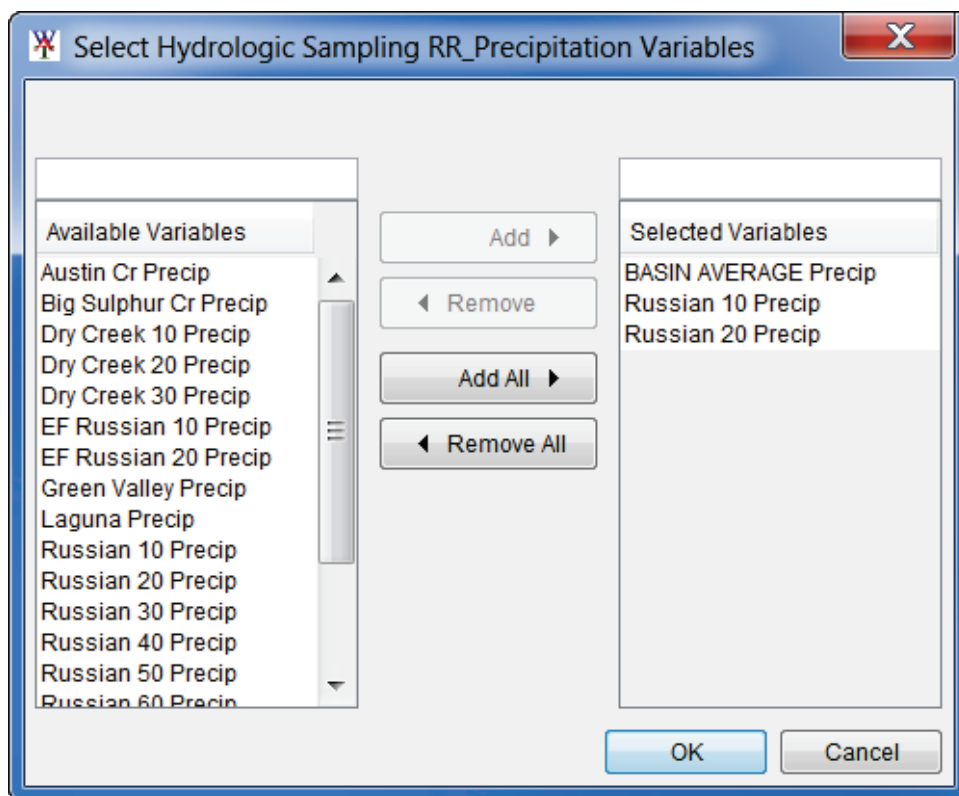


**Figure 16.2** HEC-WAT Main Window

2. The **Output Variable Editor** will open (Figure 16.1). From the editor, the user can select variables from the model alternatives that are part of a selected FRA simulation. Currently, the maximum value for each of the output variables selected will be saved to the *simulation.dss* file and if the user wants to generate a frequency curve for a selected output variable, the user must select **Frequency** from the **Output Variable Editor** (Figure 16.1).



- From the **Simulation** list, select an FRA simulation (only FRA simulations will be available). Next, from the **Model** list select the appropriate software application; and, then from the **Alternative** list select the appropriate model alternative.
- Next, click **Select Variables to Save**, the **Select model name and model alternative name Variables** selector will open (Figure 16.3).

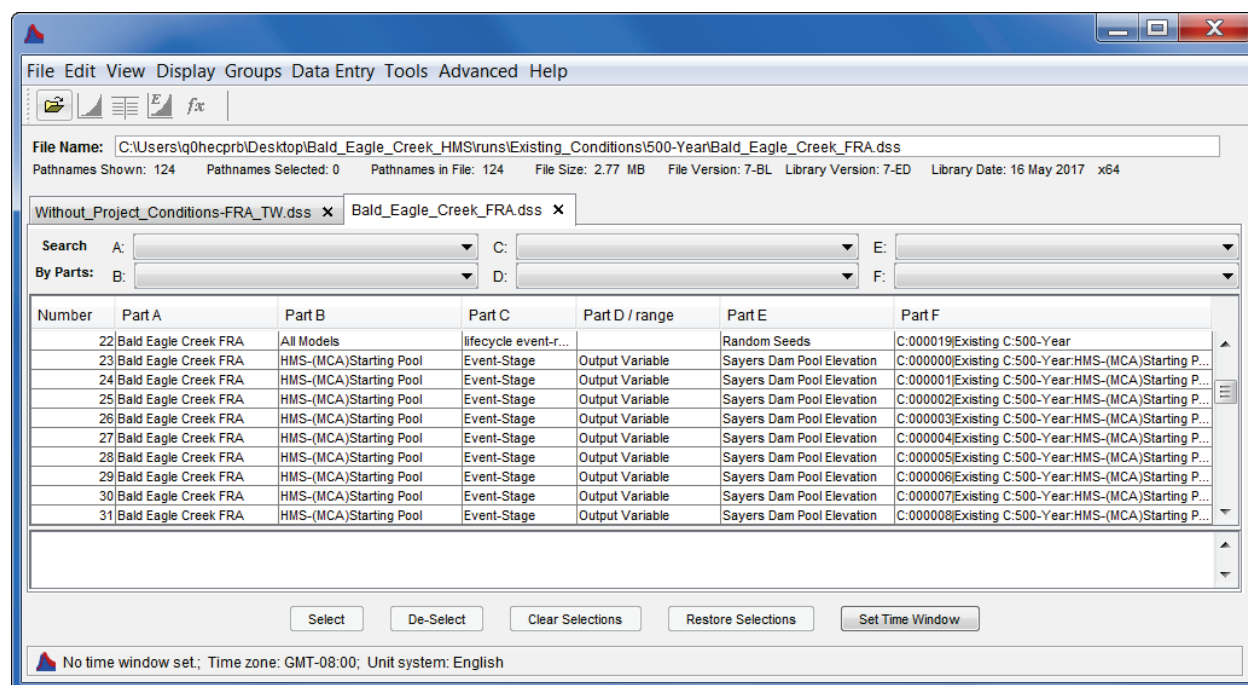


**Figure 16.3** Select model name and model alternative name Variables Selector

- A list of the selected model alternative's available output variables is listed in the **Available Variables** list (e.g., *Hydrologic Sampling, RR\_Precipitation*). To select an output variable, highlight the variable, and then click **Add**. The selected variable is moved to the **Selected Variables** list. Click **OK**, the **Select model name and model alternative name Variables** selector (Figure 16.3) closes and the selected output variables appear on the **Output Variable Editor** (Figure 16.1).
- From the **File** menu, click **Save**. Close the **Output Variable Editor** (Figure 16.1)

## 16.1 Scalar Values

The selected maximum value from each selected time-series is saved to the *simulation.dss* file. The selected output variables can be referred to as scalar values (Figure 16.4) since only the maximum magnitude is saved from the selected time-series records. The output variables are organized by realization in the *simulation.dss* file. Each realization is a collection member, and within a realization record, the individual life cycle results are saved in separate columns of a multi-column paired data record. The x-parameter is the event number, and the y-parameter is



**Figure 16.4** Maximum Scalars Saved to *simulation.dss* File

the maximum value. As shown in Figure 16.5, the results for Realization 1 are broken into two life cycles, Lifecycle 1 and 2, and each life cycle is a separate column in the paired data record. For the example HEC-WAT study being used (Figure 16.5), only two life cycles in a realization were specified which was due to the configuration of the analysis period and the FRA simulation. Other HEC-WAT studies may have a different number of life cycles per realization. Also, notice in Figure 16.5, that there are not scalars for every single event as some events were skipped because model skip flags was being applied (Chapter 18).

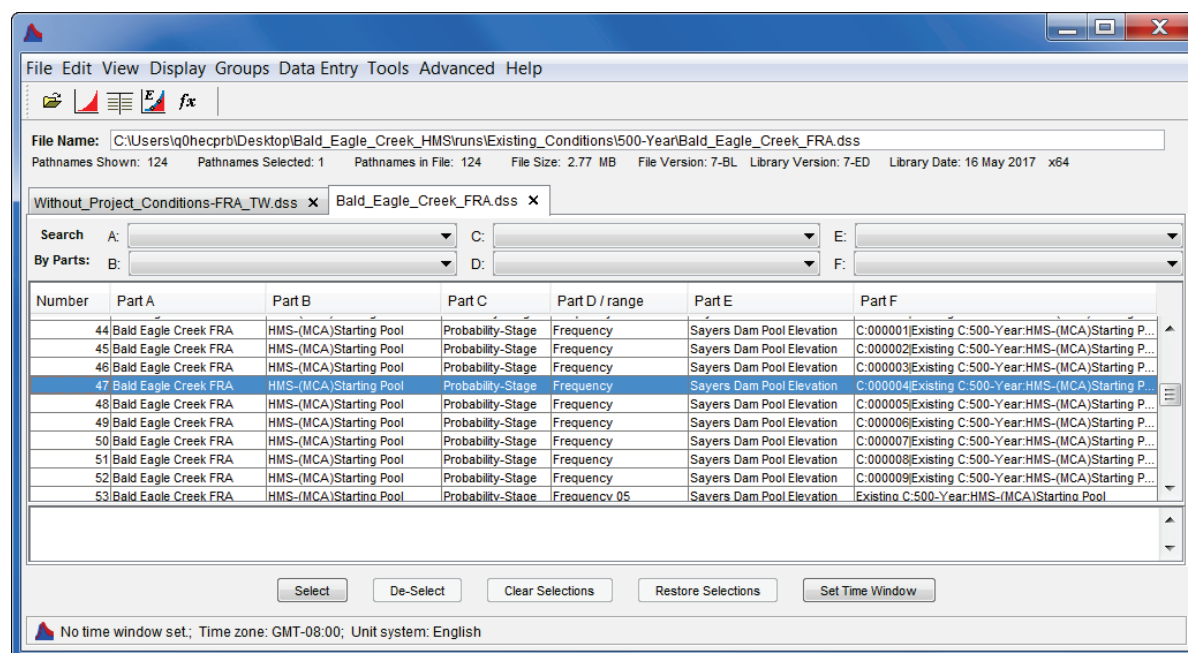
The screenshot shows the 'Tabulated View of Maximum Scalars Saved to simulation.dss File' window. The window title is '/Bald Eagle Creek FRA/HMS-(MCA)Starting Pool/Event-Stage/Output Variable/Sayers Dam Pool Elevation/C:000000\Existing C:500-Year:HMS-(MCA)Starting Pool/'. The window displays a table with columns: Ordinate, Event, HMS-(MCA)Starting Pool Stage lifecycle 1, and HMS-(MCA)Starting Pool Stage lifecycle 2. The table lists 22 rows of data, including 'Labels', 'Units', 'Type', and numerical values for 'lifecycle 1' and 'lifecycle 2'.

Ordinate	Event	HMS-(MCA)Starting Pool Stage lifecycle 1	HMS-(MCA)Starting Pool Stage lifecycle 2
Labels			
Units			
Type			
1			
2			
3			
4			
5			
6			
7	7.00	639.42	648.11
8			
9			
10	10.00	641.25	
11	11.00		628.76
12			
13			
14	14.00		650.64
15	15.00		638.61
16	16.00	641.54	
17			
18			
19			
20			
21			
22			

**Figure 16.5** Tabulated View of Maximum Scalars Saved to *simulation.dss* File

## 16.2 Frequency Curves

For each scalar value selected, a frequency curve can be created. From the **Output Variable Editor** (Figure 16.1), in the **Frequency** column (Figure 16.1), the user can select, for each scalar value, that a frequency curve be computed from results in each realization, and the combined frequency curve (computed by combining results from all realizations) will be computed (generated) along with the 5 and 95 percent confidence limits for the combined curve by HEC-WAT. The checkbox in the **Frequency** column (Figure 16.1) must be checked, so that when the selected FRA simulation computes, results will be added to the simulation DSS file. Figure 16.6 provides an example of DSS pathnames with frequency curve results for each realization in addition to the combined curve and confidence limits. The frequency curves are computed based on the total number of events that were simulated including events that were skipped using model skip flags. The scalars (maximum values) are ranked from largest to smallest and the exceedance probability is computed based on the rank divided by the total number of events (plus one) in the realization.



**Figure 16.6** Frequency Curves in the *simulation.dss* File

If frequency curves were not created for certain output variables after an FRA simulation has computed, the user can compute frequency curves. After selecting output variables to create frequency curves, from the **File** menu (Figure 16.1), click **Save and Compute Selected Frequencies**. HEC-WAT will then compute frequency curves for the selected output variables. This option will only work when an FRA simulation has been previously computed.

## 16.3 Results

Results from the output variables can be accessed from the HEC-WAT main window (Figure 16.2). From the **Results** menu (Figure 16.7), point to **Output Variables**. Three options are available to visualize output variables - **Histogram Viewer**, **Scalar Viewer**, and **Frequency Viewer**.

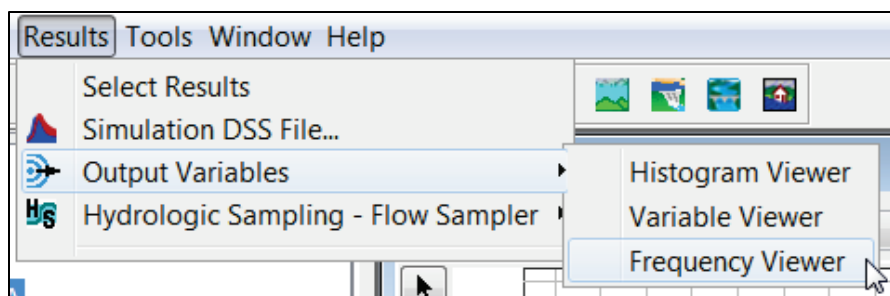


Figure 16.7 HEC-WAT Main Window – Results Menu – Output Variables

### 16.3.1 Histogram Viewer

The **Histogram Viewer** (Figure 16.8) provides histogram plots of the user selected output variable from the **Variable** list (Figure 16.8) and then the realization (**Realization** list) and life cycle number (**Lifecycle** list). The **Lifecycle** list does include an option to view all life cycles within a realization. The **Histogram Viewer** (Figure 16.8) provides the user with a quick way to visualize the range of values (x-axis) for the selected model results and the relative probability (y-axis). For example, in Figure 16.8, the user has chosen the output variable to plot a histogram for Realization 6 and all of its life cycles.

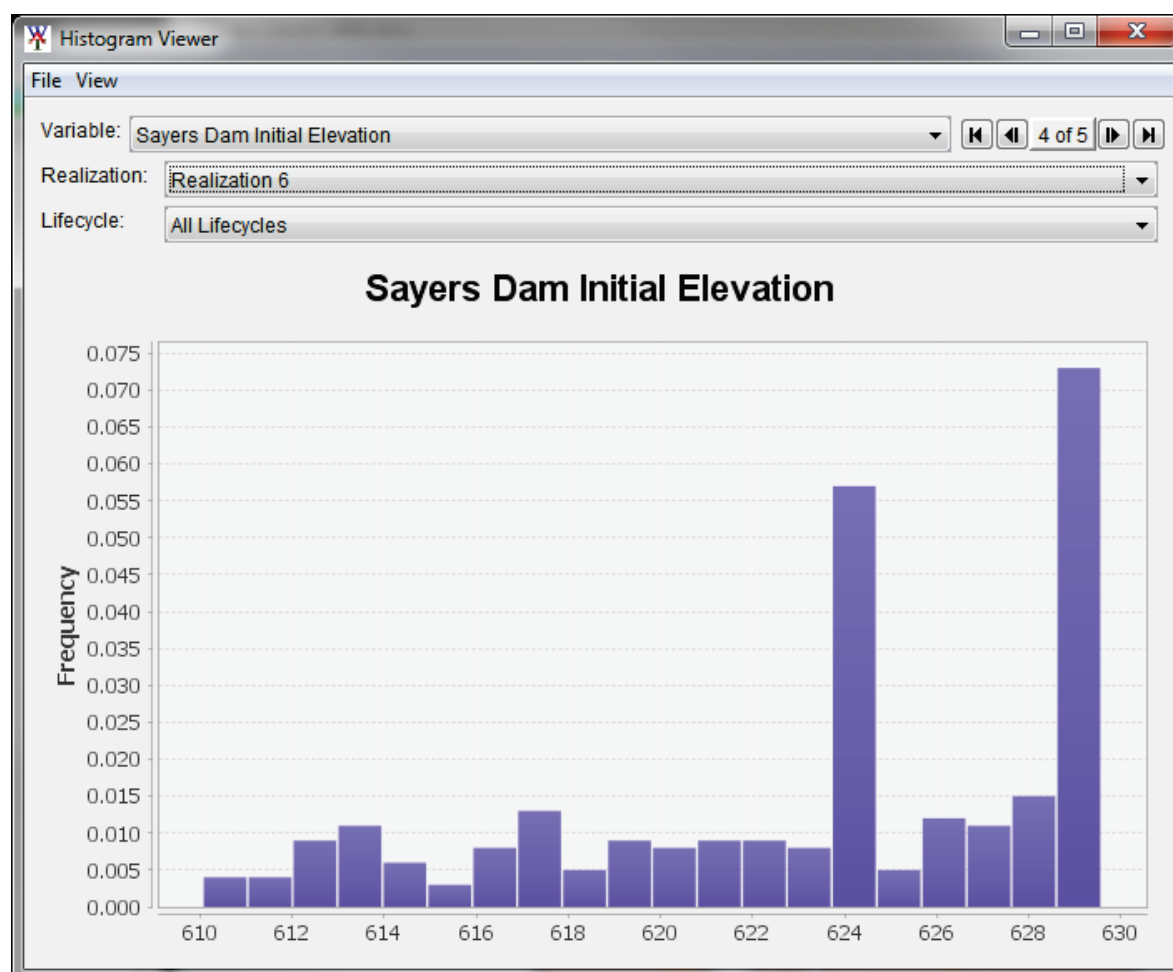


Figure 16.8 Histogram Viewer

### 16.3.2 Variable Viewer

The **Variable Viewer** (Figure 16.9) provides scalar plots of the user selected output variable from the **Variable** list (Figure 16.9) and the realization (**Realization** list) and life cycle number (**Lifecycle** list). The **Lifecycle** list does include an option to view all life cycles within a realization. The **Output Variable** Viewer (Figure 16.9) displays the output value (y-axis) for each event (x-axis) in the selected life cycle or from all life cycles in the selected realization. The **Output Variable Viewer** can be used to quickly identify outliers in the model results that might require additional investigation. For example, in Figure 16.9, the user has chosen the output variable to plot a histogram for Realization 6, and all its life cycles.

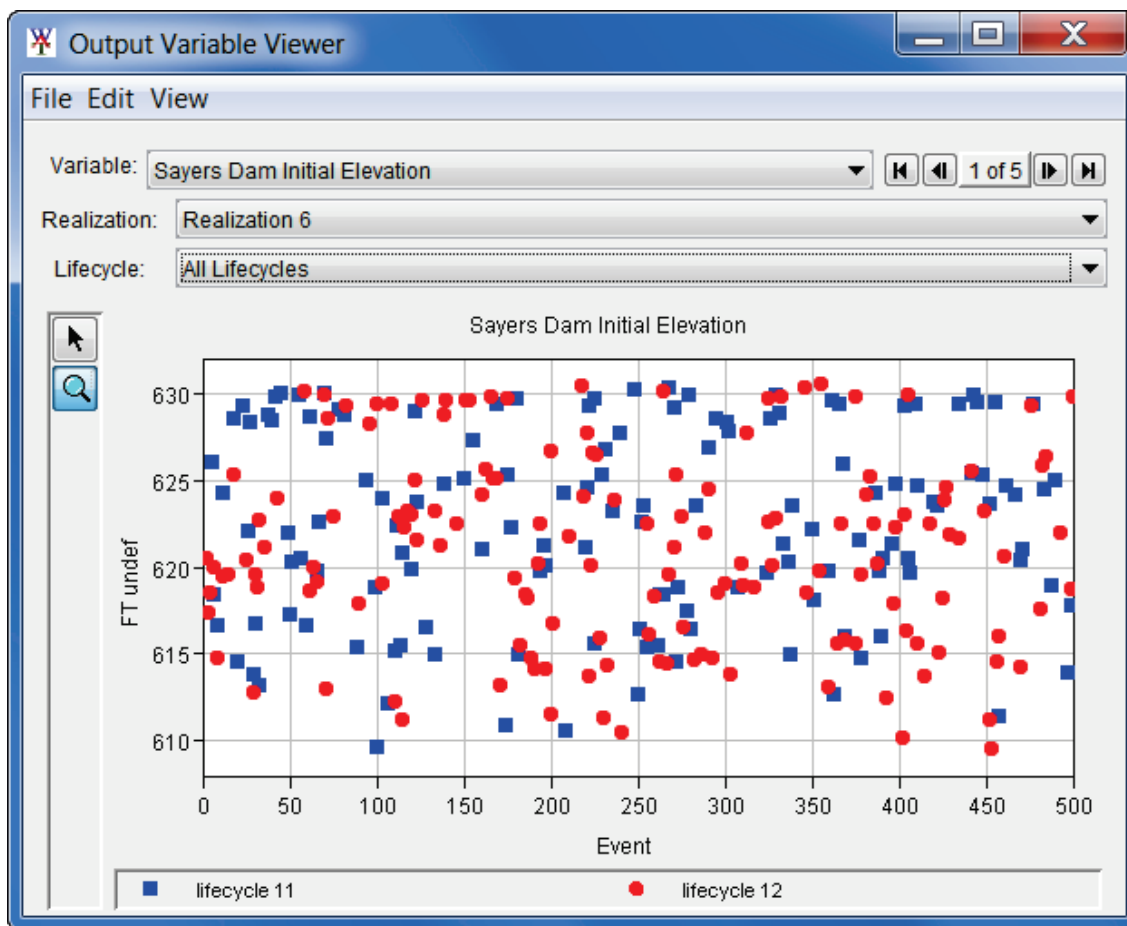
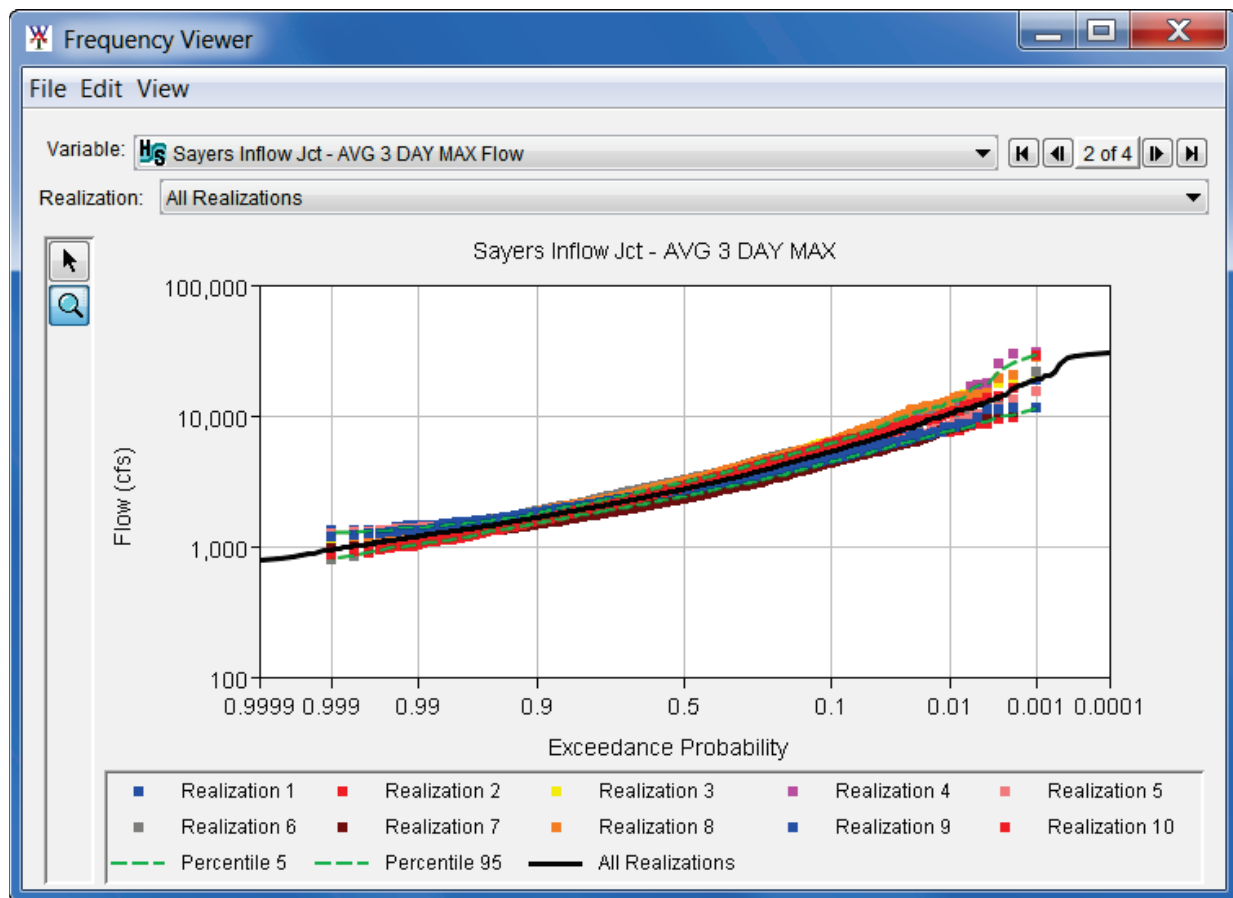


Figure 16.9 Output Variable Viewer

### 16.3.3 Frequency Viewer

The **Frequency Viewer** (Figure 16.10) provides frequency plots of the user selected output variable from the **Variable** list (Figure 16.10) and the realization (**Realization** list). The **Realization** list does include an option to view all realizations. For example, Figure 16.10, displays a frequency curve for *All Realizations*. A separate frequency curve is plotted with results from each realization plus the combined frequency curve and the 5 and 95 percent confidence limits for the combined curve. Only those output variables with **Frequency** selected in the **Output Variable Editor** (Figure 16.1) will have frequency curve results to visualize.

**Figure 16.10** Frequency Viewer

# CHAPTER 17

## Fragility Curve Sampling

A fragility curve defines a structure's (i.e., levee) probability of failure over a range of elevation values at a specific location along the structure (i.e., levee). To capture the likelihood of structural (i.e., levee) failure at specified locations, the fragility curve sampling in HEC-WAT occurs in a systems context with failure elevations at multiple locations being sampled either by realization or by event. The elevation of failure that is sampled is then used by the hydraulics software (i.e., HEC-RAS) to evaluate breaching. When sampling by realization, the failure elevation is sampled once per realization and held constant for every event in the realization. For sampling by event, a different failure elevation is generated for each event in a realization. In Version 1.0 of HEC-WAT, the fragility curves should be representative of all potential failure modes (i.e., under seepage, through seepage, erosion), and there is no uncertainty around the fragility curve.

The User's Manual describes the use of fragility curves in levee evaluations, but fragility curves can also be defined and used within HEC-WAT for structures situated perpendicular to a water course (i.e. dam). In this case, the **Inline Structure Breach Data Editor** in HEC-RAS is used in place of the **Levee (Lateral Structure) Breach Data Editor** (Section 17.1) to define the fragility curve characteristics for inline structures.

### 17.1 Overview

To capture the likelihood of levee failure at specified levee locations, levee failure elevations will be sampled from the input fragility curves at each project location for each event or realization. HEC-WAT randomly selects a value between zero and one for either each event or each realization (user's choice), from the user-defined fragility curve(s) in the **Fragility Curve Editor** (Figure 17.1). The corresponding levee breach elevation is then passed to the RAS model alternative. HEC-RAS uses that elevation as the trigger failure elevation, which is defined in the HEC-RAS **Levee (Lateral Structure) Breach Data Editor** (Figure 17.2; for further details refer to the HEC-RAS User's Manual). If the HEC-RAS computed water surface elevation meets or exceeds the elevation sampled from the fragility curve, the levee is assumed to breach and the breach progresses according to the defined values within the HEC-RAS model.

Fragility is also an element of the project life cycle process. Commonly, without maintenance, structures (i.e., levees) deteriorate over time. This can be reflected within a fragility curve by increasing the likelihood of failure at a given water surface elevation (or a lower elevation for a given probability). Scheduled maintenance can be reflected within a fragility curve by decreasing the likelihood of failure at a given elevation or raising the elevation for a given probability. A levee failure and subsequent repair would also have an effect on the fragility curves. Figure 17.3 displays an example 50-year life cycle, and the hypothetical change in levee fragility with time as well as failure and repair. Also, the randomly sampled failure elevation



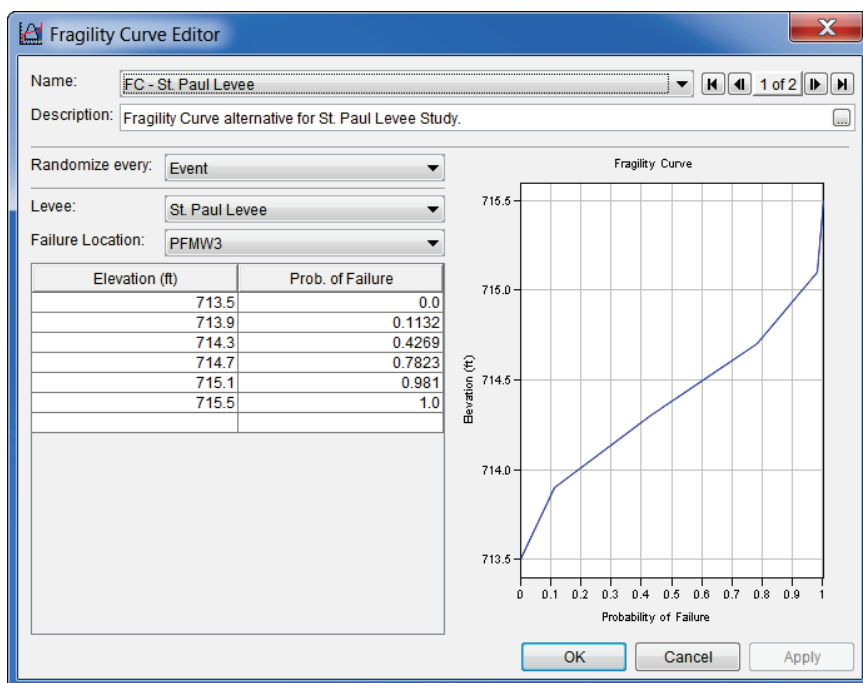


Figure 17.1 Fragility Curve Editor

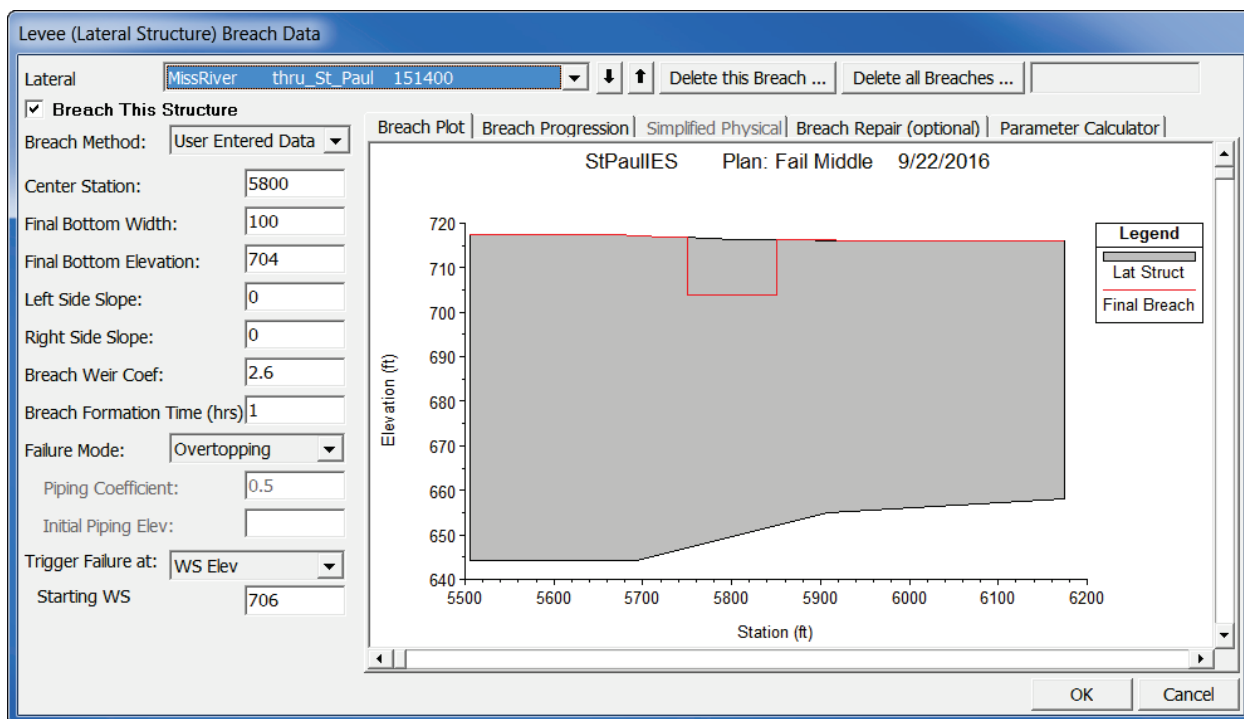
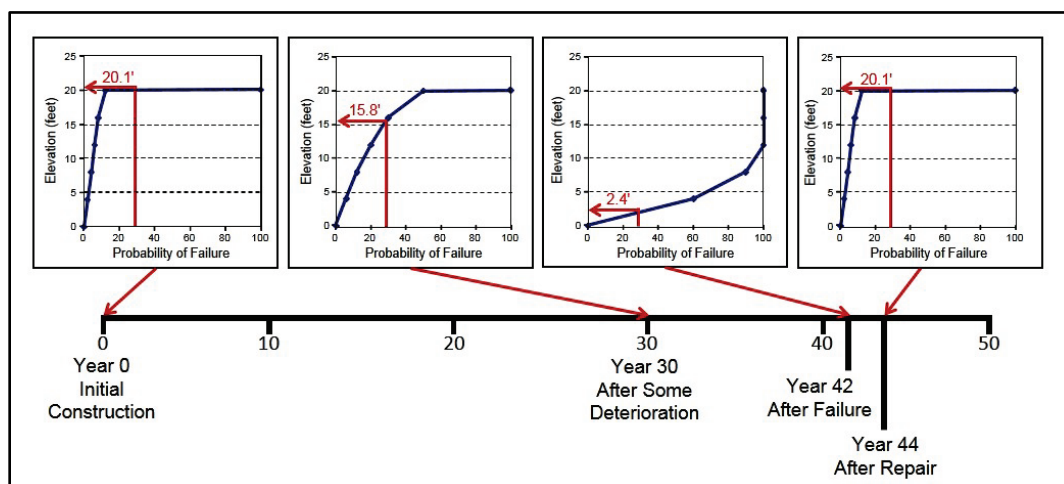


Figure 17.2 HEC-RAS – Levee (Lateral Structure) Breach Data Editor

at that location (from random value 0.29) used for one realization of the Monte Carlo simulations is displayed in Figure 17.3. This sampled failure elevation would decrease as the fragility curve showed weakening over time and would further decrease after a failure, but would increase after subsequent repair. To capture these changing conditions, the user must enter a different fragility curve and perform a separate analysis for each condition within HEC-WAT.



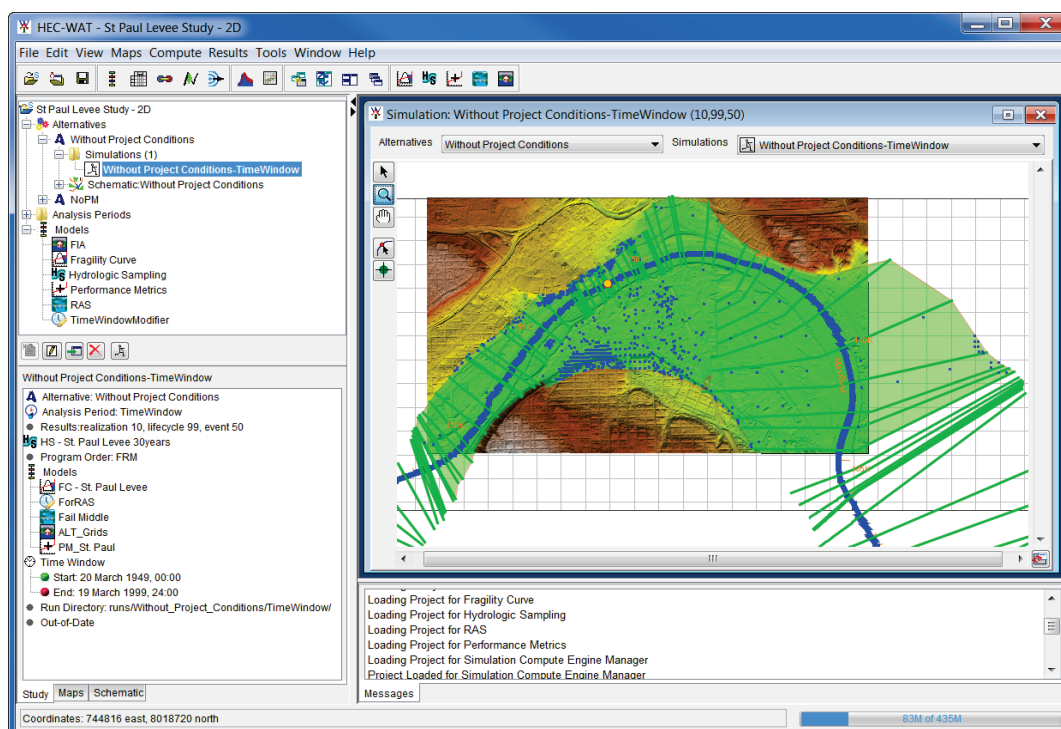


**Figure 17.3** Levee Fragility Curves at Different Points during a Fifty-Year Life Cycle

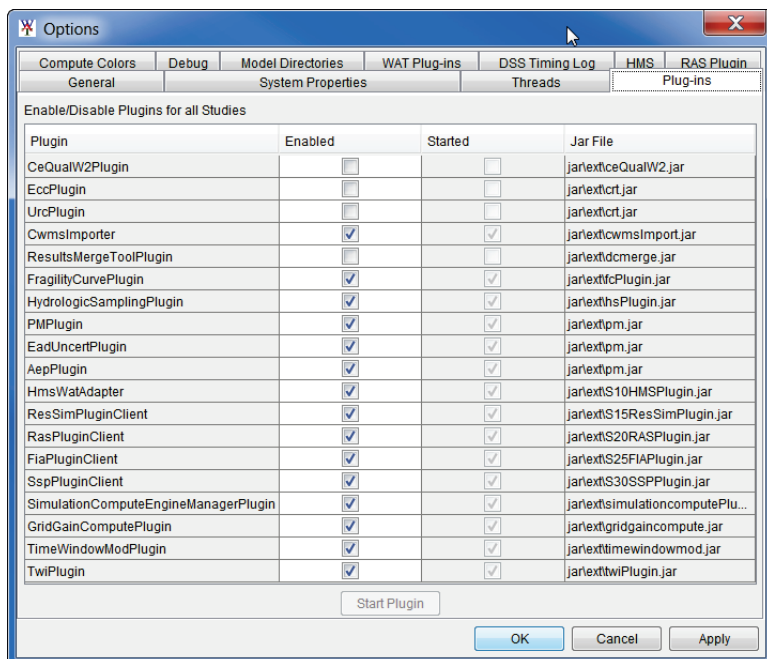
## 17.2 HEC-WAT Fragility Curve Sampling Prerequisites

There are several prerequisites to creating fragility curves within HEC-WAT:

1. To perform fragility curve sampling in an HEC-WAT study, the fragility curve plug-in should be enabled. By default, the fragility curve plug-in should be enabled in HEC-WAT. To verify that the plug-in is enabled, from the HEC-WAT main window (Figure 17.4), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure 17.5), click the **Plug-ins** tab. A display of the enabled/disabled plug-ins available in HEC-WAT is displayed, check *FragilityCurvePlugin* and make sure it is enabled.

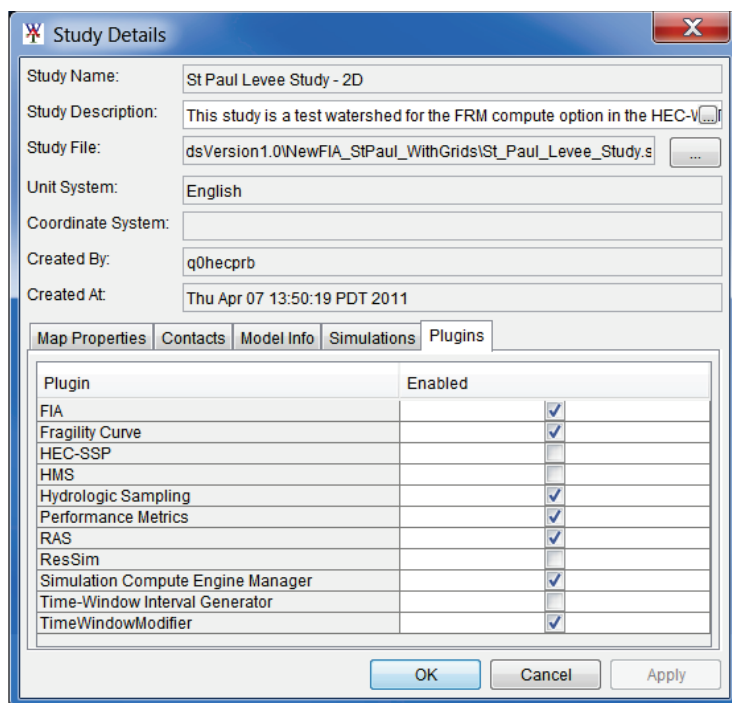


**Figure 17.4** HEC-WAT Main Window



**Figure 17.5** Options Dialog Box – Plug-Ins Tab

- To enable fragility curve sampling for an HEC-WAT study, from the HEC-WAT main window (Figure 17.4), from the **File** menu, click **Study Details**, the **Study Details** dialog box (Figure 17.6) will open (for further information on the **Study Details** dialog box, see Chapter 4, Section 4.1.5).



**Figure 17.6** Study Details Dialog Box – Plugins Tab

- Click the **Plugins** tab (Figure 17.6), by default, all plug-ins are enabled (Figure 17.6). For example, in Figure 17.6, the plug-ins enabled include *FIA*, *Fragility Curve*,


*Hydrologic Sampling, Performance Metrics, RAS, Simulation Compute Engine Manager, and TimeWindowModifier.* To ensure that the fragility curve sampler is available, a check mark should be displayed in the **Enabled** column of the table (Figure 17.6). When the appropriate plug-in configuration is selected, click **OK**. The **Study Details** dialog box will close (Figure 17.6) and the plug-in configuration for the active study will be set.

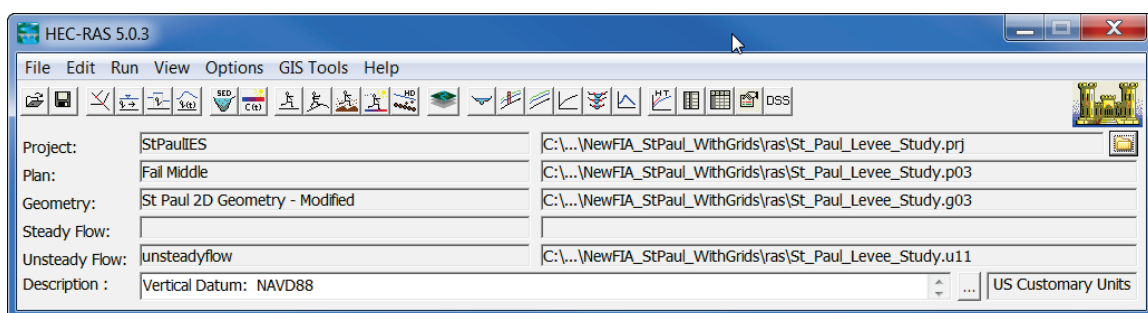
4. The HEC-WAT study must include a RAS model alternative (plan) with at least one lateral or inline structure and defined breach information.
5. Fragility curves are associated with alternatives within HEC-WAT, and each fragility curve requires a fragility curve common computation point (CCP) defined within an HEC-WAT alternative.

In Version 1.0, the user can import levee breach locations from HEC-RAS (Section 17.4), or the user can define each levee and/or breach location (CCPs) in the HEC-WAT schematic. The CCPs must correspond to breach location(s) defined in the HEC-RAS model. For further details on adding levees and CCPs to an HEC-WAT study, see Chapter 6.


## 17.3 HEC-RAS Breach Configuration Considerations

For fragility curve sampling to work in HEC-WAT, the RAS model alternative (plan) must be setup for levee breaching.

1. To ensure the RAS model alternative (plan) for the current HEC-WAT simulation is setup correctly, from the HEC-WAT main window (Figure 17.4), from the **Toolbar**, click . The **HEC-RAS** main window will open (Figure 17.7).



**Figure 17.7** HEC-RAS Main Window

2. From the HEC-RAS **Toolbar** click , or from the **Run** menu, click **Unsteady Flow Analysis**. The HEC-RAS **Unsteady Flow Analysis** dialog box will open (Figure 17.8).
3. From the HEC-RAS **Unsteady Flow Analysis** dialog box (Figure 17.8), from the **Options** menu, click **Levee (Lateral Structure) Breach**, the **Levee (Lateral Structure) Breach Data Editor** will open (Figure 17.2). **Note:** Fragility curves may also be associated with inline structures (i.e., dams). This data can be entered on the **Dam (Inline Structure) Breach Data Editor**. The following example will only provide descriptions for the definition of levee breach information. However, the data requirements are similar for inline structures.

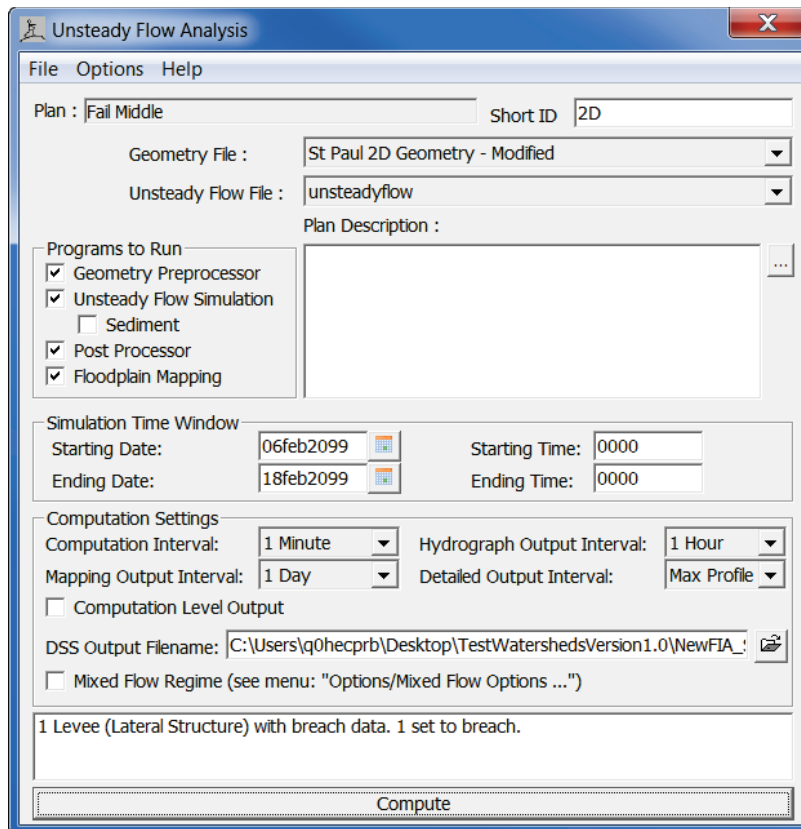


Figure 17.8 HEC-RAS – Unsteady Flow Analysis Dialog Box

- From the HEC-RAS **Levee (Lateral Structure) Breach Data Editor** (Figure 17.2), the user will need to select breach options (Figure 17.9) for the defined lateral structure at a location. The user will need to select **Breach This Structure**, select a breach method from the **Breach Method** list (default – *User Entered Data*), select a failure mode from the **Failure Mode** list, and select **WS Elev** from the **Trigger Failure at** list as the trigger failure option.

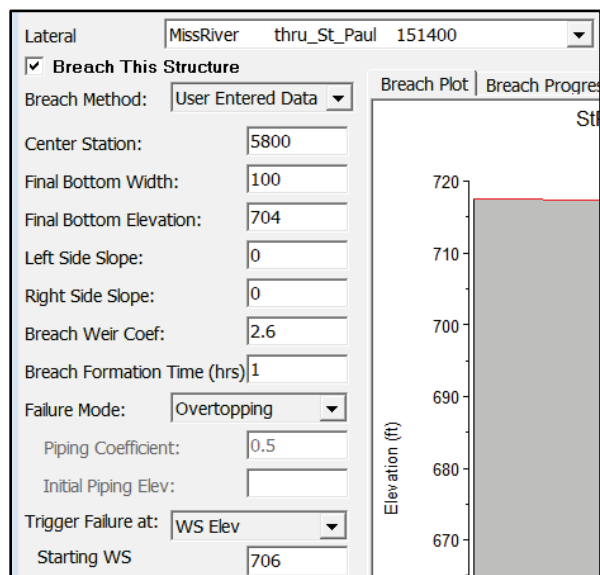
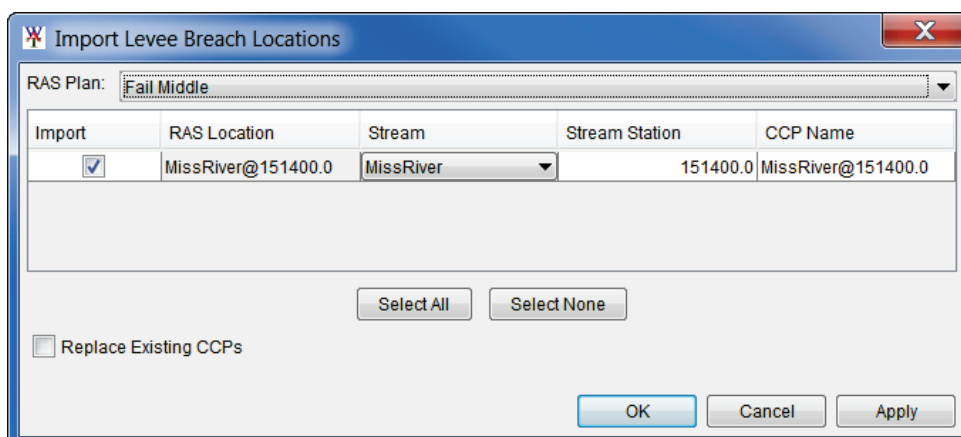


Figure 17.9 HEC-RAS – Levee Breach Options

6. From the **Failure Mode** list (Figure 17.9), HEC-RAS currently has two different breaching methods - piping and overtopping. The user must specify only one of these modes, even if the fragility curve combines the probability of failure due to both modes. If the levee is going to overtop and fail then select the **Overtopping** failure mode. If the breach is expected to initiate from a piping failure mode and progress upwards and downwards until a complete breach has occurred, the **Piping** failure mode should be selected.
7. The user must define a trigger failure, from the **Trigger Failure at** list (Figure 17.9). For HEC-WAT 1.0, the user should select **WS Elev**. The **WS Elev+Duration** and **Set Time** options should not be selected for an FRA compute. However, if the user does select the **WS Elev+Duration** or the **Set Time** option and an FRA compute has been selected, then the trigger failure at option is automatically switched to the **WS Elev**. The trigger failure elevation is used by HEC-RAS to begin initiation of the lateral structure breach. The breach is initiated when the computed water surface elevation exceeds the trigger elevation and is not dependent on the selected failure mode.
8. When the user is finished configuring breach information for the study area in the RAS model alternative. From the **Unsteady Flow Analysis** dialog box (Figure 17.8), from the **File** menu, click **Save Plan** to save changes. From the **File** menu, click **Exit**, the **Unsteady Flow Analysis** dialog box will close (Figure 17.8). From the HEC-RAS main window (Figure 17.7), from the **File** menu, click **Exit**, the HEC-RAS main window will close (Figure 17.7).
9. If the RAS model alternative in the HEC-WAT FRA simulation has all of the above set, then the user can go on to defining fragility curve alternatives and input data in HEC-WAT.

## 17.4 Import HEC-RAS Breach Locations

When an HEC-WAT simulation contains a RAS model alternative (plan) that includes structure breach data, the user can import HEC-RAS breach locations as fragility CCPs. From the HEC-WAT main window (Figure 17.4), from the **Edit** menu, point to **RAS**, click **Import Breach Locations**. The **Import Levee Breach Locations** dialog box will open (Figure 17.10).



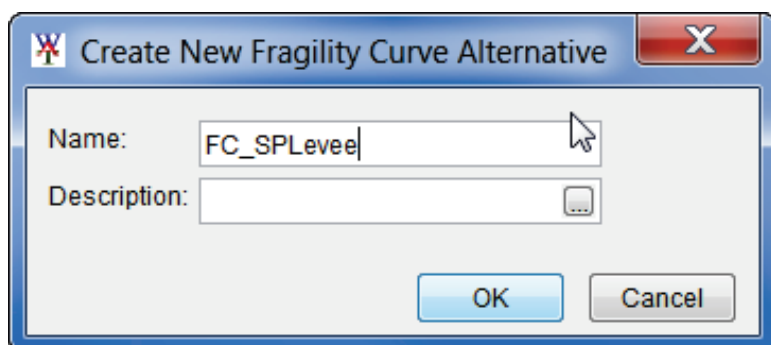
**Figure 17.10** Import Breach Locations Dialog Box

1. From the **RAS Plan** list (Figure 17.10) select the RAS plan (model alternative) that contains the breach locations which should be imported.
2. The table (Figure 17.10) lists all of the defined breach locations (all lateral structures with breaching turned on) in the selected RAS plan (model alternative). From the table, the user can select individual breach locations from the **Import** column (Figure 17.10) by clicking the check box. The user can also change the stream station of the breach location from the **Stream Station** (Figure 17.10) column and change the name of the CCP from the **CCP Name** column (Figure 17.10).
3. The user can select all known breach locations (**Select All**) or clear the selections in the table (**Select None**). If fragility curve CCPs already exist, the user can replace by selecting **Replace Existing CCPs** (Figure 17.10).
4. Click **OK**, the **Import Levee Breach Locations** dialog box will close (Figure 17.10). The HEC-RAS breach locations will be imported as fragility CCPs in the HEC-WAT study. Please note that the import process only adds a geographic data layer based on the geographic coordinates of the breach locations. There is no data linking (i.e., fragility curve input) when importing fragility curve CCPs.
5. Optionally, the user can associate the fragility CCPs with levees or other structures that may have been created for the HEC-WAT study. However, this is not a requirement.

## 17.5 Creating Fragility Curves Alternatives

Now that the user has verified that the fragility curve plug-in is enabled and that the RAS model alternative (plan) associated with the FRA simulation is setup for levee breaching, a fragility curve alternative needs to be created. For each fragility curve alternative, the user will need to define fragility curves at each breach location.

1. From the HEC-WAT main window (Figure 17.4), from the **Study Tree**, from the **Models** node, right click on **Fragility Curve**, from the shortcut menu click **New**. The **Create New Fragility Curve Alternative** dialog box will open (Figure 17.11). Another way to create a fragility curve alternative is from the **Edit** menu, point to **Fragility Curve**, click **New**.



**Figure 17.11** Create New Fragility Curve Alternative Dialog Box



2. In the **Name** box (Figure 17.11), the user must enter a unique name for the fragility curve alternative. The user can also add a description in the **Description** box. Click **OK**, the **Create New Fragility Curve Alternative** dialog box will close (Figure 17.11) and the **Fragility Curve Editor** will open (Figure 17.1).
3. The **Fragility Curve Editor** will display the name of the fragility curve alternative and a description, if entered. Click **OK**, the **Fragility Curve Editor** will close (Figure 17.1). The name of the fragility curve alternative will appear in the **Content Pane** of the HEC-WAT main window (Figure 17.12).

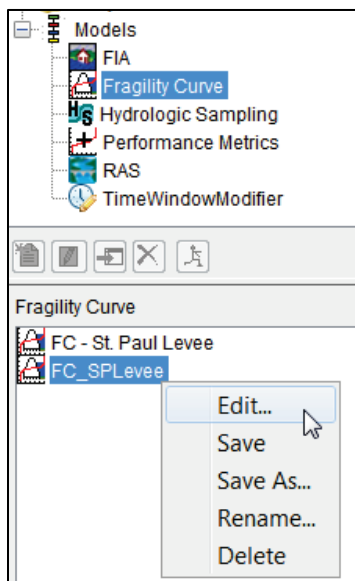


Figure 17.12 Content Pane – Fragility Curve Alternative Shortcut Menu

## 17.6 Fragility Curve Editor

Now that fragility curve alternatives have been created, the user needs to define the fragility curves and to associate each curve with a failure location on a levee (structure). From the **Fragility Curve Editor** (Figure 17.1):

1. The user can select from the **Randomize every** list (Figure 17.13) to have the failure elevations sampled by every event in a realization or sampled once in a realization. The default is to randomize the failure elevations by event.

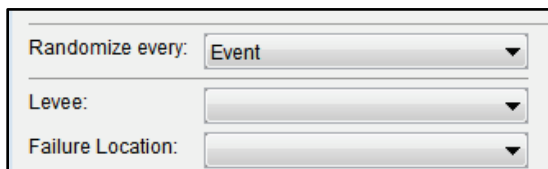


Figure 17.13 Fragility Curve – Initial Setup

2. From the **Levee** list (Figure 17.13), the user can filter the list of fragility CCPs. The list will either contain the names of levees that have been included in the HEC-WAT schematic (created in HEC-WAT for visual purposes only and not provided by the RAS

model alternative) or the **<Not Selected>** option. If the user selects the **<Not Selected>** option, then all of the fragility curve CCPs will be available from the **Failure Location** list (Figure 17.13).

3. Elevation-probability information, which is used to define a fragility curve (Figure 17.14), can then be entered. The elevations should correspond to the levee structure elevations in the RAS model alternative (plan).

Elevation (ft)	Prob. of Failure
713.5	0.0
713.9	0.1132
714.3	0.4269
714.7	0.7823
715.1	0.981
715.5	1.0

**Figure 17.14** Defining a Fragility Curve

4. A fragility curve (within HEC-WAT) is defined as a cumulative distribution function (CDF) where the probability of failure must start at zero (0.0) and span to a probability of one (1.0). Both elevation and probability of failure must be monotonically increasing.
5. By right-clicking on the table that defines fragility curves, a shortcut menu will display (which is shown in the figure to the right). From this shortcut menu, the user can cut/copy/paste items; clear selected cells; select all cells; delete rows; print the table; and export the table.
6. The user can fill cells that have been selected, from the shortcut menu click **Fill**, the **Table Fill Options** dialog box (Figure 17.15). The user has several options to choose from:

Cut
Copy
Paste
Clear
Fill...
Select All
Insert Row(s)...
Append Row
Delete Row(s)
Print...
Print Preview...
Export...
Sum Selected Cells
Sum Entire Column

- **Linear Fill** - when selecting the cells, for **Linear Fill** (Figure 17.18), the first and last rows must have data. Click **OK**, the **Table Fill Options** dialog box will close and the table will be filled with linearly interpolated data.
- **Repeat Fill** - when selecting the cells, for **Repeat Fill** (Figure 17.15), the user must select a row that contains the data that will be repeated in the other selected rows. Click **OK**, the **Table Fill Options** dialog box will close and the table will be filled with repeated data.
- **Add Constant** - when selecting the cells, for **Add Constant** (Figure 17.15), the user must select rows that contain data that the user wishes to increase by a constant value. The user will enter a value in the box next to **Add Constant**. Click **OK**, the **Table Fill Options** dialog box will close and the rows selected in table will be filled with data that has been increased by the constant value entered by the user.



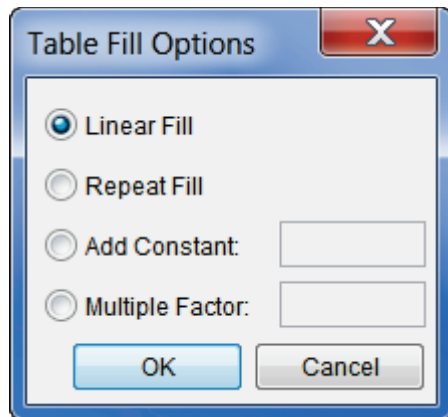


Figure 17.15 Table Fill Options Dialog Box

- **Multiple Factor** - when selecting the cells, for **Multiple Factor** (Figure 17.15), the user must select rows that contain data that the user wishes to increase by a multiplier. The user will enter the multiplier in the box next to **Multiple Factor**. Click **OK**, the **Table Fill Options** dialog box will close and the rows selected in table will be filled with data that has been increased by the multiplier entered by the user.
7. When the user chooses to **Sum Selected Cells** or **Sum Entire Column** from the shortcut menu, a **Sum** window will open (Figure 17.16) providing the user with the desired information.

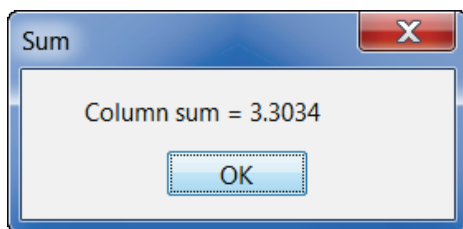


Figure 17.16 Sum Window

8. Once the user has entered all of the information for the fragility curve, click **OK**, the **Fragility Curve Editor** (Figure 17.1) will close.

## 17.7 Individual Fragility Curve Alternatives

The individual fragility curve alternative shortcut menu (Figure 17.12) will allows the user to edit, save, create a copy of an existing fragility curve alternative, rename, and delete.

### 17.7.1 Edit

1. From the HEC-WAT main window (Figure 17.4), from the **Content Pane** (Figure 17.12), right-click on a fragility curve alternative, from the shortcut menu click **Edit**. The **Fragility Curve Editor** will open (Figure 17.1).
2. From the **Fragility Curve Editor**, the user can edit an existing fragility curve alternative. When editing is finished, click **OK**, the **Fragility Curve Editor** will close (Figure 17.1).

## 17.7.2 Save

From the HEC-WAT main window (Figure 17.4), from the **Content Pane** (Figure 17.12), right-click on a fragility curve alternative, from the shortcut menu click **Save**. The fragility curve data is saved.

## 17.7.3 Save As

1. From the HEC-WAT main window (Figure 17.4), from the **Content Pane** (Figure 17.12), right-click on a fragility curve alternative, from the shortcut menu click **Save As**. The **Save Fragility Curve As** dialog box will open (Figure 17.17).

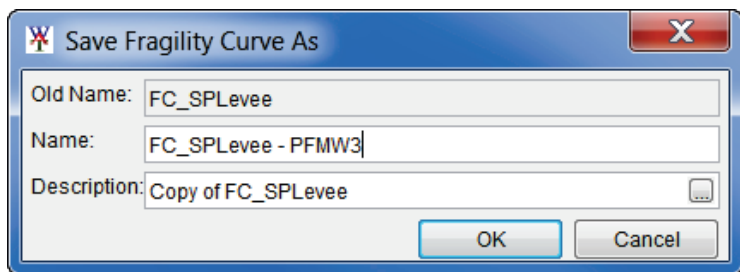


Figure 17.17 Save Fragility Curve As Dialog Box

2. The name of the fragility curve alternative which is being copied is displayed in the **Old Name** box (Figure 17.17). The user must enter a new unique name in the **Name** box, and can provide a description in the **Description** box (Figure 17.17).
3. Click **OK**, the **Save Fragility Curve As** dialog box will close (Figure 17.17). The name of the new fragility curve alternative will appear in the **Content Pane** (Figure 17.14) of the HEC-WAT main window (Figure 17.4).

## 17.7.4 Rename

1. From the HEC-WAT main window (Figure 17.4), from the **Content Pane** (Figure 17.12), right-click on a fragility curve alternative, from the shortcut menu click **Rename**. The **Rename Fragility Curve** dialog box will open (Figure 17.18).

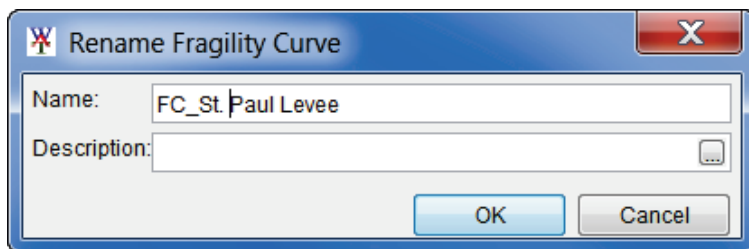


Figure 17.18 Rename Fragility Curve Dialog Box

2. The name of the fragility curve alternative that the user is renaming is displayed in the **Name** box. The user must enter a new unique name in the **Name** box (Figure 17.18), and can provide a description in the **Description** box (Figure 17.18).

3. Click **OK**, the **Rename Fragility Curve** dialog box will close (Figure 17.18). The re-named fragility curve alternative will appear in the **Content Pane** (Figure 17.12) of the HEC-WAT main window (Figure 17.4).

### 17.7.5 Delete

1. From the HEC-WAT main window (Figure 17.4), from the **Content Pane** (Figure 17.12), right-click on a fragility curve alternative, from the shortcut menu click **Delete**. A **Confirm Delete** window box will open (Figure 17.19).

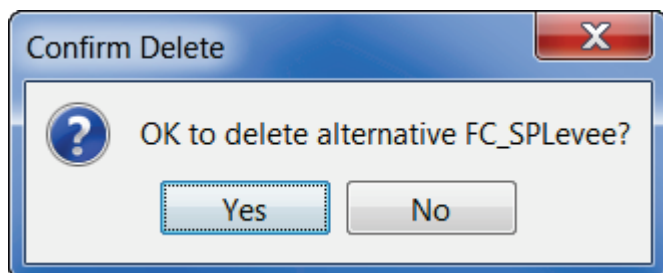


Figure 17.19 Confirm Delete Window

2. Click **Yes**, the selected fragility curve alternative will no longer be displayed in the **Content Pane** (Figure 17.12) of the HEC-WAT main window (Figure 17.4).

## 17.8 Multiple Fragility Curve Alternatives

Multiple fragility curve alternatives can be created that evaluate different scenarios of levee fragility, like weak or strong levee alternatives. The user defined elevation-probability information is saved per fragility curve alternative. The same fragility curve CCPs can be used in multiple fragility curve alternatives with different elevation-probability information. The user can edit and view the multiple fragility curve alternatives in the **Fragility Curve Model Editor** (Figure 17.1) using the **Navigator Tool** (Figure 17.20) or manipulate the fragility curve alternatives from the **Content Pane** (Figure 17.12) using the shortcut menu (Figure 17.12).

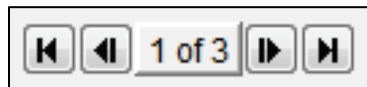







Figure 17.20 Navigator Tool


1. From the **Fragility Curve Editor** (Figure 17.1), using the **Navigator Tool** (Figure 17.20), the user can move through the defined fragility curve alternatives.
2. The  symbol places the user at the top (first) of the fragility curve alternative list, while the  symbol places the user at the bottom (last) of the fragility curve alternative list. The  (previous) symbol and the  (next) symbol moves the user back one and forward one in the fragility curve alternative list, respectively. The center of the navigation button indicates the number of fragility curve alternatives in the list and which fragility curve alternative the user is presently accessing.

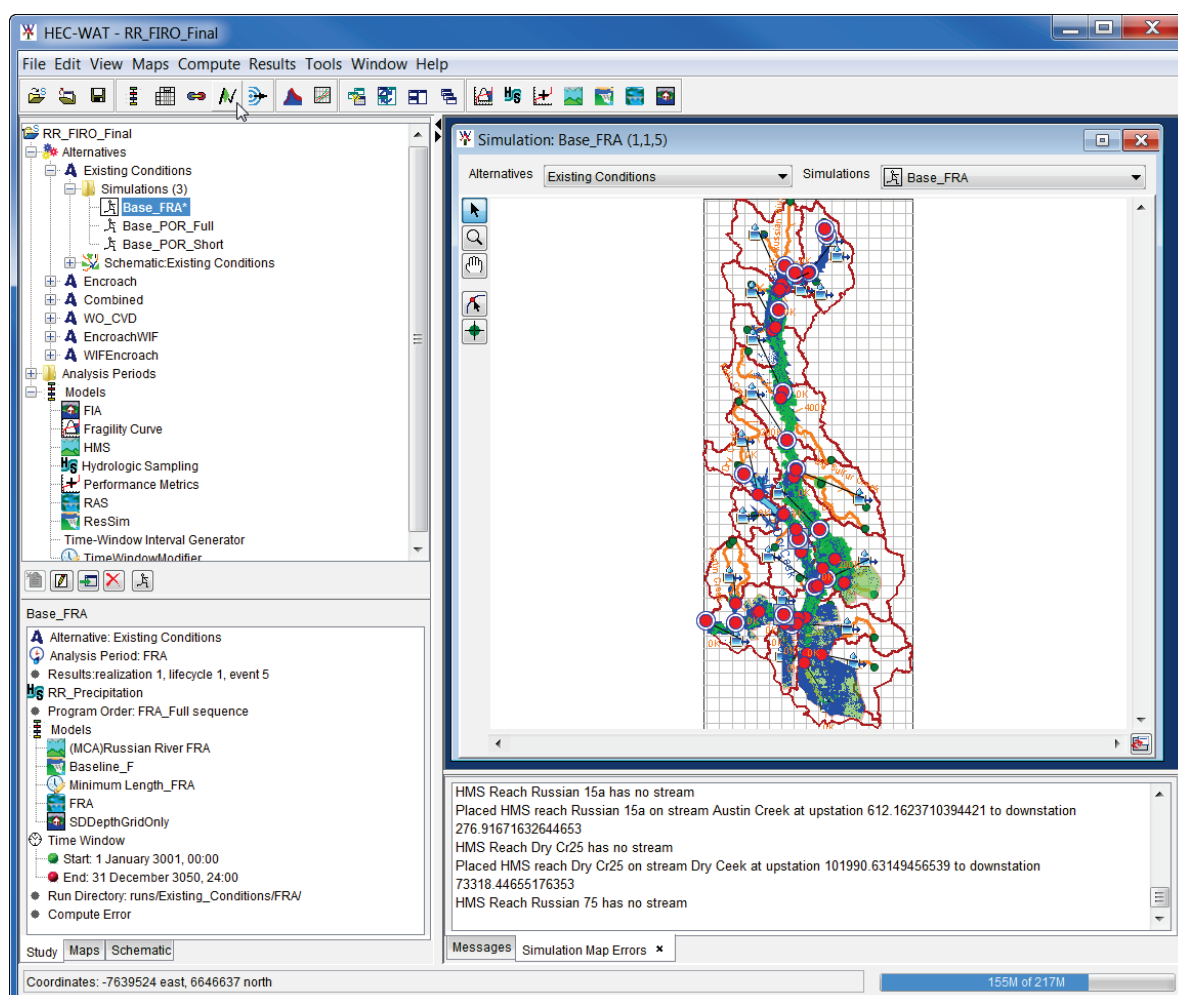
3. For example, the user could edit the first fragility curve alternative, click **Apply** (which saves any edits), click . Now the user can view or edit the next fragility curve alternative in the list.

# CHAPTER 18

## Model Skip Rules Editor

The **Model Skip Rules Editor** is available as part of the flood risk analysis (FRA) compute of HEC-WAT. The purpose of the **Model Skip Rules Editor** is to allow the user to define logical expressions (i.e., if-then statements) of conditions when model computations will be skipped, or not performed, within an FRA compute. This allows the user to eliminate unnecessary computations and reduce run-times for an FRA compute. Note the user needs to understand what it might mean to skip a model alternative within an FRA compute. Some model alternatives should never be skipped within the compute sequence. For a performance metrics alternative (Chapter 19) it should not be skipped, because some of the computations being performed by the performance metrics alternative cannot be skipped.

To access the **Model Skip Rules Editor**, from the HEC-WAT main window (Figure 18.1), from the toolbar click , or from the **Edit** menu, point to **FRA**, click **Model Skip Rules Editor**. Either way the **Model Skip Rules Editor** (Figure 18.2) will open.



**Figure 18.1** HEC-WAT Main Window

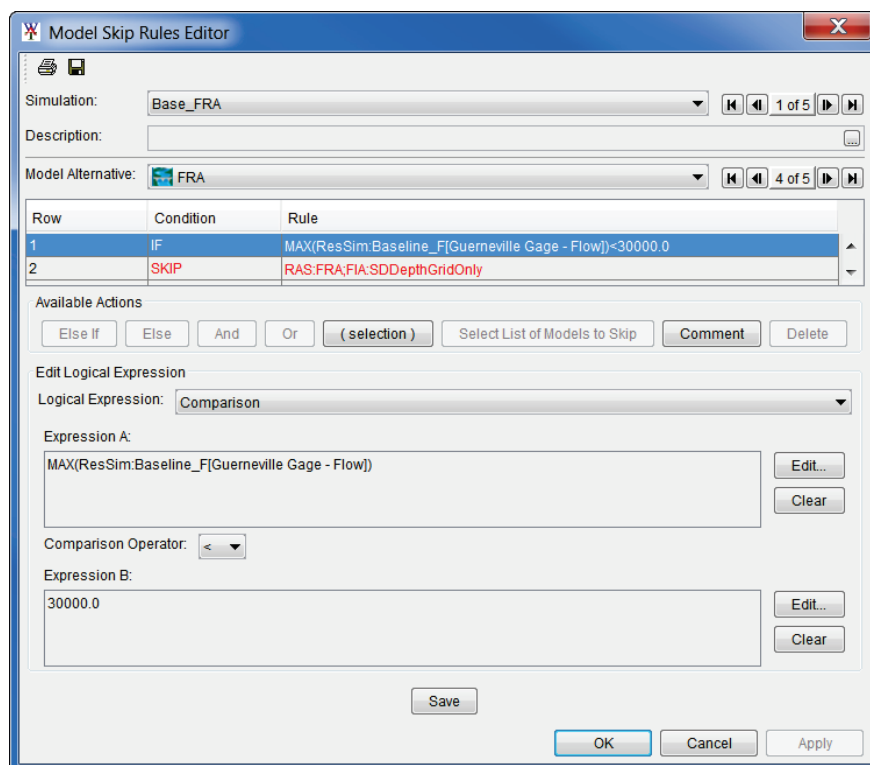


Figure 18.2 Model Skip Rules Editor

## 18.1 Create a Skip Rule

To create a skip rule for a simulation and a model alternative that is part of that simulation's program order:

1. From the **Model Skip Rules Editor** (Figure 18.2), from the **Simulation** list (Figure 18.2) select a simulation. From the **Description** box, the user can enter an optional description.
2. From the **Model Alternative** list (Figure 18.2), select a model alternative that is part of the selected simulation. The skip rule that is being created will be applied **prior** to the selected model alternative. This is important, the skip rule is not automatically applied to the selected model alternative. The selected model alternative is required to place the skip rule within the compute sequence.
3. Only models at and below the selected model alternative are available to be skipped, and standard practice is to select the model alternative that corresponds to the model that will be skipped first.
4. The **Build Logical Expression** table (Figure 18.2) is where a logical expression is defined that provides information to the simulation about when and which model computation will be skipped during an FRA compute. A logical expression is tied to the selected model alternative, which means that only one logical expression can be defined per model alternative. The default values presented in the table are the IF and END conditions, and the user defines desired conditions and rules. Further information about building a logical expression is detailed in Section 18.2.

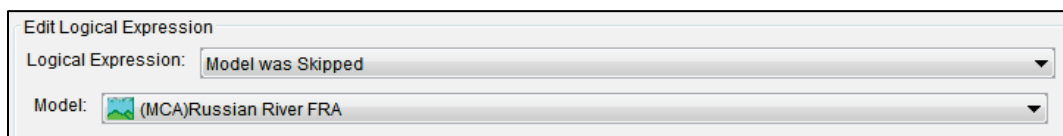
- From the **Edit Logical Expression** box (Figure 18.2), the user can select which type of logical expression needs to be built from the **Logical Expression** list (Figure 18.2). The **Logical Expression** list has two options - **Comparison** and **Model was Skipped**. The **Comparison** option allows the user to compare one expression to another to determine whether a computation should be skipped. When the first model alternative in the list is selected, only the **Comparison** option is available. The **Model was Skipped** option allows the user to include the following condition within the logical expression: a model alternative located earlier in the compute sequence has been skipped. Further information about editing a logical expression is detailed in Section 18.3.

## 18.2 Building Logical Expressions

The basic format of a logical expression follows: IF [*Expression A*] compared to [*Expression B*] is true, SKIP [*Selected Models*]. The user can add more complex logic using ELSEIF, ELSE, AND and OR logic actions, and can add parentheses around a selection or a COMMENT to the logical expression to support understanding of the decision logic. Each expression must be defined to return a scalar value, and two expressions are evaluated to determine whether the specified comparison of scalar values results in a true or false condition. If the comparison results in a false condition, no action is taken. If the comparison results in a true condition, the model alternatives selected by the user are skipped in the compute sequence.

To build the first part of each skip rule (IF [*Expression A*] compared to [*Expression B*]), the user starts by selecting the *IF* row in the **Build Logical Expression** table (Figure 18.2). This enables the **Edit Logical Expression** box (Figure 18.2) of the **Model Skip Rules Editor**.

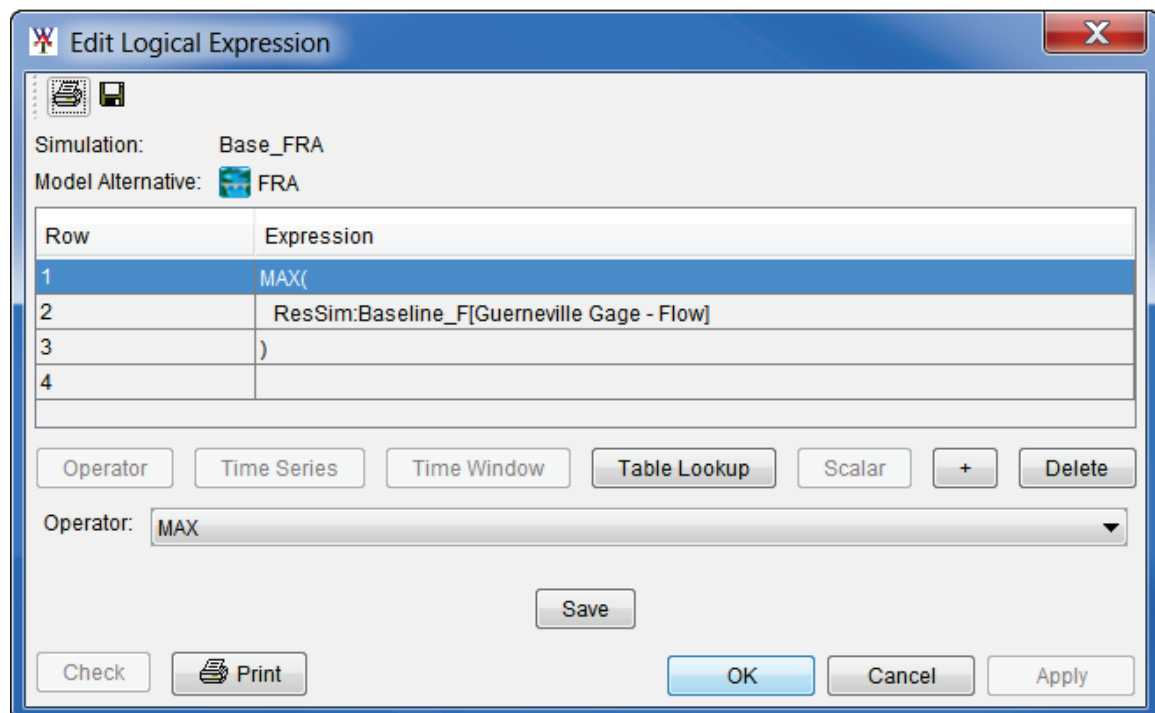
- From the **Logical Expression** list (Figure 18.2), select **Comparison** or **Model was Skipped**. The **Comparison** function is used to compare the scalar values created by the two expressions to determine whether the comparison results in a true or false condition. The **Model was Skipped** function is used to evaluate whether a previous model alternative was skipped due to a skip rule. This option is most beneficial when the user wants to base skipping of a model alternative on another model alternative that does not immediately precede the model alternative of interest (i.e., is several levels higher in the **Program Order**).
- If the logical expression choice is **Model was Skipped** (Figure 18.3), the user only has to select the model alternative that will be skipped from the **Model** list (Figure 18.3). Only model alternatives in the compute sequence before the selected model alternative are available in the list. Click **Save**, in the **Build Logical Expression** table, row one, **Rule** column (Figure 18.2), the model alternative selected will display.



**Figure 18.3** Model Skip Rules Editor – Edit Logical Expression – Model was Skipped

- If the logical expression choice is **Comparison**, in the **Expression A** box (Figure 18.2), start creating the *Expression A* part of the logical expression. To the right of the

**Expression A** box, click **Edit**, the **Edit Logical Expression** dialog box will open (Figure 18.4). From this editor the user will build the *Expression A* part of the logical expression. Further information about editing a logical expression is detailed in Section 18.3. When finished click **Save** (Figure 18.4), click **OK**, the **Edit Logical Expression** dialog box will close (Figure 18.4). In the **Expression A** box of the **Model Skip Rules Editor** (Figure 18.2), the created expression will display. *Expression A* in the **Build Logical Expression** table can be updated by selecting **Apply** in the **Model Skip Rules Editor**.



**Figure 18.4** Edit Logical Expression Dialog Box

4. If the logical expression choice was **Comparison**, in the **Expression B** box (Figure 18.2), start creating the *Expression B* part of the logical expression. To the right of the **Expression B** box, click **Edit**, the **Edit Logical Expression** dialog box will open (Figure 18.4). From this editor the user will build the *Expression B* part of the logical expression. Further information about editing a logical expression is detailed in Section 18.3. When finished click **Save** (Figure 18.4), click **OK**, the **Edit Logical Expression** dialog box will close (Figure 18.4). In the **Expression B** box of the **Model Skip Rules Editor** (Figure 18.2), the created expression will display. *Expression B* in the **Build Logical Expression** table can be updated by selecting **Apply** in the **Model Skip Rules Editor**.

### 18.3 Edit Logical Expression Dialog Box

From the **Edit Logical Expression** dialog box (Figure 18.4) the user will build *Expression A* and *Expression B* for the logical expression that is being created for a model alternative. Initially there are three commands available to the user to start creating an expression for **Comparison - Operator**, **Table Lookup**, and **Scalar** (Figure 18.5). As an expression is built, the other commands become available – **Time Series**, **Time Window**, and **Delete**. When building a logical expression, note that the contents of a selected row affect where a command is placed.



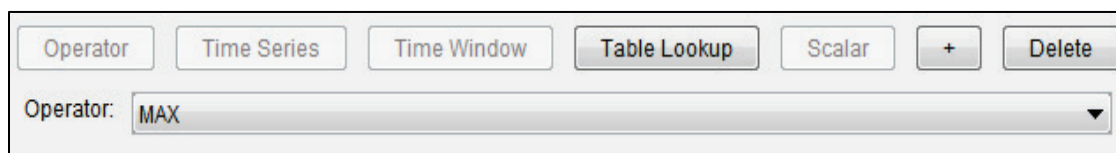


**Figure 18.5** Edit Logical Expression Dialog Box – Initial Commands

Specifically, if a selected row contains **\*\*Not Set\*\***, the command will be placed on that row, and if a selected row contains anything other than **\*\*Not Set\*\***, the command will be placed one row above the selected row. The following sections provide details on each of the individual commands.

### 18.3.1 Operator

The **Operator** command is used to select the maximum (**MAX**), average (**AVG**) or minimum (**MIN**) value of a designated dataset for the logical expression comparison. When the user selects **Operator**, a row is added to the logical expression table with the default value of **MAX()**. The user can change this default operator from the **Operator** list (Figure 18.6). Be sure the row with **MAX** is highlighted so the **Operator** list will display on the **Edit Logical Expression** dialog box (Figure 18.4).



**Figure 18.6** Edit Logical Expression Dialog Box – Operator List

Once the desired operator is specified, the user then selects the row inside the operator parentheses labeled **\*Not Set\*** to define the source of information used for comparison. Three commands for source data are available: **Time Series** (Section 18.3.4), **Time Window** (Section 18.3.5), and **Table Lookup** (Section 18.3.2).

### 18.3.2 Table Lookup

**Table Lookup** allows the user to define a set of related data (e.g., a hydraulic rating curve), and is used to look up a dependent variable based on an independent variable. Two actions are needed to configure the **Table Lookup** option: define the contents of the lookup table and define a logical expression that specifies the independent variable.

The first **Table Lookup** action is to define the contents of the lookup table. When **Table Lookup** is selected (Figure 18.7), a row is added to the logical expression table with the **LOOKUP@** expression and the interface is updated to present the user with two options for entering tabulated data from the **Table Type** list (Figure 18.7) - **User Table** and **DSS Table**. For either option, the user can optionally enter a name in the **Table Name** box (Figure 18.7).

- The **User Table** option (Figure 18.7) allows for the manual entry of X and Y values, with X as the independent variable and Y as the dependent variable. The number of rows in the table can be expanded by right-clicking inside the table for a shortcut menu of table editing options.

**Figure 18.7** Edit Logical Expression Dialog Box – Table Lookup – User Table

- The **DSS Table** option (Figure 18.8) allows the user to select a DSS file (click **Select**, the **Select Time Series** dialog box will open) for the reference table in the same manner as described in the **Time Series** section (Section 18.3.4).

**Figure 18.8** Edit Logical Expression Dialog Box – Table Lookup – DSS Table

The second **Table Lookup** action is to define a logical expression that specifies the independent variable (Figure 18.9), click **Operator**. The **MAX** operator is added to the expression building table (Figure 18.9). For example, in Figure 18.9, the **Table Lookup** command is using the maximum value from the time series (click **Time Series**) referenced in the **MAX** command as the independent variable. From the **Time Series Expression** list (Figure 18.9), select **Time Series from Model**. From the **Select Time Series** box (Figure 18.9), select the model alternative that contains the time series that the user is looking for. In the **Time Series** list box (Figure 18.9), is a list of available time series data for the selected model alternative. Click **Apply**, the row in the expression building table (Figure 18.9) that contains the independent variable will now display the time series information for the independent variable.

### 18.3.3 Scalar

The **Scalar** command allows the user to specify a constant value (default). From the **Scalar Expression** list (Figure 18.10) select **Constant**, in the **Constant** box (Figure 18.10), enter the value (default is zero).

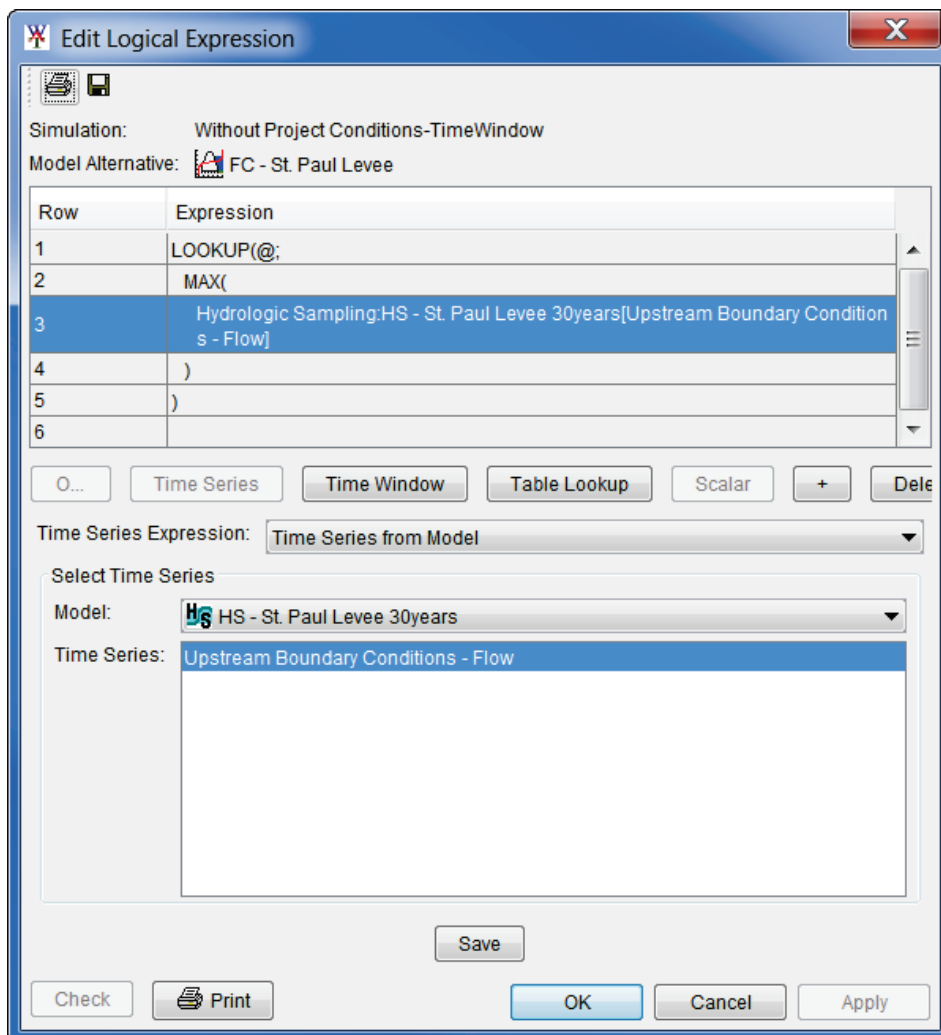


Figure 18.9 Edit Logical Expression Dialog Box – Table Lookup – Time Series

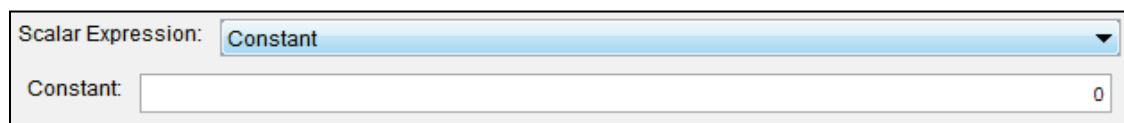
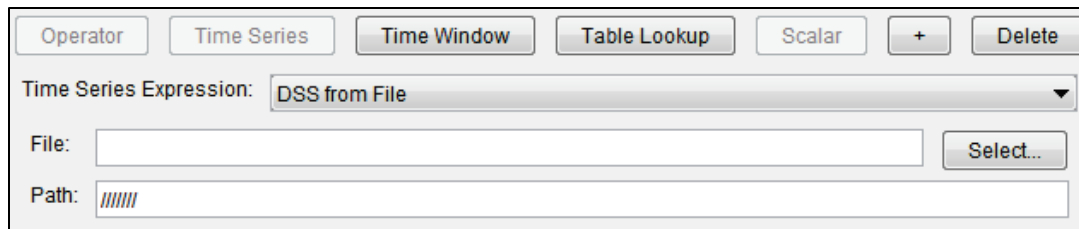


Figure 18.10 Edit Logical Expression Dialog Box – Scalar

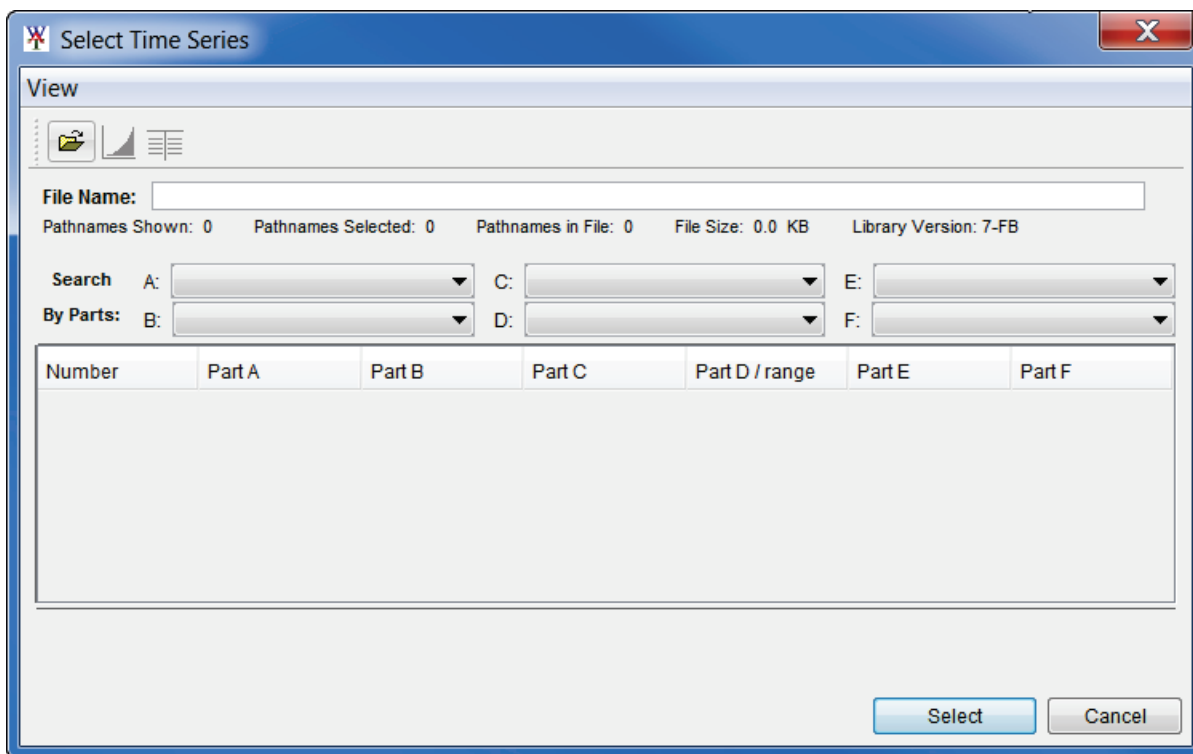
### 18.3.4 Time Series

The **Time Series** option allows the user to reference a time series of data in a logical expression. Note that a **Time Series** can only be added to the expression inside an **Operator** (Section 18.3.1). From the table on the **Edit Logical Expression** dialog box (Figure 18.4), make sure the row with *\*Not Set\** has been selected, click **Time Series** (Figure 18.11), the interface will change. From the **Time Series Expression** list (Figure 18.11), there are two options - **DSS from File** (Figure 18.11) or **Time Series from Model**.

For the **DSS from File** option (Figure 18.11), the user can select a DSS file and pathname, click **Select** (Figure 18.11). The **Select Time Series** dialog box will open (Figure 18.12), navigate to the DSS file location, from the table select the appropriate pathname, click **Select** (Figure 18.11).



**Figure 18.11** Edit Logical Expression Dialog Box – Time Series – DSS from File



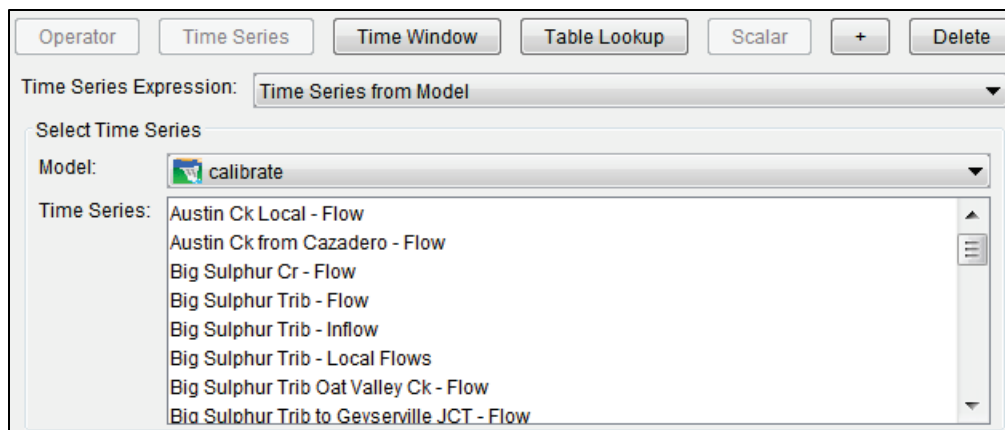
**Figure 18.12** Select Time Series Dialog Box

The **Select Time Series** dialog box will close (Figure 18.12), and the selected information will display on the **Edit Logical Expression** dialog box (Figure 18.11) in the **File** box and the **Path** box. The logical expression can be updated to display the **Time Series** by clicking **Save** or **Apply** on the **Edit Logical Expression Editor** (Figure 18.9).

The **Time Series from Model** option (Figure 18.13) allows the user to select time series data from model alternatives that are part of the FRA simulation. From the **Select Time Series** box (Figure 18.12), from the **Model** list (Figure 18.13), select the appropriate model alternative. The **Time Series** list (Figure 18.13) displays the time series data available from the selected model alternative. Select a single time series to include in the logical expression, click **Apply**, the selected time series will be added to the expression.

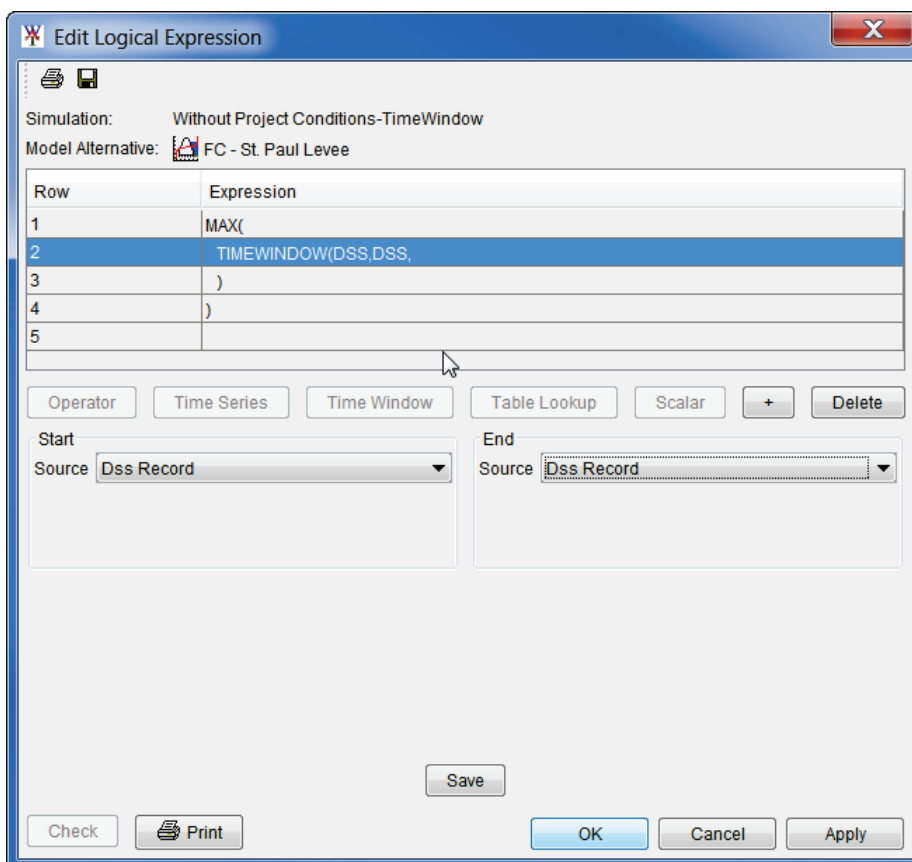
### 18.3.5 Time Window

The **Time Window** can only be added to the expression inside an **Operator** (Section 18.3.1) and allows the user to apply an **Operator** to a portion or subset of a time-series. For example, the user can find the maximum flow between two dates of interest, as specified by the time



**Figure 18.13** Edit Logical Expression Dialog Box – Time Series – Time Series from Model

window. From the table on the **Edit Logical Expression** dialog box (Figure 18.4), make sure the row with *\*Not Set\** has been selected, click **Time Window** (Figure 18.14), the interface will change. A row is added to the logical expression table on the **Edit Logical Expression** dialog box (Figure 18.14), with the *TIMEWINDOW* expression.




**Figure 18.14** Edit Logical Expression Dialog Box – Time Window

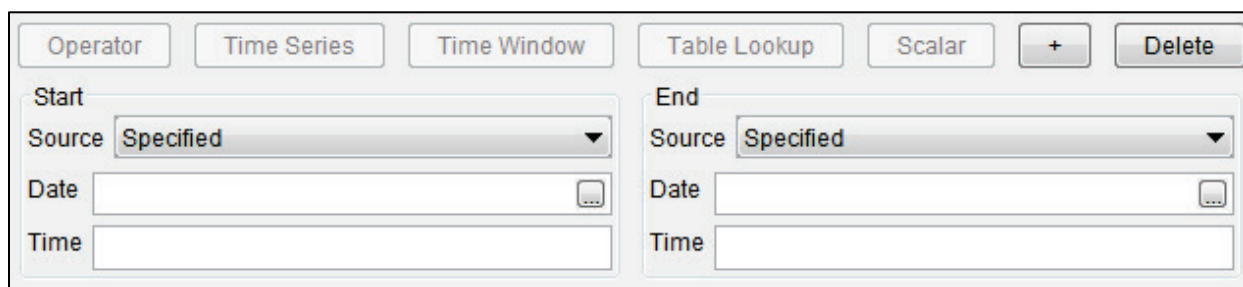
For the **Start** and **End** of the time window (Figure 18.14) there are three options - **DSS Record**, **Model's Compute Window**, and **Specified**. These options can be selected independently for the start and end dates and times. For example, the user could select **DSS Record** for **Start** and **Specified** for **End** (Figure 18.14).

In addition to specifying a source for both the start and end of a time window, the user must also specify a time series for application of the **Operator**. For example, a **MAX Operator** could be applied to a stage time series from HEC-RAS or a flow time series from the Hydrologic Sampler to find the maximum stage or flow, respectively, within a given time window. The time series is specified by selecting the row immediately below the *TIMEWINDOW* row in the logical expression, which activates the **Time Series** command (Figure 18.5). Refer to Section 18.3.4 for details on how to select a time series from a DSS file.

The **DSS Record** option (Figure 18.13) bases the start or end date and time on a user-specified DSS record. In this case, the DSS record selected to provide the time series data for the **Operator** is also used to set the time window start or end time.

The **Model's Compute Window** bases the start or end date and time on the compute window of the selected model alternative. The selected model alternative is identified on the **Edit Logical Expression** dialog box (Figure 18.3), along with the name of the FRA simulation. If a **Time Window Modifier** (Chapter 9) has been applied to the selected model alternative, the **Model's Compute Window** option will reference the modified time window associated with that model alternative.

The **Specified** option (Figure 18.15) allows the user to enter a specific date and time for either the **Start** or **End** time. For both the **Start** and **End** boxes (Figure 18.15) there are **Date** and **Time** boxes (Figure 18.14). The date should be entered in DDMMM format (e.g., 10Jan) or selected from a calendar, from the right of the **Date** box (Figure 18.15) click , a calendar window will open from which the user can select a date (although year is displayed in the calendar, it is not used in the **Date** box or computations). The time should be entered in 24-hour format (e.g., 1630).



**Figure 18.15** Edit Logical Expression Dialog Box – Time Window - Specified

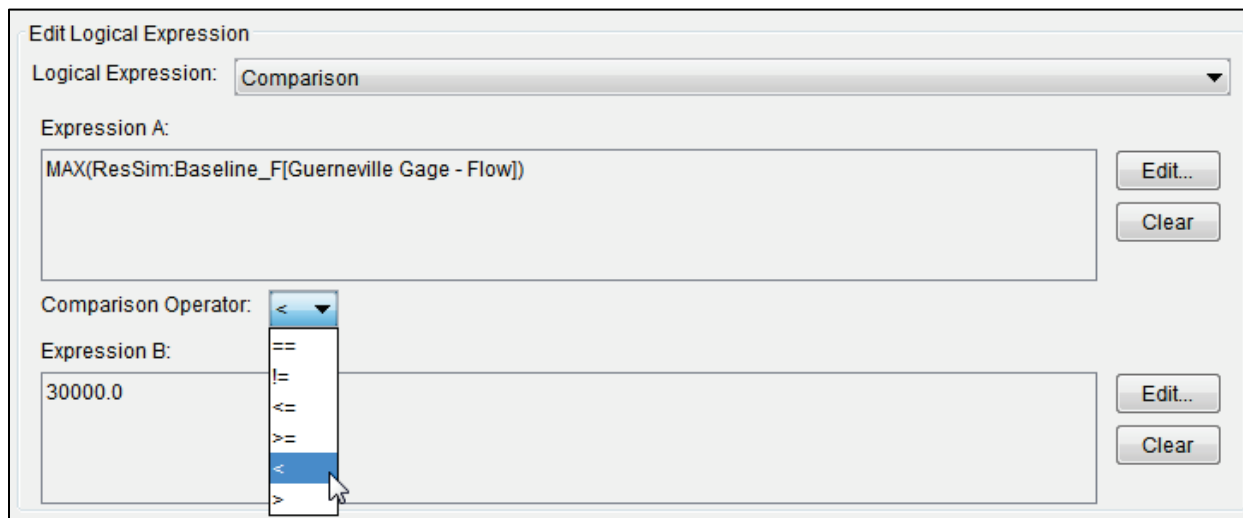
### 18.3.6 Delete

The **Delete** option can be used to delete one or more highlighted rows from the expression.

## 18.4 Model Skip Rules Editor - Comparison Operator

The **Comparison Operator** defines how *Expression A* will be compared to *Expression B*. From the **Model Skip Rules Editor** (Figure 18.2), from the **Edit Logical Expression** box, the **Comparison Operator** list (Figure 18.16) contains the following operators:

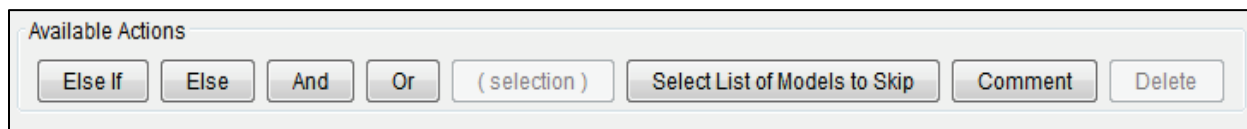
- = (equal to)
- != (not equal to)
- <= (less than or equal to)
- >= (greater than or equal to)
- < (less than)
- > (greater than)



**Figure 18.16** Edit Logical Expression Dialog Box – Comparison Operator List

## 18.5 Model Skip Rules Editor - Available Actions

The user has the option to add other conditions to the skip rule beyond the simple *IF* statement. If the user selects a row in the middle of the skip rule (i.e., not the first or the last row), all four commands in the **Available Actions** box (Figure 18.17) are enabled - **Else If**, **Else**, **And**, and **Or**. When the user selects one of these options, a new row with the selected command is added to the **Build Logical Expression** table (Figure 8.2) above the highlighted row. If the user selects the *END* row, only the **Else If** and **Else** commands are enabled. In this case, a new row with the selected command is added to the **Build Logical Expression** table (Figure 8.2) above the *END* row. The commands function is detailed in the following sections.



**Figure 18.17** Model Skip Rules Editor – Available Actions - End

### 18.5.1 Default - If

This condition specifies the first rule that is tested for true or false. This is included in the **Build Logical Expression** table by default. If this rule is true, the evaluation moves to the *Skip* rule. If the **If** rule is false, the evaluation moves to the first **Else If** rule (Section 18.5.2). If all rules are false, the evaluation moves to the **Else** rule if the user has chosen to specify a default action. Otherwise the evaluation stops and no models are skipped.

## 18.5.2 Else If

This condition allows the user to evaluate additional rules for true or false beyond the initial **If** rule. If the evaluation is false for the initial **If** rule (Section 18.5.1), the evaluation moves to the first **Else If** rule (Figure 18.17) to test for true or false. If an **Else If** rule is true, the evaluation moves to the *Skip* rule. If an **Else If** rule is false, the evaluation moves to the next **Else If** rule. If all rules are false, the evaluation moves to the **Else** rule if the user has chosen to specify a default action. Otherwise the evaluation stops and no models are skipped. The user can include as many **Else Ifs**, or alternate rules, as desired.

## 18.5.3 Else

This condition specifies the default action when none of the **If** or **Else If** rules are evaluated as true. The **Else** rule (Figure 18.17) is optional, and only one **Else** rule is allowed in a logical expression.

## 18.5.4 And

The **And** condition (Figure 18.17) can be used to ensure that multiple rules are evaluated as true before models are skipped. If any part of an **And** rule set is evaluated as false, the logical expression evaluation stops and no models are skipped.

## 18.5.5 Or

The **Or** condition (Figure 18.17) allows evaluation of additional expressions if previous expressions are evaluated as false. If any part of an **Or** rule is evaluated as true, the logical expression evaluation moves to directly to the *Skip* rule.

## 18.5.6 Selection

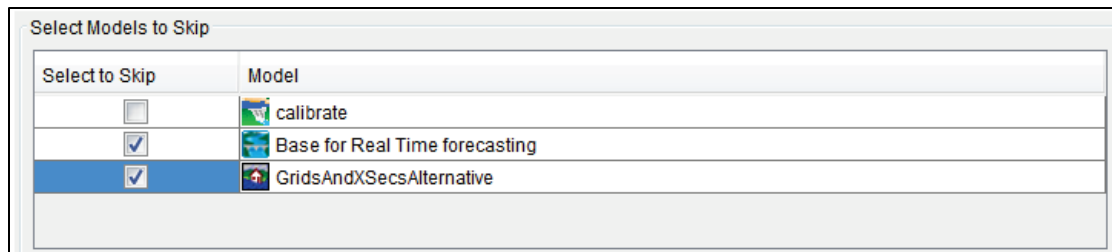
This option lets the user specify the order of operation using parentheses, where operations inside parentheses are completed first.

## 18.5.7 Select List of Models to Skip

The user should specify which models to skip in the FRA compute if the skip rule is met. This is done by selecting the row in the **Build Logical Expression** table that contains *END*. In the **Available Actions** box (Figure 8.17), several options become available.

To skip models in the selected FRA simulation, click **Select List of Models to Skip** (Figure 18.17), the **Select Models to Skip** box (Figure 18.18) contains a list of model alternatives that could be skipped. The list is based on the selected model alternative and the listed models follow the selected model alternative in the program order. The user should select the model of interest to skip, as well as all other models that follow in the compute sequence because they will not have input data to run.





**Figure 18.18** Model Skip Rules Editor – Select Models to Skip Box

## 18.5.8 Comment

This command allows the user to enter documentation within a logical expression. **Comments** (Figure 18-17) do not affect the evaluation of the logical expression.

## 18.5.9 Delete

Multiple conditions can be added to the **Model Skip Rules Editor**, and one or more rows can be deleted by highlighting them and selecting the **Delete** button.

## 18.6 Default - End Condition

The *END* condition signifies the end of the defined logical expression or skip rule.



# CHAPTER 19

## Performance and Economic Metrics

USACE requires that for USACE planning studies, risk and uncertainty analyses be performed in a systems context. From these analyses, the performance of the system's reaction to an event needs to be stated. The performance and economic metrics that can be computed in Version 1.0 of HEC-WAT meet these USACE requirements. The user will need to determine if the study being conducted needs to report performance and economic metrics. If the study requires the reporting of performance and economic metrics, then the user will need to build a Performance Metrics Alternative for the FRA compute. The HEC-WAT Technical Reference Guide (not available for Version 1.0 release) will provide the user with further details on the computation of performance and economic metrics in HEC-WAT.

### 19.1 Available Performance and Economic Metrics

The performance and economic metrics available in Version 1.0 of HEC-WAT are described in the following sections.

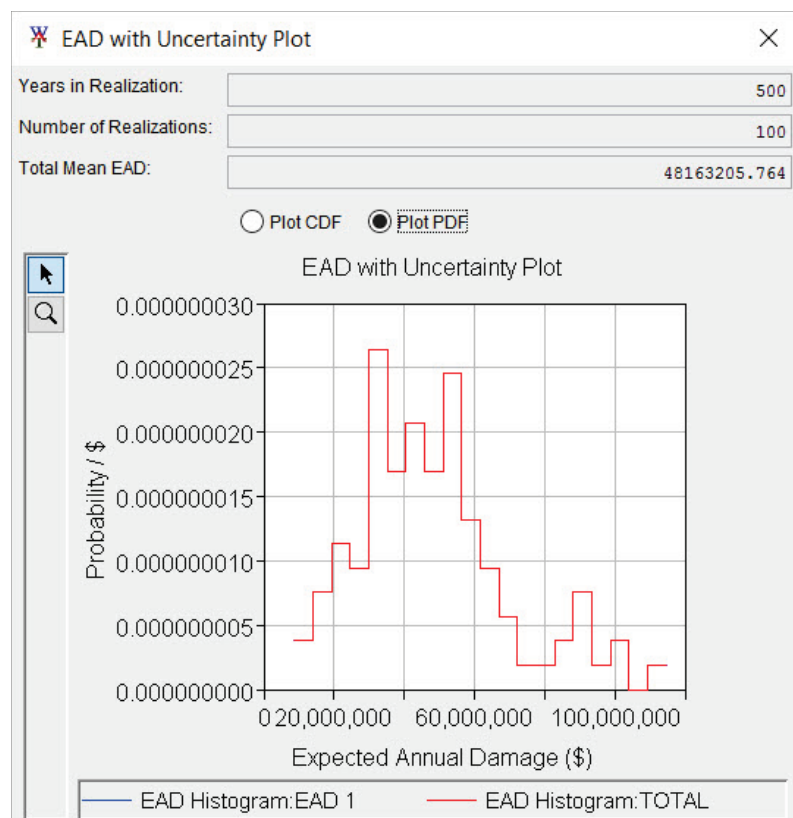
#### 19.1.1 Expected Annual Damage (EAD)

Expected Annual Damage (EAD) is an economic metric that is the average or mean of all annual damage determined from a Monte Carlo (a numerical integration approach) analysis of variables that contribute to EAD, along with those variables' associated uncertainties. HEC-WAT can compute both EAD and the uncertainty about EAD, as shown in Figure 19.1. An HEC-FIA model is required in the FRA compute for EAD to be computed.

HEC-WAT results for EAD provide the user with a general idea of how the EAD estimates are probabilistically distributed and easily characterize some global aspects of the distribution (skew, data gaps, etc.). During an FRA simulation, the consequence model alternative (FIA) can produce damage for each simulated flood event. HEC-WAT can then collect these damage results and calculate an average value per life cycle for each simulation which is analogous to an EAD estimate. All of these EAD estimates can then be assigned an equal probability. Finally, HEC-WAT can create a probability density function of EAD with uncertainty.

#### 19.1.2 Annual Exceedance Probability (AEP)

Annual Exceedance Probability (AEP) is the probability that a specific target stage at a location of interest will be exceeded in a given year, based on the full range of possible flows. Within the HEC-WAT **Performance Metrics** tool the user can select a common computation point (CCP) location and, for each location the user can specify a target stage. This means that the target stage is per location, and the locations must be CCPs. For each selected CCP, the user will be able to



**Figure 19.1** EAD with Uncertainty Plot – PDF (probability distribution function)

select an input DSS time series record from any model alternative. An example, is an AEP of stage at a CCP, is generated by an RAS model alternative. It should be noted that stage information from HEC-RAS storage areas is not currently available for AEP evaluation. AEP is used in the calculation of Assurance and Long Term Exceedance Probability (LTEP).

### 19.1.3 Assurance

The performance metric Assurance (also known as Conditional Non-Exceedance Probability, CNP), is the probability that a specific target (e.g., the top of a levee) will not be exceeded, given the occurrence of a specific flood event. This is illustrated in Figure 19.2, which shows that a stage of 53 feet is not exceeded for 90 percent of the stages modeled for the 1 percent ACE (Annual Chance Exceedance). To compute Assurance, create a performance metrics alternative and define an AEP location (Section 19.1.4). When AEP is calculated, assurance will also be automatically calculated for six exceedance probabilities: 10%, 4%, 2%, 1%, 0.5% and 0.2%.

### 19.1.4 Long Term Exceedance Probability (LTEP)

Long Term Exceedance Probability (LTEP) is a performance metric that is the probability that one or more flood events will occur within a specified time period or the likelihood that the target stage will be exceeded in a specified time period. LTEP results are currently available for three time periods in HEC-WAT: 10-, 30- and 50-years. The calculations use the binomial distribution and the computed AEP (EM 1110-2-1415).

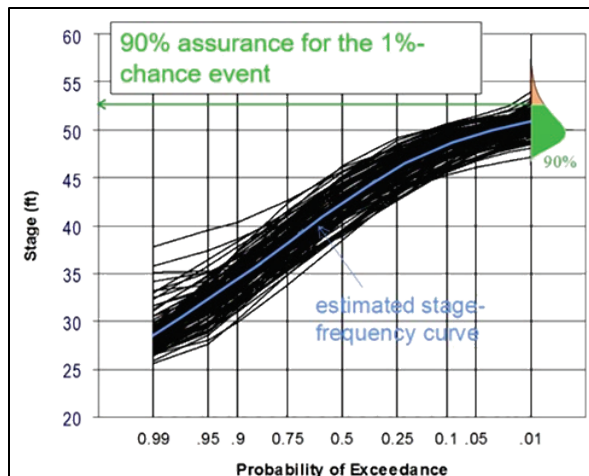


Figure 19.2 Assurance

## 19.2 Performance Metrics Alternative

For HEC-WAT to compute performance and economic metrics the user will need to create and setup certain parameters in a performance metrics alternative. This section provides information on creating, editing, saving, creating copies, renaming, and deleting performance metrics alternatives.

### 19.2.1 Create

To create a performance metrics alternative:

1. From the HEC-WAT main window (Figure 19.3), from the **Study Tree**, from the **Models** folder, right-click on **Performance Metrics**. From the shortcut menu (Figure 19.4), click **New**, or from the HEC-WAT main window (Figure 19.3), from the **Edit** menu, point to **Performance Metrics**, click **New**. Using either approach, the **Create New Performance Metrics Alternative** dialog box will open (Figure 19.5).

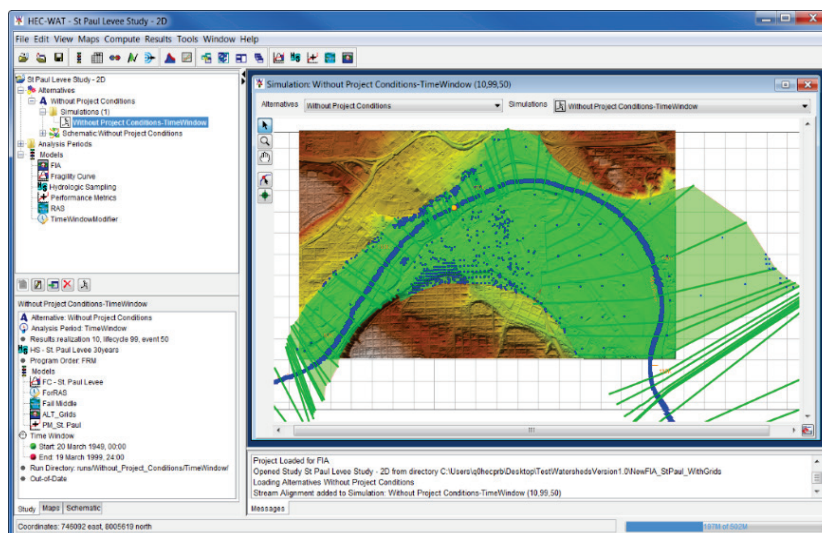
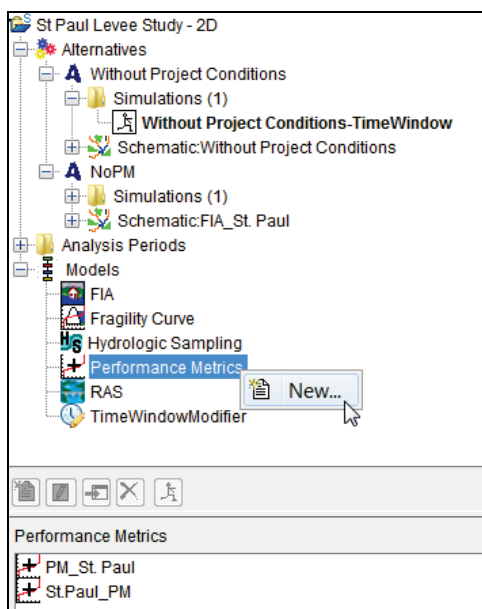
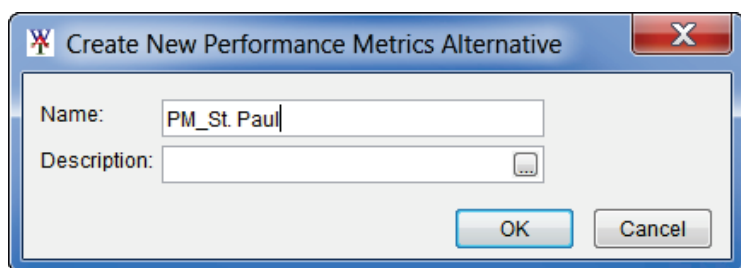


Figure 19.3 HEC-WAT Main Window

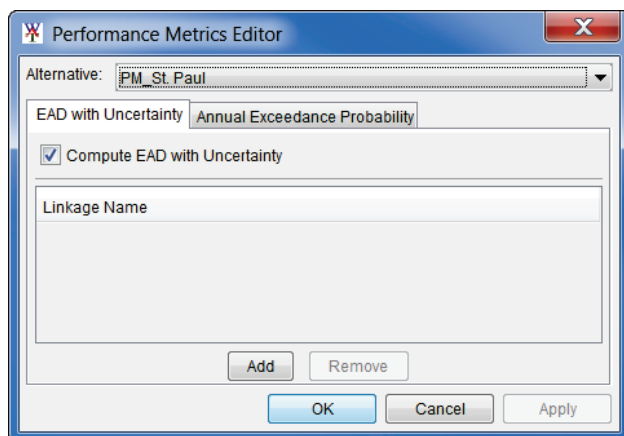


**Figure 19.4** Study Tree – Performance Metrics – Shortcut Menu



**Figure 19.5** Create New Performance Metrics Alternative Dialog Box

2. In the **Name** box (Figure 19.5), enter a name for the performance metrics alternative. A description for the alternative can be entered in the **Description** box (Figure 19.5).
3. Click **OK**, the **Create New Performance Metrics Alternative** dialog box (Figure 19.5) will close. The **Performance Metrics Editor** will open (Figure 19.6) and the name of the performance metrics alternative will display in the **Content Pane** (Figure 19.4) of the HEC-WAT main window.



**Figure 19.6** Performance Metrics Editor

4. By default the **Performance Metrics Editor** (Figure 19.6) defaults to computing EAD with uncertainty. If the user wishes not to compute EAD with uncertainty, click **Compute EAD with Uncertainty** (check-mark will disappear).
5. To create a name for linking the models to the active performance metrics alternative (i.e., *PM\_St. Paul*), click **Add** (Figure 19.6). A default name will display (*EAD 1*, *EAD 2*, etc.) in the **Linkage Name Table** (Figure 19.6). The user can change this default name by selecting a row in the table and changing the name. A name can be deleted by selecting a row, clicking **Remove** (Figure 19.6) and the selected name is deleted.
6. From the **Annual Exceedance Probability** tab (Figure 19.7) of the **Performance Metrics Editor**, the user can setup the computation of AEP. By default, the computation of AEP is set. If the user does not wish to calculate AEP, click **Compute AEP** (check-mark will disappear). It should be noted that AEP is used in the calculation of the other performance metrics (e.g., Assurance, LTEP). Therefore, ensure that AEP is being computed when also computing Assurance and/or LTEP.

Performance Metrics Editor

Alternative: PM\_St. Paul

EAD with Uncertainty Annual Exceedance Probability

☒ Compute AEP

Number of AEP Histogram Bars: 20

Number of LTEP Histogram Bars: 20

Select Locations

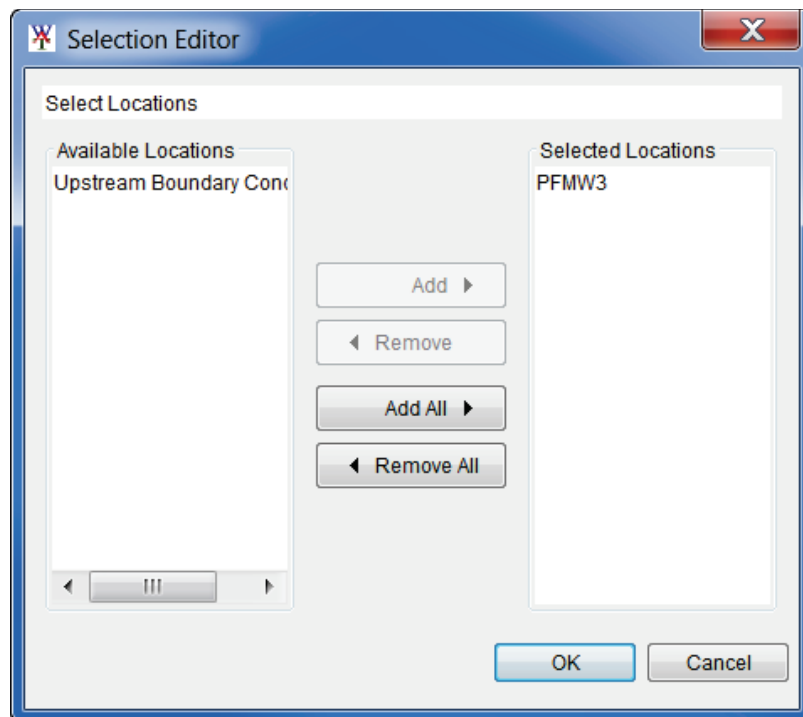
Location	Target Stage
PFMW3	700.0

OK Cancel Apply

**Figure 19.7** Performance Metrics Editor – Annual Exceedance Probability Tab

7. To display AEP and LTEP in a histogram, the number of bars (bins) is required. By default the number of bars (bins) in the histograms is set to twenty (20). The user can change the number of bars (bins) in the **Number of AEP Histogram Bars** and the **Number of LTEP Histogram Bars** boxes (Figure 19.7).
8. Next the user needs to select the location(s) where AEP is to be computed in the study. These locations can only be CCPs that have already been defined for the study area. From the **Performance Metric Editor** (Figure 19.7), click **Select Locations**, the **Selection Editor** (Figure 19.8) will open. From the **Available Locations** box, select the

location(s) where AEP is to be computed. Click **Add**, the selected location(s) will now appear in the **Selected Locations** box (Figure 19.8). Click **OK**, the **Selection Editor** will close (Figure 19.8) and the names of the selected location(s) will appear on the **Performance Metrics Editor** (Figure 19.7) in the table.



**Figure 19.8** Selection Editor

9. For the specified location(s), the user will need to enter a target stage, from the table (Figure 19.7), under the **Target Stage** column.
10. Now that information has been defined for the performance metric alternative, click **OK**, the **Performance Metrics Editor** (Figure 19.7) will close.

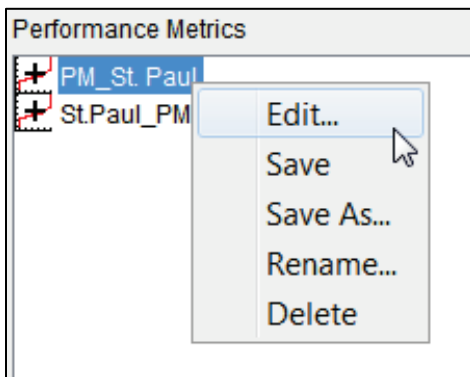
## 19.2.2 Edit

1. From the HEC-WAT main window (Figure 19.3), from the **Content Pane** (Figure 19.9), right-click on a performance metrics alternative, from the shortcut menu click **Edit**. The **Performance Metrics Editor** will open (Figure 19.6).
2. From the **Performance Metrics Editor**, the user can edit an existing performance metrics alternative. When editing is finished, click **OK**, the **Performance Metrics Editor** will close (Figure 19.6).

## 19.2.3 Save

From the HEC-WAT main window (Figure 19.3), from the **Content Pane** (Figure 19.9), right-click on a performance metrics alternative, from the shortcut menu click **Save**. The performance metrics alternative data is saved.

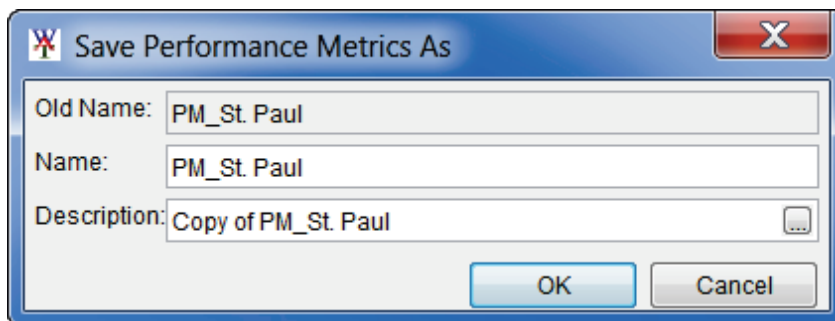




**Figure 19.9** Individual Performance Metrics Alternative - Content Pane- Shortcut Menu

## 19.2.4 Save As

1. From the HEC-WAT main window (Figure 19.3), from the **Content Pane** (Figure 19.9), right-click on a performance metrics alternative, from the shortcut menu, click **Save As**. The **Save Performance Metrics As** dialog box will open (Figure 19.10).

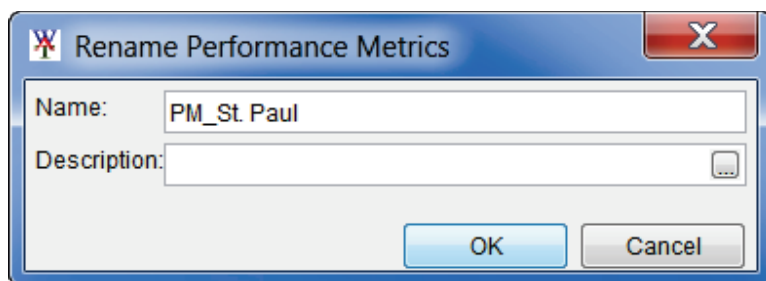


**Figure 19.10** Save Performance Metrics As Dialog Box

2. The name of the performance metrics alternative which is being copied is displayed in the **Old Name** box (Figure 19.10). The user will enter a new unique name in the **Name** box. An optional can be provided description in the **Description** box (Figure 19.10).
3. Click **OK**, the **Save Performance Metrics As** dialog box will close (Figure 19.10), and the name of the new performance metrics alternative will appear in the **Content Pane** (Figure 19.9) of the HEC-WAT main window (Figure 19.3).

## 19.2.5 Rename

1. From the HEC-WAT main window (Figure 19.3), from the **Content Pane** (Figure 19.9), right-click on a performance metrics alternative, from the shortcut menu click **Rename**. The **Rename Performance Metrics** dialog box will open (Figure 19.11).
2. The name of the performance metrics alternative which is being renamed is displayed in the **Name** box. The user must enter a new unique name in the **Name** box (Figure 19.11). An optional description can be provided in the **Description** box (Figure 19.11).

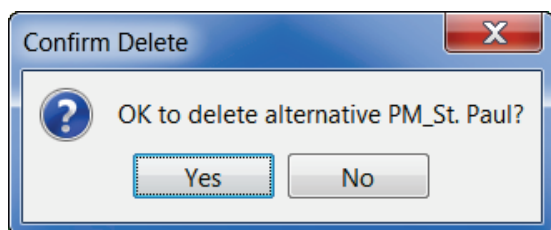


**Figure 19.11** Rename Performance Metrics Dialog Box

3. Click **OK**, the **Rename Performance Metrics** dialog box will close (Figure 19.11), and the re-named performance metrics alternative will appear in the **Content Pane** (Figure 19.9) of the HEC-WAT main window (Figure 19.3).

## 19.2.6 Delete

1. From the HEC-WAT main window (Figure 19.3), from the **Content Pane** (Figure 19.9), right-click on a performance metrics alternative, from the shortcut menu click **Delete**. A **Confirm Delete** window box will open (Figure 19.12).



**Figure 19.12** Confirm Delete Window

2. Click **Yes**, the selected performance metrics alternative will no longer be displayed in the **Content Pane** (Figure 19.9) of the HEC-WAT main window (Figure 19.3).

## 19.3 Model Skip Rules Editor

The **Model Skip Rules Editor** (Chapter 18) is available as part of the flood risk analysis (FRA) compute of HEC-WAT. The purpose of the **Model Skip Rules Editor** is to allow the user to define logical expressions (i.e., if-then statements) of conditions when model computations will be skipped, or not performed, within an FRA compute. A performance metrics alternative should never be skipped, because some of the computed results may not be correct if the performance metrics alternative is skipped.

## 19.4 Model Linking

Model linking (Chapter 12) is the process within the HEC-WAT framework that allows the individual models to communicate with each other and how data is handed-off from model alternative to model alternative. For a performance metrics alternative, the EAD metric should be linked to an FIA model alternative and the AEP metric should be linked to stage at an HEC-RAS cross-section.

## 19.5 Results

Performance metrics results are available from a series of plots and reports that will be discussed in the following sections. Chapter 21 will provide further details on where in the HEC-WAT interface these results can be obtained. The *simulation.dss* file (e.g., *Without Project Conditions-TimeWindow.dss*) contains performance metrics results (EAD, AEP) that the user can access with HEC-DSSVue (Figure 19.13) and create specific plots and reports.

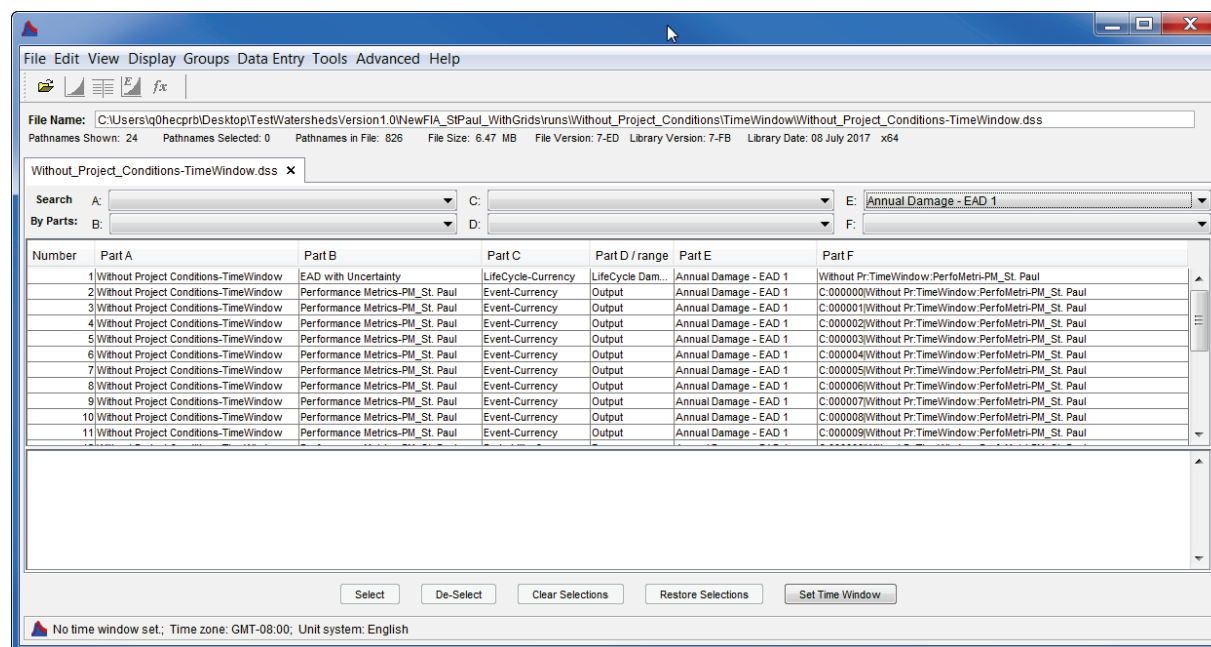


Figure 19.13 HEC-DSSVue – *simulation.dss* File

HEC-WAT results for a performance metrics alternative are available for the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 19.3). From the **Results** menu (Figure 19.14), point to **Performance Metrics**, from the sub-menu are the available performance metrics results from HEC-WAT.

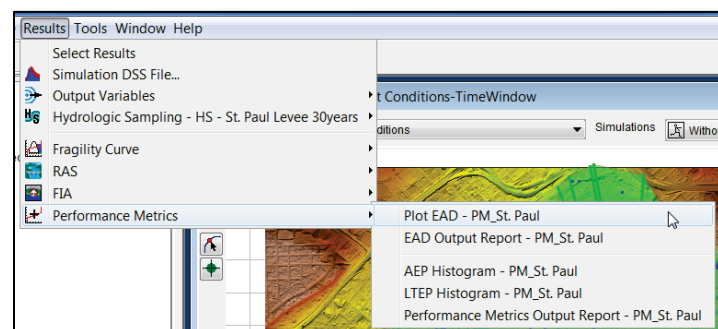


Figure 19.14 Results Menu – Performance Metrics

### 19.5.1 Select Event Results

To provide meaningful results, the user can setup how to organize those results. From the HEC-WAT main window (Figure 19.3), from the **Results** menu (Figure 19.14), click **Select Results**.

The **Select Event Results** dialog box will open (Figure 19.15). The user can select a realization, lifecycle, and/or event, for which performance metrics results will be displayed.

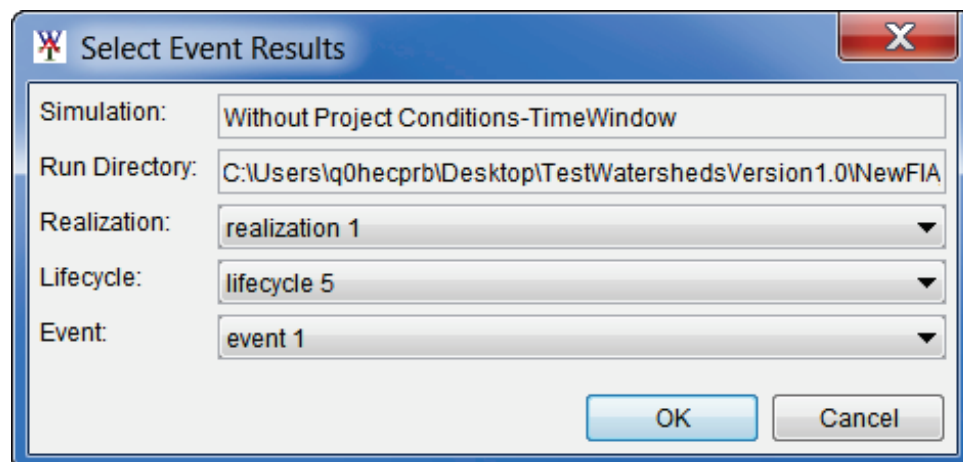


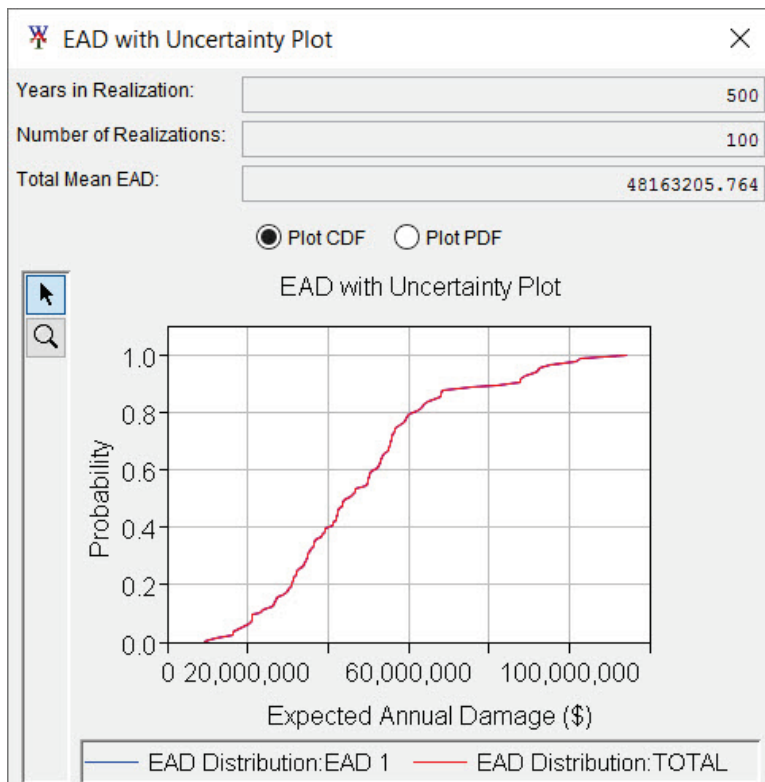
Figure 19.15 Select Event Results Dialog Box

## 19.5.2 Plot EAD

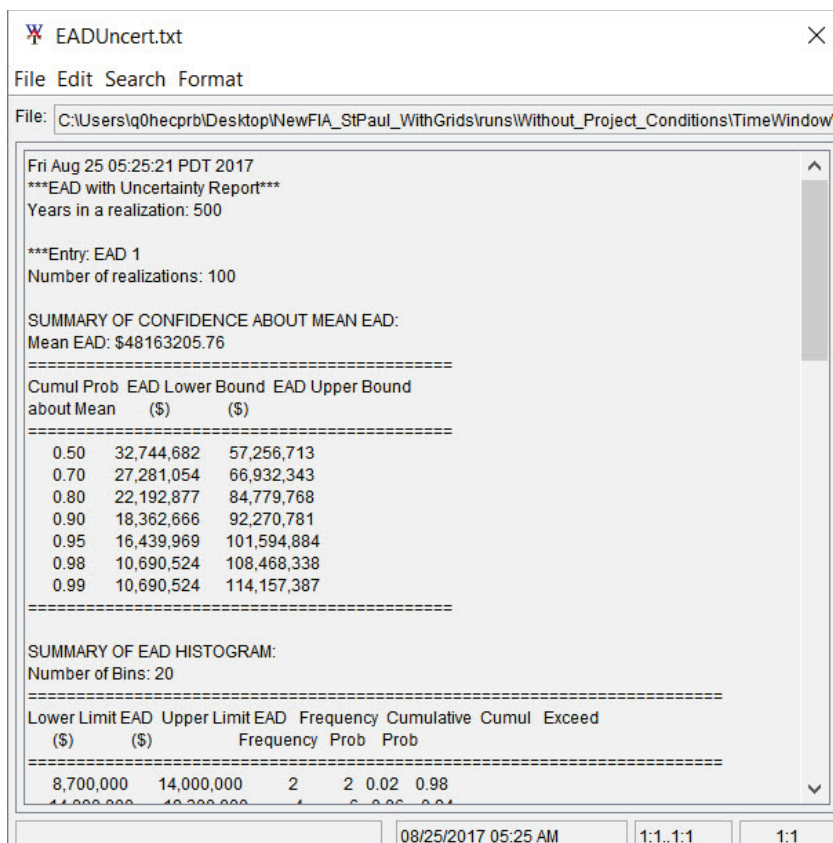
For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 19.3), from the **Results** menu (Figure 19.14), point to **Performance Metrics**, from the sub-menu click **Plot EAD**. The **EAD with Uncertainty Plot** dialog box will open (Figure 19.16), displaying (by default) the cumulative distribution function (CDF) of the **EAD with Uncertainty Plot**. For EAD, this plot is for all realizations. For example, in Figure 19.16, ten realizations of 500 events each (total of 5,000 events). An example of the probability density function (PDF) is provided in Figure 19.1. The CDF displayed in Figure 19.16 records the EAD from each realization, ranked from smallest to largest, plotted by the position of the record in the ranked list as an exceedance probability. Within any realization, the damage from all events are accumulated and divided by the total number of events simulated within a realization. This produces an estimate of EAD at the realization level. Each realization estimate of EAD will differ slightly from other realization estimates, based on the sampled frequency curve and sampled uncertainty in each model in the compute sequence. The average of all realization estimates of EAD is presented in the **Total Mean EAD** box (Figure 19.16), and the variance in the realization level EAD values represents the uncertainty around the average. Equivalently, the PDF plot presented in Figure 19.1 also describes the distribution of the realization estimates of EAD.

## 19.5.3 EAD Output Report

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 19.3), from the **Results** menu (Figure 19.14), point to **Performance Metrics**, from the sub-menu click **EAD Output Report**. A text editor will open (Figure 19.17), which contains the **EAD Output Report**. This report provides information about the years in a realization (i.e., 500); the number of realizations (i.e., 10); the mean EAD (i.e., \$48,618,722.38); a table summarizing confidence about the mean EAD; numbers of bins (bars) (i.e., 20) for the EAD histogram; and, a table that represents the EAD histogram. This report is generated in after the completion of an FRA compute.



**Figure 19.16** EAD with Uncertainty Plot Dialog Box – Plot CDF



**Figure 19.17** EAD Output Report

### 19.5.4 AEP Histogram

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 19.3), from the **Results** menu (Figure 19.14), point to **Performance Metrics**, from the sub-menu click **AEP Histogram**. An **AEP Histograms** dialog box will open (Figure 19.18), providing a plot of the calculated AEP in a histogram. The histogram provides a graphical representation of numerical data and allows the user to discover and display the underlying frequency distribution (shape) of the numerical data. This plot is representative of all realizations (e.g., 5,000 events), and for the first watershed location (i.e., PFMW3) in the **Location** list (Figure 19.18).

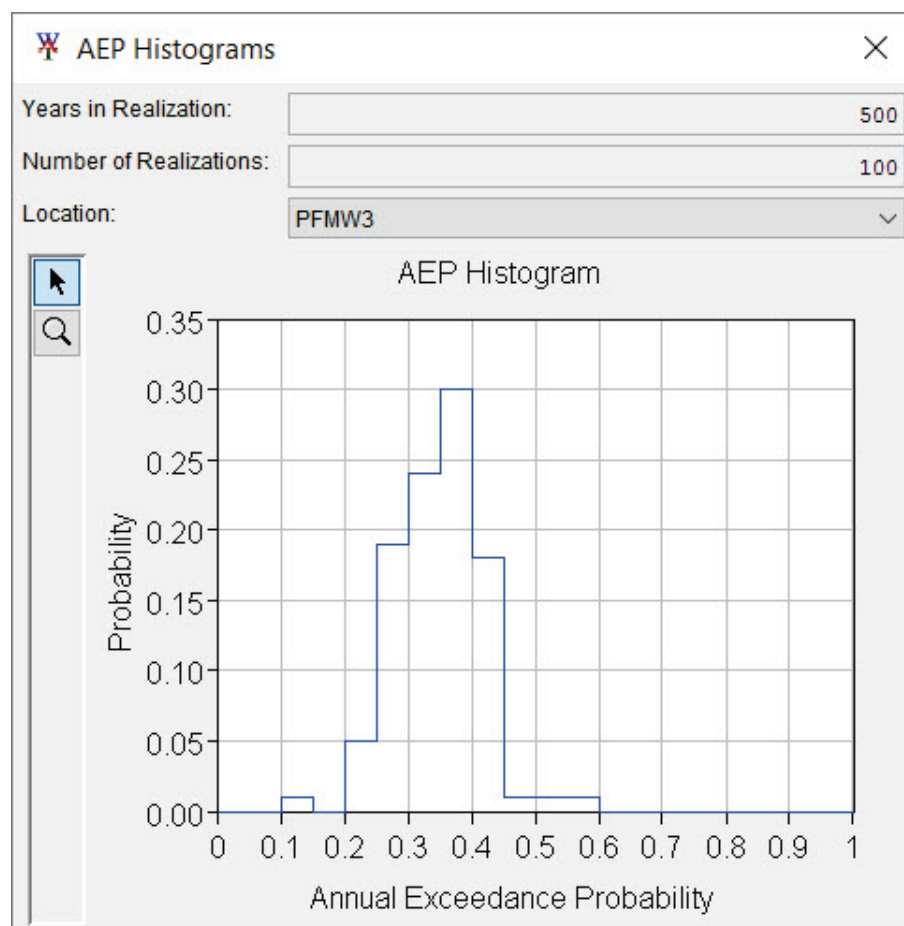


Figure 19.18 AEP Histogram

### 19.5.5 LTEP Histogram

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 19.3), from the **Results** menu (Figure 19.14), point to **Performance Metrics**, from the sub-menu click **LTEP Histogram**. An **LTEP Histograms** dialog box will open (Figure 19.19), providing a plot of the calculated LTEP values in a histogram. The histogram provides a graphical representation of numerical data and allows the user to discover and display the underlying frequency distribution (shape) of numerical data. This plot is representative of all realizations (e.g., 5,000 events), and for the first watershed location (i.e., PFMW3) in the **Location** list (Figure 19.19).

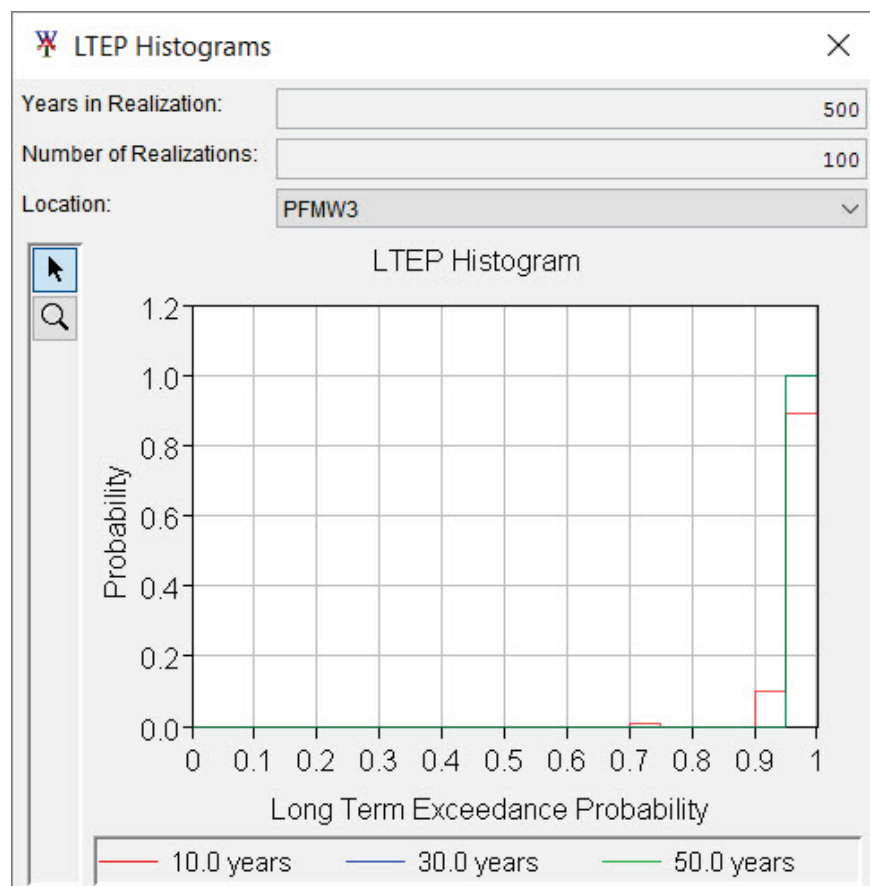
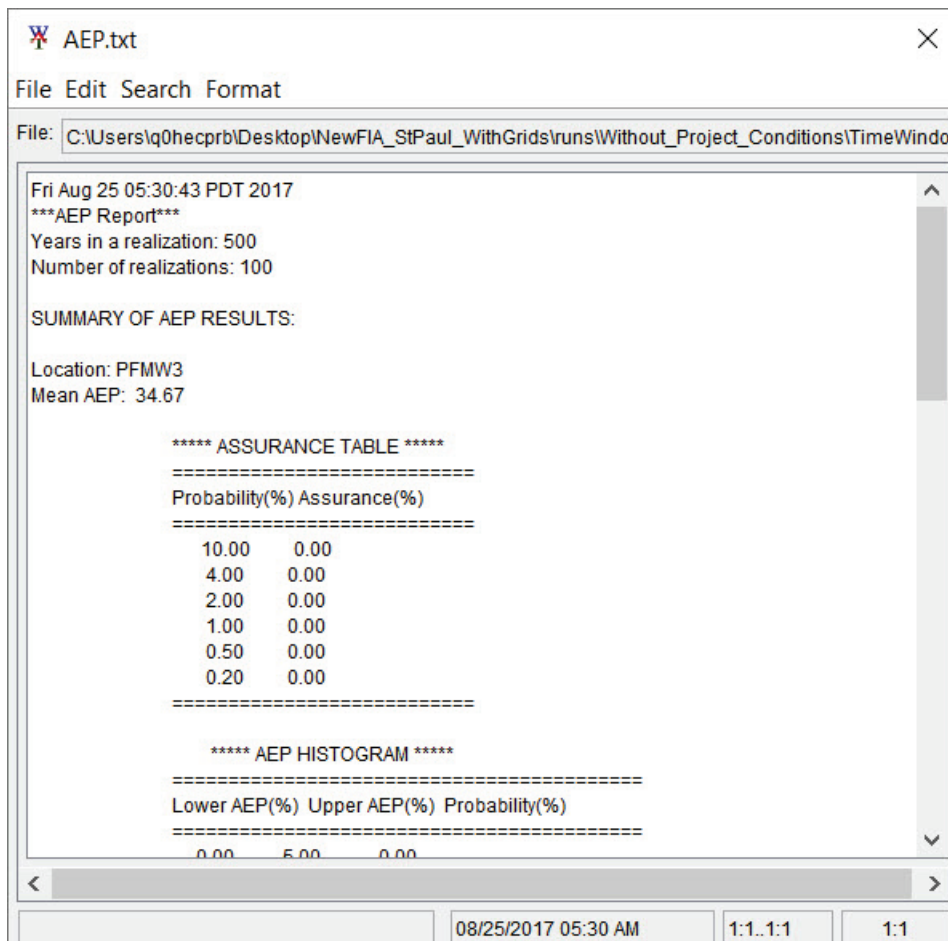


Figure 19.19 LTEP Histogram

### 19.5.6 Performance Metrics Output Report

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 19.3), from the **Results** menu (Figure 19.14), point to **Performance Metrics**, from the sub-menu click **Performance Metrics Output Report**. A text editor will open (Figure 19.20), which contains the **Performance Metrics Report**. This report provides information about the years in a realization (i.e., 500); the number of realizations (i.e., 10); the mean AEP (i.e., 34.57) for a specific watershed location (i.e., PFMW3); a table that is the summary of Assurance; a table of the AEP histogram; a table of the mean LTEP; and, a table that represents the LTEP histogram. This report is generated in after the completion of an FRA compute.





**Figure 19.20** Performance Metrics Output Report



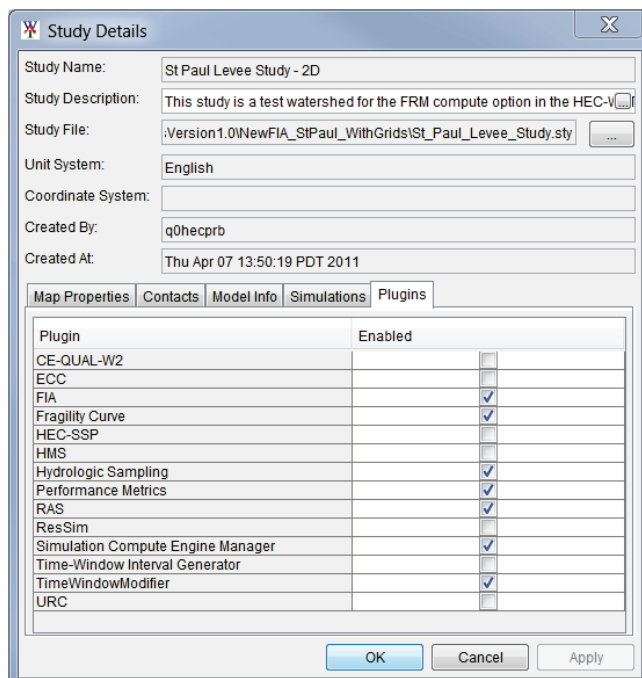
# CHAPTER 20

## Final Study Setup – Flood Risk Analysis

Now the user has an understanding about the HEC-WAT framework with an FRA study in mind - how to create a study; an introduction to map layers; model alternatives have either been created or imported into the study; analysis periods (time windows); alternative and simulations have been created; and, model linking has been defined. There are a few more setup items for an FRA compute that need to occur: which plug-ins are associated with an FRA study; manipulating map layers associated with the study; entering the correct lookback window for an HEC-ResSim model (if part of the study); creating specific FRA model alternatives; time window modifiers; model linking the FRA model alternatives; creating an FRA simulation; and selecting specific output for an FRA simulation.

### 20.1 Define Plug-Ins for an FRA Study

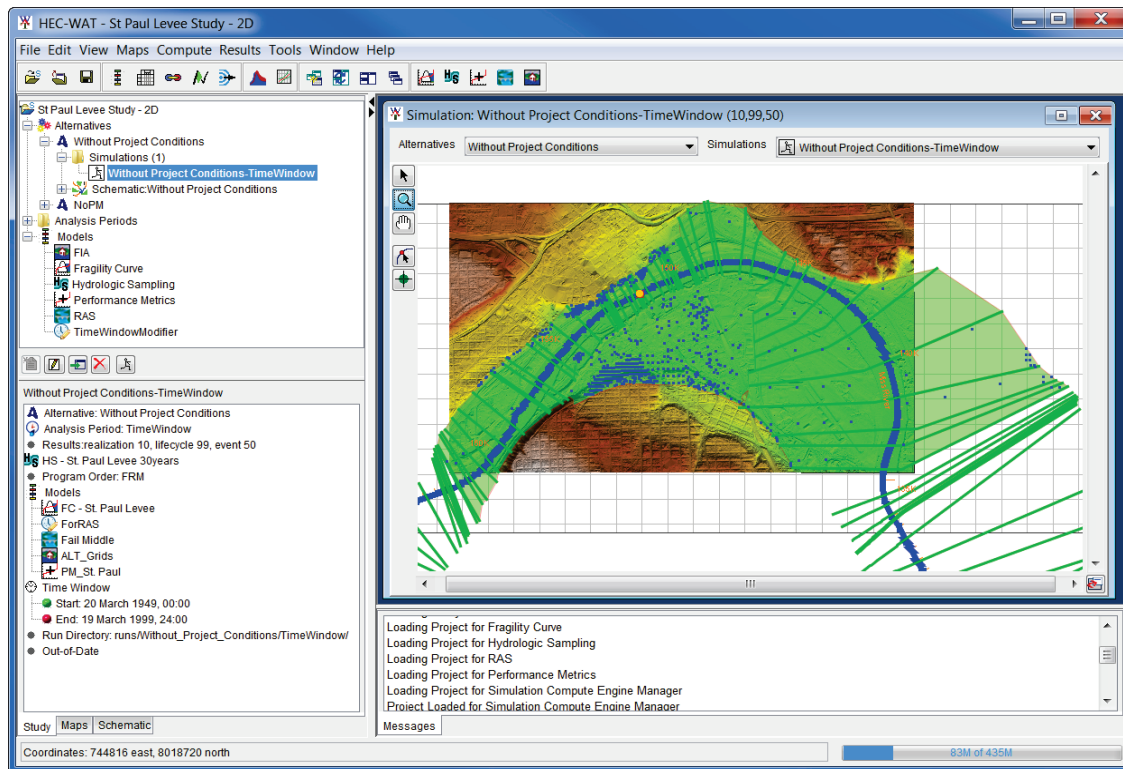
Plug-ins (Chapter 2) allow HEC-WAT to integrate software applications into its framework without requiring special code in HEC-WAT to support the individual software applications. Currently there are nineteen plug-ins that have been created (Appendix B provides further details), eight of those specifically for standalone software applications, and eleven plug-ins specifically created for HEC-WAT functions. While all of these plug-ins are available, the user must inform HEC-WAT which plug-ins are needed for a given study from the **Study Details** dialog box (Figure 20.1). Plug-ins can be enabled/disabled from the **Options** dialog box (Appendix B), but this should only be done to enable/disable specific plug-ins for specialized studies or when there is an issue with a plug-in.



**Figure 20.1** Study Details Dialog Box – Plugins Tab – FRA

To set the specific plug-ins for an FRA study:

1. From the HEC-WAT main window (Figure 20.2), from the **File** menu, click **Study Details**, the **Study Details** dialog box (Figure 20.1) will open.



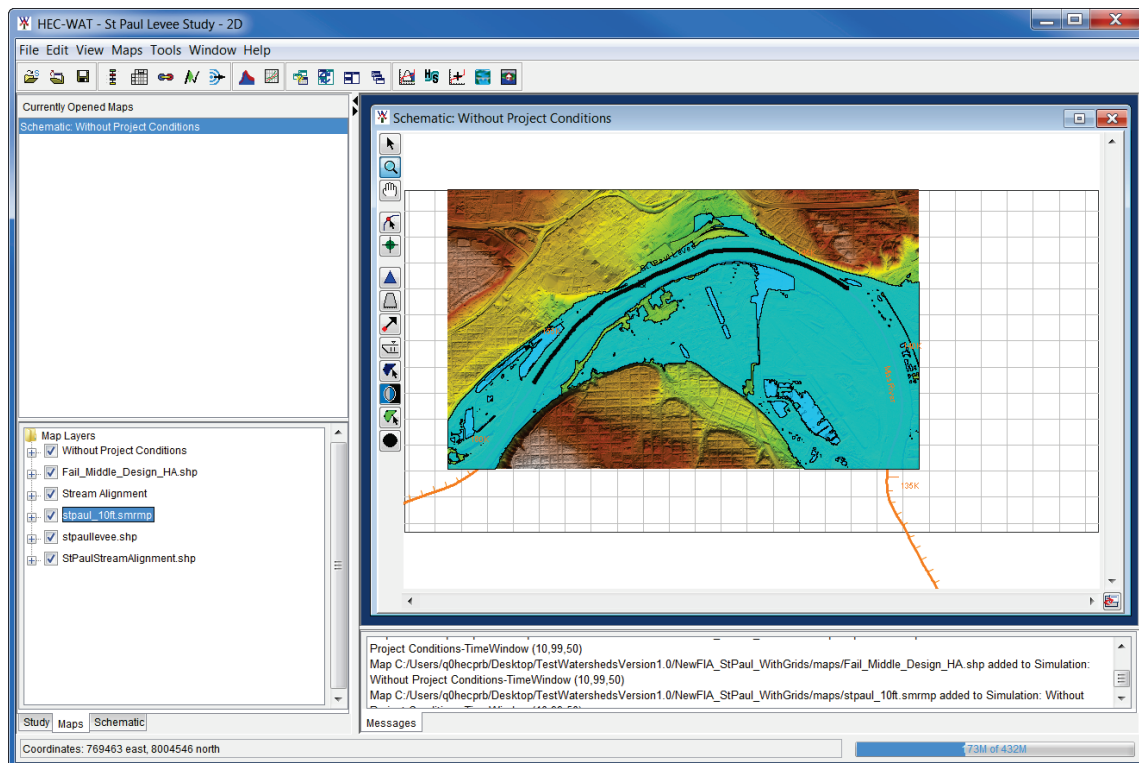
**Figure 20.2** HEC-WAT Main Window

2. The **Study Details** dialog box (Figure 20.1) displays the name of the study, the study description (which the user can edit), location of the study file (\*.sty), the selected unit system, the selected coordinate system, the user name of the team member that created the study, and the date and time the study was created.
3. Click the **Plugins** tab (Figure 20.1), by default, all plug-ins are enabled; for an FRA study the user should choose the software applications that will be used in an FRA study. For example, in Figure 20.1, for the active FRA study the plug-ins enabled are *FIA*, *Fragility Curve*, *Hydrologic Sampling*, *Performance Metrics*, *RAS*, *Simulation Compute Engine Manager*, and *TimeWindowModifier*.
4. For an FRA study, the only required plug-in is the Hydrologic Sampling plug-in, for all other plug-ins and software applications the user can select based on the analyses required of the FRA study area.
5. To disable a plug-in clear the check mark in the **Enabled** column of the table (Figure 20.1). When the user has the right plug-in configuration, click **OK**. The **Study Details** dialog box will close (Figure 20.1) and the plug-in configuration for the FRA study has been set.

## 20.2 Adjust Map Layers

Whether models were built from within the HEC-WAT study or imported, there could be map layers that define the study area. The user may need to adjust the map layers so that the schematic displays information to the study team and others.

1. From the HEC-WAT main window, click the **Maps** tab (Figure 20.3). Now the user can see which **Map Window** is currently active and what layers make up that **Map Window**. The user can now make adjustments (changes to draw properties) to the map layers, from the **Map Layers** tree:



**Figure 20.3** HEC-WAT Main Window – Maps Tab

- Un-check a map layer so that it will no longer display in the active map window. For example in Figure 20.3, the *stpaul\_10ft.smrmp* map layer has been un-checked.
- For map layers, the user can change the display properties of the selected map layer. For example, in Figure 20.3, the user could right-click on the *Fail\_Middle\_Design\_HA.shp* map layer, from the shortcut menu, click **Properties**. The **Edit Polygon Properties Editor** will open (Figure 20.4). From the **Fill** tab, change the color to "lightblue", click **OK**. The impact areas on the active map window will now display in "lightblue".
- Move layers to better display certain aspects of the schematic. For example, in Figure 20.3, right-click on **Stream Alignment**, from the shortcut menu click **Move To Top**. The **Stream Alignment** layer is now the top layer in the schematic.

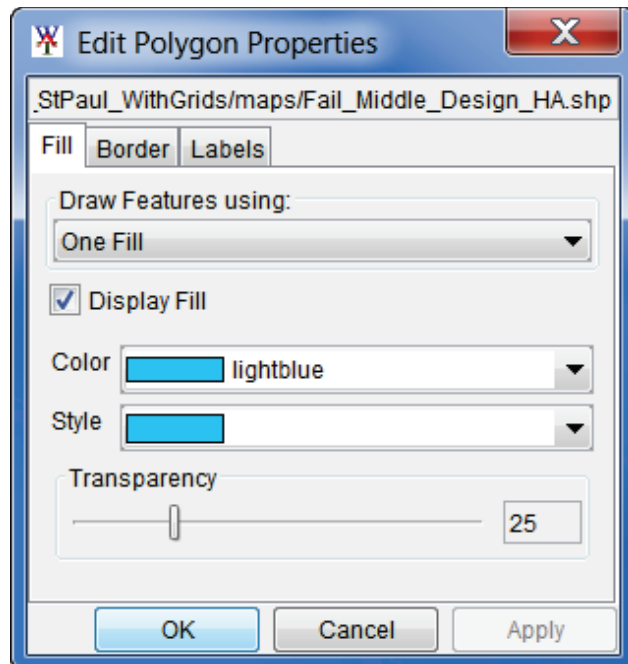


Figure 20.4 Edit Polygon Properties Editor

2. The user can adjust the view of the study area in the active map window. Using the **Magnifier** tool, zoom the study area in the active map window to the appropriate area that the user would like displayed. From the HEC-WAT main window (Figure 20.3), from the **Maps** menu, click **Default Map Properties**, the **Default Map Properties for** dialog box will open (Figure 20.5). Click **Set Map Extents to Display**, click **OK**. The **Default Map Properties for** dialog box will close.

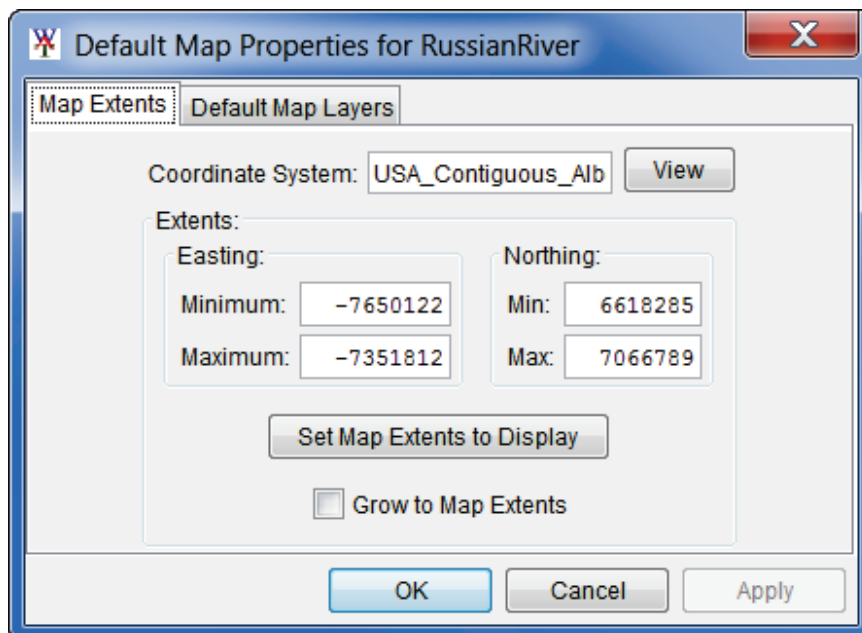


Figure 20.5 Default Map Properties for Dialog Box

This sets the extents for the **Map Window** so that when the study is opened the next time the **Map Window** will be zoomed in to the tighter area.

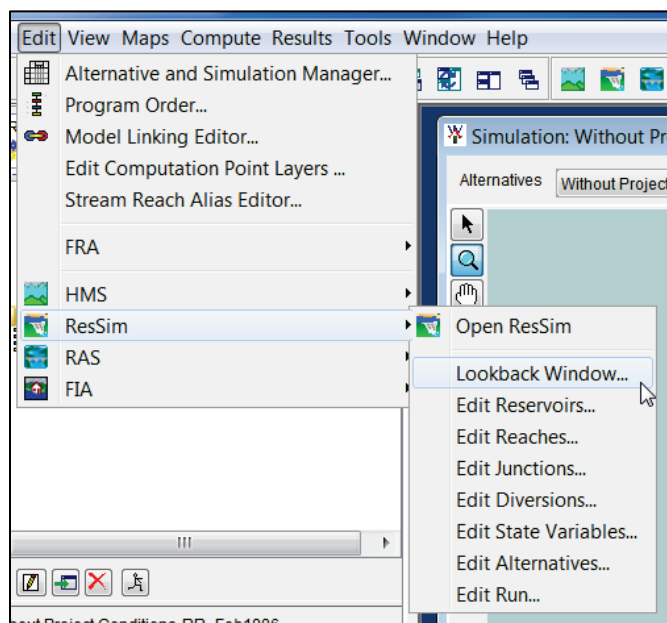
## 20.3 Lookback Window – HEC-ResSim (only)

The time window for an HEC-ResSim run has two parts, a "lookback period" and a "simulation or forecast period". The lookback period is used by HEC-ResSim to "warm up" a ResSim model alternative. During this period, routing of flows through the river and reservoir network are performed but no release decisions are made nor are any mass balance computations evaluated. The user should think of the lookback period as the time to establish the state of the river network and the starting conditions of the reservoirs. The simulation period is the portion of the time window during which HEC-ResSim simulates reservoir operations, and makes release decisions based on the operation logic defined by the user. Releases are then routed through the river network, combining with local inflows along the way.

HEC-WAT and most of the models treat the analysis period as a single, continuous time window. Because HEC-ResSim splits the analysis period into two parts, an additional setup step is required for each active HEC-ResSim alternative in an HEC-WAT study. The setup step lets each ResSim model alternative know how much of the analysis period to use for the lookback period.

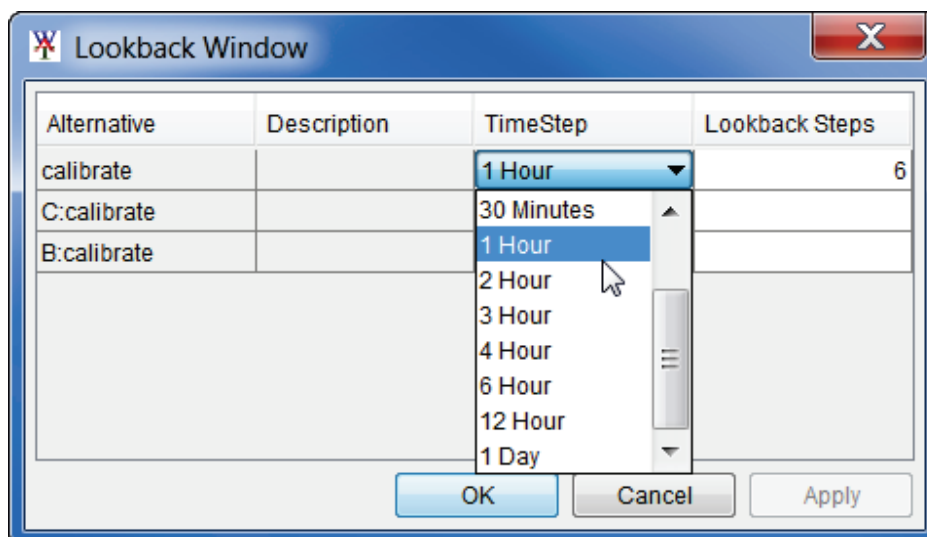
To set-up the lookback period:

1. From the HEC-WAT main window (Figure 20.2), from the **Edit** menu, point to **ResSim**, click **Lookback Window** (Figure 20.6), the **Lookback Window** dialog box (Figure 20.7) will open.



**Figure 20.6** Edit Menu – ResSim – Lookback Window

2. The table on the **Lookback Window** dialog box (Figure 20.7) displays the ResSim model alternatives that are available in the HEC-WAT study. Each model alternative that is being used in an HEC-WAT simulation will need to have a lookback window set. For example, in Figure 20.7, the ResSim model alternative *calibrate* has a **TimeStep** of 1 hour and **Lookback Steps** of 6.



**Figure 20.7** Lookback Window Dialog Box

- For each **Alternative** listed, a **TimeStep** (compute interval) and number of **Lookback Steps** must be specified. The time step can be selected from the **TimeStep** column (Figure 20.7), in each cell there is a list of available time steps for the user to choose from. The selected time step has to match the time step that was specified for the ResSim model alternative as part of the alternative's original Run Control data (which is located in the HEC-ResSim Alternative Editor). The number of lookback steps must be entered in a cell in the **Lookback Steps** column (Figure 20.7). At least one lookback time step is required for a ResSim model alternative to compute, however more lookback steps may be needed, depending on a variety of factors in the ResSim model alternative's operating rules. The HEC-ResSim modeler should be consulted to determine the minimum lookback window needed by each alternative. As mentioned, the lookback period takes place within the analysis period (time window) that HEC-WAT provides to the ResSim model alternative. No reservoir operations will be simulated during the lookback period, which could impact model results.
- Click **OK**, the **Lookback Window** dialog box (Figure 20.7) will close.

## 20.4 FRA Specific Model Alternatives

The HEC-WAT framework has several FRA specific model alternatives – hydrologic sampling, fragility curve sampling, performance and economic metrics, model skip flags, time window modifiers, and selecting specific output for an FRA simulation. This section will provide an overview of these model alternatives (Chapters 16 through 19).

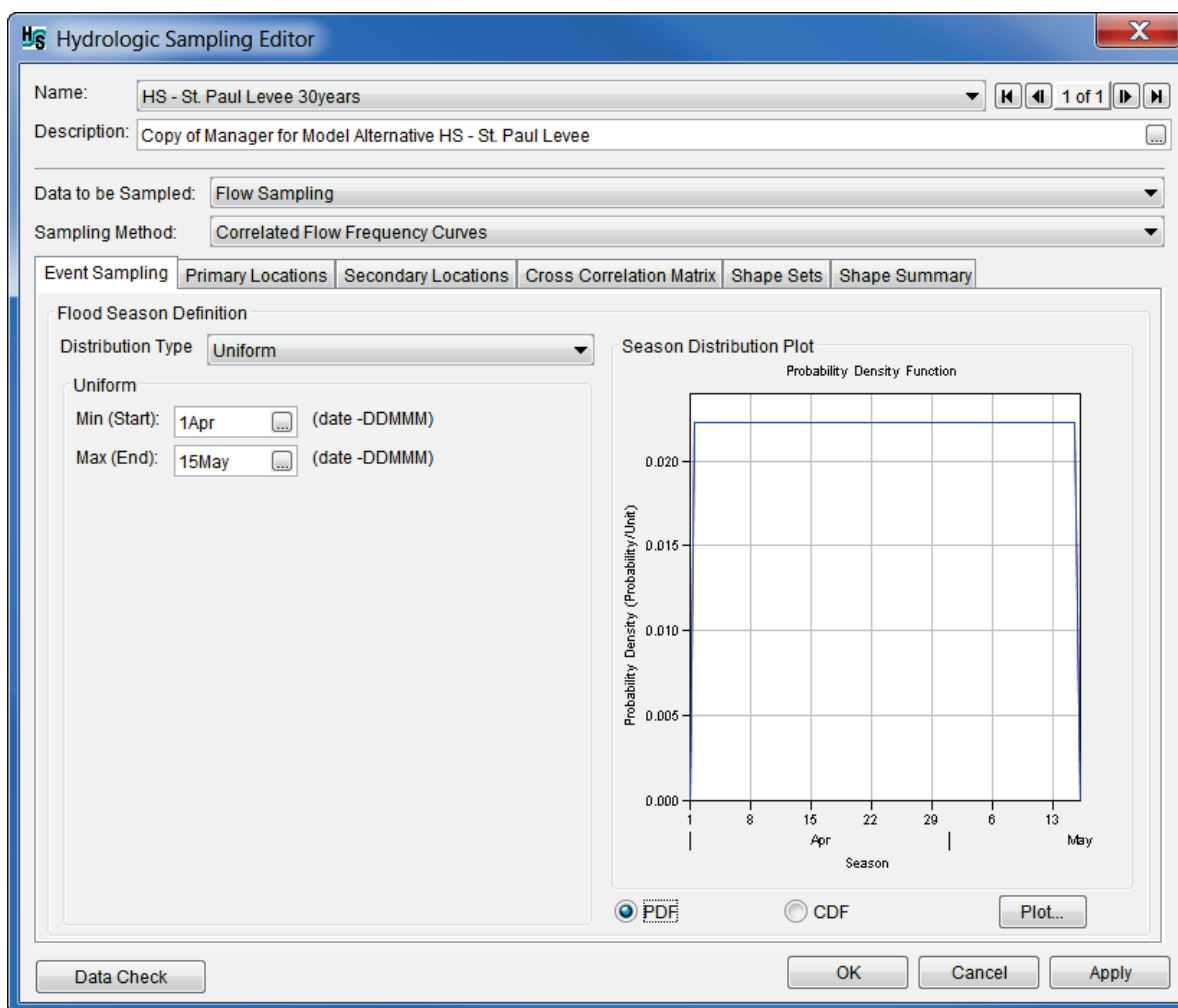
### 20.4.1 Hydrologic Sampling

The first step in an FRA compute is the sampling of the meteorology or hydrology of the study area to create perhaps thousands of events in meteorologic/hydrologic sequences. The hydrologic information is needed as time series of flow or precipitation to be routed through the system being studied. Both precipitation and flow sampling are supported within HEC-WAT,



although not within the same alternative. Precipitation would be sampled if an HEC-HMS model alternative is included in the compute sequence and is used to transform precipitation to runoff, which is then passed to other model alternatives in the compute sequence. Flow would be sampled when the decision was made to bypass a precipitation-runoff model and go directly to reservoir or river hydraulics modeling.

Hydrologic sampling (Figure 20.8) generates the hydrologic sequences, precipitation hyetographs or flow hydrographs, required for the simulation of the hydrology, reservoir operation, and hydraulics. The hydrologic information, such as flow or precipitation frequency curves, cross correlations between curves, and hydrograph or hyetograph shapes is defined within the **Hydrologic Sampling Editor**. For details on further details on hydrologic sampling in HEC-WAT, review the Hydrologic Sampler User's Manual.



**Figure 20.8** Hydrologic Sampling Editor

## 20.4.2 Fragility Curve Sampling

A fragility curve defines a structure's (i.e., levee) probability of failure over a range of elevation values at a specific location along the structure (i.e., levee). To capture the likelihood of structural (i.e., levee) failure at specified locations, the fragility curve sampling in HEC-WAT

occurs in a systems context with failure elevations at multiple locations being sampled either by realization or by event. The elevation of failure that is sampled is then used by the hydraulics software (i.e., HEC-RAS) to evaluate breaching. When sampling by realization, the failure elevation is sampled once per realization and held constant for every event in the realization. For sampling by event, a different failure elevation is generated for each event in a realization. For further details on how to enter data for fragility curve sampling, see Chapter 17 of this User's Manual. The HEC-WAT Technical Reference Guide (which will not be available with the initial release of Version 1.0) will provide the user with further details on fragility curve sampling in HEC-WAT. Fragility curve sampling is not required for an FRA compute, the user needs to determine if fragility curve sampling is needed for a flood risk management study.

### 20.4.3 Performance Metrics Alternative

As described in Chapter 19, there are several economic and performance metrics that can be computed that measure the performance of a system's reaction to an event. Currently, in Version 1.0 of HEC-WAT the user can (not required) request the computation of economic and performance metrics through a **Performance Metrics Alternative**. The creation and entering of data for a **Performance Metrics Alternative** is described in Chapter 19. The HEC-WAT Technical Reference Guide will provide the user with further details on the computation of economic and performance metrics in HEC-WAT (which will not be available with the initial release of Version 1.0). Economic and performance metrics are not required for an FRA compute, the user needs to determine if reporting of economic and performance metrics are needed for a flood risk management study.

## 20.5 Model Skip Flags

An FRA compute requires a large amount of computation resources and a large amount of storage for results. HEC-WAT provides a way to aid in the budgeting of computation resources and simulation times based on user entered criteria. The **Model Skip Rules Editor** (Chapter 18) allows the user to define logical expressions (i.e., if-then statements) of conditions when model alternative computations will be skipped, or not performed, within an FRA compute sequence. This allows the user to eliminate unnecessary computations and reduce run-times for an FRA compute. Detailed information on the **Model Skip Rules Editor** and its available options is in Chapter 18.

## 20.6 Time Window Modifiers


An analysis period (time window) for an FRA simulation is different than when modeling historic events. The analysis period for an FRA simulation is used to set the length of each life cycle within the FRA compute. Typically, life cycles are fifty-years in length. If the FRA simulation does not require damage being analyzed and life cycles are not required, then the analysis period can be an arbitrary length; however, 100 or 500 year life cycles are optimal for results management. The HEC-WAT framework provides several methods for modifying the analysis period time window within a simulation. Modifying (time window modifiers are not required for an FRA simulation) the simulation time window is a way to make a simulation run faster or help make simulations more stable by adjusting the time window for each model that is part of an HEC-WAT simulation.

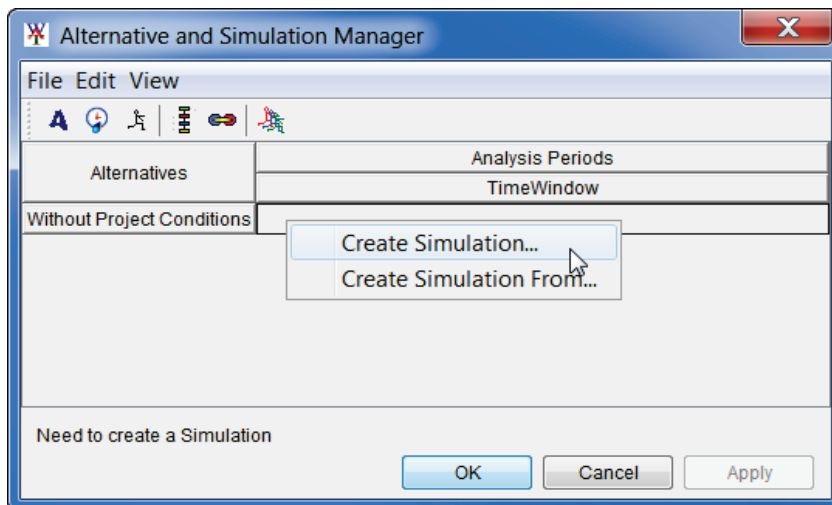


The **Time Window Adjustment** option (Chapter 9, Section 9.2.1) provides the user with simple methods to adjust the simulation time window for a specific model. The user can independently adjust the start and end dates and times of a simulation time window. The **Time Window Modifier** (Chapter 9, Section 9.2.2) allows users to also alter the simulation time window, but based on model alternative results (e.g., adding or subtracting days relative to the date and time of a peak flow or stage) instead of date shifts.

## 20.7 Create an HEC-WAT FRA Simulation

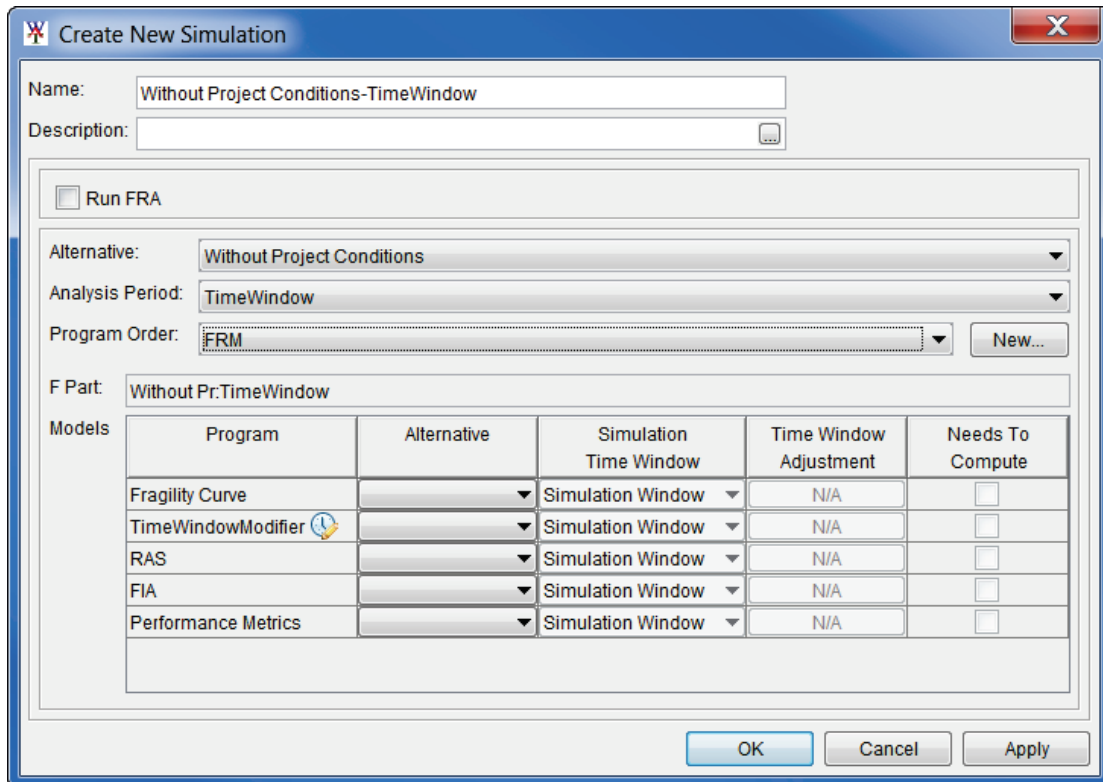
Now that all of the building blocks have been configured, the user can create an HEC-WAT FRA simulation. To create an HEC-WAT FRA simulation:

1. From the HEC-WAT main window (Figure 20.3), from the **WAT Tools** toolbar, click .
2. The **Alternative and Simulation Manager** will open (Figure 20.9). From this manager the user can create/modify alternatives, analysis periods, simulations, program order, link model alternatives, and compute FRA simulations.



**Figure 20.9** Alternative and Simulation Manager

3. To create a simulation, from the **Alternative and Simulation Manager** (Figure 20.9) table, right-click on the intersection of an alternative and analysis period. An **Analysis Period** must be available in order for a simulation to be created. An analysis period can only be used once per HEC-WAT alternative. From the shortcut menu click **Create Simulation**. The **Create New Simulation** dialog box will open (Figure 15.6).
4. HEC-WAT has defined a default name for the simulation (e.g., *Without Project Conditions-TimeWindow*) in the **Name** box (Figure 20.10). The name is a combination of the HEC-WAT alternative name and analysis period name. The simulation name can be changed. Also, in the **Alternative** and **Analysis Period** lists (Figure 20.10) the selections have already been made based on the intersection in the table. The selected **Alternative** (Figure 20.10) cannot be changed, but the selected **Analysis Period** can be changed if there is an available analysis period to select.



**Create New Simulation**

Name: Without Project Conditions-TimeWindow

Description:

☐ Run FRA

Alternative: Without Project Conditions

Analysis Period: TimeWindow

Program Order: FRM New...

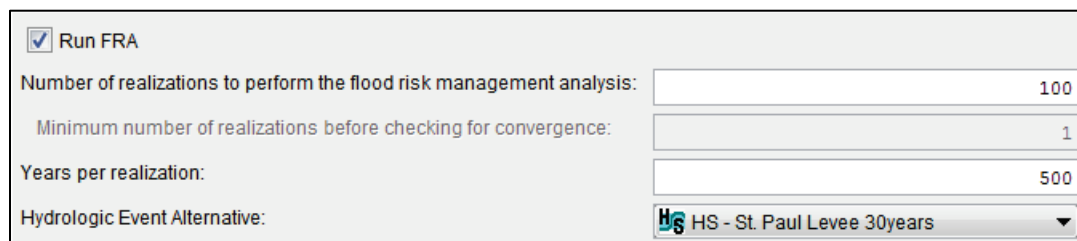
F Part: Without Pr.TimeWindow

Models	Program	Alternative	Simulation Time Window	Time Window Adjustment	Needs To Compute
	Fragility Curve		Simulation Window	N/A	<input type="checkbox"/>
	TimeWindowModifier		Simulation Window	N/A	<input type="checkbox"/>
	RAS		Simulation Window	N/A	<input type="checkbox"/>
	FIA		Simulation Window	N/A	<input type="checkbox"/>
	Performance Metrics		Simulation Window	N/A	<input type="checkbox"/>

OK Cancel Apply

**Figure 20.10** Create New Simulation Dialog Box

- In the **F Part** box (Figure 20.10), a default DSS F-Part is displayed that was generated by HEC-WAT based on the alternative and analysis period (this is informational and cannot be changed).
- To create an FRA simulation, select **Run FRA** (Figure 20.11). The options for setting up an FRA simulation are now available.



☒ Run FRA

Number of realizations to perform the flood risk management analysis: 100

Minimum number of realizations before checking for convergence: 1

Years per realization: 500

Hydrologic Event Alternative: HS - St. Paul Levee 30years

**Figure 20.11** Create New Simulation Dialog Box – FRA Setup

- Number of realizations to perform the flood risk management analysis** - enter the maximum number of realizations (e.g., 100) that are needed to perform the FRA analysis.
- Years per realization** - default is 500; number can be increased.

**Note:** The number of events and the analysis period length are used to define the number of life cycles within a realization. For example, an analysis period that is 50 years long will result in 10 life cycles if the years per realization is set to 500. The years per

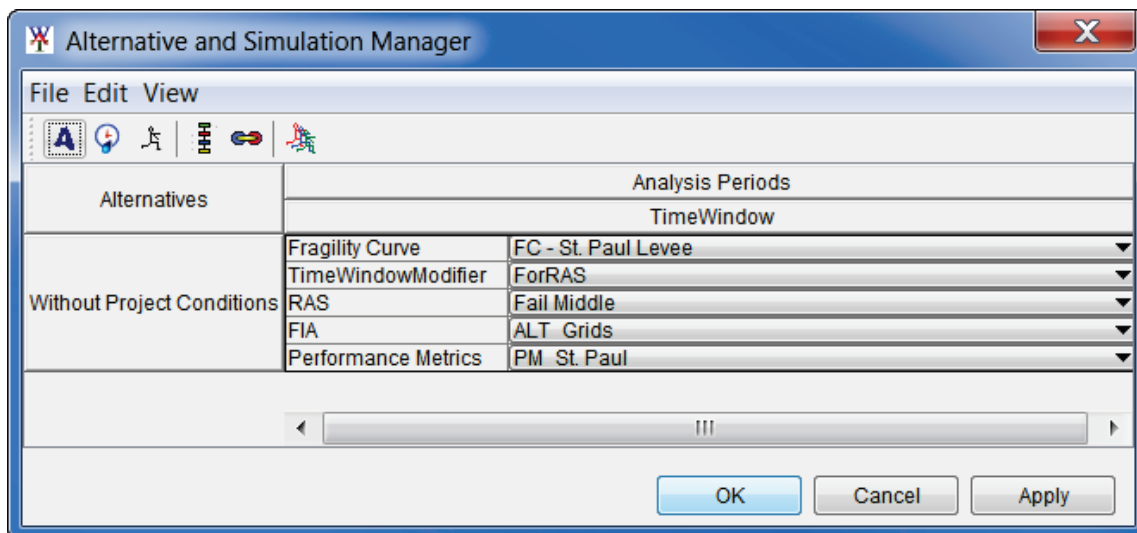
realization should be set to an even multiplier of the analysis period length. The user can enter 1,000 years per realization and then 100 realizations. In this example, 100 separate realizations of 1,000 years will be simulated, providing 100 flow and stage frequency curves that extend to 1/1,000 ACE (by sorting and ranking the flows/stages then dividing the rank by the total number of years in a realization, 1,000). In general, the number of events per realization should be two to three times the frequency storm event desired. For example, if the 1/100 pool elevation is desired, the number of sampled events for each realization should be a minimum of 250.

7. From the **Hydrologic Event Alternative** list (Figure 20.11) select the appropriate **Hydrologic Sampling Alternative** (e.g., *HS – St. Paul Levee 30years*).
8. A program order needs to be selected. From the **Program Order** list (Figure 20.10) select the appropriate (i.e., *FRM*) program order for the simulation.
9. In the **Programs** table (Figure 20.12), the software applications that were defined in the program order appear in the order that was set in the program order. Now the user must select the appropriate model alternative (i.e., plan, simulation run, alternative) for each software application. From the **Alternative** column (Figure 20.12), from the list for **Fragility Curve** (Figure 20.12), select the appropriate fragility curve alternative (e.g., *FC – St. Paul Levee*). Repeat the process for the other software applications.

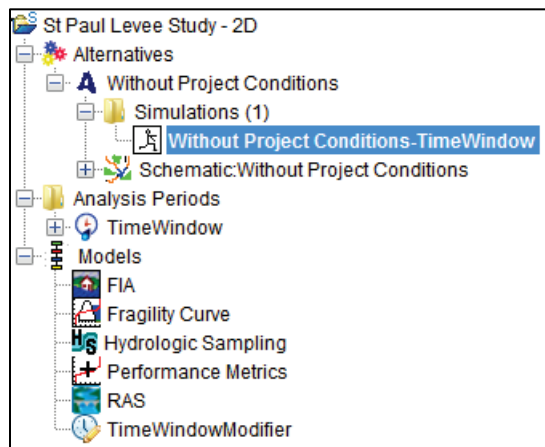
Program	Alternative	Simulation Time Window	Time Window Adjustment	Needs To Compute
Fragility Curve	FC - St. Paul Levee	Simulation Window	Edit...	<input type="checkbox"/>
TimeWindowModifier	ForRAS	Simulation Window	Edit...	<input type="checkbox"/>
RAS	Fail Middle	Simulation Window	Edit...	<input type="checkbox"/>
FIA	ALT_Grids	Simulation Window	Edit...	<input type="checkbox"/>
Performance Metrics	PM St. Paul	Simulation Window	Edit...	<input type="checkbox"/>

**Figure 20.12** Create New Simulation Dialog Box - Selection of Model Alternatives

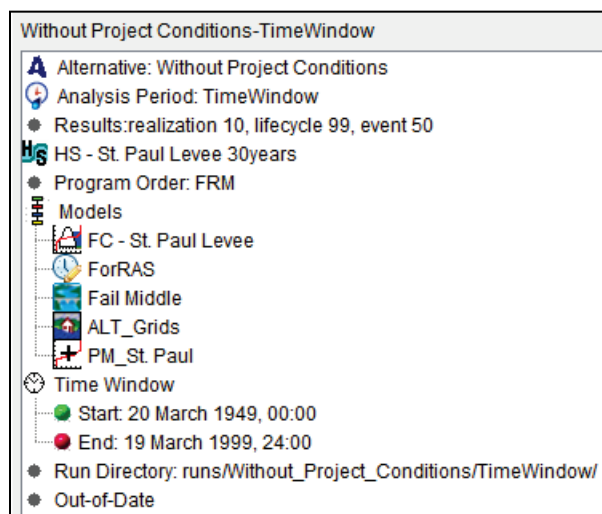
10. Now that all of the model alternatives have been selected, click **OK**. The **Create New Simulation** dialog box will close (Figure 20.11). On the **Alternative and Simulation Manager** (Figure 20.13) dialog box, the intersection of the alternative and analysis period now provides information about the simulation.
11. Click **OK**; the **Alternative and Simulation Manager** dialog box will close (Figure 20.13). From the HEC-WAT main window (Figure 20.3), the created simulation appears on the **Study Tree**, under the **Simulations** folder (Figure 20.14).
12. Click on the simulation in the **Study Tree** (Figure 20.14), the **Content Pane** (Figure 20.15) displays information about the selected simulation.
13. Double-click on the simulation name (e.g., *Without Project Conditions-TimeWindow*), a **Select Map** dialog box will open. Click **New Map Window**, click **OK**. The **Select Map** dialog box will close. The new map window will contain the schematic elements that represent the simulation (Figure 20.16).



**Figure 20.13** Alternative and Simulation Manager - Completed Simulation



**Figure 20.14** Study Tree with Created Simulation



**Figure 20.15** Content Pane

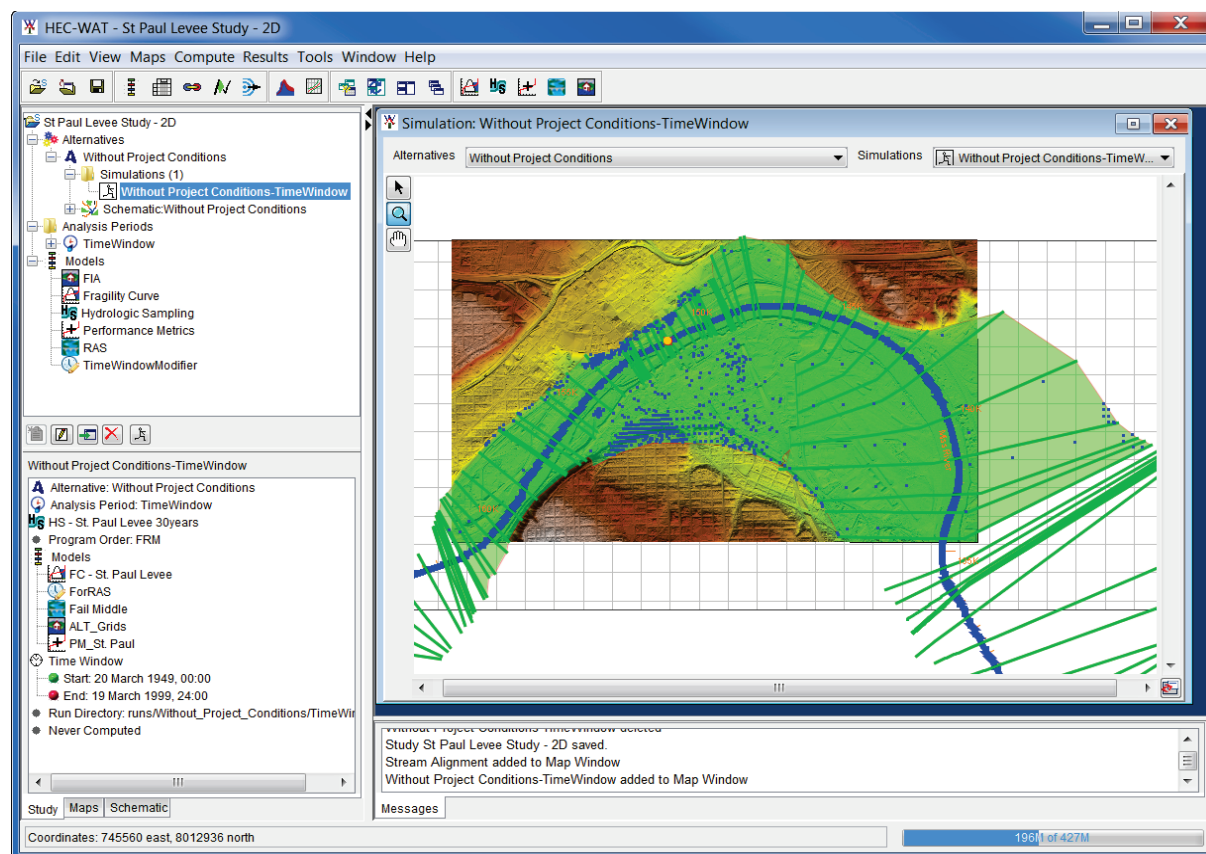


Figure 20.16 Map Window - Schematic of Current HEC-WAT Simulation - FRA

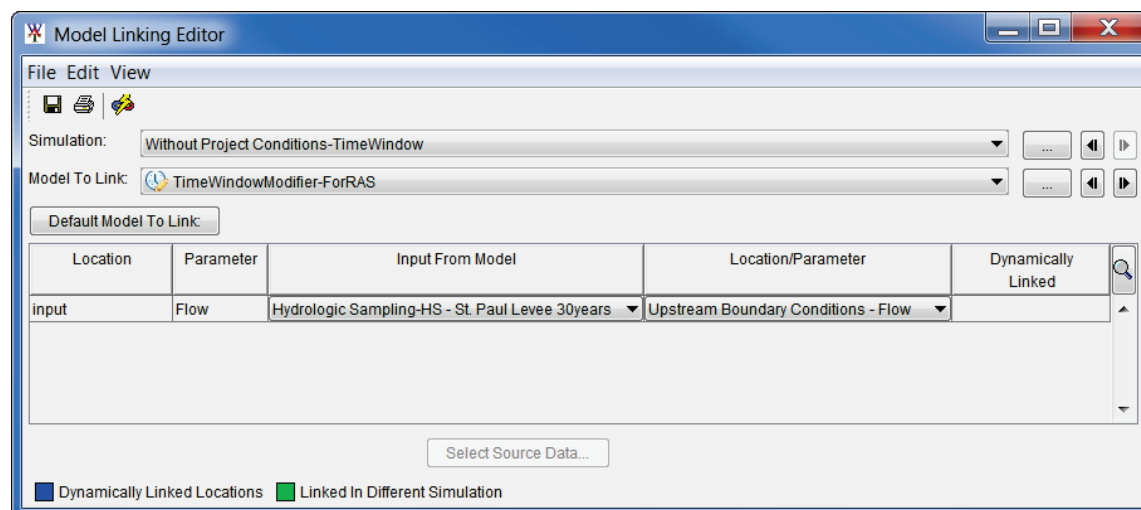
## 20.8 Manipulating FRA Simulations

FRA simulations can be manipulated from shortcut menus that are available from the **Study Tree** (Chapter 11, Section 11.3.3), and the **Alternative and Simulation Manager** (Chapter 11, Section 11.2.6). These shortcut menus will allow the user to view the selected simulation in a map window; edit the model alternatives associated with the selected simulation; remove the simulation map window; edit the active simulation; open the **Model Linking Editor** (Chapter 12); compute; view the log of the compute; view results; save changes to the simulation; delete the simulation from the study; view the properties of the simulation; and, browse the run folder associated with the active simulation. Chapter 11 provides further details on these capabilities from the individual simulation shortcut menu.

## 20.9 Model Linking

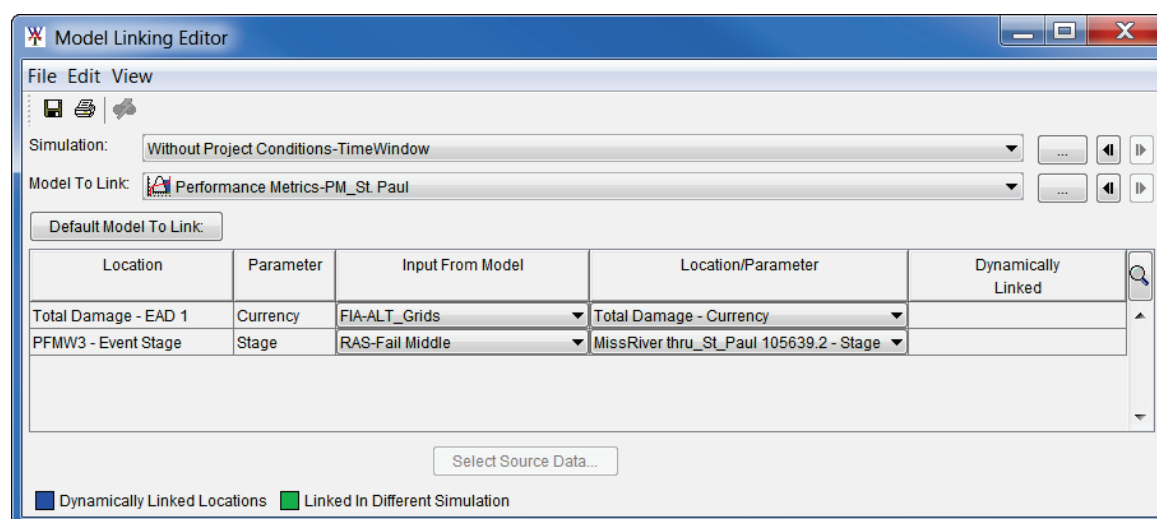
Now that FRA simulation(s) are setup, "linking" between the models will need to be defined. Linking is the process within the HEC-WAT framework that allows the individual models to communicate with each other and how data is handed-off from model alternative to model alternative. The majority of linking in HEC-WAT is accomplished through DSS mapping and the use of simulation names. Additional linking capabilities include inundation boundary maps, water depth maps, and other DSS files. For example, the ResSim model alternative might require information from an HMS model alternative. Chapter 12 provides information on using the **Model Linking Editor** and details other available linking options.

The hydrologic sampling and fragility curve sampling alternatives do not require linking to other model alternatives. An example of modeling linking for the **Time Window Modifier** alternative is displayed in Figure 20.17. This **Time Window Modifier** alternative (*TimeWindowModifier-ForRAS*) shortens the time window for the RAS model alternative based on sampled upstream boundary conditions that are provided by the hydrologic sampling alternative (*Hydrologic Sampling-HS – St. Paul Levee 30years*).



**Figure 20.17** Model Linking Editor – Time Window Modifier Alternative

For the **Performance Metrics** alternative, in the example displayed in Figure 20.18, there are two locations that are being linked, one location is being linked to an FIA model alternative (*FIA\_ALT\_Grids*) for the computation of EAD. The second location (fragility curve location) is linked to a RAS model alternative (*RAS-Fail Middle*) for the computation of AEP and/or LTEP.

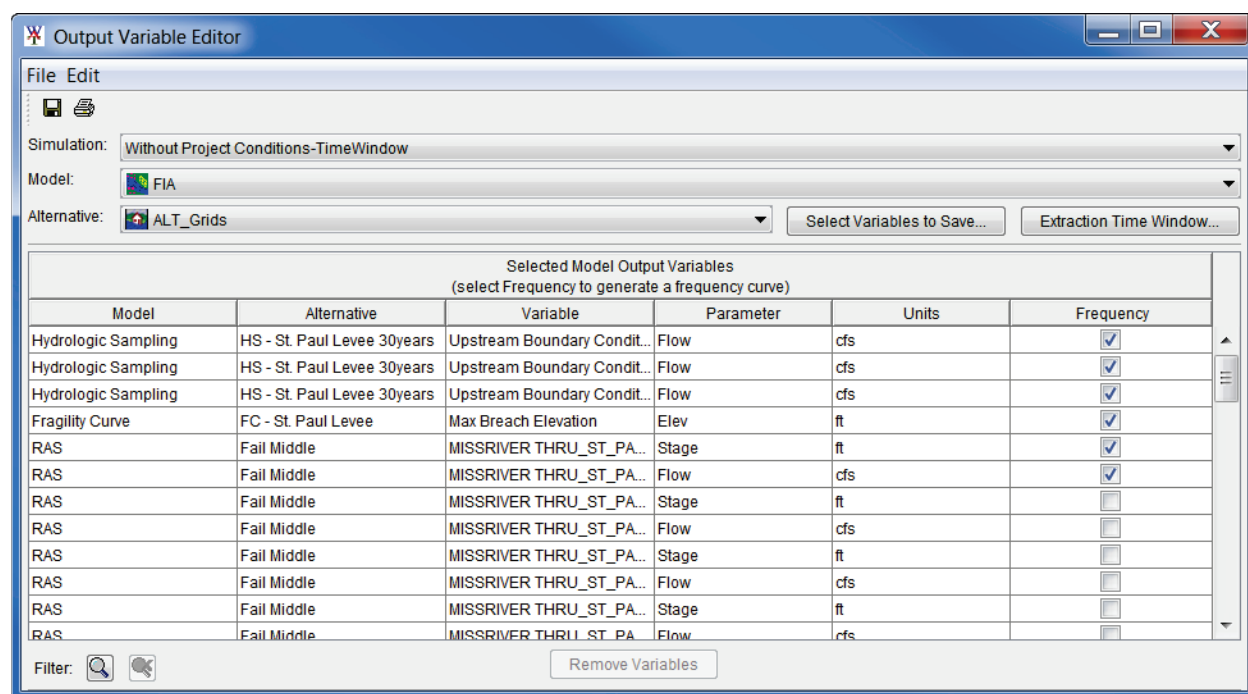


**Figure 20.18** Model Linking Editor – Performance Metrics Alternative

## 20.10 Output Variables

The **Output Variable Editor** (Figure 20.19) provides an interface for selecting output from an HEC-WAT FRA simulation. Currently, only the maximum values from selected model outputs





**Figure 20.19** Output Variable Editor

and the sampled model parameters from some of the model applications are saved through output variables. As previously mentioned, there are multiple options for saving files and model results for an FRA simulation. All time-series information is saved in what is referred to as the lifecycle DSS files. In many cases, saving and maintaining many thousands of time-series data records is not possible due to storage limitations. However, the maximum value from each time-series is useful, and not storage-intensive to save. For example, the peak flow or stage value from a hydrograph time-series can be used to compute a flow/stage frequency curve or these values can be plotted to quickly show if a flow or stage threshold was exceeded. Saving the sampled parameters or initial conditions is useful when evaluating the conditions that led to certain results (i.e., a high reservoir stage is a result of sampling a high starting pool condition). Results from many, but not all, variables from the individual applications can be saved through the **Output Variable Editor** (Chapter 16), and are written to a DSS file at the simulation level.

The **Output Variable Editor** (Figure 20.19), has options for selecting an HEC-WAT FRA simulation, for selecting the model that is part of the selected FRA simulations, and then the model alternative (a compute sequence can contain multiple instances of the same model). Once a simulation, model, and model alternative are selected, click **Select Variables to Save**, from the selector that opens (Chapter 18), the user will select variables that will be saved. The user must select at least one output variable from the models in the compute sequence or tell the FRA simulation to compute without an output variable being chosen before computing an FRA simulation. For a "production" simulation where output is required, the user should choose all appropriate output variables before running the simulation.

Now that all of the setup has been completed, the user is ready to compute HEC-WAT flood risk analysis simulations.





# CHAPTER 21

## Compute/Results – Flood Risk Analysis

Now that an FRA simulation has been defined – which means model alternatives have been imported for an HEC-WAT study (Chapter 8); analysis periods (time window) have been defined (Chapter 9); a hydrologic sampling alternative has been defined (Hydrologic Sampler User's Manual); creation of fragility curve sampling (Chapter 17) and performance metrics alternatives (Chapter 19) are optional; time window modifiers (Chapter 9) have been defined if necessary; linking of model alternatives has been completed (Chapter 12); model skip flags (Chapter 18) have been defined if necessary; and, output variables have been selected (Chapter 16), the user is ready to compute an FRA simulation.

### 21.1 Compute – FRA Simulation

#### 21.1.1 Study Tree

Computing an FRA simulation from the **Study Tree**:

1. From the HEC-WAT main window (Figure 21.1), from the **Study Tree**, from the **Simulations** folder, right-click on a simulation (e.g., *Without Project Conditions-TimeWindow*). From the shortcut menu (Figure 21.1) point to **Compute**, click **Simulation**.

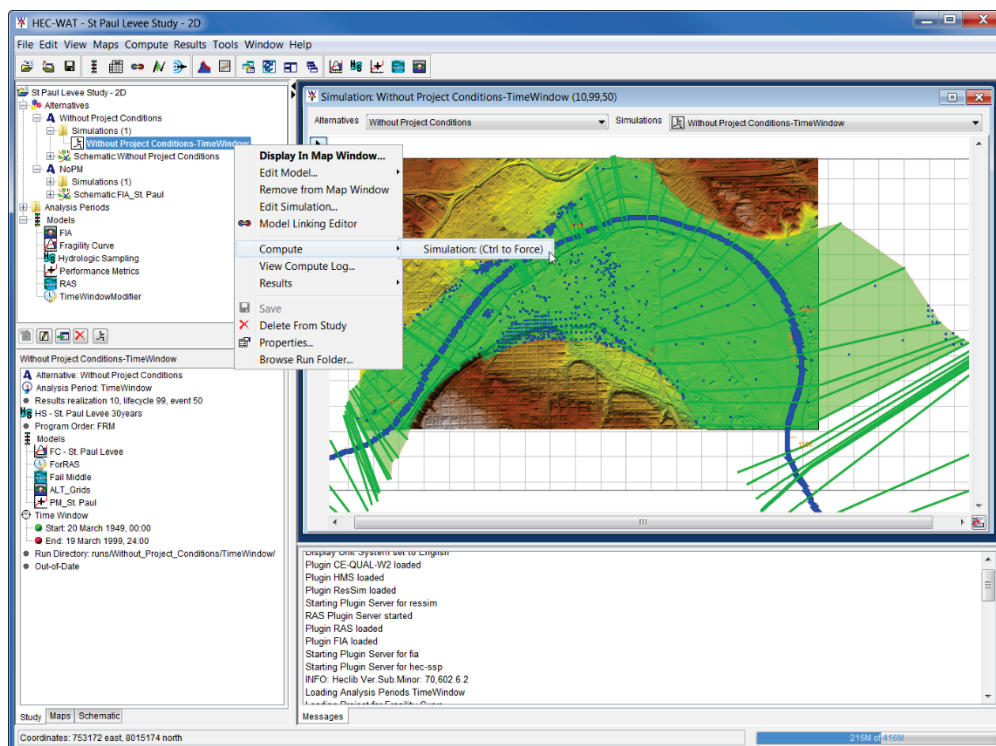
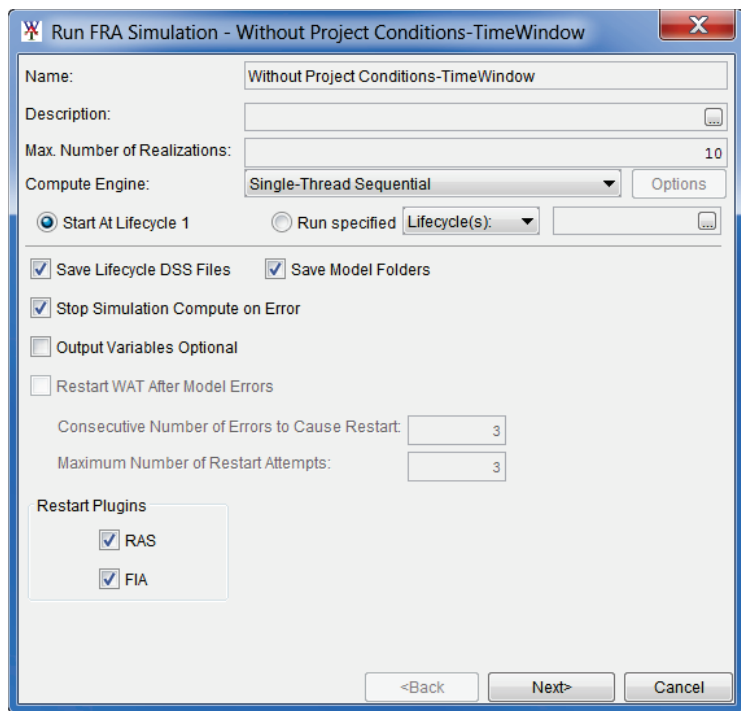


Figure 21.1 HEC-WAT Main Window – FRA Compute

2. The **Run FRA Simulation** dialog box will open (Figure 21.2). In the **Name** box is the name of the simulation that will be computed (e.g., *Without Project Conditions-TimeWindow*). The number of realizations (*10*) that will be computed is provided in the **Max. Number of Realizations** box. Other options are:



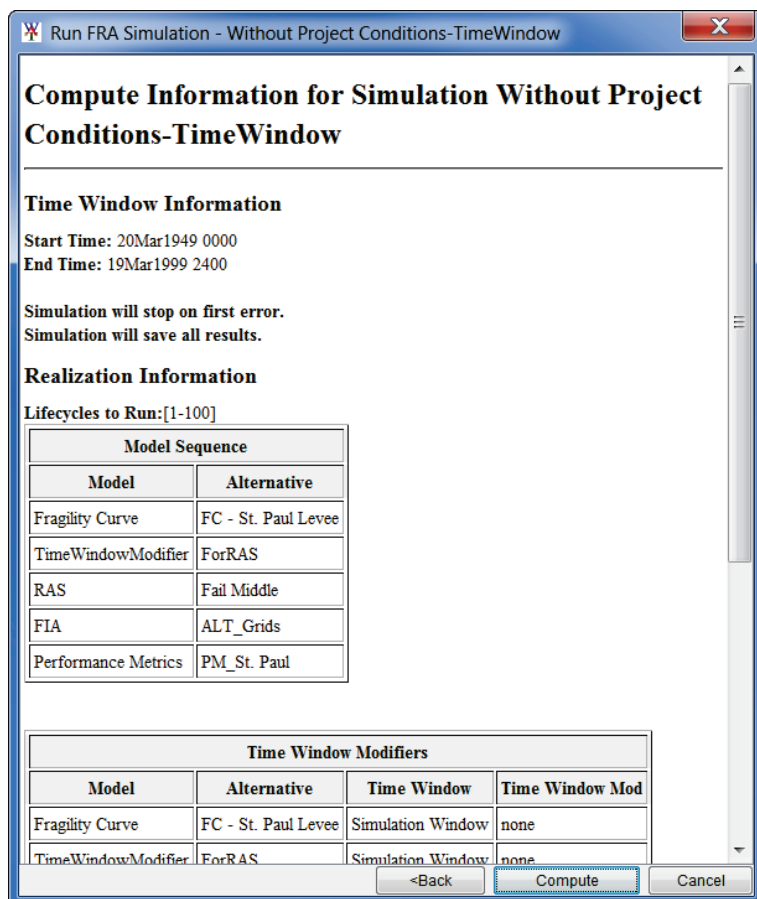
**Figure 21.2** Run FRA Simulation Dialog Box

- **Start at Lifecycle 1** - default starting point of an FRA compute (Figure 21.2).
- **Run specified** - by selecting this option (Figure 21.2) the user can choose whether to run a specific life cycle or realization, or a range of life cycles or realizations. For example, the user can enter 2-5, 22 to run Lifecycles 2 through 5 and then Lifecycle 22.
- **Save Lifecycle DSS Files** - when the user selects this option (Figure 21.2) all FRA results written to the life cycle DSS files are saved. All HEC software applications - HEC-HMS, HEC-RAS, HEC-ResSim, and HEC-FIA write time-series results to the life cycle DSS files during an FRA compute. The output variables selected by the user are used by HEC-WAT to extract maximum values from the user selected time-series records. If the user does not want the time-series results to be saved, the user should not select **Save Lifecycle DSS Files**.

**Note:** It is a good practice to turn on the **Save Lifecycle DSS Files** (Figure 21.2) option when initially setting up an FRA simulation and evaluating results. Once the user is comfortable that results are reasonable, then the life cycle DSS option can be turned off. Also, the individual software applications have options for limiting the amount of data written to the life cycle DSS files. The user could ensure that only necessary information was saved to the life cycle DSS files and then choose to keep these files.

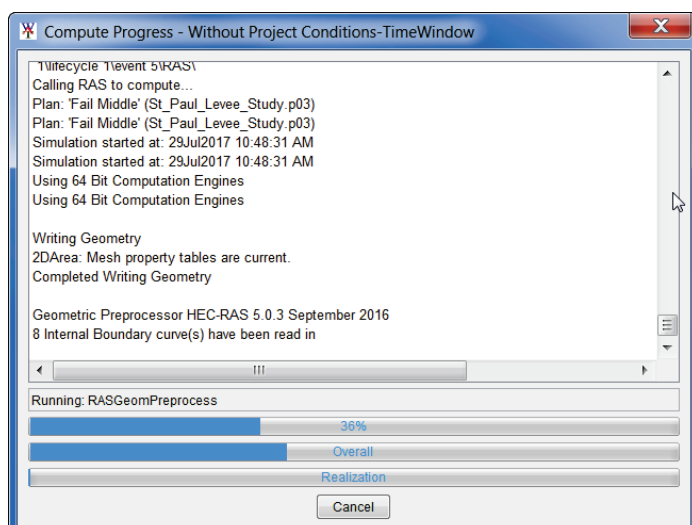
- **Save Model Folders** – model alternative files by event are not saved by default; if the user wishes to save all information for each event, **Save Model Folders** (Figure 21.2) must be selected. This information aids in the debugging of any issues that might occur when attempting to run an FRA compute. As mentioned for the **Save Lifecycle DSS Files** option, this option can be turned off after the user verifies model alternative results are reasonable.
  - **Stop Simulation Compute on Error** - selecting this option (Figure 21.2) will cause the FRA compute to stop when any kind of error is detected during the simulation (compute). This is a good option to turn on when initially making sure the FRA simulation can run. However, when performing final production simulations, it might be preferred to let the simulation run even though issues might have stopped an individual event from completing. For example, when a RAS model alternative goes unstable due to initial conditions, the error is detected, and the simulation continues to the next model alternative in the compute sequence. It is likely that the next model alternative will fail as well since adequate boundary conditions were not computed by the previous model alternative. Eventually, the simulations will get through all the model alternatives within the compute sequence and then start the next event. The output log will document any errors that prevented the successful completion of all model alternatives within the compute sequence for an event.
  - **Output Variables Optional** – by default an FRA compute requires that at least one output variable be selected; if **Output Variables Optional** (Figure 21.2) is selected then output variables are not required for the FRA compute. Care should be taken when considering the selection of this option. If no output variables are selected, then there will be no maximum values in the simulation DSS file.
  - **Restart WAT After Model Errors** – if **Stop Simulation Compute on Error** has not been selected, the **Restart WAT After Model Errors** option (Figure 21.2) becomes available. If this option is selected, the user can set the consecutive number of errors that will make HEC-WAT restart and the maximum number of restarts. This option is a way to restart HEC-WAT and all software applications computing within an FRA simulation. When HEC-WAT is restarted, the FRA simulation will restart after the last successful life cycle.
  - **Restart Plugins** - this option allows the user to decide which software applications to restart during an FRA compute. **Restart Plugins** (Figure 21.2) should be enacted if the user notices the compute runtimes slowing down for each model alternative in the compute sequence as the simulation progresses. The software applications are restarted at the end of each life cycle, which frees up any virtual memory the software applications might be hanging onto while compute the events within a life cycle.
3. Click **Next**, the **Run FRA Simulation Information** dialog box (Figure 21.3) will open. This dialog box provides summary information about the FRA simulation that is about to be computed. Information includes the time window, when the simulation will be

stopped, whether results will be saved, life cycles that will be run, model sequence information, time window modifiers; and output variable time windows.



**Figure 21.3** Run FRA Simulation Information Dialog Box

4. Click **Compute**, the **Compute Progress** dialog box will open (Figure 21.4). When the compute is finished, click **Close**, the **Compute Progress** dialog box will close.



**Figure 21.4** Compute Progress Dialog Box - FRA Compute

## 21.1.2 Compute Menu

From the HEC-WAT main window (Figure 21.1) from the **Compute** menu (Figure 21.5), the user can compute an FRA simulation from different commands. If an FRA simulation is active (displayed in a **Simulation Map Window** in the **Desktop Pane**), then the first item in the **Compute** menu will be that FRA simulation's name (e.g., *Without Project Conditions-TimeWindow*), hold down the **CTRL** key, click the FRA simulation, the **Compute Progress** dialog box will open (Figure 21.4) and the compute will start.

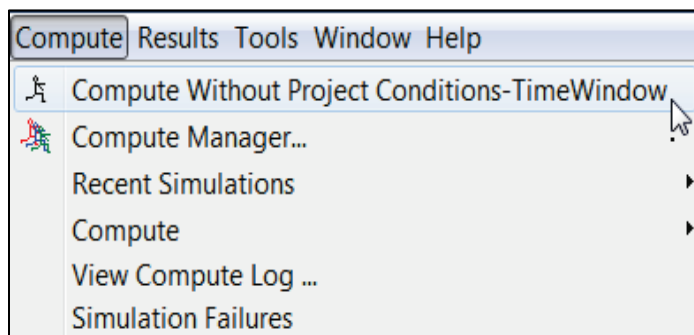


Figure 21.5 HEC-WAT Main Window – Compute Menu

From the **Compute** menu (Figure 21.5), point to **Recent Simulations**, a list of recently computed simulations will display, hold down the **CTRL** key, click on an FRA simulation that is to be computed. The **Compute Progress** dialog box will open (Figure 21.4) and the compute will start.

From the **Compute** menu (Figure 21.5), point to **Compute**, hold down the **CTRL** key, click **Simulation**, the **Compute Progress** dialog box will open (Figure 21.4) and the compute will start. This will compute the active simulation (displayed in a **Simulation Map Window** in the **Desktop Pane**).

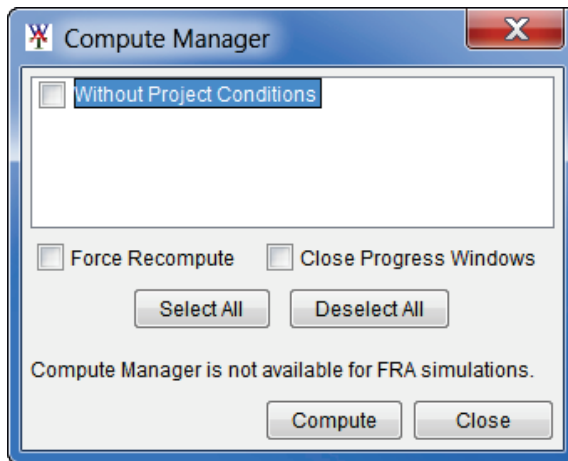
## 21.2 Compute Manager

The **Compute Manager** (Figure 21.6) is not available for FRA simulations, the main purpose of the **Compute Manager** is to setup running multiple simulations in deterministic mode. FRA simulations are compute intensive; one simulation could run for several hours/days; and, a great deal of results are generated (consuming disk space). For example, in Figure 21.6, since simulations are organized by HEC-WAT alternatives (i.e., *Without Project Conditions*), the only simulation displaying in the **Compute Manager** is the alternative that is not an FRA compute.

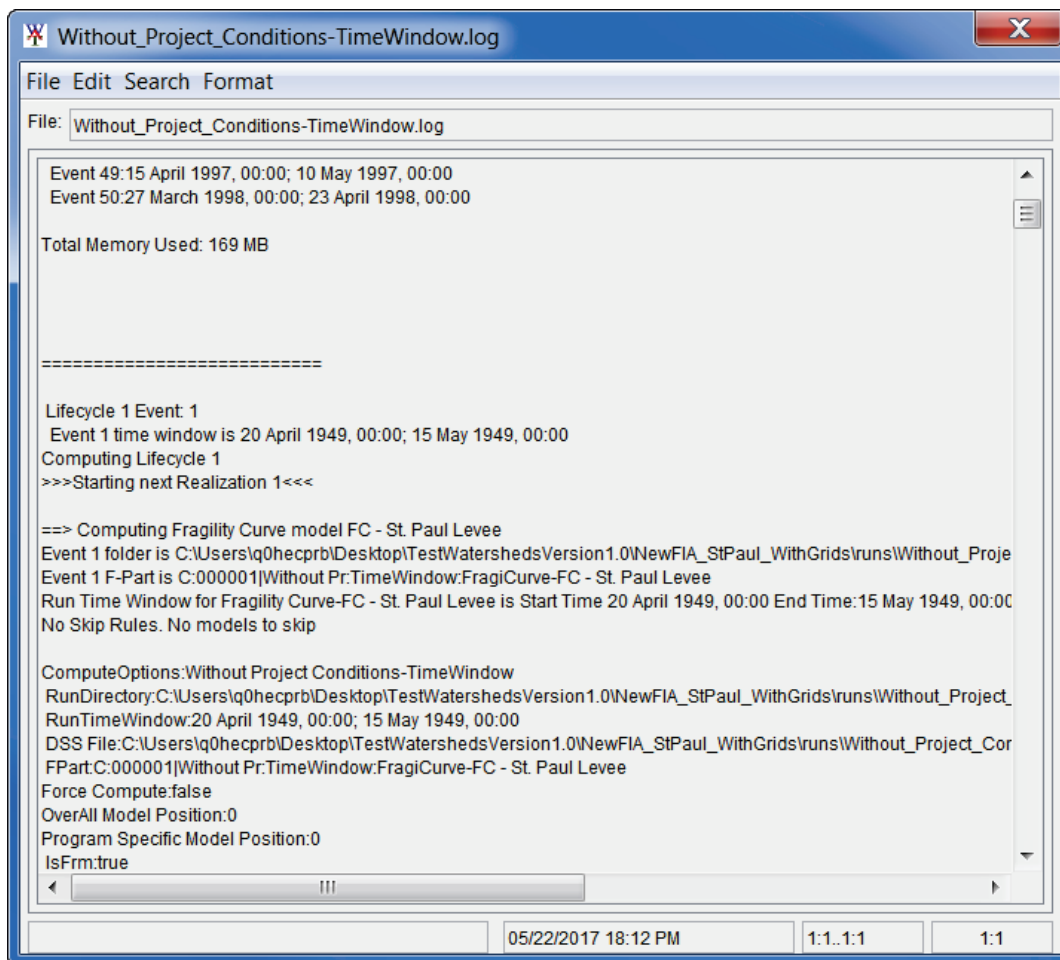
## 21.3 Compute Log

To view an FRA simulation compute log:

1. From the HEC-WAT main window (Figure 21.1), from the **Compute Menu** (Figure 21.5), click **View Compute Log** – this command is only available when there is an active simulation (displayed in a **Simulation Map Window** in the **Desktop Pane**), the **View Compute Log Editor** (Figure 21.7).



**Figure 21.6** Compute Manager Dialog Box



**Figure 21.7** Compute Log Editor

2. The compute log opens in an editor that allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot what is going on with the compute or review a detail about one of the software applications.
3. From the **File** menu, click **Close**, the **Compute Log Editor** will close (Figure 21.7).

## 21.4 Distributed Compute

The FRA compute option relies on a Monte Carlo computational algorithm that requires potentially many thousands of simulations (realizations) of the individual model alternatives included in the program sequence defined for an FRA simulation. To accommodate this need, the HEC-WAT framework includes a distributed compute option. This distributed compute option allows the HEC-WAT software to distribute FRA computes across several compute nodes. The compute node is the basic component of the distributed compute. This option is available in Version 1.0 of HEC-WAT, if there is interest in using please contact the Hydrologic Engineering Center.

## 21.5 Results Menu

From the HEC-WAT **Results** menu, the user can access results from the different software applications and results from the FRA specific plug-ins that have been defined in an FRA simulation. From the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.8), the user will point to a software application or a specific FRA plug-in from which the user wants to view results.

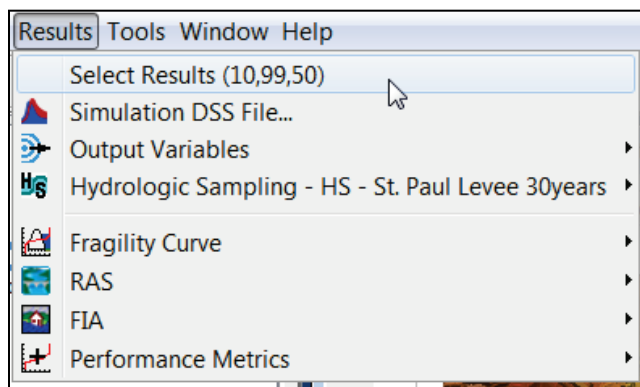


Figure 21.8 HEC-WAT Main Window - Results Menu - FRA

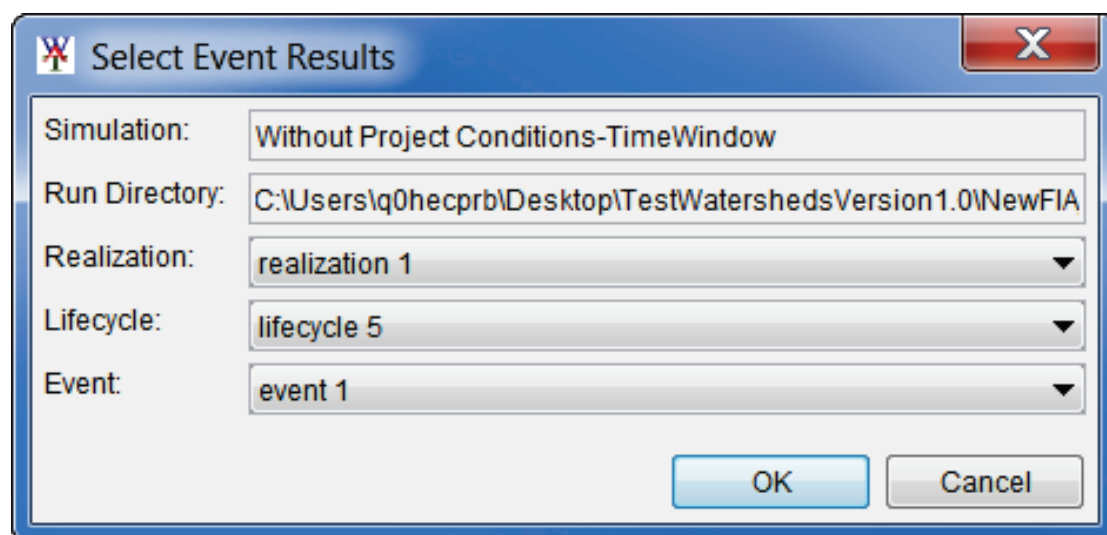
### 21.5.1 Select Event Results

If the **Save Model Folders** option (Section 21.1.1) has been selected then results are available, and in an FRA compute that means all time series results from model alternatives that ran during the simulation. To provide meaningful results, the user can choose which individual event results to view. From the HEC-WAT main window (Figure 21.1.), from the **Results** menu (Figure 21.8), click **Select Results**, the **Select Event Results** dialog box will open (Figure 21.9). The user can select by realization, life cycle, and event; with that selection define any of the FRA specific results will default to the selection.

### 21.5.2 Simulation DSS File

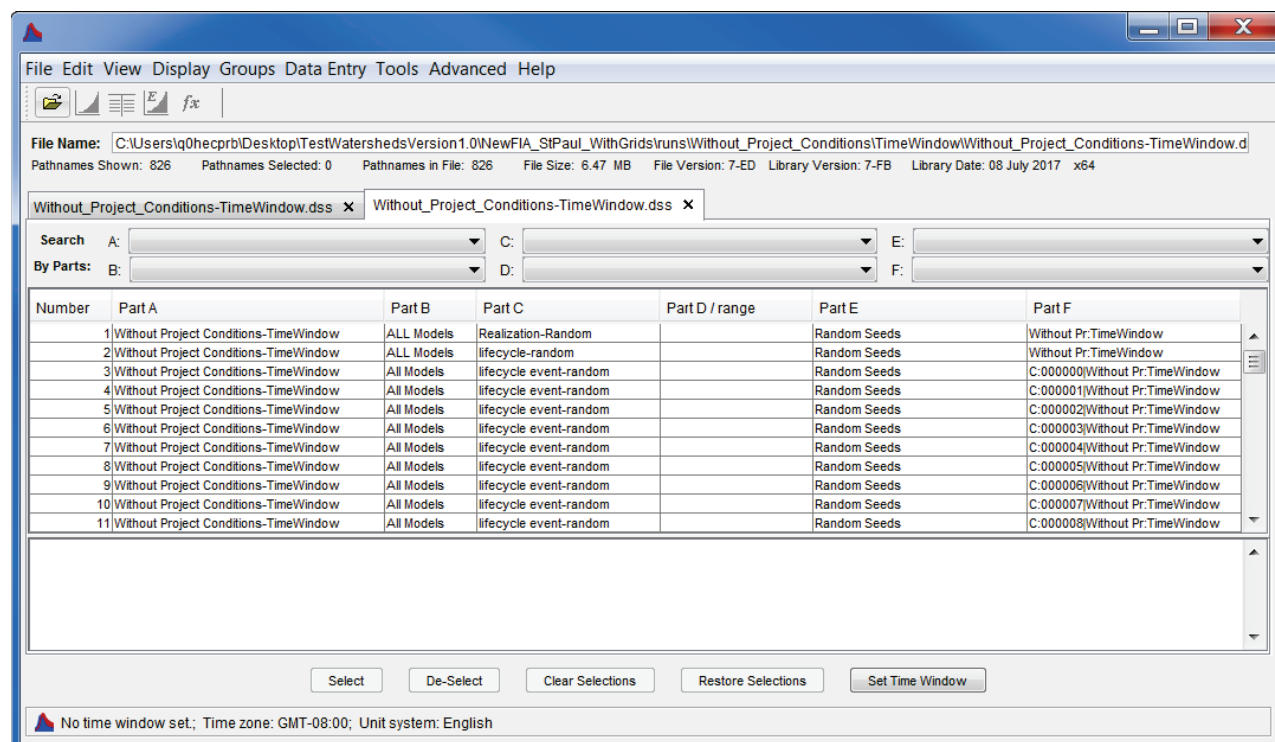
In an FRA compute, results from the model alternatives are stored in the DSS file that is stored in each life cycle folder (*lifecycle.dss*) of a realization. Scalar results (maximum values from the time-series records), generated by the FRA specific model alternatives are stored in the





**Figure 21.9** Select Event Results Dialog Box

*simulation.dss* file (e.g., random numbers; output variables, frequency curves, etc.). For Version 1.0 not all of the FRA generated results are available from the HEC-WAT framework. From the HEC-WAT main window (Figure 2.1), from the **Results** menu (Figure 21.8), click **Simulation DSS File**, a HEC-DSSVue window will open (Figure 21.10), with the DSS file of the active simulation displayed. Using the HEC-DSSVue interface, the user can view and create results, Appendix K provides further details on using the HEC-DSSVue software. Before opening the simulation DSS file, from the **Results** menu (Figure 21.8), a user should access model results stored in the simulation DSS file from the **Output Variables** menu item (Section 21.5.3).



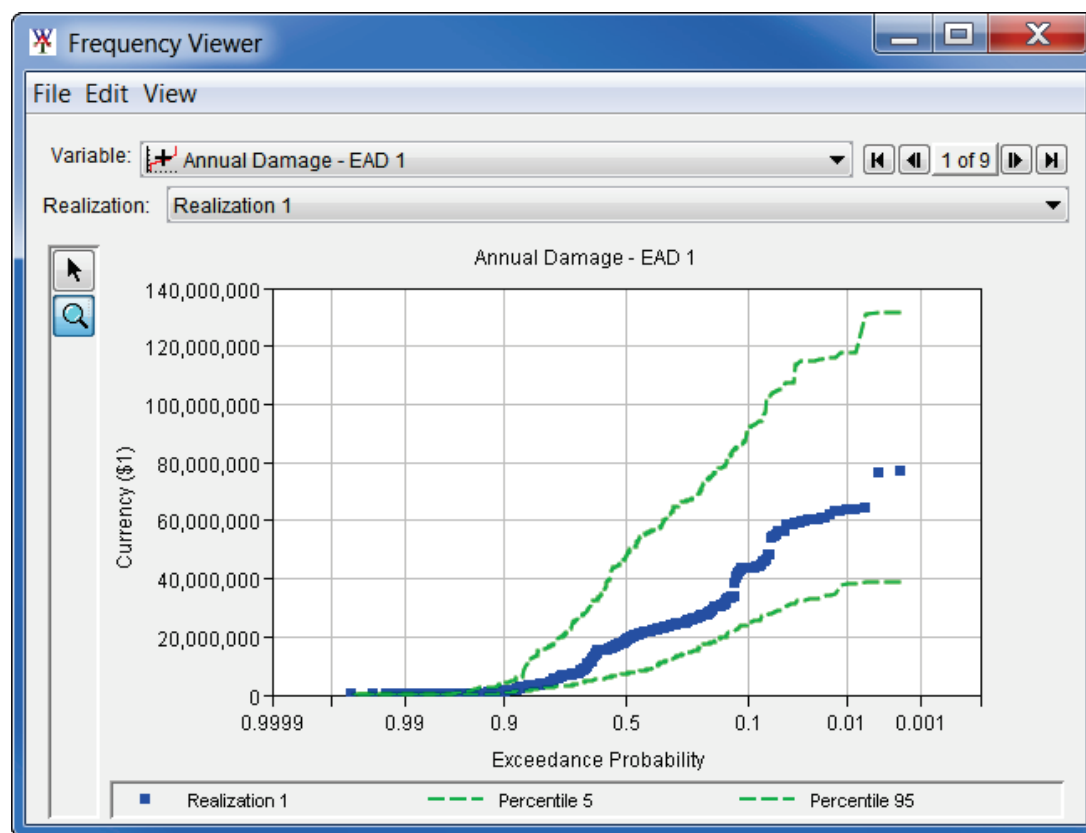
**Figure 21.10** *simulation.dss* File



### 21.5.3 Output Variables

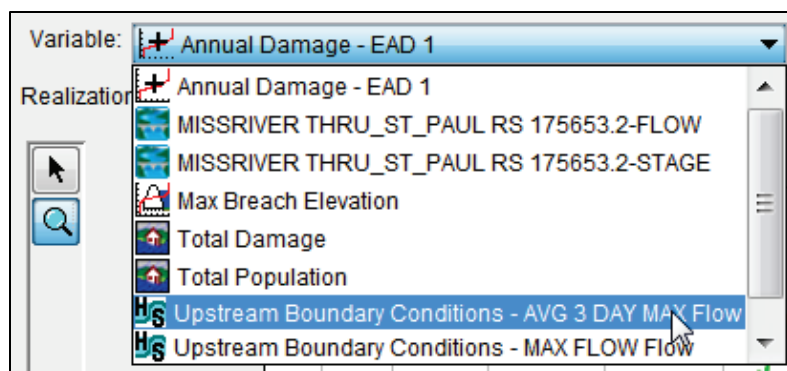
Output variables in Version 1.0 are only the maximum values from user selected model alternative results and sampled parameters from some of the model alternatives. The maximum value from each time series is useful, for example, the peak flow or stage value from a hydrograph time-series can be used to compute a flow/stage frequency curve or these values can be plotted to quickly show if a flow or stage threshold was exceeded. Saving the sampled parameters or initial conditions is useful when evaluating the conditions that led to certain results (a high reservoir stage is a result of sampling a high starting pool condition). Chapter 16 provides further details on output variables.

There are three options for visualizing scalar results (output variables) – **Histogram Viewer**, **Variable Viewer**, and **Frequency Viewer**. From the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.8), point to **Output Variables**, click **Frequency Viewer**, the **Frequency Viewer** will open (Figure 21.11).



**Figure 21.11** Frequency Viewer - Default

The **Frequency Viewer** by default displays the first defined output variable in the **Variable** list (Figure 21.12), and the first realization in the **Realization** list (Figure 21.11). For example, to view the three-day average maximum flow frequency curves for all realizations for a particular location, from the **Variable** list (Figure 21.12), click *Upstream Boundary Conditions – AVG 3 DAY Max Flow* (results generated by the hydrologic sampling). From the **Realization** list (Figure 21.11), click *All Realizations*. The **Frequency Viewer** (Figure 21.13) will now display the frequency curves at the selected location for all realizations in the simulation.



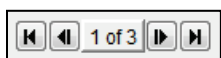
**Figure 21.12** Frequency Viewer – Variable List







**Figure 21.13** Frequency Viewer – Selected Location and All Realizations

From the **Edit** and **View** menus of all the output variable viewers, the user can adjust items in the plot. Also, by right-clicking in the viewer in various locations, the user can change the legend, change both axes, change the title, and more. From the **File** menu, the user can **Print**, save the display plot as a graphics file (**Save As**), **Tabulate**, create/apply a template, and save the specifications of the plot. For further information on manipulating the viewers, refer to Appendix M of this User's Manual, and HEC-DSSVue User's Manual.

By using the **Navigator Tool** (Figure 21.14) the user can click through the output variables that have been defined, instead of making a selection from the **Variable** list (Figure 21.12).

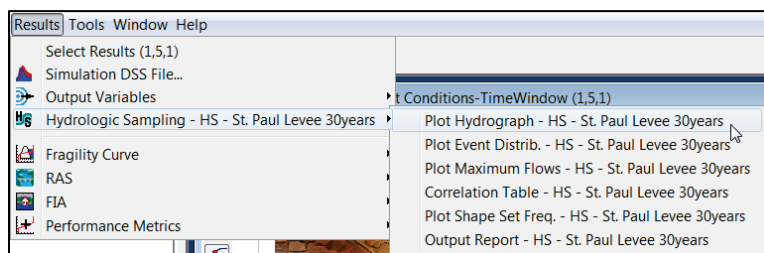


**Figure 21.14** Navigator Tool

1. From the **Frequency Viewer** (Figure 17.1), using the **Navigator Tool** (Figure 21.14), the user can move through the defined output variables.
2. The  symbol places the user at the top (first) of the output variable list, while the  symbol places the user at the bottom (last) of the output variable list. The  (previous) symbol and the  (next) symbol moves the user back one and forward one in the output variable list, respectively. The center of the navigation button indicates the number of output variables in the list and which output variable the user is presently accessing.

## 21.5.4 Hydrologic Sampling Results

The sampling of hydrology can possibly generate thousands of events in a hydrologic sequence. Results will be hydrologic information such as flow or precipitation frequency curves, cross correlations between curves, and hydrograph or hyetograph shapes. From the **Results** menu (Figure 21.15), point to **Hydrologic Sampling**, from the sub-menu there are various plots and reports that provide a view of some of the hydrology information. For further details on the hydrologic sampling options available in HEC-WAT, refer to the Hydrologic Sampling User's Manual. **Note:** the hydrologic sampling results are only available if the user chooses to save all model files during the FRA compute. For many simulations, it is not practical so save all model files as disk storage is not adequate. Output variables (Chapter 16) can be defined for most of the hydrologic sampling results.



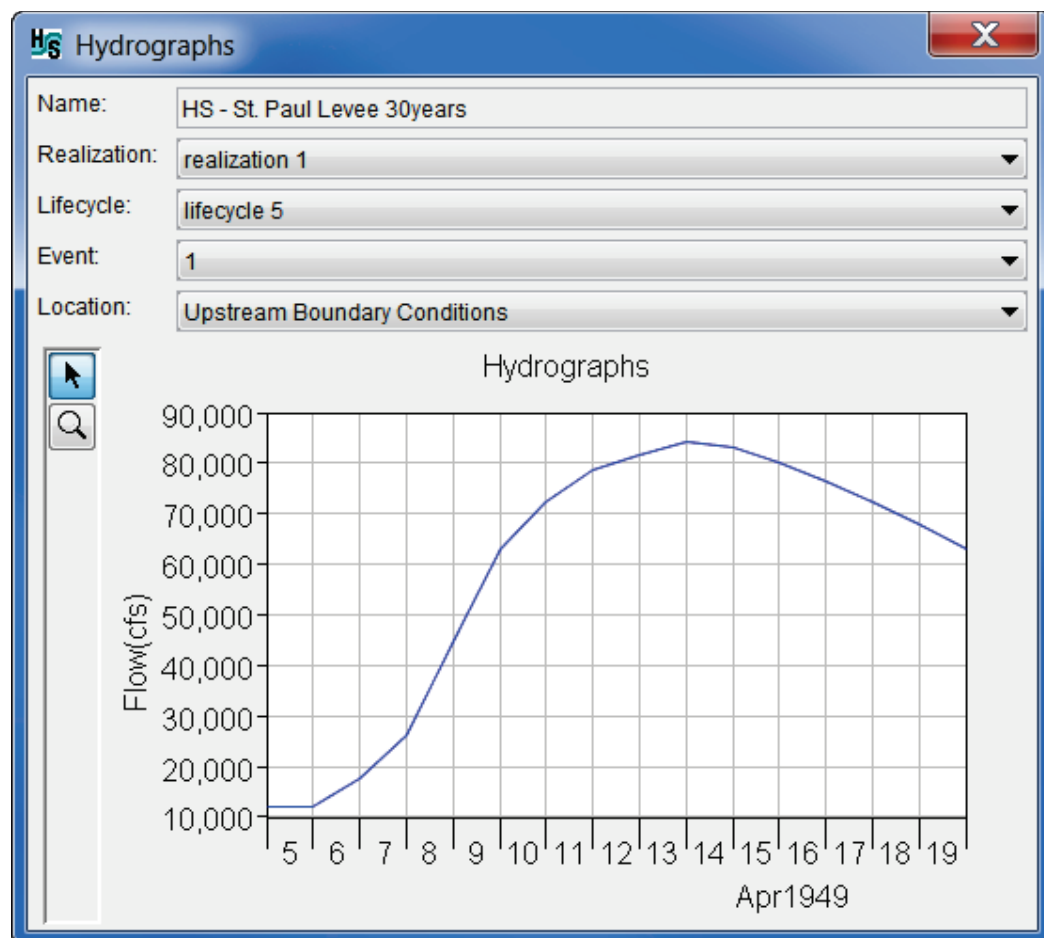
**Figure 21.15** FRA Results Menu – Hydrologic Sampling

All six results options described below are available for the Flow Sampling – Correlated Frequency Curves method, while only two of the items are available for the Flow Sampling – Bootstrapping Historical/Synthetic Basin-wide Events method (Plot Hydrograph and Output Report). No results are currently available through the interface for the Precipitation Sampling method, but these can be viewed through the DSS results file. For further details on the hydrologic sampling options available in HEC-WAT, refer to the Hydrologic Sampler User's Manual.


## Plot Hydrograph

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Hydrologic Sampling**, from the sub-menu click

**Plot Hydrograph**, the **Hydrographs** dialog box will open (Figure 21.16). The initial hydrograph displayed is based on the selections (realization, life cycle, and event) made in the **Select Event Results** dialog box (Figure 21.9). The user can view other hydrographs by selecting items in the lists (**Realization**, **Lifecycle**, **Event**, and **Location**).

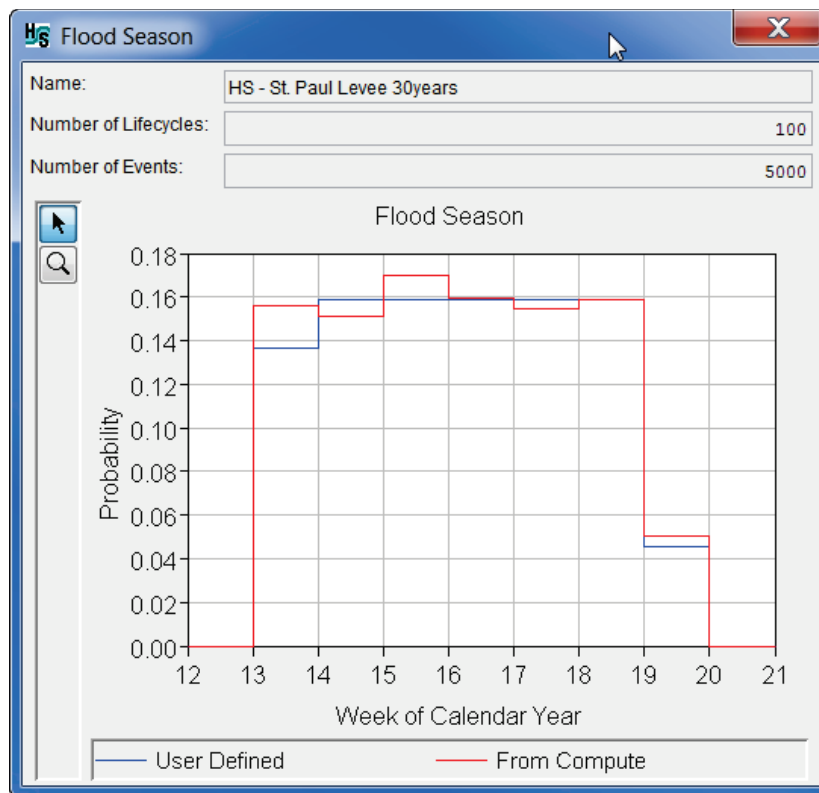


**Figure 21.16** Hydrographs Dialog Box


Using the **Zoom Tool**,  (Figure 21.16) the user can zoom in on areas of interest in the plot. The user can modify the plot by right-clicking on areas in the plot, from the shortcut menus various items could be modified - the axes title, the title of the plot, the viewport, axis ticks, the curve, and many other things. For further information on manipulating the plots, refer to Appendix M of this User's Manual, and HEC-DSSVue User's Manual.

## Plot Event Distribution

The **Plot Event Distribution** option plots a histogram of the event dates of all sampled floods generated by the hydrologic sampling within an FRA compute. Each sampled date is used to place the peak of the flood event hydrograph in time, on a month and day. For the active FRA simulation, from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Hydrologic Sampling**, from the sub-menu click **Plot Event Distrib.**, the **Flood Season** dialog box will open (Figure 21.17). This plot is for all life cycles (i.e., 100) and the number events (i.e., 5,000 events). The plot contains both the user defined and sampled dates.




**Figure 21.17** Flood Season Dialog Box

Using the **Zoom Tool**,  (Figure 21.17) the user can zoom in on areas of interest in the plot. The user can modify the plot by right-clicking on areas in the plot, from the shortcut menus various items could be modified - the axes title, the title of the plot, the viewport, axis tics, the curve, and many other things. For further information on manipulating the plots, refer to Appendix M of this User's Manual, and HEC-DSSVue User's Manual.

## Plot Maximum Flows

The **Plot Maximum Flow** option creates a frequency plot of the sampled maximum flow of all flood events at each primary location generated by the hydrologic sampling within an FRA compute. A peak flow magnitude is generated for every event at each primary location based on correlated sampling from all locations' user-defined frequency curves. The results of this sampling are compared to the user-defined curve on a frequency plot. For the active FRA simulation from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Hydrologic Sampling**, from the sub-menu click **Plot Maximum Flows**, the **Primary Maximum Flow Frequency** dialog box will open (Figure 21.18). This plot is for all life cycles (i.e., 100), number of events (5,000 events), and a flow location. From the **Flow Location** list (Figure 21.18), the user can select different locations that have been defined.

Using the **Zoom Tool**,  (Figure 21.18) the user can zoom in on areas of interest in the plot. The user can modify the plot by right-clicking on areas in the plot, from the shortcut menus various items could be modified - the axes title, the title of the plot, the viewport, axis tics, the curve, and many other things. For further information on manipulating the plots, refer to Appendix M of this User's Manual, and HEC-DSSVue User's Manual.

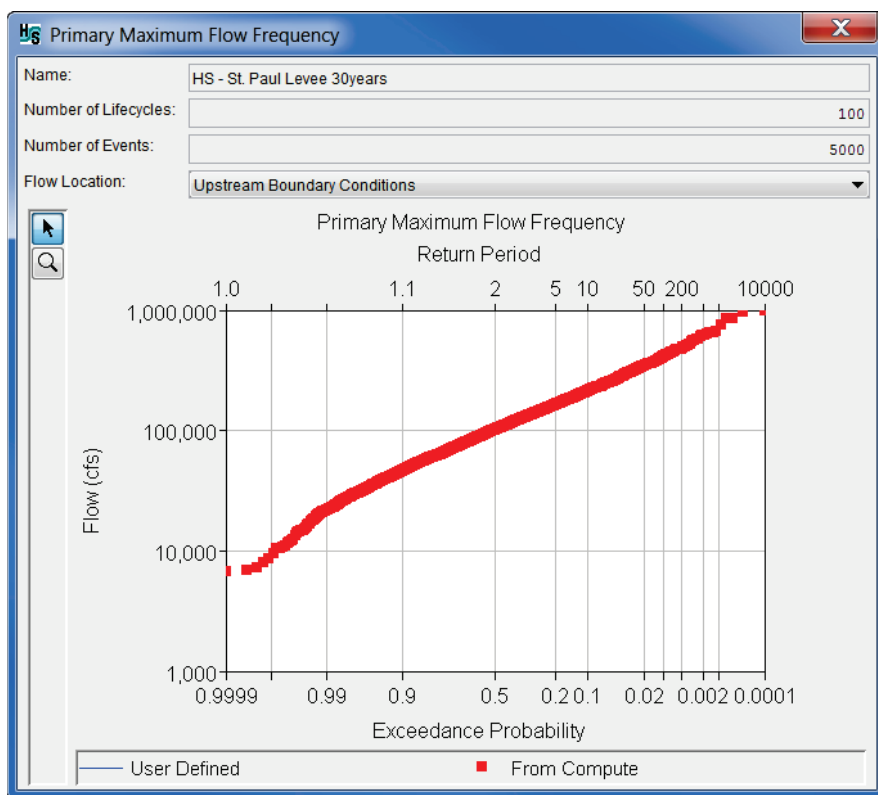


Figure 21.18 Primary Maximum Flow Frequency Dialog Box

## Correlation Table

The **Correlation Table** contains the computed correlation coefficient for every pair of primary location maximum flows. Maximum flows for each event are generated by correlated random sampling from the frequency curves at every location, maintaining cross-correlations entered by the user. For the active FRA simulation from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Hydrologic Sampling**, from the sub-menu click **Correlation Table**, the **Cross Correlations** dialog box will open (Figure 21.19). This plot is for all lifecycles (i.e., 100) and number of events (5,000 events).

The dialog box is titled "Cross Correlations". It contains the following fields:

- Name: HS - St. Paul Levee 30years
- Number of Lifecycles: 100
- Number of Events: 5000

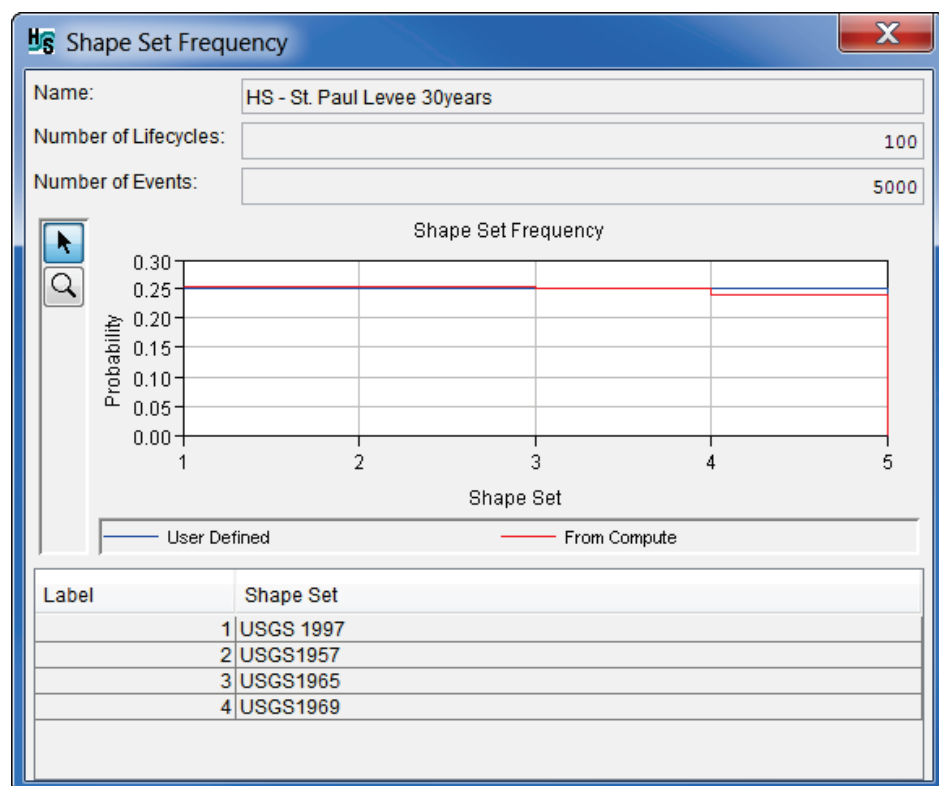
The dialog box is divided into three sections for different boundary conditions:

- User Defined:** Upstream Boundary Conditions (1.0)
- From Compute:** Upstream Boundary Conditions (1.00)
- Difference:** Upstream Boundary Conditions (0.00)


Figure 21.19 Cross Correlations Dialog Box

## Plot Shape Set Frequency

The **Plot Shape Set Frequency** option plots a histogram of the event dates of all sampled floods generated by the hydrologic sampling within an FRA compute. Each sampled date is used to place the peak of the flood event hydrograph in time, on a month and day. For the active FRA simulation from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Hydrologic Sampling**, from the sub-menu click **Plot Shape Set Freq.**, the **Shape Set Frequency** dialog box will open (Figure 21.20). This plot is for all life cycles (i.e., 100) and number of events (5,000 events).



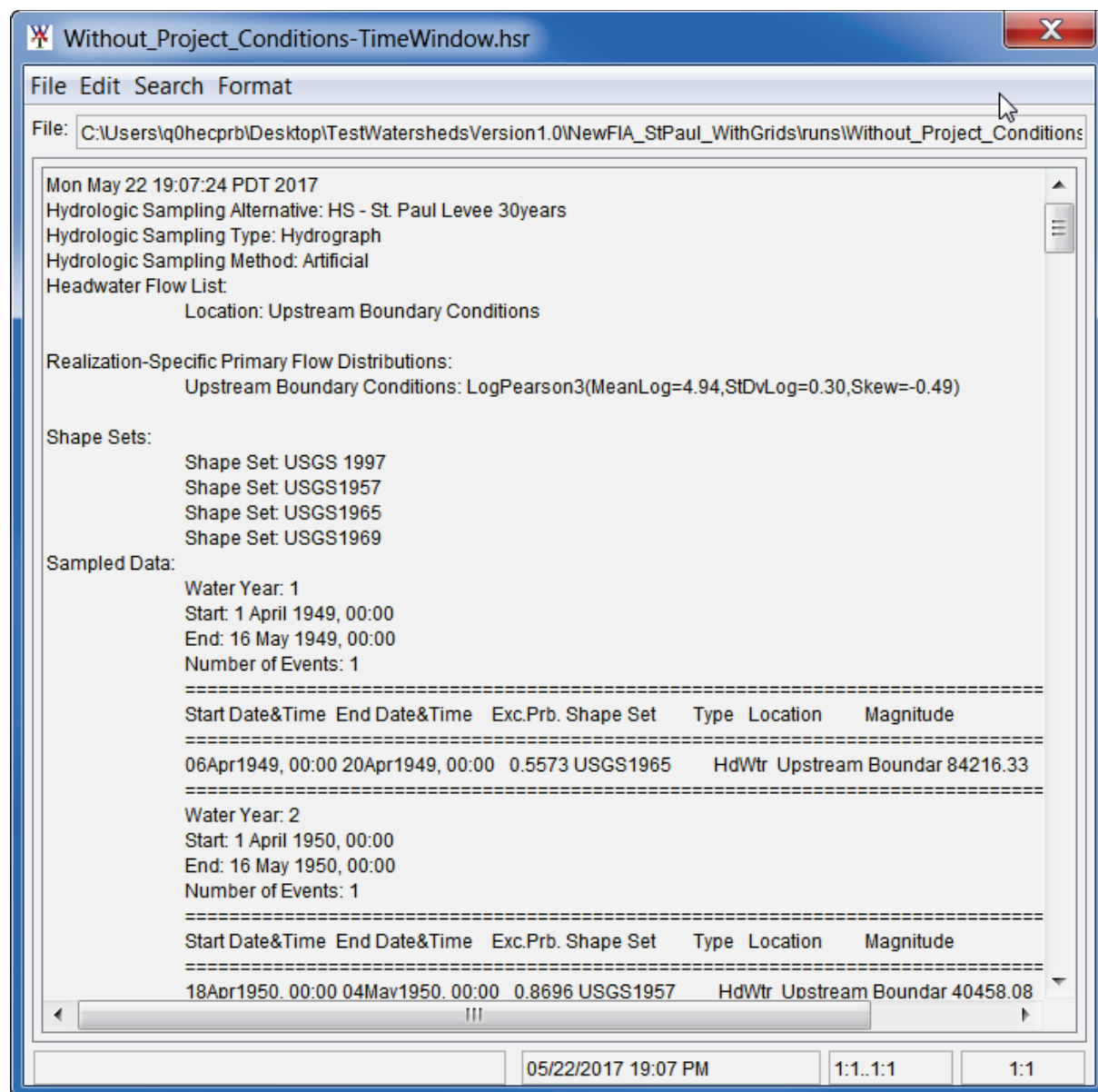
**Figure 21.20** Shape Set Frequency Dialog Box

Using the **Zoom Tool**,  (Figure 21.20) the user can zoom in on areas of interest in the plot. The user can modify the plot by right-clicking on areas in the plot, from the shortcut menus various items could be modified - the axes title, the title of the plot, the viewport, axis ticks, the curve, and many other things. For further information on manipulating the plots, refer to Appendix M of this User's Manual, and HEC-DSSVue User's Manual.

## Output Report

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Hydrologic Sampling**, from the sub-menu click **Output Report**, a text editor will open (Figure 21.21). This editor contains the hydrologic sampling results file (i.e., *Without\_Project\_Conditions-TimeWindow.hsr*), which provides the user with information about the hydrologic sampling compute.





**Figure 21.21** Output Report Editor – Hydrologic Sampling

The editor allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot what is going on with the hydrologic sampling compute. Refer to the Hydrologic Sampling User's Manual for further details.

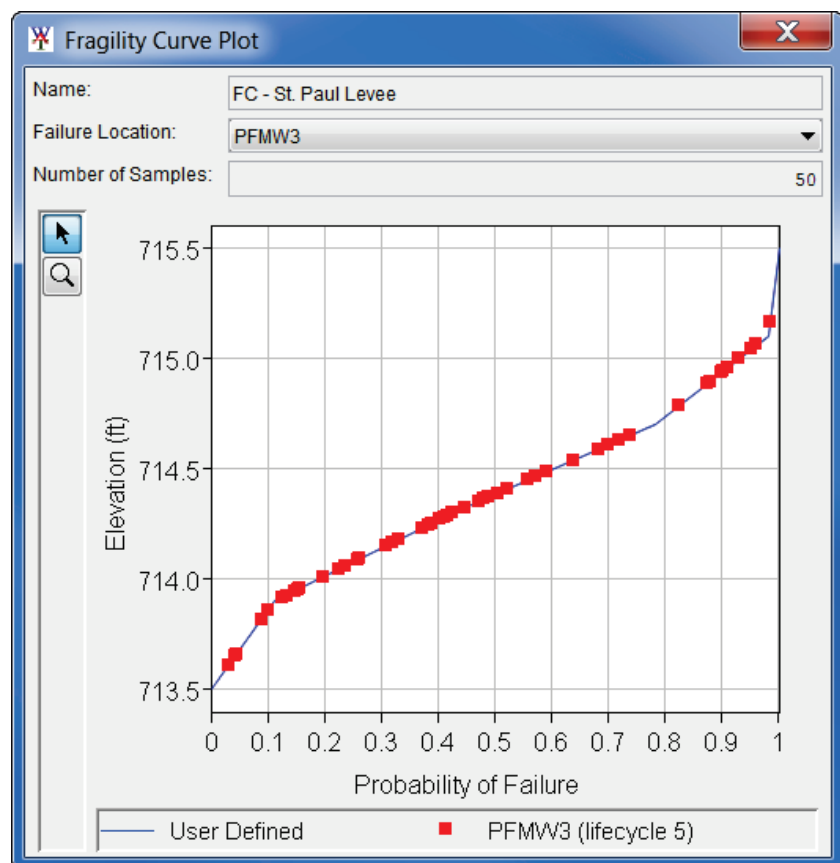
### 21.5.5 Fragility Curve Results

The sampling of levee failure trigger elevations from fragility curves is accomplished through the **Fragility Curve Sampler** with the results being an evaluation of the full range of levee failure possibilities for each pre-defined location in the entire system. For further details on the fragility curve sampling available in HEC-WAT, refer to Chapter 17 of this User's Manual. **Note:** results from the **Fragility Curve** menu item (Figure 21.8) will only be available if the user chooses to save all model files. Output variables (Chapter 16) can also be used to save the sampled failure elevation.




## Plot – FC (Fragility Curve)

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Fragility Curve**, from the sub-menu click **Plot - FC**, the **Fragility Curve Plot** dialog box will open (Figure 21.22). This plot displays the samples (i.e., 50) for a defined failure location (i.e., *PFMW3*) in addition to the original user defined curve. From the **Failure Location** list (Figure 21.22), the user can select different failure locations that have been defined.

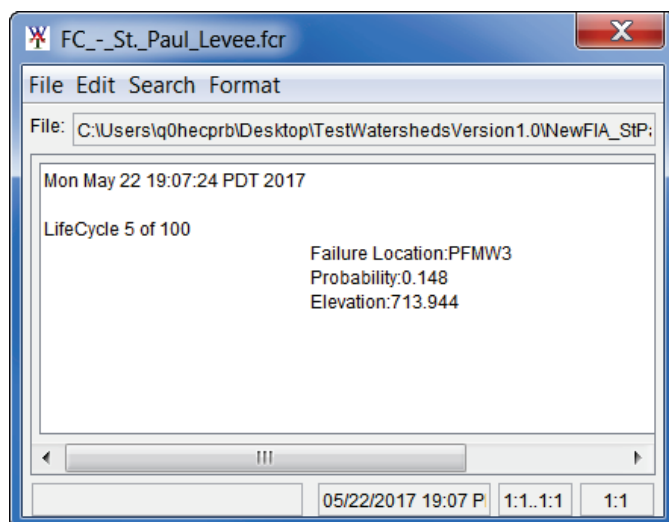


**Figure 21.22** Fragility Curve Plot Dialog Box

Using the **Zoom Tool**,  (Figure 21.22) the user can zoom in on areas of interest in the plot. The user can modify the plot by right-clicking on areas in the plot, from the shortcut menus various items could be modified - the axes title, the title of the plot, the viewport, axis tics, the curve, and many other things. For further information on manipulating the plots, refer to Appendix M of this User's Manual, and HEC-DSSVue User's Manual.

## Output Report

For the active HEC-WAT FRA simulation from the HEC-WAT main window (Figure 21.1), from the **Results** menu (Figure 21.15), point to **Fragility Curve**, from the sub-menu click **Output Report**, a text editor will open (Figure 21.23). This editor contains the fragility curve sampling results file (i.e., *FC - St. Paul levee.fcr*), which includes the sampled failure trigger elevations for each location.



**Figure 21.23** Output Report Editor – Fragility Curve Sampling

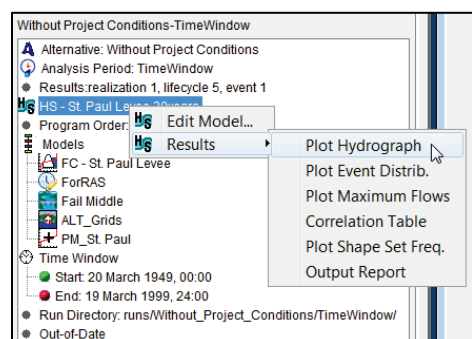
The editor allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot what is going on with the fragility curve sampling compute. Refer to the HEC-WAT Technical Reference Manual for further details (will not be available when HEC-WAT Version 1.0 is released).

## 21.5.6 Performance Metrics Results

USACE guidance and policy requires that risk and uncertainty analyses be performed for USACE planning studies. Risk for USACE is the measure of the probability and severity of undesirable consequences (ER 1105-2-101). The performance metrics provided by HEC-WAT measure a system's reaction to a flood which must be included in a USACE planning study. Performance metrics is discussed in Chapter 19, and performance metrics results are presented in Section 19.5.

## 21.6 Content Pane


Once a simulation has been computed, the user can review the same FRA results that are available from the **Results** menu from the **Content Pane**. From the **Content Pane**, right-click on one of the available model alternatives, from the shortcut menu (Figure 21.24), point to **Results**, click on the results that are available.

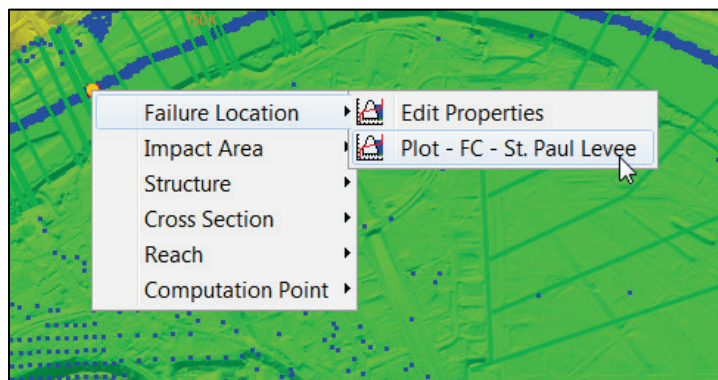


**Figure 21.24** Content Pane - Shortcut Menu – Results – Hydrologic Sampling

For example, in Figure 21.24, from the **Content Pane**, right-click on the hydrologic sampling *St. Paul Levee 30years* alternative, point to **Results**. The submenu provides a list of available hydrologic sampling results from which the user can select. For example, point to **Results**, click **Plot Hydrograph**, the **Hydrographs** dialog box will open (Figure 21.16). Section 21.5.4 provides details on the available hydrological sampling results.

## 21.7 Schematic

FRA results from the schematic are available by right-clicking on schematic elements (i.e., failure locations, common computation points) and from the shortcut menu select result items (zooming in on an area is a good idea). Results are available for both the model alternatives and the FRA results. From the map window click the **Pointer Tool** , right-click on a schematic element, a shortcut menu will appear (Figure 21.25). For example, right-click on a failure location, the shortcut menu (Figure 21.25), besides providing information about the failure location, also provides information on schematic elements that are around the junction, like impact areas, routing reaches, and cross sections.



**Figure 21.25** Schematic Shortcut Menu – Failure Location

In the example (Figure 21.25), the user right-clicks on a failure location from the schematic, from the shortcut menu (Figure 21.25), point to **Failure Location**, click **Plot - FC**, the **Fragility Curve Plot** will open (Figure 21.22). Section 21.5.5 provides details on the available fragility curve sampling results.



# Appendix A

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# Appendix B


## Tools

The HEC-WAT has several types of tools available for the user: a software application to manipulate DSS data (Appendix J); a software tool to perform statistical analysis on data; setting options for HEC-WAT; viewing the HEC-WAT log; viewing the logs of the software applications defined for an HEC-WAT study; check on HEC-WAT memory usage; the available graphic elements from each model alternative defined for an HEC-WAT study; model alternative usage within an HEC-WAT study; checking the setup for distributed computing; and, debugging compute times of an HEC-WAT simulation.

### B.1 HEC-SSP

The Statistical Software Package, HEC-SSP, is used to perform statistical analyses of hydrologic data (Figure B.1). The current version of HEC-SSP can perform flood flow frequency analysis based on Bulletin 17B (Interagency Advisory Committee on Water Data, 1982) and Bulletin 17C (England, et al., 2015). The software can also perform a generalized frequency analysis on flow data and other hydrologic data as well; perform a volume frequency analysis on high and low flows; duration analysis; coincident frequency analysis; and, a balanced hydrograph analysis. From HEC-WAT a frequency analysis would be performed at stream gages to create frequency curves that could be used by other software in the HEC-WAT study's program order. See the HEC-SSP User's Manual (CPD-86) for further details.

To perform a frequency analysis:

1. From the HEC-WAT main window (Figure B.2), from the **WAT Tools** toolbar, click , or from the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **HEC-SSP**. Either way, the HEC-SSP main window will open (Figure B.1).
2. To create a new HEC-SSP study, from the HEC-SSP main window (Figure B.1), from the **Study Tree**, right-click on Bulletin 17, or from the **Analysis** menu, point on **New**, click **Bulletin 17 Flow Frequency**. The **Bulletin Editor** will open (Figure B.1).
3. Enter a name for the frequency analysis, select a flow dataset; select a name for the output DSS file; and, enter a name for the report file.
4. The **General** tab (Figure B.1) is where the user will set the general settings for a frequency analysis. This includes: generalized skew, expected probability curve (frequency curve), plotting positions, and confidence limits.
5. The **Options** tab (Figure B.1) is for optional data like low outlier threshold, historic period data, and user-specified frequency outliers.



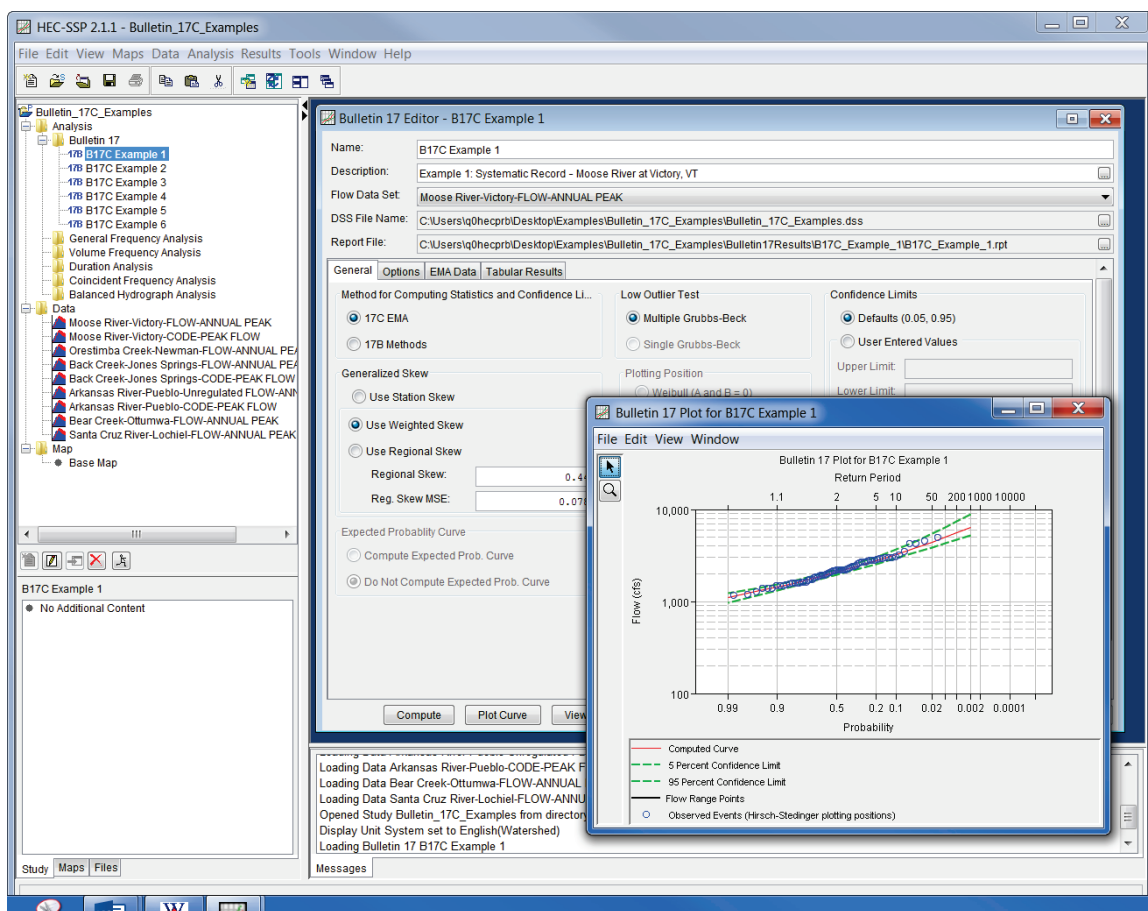


Figure B.1 HEC-SSP Main Window

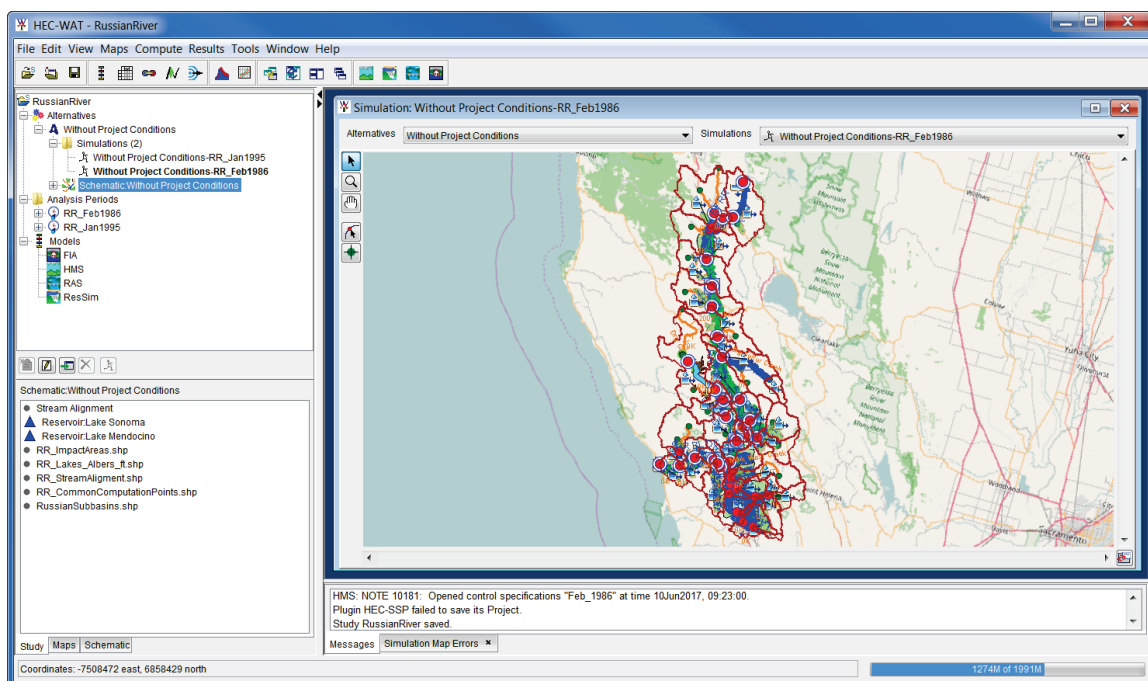


Figure B.2 HEC-WAT Main Window



6. The last tab is the **Tabular Results** tab (Figure B.1), which is populated after the user clicks **Compute**. This tab contains the computed flow frequency curve, the expected probability adjusted curve, general statistics about the data, and information on the events. Also, the user can view data graphically and in a report form from this tab.
7. The **EMA Data** tab (Figure B.1) is for a Bulletin 17C analysis only.
8. HEC-SSP data is stored to a DSS file and can be retrieved by software applications in an HEC-WAT study.

## B.2 HEC-WAT Options Dialog Box

HEC-WAT allows a user to configure several options for the HEC-WAT framework: create/modify HEC-WAT system properties; view threads being used by HEC-WAT; available software application plug-ins; set the color scheme for the HEC-WAT compute messages; set DSS debug levels and information on the library being used by DSS; define directories where HEC-WAT studies can be stored; use plug-ins for the active HEC-WAT study; enable tracking of the compute timings for DSS files; and, debug information for both HEC-HMS and HEC-RAS.

### B.2.1 General Tab

From this worksheet, the user can set the last study to be loaded during the startup of HEC-WAT; display a dialog box that allows the user to open or create a study; save the study automatically when exiting HEC-WAT; restore the default layout; synchronize the **Study Tree** to the active **Map Window**; set an interval (minutes) for automatically saving a study; display tooltips; set default scheme for cascading windows; and, specify the number of HEC-WAT studies to display in the **Recent Studies** item under the **File** menu.

### Load Last Study at Startup

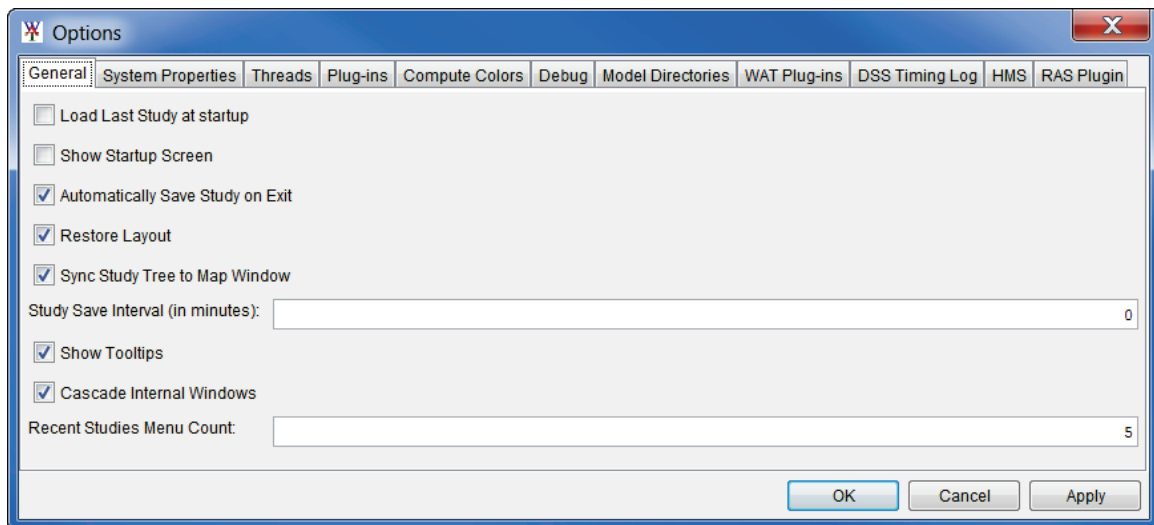
To set the automatic reload of the last study:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).
2. If the user wants to have the last study automatically loaded the next time HEC-WAT is started, click **Load Last Study at startup**. Click **OK**, the **Options** dialog box (Figure B.3) will close.

### Show Startup Screen

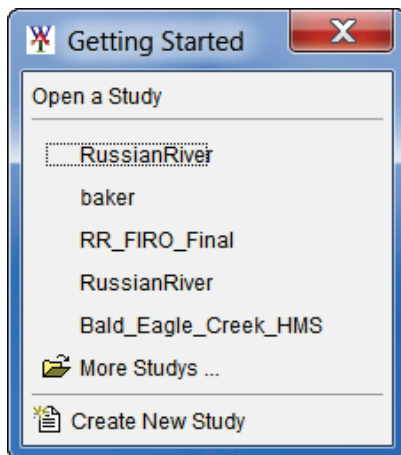
Ability to open or create a study when HEC-WAT loads:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).



**Figure B.3** Options Dialog Box

2. If the user wants to open or create a study when the HEC-WAT software loads, select **Show Startup Screen** (Figure B.3). When HEC-WAT loads the next time, the **Getting Started** dialog box (B.4) will open. This allows the user a convenient way to open or create a study. **Note:** for this option to work properly, the **Load Last Study at startup** option cannot be selected (Figure B.3).



**Figure B.4** Getting Started Dialog Box

3. Click **OK**, the **Options** dialog box will close (Figure B.3). The next time HEC-WAT is loaded, the **Getting Started** dialog box will display (Figure B.4). This allows the user a convenient way to open or create a study.

## Automatically Save Study on Exit

To automatically save an HEC-WAT study on exit:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).

2. By default, an HEC-WAT study is saved automatically when exiting HEC-WAT. If the user does not want to save a study automatically, click **Automatically Save Study on Exit** (Figure B.3), the checkmark will no longer display.
3. When exiting HEC-WAT, the **Save File** dialog box will open (Figure B.5), a list of items that need to be saved will be displayed. Ensure that all selected items are to be saved, click **OK**, the **Save File** dialog box will close (Figure B.5) and the HEC-WAT main window (Figure B.2) will close.

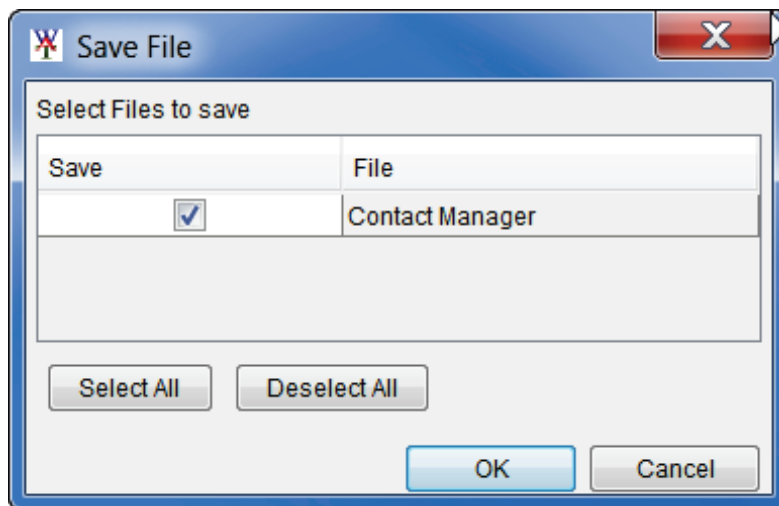


Figure B.5 Save File Dialog Box

## Restore Layout

Displaying the layout of a study:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).
2. By default, as an HEC-WAT study is saved, information about the current "layout" (display in the **Desktop Pane**) is automatically saved when exiting HEC-WAT. When the study is opened the next time, the layout will be the same.

## Sync Study Tree to Map Window

Synchronize the study tree with the active **Map Window** in the **Desktop Pane**:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).
2. By default, the study tree of the current study is synchronized with the active **Map Window** currently displayed in the **Desktop Pane** of the HEC-WAT main window (Figure B.2). If the user does not want the study tree to be synchronized with the active **Map Window**, de-select **Sync Study Tree to Map Window** (Figure B.3).

## Study Save Interval

Setting how often the current study will be saved:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).
2. By default, the study that is currently opened in HEC-WAT is not automatically saved. If the user wishes to set the interval (in minutes) for automatically saving a study, from the **General Tab** (Figure B.3), enter a time in minutes for the automatic saving in the **Study Save Interval** box.

## Show Tooltips

Controlling tooltips in HEC-WAT:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).
2. By default, all tooltips are displayed. If the user no longer wants to have tooltips display, click **Show Tooltips** (Figure B.3), this clears the setting. Tooltips will no longer display in the HEC-WAT interface.

## Cascade Internal Windows

Controlling map windows:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).
2. By default, the capability to cascade map windows in the **Desktop Pane** of the HEC-WAT main window (Figure B.2) is set. If the user does not want map windows to cascade, click **Cascade Internal Windows** (Figure B.3), this clears the setting. Map windows will no longer cascade.

## Recent Studies Menu Count

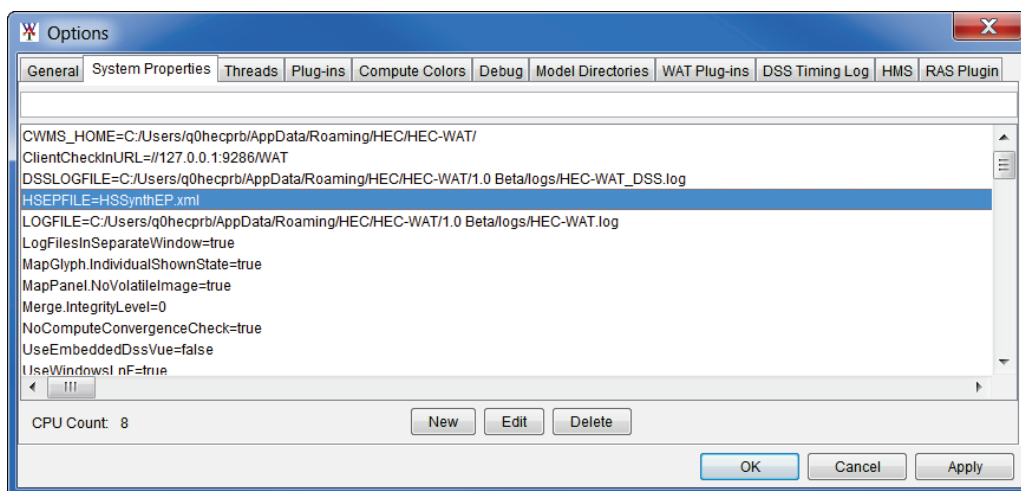
Setting the number of studies available from the **Recent Studies** menu item:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open, click the **General** tab (Figure B.3).
2. By default, the number of recent HEC-WAT studies for display is set to five. The user can change this number by entering a new number in the **Recent Studies Menu Count** (Figure B.3). Once this number had been changed, the number of recent HEC-WAT

studies that display from the HEC-WAT main window (Figure B.2), from the **File** menu, point to **Recent Studies**, will be different.

## B.2.2 System Properties Tab

The **System Properties** tab (Figure B.6) allows the user to view system properties. If the user has the correct user access, the user can edit some or all of the system properties. It is recommended that the user only use this information for debugging purposes and viewing. Editing must be done with extreme caution as any changes made can directly affect the WAT functionality.



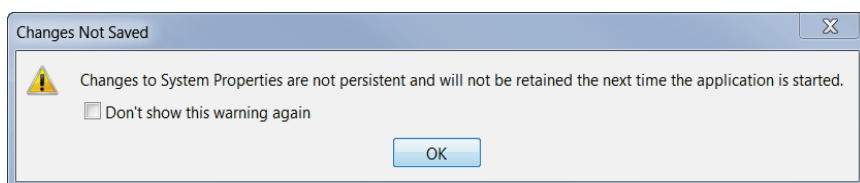
**Figure B.6** Options Dialog Box – System Properties Tab

To view system properties:

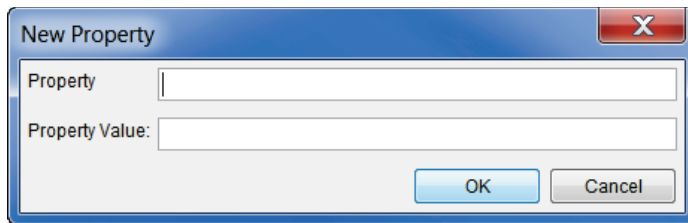
1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **System Properties** tab (Figure B.6).
2. The **Server Properties Worksheet** provides the user with information regarding HEC-WAT system properties that have been set.

## Add a System Property

If a user has the correct user access level, then that user can add a system property, click **New**, a warning window will open (Figure B.7). This warning window lets the user know that any changes made will not be retained once HEC-WAT is exited. Click **OK**, the warning window will close (Figure B.7) and the **New Property** dialog box (Figure B.8) will open.



**Figure B.7** Changes Not Saved Window

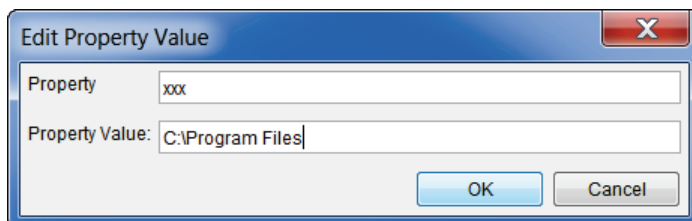


**Figure B.8** New Property Dialog Box

In the **Property** box (Figure B.8), enter the name of the new system property. For the parameters of the new system property, enter the parameters in the **Property Value** box. Click **OK**, the **New Property** dialog box (Figure B.8) closes, and the new system property will appear on the **System Properties** worksheet (Figure B.6).

## Edit a System Property

If a user has the correct user access level, then that user can edit a system property. Select a system property from the available list, click **Edit**, a warning window will open (Figure B.7). This warning window lets the user know that any changes made will not be retained once HEC-WAT is exited. Click **OK**, the warning window will close (Figure B.7) and the **Edit Property Value** dialog box (Figure B.9) will open.

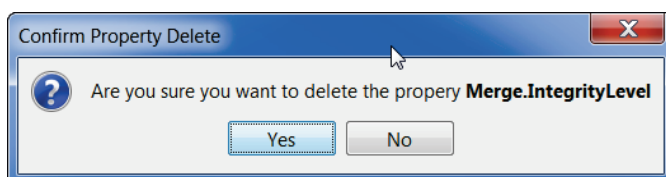


**Figure B.9** Edit Property Value Dialog Box

In the **Property** and **Property Value** boxes (Figure B.9), from the selection made, the user can edit the items. Click **OK**, the **Edit Property Value** dialog box will close (Figure B.9), and the changed system property will appear on the **System Properties** worksheet (Figure B.6).

## Delete a System Property

If a user has the correct user access level, then that user can delete a system property. Select a system property from the available list, click **Delete**, a **Confirm Property Delete** message window (Figure B.10) will open. If user wishes to delete the selected system property, click **Yes**. The **Confirm Property Delete** message window will close and the selected system property will be removed from the **System Properties** worksheet (Figure B.6).



**Figure B.10** Confirm Property Delete Message Window

## B.2.3 Threads Tab

A thread is a single sequential flow of control within software. Within Java the user has the ability to have multiple threads in a piece of software all running at the same time and performing different tasks. HEC-WAT is a multi-threaded software application, to view HEC-WAT threads:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **Threads** tab (Figure B.11).

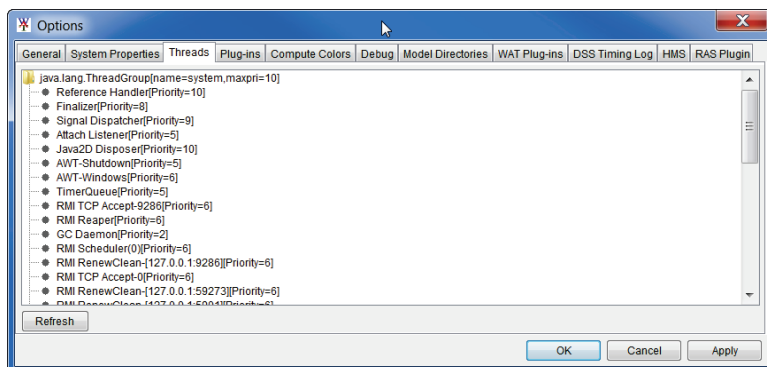


Figure B.11 Options Dialog Box – Threads Tab

2. The **Threads Worksheet** displays information regarding the threads that are actively being used by HEC-WAT. To provide an up-to-date list of the active threads, click **Refresh**.

## B.2.4 Plug-ins Tab

From the **Plug-ins** tab (Figure B.12), is a table of the plug-ins that are enabled by default for HEC-WAT Version 1.0. Disabling plug-ins using this tab will disable those plug-ins for all studies. Disabling plug-ins for specific studies should be done from the **Study Details** dialog box (Chapter 4, Section 4.1.5), which is the recommended place to disable plugins.

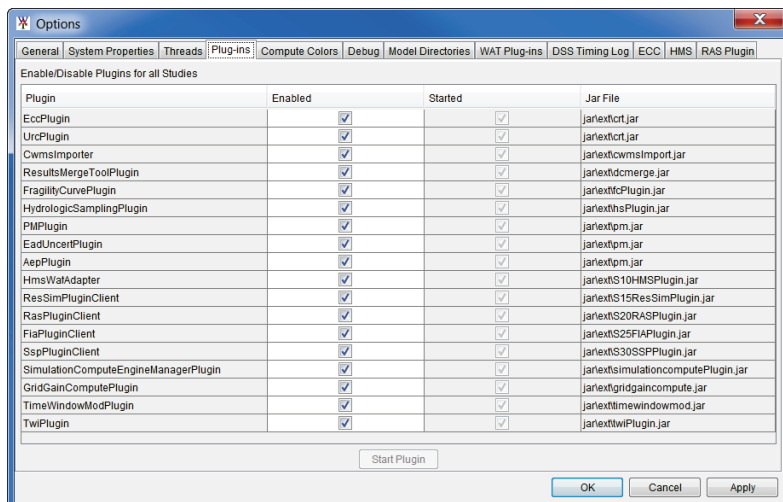
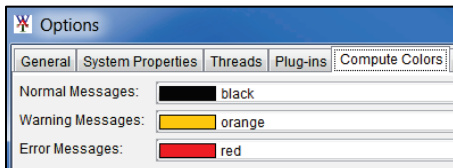


Figure B.12 Options Dialog Box – Plug-ins Tab

## B.2.5 Compute Colors Tab

Setup color scheme for the **Compute Progress** dialog box:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **Compute Colors** tab (Figure B.13).



**Figure B.13** Options Dialog Box – Compute Colors Tab

2. By default, during an HEC-WAT simulation the **Compute Progress** dialog box displays information about the compute. In Figure B.13, is the default color scheme for **Normal Messages**, **Warning Messages**, and **Error Messages**.
3. For example, in Figure B.13, if the user wishes to change the color of the warning messages in the **Compute Progress** dialog box, from the **Warning Messages** list (Figure B.13), the user can choose from several default colors that are available (i.e., dark blue).
4. Click **Apply**, when an HEC-WAT simulation is computing the warning messages in the **Compute Progress** dialog box will now display in the user selected color.

## B.2.6 Debug Tab

To set the debug level for DSS:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **Debug** tab (Figure B.14).



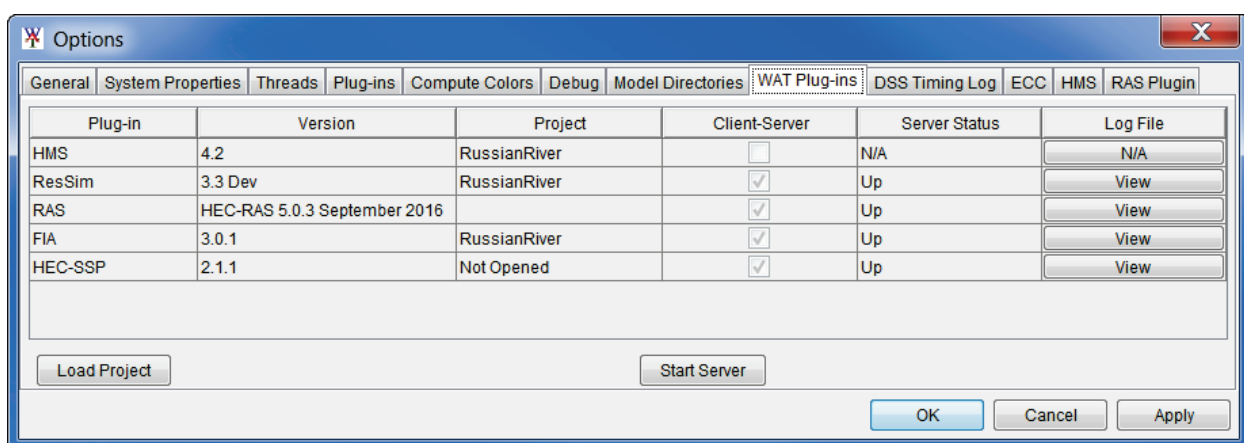
**Figure B.14** Options Dialog Box – Debug Tab

2. The default **DSS Debug Level** (Figure B.14) is three (3); the user can enter a value from 1 to 15. If a user is contemplating changing this number please contact the Hydrologic Engineering Center, increasing this number can generate very large log files. This determines how much DSS debug information is written to the HEC-WAT log file, the debug information will assists users in debugging DSS and HEC-DSSVue issues. Click **Apply**, to set the new debug level.



## B.2.7 WAT Plug-ins Tab

This worksheet (Figure B.15) provides information on the plug-ins that are currently being used in the HEC-WAT for the four basic software applications in the default program order, plus the plug-in for the HEC-SSP software application (Section B.1, page B.1). The information includes the plug-in name; the version of the software application the plug-in represents; the name of the HEC-WAT study; whether the plug-in is written in client/server mode or not; status of the server side of a plug-in; and, a log file associated with the plug-in. The log file is very important when debugging issues related to the individual software applications in HEC-WAT. The only software application that does not have a log file for Version 1.0 is HEC-HMS. The following steps use HEC-RAS as an example, but can be followed for any of the software application plug-ins.



**Figure B.15** Options Dialog Box – WAT Plug-ins Tab

To access the RAS log file:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **WAT Plug-ins** tab (Figure B.15).
2. To view the log file for RAS, on the table, in the **RAS** row, click **View** (Figure B.15). The **rasserver5901.log** will open (Figure B.16).
3. Review the **rasserver5901.log** for any information that can help debug any issues with the HEC-RAS software application. From the **File** menu, click **Close**, the **rasserver5901.log** will close (Figure B.12).

## B.2.8 DSS Timing Log Tab

Another debugging tool is to track the compute timings in DSS files. To enable this capability:

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **DSS Timing Log** tab (Figure B.17).

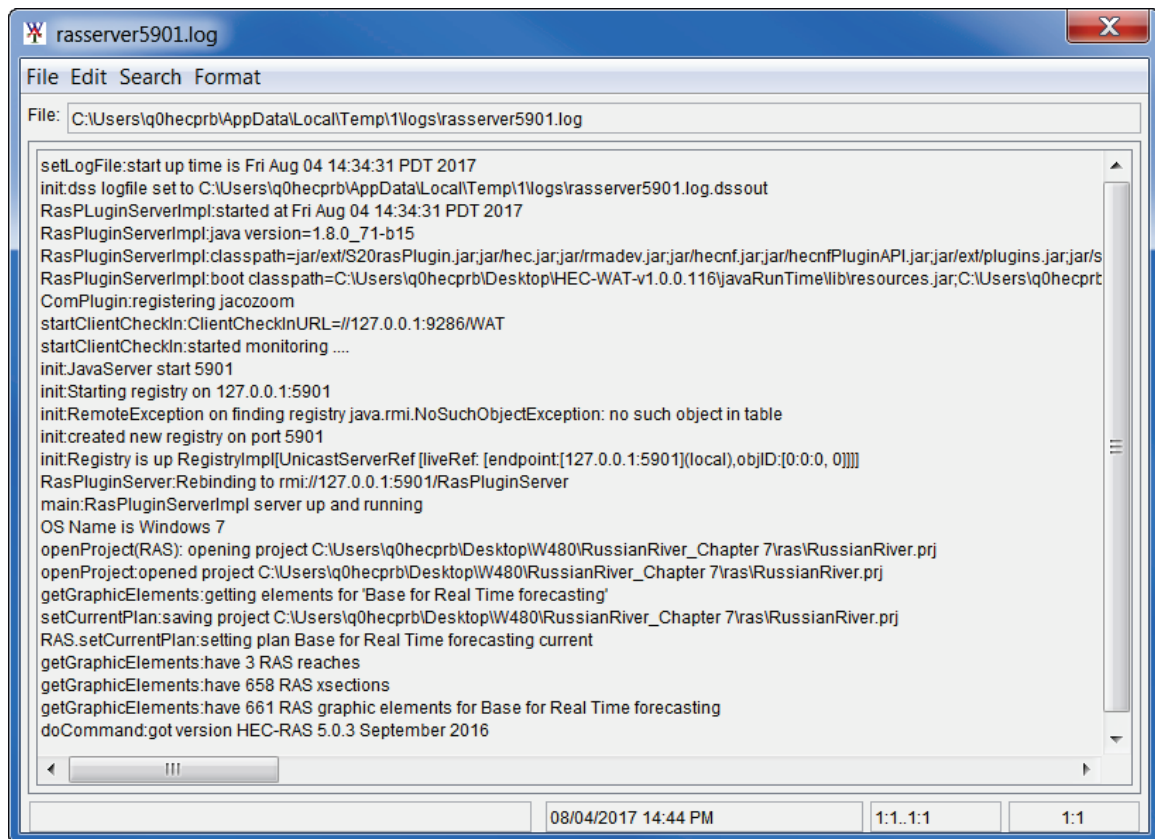


Figure B.16 rasserver5901.log

2. Click **Enable Compute Timings to DSS File** (Figure B.17), this will enable the tracking of compute timings in DSS files. The tracking information will be written to the DSS log file (Section B.4). Click **Apply**, to set the tracking of compute timings in DSS files.

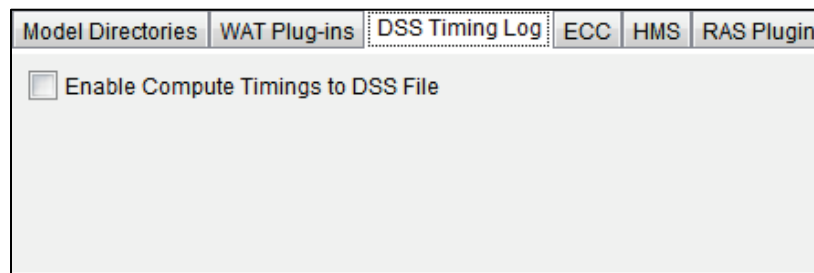


Figure B.17 Options Dialog Box – DSS Timing Log Tab

## B.2.9 ECC Tab

The ECC (Energy Content Curve) software is used specifically for the Columbia River Treaty study that the Hydrologic Engineering Center (HEC) assisted the USACE Northwest Division and Districts with.

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **ECC** tab (Figure B.18).

- For the ECC software to run in HEC-WAT, the user must provide the location of the ECC executable (**ECC Exe** box, Figure B.18); the location of the ECC pre-processor (**Preprocessor Exe** box); and, the location of the ECC post-processor (**Postprocessor Exe** box).

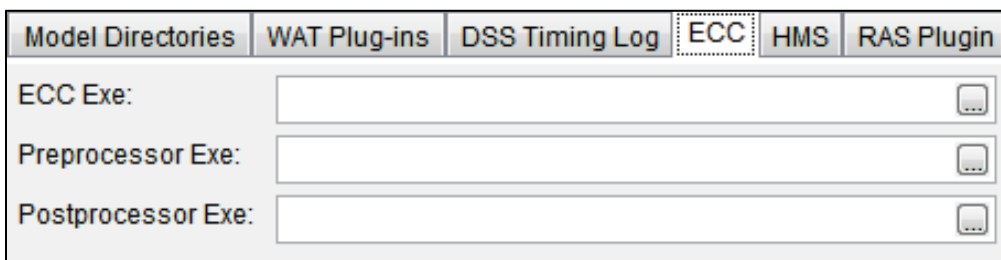


Figure B.18 Options Dialog Box – ECC Tab

- Click **Apply**, now the ECC software will execute in the HEC-WAT framework.

## B.2.10 HMS Tab

Another debugging tool is available by turning on debugging for the HMS software application. To enable this capability:

- From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **HMS** tab (Figure B.19).
- Click **Debug** (Figure B.19), this will debug XML (eXtensible Markup Language) calls in the HMS software application. Click **Apply**, to set the HMS debug option.

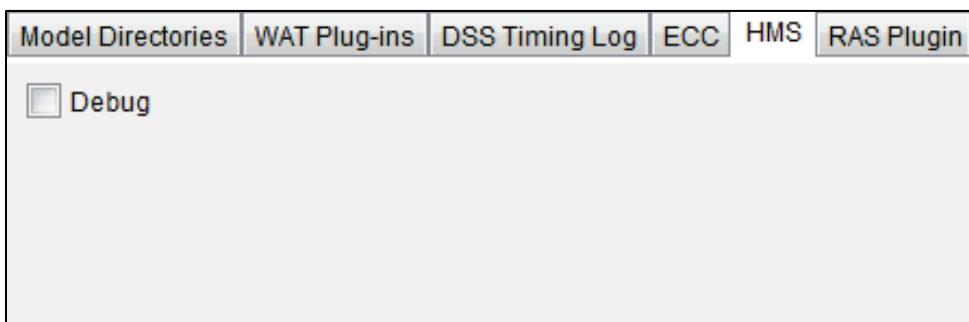


Figure B.19 Options Dialog Box – HMS Tab

## B.2.11 RAS Plugin Tab

Another debugging option is to turn on debugging of XML calls and display the **HEC-RAS Computations** dialog box (Figure B.20) for the RAS software application. To enable this capability:

- From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Options**. The **Options** dialog box will open (Figure B.3), click the **RAS Plugin** tab (Figure B.21).

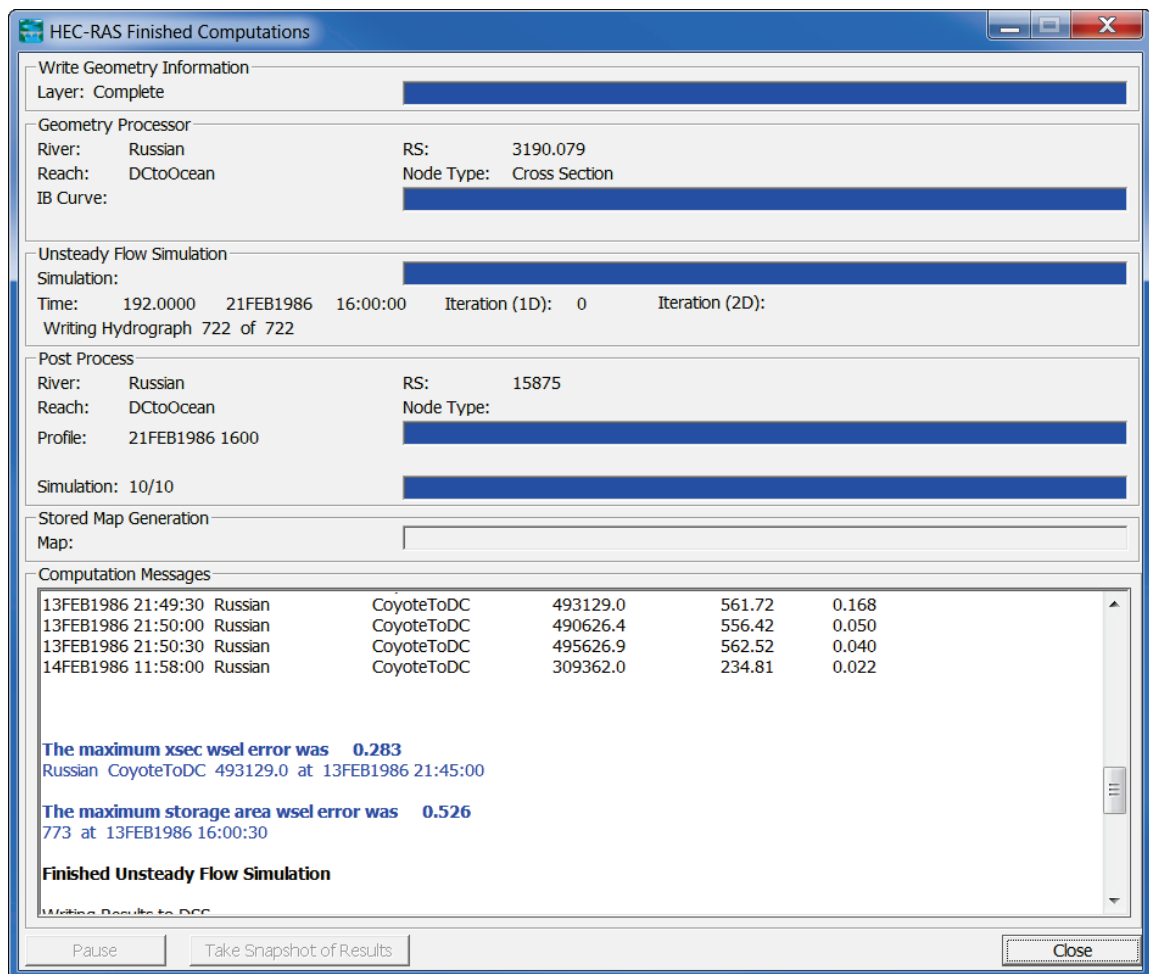


Figure B.20 HEC-RAS Computations Dialog Box

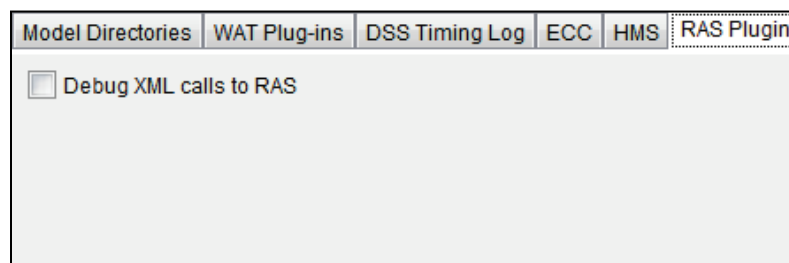
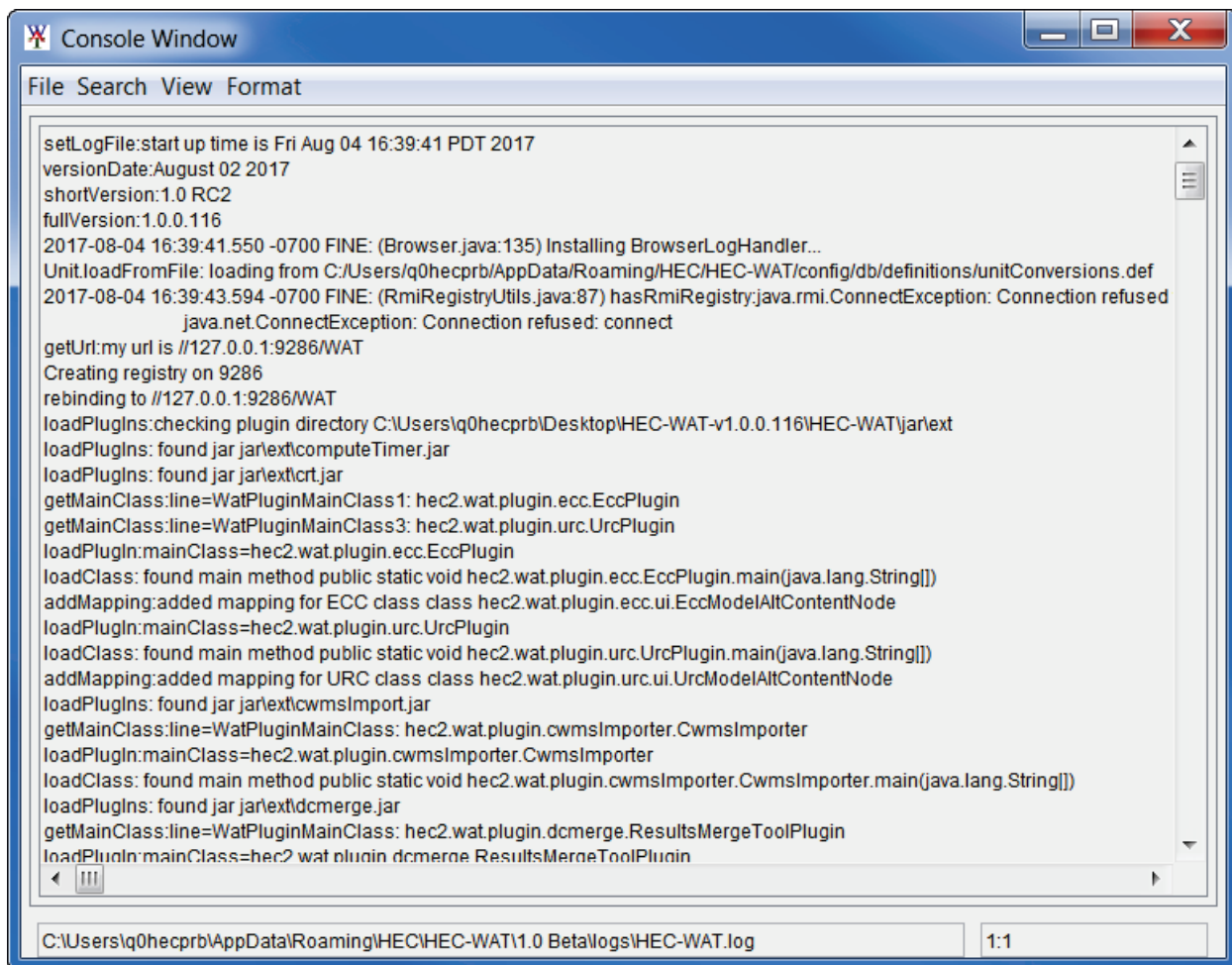


Figure B.21 Options Dialog Box – RAS Plugin Tab

- Click **Debug XML calls to RAS** (Figure B.21), this will debug XML calls in the HEC-RAS software application, plus the **HEC-RAS Computations** dialog box (Figure B.20) will display during the selected simulation's compute. The tracking information will be written to the RAS log file (Section B.2.7). Click **Apply**, to set the RAS debug option.

## B.3 Console Output

To review the progress of HEC-WAT, on the **Tools** menu, click **Console Output**, the **Console Window** will open (Figure B.22).



**Figure B.22** Console Window

From this editor (Figure B.22) a user can view the progress of HEC-WAT; the editor helps in debugging issues with HEC-WAT; search for certain items; format the text displayed in the editor; and, print the contents of the editor (Figure B.22). From the **File** menu, click **Close**, the **Console Window** will close (Figure B.22).

## B.4 Logs

Log files for three of the HEC basic software applications and the log file for DSS are available from the HEC-WAT framework.

### B.4.1 HEC-DSS Log

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, point to **Logs**, click **HEC-DSS Log**, the **HEC-WAT\_DSS.log Editor** will open (Figure B.23).
2. The editor allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot issues with DSS files.

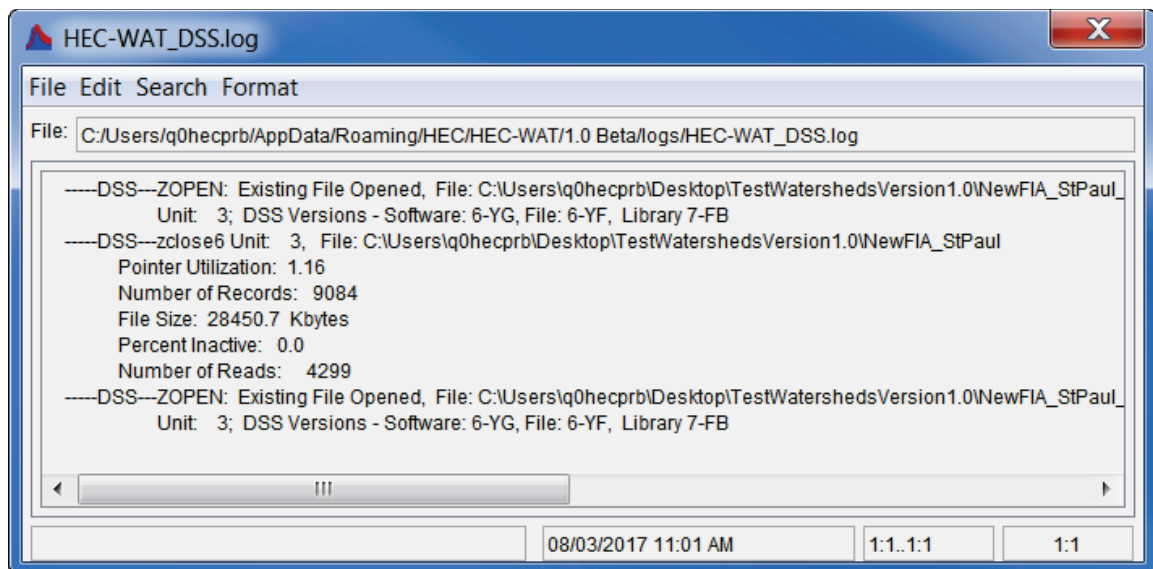


Figure B.23 HEC-WAT\_DSS.log Editor

## B.4.2 ResSim

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, point to **Logs**, click **ResSim**, the **ressimserver.log Editor** will open (Figure B.24).

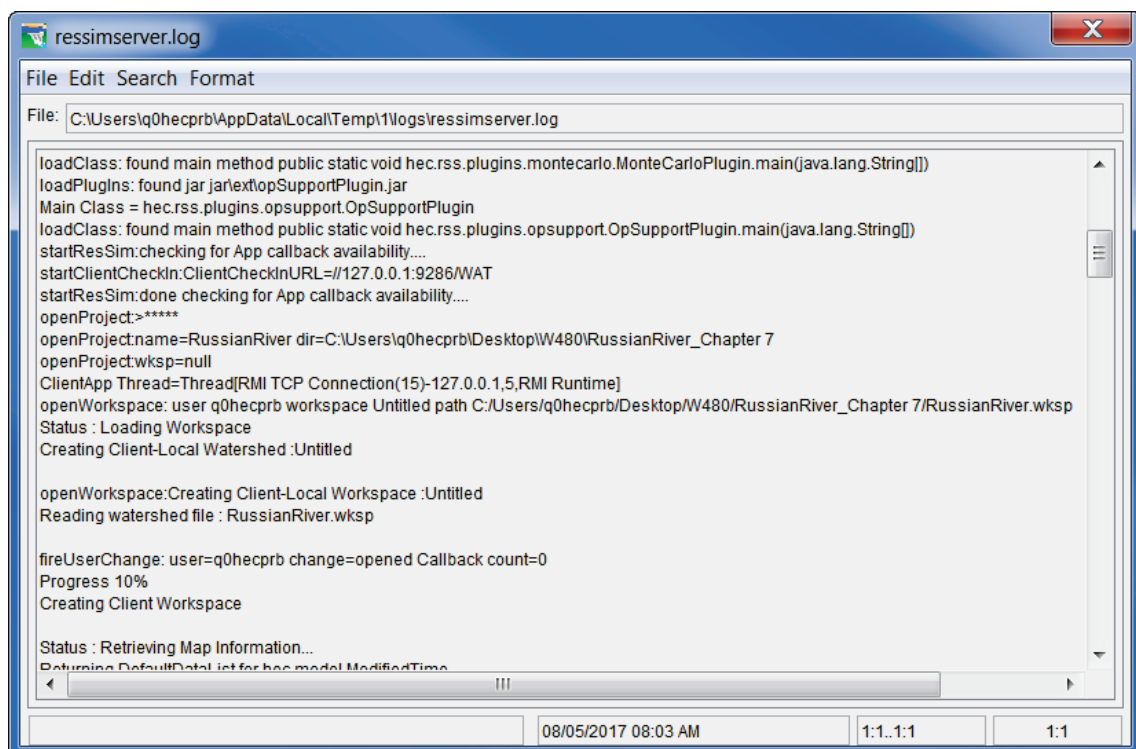


Figure B.24 ressimservers.log Editor

2. The editor allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot issues with the ResSim compute.



### B.4.3 RAS

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, point to **Logs**, click **RAS**, the **rasserver5901.log Editor** will open (Figure B.25).

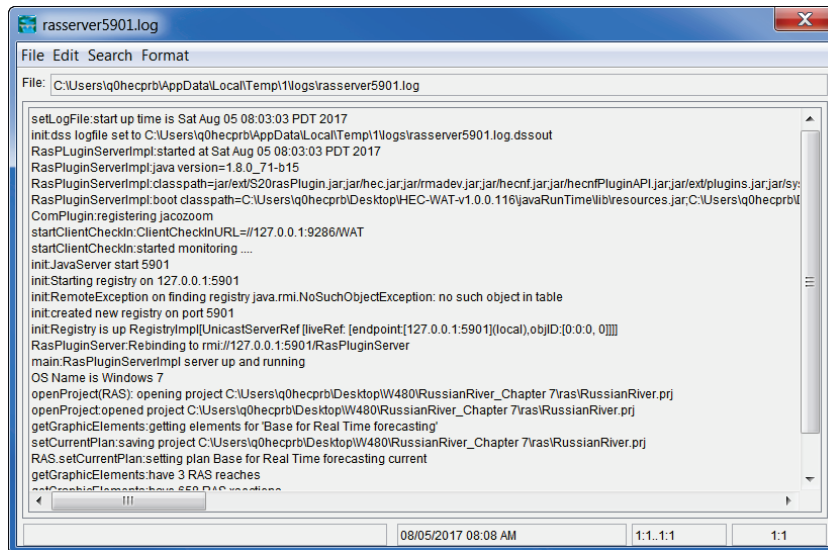


Figure B.25 rasserver5901.log Editor

2. The editor allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot issues with the RAS compute.

### B.4.4 FIA

1. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, point to **Logs**, click **FIA**, the **HEC-FIA.log Editor** will open (Figure B.26).

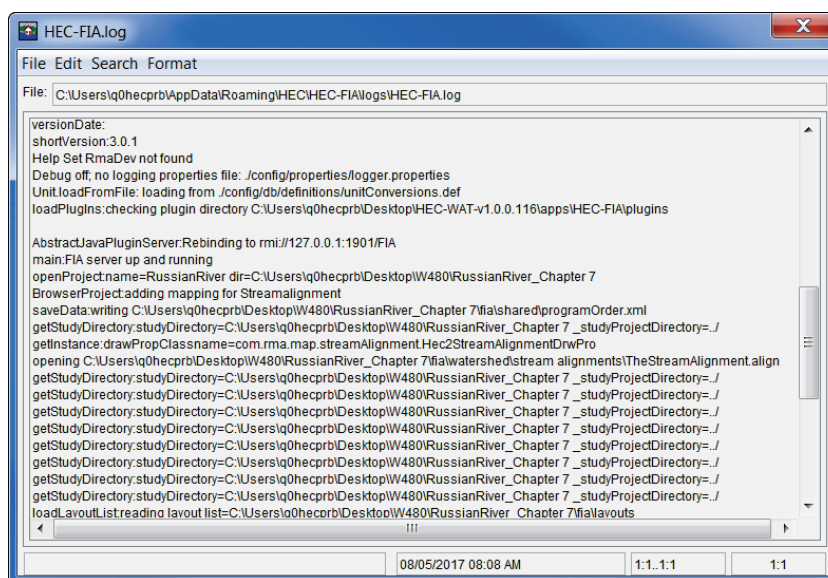



Figure B.26 HEC-FIA.log Editor

- The editor allows the user to edit, search, print, and format the log. The search function lets the user search for specific items to troubleshoot issues with the FIA compute.

## B.5 HEC-WAT Memory Usage

To review the memory being used by HEC-WAT, on the **Tools** menu, click **Memory Monitor**, the **Memory Monitor** dialog box will open (Figure B.27). From this dialog box the user can view the memory usage of HEC-WAT. Click  to close the **Memory Monitor** dialog box.

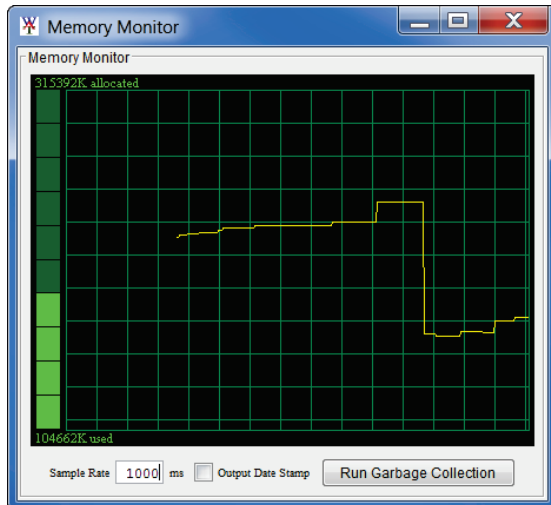


Figure B.27 Memory Monitor Dialog Box

## B.6 Graphic Elements

On an HEC-WAT schematic the graphic elements that represent the individual model alternatives of a study are displayed. To view a list of these graphics elements:

- From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Graphic Elements**, the **Graphic Element Report** dialog box will open (Figure B.28).

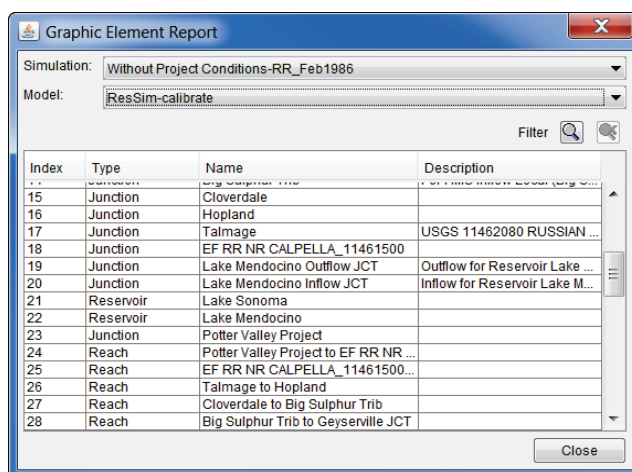




Figure B.28 Graphic Element Report Dialog Box



- From the **Simulation** list (Figure B.28) select a simulation (i.e., *Without Project Conditions-RR\_Feb1986*). From the **Model** list (Figure B.28), select a model alternative (i.e., *ResSim-calibrate*). The table will display the known graphic elements for the selected model alternative. This report can be used when debugging issues on the schematic of the selected simulation.
- If the report is lengthy, the user can search the listed graphic elements by using a filter. Click , a **Filter** dialog box will open (Figure B.29). By defining filters, the user can scan the list of graphic elements. Click **OK**, the **Filter** dialog box will close, and the table on the **Graphic Element Report** dialog box (Figure B.28) will reflect the results of the defined filter. To clear the filter, click .

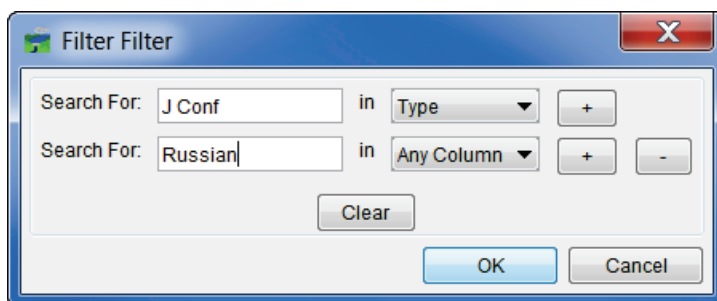


Figure B.29 Filter Dialog Box

## B.7 Model Alternative Usage

For a very large HEC-WAT study, there could possibly be a large number of model alternatives that are being used by HEC-WAT simulations. Being able to view where these models alternative are being used from the HEC-WAT study tree can be overwhelming to process. The HEC-WAT framework provides a way to view this usage by model alternative.

- From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Model Alternative Usage**, the **Model Alternative Usage** dialog box will open (Figure B.30).

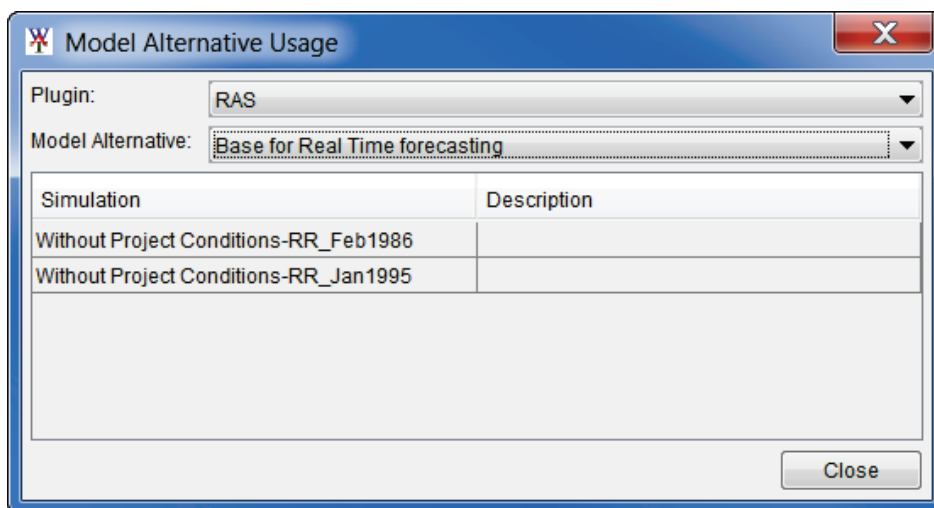
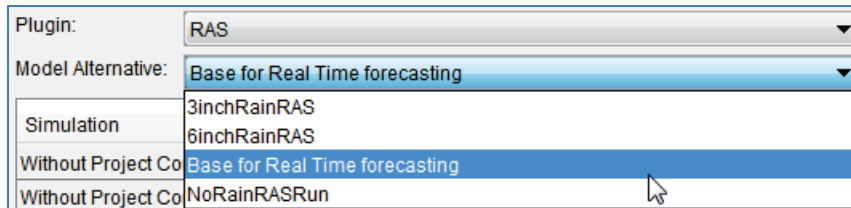


Figure B.30 Model Alternative Usage Dialog Box

- From the **Plugin** list (Figure B.31) select the associated software application with a model alternative (i.e., *RAS*). From the **Model Alternative** list (Figure B.30), select a model alternative (i.e., *Base for Real Time forecasting*). The table will display a list of all the simulations in an HEC-WAT study that contain the selected model alternative.

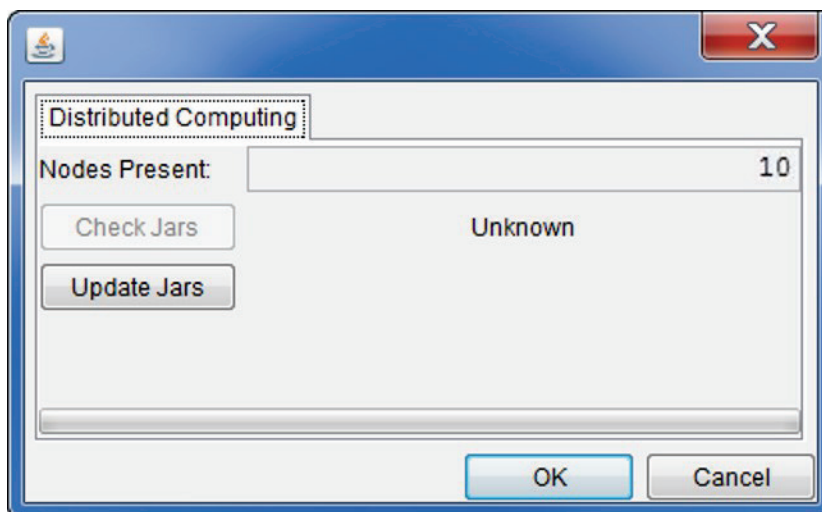


**Figure B.31** Model Alternative Usage Dialog Box – Model Alternative List

## B.8 Simulation Compute Engine Manager

The FRA compute option relies on a Monte Carlo computational algorithm that requires potentially many thousands of simulations (realizations) of the individual model alternatives that are included in the program sequence defined for an FRA simulation. To accommodate this need, the HEC-WAT framework includes a distributed compute option. This distributed compute option allows the HEC-WAT software to distribute FRA computes across several compute nodes. The distributed compute option is available in Version 1.0 of HEC-WAT, if there is interest in using distributed FRA computes, please contact the Hydrologic Engineering Center.

There is a certain amount of setup required for distributed computing, one step is the creation of compute nodes where simulations will be performed. The "master" node needs to be able to find the defined compute nodes on a network. From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Simulation Compute Engine Manager**, the **Simulation Compute Engine Manager** will open (Figure B.30). HEC-WAT will automatically search the network to find the computed nodes, when done searching a number will appear in the **Nodes Present** box (Figure B.32)



**Figure B.32** Simulation Compute Engine Manager

## B.9 Compute Timings

This debugging tool allows the user to review the compute time of HEC-WAT simulations by the models alternatives that are being computed. The **DSS Timing Log** option (Section B.2.8) must be enabled, and a simulation needs to be computed with the timings option turned on.

From the HEC-WAT main window (Figure B.2), from the **Tools** menu, click **Compute Timings**, the **Simulation Compute Engine Manager** will open (Figure B.33). From the **Simulation** list (Figure B.33), select a simulation that has been computed. If the simulation has not been computed, a **No Timings** window (Figure B.34) will display letting the user know that there are no compute timings saved for the selected simulation.

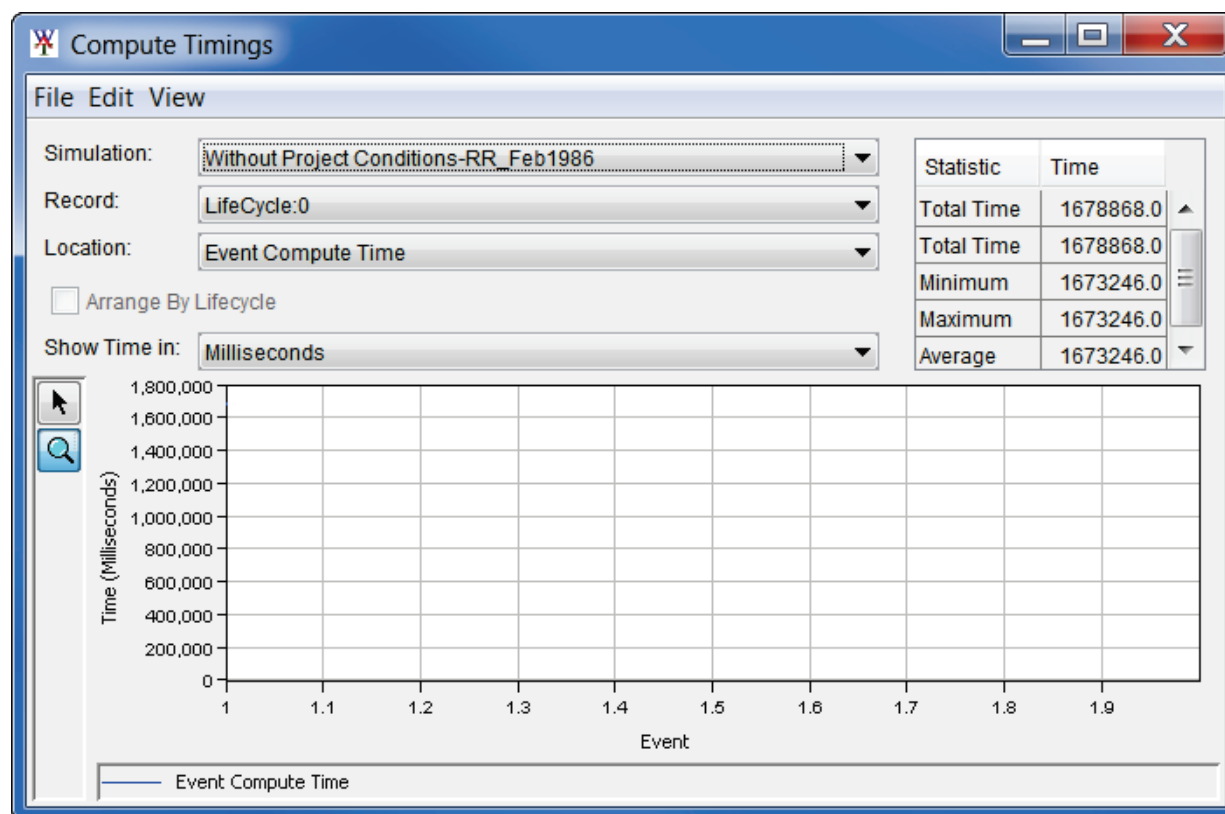


Figure B.33 Compute Timings Dialog Box

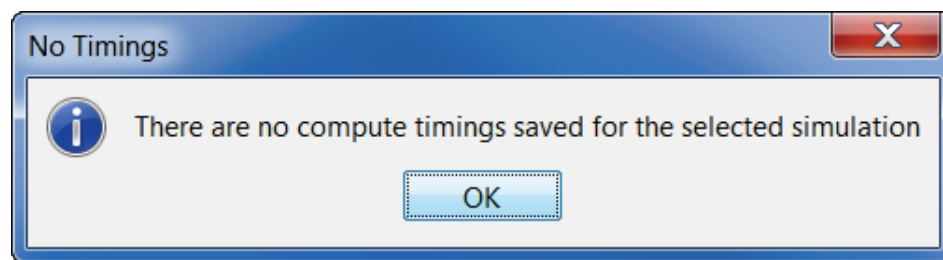
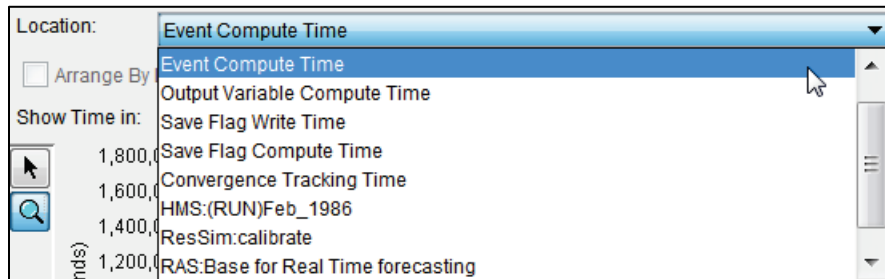


Figure B.34 No Timings Window

The **Record** list (Figure B.33) is used when the simulation is an FRA compute, the user can review timings by Lifecycle. From the **Location** list (Figure B.35), the user can select what compute timings to review. For example, in Figure B.32, the default is **Event Compute Time**, this provides the timings for the entries simulation. Those timings are displayed in the table in the upper right of the **Compute Timings** dialog box (Figure B.32).



**Figure B.35** Compute Timings Dialog Box – Location List

The example simulation (i.e., *Without Project Condition-RR\_Feb1986*) selected in Figure B.32 is a deterministic simulation. The only compute timings of interest would be the overall compute time of the simulation (**Event Compute Time**) and the times for the model alternatives that are part of the simulation. Therefore, if the user wishes to see the compute timing for the HMS model alternative, from the **Location** list (Figure B.35), the user would select **HMS:(RUN)Feb\_1986**. The table (Figure B.36), will change for the **Minimum**, **Maximum**, and **Average** timings.

Statistic	Time
Total Time	1678868.0
Minimum	10186.0
Maximum	10186.0
Average	10186.0

**Figure B.36** Compute Timings Dialog Box – Table

# Appendix C

## Setting Up the Coordinate System

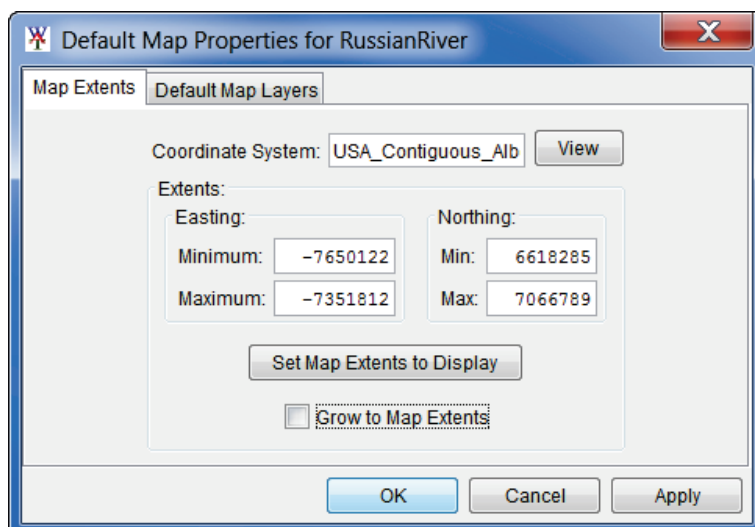
Map projections have been developed because the true image of places on earth would have to be a three-dimensional solid (spherical globes). Sets of mathematical models transform spherical coordinates (latitude, longitude) to planar coordinates in a map projection (X- and Y-coordinates). Data is then projected onto a flat plane (surface), where that data can be converted without stretching, and features will be referenced by a planar coordinate system. The x-coordinate is referred to as "easting" and the y-coordinate is referred to as "northing". The user can select the extent of this grid, the dimensions of the cells of the grid, the units of measurement of the grid, and even the location of the origin of the grid. Because of this flexibility, a user can specify and use virtually any grid coordinates convenient for water resources studies.

When creating a study, users are encouraged to set the coordinate system by selecting a map layer that is in the correct projection. Once that is done, the coordinate system cannot be changed. If the study does not have any available map layers in the correct coordinate system, the user at the time of creating a study can select a coordinate system and provide the information of that coordinate system. This appendix focuses on how to setup and edit different coordinate systems.

### C.1 Geographic Referencing

To maintain a geographic reference in a study and when a projection is established, a coordinate system is created for each HEC-WAT study which establishes the grid size:

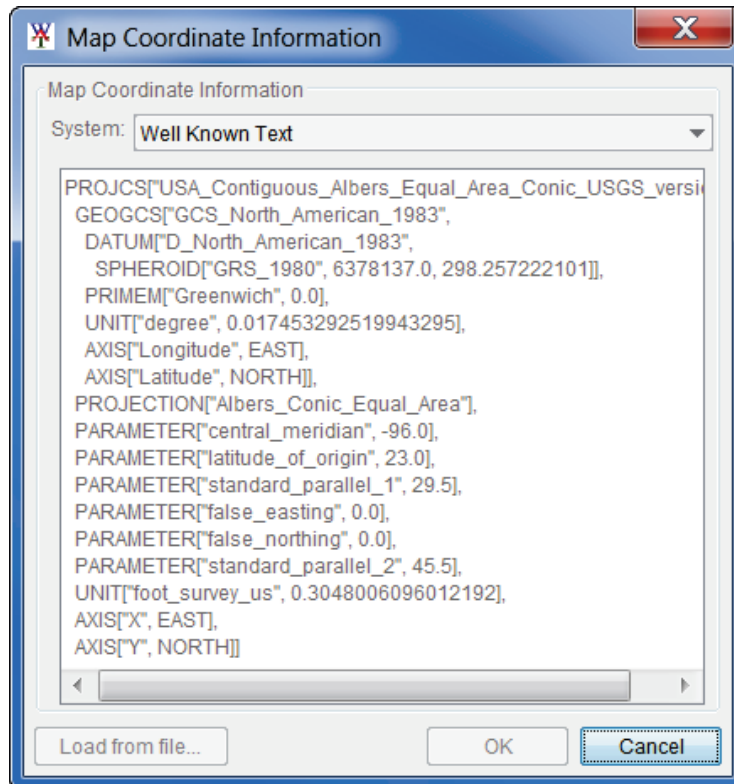
1. From the **Maps** menu, click **Default Map Properties**, the **Map Default Properties for StudyName** dialog box will open (Figure C.1). By default, the **Map Extents** tab is selected.



**Figure C.1** Map Default Properties for *StudyName* Dialog Box

2. The information in the **Map Extents** tab includes:

- **Coordinate System.** This box identifies the established coordinate system for a study. To view the coordinate system, click **View**, and the **Map Coordinate Information** dialog box (Figure C.2) will open.



**Figure C.2** Map Coordinate Information Dialog Box

- **Extents – Easting Minimum, Maximum, Northing Minimum, and Maximum.** These values (Figure C.1) indicate the location of the left, right, bottom and top borders (respectively) of the grid in the map window.
- **Grow to Map Extents.** When selected, HEC-WAT automatically sets the geographic extents to define the smallest rectangle that encompasses all the objects in the study.
- **Set Map Extents to Display.** This will set the limits of the map window. If the user zooms in on an area, and clicks **Set Map Extents to Display** (Figure C.1), the **Map Default Properties for StudyName** dialog box (Figure C.1) extents will change to the zoomed area.

Note that the geographic extents of map layers must be selected carefully to ensure that the entire study is included. Further, the extents specified and the coordinate system used must be consistent with the projection of the study.

## C.2 Coordinate System Types

A **coordinate system** is a method of representing points in a space of given dimensions by coordinates. There are several different types of coordinate systems; including geographic coordinate systems, which are based on latitude and longitude coordinates, and projected coordinate systems, which represent the projection of a geographic coordinate system on a plane and use linear measures (like feet or meters) for coordinates. The following list of coordinate systems is available in HEC-WAT.

- Google/Bing Web Mercator
- Geographic
- Universal Transverse Mercator
- State Plane Coordinates
- Albers Equal-Area Conic
- Lambert Conformal Conic
- Transverse Mercator
- Albers Equal-Area Conic (SHG)
- Polar Stereographic (HRAP)

### C.2.1 Google/Bing Web Mercator

Google/Bing Web Mercator (i.e., Web Mercator, Google Web Mercator, WGS 84 Web Mercator, etc.) is a variation of the Mercator projection and is the standard for web mapping applications. This system uses the same formulas as the standard Mercator systems, but uses the spherical formulas at all scales. Geographical coordinates are required to be in the WGS 84 ellipsoidal datum. Google/Bing Web Mercator does not quite conform due to the use of the ellipsoidal datum against a spherical projection. United States Department of the Defense does not encourage the use of this map projection in official capacity.

### C.2.2 Geographic Coordinate System

For the geographic coordinate system, the user can specify units and a spheroid type. To set parameters for the Geographic Coordinate System:

1. Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).
2. From the **System** list, select **Geographic**, the **Map Coordinate Information** dialog box (Figure C.4) will now display the data needed to setup a *Geographic* coordinate system for the study.
3. From the **Units** list (Figure C.4), select the units for the *Geographic* coordinate system. Available units are **Radians**, **Seconds of Arc**, and **Degrees of Arc**.

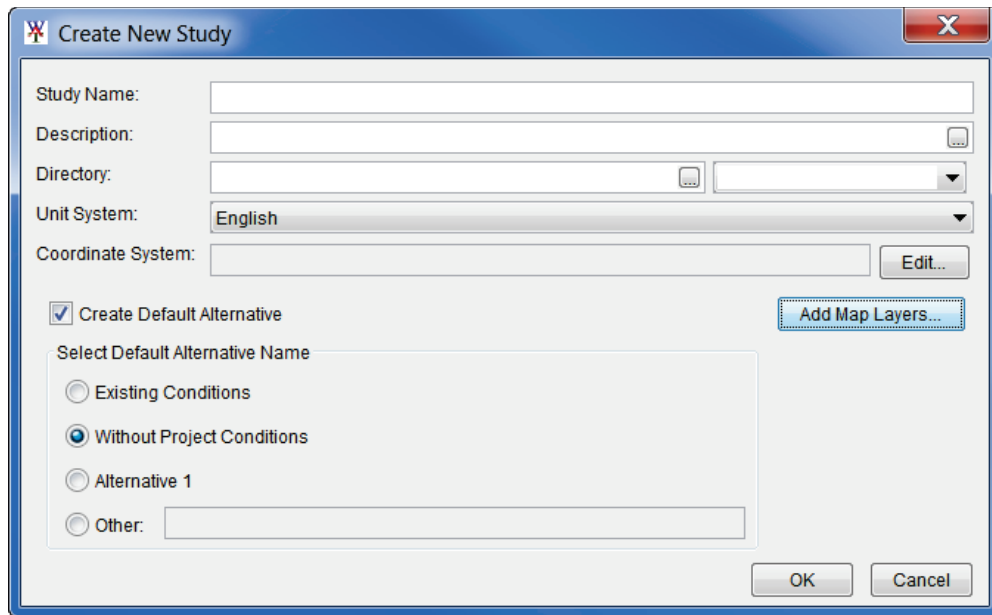


Figure C.3 Create New Study Dialog Box

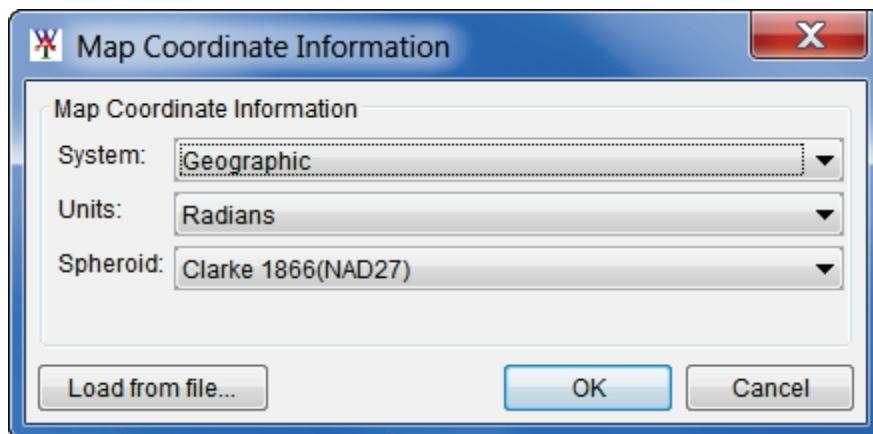


Figure C.4 Geographic Coordinate System

4. From the **Spheroid** list, select a spheroid type for the *Geographic* coordinate system.
5. Click **OK**, the **Map Coordinate Information** dialog box (Figure C.4) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *Geographic* will be displayed.

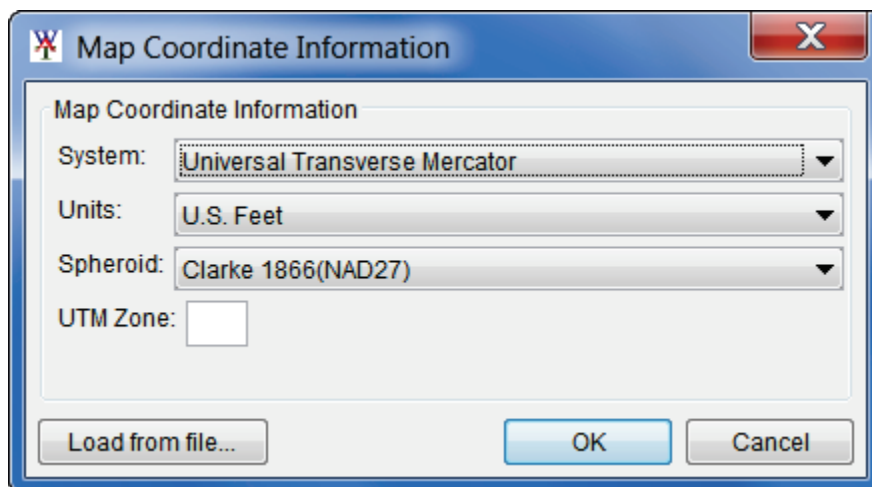
### C.2.3 Universal Transverse Mercator Coordinate System

The Universal Transverse Mercator (UTM) coordinate system is a projection coordinate system. UTM is used to define horizontal positions throughout the world by dividing the surface of the Earth into six-degree zones, with a central meridian in the center of each zone.

To set parameters for the Universal Transverse Mercator Coordinate System:



1. Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).
2. From the **System** list, select **Universal Transverse Mercator**, the **Map Coordinate Information** dialog box (Figure C.5) will now display the data needed to setup a *Universal Transverse Mercator* coordinate system for the study.



**Figure C.5** Universal Transverse Mercator Coordinate System

3. From the **Units** list (Figure C.5), select the units for the *Universal Transverse Mercator* coordinate system.
4. From the **Spheroid** list (Figure C.5), select a spheroid type for the *Universal Transverse Mercator* coordinate system.
5. In the **UTM Zone** box (Figure C.5), enter the UTM zone number.
6. Click **OK**, the **Map Coordinate Information** dialog box (Figure C.5) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *Universal Transverse Mercator* will be displayed.

## C.2.4 State Plane Coordinate System

The State Plane Coordinate System (SPCS) was established in the 1930's and now covers all fifty states. Zones were established for each state using either the Lambert Conformal or Traverse Mercator projections. Units are generally in feet (NAD27) or meters (NAD83).

To set parameters for the State Plane Coordinate System:

1. Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).

- From the **System** list, select **State Plane Coordinates**, the **Map Coordinate Information** dialog box (Figure C.6) will now display the data needed to setup a *State Plane* coordinate system for the study.

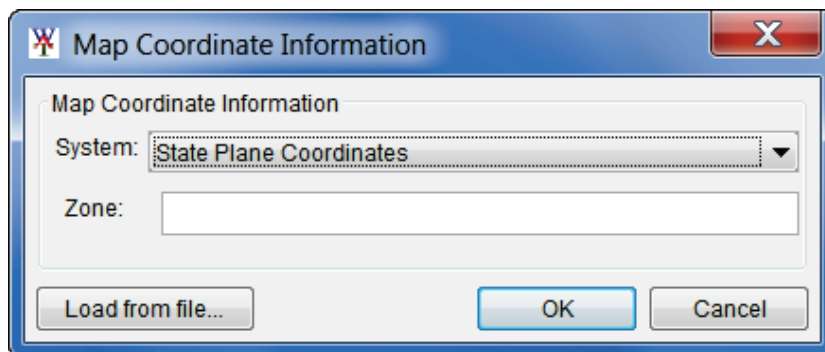


Figure C.6 State Plane Coordinate System

- In the **Zone** box (Figure C.6), enter the zone for the state (FIPS codes).
- Click **OK**, the **Map Coordinate Information** dialog box (Figure C.6) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *State Plane Coordinates* will be displayed.

## C.2.5 Albers Equal-Area Conic Coordinate System

The Albers Equal-Area Conic projection was established for mapping large countries like the United States. The projection is an equivalent projection, where areas are proportional and directions are true in limited areas.

To set parameters for the Albers Equal-Area Conic Coordinate System:

- Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).
- From the **System** list, select **Albers Equal-Area Conic**, the **Map Coordinate Information** dialog box (Figure C.7) will now display the data needed to setup an *Albers Equal-Area Conic* coordinate system for the study.
- From the **Units** list (Figure C.7), select the units for the *Albers Equal-Area Conic* coordinate system.
- From the **Spheroid** list (Figure C.7), select a spheroid type for the *Albers Equal-Area Conic* coordinate system.
- The remaining items (Figure C.7) to be entered are the angular parameters that are required to fine-tune the projection. When specifying latitudes the user will enter N or S, and for longitudes, enter E or W. Use the **SPACEBAR** to toggle between the entries.

**Figure C.7** Albers Equal-Area Conic Coordinate System

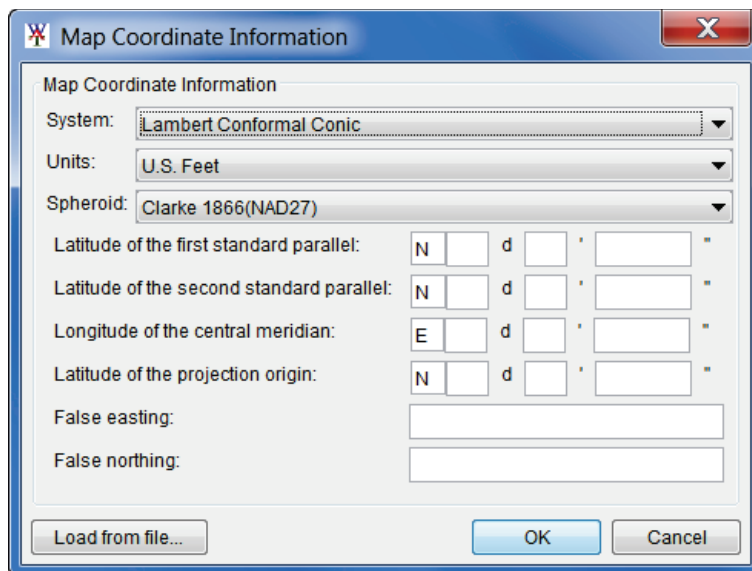
- Click **OK**, the **Map Coordinate Information** dialog box (Figure C.7) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *Albers Equal-Area Conic* will be displayed.

## C.2.6 Lambert Conformal Conic Coordinate System

The Lambert Conformal Conic projection is used extensively for mapping areas of the world with predominantly east-west orientation. Similar to the Albers Equal-Conic projection, however the projection is not done in an equal-area.

To set parameters for the Lambert Conformal Conic Coordinate System:

- Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).
- From the **System** list, select **Lambert Conformal Conic**, the **Map Coordinate Information** dialog box (Figure C.8) will now display the data needed to setup a *Lambert Conformal Conic* coordinate system for the study.
- From the **Units** list, select the units for the *Lambert Conformal Conic* coordinate system.
- From the **Spheroid** list (Figure C.8), select a spheroid type for the *Lambert Conformal Conic* coordinate system.



**Figure C.8** Lambert Conformal Conic Coordinate System

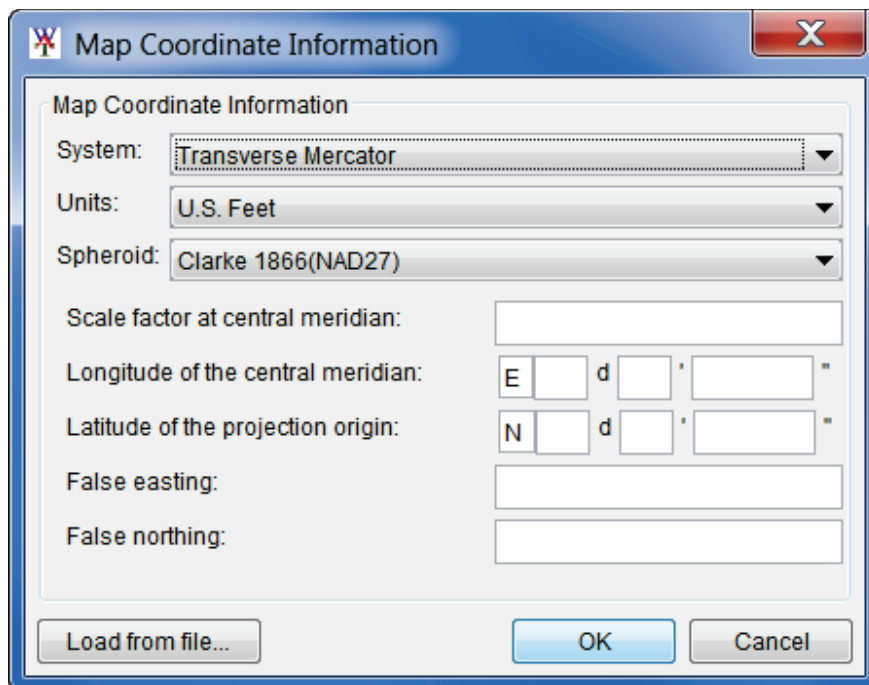
5. When specifying latitudes the user will enter **N** or **S**, and for longitudes, enter **E** or **W**. Use the **SPACEBAR** to toggle between the entries.
6. Click **OK**, the **Map Coordinate Information** dialog box (Figure C.7) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *Lambert Conformal Conic* will be displayed.

## C.2.7 Transverse Mercator Coordinate System

The Transverse Mercator projection is when a sphere is projected onto a cylinder tangent to a central meridian. This projection is similar to the Lambert Conformal Conic projection, but used to portray large areas in a north-south orientation. Many national grid systems are based on the Transverse Mercator projection.

To set parameters for the Transverse Mercator Coordinate System:

1. Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).
2. From the **System** list, select **Transverse Mercator**, the **Map Coordinate Information** dialog box (Figure C.9) will now display the data needed to setup a *Transverse Mercator* coordinate system for the study.
3. From the **Units** list (Figure C.9), select the units for the *Transverse Mercator* coordinate system.
4. From the **Spheroid** list (Figure C.9), select a spheroid type for the *Transverse Mercator* coordinate system.



**Figure C.9** Transverse Mercator Coordinate System

5. Enter a scaling factor for central meridian, in the **Scale factor at central meridian** box (Figure C.9).
6. When specifying latitudes the user will enter **N** or **S**, and for longitudes, enter **E** or **W**. Use the **SPACEBAR** to toggle between the entries.
7. Click **OK**, the **Map Coordinate Information** dialog box (Figure C.9) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *Transverse Mercator* will be displayed.

## C.2.8 Albers Equal-Area Conic (SHG) Coordinate System

The Standard Hydrologic Grid, or SHG version of the Albers Equal-Area Conic coordinate system. The parameters are set to match USACE map coordinates for SHG, so do not change any parameter settings.

To view the parameters for the Albers Equal-Area Conic (SHG) Coordinate System:

1. Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).
2. From the **System** list, select **Albers Equal-Area Conic (SHG)**, the **Map Coordinate Information** dialog box (Figure C.10) will now display the data needed to setup an *Albers Equal-Area Conic (SHG)* coordinate system for the study.

- From the **Units** list (Figure C.10), select the units for the *Albers Equal-Area Conic (SHG)* coordinate system.

**Figure C.10** Albers Equal-Area Conic (SHG) Coordinate System

- From the **Spheroid** list (Figure C.10), select a spheroid type for the *Albers Equal-Area Conic (SHG)* coordinate system.
- The remaining parameters are informational and are not editable.
- Click **OK**, the **Map Coordinate Information** dialog box (Figure C.9) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *Albers Equal-Area Conic (SHG)* will be displayed.

## C.2.9 Polar Stereographic (HRAP) Coordinate System

The Hydrologic Rainfall Analysis Project (HRAP) grid was designed by the National Weather Service (NWS) for use with NEXRAD radar precipitation data. The Polar Stereographic (HRAP) is used for navigation in polar regions. The parameters are set to match NWS map coordinates used for radar grids, so do not change any parameter settings.

To view the parameters for the Polar Stereographic (HRAP) Coordinate System:

- Create a new study (Chapter 4, Section 4.1.1), from the **Create New Study** dialog box (Figure C.3), click **Edit** (by the **Coordinate System** box), the **Map Coordinate Information** dialog box will open (Figure C.2).

- From the **System** list, select **Polar Stereographic (HRAP)**, the **Map Coordinate Information** dialog box (Figure C.11) will now display the data needed to setup a *Polar Stereographic (HRAP)* coordinate system for the study.

**Figure C.11** Polar Stereographic (HRAP) Coordinate System

- From the **Units** list, select the units for the *Polar Stereographic (HRAP)* coordinate system.
- From the **Spheroid** list (Figure C.11), select a spheroid type for the *Polar Stereographic (HRAP)* coordinate system.
- From the **Axis** box the user can edit the axes information for either the **Semi-major** or the **Semi-minor** axes.
- The remaining parameters are informational and are not editable.
- Click **OK**, the **Map Coordinate Information** dialog box (Figure C.11) will close, and the user will be returned to the **Create New Study** dialog box (Figure C.3). In the **Coordinate System** box, *Polar Stereographic (HRAP)* will be displayed.

## C.3 Well Known Text

Well Known Text (WKT) is an Open Geospatial Consortium (OGC) standard that provides a textual description of a geographic coordinate reference system. Allows the user the flexibility to copy a coordinate reference description that is not included in HEC-WAT. Descriptions of WKT can be found on the Internet.





# Appendix D

## Using Map Editors

There are seven map layers supported by HEC-WAT. The different map layers are described in Chapter 5, Section 5.2.1 of this user's manual. In HEC-WAT the user can configure several options for each type of map layer, except for AutoCAD® DXF files; additional customization is under development for future versions of the software.

The user can access the map layer editors, from the **Maps Tab** (Chapter 3, Section 3.2), which provides a view of the active map window in the **Desktop Pane** (Chapter 3, Section 3.1). From the **Content Pane** (Figure D.1), either double-click on a map layer name, or right-click, and from the shortcut menu click **Properties**. An editor specific to the type of map layer selected will open.

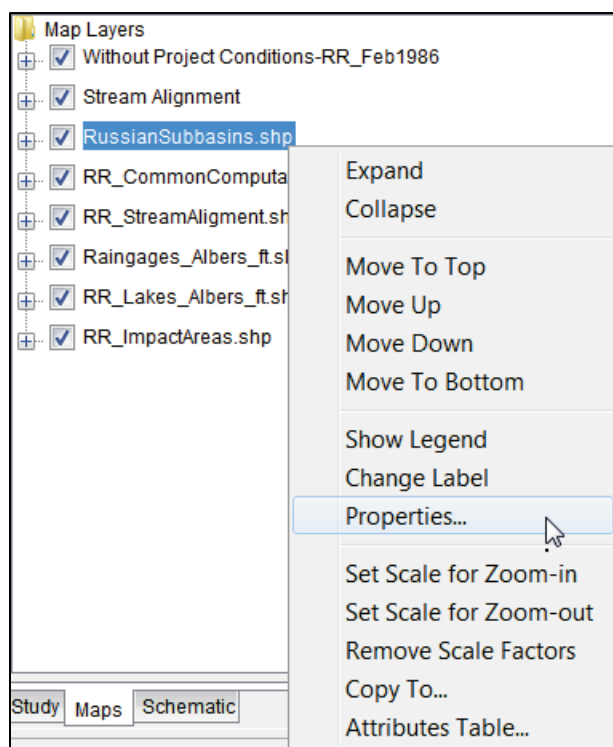


Figure D.1 Maps Tab – Content Pane

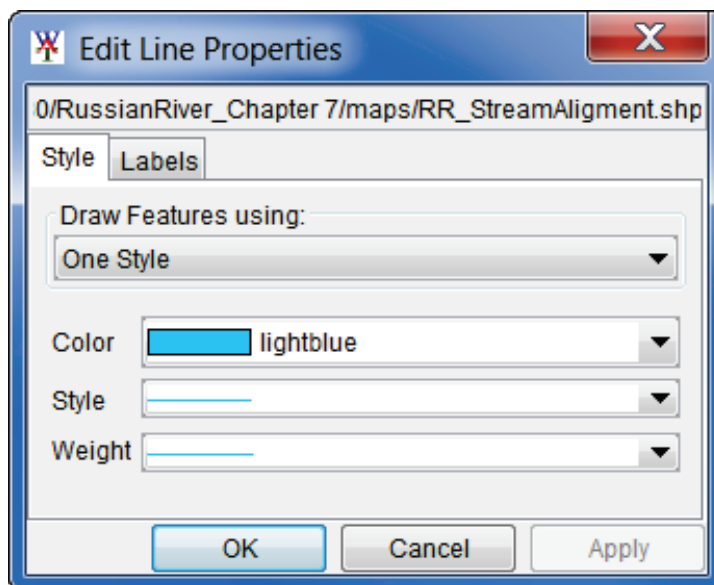
### D.1 Shapefiles (.shp)

Shapefiles store non-topological geometry and attribute information for the spatial features of a data set. There are three kinds of shapefiles: line, polygon, and point. The following sections discuss examples of line and polygon shapefiles.

## D.1.1 Line

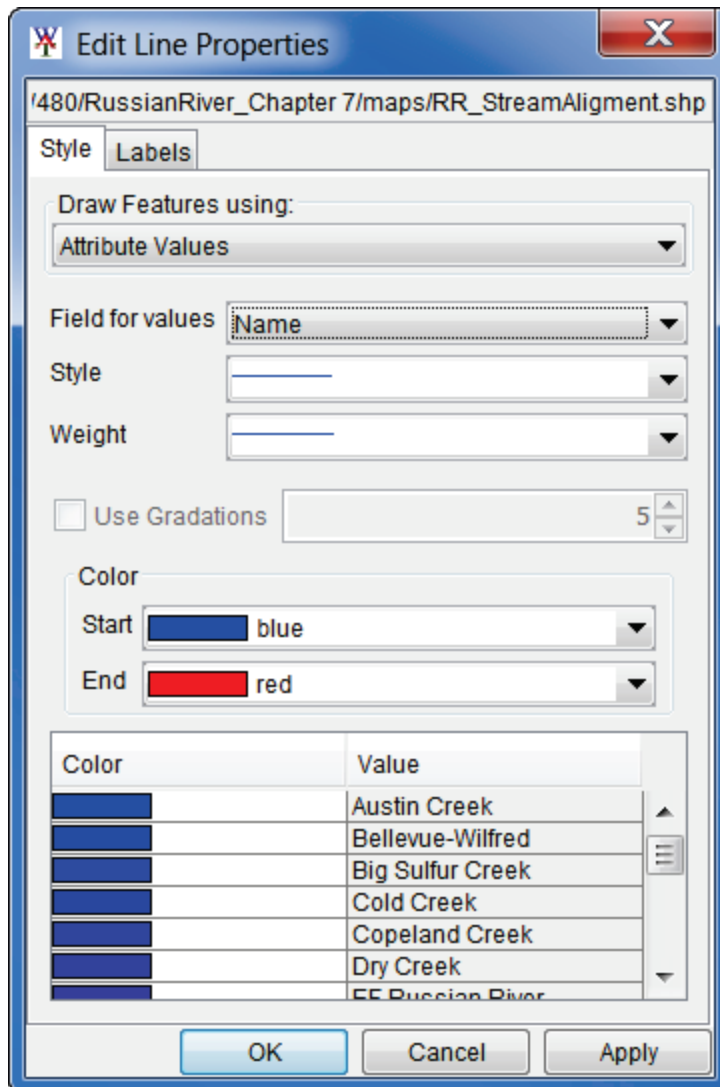
To edit a line shapefile:

1. With an active map window displayed in the **Desktop Pane**, from the **Maps Tab**, from the **Content Pane** (Figure D.1), right-click on a shapefile that the user knows is a line shapefile. From the shortcut menu click **Properties** or double-click on the shapefile filename. For example, in Figure D.1, from the **Map Layers** tree, the user right-clicked on *RR\_StreamAlignment.shp* which is a line shapefile.
2. The **Edit Line Properties** dialog box (Figure D.2) will open.



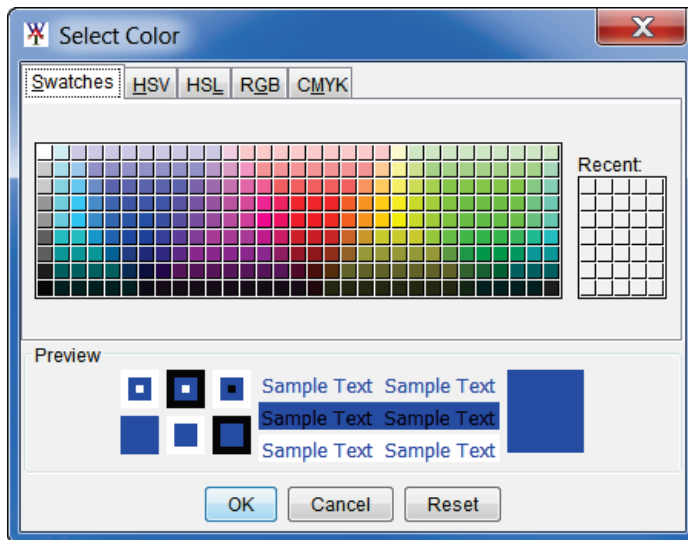
**Figure D.2** Edit Line Properties Dialog Box

3. By default the **Style Tab** is selected. Also, by default, all the shapes (lines) in a line Arc Shapefile are set to one color, style, and weight. From the **Draw Features using** list (Figure D.2), this default is **One Style**. The user can change the color of the shapes from the **Color** list; change the style of shapes from the **Style** list; and, change the weight of the shapes from the **Weight** list (Figure D.2).
4. A shapefile has three files associated with it, which contain shape information, attributes, and an index that links a shape to its attributes. If the user wishes to change the individual shapes (lines) contained in a shapefile by attribute, from the **Draw Features using** list, select **Attribute Values**. The **Edit Lines Properties** dialog box now displays (Figure D.3) the items the user can edit for individual shapes by attribute.
5. To select the attribute the user wishes to change, the user must have some knowledge of the Arc Shapefile and its attributes. For example, in Figure D.3, for the *RR\_StreamAlignment.shp* file, from the **Field for values** list (Figure D.3), the attribute *Name* has been selected. This provides the user with the shapes by stream name, which are displayed in the table below the **Color** box (Figure D.3).



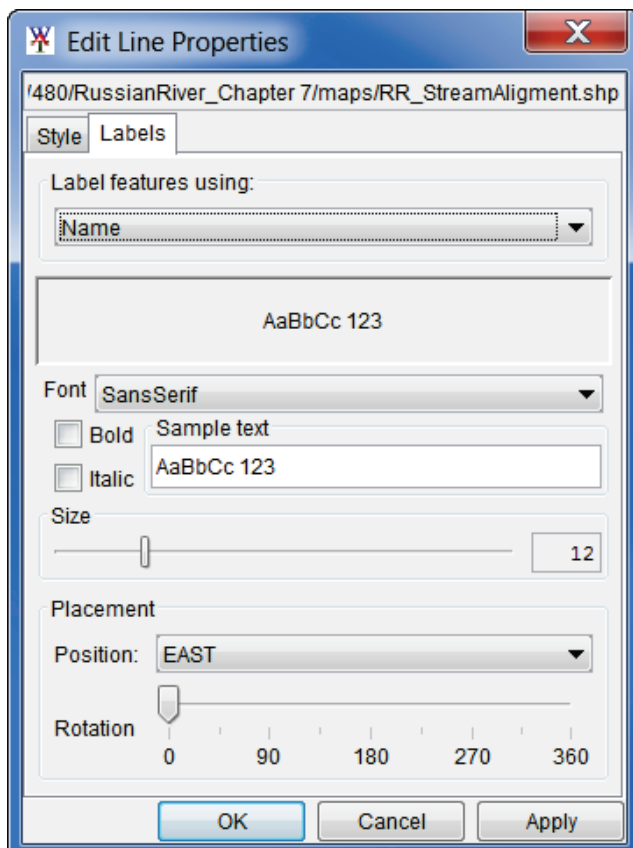
**Figure D.3** Edit Line Properties Dialog Box – Attribute Values

6. For the selected attribute the user can change the style of the shapes from the **Style** list (Figure D.3), and change the weight of the shapes from the **Weight** list.
7. From the **Color** box (Figure D.3), the user can set a range of colors for all the shapes displayed in the table below the **Color** box (Figure D.3).
8. To change the colors of the individual shapes, from the table, in the **Color** column, double-click on a color square. The **Select Color** dialog box (Figure D.4) will open.
9. The properties of the **Select Color** dialog box are similar to the **Color Chooser** (Appendix E). From the color palette, select a color, click **OK**. The **Select Color** dialog box (Figure D.4) will close.
10. From the **Edit Line Properties** dialog box (Figure D.3), click **Apply**, the shape associated with the color square that was selected, will now display the new color in the active **Map Window** on the **Desktop Pane**.



**Figure D.4** Select Color Dialog Box

11. Associated with each shape (line) is a label, to edit the label properties, from the **Edit Line Properties** dialog box (Figure D.3) select the **Labels** tab (Figure D.5).
12. By default, the label for the shapes is turned off (<None>), if the user wishes to display the label, from the **Label features using** list (Figure D.5) select the attribute that contains the information that is to be displayed.



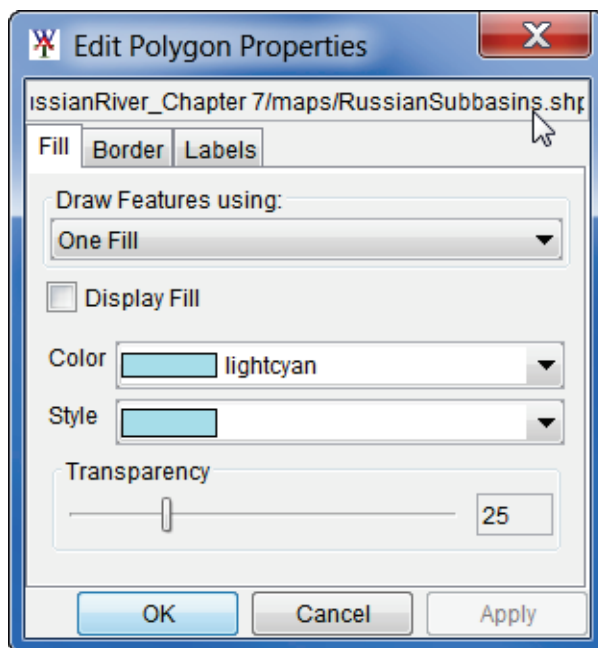
**Figure D.5** Edit Line Properties Dialog Box – Labels Tab

13. For labels, the user can select what font to use; styles like bold or italics; select the size and position; and, rotate the labels.
14. From the **Edit Line Properties** dialog box (Figure D.5), click **Apply**, the labels for the shapes (lines) will now display in the active **Map Window** on the **Desktop Pane**.
15. Once the user is finished with making changes, click **OK**, the **Edit Line Properties** dialog box (Figure D.5) will close.
16. If the user wishes to save any changes made to the selected shapefile, from the **File** menu, click **Save Study**. Changes are saved to a file with the extension *.gdr*. For this example, the selected shapefile name was *RR\_StreamAlignment.shp*, if changes were made and saved, a file *RR\_StreamAlignment.gdr* will be created.

## D.1.2 Polygon

To edit a polygon shapefile:

1. With an active map window displayed in the **Desktop Pane**, from the **Maps Tab**, from the **Content Pane** (Figure D.1), right-click on a shapefile that the user knows is a polygon shapefile. From the shortcut menu click **Properties** or double-click on the shapefile filename. For example, in Figure D.1, the user would right-click on *RussianSubbasins.shp* which is a polygon shapefile.
2. The **Edit Polygon Properties** dialog box (Figure D.6) will open.

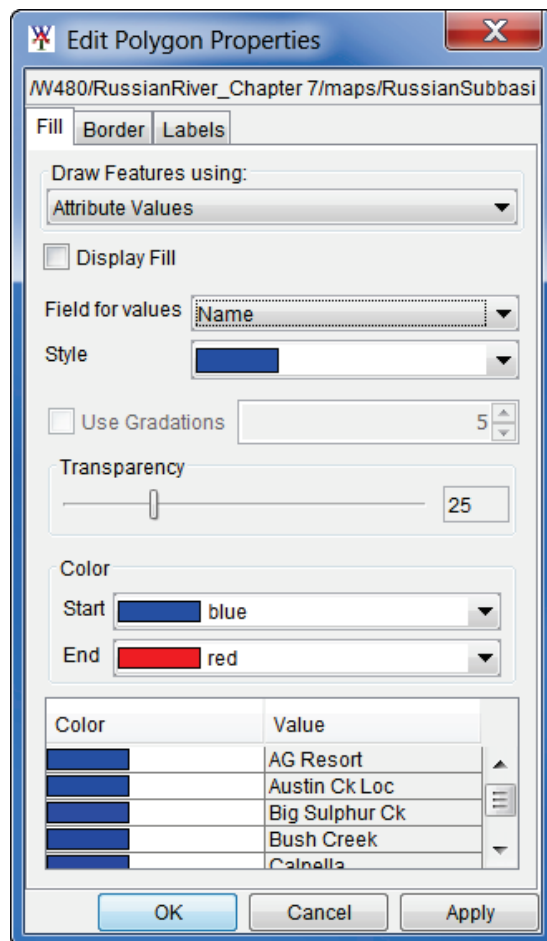


**Figure D.6** Edit Polygon Properties Dialog Box

3. By default the **Fill Tab** is selected. Also, by default, all the shapes (polygons) in a polygon shapefile are set to one color, style, and weight. From the **Draw Features using**

list, this default is **One Fill**, with **Display Fill** (Figure D.6) set. The user can turn on and off the filling of the shapes (polygons) by selecting and un-selecting **Display Fill**; change the color of the shapes from the **Color** list (Figure D.6); change the style of shapes from the **Style** list; and, change the transparency of the shapes from the **Transparency** slider (Figure D.6).

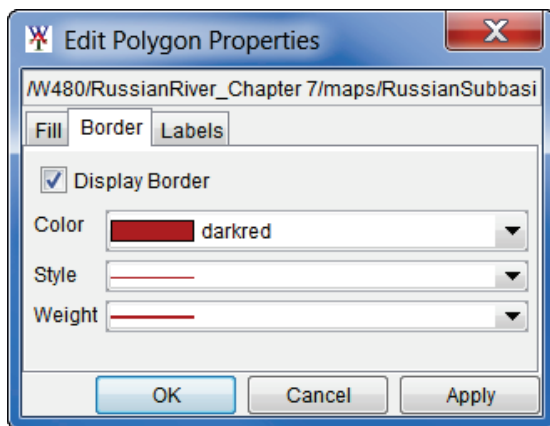
4. A shapefile has three files associated with it, which contain shape information, attributes, and an index that links a shape to its attributes. If the user wishes to change the individual shapes (polygons) contained in an Arc Shapefile by attribute, from the **Draw Features using** list, select **Attribute Values**. The **Edit Polygon Properties** dialog box now displays (Figure D.7) the items user can edit for individual shapes by attribute.



**Figure D.7** Edit Polygon Properties Dialog Box – Attribute Values

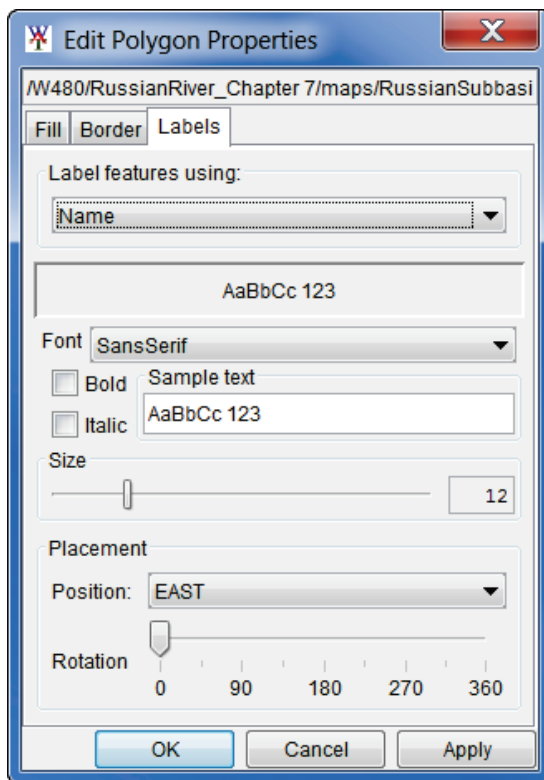
5. To select the attribute you wish to change, the user must have some knowledge of the shapefile and its attributes. For example, in Figure D.7, for the *RussianSubbasins.shp* file, the attribute *Name* has been selected from the **Field for values** list. This provides the user with the shapes by subbasin name, which are displayed in the table below the **Color** box (Figure D.7).
6. For the selected attribute the user can change the style of the shapes from the **Style** list (Figure D.7), and change the weight of the shapes from the **Weight** list (Figure D.7).

7. From the **Color** box, the user can set a range of colors for all the shapes displayed in the table (Figure D.7) below the **Color** box.
8. To change the colors of the individual shapes, from the table, in the **Color** column, double-click on the color square. The **Select Color** dialog box (Figure D.4) will open.
9. The properties of the **Select Color** dialog box are similar to the **Color Chooser** (Appendix E). From the color palette, select a color, click **OK**. The **Select Color** dialog box will close (Figure D.4).
10. From the **Edit Line Properties** dialog box (Figure D.7), click **Apply**, the shape associated with the color square selected, will now display the new color in the active **Map Window** on the **Desktop Pane**.
11. Associated with each shape (polygon) is a border, to edit border properties, from the **Edit Polygon Properties** dialog box (Figure D.7) select the **Border Tab** (Figure D.8).



**Figure D.8** Edit Polygon Properties Dialog Box – Border Tab

12. By default, the border for the shapes is turned on. If the user does not want the border to display, click **Display Border** (Figure D.8). The user can change the color of the shapes from the **Color** list; change the style of shapes from the **Style** list (Figure D.8); and, change the weight of the shapes from the **Weight** list (Figure D.8).
13. Associated with each shape (polygon) is a label. To edit the label properties, from the **Edit Polygon Properties** dialog box (Figure D.7) select the **Labels Tab** (Figure D.9).
14. By default, the labels for the shapes is turned off (<None>), if the user wishes to display the labels from the **Label features using** list (Figure D.9) select the attribute that contains the information that will be displayed.
15. For labels, the user can select what font to use; styles like bold or italics; select the size and position; and, rotate the labels.
16. From the **Edit Polygon Properties** dialog box (Figure D.9), click **Apply**, the labels for the shapes (lines) will now display in the active **Map Window** on the **Desktop Pane**.



**Figure D.9** Edit Polygon Properties Dialog Box – Labels Tab

17. Once the user is finished with making changes, click **OK**, the **Edit Polygon Properties** dialog box (Figure D.9) will close.
18. If the user wishes to save any changes made to the selected shapefile, from the **File** menu, click **Save Study**. Changes are saved to a file with the extension *.gdr*. For example, in Figure D.1, the shapefile name is *RussianSubbasins.shp*, if changes have been made and saved, a file *RussianSubbasins.gdr* will be created.

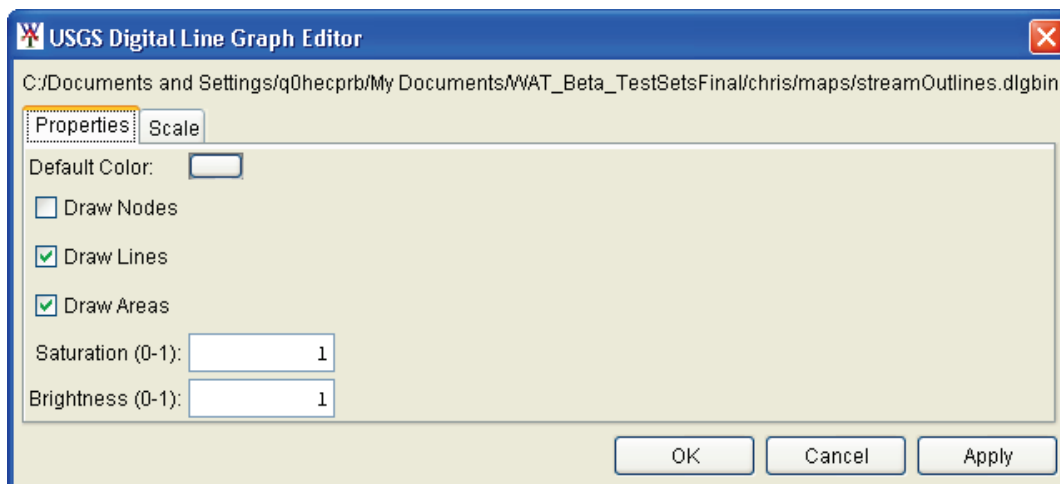
## D.2 USGS Digital Line Graph (.dlg)

This layer type is a vector representation of the data. When HEC-WAT interacts with a *dlg* file it automatically creates a *dlgbin* file for use.

To edit a USGS Digital Line Graph file:

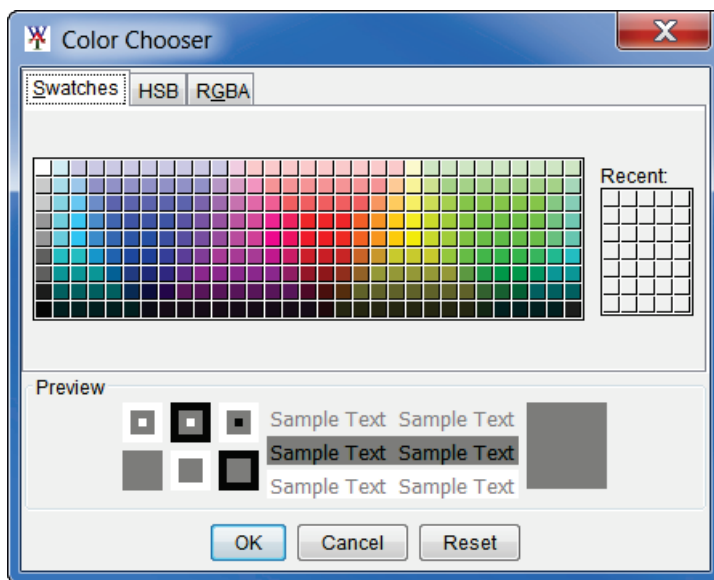
1. From the **Maps** tab, from the **Content Pane**, right-click on a USGS Digital Line Graph file. From the shortcut menu, click **Properties**, or double-click on the USGS Digital Line Graph filename.
2. The **USGS Digital Line Graph Editor** (Figure D.10) will open.
3. Across the top of the dialog box, is displayed the location and name of the USGS Digital Line Graph file.





**Figure D.10** USGS Digital Line Graph Editor

4. To change the color of the lines of the *dlg* file, click the color box. The **Color Chooser** dialog box will open (Figure D.11).



**Figure D.11** Color Chooser

5. The properties of the **Color Chooser** are discussed in detail in Appendix E. From the color palette, select a color, click **OK**. The **Color Chooser** will close (Figure D.11) and the selected color will now appear in the color box.
6. Click **Apply**, the color change will appear on the **Map Window** in the **Desktop Pane**.
7. The user can control the appearance of nodes, lines, and areas by selecting and clearing **Draw Nodes**, **Draw Lines**, and **Draw Areas**, respectively.
8. The user can also control the saturation and brightness level of the selected color by entering values in the **Saturation** or **Brightness** boxes. Values entered for saturation or brightness must be between zero (0) and one (1).

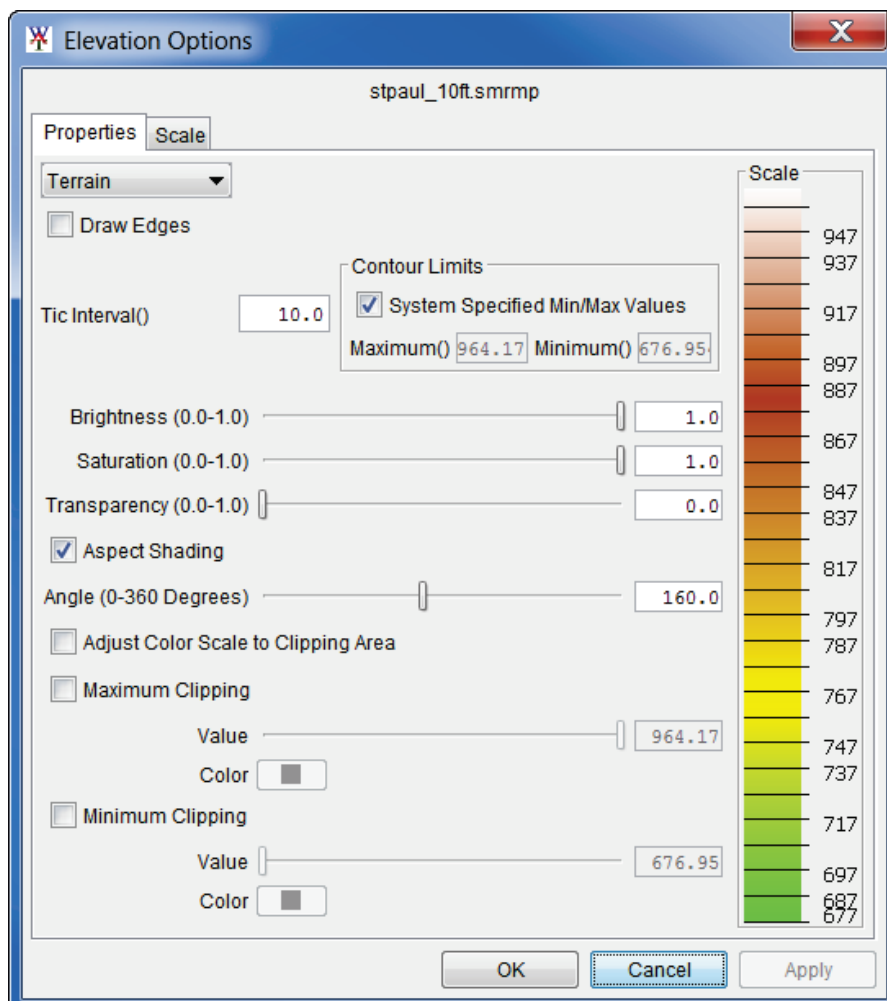
9. Once the user is finished with changes, click **OK**, the **USGS Digital Line Graph Editor** (Figure D.10) will close.
10. If the user wishes to save any changes made to the selected USGS digital line graph, from the **File** menu, click **Save Study**, changes are saved to the study file (\*.sty).

### D.3 Elevation Options Dialog Box

For the other map layer formats – USGS DEM, ASCII NetTin, SMRMP, and ArcInfo® DEM; they all have the same editor, the **Elevation Options** dialog box.

To edit a SMRMP file:

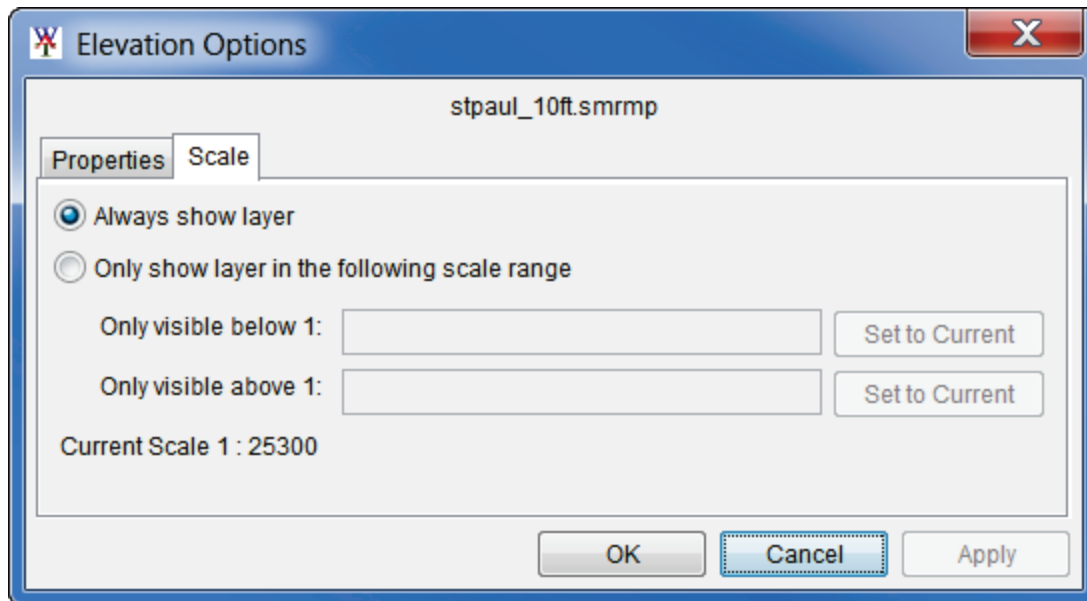
1. From the **Maps** tab, from the **Content Pane**, right-click on a SMRMP file. From the shortcut menu, click **Properties**, or double-click on the SMRMP name.
2. The **Elevation Options** dialog box (Figure D.12) will open with the **Properties Tab** selected by default.



**Figure D.12** Elevation Options Dialog Box

3. Across the top of the **Elevation Options** dialog box (Figure D.12), is displayed the name of the SMRMP file. For example, in Figure D.12, the name is *stpaul\_10ft.smrmp*.
4. From the list box, there are available color contour schemes – **Aspect Shading**, **Grayscale**, **Linear**, **Precipitation**, **Red-Green-Blue**, **Terrain** (default), and **Water Depth**.
5. The **Draw Edges** check box (Figure D.12) is specifically for ASCII NetTin files. If **Draw Edges** is selected, the edges of the triangles that make up an ASCII NetTin file will be drawn.
6. The user can set the contour tic interval, by entering a value in the **Tic Interval** box (Figure D.12). HEC-WAT sets the maximum and minimum limits of the contours automatically. The user can set maximum and minimum limits, from the **Contour Limits** box (Figure D.12), clear **System Specified Min/Max Values**. The **Maximum** and **Minimum** boxes are now available for the user to enter values.
7. The user can control the brightness (amount of white), saturation (amount of black), and transparency (level of opacity or alpha) for the colors. Also, the user can adjust the values by using the **Brightness**, **Saturation**, and **Transparency** slider bars or boxes (Figure D.12).
8. By default the **Aspect Shading** option (Figure D.12) is on, aspect shading is where the user can make the map layer appear in relief by placing an imaginary light source above the map and shading the contours. The user can adjust the angle of the light source by using the **Angle** slider bar or the box (Figure D.12). If the user does not want aspect shading, clear **Aspect Shading**.
9. Clipping provides a way to highlight an area based on color choices and values. For maximum clipping, the user would fill the contour with the clip color from the maximum value of the map to the value entered for **Maximum Clipping** (Figure D.12). An example of where the user might use maximum clipping would be smog levels, cloud cover, or snow level at a particular elevation. By default, maximum clipping is turned off, to turn this option on, click **Maximum Clipping** (Figure D.12). The user can either enter a maximum clipping value by using the slider bar or entering a value in the box (Figure D.12). The user can change the color by clicking the **Color** box (Figure D.12), a **Color Chooser** will open (Figure D.11).
10. Minimum clipping will fill the contour with the clip color from the minimum value of the map to the value entered for **Minimum Clipping**. An example of where the user might use minimum clipping would be to see where a water level would be if it flooded to a particular elevation. By default, minimum clipping is turned off. To turn this option on, click **Minimum Clipping** (Figure D.12). The user can either enter a minimum clipping value by using the slider bar or entering a value in the box (Figure D.12). The user can change the color by clicking the **Color** box (Figure D.12), a **Color Chooser** will open (Figure D.11).

11. Scaling for the SMRMP file can be set from the **Scale Tab** on the **Elevation Options** dialog box (Figure D.13).



**Figure D.13** Elevation Options Dialog Box – Scale Tab

12. If the user wishes to save any changes made to the selected SMRMP, from the **File** menu, click **Save Study**, changes are saved to the study file (\*.sty).

# Appendix E

## Using the Color Chooser

The **Color Chooser** (Figure E.1) affords great flexibility when the user needs to select default colors for map layers, labels, and background colors for the watershed display. The **Color Chooser** has three tabs: **Swatches**, **HSB**, and **RGB**, offering three methods for choosing a color. For each method, the preview area allows the user to see the choices made before applying changes.

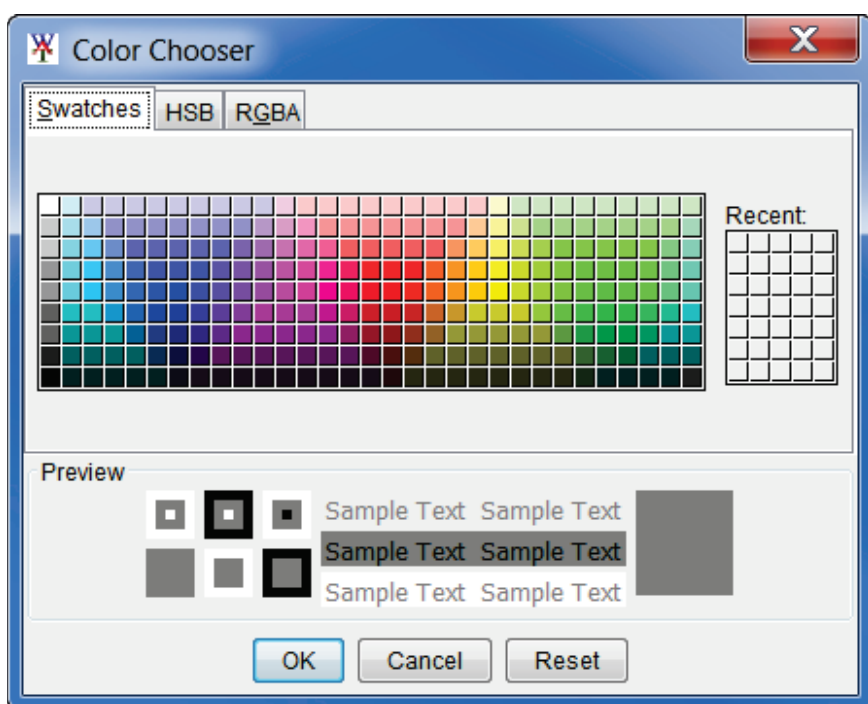


Figure E.1 Color Chooser

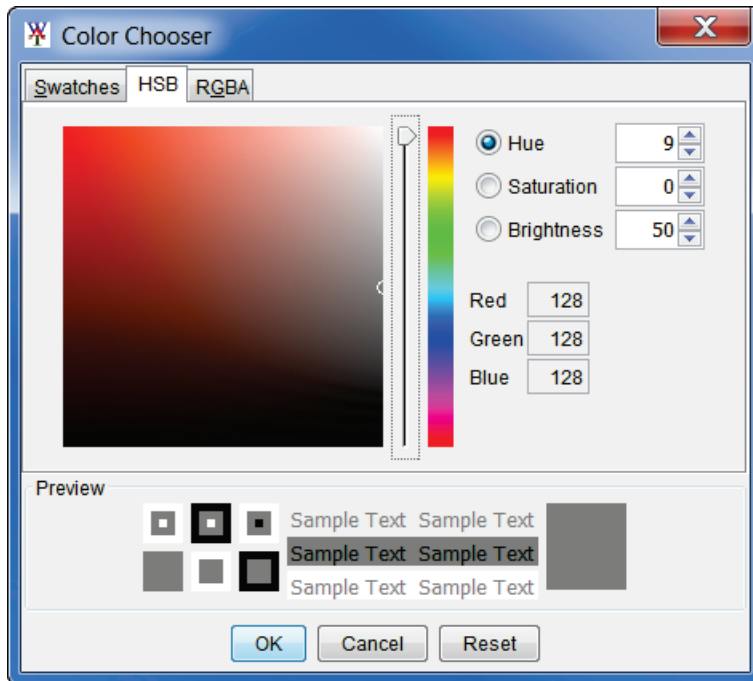
### E.1 Swatches Worksheet

The **Swatches** worksheet provides a palette of pre-defined colors. From the palette, select a color. Once a color has been selected, the **Recent** box displays that color, as also does the **Preview** box. Click **OK**, the **Color Chooser** will close. Depending on where the **Color Chooser** was accessed, the user will need to click either **Apply** or **OK** for the color change to appear in the map window.

For example, for a USGS Digital Line Graph, the user would have accessed the **Color Chooser** from the **USGS Digital Line Graph Editor** (Appendix D, Section D.2). Once a color has been selected from the **Color Chooser** (Figure E.1) and closed, then the user needs to click **OK** or **Apply** from the **USGS Digital Line Graph Editor** for the color change to appear in the map window.

## E.2 HSB Worksheet

**HSB** is the Hue, Saturation, and Brightness color model, which allows the user to set the hue, saturation, and brightness of the colors. From the **Color Chooser**, select the **HSB** tab; the **HSB Worksheet** (Figure E.2) becomes available.



**Figure E.2** Color Chooser – HSB Worksheet

There are several ways to adjust the hue, saturation, and brightness of the colors. The slider bar in conjunction with the **H**, **S**, and **B** options will change the color, if *red* is selected with the **Hue** option selected, then when the user switches to the **Saturation** and **Brightness** options, the slider bar will be changing the saturation and brightness of the selected color (i.e., *red*). Another way to affect the colors is in the **Hues**, **Saturation**, and **Brightness** boxes the user can directly enter a value for hue, saturation, and brightness. The following rules apply when entering values for each option:

**Hue Box:** Hue is measured in a circle from zero (0) to 359 degrees.  
0 = red, 60 = yellow, 120 = green, 180 = cyan  
240 = blue, 300 = magenta

**Saturation Box:** Saturation is the amount of black, measured from zero (0) to one hundred (100) percent.

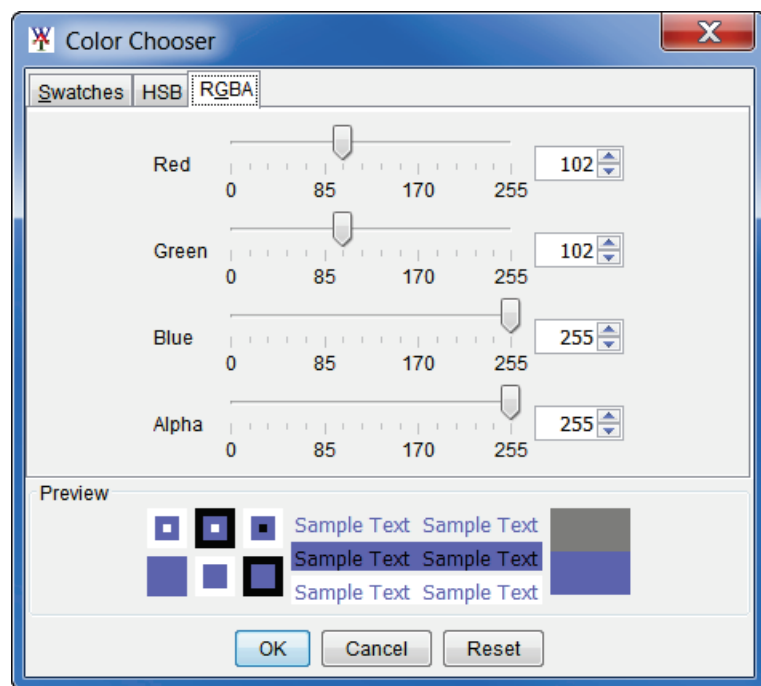
**Brightness Box:** Brightness is the amount of white, measured from zero (0) to one hundred (100) percent.

A finally a way to set a color on the HSB worksheet is from the color palette by clicking and dragging the little white circle (Figure E.2). This will automatically change the hue, saturation, and brightness values, along with the red, green and blue color values. The red, green, and blue values in the **Red**, **Green**, and **Blue** boxes (Figure E.2) are not editable and are informational only.

Click **OK**, the **Color Chooser** will close. Depending on where the **Color Chooser** was accessed, the user will need to click either **Apply** or **OK** for the color change to appear in the map window.

### E.3 RGBA Worksheet

**RGBA** is the Red, Green, Blue, and Alpha color model, which allows the user to set the red, green, blue, and alpha values. Alpha is normally used as an opacity channel, with zero percent being fully transparent (invisible) and 100 percent being fully opaque. From the **Color Chooser**, select the **RGBA** tab; the **RGBA Worksheet** (Figure E.3) becomes available.



**Figure E.3** Color Chooser – RGBA Worksheet

There are two ways to adjust the red, green, blue, and alpha values. The slider bar available for each item changes the value, the color being produced is displayed in the **Preview** box (Figure E.3). Another way to affect colors is in the **Red**, **Green**, **Blue**, **Alpha** boxes the user can directly enter a value. Click **OK**, the **Color Chooser** will close. Depending on where the **Color Chooser** was accessed, the user will need to click either **Apply** or **OK** for the color change to appear in the map window.

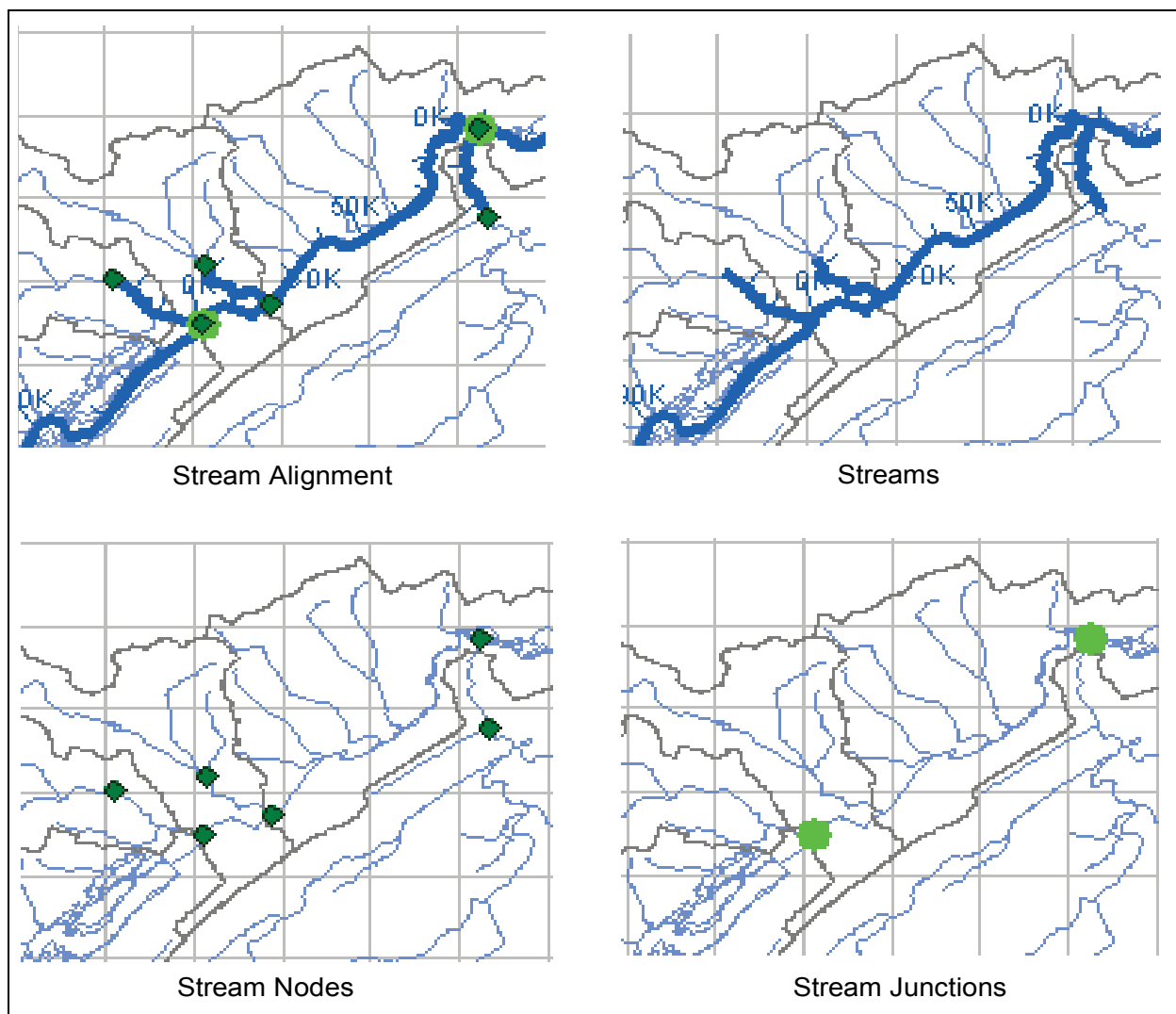




# Appendix F

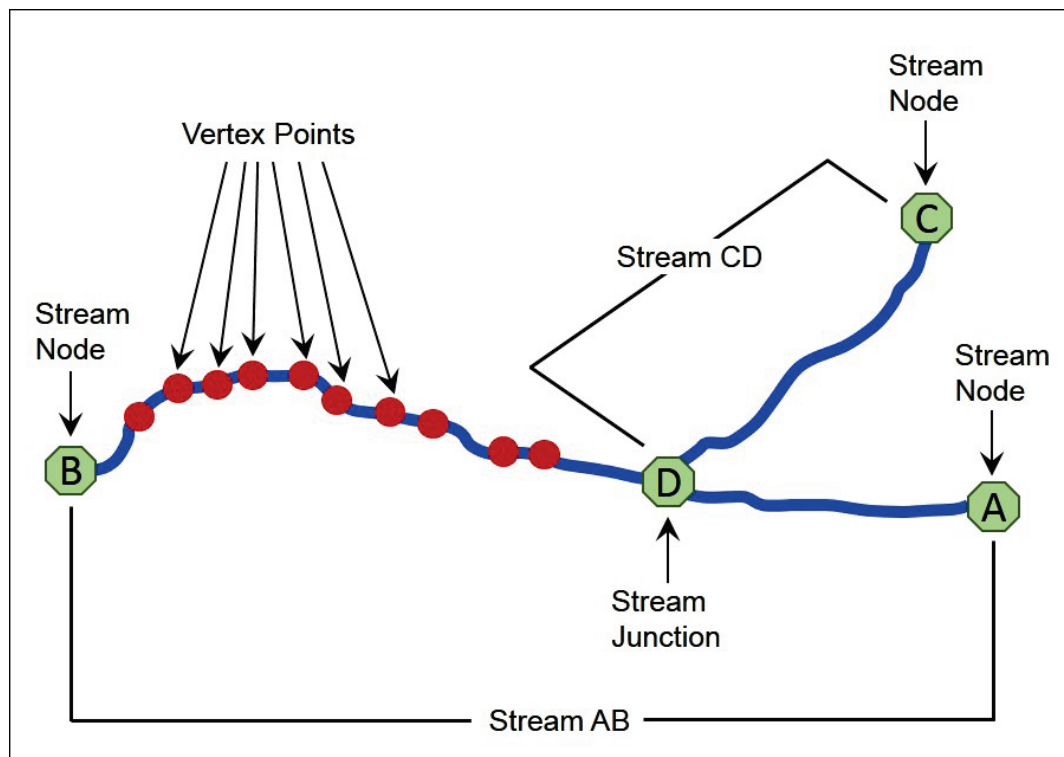
## Stream Alignment

**Stream alignments** represent the stream system in the study. The alignment indicates where confluences and bifurcations occur and provides a sense of distance and scale. Stream alignments are composed of a series of streams, stream nodes, and stream junctions (Figure F.1). A **stream** typically begins or ends at a confluence, bifurcation, or at the boundary of the river system. A stream is composed of vertex points, with the beginning and ending vertex points being stream nodes.



**Figure F.1** Stream Alignment Parts

Streams are drawn as multi-segmented lines. Each stream must have at least two stream nodes, defining the beginning and end of the stream. Streams, stream nodes, and stream junctions, are illustrated in Figure F.2.



**Figure F.2** Relationships of Streams in a Stream Alignment

HEC-WAT creates and labels stream stations (or river stations) along each stream. The station at the downstream end of a stream is Station 0 (zero), and the stationing increases upstream along the stream according to the linear distance between vertices on the stream in the study coordinate system. The user can override the default stationing by editing the station values of the stream nodes at the upstream and downstream ends of the stream, as well as by adding additional nodes along the stream. Stream stationing is based on the geographic extents that are defined when a stream is drawn. If the geo-extents are based on a map layer, the units for the stream stationing are the same as the map layer (i.e., feet, meters). In Version 1.0 of HEC-WAT, where there is no unit indicator, there will be a way for the user to view the units in future versions.

## F.1 Creating the Default Stream Alignment

If the stream alignment is going to be based on a map layer, the map layer should already have been included in the study. The details on how to include a map layer are given in Chapter 5. The map layer should contain water features, such as stream channels and reservoirs. Use this map layer as a guide while creating the stream alignment. By doing this, the units of the labels on the stream alignment will be the same as the units of the water feature layer (i.e., if the water feature layer is projected in state plane coordinates (feet), then the labels on the stream alignment will be in feet).

The user can either import a stream alignment from a shapefile or digitize a stream alignment by hand. The following are the steps for importing a stream alignment, details on digitizing a stream alignment are provided later in this appendix.

To import a stream alignment:

1. From the HEC-WAT main window (Figure F.3), from the **Maps Tab**, from the **Map Layers** tree, right-click on *Stream Alignment* (Figure F.4). From the shortcut menu, click **Import**.

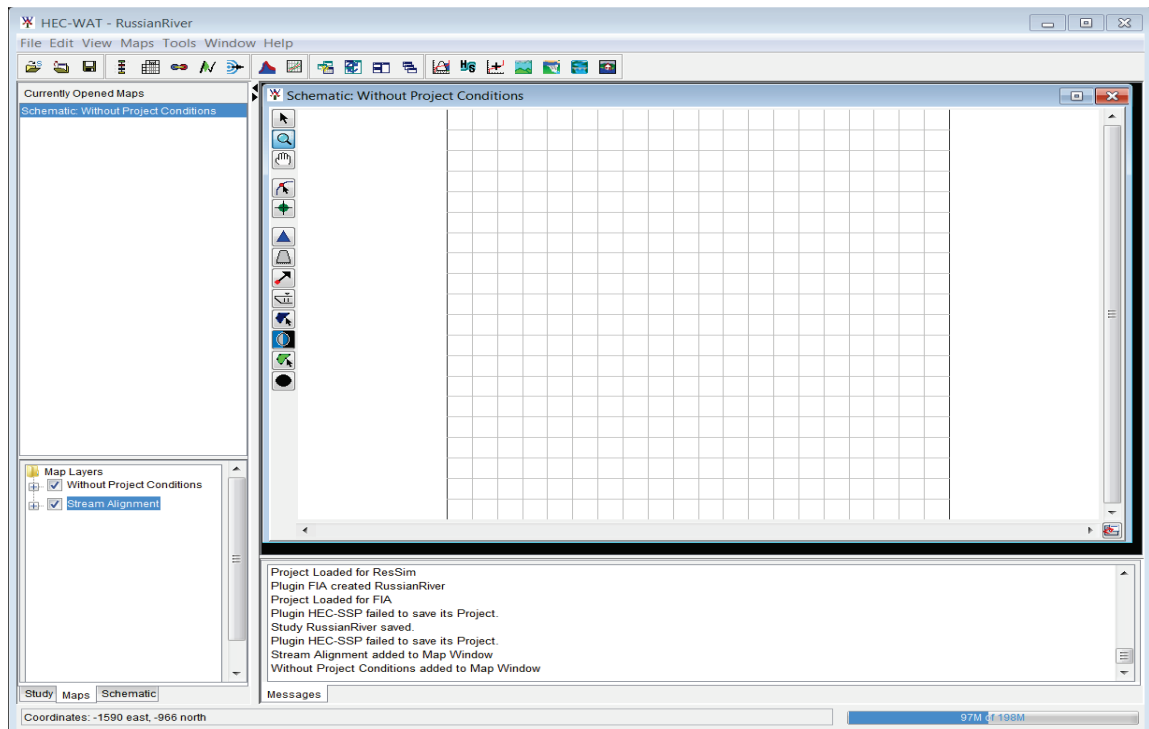


Figure F.3 HEC-WAT Main Menu – Maps Tab

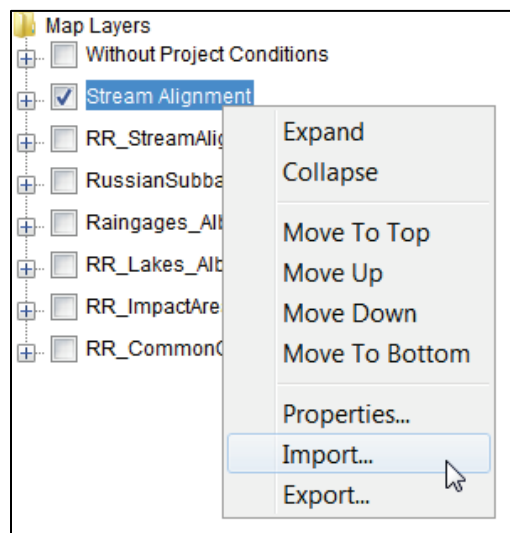
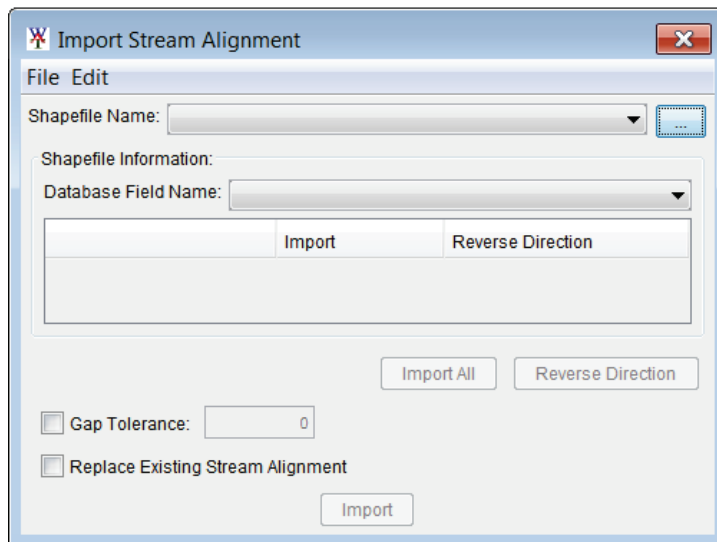



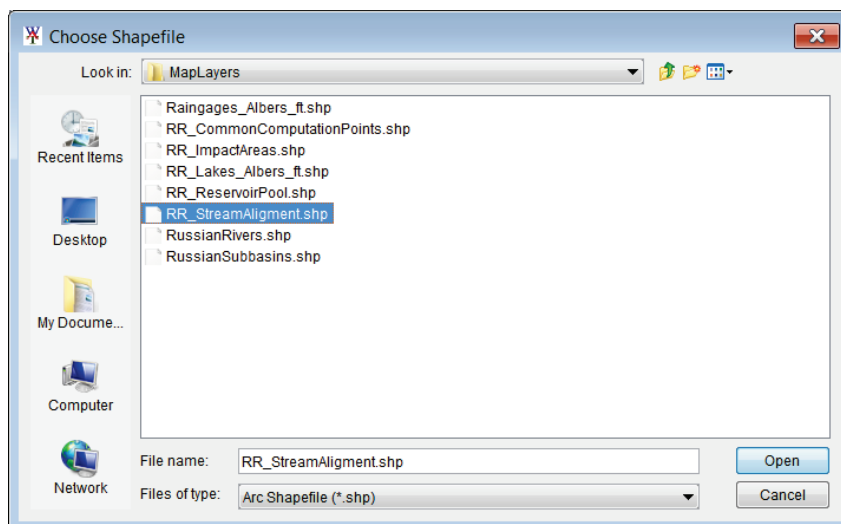
Figure F.4 Map Layers Tree - Shortcut Menu

- The **Import Stream Alignment** dialog box will open (Figure F.5). The **Shapefile Name** list defaults to the first line shapefile it can find in the **maps** directory; which in this example happens to be the shapefile that represents the stream alignment for the *RussianRiver* study - *RR\_StreamAlignment.shp*.



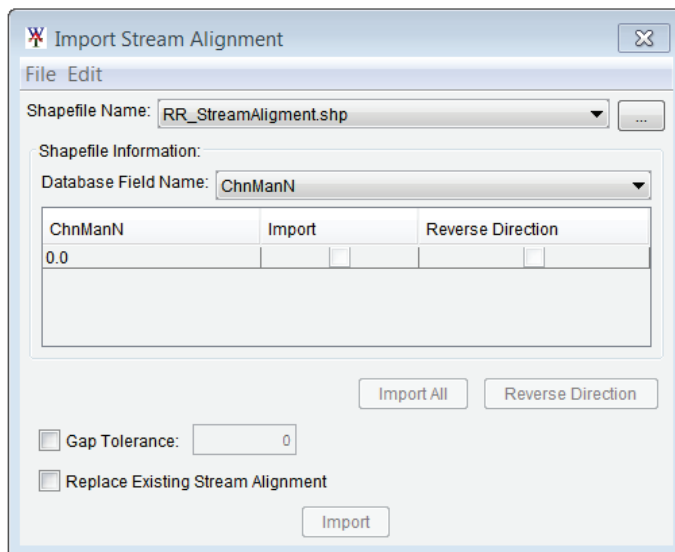
**Figure F.5** Import Stream Alignment Dialog Box

- If the map layer that represents the stream alignment is not stored in the maps directory of the HEC-WAT study, click , a **Choose Shapefile Browser** will open (Figure F.6). Browse to the location where the shapefile that represents the stream alignment is stored on the computer. Click on the filename (e.g., *RR\_StreamAlignment.shp*), the filename will appear in the **File name** box of the browser (Figure F.6). Click Open, the **Choose Shapefile Browser** will close (Figure F.6).



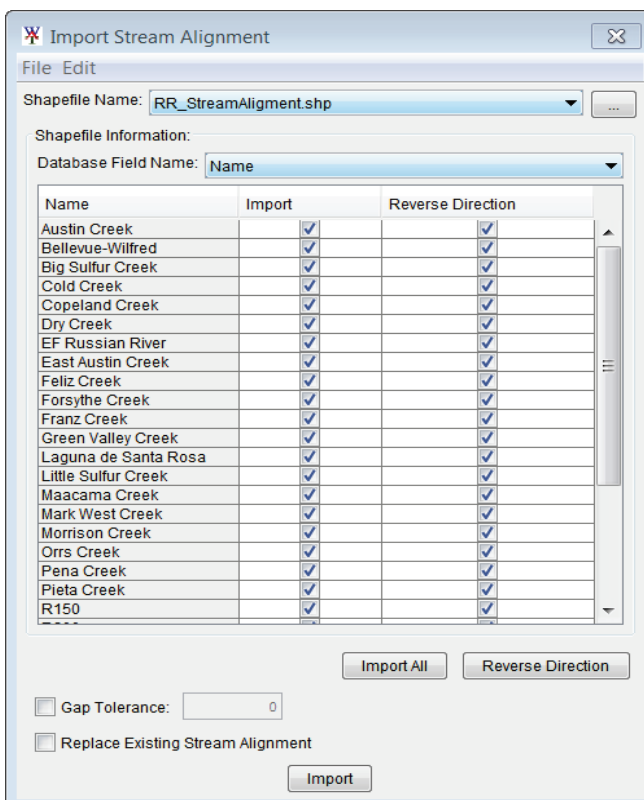
**Figure F.6** Choose Shapefile Dialog Box

- The name of the selected shapefile will appear in the **Shapefile Name** box on the **Import Stream Alignment** dialog box (Figure F.7).



**Figure F.7** Import Stream Alignment Dialog Box – Shapefile Name

- From the **Database Field Name** list (Figure F.8), the user needs to select the field name in the attribute file that contains the names of the streams - **Name**. Once a field name is selected, the table below will populate with the streams contained in the shapefile. If there is an issue with any of the stream segments the checkbox in the **Import** column (Figure F.8) will not be selected. This means the stream segment is not continuous and will not be imported.

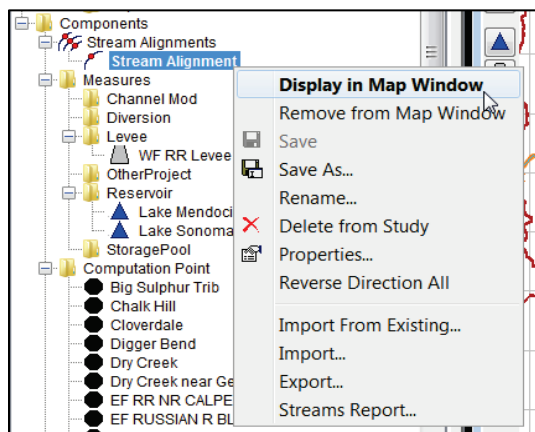


**Figure F.8** Import Stream Alignment Dialog Box – Example Shapefile

6. **Gap Tolerance** (Figure F.8) is used when stream segments are not continuous and the user wants HEC-WAT to connect the segments via the gap tolerance. The gap tolerance units are based on the selected shapefile units (i.e., shapefile units is feet, the gap tolerance will be in feet). To set the gap tolerance, select **Gap Tolerance** and enter a value in the box. Recommended that users enter one (1) for the unit of tolerance to connect. The value entered can also be fractional so for units that are in large units of distance. For example, a gap tolerance of .001 might be used for a shapefile file that has units in miles.
7. Click **Reverse Direction** (Figure F.8). The flow direction in the *RR\_StreamAlignment.shp* shapefile is not correct. So instead of fixing the issues with ArcMap® (ESRI GIS software), the user can perform the **Reverse Direction** procedure on the system of streams to correct flow direction.
8. Click **Import**, the **Import Stream Alignment** dialog box will close (Figure F.8). Once the import of the stream alignment is completed, a message window will appear letting the user know that the stream alignment imported successfully. In the active **Map Window** the stream alignment appears (orange stream segments; green stream nodes and stream junctions).

## F.2 Existing Stream Alignments

After creating a stream alignment, the user can view the stream alignment; remove the stream alignment from an active map window; save the stream alignment; create a copy of an existing stream alignment; rename an existing stream alignment; delete an existing stream alignment; view an existing stream alignment's properties; reverse direction of all streams that make up a stream alignment; import a stream alignment from an existing HEC-WAT stream alignment (*stream.align*); import a stream alignment from a shapefile (Figure F.8); export an HEC-WAT stream alignment to a shapefile; and, view a list of all streams contained in a stream alignment. All of these tasks are accomplished through the stream alignment shortcut menu (Figure F.9). The stream alignment shortcut menu is available from the HEC-WAT main window (Figure F.3), click **Schematic Tab**, on the **Study Pane**, under the **Components** folder, under the **Stream Alignments** folder, and then right-click on an existing stream alignment.



**Figure F.9** Stream Alignment Shortcut Menu

## F.2.1 View a Stream Alignment

To view a stream alignment in a map window:

1. Right click on an existing stream alignment, from the stream alignment shortcut menu (Figure F.9) click **Display in Map Window**.
2. If there is not a map window open in the **Desktop Pane**, the map window for the selected stream alignment will open in the **Desktop Pane** (Chapter 3, Section 3.1). From the map window the user can edit the streams, stream nodes, and stream junctions that make-up the stream alignment.
3. If a map window is open in the **Desktop Pane**, the **Select Location** message box will open letting the user know that the stream alignment is already displayed in the active map window. If the user wishes to open a separate map window for the stream alignment, click **Yes**. The message box will close, and a map window will open with the selected stream alignment displayed.

## F.2.2 Remove a Stream Alignment from the Active Map Window

To remove a stream alignment in a map window:

1. Right click on an existing stream alignment, from the stream alignment shortcut menu (Figure F.9) click **Remove from Map Window**.
2. The **Remove from Map?** message box will open letting asking the user do you wish to remove the stream alignment from the active map window, click **Yes**. The message box will close, and the map window will no longer display the stream alignment.

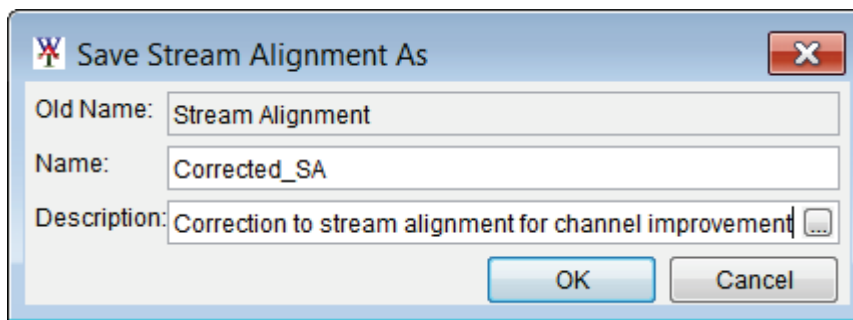
## F.2.3 Save a Stream Alignment

To save the active stream alignment, from the stream alignment shortcut menu (Figure F.9), click **Save**. Any changes that have occurred to the selected stream alignment will be saved by HEC-WAT.

## F.2.4 Make a Copy of a Stream Alignment

To create a copy of a stream alignment:

1. Right click on an existing stream alignment, from the stream alignment shortcut menu (Figure F.9) click **Save As**.
2. The **Save Stream Alignment As** dialog box will open (Figure F.10). The name of the stream alignment that is being copied is displayed in the **Old Name** box (Figure F.10).



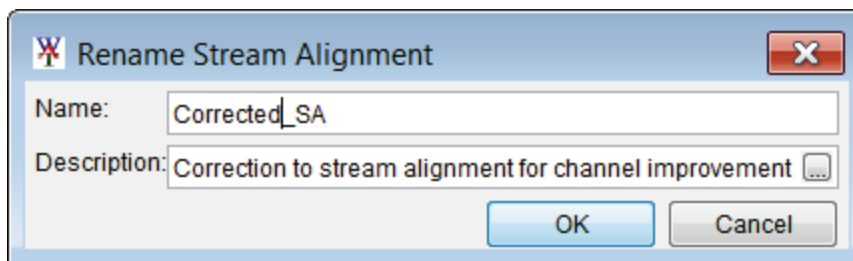
**Figure F.10** Save Stream Alignment As Dialog Box

3. The user should enter a new name in the **Name** box (required) and provide a new description in the **Description** box (optional).
4. Click **OK**, the **Save Stream Alignment As** dialog box will close (Figure F.10). The new stream alignment is displayed on the **Schematic Tab** (Figure F.9), in the **Study Pane**, under the **Stream Alignments** folder.

## F.2.5 Rename a Stream Alignment

To rename a stream alignment:

1. Right click on an existing stream alignment, from the stream alignment shortcut menu (Figure F.9) click **Rename**.
2. The **Rename Stream Alignment** dialog box will open (Figure F.11). The name of the existing stream alignment is displayed in the **Name** box (Figure F.11).



**Figure F.11** Rename Stream Alignment Dialog Box

3. The user should enter a new name in the **Name** box (required) and provide a new description in the **Description** box (optional).
4. Click **OK**, a **Confirm Rename** message window will open asking the user are sure that you really want to rename the stream alignment (renaming a stream alignment in a study that already has alternatives created could cause issues). Click **Yes**, the **Rename Stream Alignment** dialog box will close (Figure F.11). The new stream alignment is displayed on the **Schematic Tab** (Figure F.9), in the **Study Pane**, under the **Stream Alignments** folder.



## F.2.6 Delete a Stream Alignment from the Study

To delete a stream alignment from the study:

1. Right click on an existing stream alignment, from the stream alignment shortcut menu (Figure F.9) click **Delete from Study**.
2. A **Confirm Manager Delete** message window will open asking the user for confirmation to delete the stream alignment (deleting a stream alignment in a study that already has alternatives created could cause issues). Click **Yes**, the **Confirm Manager Delete** message window will close. The selected stream alignment is no longer displayed on the **Schematic Tab** (Figure F.9), in the **Study Pane**, under the **Stream Alignments** folder.

## F.2.7 Stream Alignment Properties

The properties of a stream alignment include the name, description, when the stream alignment was last modified, who created the stream alignment, when the stream alignment was created, the file that contains the stream alignment data; and the spatial layout of the stream alignment. To view the properties of a stream alignment, from the stream alignment shortcut menu (Figure F.9), click **Properties**. The **Properties for Stream Alignment** dialog box will open (Figure F.12).

The screenshot shows the 'Properties for Stream Alignment' dialog box with the following data:

Field	Value
Name	Stream Alignment
Description	
Modified Time	Fri Aug 26 19:08:17 PDT 2016
Created By	q0hecprb
Create At	Tue Nov 03 09:20:57 PST 2015
File	C:\Users\q0hecprb\Desktop\W4801RussianRiver_Chapter 7\stream.align
Class	com.rma.model.StreamAlignmentContainer
<b>Extents</b>	
<b>Easting</b>	
Minimum	-7590987
Maximum	-7455173
<b>Northing</b>	
Minimum	6640088
Maximum	7049698

**Figure F.12** Properties for Stream Alignment Dialog Box

## F.2.8 Reverse Direction of All Streams in a Stream Alignment

When importing a stream alignment from ArcView® as shapefiles or when digitizing a stream alignment, individual streams segments can be in the wrong direction (downstream to upstream). The user can reverse the direction of all the streams if the streams are in the wrong direction.

From the stream alignment shortcut menu (Figure F.9), click **Reverse Direction All**. The **Confirm Reverse Direction** warning message box will appear. The user will be warned that reversing the streams direction will reverse the default stationing for all the streams in the stream alignment. Click **Yes**, the warning message box will close, and all streams associated with the stream alignment will have reversed direction.

## F.2.9 Import from an HEC-WAT Stream Alignment

1. Right click on an existing stream alignment, from the stream alignment shortcut menu (Figure F.9) click **Import from Existing**.
2. A **Confirm Import** message window will open letting the user know that this command will replace the contents of the HEC-WAT *stream.align* file. Click **yes**, an **Open Browser** will appear (Figure F.13). Browse to an HEC-WAT study, click on the *stream.align* file (which appears in the **File name** box).

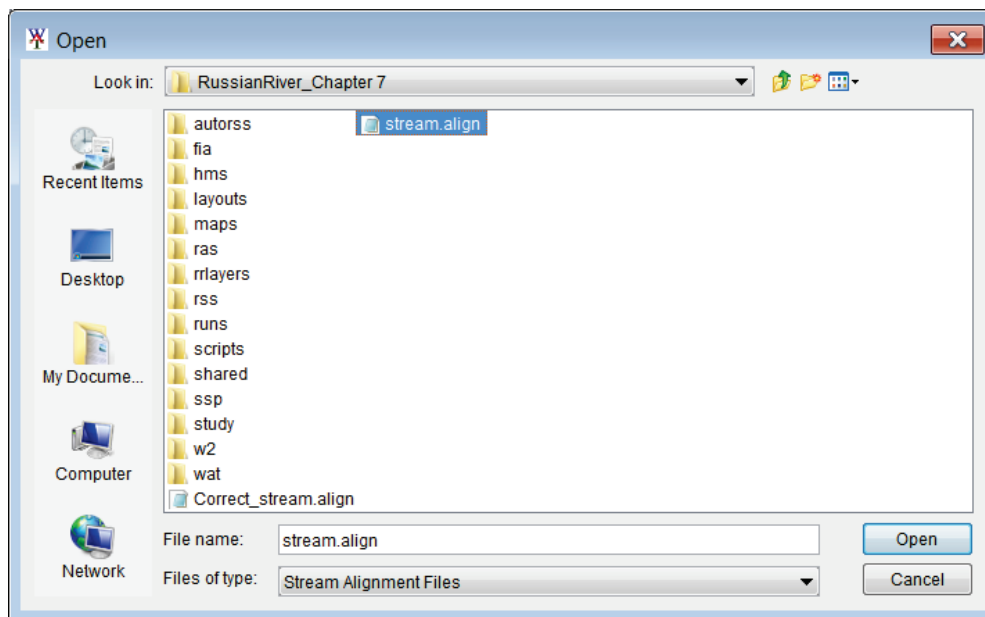


Figure F.13 Open Browser

3. Click **Open**, the **Open Browser** will close (Figure F.13) and the stream alignment from the selected HEC-WAT study is displayed.

## F.2.10 Export an Existing Stream Alignment

If adjustment have been made to the stream alignment or the stream alignment was digitized, the stream alignment can be saved as a shapefile. To export a stream alignment the user must have a stream alignment in the map window.

To export a stream alignment:

1. Right click on an existing stream alignment, from the stream alignment shortcut menu (Figure F.9) click **Export**.
2. A **Save** browser will open (Figure F.14). Enter a name in the **File name** box. Click **OK**, the **Save** browser will close, and a shapefile of the displayed stream alignment will be saved in the selected location.

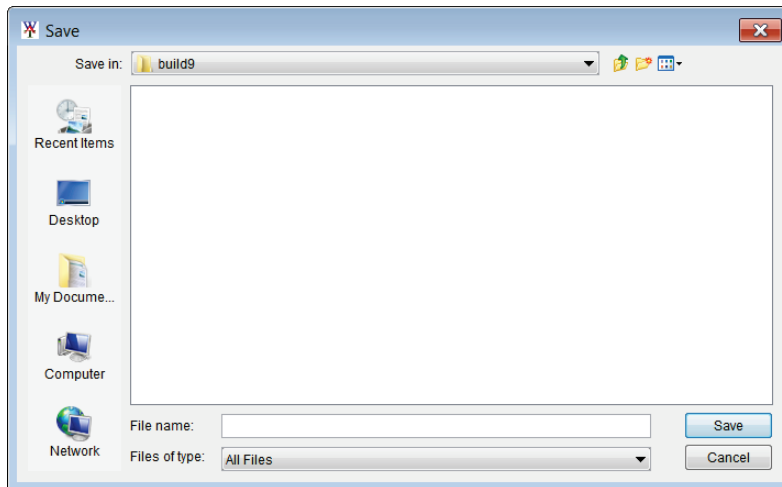


Figure F.14 Save Browser

### F.3 Edit a Stream Alignment

From a map window (Figure F.15) a user can edit the individual components of a stream alignment – streams, stream nodes, and stream junctions. The following sections describes the editing capabilities provided for each stream component.

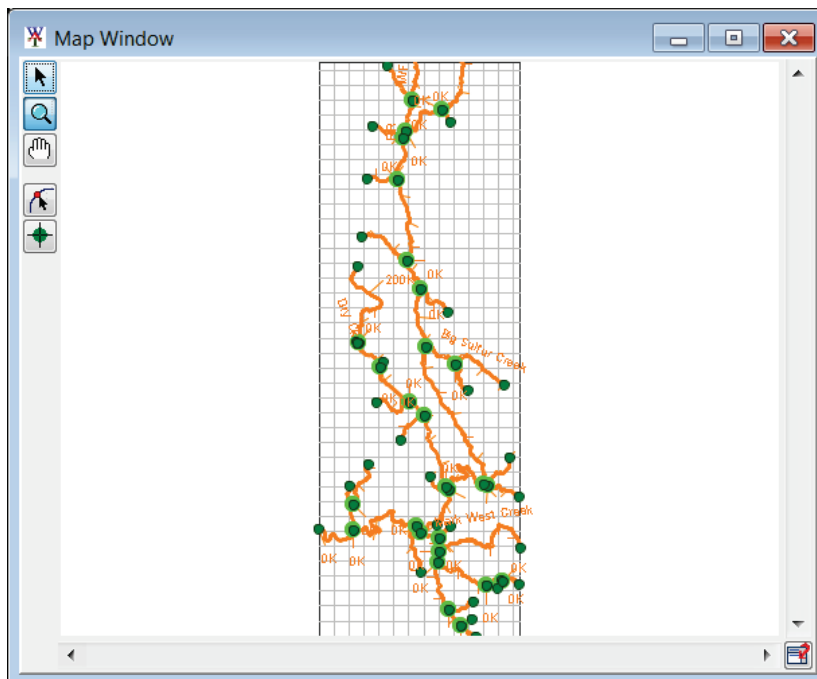



Figure F.15 Map Window – Stream Alignment

### F.3.1 Streams

After establishing a stream alignment, the user can rename and edit the description of individual streams, delete individual streams, reverse the direction of a stream, disconnect a stream at both the upstream or downstream end, and view the stream stationing and coordinates of the stream nodes on a stream. All of these tasks are accomplished through the stream shortcut menu (Figure F.16). To access the stream shortcut menu, the **Stream Alignment Tool**  must be selected, and from the map window (Figure F.15), right-click on a stream.

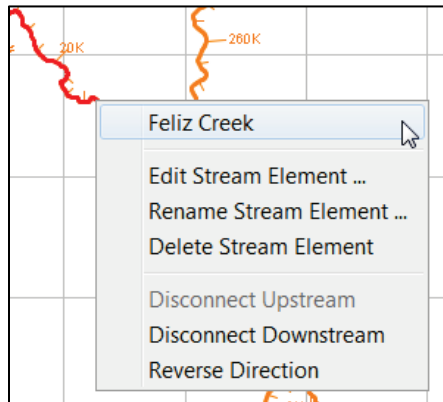


Figure F.16 Stream Shortcut Menu

### Edit a Stream

The user can edit a stream's description and view the stream's stationing and coordinates of the upstream and downstream stream nodes, plus any stream nodes in between the two.

To edit the description of a stream:

1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15), right-click on the stream element to edit, click **Edit Stream Element** from the stream shortcut menu (Figure F.16), the **Stream Editor** will open (Figure F.17).

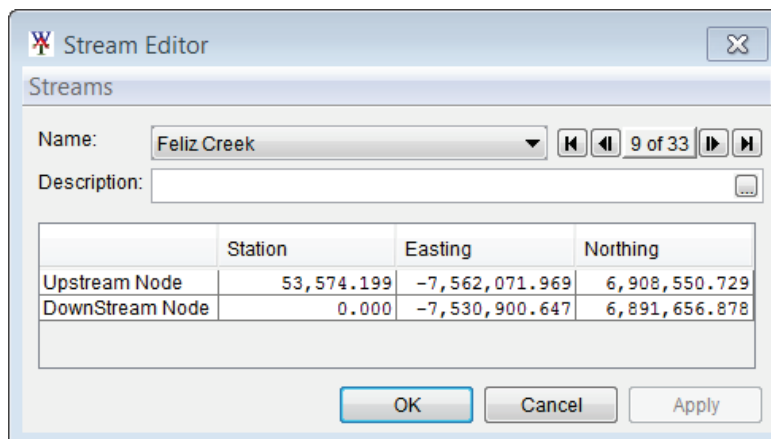


Figure F.17 Stream Editor

2. The user can either enter a new description (recommended) or edit the description of the stream in the **Description** box.
3. The table provides the user with the stream stationing and coordinates of the stream nodes that are on the selected stream and is informational only.
4. Click **OK**, the **Stream Editor** will close (Figure F.17).

## Rename a Stream

To rename a stream:

1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15), right-click on the stream to rename, and click **Rename Stream Element** from the stream shortcut menu (Figure F.16).
2. The **Rename Stream** dialog box opens (Figure F.18). Enter the new name in the **Name** box (required) and description in the **Description** box (optional, but recommended).

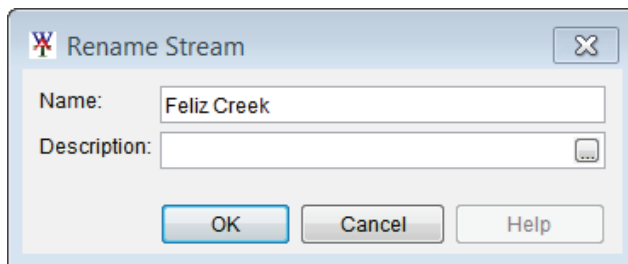


Figure F.18 Rename Stream Dialog Box

3. Click **OK** and the **Rename Stream** dialog box will close (Figure F.18). The new name of the stream will be shown on the map window.

## Delete a Stream

To delete a stream:

1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15), right-click on the stream to delete and click **Delete Stream Element** from the stream shortcut menu (Figure F.16).
2. A **Confirm Delete** warning message will open asking the user whether you really want to delete the selected stream. Click **Yes**, the warning message will close and the stream will be deleted from the map window.

## Disconnect a Stream

If the user wants to disconnect a stream from another stream, HEC-WAT will allow the user to do so at either the upstream or downstream end of the stream.

To disconnect a stream from another stream:

1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15), right-click on the stream to disconnect and either click **Disconnect Upstream** or **Disconnect Downstream** from the stream shortcut menu (Figure F.16).
2. The stream will now be disconnected from the stream at the location chosen. On the map window, the upstream or downstream point will physically move away from the connecting stream and a stream node will remain on the connecting stream.


## Reverse Direction of a Stream

If a stream is drawn in the wrong direction (downstream to upstream), HEC-WAT provides a way to reverse the direction of a stream, instead of having to delete and redraw the stream.

To reverse direction of a stream:

1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15), right-click on the stream you want to reverse and click **Reverse Direction** from the stream shortcut menu (Figure F.16).
2. A **Confirm Reverse Direction** warning message will appear asking if the user really wants to reverse the direction of the stream. Click **Yes**, the warning message will close and the stream's direction will be reversed.

## Graphically Edit a Stream

After establishing a stream alignment, the user can graphically edit the individual streams of the stream alignment. By using the **Stream Alignment Tool** , the **CTRL** key, and the **SHIFT** key, the user can edit individual streams by adding, moving, and deleting vertex points. The edit is performed graphically on the schematic in the active map window.

## Add Vertices to a Stream

To add vertex points to an existing stream:

1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15), double-click on a stream that needs additional vertices, and the stream will turn red, with blue points that represent vertices.
2. Place the pointer on the selected stream where a new vertex point needs to be added. Hold down the **CTRL** key and click. A blue point will now appear on the selected stream, which represents a new vertex point.

## Move the Vertices of a Stream

To move vertex points on an existing stream:


1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15); double-click on the stream where a vertex point needs to be moved. The selected stream will turn red, and the individual vertex points will be blue points.
2. Click on the vertex point that needs to be moved and then drag the vertex point to a new location; the vertex point has been moved.

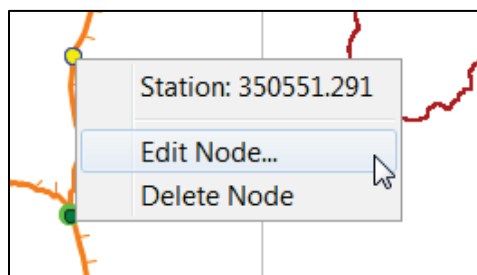
## Delete Vertices from a Stream

To delete vertex points from an existing stream:

1. Press the **Stream Alignment Tool** from the toolbar on the map window (Figure F.15); double-click on the stream where a vertex point needs to be deleted. The selected stream will turn red, and the individual vertex points will be blue points.
2. Hold down the **SHIFT+CTRL** keys and click on the vertex point to be deleted. The blue vertex point will disappear from the stream.

### F.3.2 Stream Nodes

After establishing the stream alignment, the user can edit and delete the individual stream nodes of a stream alignment. Both of these tasks are accomplished through the stream node shortcut menu (Figure F.19). To access the stream node shortcut menu, the **Stream Node** tool  must be selected, and from the map window right-click on a stream node.



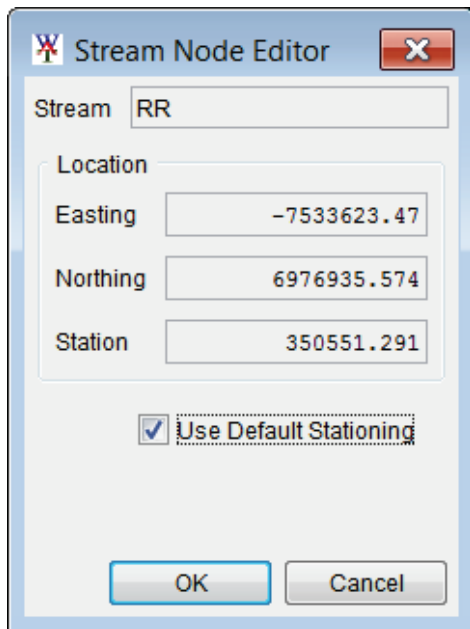
**Figure F.19** Stream Node Shortcut Menu

## Establish Stream Stationing

HEC-WAT creates a beginning and ending stream node for each stream. Stream nodes are also created where streams meet (stream junctions). Stream nodes are used to establish stationing for a stream. To establish stream stationing for a stream, the user can edit the stream nodes.

To edit a stream node:

1. Press the **Stream Node Tool** from the toolbar on the map window (Figure F.15), right-click on the stream node to edit. From the stream node shortcut menu (Figure F.19), click **Edit Node**; the **Stream Node Editor** will open (Figure F.20).



**Figure F.20** Stream Node Editor

2. The default stream station has the downstream node at zero (0) and the upstream node is based on the coordinate system from the imported stream alignment. To change the stream stationing, clear **Use Default Stationing**. The **Station** box can now be edited.
3. Click **OK**, the **Stream Node Editor** will close (Figure F.20). Based on what is entered, HEC-WAT will automatically adjust the stream stationing for the stream associated with the stream node. This includes the upstream and downstream nodes.

## Delete a Stream Node


To delete a stream node, press the **Stream Node Tool** from the toolbar, right-click on the stream node that needs to be deleted. From the stream node shortcut menu (Figure F.19) click **Delete Node**. A **Confirm Delete** warning message will open to request for user confirmation prior to node deletion. Click **Yes**, the warning message will close and the stream node will be deleted from the stream alignment. The beginning and ending stream nodes of a stream element cannot be deleted.

## Graphically Edit a Stream Node

After establishing a stream alignment, the user can graphically edit the individual stream nodes of the stream alignment. By using the **Stream Node Tool**, and the **CTRL** key, the user can add and move stream nodes. This edit is performed graphically on the schematic in the active map window.



## Add a Stream Node

Two stream nodes are created automatically at the beginning and ending stream nodes of a stream. The user can add stream nodes to a stream by pressing the **Stream Node Tool** from the toolbar. Using the **Stream Node Tool** , place the pointer on the stream where a stream node needs to be added. Hold down the **CTRL** key and click. A circle will now appear on the stream that indicates the new stream node.

## Move a Stream Node

To move a stream node, press the **Stream Node Tool** from the toolbar; double-click on the stream node that needs to be moved. The stream node becomes a yellow circle with a black outline and four small black dots (Figure F.21). Click and drag the stream node along the stream to its new position. The beginning and ending stream nodes of a stream cannot be moved.

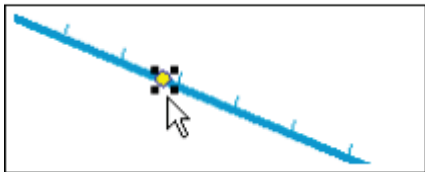



Figure F.21 Move a Stream Node

## F.3.3 Stream Junctions

When two streams intersect, a stream junction is created. A stream junction is multiple stream nodes at one location and is represented by a dark green circle with a light green halo around the circle. The user can establish stream stationing at a stream junction. This task is accomplished through the stream junction shortcut menu (Figure F.22). To access the stream junction shortcut menu, the **Stream Node**  tool must be selected, and from the map window right-click on a stream junction.

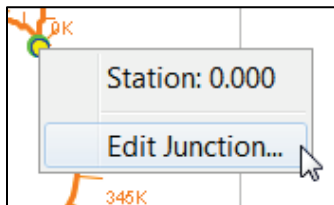
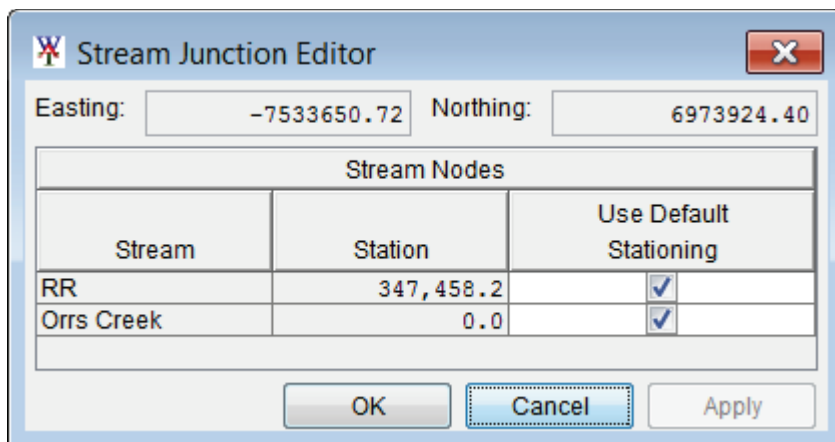


Figure F.22 Stream Junction Shortcut Menu

## Edit a Stream Junction

To edit a stream junction:

1. Press the **Stream Node Tool** from the toolbar on the map window (Figure F.15), right-click on the stream junction that you want to edit. From the stream junction shortcut menu (Figure F.22), click **Edit Stream Junction**. The **Stream Junction Editor** will open (Figure F.23).



The Stream Junction Editor dialog box shows the following information:

Easting: -7533650.72    Northing: 6973924.40

Stream Nodes		
Stream	Station	Use Default Stationing
RR	347,458.2	<input checked="" type="checkbox"/>
Orrs Creek	0.0	<input checked="" type="checkbox"/>

Buttons: OK, Cancel, Apply


**Figure F.23** Stream Junction Editor

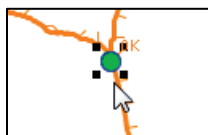
- The editor displays information about the stream nodes associated with the stream junction. To change the stream stationing for a stream node, clear the checkbox for a stream node from the **Use Default Stationing** column of the table. The cell in the **Station** column becomes active. Based on the station is entered, HEC-WAT will automatically adjust the stream stationing for the stream associated with the stream node.
- Click **OK**, the **Stream Junction Editor** will close (Figure F.23).

## Graphically Edit a Stream Junction

After establishing a stream alignment, the user can graphically edit the individual stream junctions of the stream alignment. By using the **Stream Node Tool**, the user can move a stream junction. This edit is performed graphically on the schematic in the active map window.

### Move a Stream Junction

To move a stream junction press the **Stream Node Tool**  from the toolbar; double-click on the stream junction that needs to be moved. The stream node becomes a green circle with a black outline and four small black dots (Figure F.24). Click and drag the stream junction along the stream element to its new position.



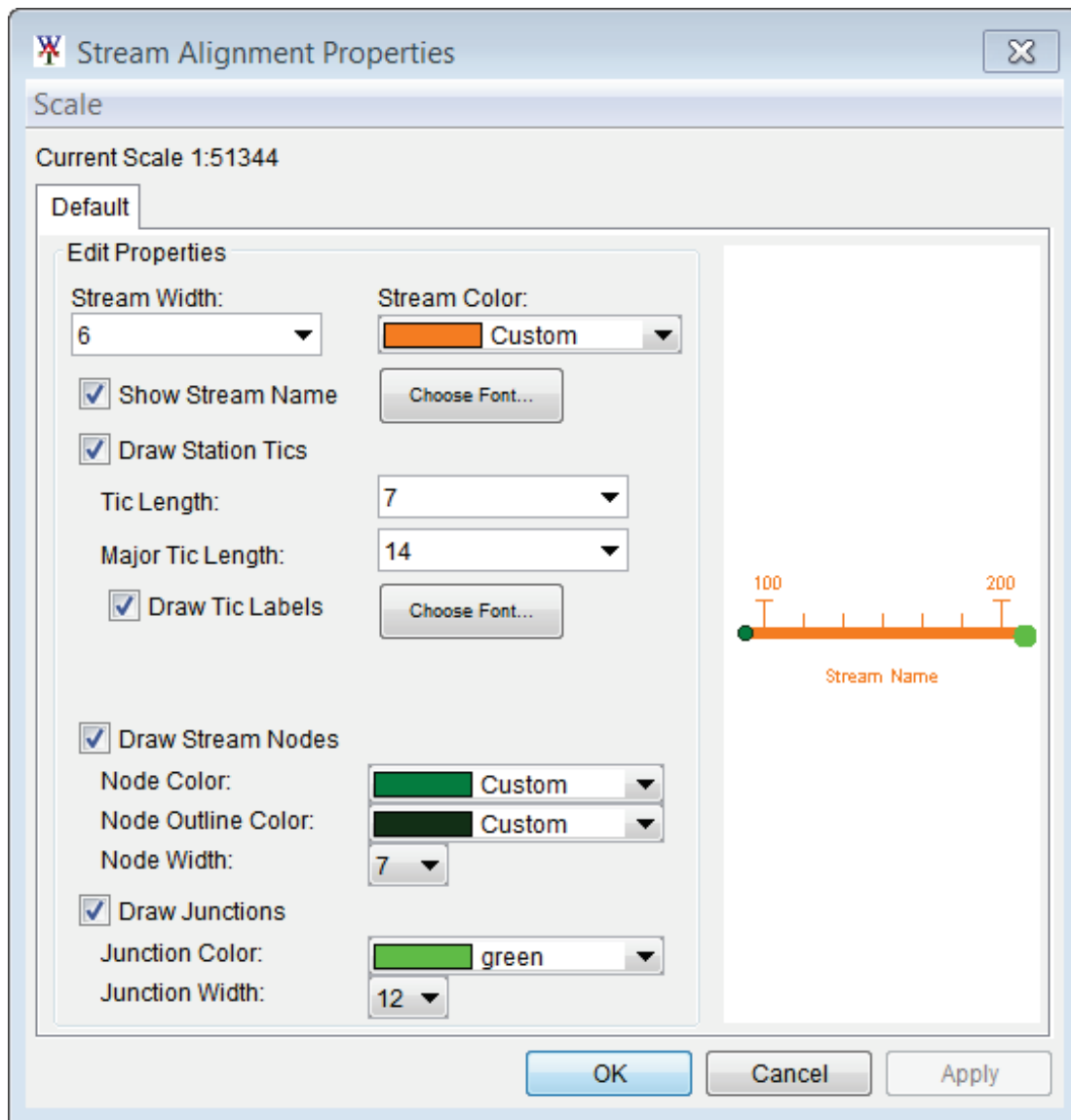
**Figure F.24** Move a Stream Junction

## F.4 Change Stream Alignment Properties

Stream alignment properties that can be changed include: color of streams, stream nodes, and stream junctions; the width of streams, stream nodes, and stream junctions; font for the stream name; tic mark properties; and visualization scaling for the stream alignment.

To change stream alignment properties:

1. From the HEC-WAT main window (Figure F.15), from the **Maps Tab**, right-click on **Stream Alignment** in the tree. From the shortcut menu, click **Properties**.
2. The **Stream Alignment Properties** dialog box will open (Figure F.25).



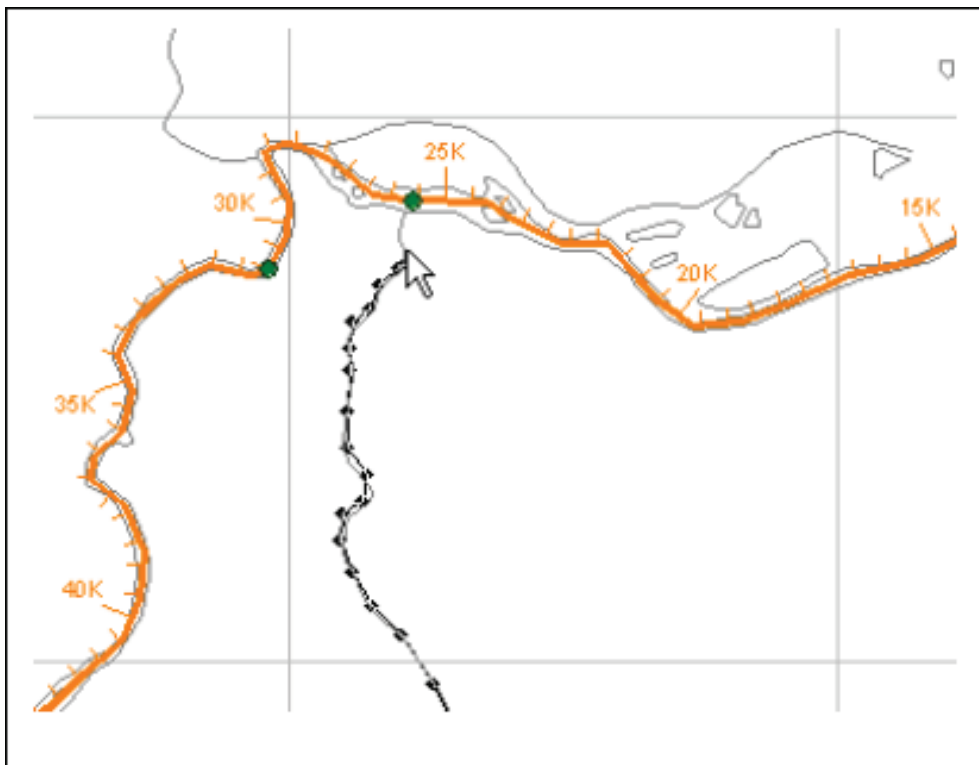
**Figure F.25** Stream Alignment Properties Dialog Box

3. To change the color of the stream alignment, select a color from the **Stream Color** list. The example to the right of the **Edit Properties** box (Figure F.25) will preview the selected color.
4. Click **OK**, the **Stream Alignment Properties** dialog box (Figure F.25) will close and the color change will appear in the map window.

## F.5 Digitize a Stream Alignment

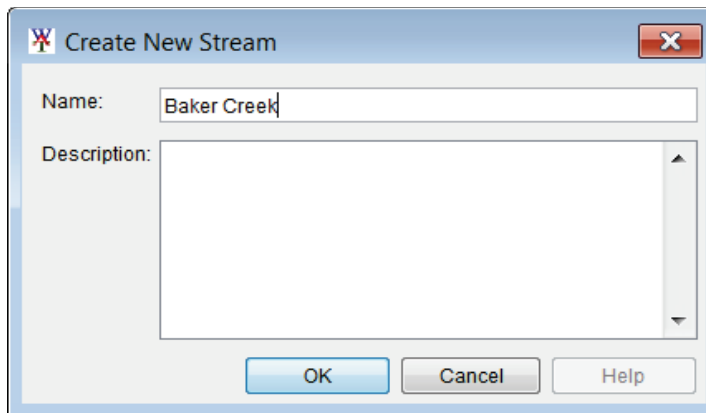
To digitize the default stream alignment for a new study:

1. When a new study is created (Chapter 4, Section 4.1.1), the default stream alignment is created (*Stream Alignment*) and a schematic map window is automatically opened in the **Desktop Pane** (Chapter 3, Section 3.1).
2. The default stream alignment is blank, to begin building the default stream alignment; find a location on the map window where a stream should start. Streams should be created from upstream to downstream. Hold down the **CTRL** key, while clicking the mouse button. Each click creates a vertex point (Figure F.26), on the stream. The first vertex point is the upstream or beginning stream node of a stream.



**Figure F.26** Creating a Stream

3. For the most downstream or last vertex point, release the **CTRL** key, and then click the mouse button. This creates the ending stream node of the stream. A single stream has been created.
4. The **Create New Stream** dialog box will open (Figure F.27). The user can either accept the default name or enter a new name (required) in the **Name** box. If needed, the user can enter an optional description (recommended) in the **Description** box. Click **OK**, the **Create New Stream** dialog box will close.



**Figure F.27** Create New Stream Dialog Box

5. Repeat steps 2 through 4 to add more streams to the stream alignment.
6. To connect a stream to an existing stream, place the first or last click of the new stream on the existing stream where the two streams to join. After naming the new stream, a **Connect Stream Reaches** message box will appear asking the user do you want to connect the new stream to the existing stream. Click **Yes** if the two streams need to be connected. Otherwise, click **No** and the new stream will not be connected to the existing stream.
7. Once the user has completed the stream alignment, save your work.

The **Zoom Tool** (Section 6.3) can be used to help define the stream alignment. Use it to magnify the stream network, which makes defining the vertices along a stream easier.

## F.6 Save Stream Alignment Data

To save stream alignment input, from the **Stream Alignment** shortcut menu (Figure F.9), click **Save**, the stream alignment has been saved. Another way to save data is from the **File** menu, click **Save Study**. Both commands will save all of the stream alignment input to the appropriate files created and used by HEC-WAT for the stream alignment.



# Appendix G

## Measures

Measures for HEC-WAT include structural/non-structural measures (flood damage reduction), and/or ecosystem measures. **Structural measures** are physical modifications designed to reduce the frequency of damaging levels of flood inundation, and include dams with reservoirs, levees, channelization measures, walls, diversion channels, pumps, bridge modifications, and ice-control structures. **Non-structural measures** are activities that reduce flood damage without significantly altering the nature or extent of flooding (e.g., flood proofing, relocation of structures, raising structures). **Ecosystem restoration measures** are physical modifications or other actions that improve the value and function of an ecosystem (e.g., channel restoration, removal of drainage structures or levees). There are various measures that can be defined for HEC-WAT, but this User's Manual will only focus on reservoirs and levees. Other measures available in HEC-WAT are diversions, channel improvements, off-channel storage, and other projects.



Measures are components of an existing or proposed physical system and provide a starting point for implementation in a particular model. All models should incorporate the presence of measures in the system, although the measures may be represented very differently from model to model.

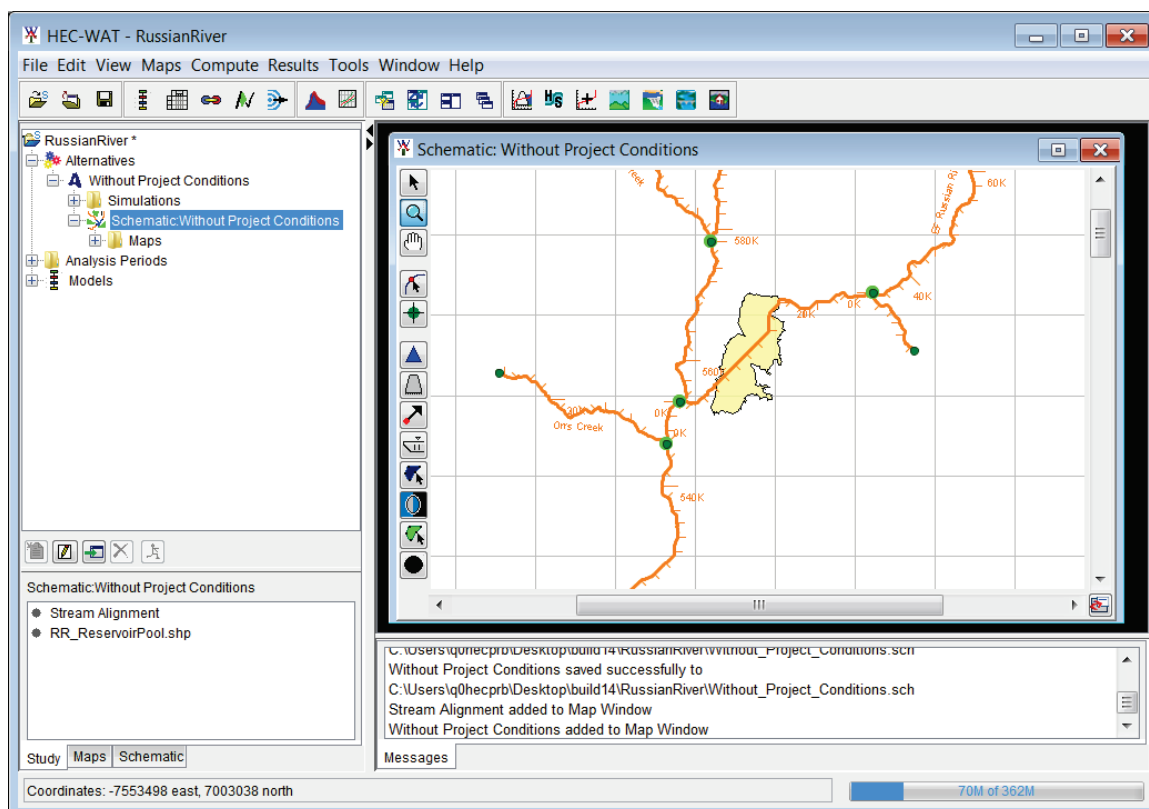
### G.1 Reservoirs

A **reservoir** is the impoundment created behind dams, or behind navigation locks and dams. For HEC-WAT a reservoir also includes the dam built on a stream to store water for uses such as flood damage reduction, hydroelectric power generation, recreation use, and water supply, etc.

#### G.1.1 Create a Reservoir

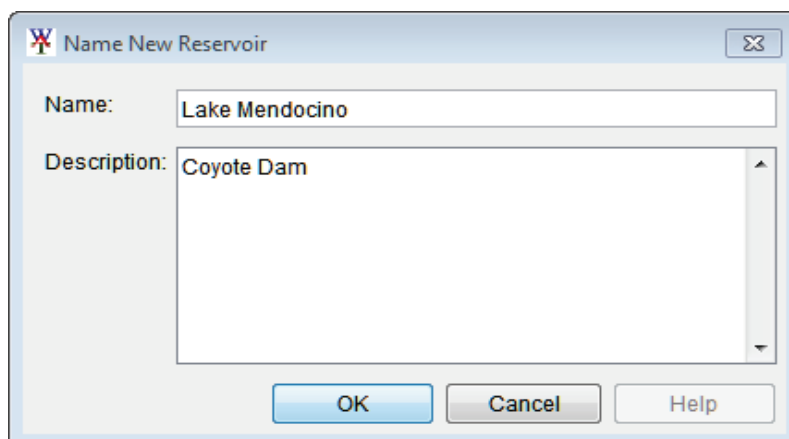
To create reservoirs, the study must have a valid stream alignment (Appendix F), once the stream alignment has been created, the following steps are how a user would add reservoirs to the study:

1. From the HEC-WAT main window (Figure G.1), from the **Study Pane**, from the **Study Tree**, under the **Simulations** folder, double click on the schematic that requires the addition of reservoirs (e.g., *Schematic:WithoutProjectConditions*). A **Schematic Map Window** will open in the **Desktop Pane** that displays a stream alignment.
2. To assist the user in the location of the reservoir(s), a map layer that displays reservoir locations for the study area should be added to the study (Chapter 5).
3. From the map window toolbar, press the **Zoom Tool** , zoom into an area on the map window where a reservoir is located. On the map window toolbar, press the **Reservoir Tool** .



**Figure G.1** HEC-WAT Main Window

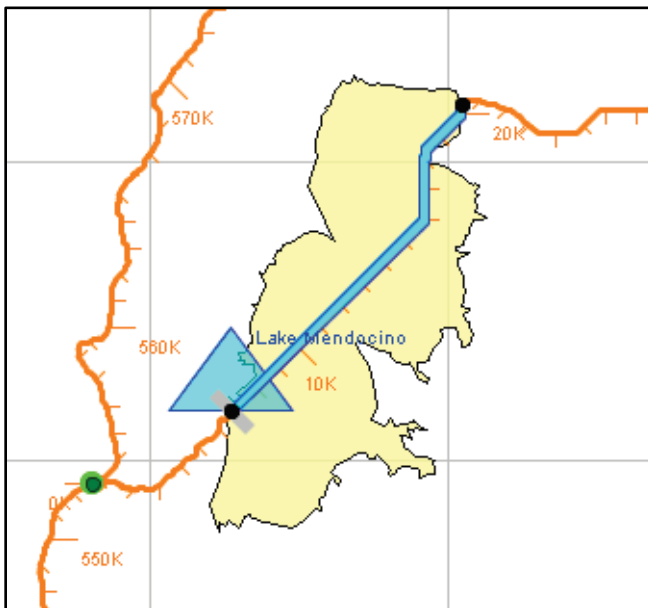
4. Hold down the **CTRL** key and click on the stream alignment to place the upstream end of the reservoir. Release the **CTRL** key; drag the mouse to the downstream end of the reservoir and click.
5. The **Name New Reservoir** dialog box will open (Figure G.2). Enter the new **Name** (required) and **Description** (optional, but recommended). Click **OK**, the **Name New Reservoir** dialog box will close.



**Figure G.2** Name New Reservoir Dialog Box

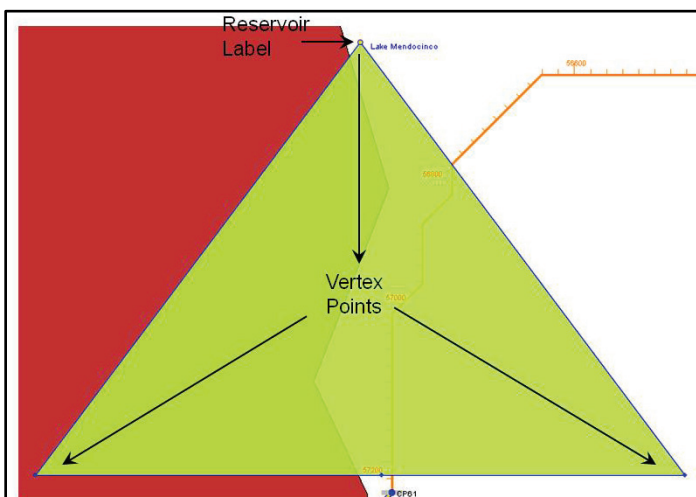


- The reservoir will now appear on the schematic as a cyan triangle (reservoir pool), a blue line (storage reach), a gray rectangle (dam), and two common computation points that represent the upstream and downstream ends of the reservoir, as shown in Figure G.3.



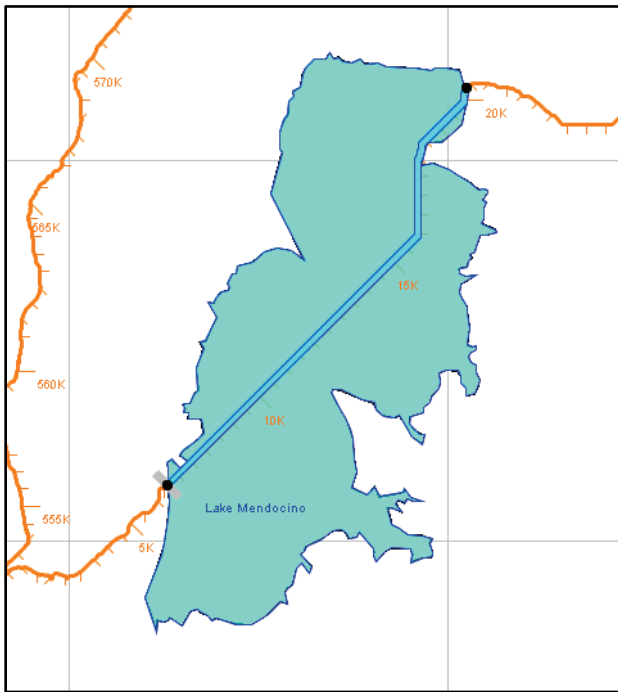
**Figure G.3** A Reservoir Added to the Map Window

- The default representation of the reservoir pool is a triangle; the user can edit this triangle if a more detailed representation of the pool is desired. With the **Reservoir Tool** pressed, double-click on the reservoir. The triangle (Figure G.4) will now be green with a blue outline color. Also, there are three vertex points (blue), and at the apex of the triangle is the reservoir label, which is represented by a yellow circle.




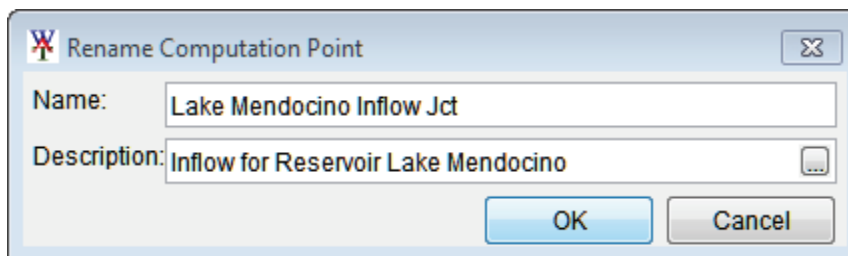
**Figure G.4** Reservoir Pool

- By clicking and dragging the yellow circle the user can move the reservoir label to an appropriate location. Similar to the stream alignment, the user can add, move, and delete vertex points to the reservoir pool. Figure G.5 illustrates how the reservoir pool shown in Figure G.6 has been edited to give a more detailed representation of the reservoir pool.



**Figure G.5** Detailed Representation of a Reservoir Pool


9. When a reservoir is created there are two common computation points that are created with default names. It is recommended that the names of the two common computation points be changed. These two common computation points represent the inflow and outflow junctions of the reservoir and should be renamed accordingly.
10. To change the name of a common computation point, press the **Computation Point Tool** , right-click on one of the common computation points. From the shortcut menu, click **Rename Computation Point**; the **Rename Computation Point** dialog box will open (Figure G.6). In the **Name** box, enter the new name, and in the **Description** box enter a description (optional, but recommended). For example, in Figure G.6, the inflow junction for *Lake Mendocino* has been labeled *Lake Mendocino Inflow Jct.*



**Figure G.6** Rename Computation Point Dialog Box

## G.1.2 Existing Reservoirs

After adding a reservoir to the schematic, the user can edit the reservoir; rename an individual reservoir; remove a reservoir from the active schematic, delete individual reservoirs from the

study; and, create configuration notes for individual reservoirs. All of these tasks are accomplished through the reservoir shortcut menu (Figure G.7). To access the reservoir shortcut menu, from a schematic, and with the **Reservoir Tool** (on the map toolbar, press the **Reservoir Tool** ) selected, right-click on a reservoir.

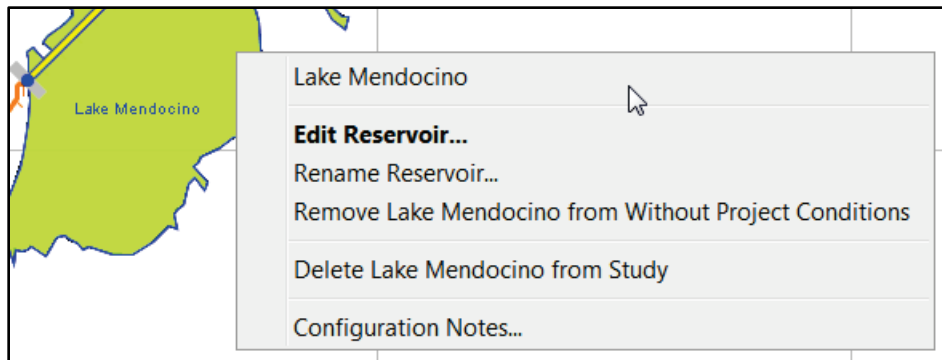


Figure G.7 Reservoir Shortcut Menu

## Edit a Reservoir

The user can edit the properties of a reservoir. Properties that can be changed are the description, whether the reservoir is an existing project, whether the reservoir is a Corps project, and the year the reservoir came on-line.

To edit reservoir properties:

1. Right-click on the reservoir whose properties need to be changed, and click **Edit Reservoir** from the reservoir shortcut menu (Figure G.7).
2. The **Reservoir Properties Editor** will open (Figure G.8). From the **Description** box you can edit or add a description.

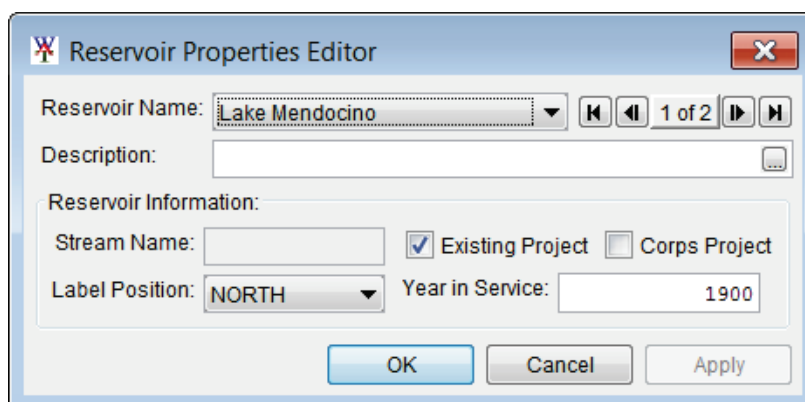


Figure G.8 Reservoir Properties Editor

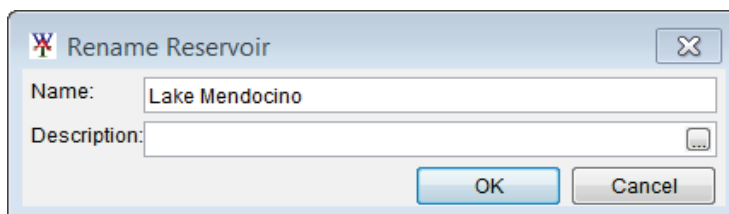
3. If the selected reservoir is an existing project, select the **Existing Project** check box (Figure G.8).
4. If the reservoir is a Corps project, select the **Corps Project** check box.

5. Enter the year the reservoir came on-line in the **Year in Service** box (Figure G.8). For Version 1.0 this is just informational and is not used in any computation.

## Rename a Reservoir

To rename a reservoir:

1. Right-click on the reservoir that needs to be renamed, and click **Rename Reservoir** from the reservoir shortcut menu (Figure G.7).
2. The **Rename Reservoir** dialog box will open (Figure G.9). Enter the new **Name** (required) and **Description** (optional, but recommended) for the reservoir.



**Figure G.9** Rename Reservoir Dialog Box

3. Click **OK**, a **Confirm Rename** warning message will open asking the user for confirmation. Click **Yes**, the warning message and the **Rename Reservoir** dialog box will close, and the reservoir will display the new name.

## Remove a Reservoir from a Schematic

HEC-WAT allows the user to remove reservoirs from existing schematics. The reservoir will be removed from the schematic, but not from the study.

To remove a reservoir from a schematic:

1. Right-click on the reservoir to be removed from the active schematic, and click **Remove ReservoirName from SchematicName** from the reservoir shortcut menu (Figure G.7).
2. A warning message will open asking the user confirmation about removing the selected reservoir from the current schematic. Click **Yes**, the warning message will close, and the reservoir will disappear from the schematic.

## Delete a Reservoir

To delete a reservoir:

1. Right-click on the reservoir to be deleted, and click **Delete ReservoirName from Study** from the reservoir shortcut menu (Figure G.7).

2. A **Confirm Delete** warning message will open asking for user confirmation to delete the selected reservoir. Click **Yes**, another warning message will open asking the user if you wish to delete the computation points associated with the reservoir. Click **Yes**, the warning message will close. The reservoir and computation points will no longer appear in the schematic and will have been removed from the study.

## Add Schematic Notes for a Reservoir

Schematic notes allow you to add information about a reservoir specific to a schematic. Schematic notes are helpful when multiple schematics have been defined.

To add schematic notes for a reservoir:

1. Right-click on the reservoir that you want to add schematic notes to, and click **Configuration Notes** from the reservoir shortcut menu (Figure G.7).
2. The **Notes:** dialog box (Figure G.10) will open. Enter information in the **Configuration Notes** box that describes the selected reservoir for the current schematic.

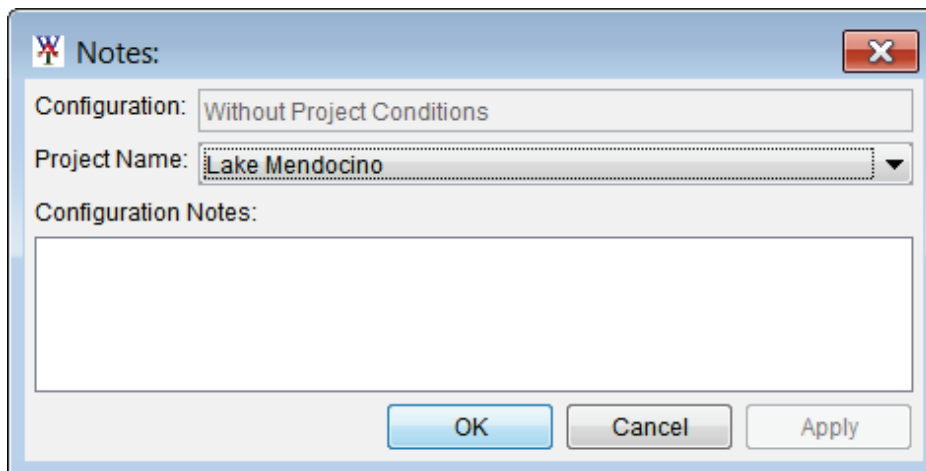



Figure G.10 Notes: Dialog Box - Reservoir

## Graphically Edit a Reservoir

After creating a reservoir, the reservoir can be edited graphically. By using the **Reservoir Tool** , the **CTRL** key, and the **SHIFT** key, the user can edit a reservoir by adding, moving, and deleting vertex points. This edit is performed graphically on the schematic in the active map window.

## Add Vertices to a Reservoir

To add vertex points to an existing reservoir:

1. Double-click on the reservoir that you want to add a vertex point to, and the polygon will turn green.

2. Place the pointer on the selected reservoir where a vertex point needs to be added. Hold down the **CTRL** key and click. A blue point will now appear on the selected reservoir, which represents a new vertex point.

## Move the Vertices of a Reservoir

To move vertex points on an existing reservoir:

1. Double-click on the reservoir where the user wants to move a vertex point. The selected reservoir will turn green, and the individual vertex points will turn blue.
2. Click on the vertex point that needs to be moved, and drag the vertex point to a new location.

## Delete Vertices from a Reservoir

To delete vertex points from an existing reservoir:

1. Double-click on the reservoir where the user wants to delete a vertex point. The selected reservoir will turn green, and the individual vertex points will turn blue.
2. Hold down the **SHIFT+CTRL** keys, and click on the vertex point that needs to be deleted. The vertex point will disappear from the reservoir.

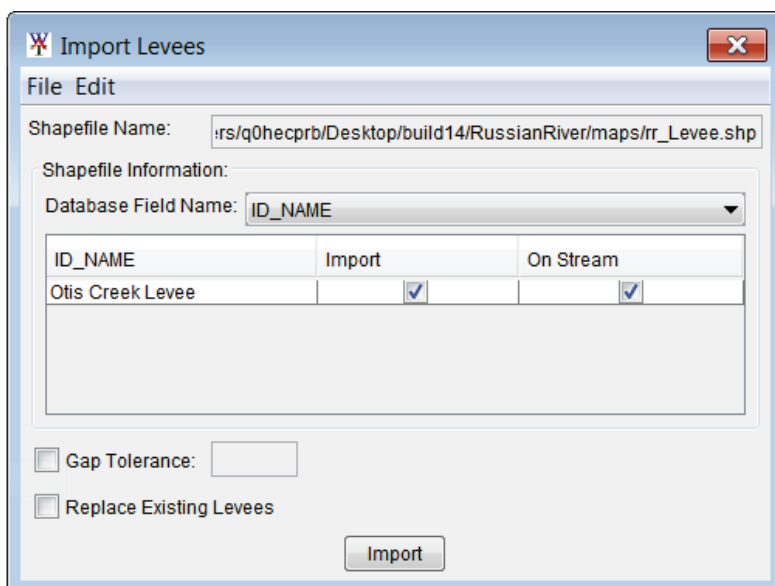
## G.2 Levees

A **levee/floodwall** is a man-made barrier built along a stream to provide protection from flooding. A levee/floodwall can reduce flood damage by preventing flood stages from reaching a potential damage area.

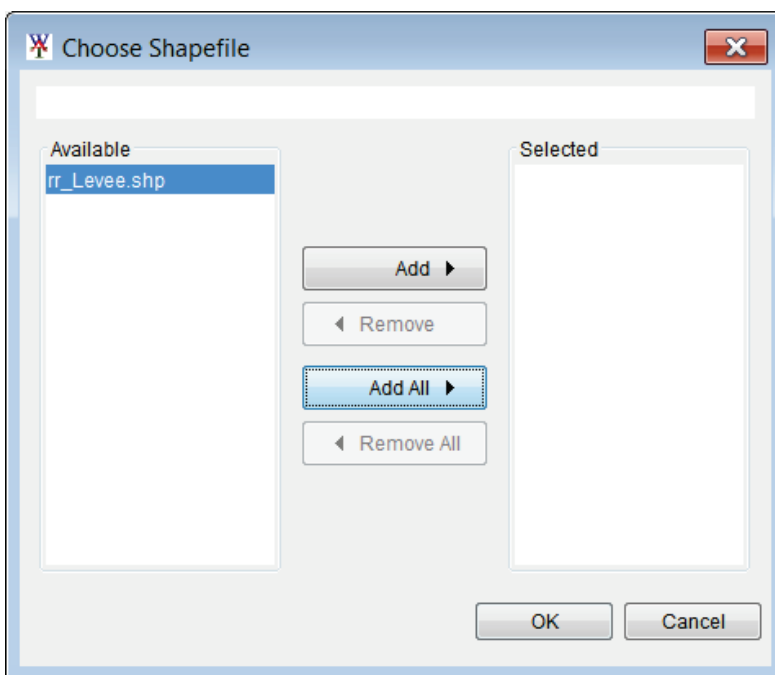
### G.2.1 Import Levees

The user can either import levees from a shapefile or digitize levees by hand (Section G.2.2). The following are the steps for importing levees:

1. From the HEC-WAT main window (Figure G.1), from the **Maps** menu, point to **Import**, click **Levees**.
2. The **Import Levees** dialog box will open (Figure G.11). The **Shapefile Name** box defaults to the first line shapefile it can find in the **maps** directory. For example in Figure G.11, HEC-WAT selected the *rr\_Levee.shp* shapefile, which is the correct file.
3. If the map layer that represents the levees does not display in the **Shapefile Name** box (Figure G.11), from the **File** menu of the **Import Levees** dialog box (G.11), click **Choose Shapefile**. A **Choose Shapefile Selector** will open (Figure G.12). From the **Available**



**Figure G.11** Import Levees Dialog Box



**Figure G.12** Choose Shapefile Selector

box, select the shapefile that represents the levees of the study area, click **Add**. The selected shapefile name will now appear in the Selected box (G.12). Click **OK**, the **Choose Shapefile Selector** will close (Figure G.12), and the name of the selected shapefile will display in the **Shapefile Name** box of the **Import Levees** dialog box (Figure G.11).



- From the **Database Field Name** list (Figure G.11), the user needs to select the field name in the attribute file that contains the names of the levees – **ID\_Name**. Once a field name is selected, the table below will populate with the levees contained in the shapefile. If there is an issue with any of the levee segments the checkbox in the **Import** column

(Figure G.11) will not be selected. This means the levee is not continuous and will not be imported.

5. Click **Import**, the **Import Levees** dialog box will close (Figure G.11). Once the import of the levees is completed, a message window will appear letting the user know that the levees have been imported successfully. In the active **Map Window** the levees appear (black lines along the stream alignment).

## G.2.2 Create a Levee

To create levees, the study must have a valid stream alignment (Appendix F), once the stream alignment has been created, the following steps for adding levees to the study:

1. From the HEC-WAT main window (Figure G.1), from the **Study Pane**, from the **Study Tree**, under the **Simulations** folder, double click on the schematic that requires the addition of reservoirs (e.g., *Schematic:WithoutProjectConditions*). A **Schematic Map Window** will open in the **Desktop Pane** that displays a stream alignment.
2. To assist the user in the location of a levee(s), a map layer that displays levee locations for the study area should be added to the study (Chapter 5).
3. From the map window toolbar, press the **Zoom Tool** , zoom into an area on the map window where a levee is located. On the map window toolbar, press the **Levee Tool** .
4. Hold down the **CTRL** key and click on the stream alignment to place the upstream end of the levee. Release the **CTRL** key, drag the mouse to the downstream end of the levee and click.
5. The **Name New Levee** dialog box opens (Figure G.13). Enter the new **Name** (required) and **Description** (optional, but recommended). Click **OK**, the **Name New Levee** dialog box will close.

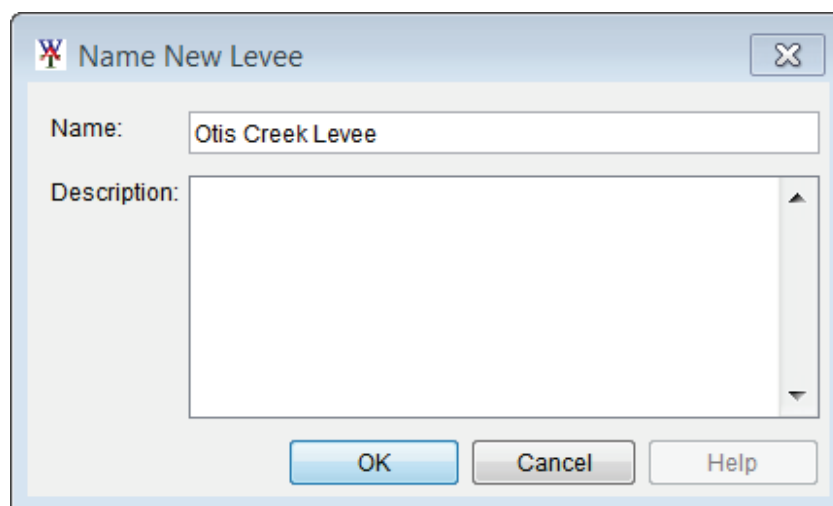


Figure G.13 Name New Levee Dialog Box



- The levee will now appear on the schematic as a black line, as shown in Figure G.14.

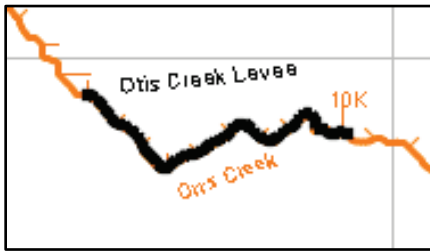



Figure G.14 A Levee Added to the Schematic

## G.2.3 Existing Levees

After adding a levee to the schematic, the user can edit the levee; the user can rename an individual levee; remove a levee from the active schematic, delete individual levees from the study; and, create configuration notes for individual levees. All of these tasks are accomplished through the levee shortcut menu (Figure G.15). To access the levee shortcut menu, from a schematic, and with the **Levee Tool** (on the map toolbar, press the **Levee Tool** ) selected, right-click on a levee.

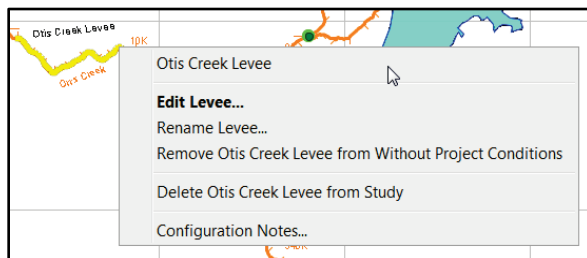


Figure G.15 Levee Shortcut Menu

## Edit a Levee

The user can now edit the properties of an existing levee. Properties that can be changed are: the description of the levee; whether the levee is an existing project; whether the levee is a Corps project; the year the levee came on-line; what stream the levee is located on; the start and end stations of the levee; adjust the distance (offset) from the stream the levee is placed; and, what stream bank the levee is located on.

To edit levee properties:

- Right-click on a levee, and click **Edit Levee** from the levee shortcut menu (Figure G.15).
- The **Levee Properties Editor** will open (Figure G.16).
- From the **Description** box (Figure G.16) the user can edit or add a description.
- If the selected levee is an existing project, click **Existing Project**.

**Levee Properties Editor**

Levee Name: **Otis Creek Levee** 1 of 1

Description:

**Levee Information:**

Stream	Start Station	End Station	Start Elevation	End Elevation
Orrs Creek	9,918.643	19,046.902		

Most likely breach elevation (from top of levee):

☒ Follows Stream ☐ Existing Project ☐ Corps Project

Bank: **Left** Average Offset: 50

Year In Service: 1900

OK Cancel Apply

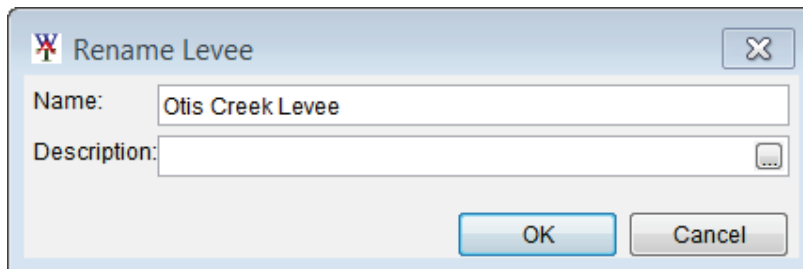
**Figure G.16** Levee Properties Editor

5. If the levee is a Corps project, select **Corps Project** (Figure G.16).
6. The table (Figure G.16) displays what stream the levee is on and the stream stationing for the starting and ending stations of the levee. If the user wants to change the starting and ending stations of the levee, edit the cells under the **Start Station** and **End Station** columns in the table.
7. HEC-WAT automatically determines the stream bank location of the levee. If the user wants to change the stream bank location, from the **Bank** list (Figure G.16) select the appropriate stream bank.
8. If the user knows what year the levee came on-line, enter a year in the **Year in Service** box. For HEC-WAT Version 1.0 this is just informational and is not used in any computation.
9. When a levee is created, a default-offset distance from the stream alignment is set. The default offset is shown in the **Average Offset** box (Figure G.16) and is 50. To change the offset, in the **Average Offset** box change the value, click **Apply**. The levee on the schematic will move according to the new offset value.
10. Click **OK**, the **Levee Properties Editor** (Figure G.16) will close.

## Rename a Levee

To rename a levee:

1. Right-click on the levee that needs to be renamed, and click **Rename Levee** from the levee shortcut menu (Figure G.15).
2. The **Rename Levee** dialog box will open (Figure G.17). Enter the new **Name** (required) and **Description** (optional, but recommended) for the levee.



**Figure G.17** Rename Levee Dialog Box

3. Click **OK**, a **Confirm Rename** warning message will open asking the user if you really want to rename the selected levee. Click **Yes**, the warning message and the **Rename** dialog boxes will close, and the levee will display the new name.

## Remove a Levee from a Schematic

HEC-WAT allows the user to remove levees from existing schematics. The levee will be removed from the schematic, but not from the study. To remove a levee from a schematic, right-click on the levee that is to be removed from the active schematic, and click **Remove LeveeName from SchematicName** from the levee shortcut menu (Figure G.15). The levee no longer appears on the schematic.

## Delete a Levee

To delete a levee:

1. Right-click on the levee that is to be deleted, and click **Delete LeveeName from Study** from the levee shortcut menu (Figure G.15).
2. A **Confirm Delete** warning message will open asking the user for confirmation to delete the selected levee. Click **Yes**, the warning message will close, the levee will no longer appear in the schematic and has been removed from the study.

## Add Schematic Notes for a Levee

Schematic notes allow the user to add information about a levee specific to a schematic. Schematic notes are helpful when multiple schematics have been defined.

To add schematic notes for a levee:

1. Right-click on the levee that the user wants to add schematic notes to, and click **Configuration Notes** from the levee shortcut menu (Figure G.15).
2. The **Notes:** dialog box will open (Figure G.18). Enter information in the **Configuration Notes** box that describes the selected levee for the current schematic.

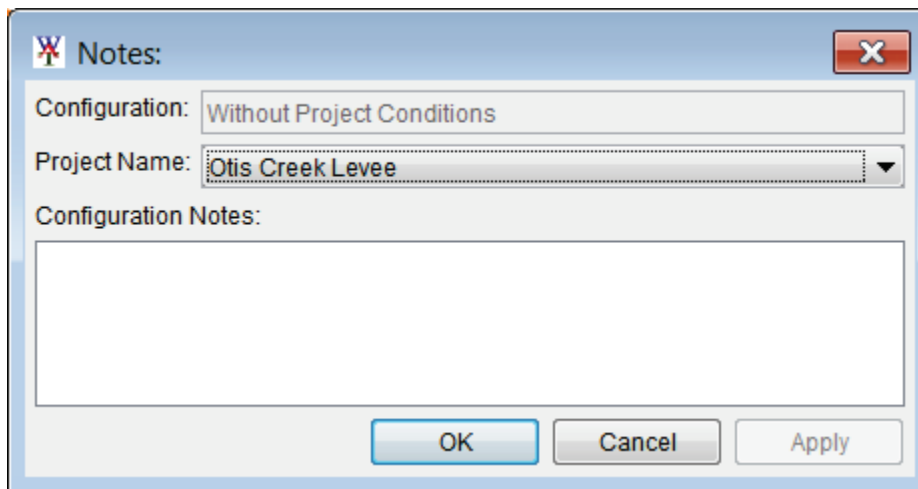


Figure G.18 Notes: Dialog Box - Levee

## G.2.4 Save Measure Data

To save data for measures, on the **File** menu, click **Save Study**. This will save all of the data for measures to the appropriate files created and used by HEC-WAT for measures.

# Appendix H

## Common Computation Points (CCPs)

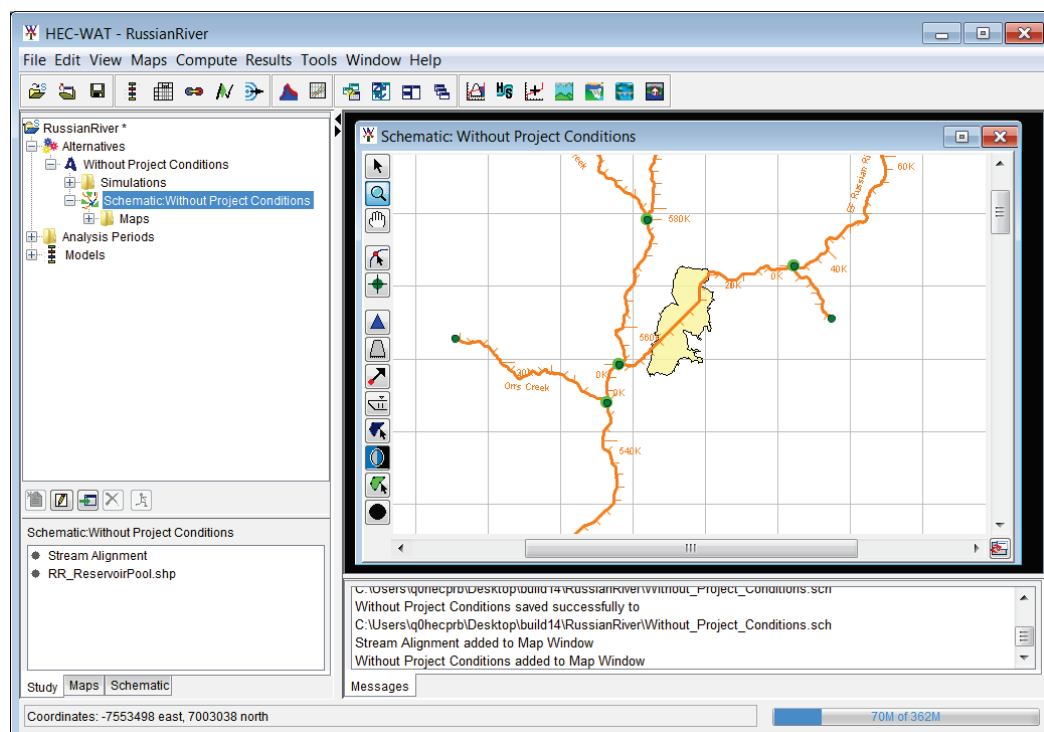
**Common computation points (CCPs)** are locations where one model transfers data to another model, where results are needed for model development or alternative analysis, and, where input boundary conditions are to be defined. The CCPs need to be consistent for all models and should be placed on the stream alignment based on knowledge of possible study alternatives. The entire study team should be involved in the definition of the CCPs.

### H.1 Import Common Computation Points

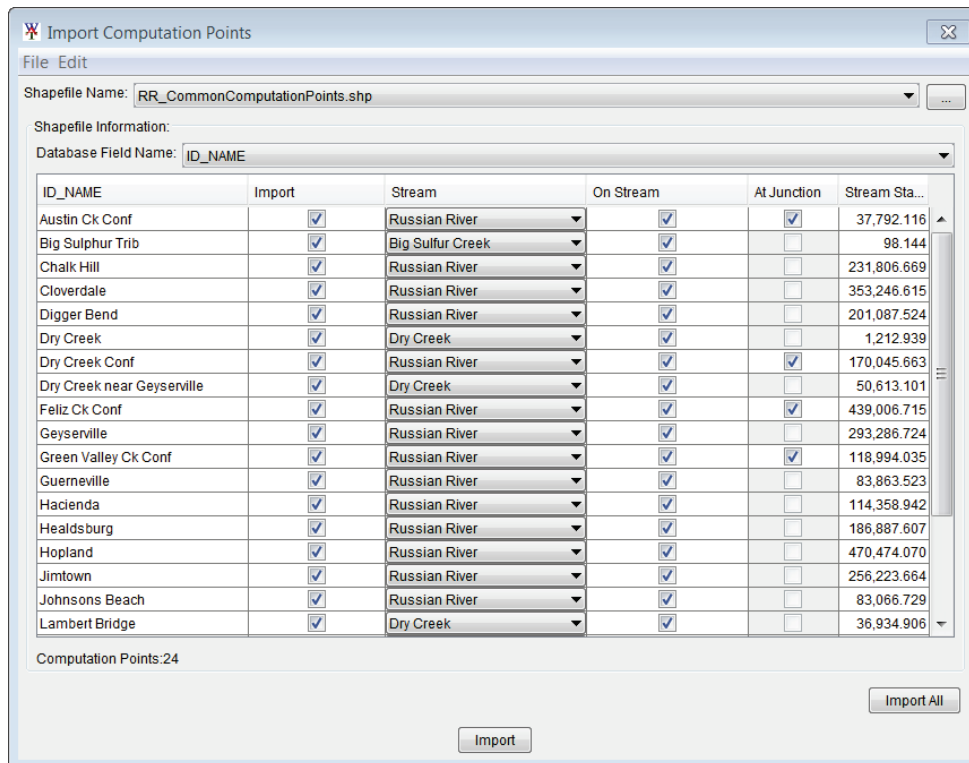
To import CCPs, an active map layer (Chapter 5) that is a shapefile that represents the CCPs for the study area must be present. This shapefile must have an attribute that is the name of each CCP, and each CCP must be a point.

To import CCPs from a shapefile:

1. From the HEC-WAT main window (Figure H.1), from the **Maps** menu, point to **Import**, click **Computation Points**. The **Import Computation Points** dialog box will open (Figure H.2). The **Shapefile Name** box figures looks for available point shapefiles in the **maps** directory of the HEC-WAT study; from the box the shapefile that represents the CCPS for the study is displayed (e.g., *RR\_CommonComputationPoints.shp*).

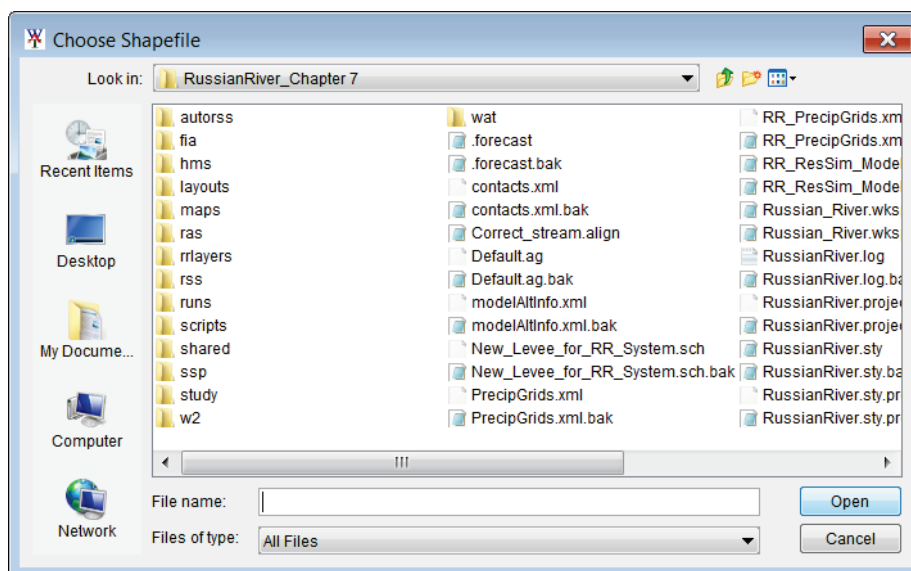


**Figure H.1** HEC-WAT Main Window



**Figure H.2** Import Computation Points Dialog Box

- If the shapefile is not in the maps directory of the HEC-WAT study, from the **Import Computation Points** dialog box (Figure H.2), from the **File** menu, click **Choose Shapefile**. The **Choose Shapefile Browser** (Figure H.3) will open and the user can browse to the location of the shapefile. Double-click on the filename and the name will appear in the **File name** box. Click **Open**, the **Choose Shapefile Browser** will close and the name of the shapefile will display on the **Import Computation Points** dialog box in the **Shapefile Name** list (Figure H.3).




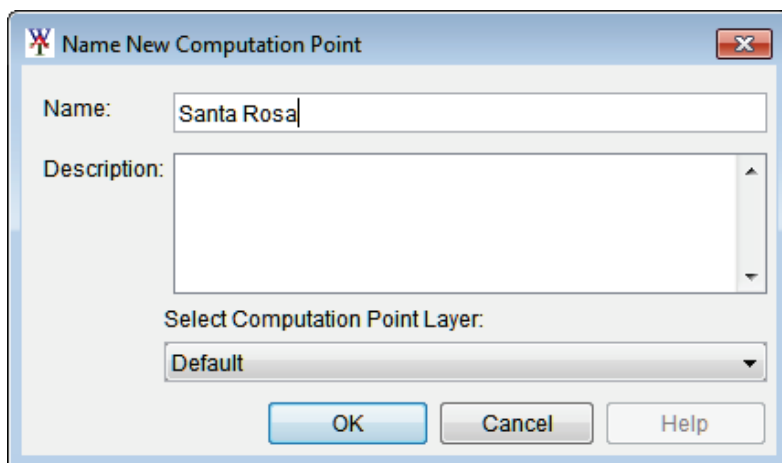
**Figure H.3** Choose Shapefile Browser

3. From the **Database Field Name** list (Figure H.2), the user needs to select the field name in the attribute file that contains the names of the CCPs - **ID\_Name**. Once a field name is selected, the table below will populate with the CCPs contained in the shapefile. If there is an issue with any of the CCPs the checkbox in the **Import** column will not be selected.
4. Click **Import**, the **Import Computation Points** dialog box will close (Figure H.2). Once the import of the CCPs is completed, a message window will appear letting the user know that the CCPs have been imported successfully. In the active **Map Window** the CCPs appear as black circles.

## H.2 Create a Common Computation Point

To add a common computation point:


1. From the HEC-WAT main window (Figure H.1), from the **Schematic Tab**, on the **Schematics** folder, right-click on the schematic that requires a CCP be added. From the shortcut menu, click **Display in Map Window**; a schematic map window will open.
2. On the map toolbar, press the **Computation Point Tool** .
3. Hold down the **CTRL** key and click on the stream alignment to place the CCP.
4. The **Name New Computation Point** dialog box will open (Figure H.4). Enter the new **Name** (required) and **Description** (optional, but recommended). Click **OK**, the **Name New Computation Point** dialog box will close.
5. The CCP will now appear in the map window as a black circle.

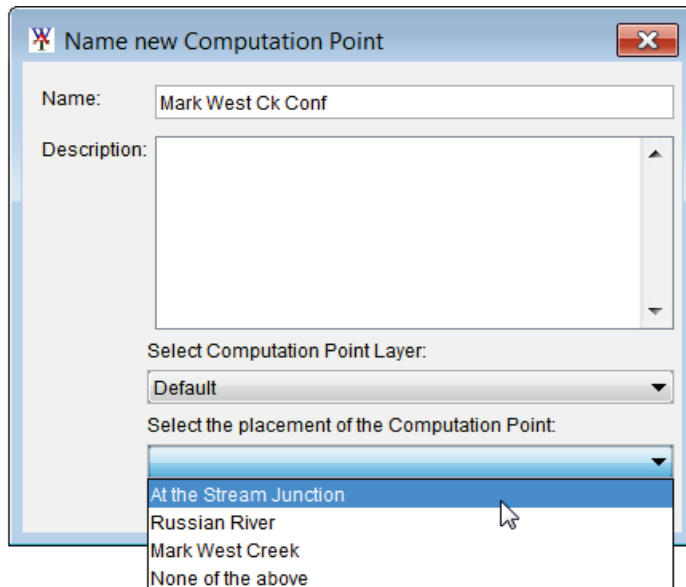


**Figure H.4** Name New Computation Point Dialog Box

To add a CCP at a stream junction (Appendix F):

1. From the **Schematic Tab**, right-click on the schematic that requires a CCP to be added. From the shortcut menu, click **Display in Map Window**; a schematic map window will open.


2. On the map toolbar, press the **Computation Point Tool** .
3. Hold down the **CTRL** key, click on the stream junction to place a CCP
4. A slightly different **Name New Computation Point** dialog box will open (H.5). Enter the new **Name** (required) and **Description** (optional, but recommended).

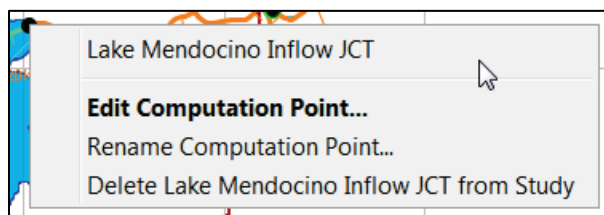


**Figure H.5** Name new Computation Point Dialog Box at a Stream Junction

5. From the **Select the Placement of the Computation Point** list (Figure H.5), determine exactly where the CCP will be placed. The user must decide to have the CCP placed on the stream junction; along one of the streams that form the stream junction; or, none of the above. For example, in Figure H.5, the CCP will be placed on the stream junction.
6. Click **OK**, the **Name New Computation Point** dialog box (Figure H.5) will close. The CCP will now appear in the display area as a black circle.

### H.3 Existing Common Computation Points

After drawing a CCP in the map window, the user can rename, delete, and edit individual CCP properties. All of these tasks are accomplished through the CCP shortcut menu (Figure H.6). To access the CCP shortcut menu, from a schematic map window, and with the **Computation Point Tool** (on the map toolbar, press the **Computation Point Tool** ) selected, right-click on a CCP.



**Figure H.6** Common Computation Point Shortcut Menu



### H.3.1 Edit a Common Computation Point

The general properties of a CCP that the user can edit include: the description; the stream; the position of the label on the map window; the stream stationing; the easting and northing; whether the CCP was system generated; what projects generated that CCP; and the location of the CCP on the stream alignment.

To edit CCP properties:

1. Right-click on the CCP whose properties need to be changed, click **Edit Computation Point** from the CCP shortcut menu (Figure H.6).
2. The **Computation Point Properties Editor** will open (Figure H.7). From the **Description** box the user can edit or add a description (recommended).

**Figure H.7** Computation Point Properties Editor

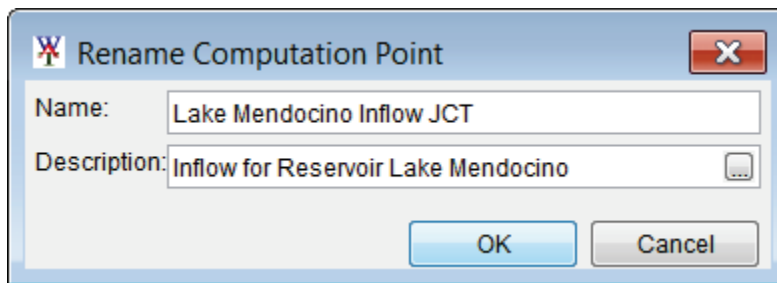
3. By default HEC-WAT automatically decides on the stream for the location of the CCP. The **Stream Name** box (Figure H.7) provides the user with this information and is not editable.
4. HEC-WAT automatically generates the stream station for the CCP. If the user wants to change the stream station, then enter a new value in the **Stream Station** box (Figure H.7) enter a new value.
5. The **Label Position** list allows the user to place the CCP label on the map window.
6. The location of the CCP is displayed by the northing and easting coordinates. These values are not editable.

7. By default, a CCP is placed on a stream in the stream alignment. If the user wishes to have a CCP that is not on a stream, clear the **Snap to Stream Element** check box (Figure H.7).
8. Once the **Snap to Stream Element** has been cleared, the user can edit the easting and northing coordinates of the CCP, and then the CCP can be moved off the stream alignment.

### H.3.2 Rename a Common Computation Point

To rename a CCP:

1. Right-click on a CCP, click **Rename Computation Point** from the CCP shortcut menu (Figure H.6).
2. The **Rename Computation Point** dialog box opens (Figure H.8). The new **Name** (required) and **Description** (optional, but recommended) are entered for the CCP.



**Figure H.8** Rename Computation Point Dialog Box

3. Click **OK**, a **Confirm Rename** warning message will open asking the user if you really want to rename the selected CCP. Click **Yes**, the warning message and the **Rename Computation Point** dialog box will close, and the CCP will display the new name.


### H.3.3 Delete a Common Computation Point

CCPs created with a project (i.e., reservoirs) or an impact area cannot be deleted. These CCPs are deleted when the project or impact area is deleted.

To delete a CCP:


1. Right-click a CCP, click **Delete ComputationPointName from Study** from the CCP shortcut menu (Figure H.6).
2. A **Confirm Delete** warning message will open for user confirmation to delete the selected CCP. Click **Yes**, the warning message will close and the CCP will no longer appear in the map window.

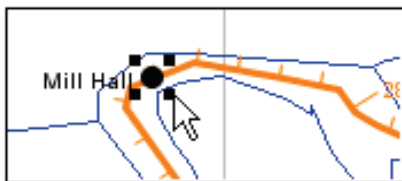
### H.3.4 Graphically Edit a Common Computation Point

After creating a CCP, the user can graphically edit a CCP. By using the **Computation Point Tool** , the user can move CCP. This edit is performed graphically on the schematic in the active map window.

#### Move a Common Computation Point

To move a CCP:

1. From the map toolbar, press the **Computation Point Tool** . Double click on a CCP (Figure H.9).



**Figure H.9** Move a Common Computation Point

2. The CCP now has four little black dots (handles) at each corner. Click and drag the CCP to where the CCP should be positioned, and release. The CCP will now appear on the map window in the new position.
3. The user will only be able to move the CCP along a stream. By default, a CCP must be on a stream. If the user does not want a CCP on the stream alignment, the user must change a setting in the editor (Section 1.2.2).

### H.4 Save Common Computation Point Data

To save data for CCPs, on the **File** menu, click **Save Study**. This will save all of the data for CCPs to the appropriate files created and used by HEC-WAT for CCPs.



# Appendix I

## Impact Areas

An **impact area** is any distinct portion of a study that is affected by rising or falling stage in a stream, river, lake, or reservoir. The boundaries of an impact area are defined by a closed polygon, and can be characterized by the effects of rising or falling stage that can be described by the property, project, and/or population at risk in the area bounded by the polygon. Impact areas are an optional element, and are only required when a user wants to compute impacts at damage area centers in the study area, and an HEC-FIA model is part of the HEC-WAT modeling effort.

The user can use underlying map layers to aid in importing impact areas (Section I.1) into the schematic or placing impact areas at the proper location on the schematic (Section I.2). Besides location, a map layer can also give the user a concept of the dimensions of an impact area. However, HEC-WAT Version 1.0 does not have any geo-referencing attached to the impact area polygon.

### I.1 Import Impact Areas

To import impact areas, an active map layer (Chapter 5) that is a shapefile (Chapter 5) that represents the impact areas should be available. This shapefile must have an attribute that is the name of each impact area, and each impact area must form a contiguous polygon.

To import impact areas from a shapefile:

1. From the HEC-WAT main window (Figure I.1), from the **Maps** menu, point to **Import**, click **Impact Areas**. The **Import Impact Areas** dialog box will open (Figure I.2). The **Shapefile Name** box figures out whether there are any polygon shapefiles available in the **maps** directory; from the box the shapefile that represents the impact areas for the study display (e.g., *RR\_ImpactAreas.shp*).
2. If the shapefile is not in the maps directory of the HEC-WAT study, from the **Import Impact Areas** dialog box (Figure I.2), from the **File** menu, click **Choose Shapefile**. The **Choose Shapefile Browser** (Figure I.3) will open and the user can browse to the location of the shapefile. Double-click on the filename and the name will appear in the **File name** box. Click **Open**, the **Choose Shapefile Browser** will close and the name of the shapefile will display on the **Import Impact Areas** dialog box in the **Shapefile Name** list (Figure I.2).
3. From the **Database Field Name** list (Figure I.2), the user needs to select the field name in the attribute file of the impact areas - **ID\_Name**. Once a field name is selected, the table below will populate with the impact areas contained in the shapefile. If there is an issue with any of the impact areas the checkbox in the **Import** column will not be selected.

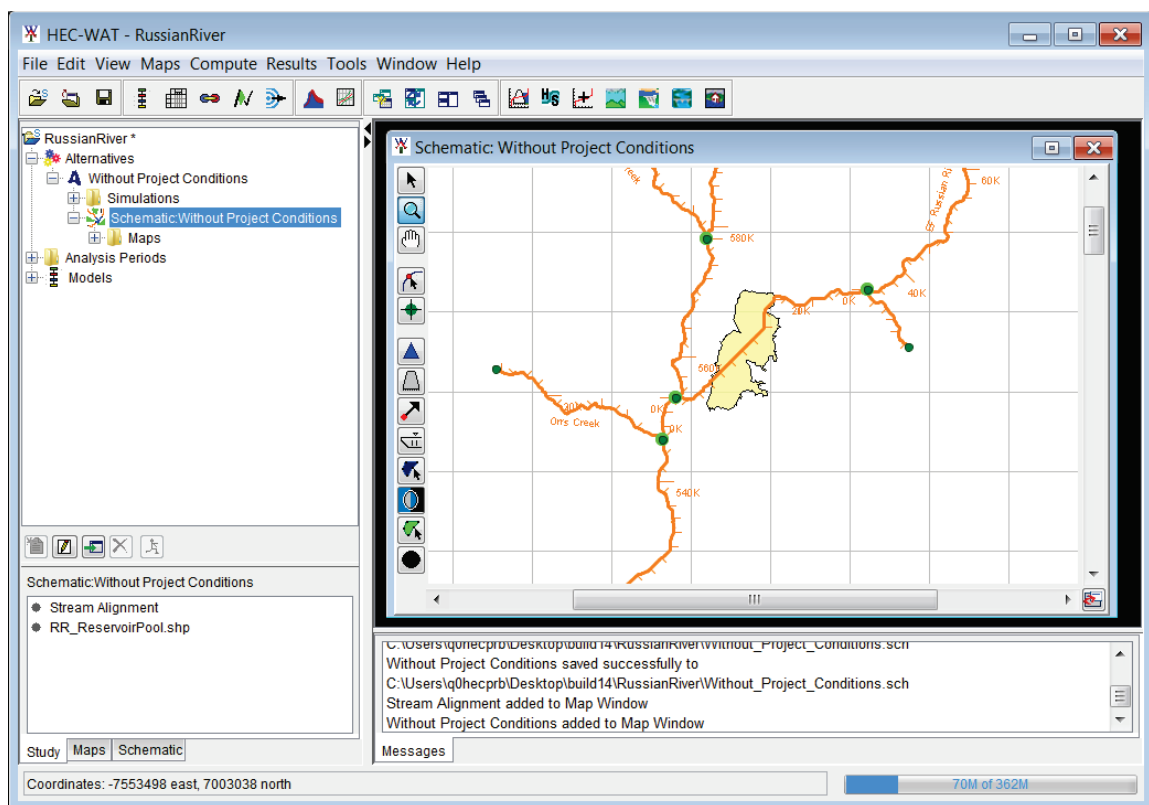


Figure I.1 HEC-WAT Main Window

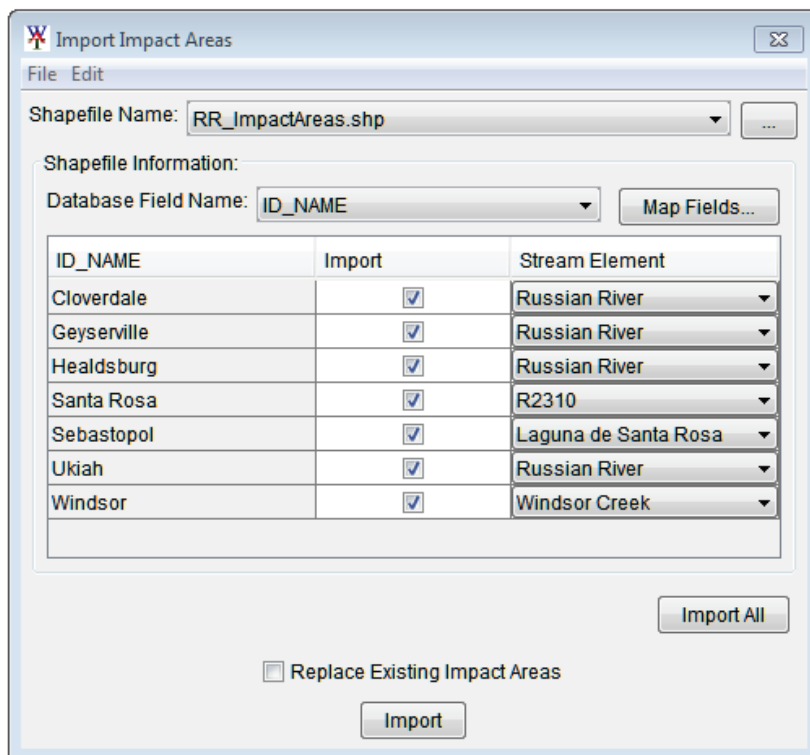
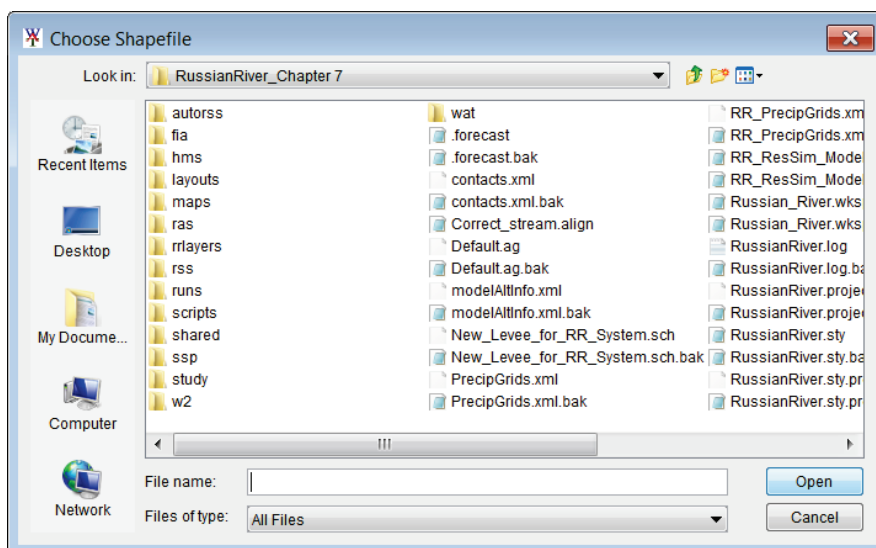


Figure I.2 Import Impact Areas Dialog Box




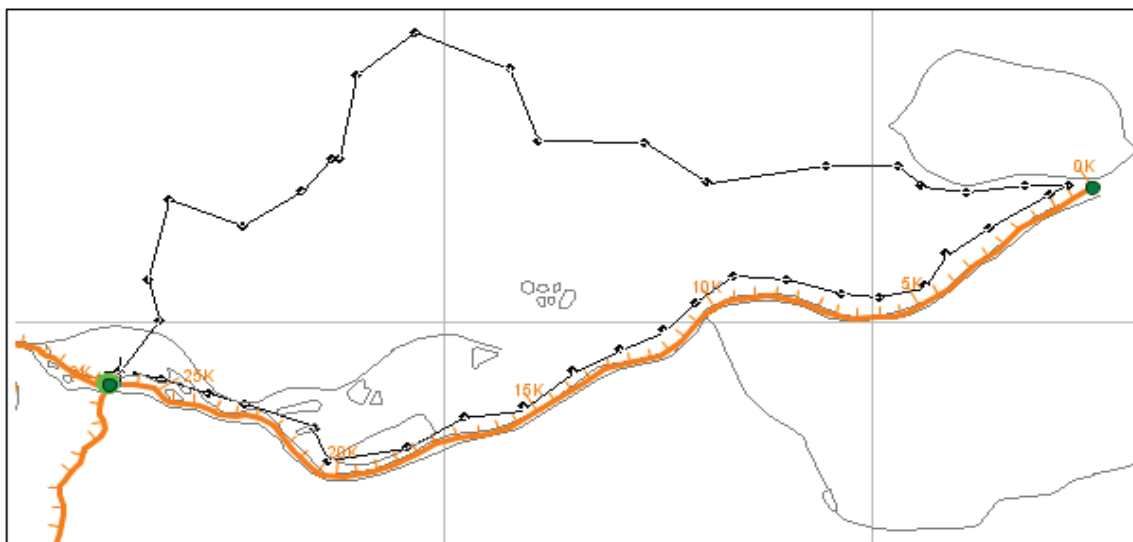
**Figure I.3** Choose Shapefile Browser

4. With the correct database field name selected, the table will list the impact area names. If each impact area is a contiguous polygon, then the check box in the **Import** column of the table (Figure I.2) will be set. If there is something wrong with the polygon that represents an impact area, the check box will not be set, and HEC-WAT will not import that impact area.
5. **Replace Existing Impact Areas** (Figure I.2) allows the user to replace the existing impact areas with the impact areas they will be imported from the selected ArcView® shapefile.
6. Click **Import**, the **Import Impact Areas** dialog box will close (Figure I.2). Once the import of the impact areas is completed, a message window will appear letting the user know that the impact areas have been imported successfully. In the active **Map Window** the impact areas appear as green polygons.

## I.2 Create an Impact Area

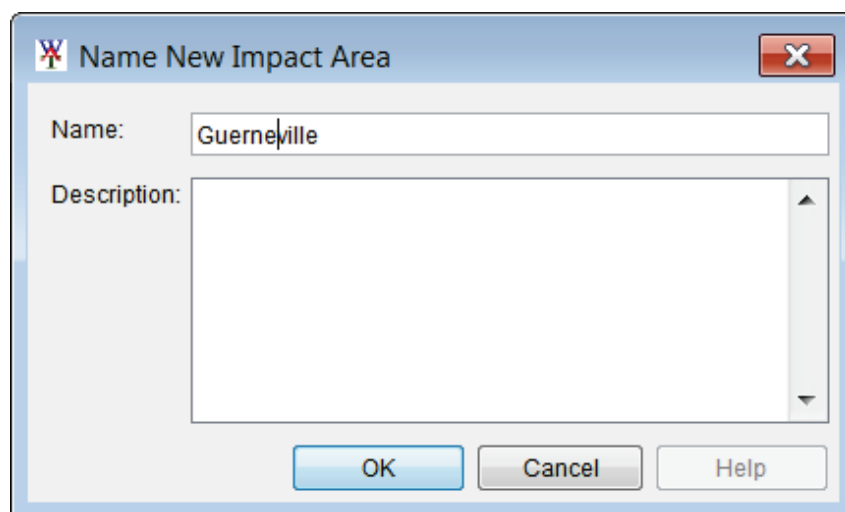
To creating an impact area on the schematic:

1. From the HEC-WAT main window (Figure I.1), from the **Schematic Tab**, from the **Schematics** folder, right-click on the schematic on the location where an impact area needs to be added. From the shortcut menu, click **Display in Map Window**; a schematic map window will.
2. On the map toolbar, press the **Impact Area Tool** .
3. Hold down the **CTRL** key while clicking the mouse button. Each click creates a vertex point (Figure I.4), which is the boundary of the polygon. When reaching the end point, release the **CTRL** key and click.



**Figure I.4** Add an Impact Area to the Schematic


4. The **Name New Impact Area** dialog box will open (Figure I.5). The user must enter a name, and if needed, enter a description. Click **OK**, the **Name New Impact Area** dialog box will close.



**Figure I.5** Name New Impact Area Dialog Box

5. The impact area will now appear in the display area as a green polygon with a name. Repeat Steps 3 and 4 for each impact area in your watershed.

## I.3 Existing Impact Areas

After drawing an impact area on the schematic, the user can edit properties, rename, delete, and create schematic notes for individual impact areas. All of these tasks are accomplished through the impact area shortcut menu (Figure I.6). To access the impact area shortcut menu, from a schematic, and with the **Impact Area Tool** (on the map toolbar, press the **Impact Area Tool**  selected, right-click on an impact area.



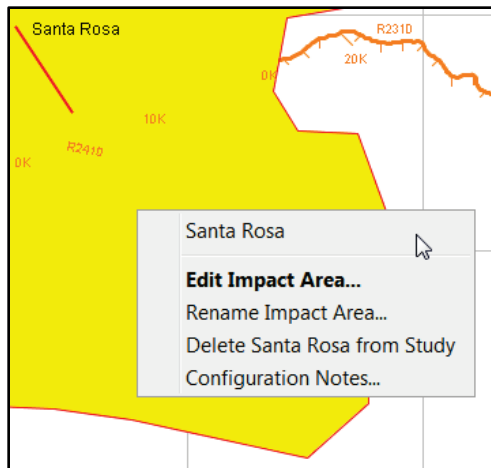


Figure I.6 Impact Area Shortcut Menu

### I.3.1 Edit an Impact Area

In a schematic, the user can describe the general and aesthetic properties of an impact area. The impact area properties that the user can edit in a schematic include: the description;

the stream; the bank of the stream the impact area is on; the color of the impact area polygon; the position of the impact area label on the display area; the geographical location of the index station; and, the geographical location of the beginning and ending stations of the impact area polygon.

To edit impact area properties:

1. Right-click an impact area and click **Edit Impact Area** from the available shortcut menu (Figure I.6). The **Impact Area Properties Editor** will open (Figure I.7). From the **Description** box (Figure I.7) the user can edit or add a description.

Figure I.7 Impact Area Properties Editor

2. If the **Auto** check box is selected for an item, the value for this data item is automatically updated as the polygon or index location is moved in the display area. By default, when a polygon is drawn in the display area, these values are filled in automatically. If the check box is cleared, data can be entered manually into these fields, and the value will not be automatically updated if changes are made to the polygon. However, reselecting the check box allows the values to be automatically determined when edits are made in the display area.
3. If the default stream name selected by HEC- WAT is incorrect, clear the **Auto** check box, and from the **Stream Name** list select the appropriate stream name.
4. If the default bank selected by HEC-WAT is incorrect, clear the **Auto** check box (Figure I.7), and select the appropriate stream bank from the **Bank** box.
5. By default, the color of an impact area polygon is green. The user can change the color by selecting a different color from the **Color** list.
6. The **Label Position** list (Figure I.7) allows the user to place the impact area label on the display area.
7. For each impact area, HEC-WAT generates an index station; this index station is a location. If the user wants to place the index station manually, clear the **Auto** check box next to the **Index** box (Figure I.7), and then enter the new stream stationing in the **Index** box.
8. HEC-WAT automatically computes a beginning and ending station for each impact area. If the user wants to change the stream stationing the program has generated, clear the **Auto** check box next to the **Upstream** and **Downstream** boxes, and enter the new stream stationing in the **Upstream** box and the **Downstream** box. Click **OK**, the **Impact Area Properties Editor** (Figure I.7) will close.

## Rename an Impact Area

To rename an impact area:

1. Right-click an impact area and click **Rename Impact Area** from the impact area shortcut menu (Figure I.6).
2. The **Rename Impact Area** dialog box will open (Figure I.8). Enter the new **Name** (required) and **Description** (optional, but recommended impact areas).
3. Click **OK**, a **Confirm Rename** warning message will open asking the user if you really want to rename the selected impact area. Click **Yes**, the warning message and the **Rename Impact Area** dialog boxes will close, and the impact area will display the new name.

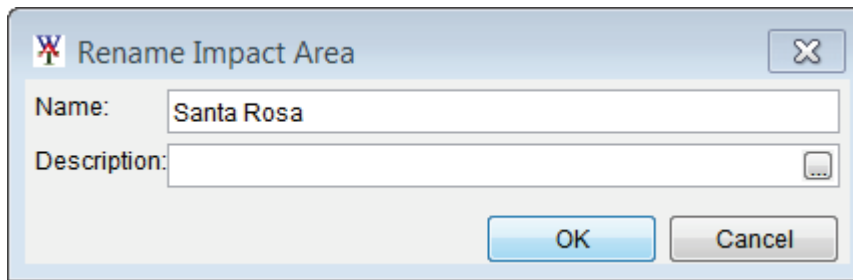


Figure I.8 Rename Impact Area Dialog Box

## Delete an Impact Area

To delete an impact area:

1. Right-click an impact area and click **Delete *ImpactAreaName* from Study** from the impact area shortcut menu (Figure I.6).
2. A **Confirm Delete** warning message will open asking the user if you really want to delete the selected impact area. Click **Yes**, the warning message will close, and the impact area will no longer appear in the display area.

## Add Schematic Notes for an Impact Area

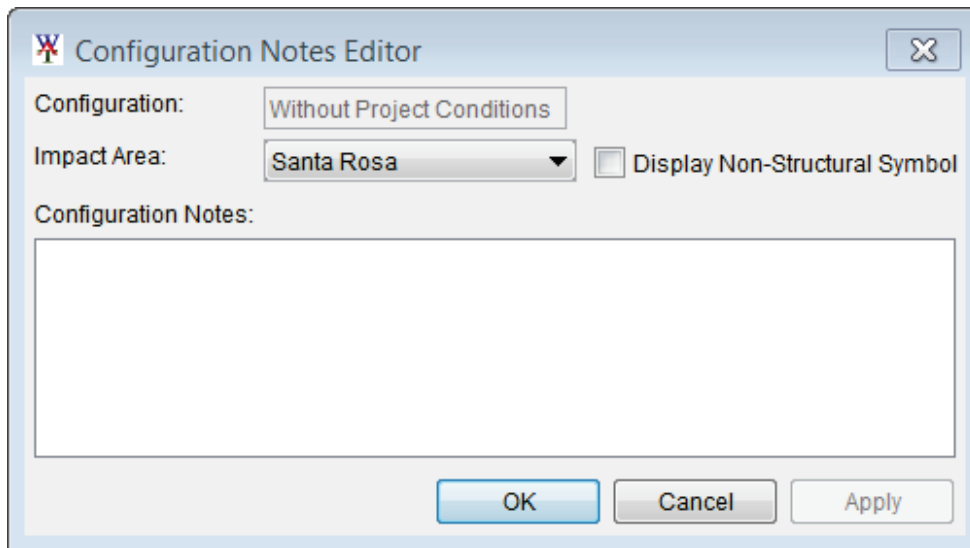
Schematic notes allow specific information about an impact area to be added to a schematic. This information is useful for describing impact areas that belong to schematics that include non-structural measures. If there are non-structural attributes for an impact area, the user can have a symbol appear in the schematic for the selected impact area. Schematic notes are only added when other schematics have been defined.

To add schematic notes for an impact area:

1. Right-click an impact area and click **Configuration Notes** from the impact area shortcut menu (Figure I.6).
2. The **Configuration Notes Editor** will open (Figure I.9). The **Configuration** box displays the current schematic. Enter information about this impact area for the current schematic in the **Configuration Notes** box.
3. If the notes are in regards to non-structural attributes, select **Display Non-Structural Symbol**. This will cause a symbol to appear in the selected impact area on the schematic.

### I.3.2 Graphically Edit an Impact Area

The user can create and graphically edit the impact area. By using the **Impact Area Tool**, the **CTRL** key, and the **SHIFT** key, the user can edit an impact area by adding, moving, and deleting vertex points. This edit is performed graphically on the schematic in the active map window.



**Figure I.9** Configuration Notes Editor

## Add Vertices to an Impact Area

To add vertex points to an existing impact area:

1. Double-click an impact area, the impact area will turn yellow.
2. Place the pointer on the selected impact area where the user wants to add a vertex point. Hold down the **CTRL** key and click. A red point will now appear on the selected impact area, which represents a new vertex point.

## Move the Vertices of an Impact Area

To move vertex points on an existing impact area:

1. Double-click an impact area, the impact area will turn yellow, and the individual vertex points will turn red.
2. Click on the vertex point that needs to be moved, and drag the vertex point to a new location.

## Delete Vertices from an Impact Area

To delete vertex points from an existing impact area:

1. Double-click an impact area, the impact area will turn yellow, and the individual vertex points will turn red.
2. Hold down the **SHIFT+CTRL** keys and click on the vertex point that needs to be deleted. The vertex point will disappear from the impact area.

### I.3.3 Export Impact Areas

If the impact areas have been digitized, the user can save the impact areas as an ArcView® shapefile. To export impact areas the user must have impact areas in the schematic.

To export impact areas:

1. From the HEC-WAT main window (Figure I.1), from the **Maps** menu, point to **Export**, and then click **Impact Areas**.
2. A **Save** browser will open (Figure I.10). Enter a name in the **File name** box. Click **OK**, the **Save** browser will close, and the user will have an ArcView® shapefile of the displayed impact areas.

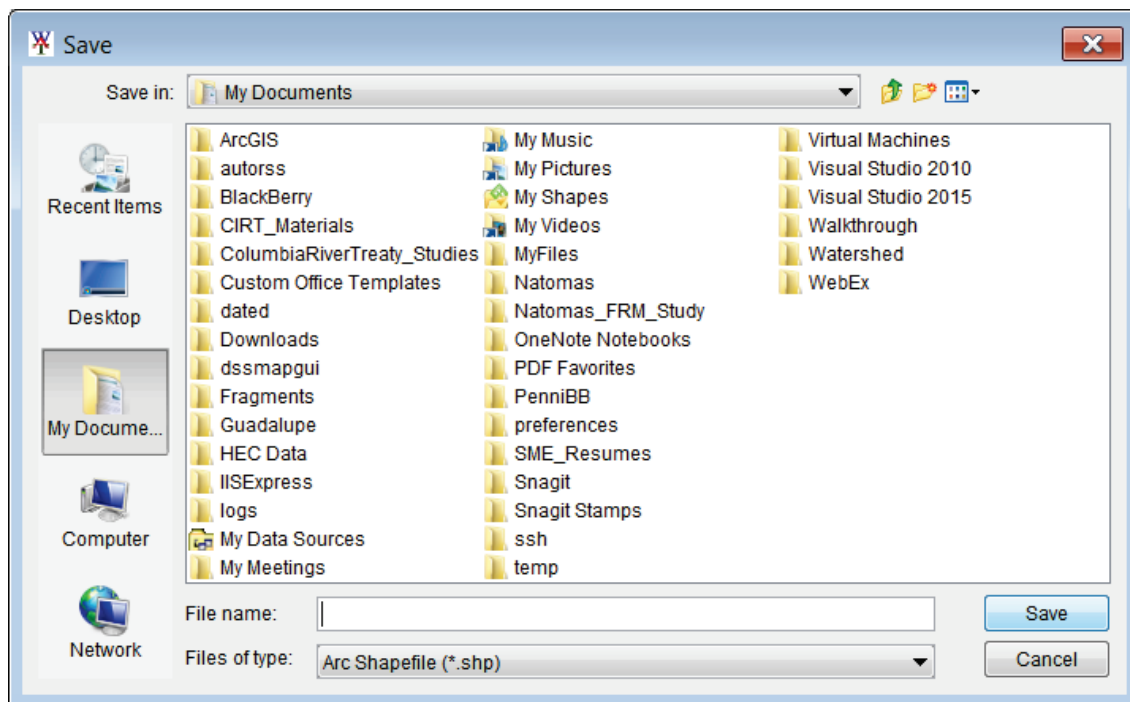


Figure I.10 Save Browser

### I.3.4 Save Impact Area Data

To save data for impact areas, from the **File** menu, click **Save Study**. This will save all of the data for impact areas to the appropriate files created and used by HEC-WAT for impact areas.



# Appendix J

## Using HEC-DSSVue

HEC-DSSVue (Hydrologic Engineering Center (HEC), Data Storage System Visual Utility Engine) is a graphical user interface program for viewing, editing, and manipulating data in HEC-DSS database files. With DSSVue, data may be plotted, tabulated, edited, and manipulated with over fifty mathematical functions. Along with these functions, DSSVue provides several utility functions, such as entering data sets into a database, renaming data set names, copying data sets to other DSS (HEC's Data Storage System) database files, and deleting data sets.


For HEC-WAT, the user will use HEC-DSSVue mainly as a viewing tool for DSS data. This appendix will review some of the general functions in HEC-DSSVue. For further detail, see the HEC-DSSVue User's Manual.

### J.1 HEC Data Storage System Concepts

HEC-DSS is a database system that was designed to efficiently store and retrieve scientific data that is typically sequential. Such data types include, but are not limited to, time series data, curve data, spatial-oriented gridded data, textual data (such as this manual), and others. The system was designed to make it easy for users and application programs to retrieve and store data.

The data are arranged into blocks. For example, one year of daily-interval data is stored in a single **record** in a DSS file. Each record is given a unique name called a pathname. The pathname is formulated in a way that makes it easy to group related data together. HEC software has the ability to read from and write to DSS files. This capability facilitates data exchange among applications. For example, a user could use HEC-ResSim to generate the time series input for HEC-FIA.

### J.2 Overview of HEC-DSSVue in the WAT

To access HEC-DSSVue, from the HEC-WAT main window, from the **Tools** toolbar (Chapter 3, Section 3.4), click . Alternatively, from the HEC-WAT main window, from the **Tools** menu, click **HEC-DSSVue**. Either way, the HEC-DSSVue main window opens. The main window and its different components are illustrated in Figure J.1.

The **Menu Bar** contains the menus for the main window of HEC-DSSVue. The following list is a description of the available menus.

<b>File</b>	This menu is used for DSS file management and contains the following command: <b>New Ver 6, New Ver 7, Open, Close DSS File, Print Catalog Preview, Print Catalog, and Close.</b>
-------------	---

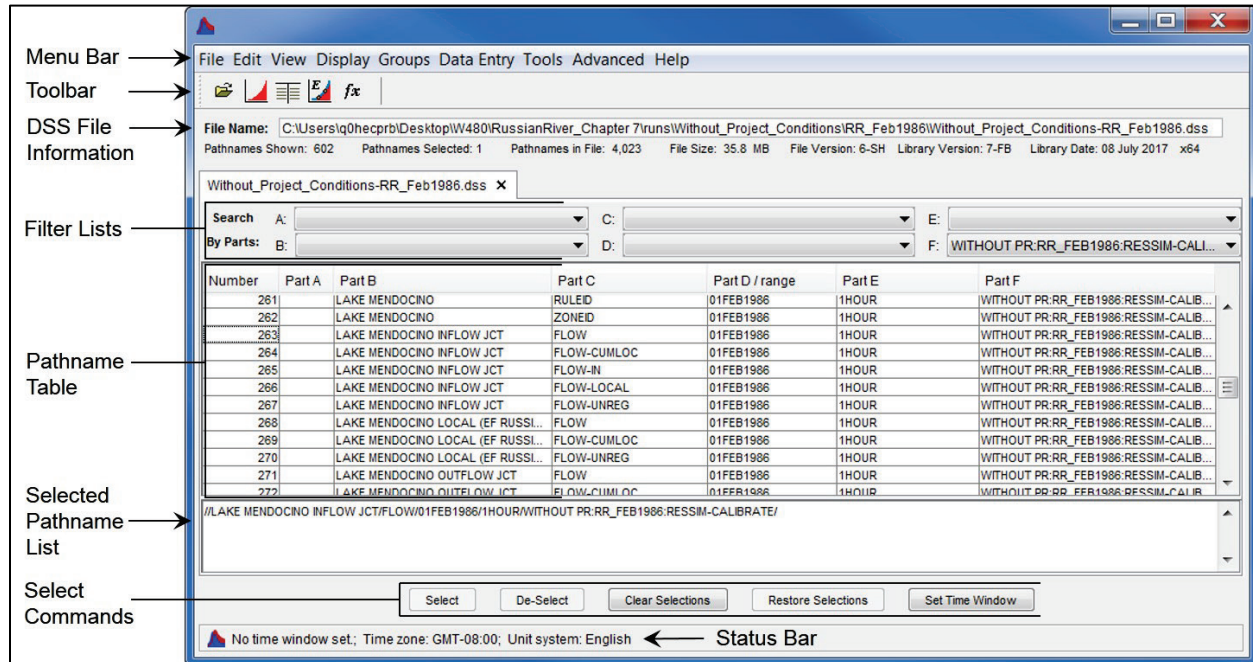


Figure J.1 HEC-DSSVue Main Window

- Edit** This menu provides editing functions and contains the following commands: **Tabular Edit, Graphical Edit, Select All, Rename Records, Delete Records, Undelete, Duplicate, Copy To, and Merge Copy.**
- View** This menu provides options for viewing DSS pathnames. Available commands are: **Pathname List, Pathname Parts, Condensed Catalog, Condensed – Group Collections, No Pathnames, Unsorted List, Search pathnames by string, Search pathnames by parts, Catalog using wild characters, Refresh Catalog, Unit System, and Time Zone.**
- Display** After a user has selected a pathname, this menu allows the user the ability to display the data for that pathname. Available commands are: **Plot, Plot Individual Data Sets, Tabulate, Display Data Options, Supplemental Information, and Time Window.**
- Groups** This menu provides the capability to save selected pathnames as groups, open a group, plot and/or tabulate a group, and perform math functions on a group. Available commands are: **Save Selected, Get, Get (add to list), Plot, Plot Individual Sets, Tabulate, Math, and Manage.**
- Data Entry** This menu provides the user with the ability to either manually enter data or import data from other sources into the selected DSS file. Also, allows the user to export DSS data into other formats. Available commands are: **Manual Time Series, Manual Paired Data, Manual Text, Import, and Export.**



<b>Tools</b>	This menu provides a user with tools that will manipulate the data stored in DSS pathnames. Available commands are: <b>Math Functions, Compare, Search for Value, Check File Integrity, Squeeze, Convert to DSS 7, Script Editor, and Script Selector.</b>
<b>Advanced</b>	This menu provides options for saving the DSS catalog to a file, output, debug issues, and setting program options. Available commands are: <b>Catalog to File, Output, Debug, and Program Options.</b>
<b>Help</b>	Displays current version information about DSSVue.

The **Toolbar** (Figure J.1) contains buttons that provide a user with the capability to open a DSS file, plot the data, and tabulate the data. These buttons provide a shortcut to the respective commands in the **Display** menu.



**Open File Button** – opens an **Open File Browser**, which allows a user to select a DSS file.



**Plot Button** – plots the data of the selected pathname(s).



**Tabulate Button** – displays the data of the selected pathname(s) in a tabular form.



**Graphical Editor Button** – opens the **Graphical Editor** (see HEC-DSSVue User's Manual, Chapter 4, Section 4.5).



**Math Functions Button** – opens the **Math Functions** dialog box (see HEC-DSSVue User's Manual, Chapter 6) which allows you to perform mathematical functions on the selected pathname(s).

The **DSS File Information** (Figure G.1) box displays the filename of the DSS file, and statistics about the pathnames in the DSS file and the size of the DSS file.


The **Filter Lists** (Figure J.1) are used to sort DSS pathnames by parts. There is a filter list for each individual part, A through F. The **Pathname Table** displays the filtered pathnames contained in the DSS file. The pathnames are displayed by the individual parts. The **Selected Pathname List** displays the pathnames that you have selected from the **Pathname Table**.

The **Select Commands** (Figure J.1) are available after you have selected the pathnames you wish to view or manipulate. Available commands are **Select, De-Select, Clear Selections, Restore Selections, and Set Time Window**. These commands will be detailed later in this appendix.

When a user has entered time window information, the **Status Bar** (Figure J.1) will display the time window information. A time window is where a user provides a specific timeframe for viewing or manipulating DSS data.

## J.3 Open a DSS File

There are several ways to open a DSS file from HEC-DSSVue. One way is to enter the path and filename of a DSS file in the **File Name** box of the HEC-DSSVue main window (Figure J.1). After the correct information has been entered, press **ENTER**, the **Pathname Table** will display the pathnames from the selected DSS file, and the **DSS File Information** (Figure J.1) box will display statistics about the DSS file.

Another way to open a DSS file is from the **File** menu, click **Open**; or, click  from the **Toolbar**. Either method opens an **Open HEC-DSS File** browser (Figure J.2). The browser defaults to *My Documents* if a simulation map window is not displayed. However, if a simulation map window is open, the browser will default to the HEC-WAT *runs* directory. A folder will be created that is based on an HEC-WAT alternative (associated with the simulation), and an analysis period. Click on the DSS file, the name should appear in the **File name** box (Figure J.2), click **Open**. The **Open HEC-DSS File** browser (Figure J.2) will close, and the HEC-DSSVue main window will display the name of the DSS file and all of the pathnames associated with that DSS file will appear in the **Pathname Table** (Figure J.1).

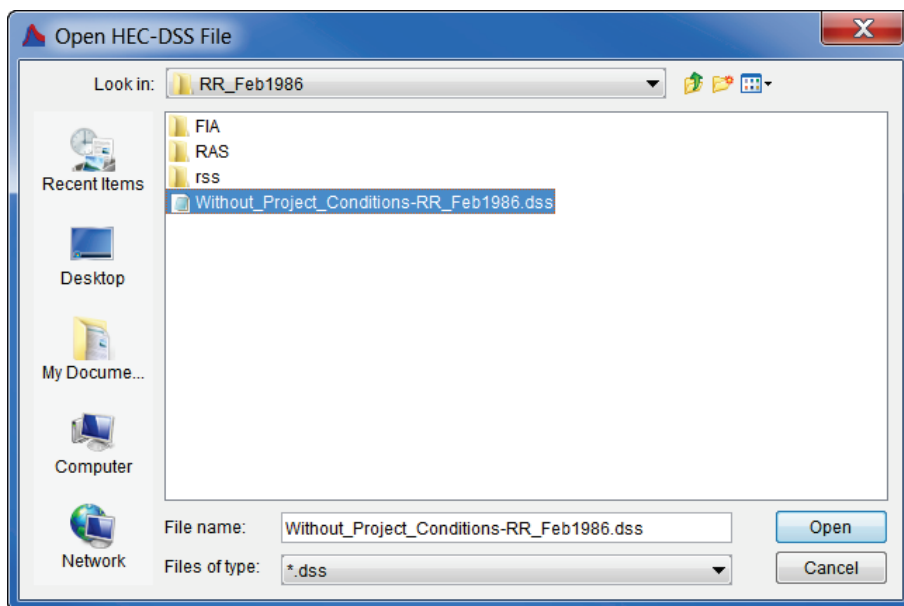
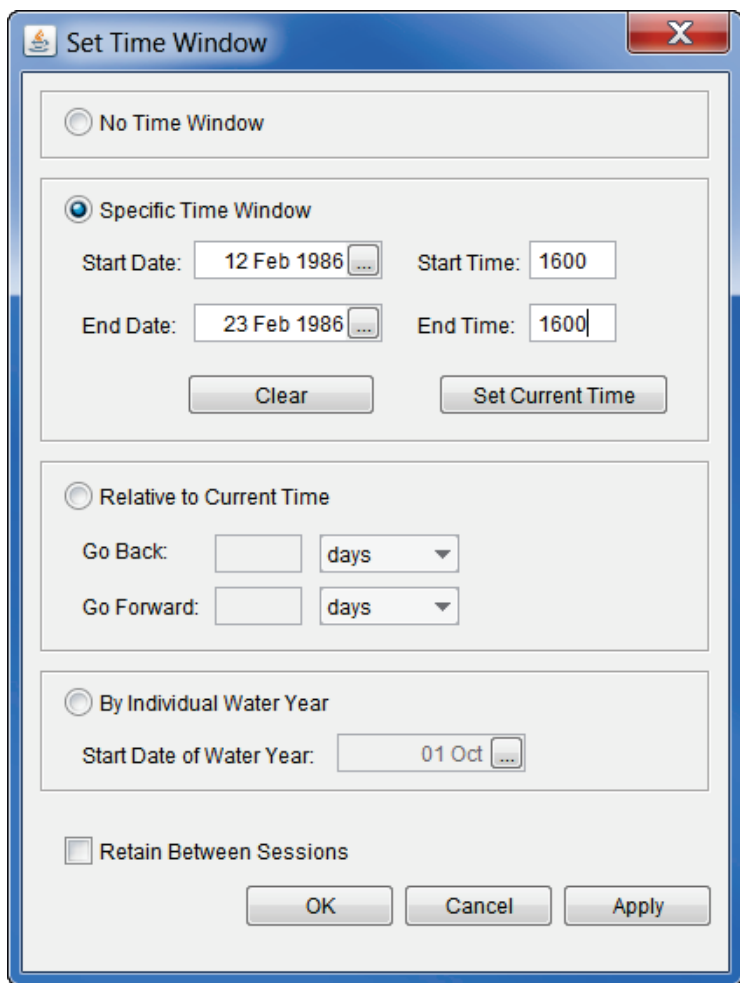


Figure J.2 Open HEC-DSS File Browser

## J.4 Set Time Window

To view the data for a certain block of time, you can set a time window:

1. From the **Display** menu, click **Time Window**, the **Set Time Window** dialog box (Figure J.3) will open.
2. To enter a start date and time, click **Specific Time Window**. In the **Start Date** box type a date in the format ddmmmyyyy (e.g., *12Feb1986*), and in the **Start Time** box type a time in the format hhmm (e.g., *1600*).



**Figure J.3** Set Time Window Dialog Box

3. To enter an ending date and time, in the **End Date** box type a date in the format ddmmmyyyy (e.g., *23Feb1986*), and in the **End Time** box type a time in the format hhmm (e.g., *1600*). To clear the time window boxes, click **Clear** (Figure J.3).
4. If the user wants to use the current date and time, click **Set Current Time** (Figure J.3). All time window boxes will be filled, the user will probably need to edit the ending date and time.
5. Click **OK**, the **Set Time Window** dialog box (Figure J.3) will close, the time window will be set, and the time window will be displayed in the **Status Bar** of the HEC-DSSVue main window (Figure J.1).

## J.5 DSS Pathnames

Data is stored in blocks, or records, within a file, and each record is identified by a unique name called a **pathname**. Each time that data is stored or retrieved from the file, its pathname must be given. The pathname is the key to the data's location in the database. A pathname is analyzed by DSS to determine an index number. This index determines where the dataset is stored within the database. The design ensures that very few disk accesses are made to retrieve or store datasets.

One dataset is not directly related to another, so there is no need to update other areas of the database when a new dataset is stored.

DSS references records (data sets) by a pathname. The pathname of a DSS record can be three hundred and ninety-one (391) characters or less, and is, by convention, separated into **six parts**. The parts can be sixty-four (64) characters or less and are delimited by slashes in the pathname. The pathname parts are designated **A** through **F**. Table J.1 provides an example naming convention for regular-interval time series:

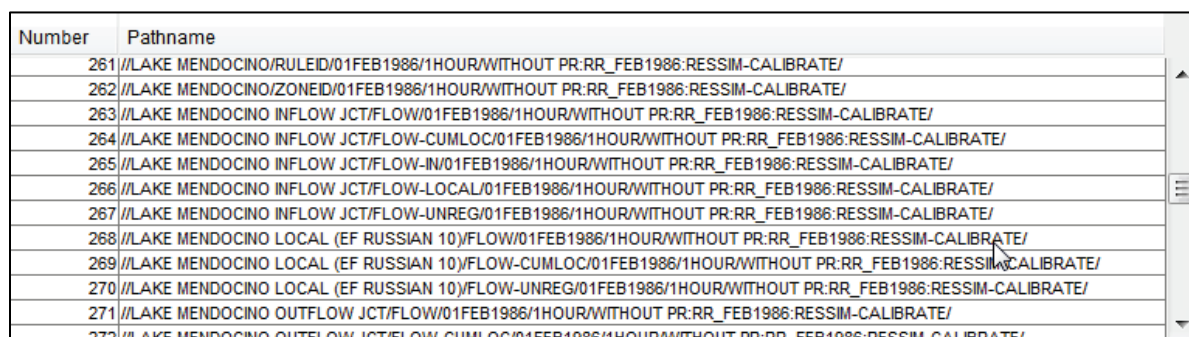
**Table J.1** DSS Pathname Parts

A	project, river, or basin name
B	location identifier
C	data parameter (e.g., FLOW, PRECIP)
D	starting block data; format ddmmyyyy
E	time interval
F	additional user-defined descriptive information

## J.5.1 View DSS Pathnames

The display of pathnames in the **Pathname Table** shows all of the pathnames by the different parts (Figure J.1). The user can change this display from the **View** menu; available commands are **Pathname List**, **Pathname Parts**, **Condensed Catalog**, and **No Pathnames**.

The **Pathname List** command (Figure J.4) displays the pathnames in the **Pathname Table**, while **No Pathnames** displays nothing. The **Pathname Parts** command is the same as the **Condensed Catalog** command, except for the D part. On the **Condensed Catalog**, the D part displays the date span for each pathname.



Number	Pathname
261	//LAKE MENDOCINO/RULEID/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
262	//LAKE MENDOCINO/ZONEID/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
263	//LAKE MENDOCINO INFLOW JCT/FLOW/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
264	//LAKE MENDOCINO INFLOW JCT/FLOW-CUMLOC/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
265	//LAKE MENDOCINO INFLOW JCT/FLOW-IN/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
266	//LAKE MENDOCINO INFLOW JCT/FLOW-LOCAL/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
267	//LAKE MENDOCINO INFLOW JCT/FLOW-UNREG/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
268	//LAKE MENDOCINO LOCAL (EF RUSSIAN 10)/FLOW/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
269	//LAKE MENDOCINO LOCAL (EF RUSSIAN 10)/FLOW-CUMLOC/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
270	//LAKE MENDOCINO LOCAL (EF RUSSIAN 10)/FLOW-UNREG/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
271	//LAKE MENDOCINO OUTFLOW JCT/FLOW/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/
272	//LAKE MENDOCINO OUTFLOW JCT/FLOW-CUMLOC/01FEB1986/1HOUR/WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE/

**Figure J.4** Pathname List Display

## J.5.2 Sort DSS Pathnames by Parts

Another way to affect the display of the pathnames is through sorting by pathname parts. Sorting the DSS pathnames by parts is the command **Search pathnames by parts** (default). However, another way to sort the pathnames is available from the **View** menu, choose **Search pathnames by string**. The details for this method are described in the HEC-DSSVue User's Manual.

To sort by pathname parts, from the **Filter Lists** (Figure J.5) decide which pathname parts will be used to sort the pathname list. There is a **Filter List** for each individual pathname part. An example is shown in Figure J.5 where filters are used to see all of the FLOW records that are observed data. In Figure J.5, *FLOW* has been selected for Filter C and *RESSIM-CALIBRATE* has been selected for Filter F. The **Pathname Table** will now display only the pathnames that fit the criteria are stated in the **Filter Lists**.

Search

A:

C:

FLOW

E:

By Parts:

B:

D:

F:

WITHOUT PR:RR\_FEB1986:RESSIM-CALIBRATE

Number	Part A	Part B	Part C	Part D	Part E	Part F
99		TALMAGE LOCAL	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
100		TALMAGE TO HOPLAND	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
101		WEST FORK INFLOW	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
102		WEST FORK INFLOW TO RUSSIAN R NR UKIAH	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
103		WEST FORK INFLOW WF RUSSIAN	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
104		WESTFORK RUSSIAN RIVER + EAST FORK RUSSIAN ...	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
105		WESTFORK RUSSIAN RIVER + EAST FORK RUSSIAN ...	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
106		WINDSOR	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
107		WINDSOR LOCAL	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
108		WINDSOR-MIRABEL	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE
109		YOAKIM-LAMBERT	FLOW	01FEB1986	1HOUR	WITHOUT PR:RR_FEB1986:RESSIM-CALIBRATE

Figure J.5 Sorting Pathnames

## J.5.3 Select Pathnames

Once an appropriate list of pathnames is displayed in the **Pathname Table**, the user can select which pathnames to view or manipulate. To select a pathname, double-click on a pathname in the **Pathname Table** and the selected pathname will appear in the **Selected Pathname List** (Figure J.1). The user can also click on a pathname in the **Pathname Table**, and then click **Select** from the **Select Commands** (Figure J.1).

To select multiple pathnames, in the **Pathname Table**, click on a pathname the pathname will be highlighted. Find the next pathname that needs to be included in a group, hold down the **SHIFT** key and click. The block of pathnames will be highlighted, click **Select**, and all the pathnames within that block will be added to the **Selected Pathname List**.

Another way to select multiple pathnames is from the **Pathname Table**, click and drag across the pathnames wanted, release the mouse button and the block of pathnames will be highlighted. Click **Select**, and all of the pathnames within that block will be added to the **Selected Pathname List**.

The user can select individual pathnames to be in a group for selection. From the **Pathname Table**, select a pathname which will be highlighted; to select another not in a contiguous group, hold down the **CTRL** key and select the next pathname which will be highlighted. Continue to do this until all desired pathnames have been selected, release the **CTRL** key and click **Select**. All the pathnames you have selected will be added to the **Selected Pathname List**.

The user can select all of the pathnames displayed in the **Pathname Table**. From the **Edit** menu, choose **Select All**. All of the pathnames will now appear in the **Selected Pathname List**.

## J.5.4 Clear Selected Pathnames


To clear a pathname from the **Selected Pathname List** (Figure J.1), select a pathname and click **De-Select** from the **Select Commands** (Figure J.1). The pathname will be cleared from the **Selected Pathname List**. To clear all pathnames from the **Selected Pathname List**, click **Clear Selections**, and the **Selected Pathname Box** will be empty.

The user can also clear groups of pathnames by using the same concepts described in selecting pathnames (Section J.5.3) by using the **SHIFT** and **CTRL** keys. Once pathnames have been cleared from the **Selected Pathname Box**, the pathnames can be restored to the **Selected Pathname Box** by clicking **Restore Selections** from the **Select Commands** (Figure J.1).

## J.6 Visualize Data

After selecting a pathname or multiple pathnames, the user can visualize the data associated with the pathname. This can be done graphically with plots, or in a tabular format (table). The examples described in this section are all for time-series data. Similar features exist for other types of datasets, such as paired data. Further details on plots and tables are discussed in the HEC-DSSVue User's Manual.

### J.6.1 Plots

To view a plot of the pathnames in the **Selected Pathname List** (Figure J.1), a user can either click  the **Toolbar**, or from the **Display** menu, choose **Plot**. Either way will open the **Plot Window** (Figure J.6).

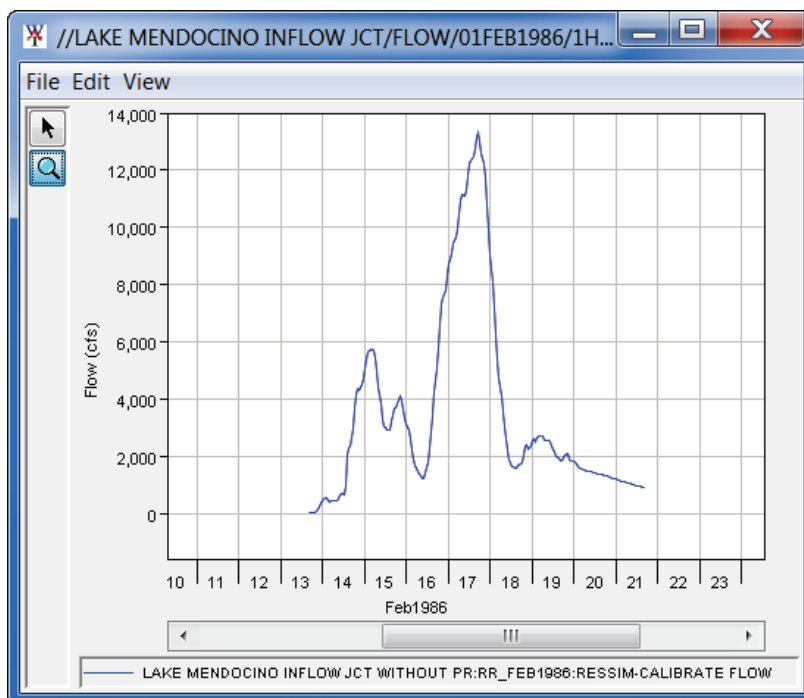




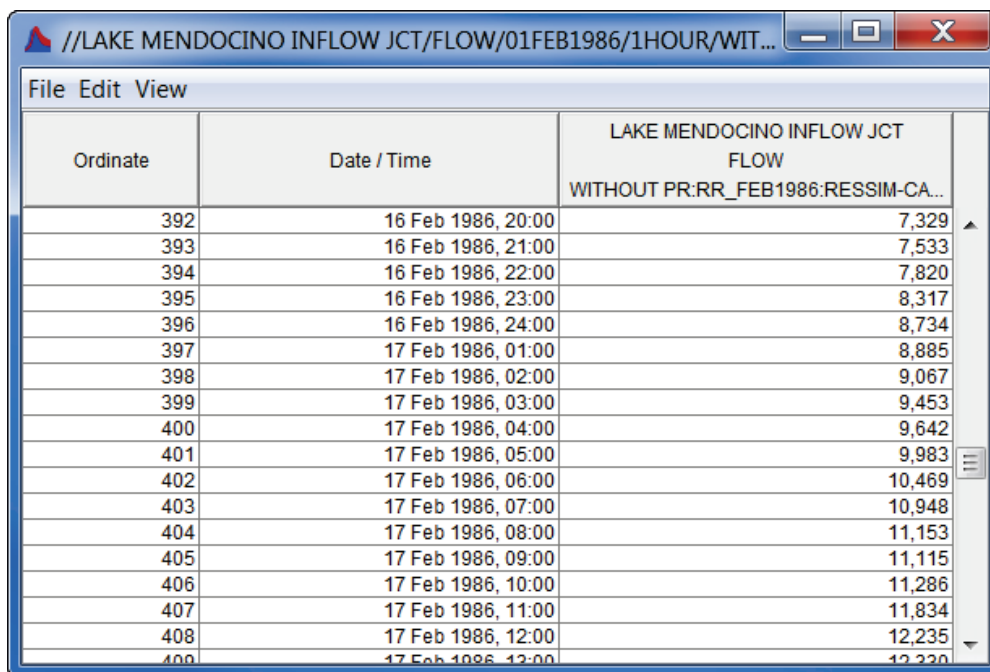
Figure J.6 Plot Window

The datasets for the plots are labeled and color-coded, date ranges are specified along one axis (if plotting time-series data), and the units of measure are specified along the other axis. A user can resize the **Plot Window** by grabbing the corner of the window and dragging it to the desired size.

The user can also zoom in on areas of the plot. Click the **Zoom Tool**,  find the area on the plot, zoom-in, click and drag over the area. The plot will refresh, the area within the zoom rectangle will fill the plot window. To zoom out, with the **Zoom Tool** selected, right-click anywhere on the plot area.

## J.6.2 Tables

To view a table of the pathnames in the **Selected Pathname List** (Figure J.1), a user can either click  from the **Toolbar**, or from the **View** menu, click **Tabulate**. Either way the **Tabulate Window** will open (Figure J.7).



Ordinate	Date / Time	LAKE MENDOCINO INFLOW JCT FLOW WITHOUT PR:RR_FEB1986:RESSIM-CA...
392	16 Feb 1986, 20:00	7,329
393	16 Feb 1986, 21:00	7,533
394	16 Feb 1986, 22:00	7,820
395	16 Feb 1986, 23:00	8,317
396	16 Feb 1986, 24:00	8,734
397	17 Feb 1986, 01:00	8,885
398	17 Feb 1986, 02:00	9,067
399	17 Feb 1986, 03:00	9,453
400	17 Feb 1986, 04:00	9,642
401	17 Feb 1986, 05:00	9,983
402	17 Feb 1986, 06:00	10,469
403	17 Feb 1986, 07:00	10,948
404	17 Feb 1986, 08:00	11,153
405	17 Feb 1986, 09:00	11,115
406	17 Feb 1986, 10:00	11,286
407	17 Feb 1986, 11:00	11,834
408	17 Feb 1986, 12:00	12,235
409	17 Feb 1986, 13:00	12,220

**Figure J.7** Tabulate Window

The **Tabulate Window** displays the ordinate (starting from the start date/time), the date and time stamp, and the values for the selected data sets. From the **Tabulate Window**, the user has several options for displaying tabular data (e.g., displaying commas in the number formatting, setting the precision of decimal places for data).

## J.7 DSS Records

HEC-DSS uses a block of sequential data as the basic unit of storage. Each block contains a series of values of a single variable over a time span appropriate for most applications. The basic concept underlying DSS is the organization of data into records of continuous, applications-related elements, as opposed to individually addressable data items. This approach is more

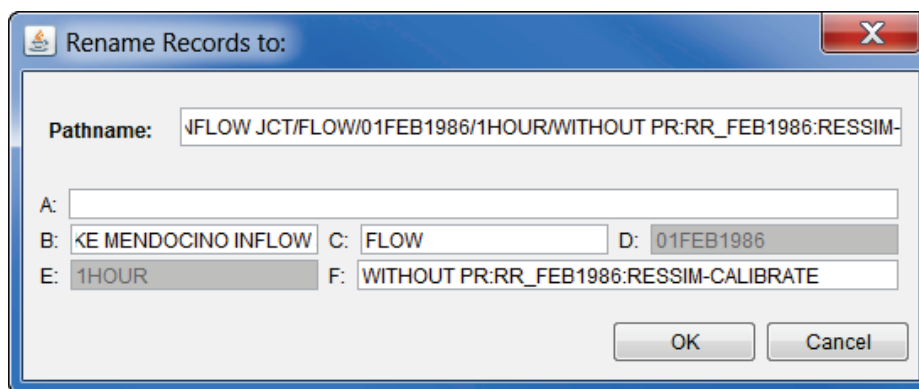


efficient for scientific applications than that of a conventional database system because it avoids the processing and storage overhead required for assembling an equivalent record from a conventional system. Data is stored in blocks, or records, within a file, and each record is identified by a pathname.

## J.7.1 Rename Records

To change the pathname parts of a pathname:

1. The user must have selected one or more pathnames (Section J.5.3) for this command to be available.
2. From the **Edit** menu, click **Rename Records**. The **Rename Records to:** dialog box (Figure J.8) will open.



**Figure J.8** Rename Records to: Dialog Box

3. Each of the boxes (A - F) represents the different pathname parts. The **D** and **E** parts are not editable. The user can change the parts **A**, **B**, **C**, and **F** by entering new information in the appropriate box.
4. Click **OK**, the **Rename Records to:** dialog box will close, a message will appear informing the user of the number of records renamed. The selected pathname will no longer be displayed in the **Selected Pathname Box** (Figure J.1) and the pathname will display in the **Pathname Table** (Figure J.1) with the new pathname parts.

## J.7.2 Duplicate Records

Duplicating a record allows a user to make a copy of a record, but with a pathname part that has been changed. To duplicate records:

1. The user must have selected one or more pathnames (Section J.5.3) for this command to be available.
2. From the **Edit** menu, click **Duplicate**. The **New pathname parts for duplicate records:** dialog box (similar to Figure J.8) will open.



3. Each of the boxes (**A - F**) represents the different pathname parts. The **D** and **E** parts are not editable. The user can change the parts **A**, **B**, **C**, and **F** by entering the new information in the appropriate box.
4. Click **OK**, the **New pathname parts for duplicate records:** dialog box will close. A message will appear informing the user of the number of records that were duplicated. A new pathname will be displayed in the **Pathname Table** (Figure J.1).

### J.7.3 Delete Records

To delete records:

1. The user must have selected one or more pathnames (Section J.5.3) for this command to be available.
2. From the **Edit** menu, click **Delete Records**, a warning message dialog box appears asking the user if you really want to delete the listed pathnames. These should be the same pathnames displayed in the **Selected Pathname List** (Figure J.1).
3. Click **Yes**, the warning message dialog box will close. A message will appear informing the user of the number of records deleted.
4. The deleted records no longer appear in the **Pathname Table** (Figure J.1).

### J.7.4 Edit Data Associated with Records

The user can edit the data associated with a pathname, if the user has the appropriate permissions, on the **Edit** menu, click **Tabular Edit** or **Graphical Edit**. The user can edit data directly, enter new time-series data or paired data, or use math functions to manipulate the data. All of these features are detailed in the HEC-DSSVue User's Manual.



# Appendix K

## Model Integration Tools

For the HEC-WAT schematics to be truly interactive, all of the graphical elements from all of the software applications must display correctly and in the correct alignment. The projection of the HEC-WAT study and the model alternatives must be the same. The HEC-ResSim software is very close to the HEC-WAT framework, as long as the projections are the same, the user will not need to make any adjustments to the HEC-ResSim graphical elements. However, for HEC-HMS, HEC-RAS, and HEC-FIA, there are HEC-WAT tools that will aid integrating graphical elements from these software applications to display nicely in the HEC-WAT schematic.

### K.1 Stream Reach Alias

The stream alignment is based on stream segment names, and those names must be exact among the model alternatives of an HEC-WAT simulation. When the stream names are not the same, instead of changing the HEC-WAT stream alignment or changing the stream naming in a model alternative, HEC-WAT has a tool that resolves naming inconsistencies through the use of aliases.

From the HEC-WAT main window (Figure K.1), with a study open, from the **Edit** menu, click **Stream Reach Alias Editor**. The **Stream Reach Alias Editor** will open (Figure K.2). The tree contains all of the stream names in the stream alignment that has been selected. When a stream name with a folder is selected, an alias for the selected stream name can be entered.

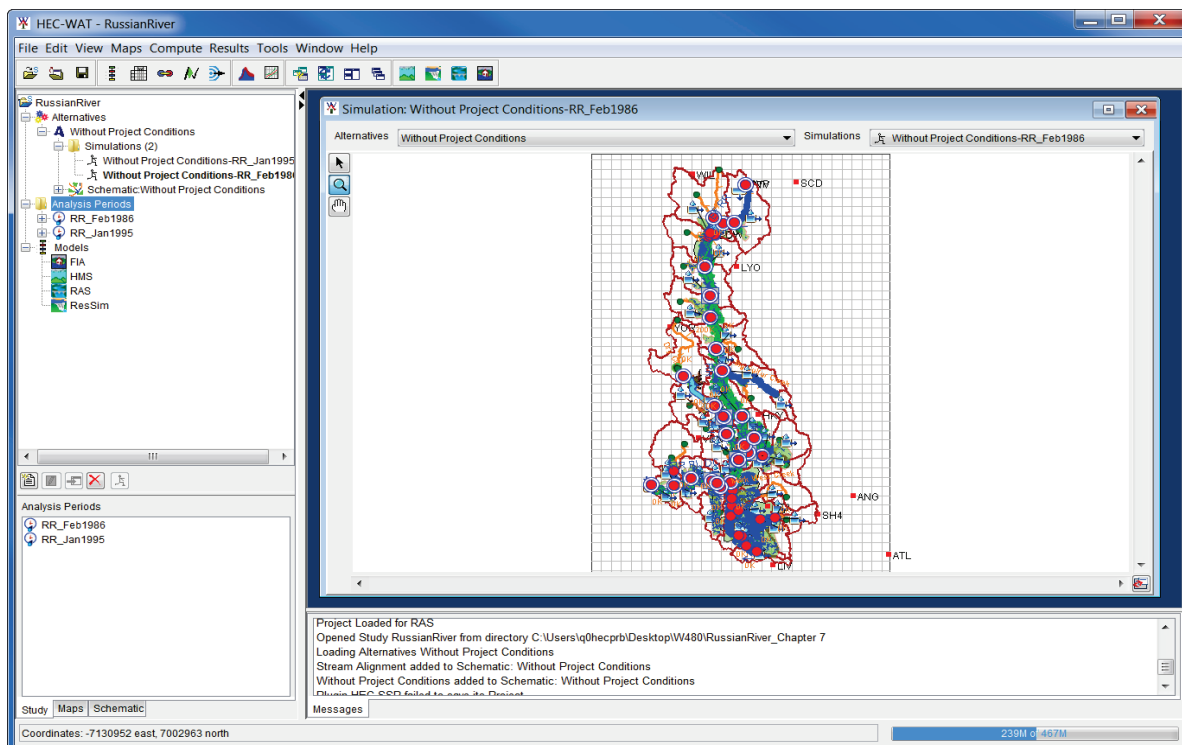
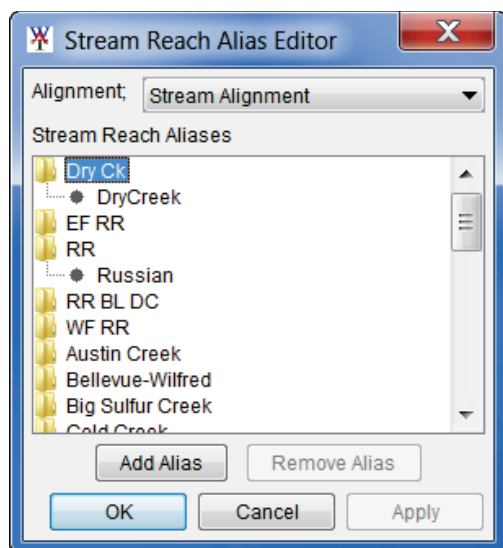
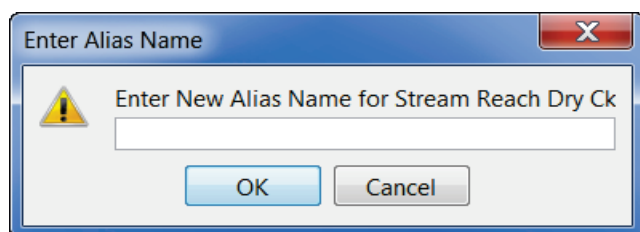


Figure K.1 HEC-WAT Main Window



**Figure K.2** Stream Reach Alias Editor

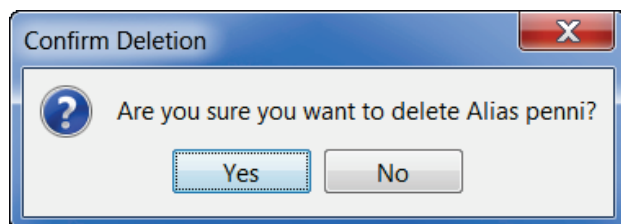
For example, in Figure K.2, *Dry Ck* is an HEC-WAT stream name, however in HEC-RAS the stream name (reach name) is *DryCreek*. For HEC-RAS graphical elements to display correctly on the HEC-WAT schematic, the user needs to let HEC-WAT know that both names for that stream are correct. From the tree on the **Stream Reach Alias Editor** (Figure K.2), select *Dry Ck*, click **Add Alias**, the **Enter Alias Name** dialog box will open (Figure K.3).



**Figure K.3** Enter Alias Dialog Box

In the **Enter New Alias Name for Stream Reach Dry Ck** (Figure K.3) – *DryCreek*. Click **OK**, the **Enter Alias Name** dialog box will close (Figure K.3), and a node under the selected stream name will be added. This needs to be done for all of the streams that do not match.

To remove an alias, from the **Stream Reach Alias Editor** (Figure K.2), from the tree, select an alias, click **Remove Alias**. A **Confirm Deletion** window will open (Figure K.4), asking the user are you sure you want to delete the selected alias, click **Yes**. The **Confirm Deletion** window will close (Figure K.4), and the alias will no longer display on the tree.



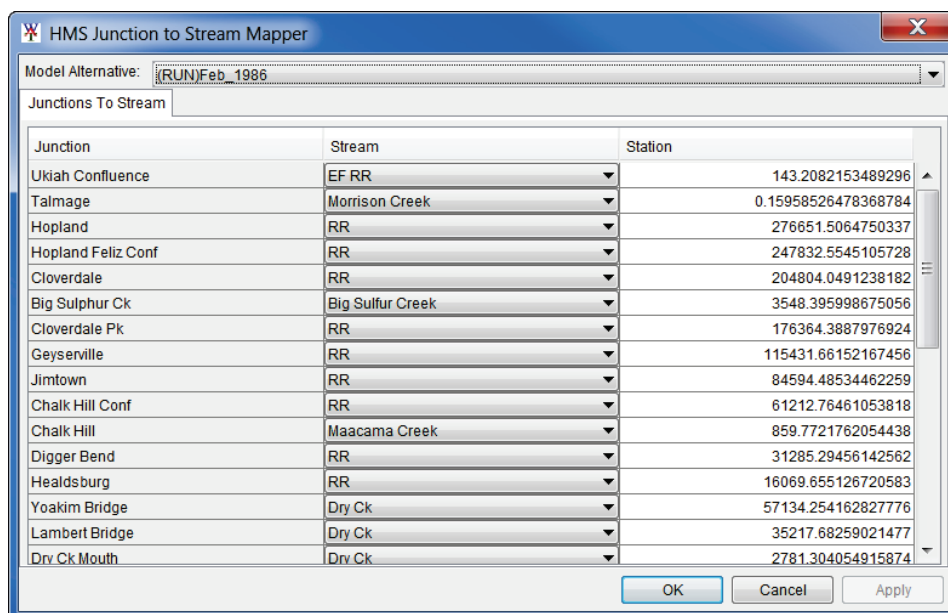
**Figure K.4** Confirm Deletion Window

## K.2 Junction Location Mapping

The HEC-HMS graphical elements that HEC-WAT recognizes do not have coordinates (geographic location information), and therefore the HEC-HMS graphical elements do not display on the HEC-WAT schematic correctly. For HEC-HMS reach and junction graphical elements, HEC-WAT provides tools that the user can use to make the HEC-HMS graphical elements display correctly on the HEC-WAT schematic. The first of these tools is for HEC-HMS junctions – **Junction to Stream Mapper**.

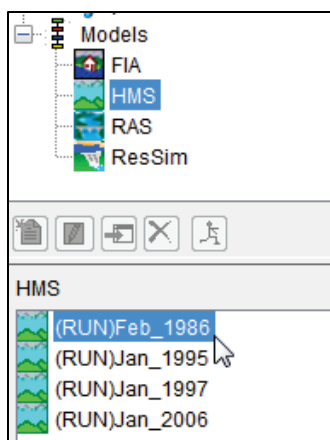
To edit the geographic location of HEC-HMS junction graphical elements:

1. From the HEC-WAT main window (Figure K.1), from the **Edit** menu, point to **HMS**, click **Junction Location Mapper**.
2. The **HMS Junction to Stream Mapper** dialog box will open (Figure K.5). This dialog box is not from HEC-HMS, but from HEC-WAT. Since the current version of HEC-HMS does not recognize the coordinate system that HEC-WAT has for a study, this dialog box allows the user to enter information that will give the HEC-HMS junction graphical element the correct geographic location on the schematic.

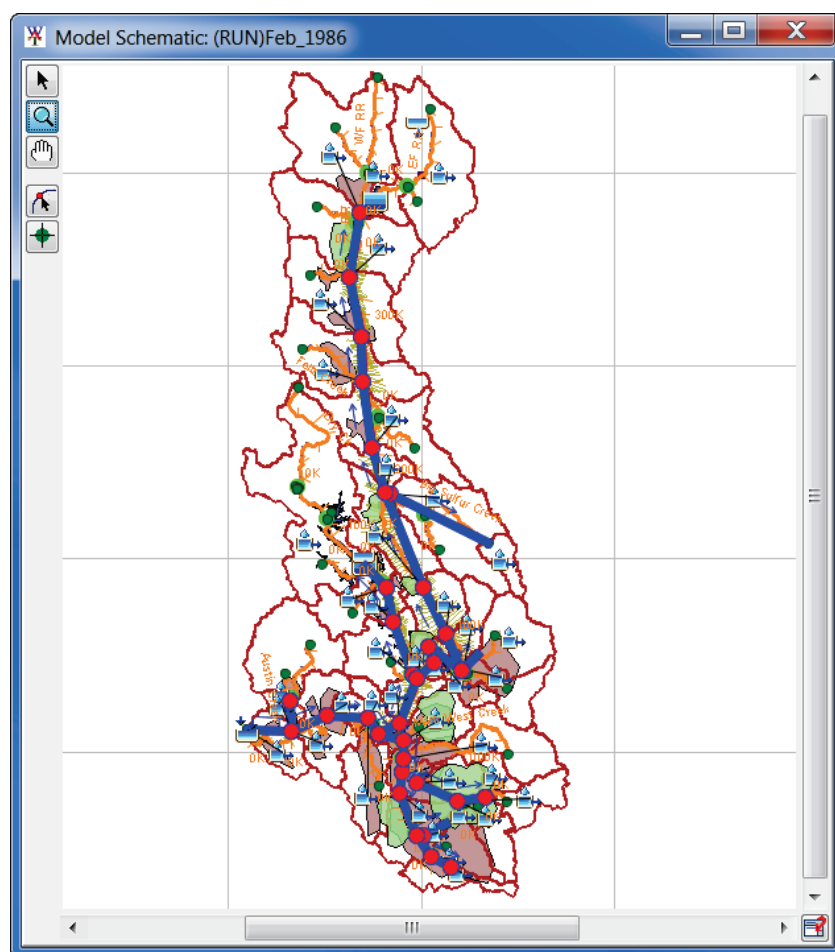


**Figure K.5** HMS Junction to Stream Mapper Dialog Box

3. From the **Model Alternative** list (Figure K.5), select an HMS model alternative (i.e., *(RUN)Feb\_1986*). This should be the HMS model alternative associated with the active HEC-WAT simulation displayed in the **Map Window** (Figure K.1).
4. From the **Study Tree** (Figure K.6), expand the **Models** node. Select **HMS**, from the **Content Pane** (Figure K.6), double-click on the HMS model alternative (i.e., *HMS:(RUN)Feb\_1986*) that has been selected in the **HMS Junction to Stream Mapper** dialog box (Figure K.5). A map window will open (Figure K.7) that displays the selected HMS model alternative.

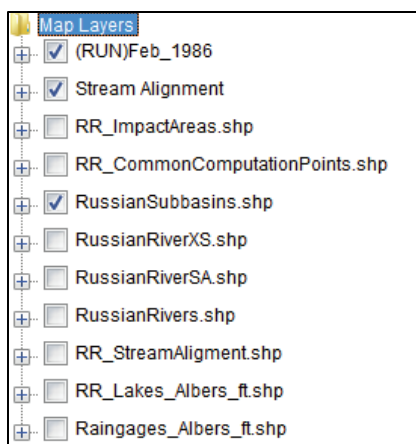


**Figure K.6** Study Tree – Models Node - HMS




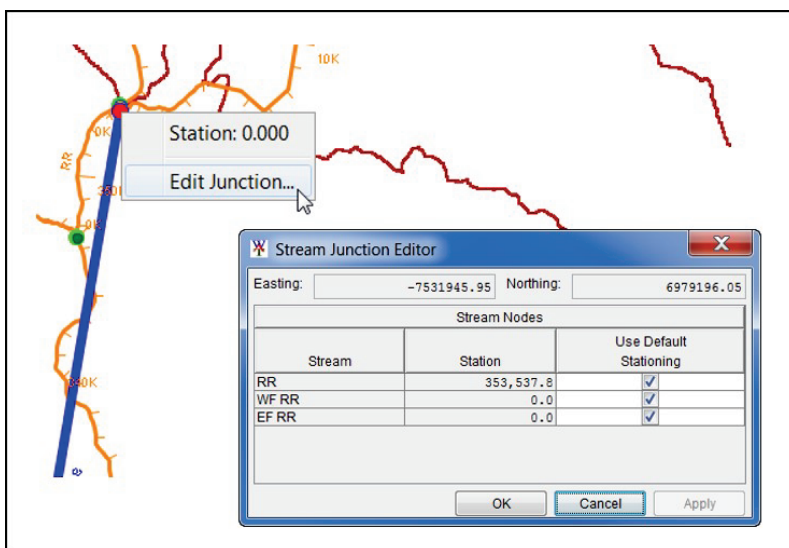
**Figure K.7** HMS Model Alternative Map Window

5. Turning off some of the map layers in the map window (Figure K.7) will help in locating the stationing for the HMS junction graphic elements. From the **Maps** tab (Figure K.8) of the HEC-WAT main window (Figure K.1), turn off all of the map layers that are not need for locating the HMS junction graphic elements. When this is done, the **Map Window** (Figure K.7) displays the HMS model alternative.



**Figure K.8** Maps Tab – Turning Map Layers Off

6. In Figure K.5, for example, the first junction (i.e., *Ukiah Confluence*), is it on the correct stream? After reviewing the map window (Figure K.7), the selected stream (i.e., *EF RR*) is not correct. To review the first junction on the map window (Figure K.7), zoom in to the first junction location (Figure K.9), which is the first red circle located in the upstream end of the study area. Select  (**Stream Node Tool**), right-click on the red circle, from the shortcut menu click **Edit Junction**, the **Stream Junction Editor** will open (Figure K.9). The HMS junction happens to be at a confluence of three streams, and an HEC-WAT stream junction is at that same location



**Figure K.9** Stream Junction Editor – Junction Stream Stationing

7. From the **Stream Junction Editor** (Figure K.9), the user can determine the stream location and the stationing for the first HMS junction. For example, in Figure K.9, the first HMS junction (i.e., *Ukiah Confluence*) should be located on stream *RR* and the junction's stationing is 353.537.8.
8. From the **HMS Junction to Stream Mapper** dialog box (Figure K.5), from the **Stream** column, for the first HMS junction (i.e., *Ukiah Confluence*), from the list select *RR*. From the **Station** column (Figure K.5), for the first HMS junction, enter 353,537.8.

9. For the rest of the HMS junctions, the user may have to repeat Steps 6 through 8, if the stream or the stationing is not correct for an HMS junction. What happens there is no stream node or junction for a location? The user will need to add a stream node/junction at that location (Appendix F, Section F.3.2). Once the stream station has been entered into the **HMS Junction to Stream Mapper** dialog box (Figure K.5), the user will need to remove the stream node/junction from the schematic. This has to be done, because any changes to the stream stationing will affect an HEC-ResSim model alternative.
10. When the **HMS Junction to Stream Mapper** dialog box (Figure K.10) is completed, click **Apply**. The junction names that display in green, means that the user has entered the stationing for that junction. Click **OK**, the **HMS Junction to Stream Mapper** dialog box (Figure K.10) will close.

Junction	Stream	Station
Ukiah Confluence	RR	353537.8
Talmage	RR	313124.8
Hopland	RR	276912.112
Hopland Feliz Conf	RR	247886.0
Cloverdale	RR	204813.274
Big Sulphur Ck	Big Sulphur Creek	3548.396
Cloverdale Pk	RR	176572.7
Geyserville	RR	115621.567
Jimtown	RR	84799.427
Chalk Hill Conf	RR	59655.7
Chalk Hill	RR	57668.346
Digger Bend	RR	30862.006
Healdsburg	RR	16100.097
Yokim Bridge	Dry Ck	57135.777
Lambert Bridge	Dry Ck	34211.082
Dry Ck Mouth	Dry Ck	2959.0
Dry Ck Confl	RR BL DC	170971.8
Windsor	RR BL DC	142977.865
Copeland	Copeland Creek	15956.923
Stony Pt	Laguna de Santa Rosa	69556.9
Colgan Ck	R2750	4387.494
Tood Rd	Laguna de Santa Rosa	50434.3
Sebastopol	Laguna de Santa Rosa	20393.984
Yulupa	R2310	14908.5
Santa Rosa Ck	Santa Rosa Creek	42489.864
Willowside	Santa Rosa Creek	11308.994
Timber Hill	Laguna de Santa Rosa	8059.8
Denner Ranch	Mark West Creek	28128.8
Mirabel Heights	Mark West Creek	15721.2
Mirabel Park	RR BL DC	126522.7
Hacienda	RR BL DC	115077.061
Johnsons Beach	RR BL DC	82360.906
Cazadero-Austin	Austin Creek	21686.3
Ducans Mills	RR BL DC	38767.2

**Figure K.10** HMS Junction to Stream Mapper Dialog Box - Completed

### K.3 Reach to Stream Mapping

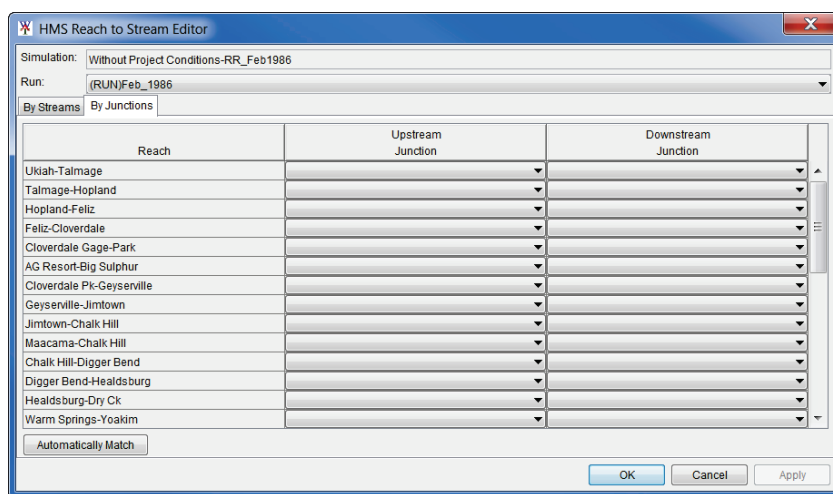
The HEC-HMS reach and junction graphical elements do not have coordinates (geographic location information), and do not display on the HEC-WAT schematic correctly. For HEC-HMS reach and junction graphical elements, HEC-WAT provides tools that correct the reach and junction graphical elements display in the HEC-WAT schematic.



### K.3.1 By Junctions

To correct the display of HMS junctions:

1. From the HEC-WAT main window (Figure K.1), from the **Edit** menu, point to **HMS**, click **Reach to Stream Mapping**.
2. The **HMS Reach to Stream Editor** will open (Figure K.11). This editor is not from HEC-HMS, but from HEC-WAT. Since the current version of HEC-HMS does not recognize the coordinate system that HEC-WAT has for a study, this editor allows the user to enter information that will give the HEC-HMS reach graphical element the correct geographic location on the schematic.



**Figure K.11** HMS Reach to Stream Editor – By Junctions Tab

3. An HEC-WAT simulation must be displayed in a map window on the HEC-WAT main window (Figure K.1). The active simulation name is displayed in the **Simulation** box (Figure K.11). For example, in Figure K.11, the HEC-WAT simulation is *Without Project Conditions-RR\_Feb1986*.
4. The HMS model alternative associated with the active HEC-WAT simulation is displayed in the **Run** list (Figure K.11). For example, in Figure K.11, the HMS model alternative is *(RUN)Feb\_1986*.
5. If the user has defined information about the HMS junctions from the **HMS Junction to Stream Mapper** dialog box (Figure K.10), click the **By Junctions** tab and proceed to Step 6. If the user has not entered HMS junction information, proceed to Section K.3.2.
6. Click **Automatically Match** (Figure K.11), a **Validate Changes** window (Figure K.12) will open. This window is letting the user know that the information that will display in the table (Figure K.13) should be reviewed for accuracy. Click **OK**, the **Validate Changes** window will close, and the table on **HMS Reach to Stream Editor – By Junctions** tab will display with junction information for each HMS reach (Figure K.13). The reach names display in blue, because items have been modified.

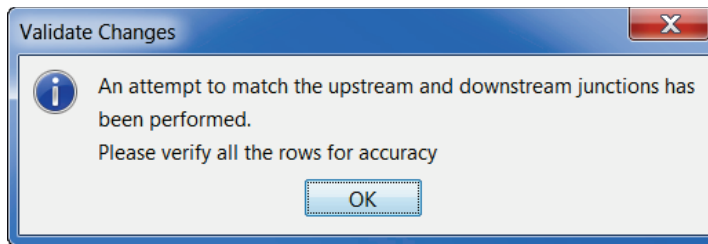


Figure K.12 Validate Changes Window

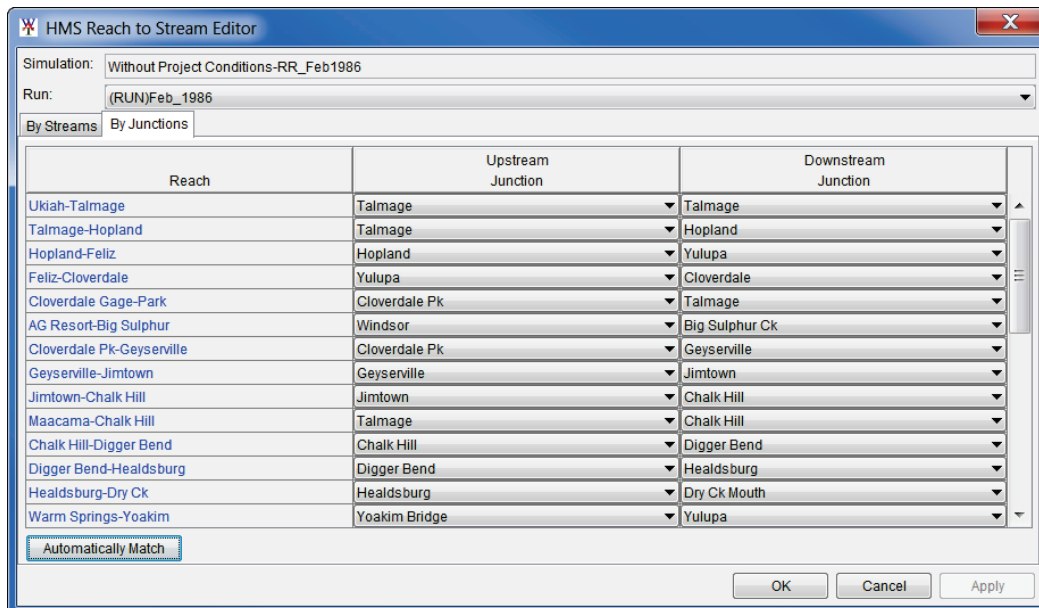
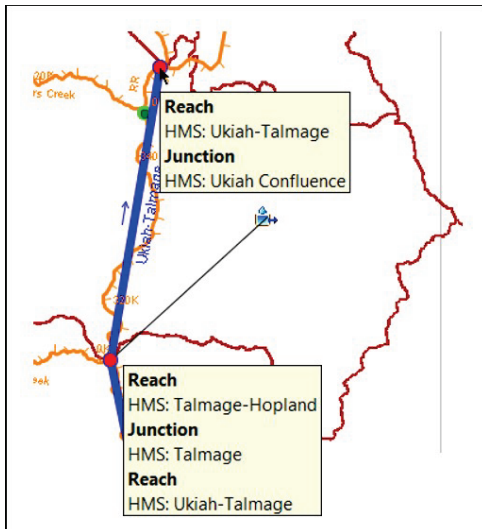


Figure K.13 HMS Reach to Stream Editor – By Junctions Tab – Automatically Match

7. From the **Study Tree** (Figure K.6), expand the **Models** node. Select **HMS**, from the **Content Pane** (Figure K.6), double-click on the HMS model alternative (i.e., *HMS:(RUN)Feb\_1986*) that has been selected in the **HMS Junction to Stream Mapper** dialog box (Figure K.5). A map window will open (Figure K.7) that displays the selected HMS model alternative.
8. Turning off some of the maps layers in the map window (Figure K.7) will help in locating the stationing for the HMS junction graphic elements. From the **Maps** tab (Figure K.8) of the HEC-WAT main window (Figure K.1), turn off all of the map layers that are not need for locating the HMS junction graphic elements. When this is done, the **Map Window** (Figure K.7) displays the HMS model alternative.
9. So, is the automatic match correct (Figure K.13), no, the user will need to make some changes. Why is HEC-WAT having a hard time getting the correct matches? The HMS junction names and reach names are not exactly identical. For example, in Figure K.13, for the first reach – *Ukiah-Talmage*, the selected upstream junction is not correct, because the upstream junction name *Ukiah* is not what that junction is named. From reviewing the HMS basin model (Figure K.14), the user knows that the upstream junction for the reach in question should be *Ukiah Confluence*. In the row associated with the reach, from the **Upstream Junction** column (Figure K.15), from the list, select *Ukiah-Confluence*. Repeat these steps for all of the rows in the table (Figure K.15).



**Figure K.14** HMS Reach – Upstream and Downstream Junctions

Reach	Upstream Junction	Downstream Junction
Ukiah-Talmage	Ukiah Confluence	Talmage
Talmage-Hopland	Talmage	Hopland
Hopland-Feliz	Hopland	Hopland Feliz Conf
Feliz-Cloverdale	Hopland Feliz Conf	Cloverdale
Cloverdale Gage-Park	Cloverdale Pk	Talmage
AG Resort-Big Sulphur	Windsor	Big Sulphur Ck
Cloverdale Pk-Geyserville	Cloverdale Pk	Geyserville
Geyserville-Jimtown	Geyserville	Jimtown
Jimtown-Chalk Hill	Jimtown	Chalk Hill
Maacama-Chalk Hill	Talmage	Chalk Hill
Chalk Hill-Digger Bend	Chalk Hill	Digger Bend
Digger Bend-Healdsburg	Digger Bend	Healdsburg
Healdsburg-Dry Ck	Healdsburg	Dry Ck Mouth
Warm Springs-Yoakim	Yoakim Bridge	Yulupa

**Figure K.15** HMS Reach to Stream Editor – By Junctions Tab – Modifying

10. What if the user encounters a reach that has a junction that is not defined in the selected HMS model alternative? For example, in Figure K.15, the *AG Resort-Big Sulphur* reach, in the HMS model alternative there is not a defined downstream junction. Do not make any changes to the reach in the **HMS Reach to Stream Editor** (Figure K.15) on the **By Junctions** tab, the change will need to be made in the **By Streams** tab (Section K.3.2).
11. Once all of the modifications have been made click **Apply** (Figure K.15), if there are issues with the mapping, an **Invalid Junction Assignments** windows will open. An issue might be that the user has selected the same junction for the upstream and downstream junctions for a reach. Click **OK**, the **Invalid Junction Assignments** windows will open, and the user should correct the issues.

- Now that identifying reaches by upstream and downstream junctions has been completed (Figure K.16). Any further adjustments that need to be made for HMS reaches will be done by streams, which is detailed in the following Section K.3.2.

Reach	Upstream Junction	Downstream Junction
Ukiah-Talmage	Ukiah Confluence	Talmage
Talmage-Hopland	Talmage	Hopland
Hopland-Feliz	Hopland	Hopland Feliz Conf
Feliz-Cloverdale	Hopland Feliz Conf	Cloverdale
Cloverdale Gage-Park	Cloverdale	Cloverdale Pk
AG Resort-Big Sulphur	Windsor	Big Sulphur Ck
Cloverdale Pk-Geyserville	Cloverdale Pk	Geyserville
Geyserville-Jimtown	Geyserville	Jimtown
Jimtown-Chalk Hill	Jimtown	Chalk Hill
Maacama-Chalk Hill	Talmage	Chalk Hill
Chalk Hill-Digger Bend	Chalk Hill	Digger Bend
Digger Bend-Healdsburg	Digger Bend	Healdsburg
Healdsburg-Dry Ck	Healdsburg	Dry Ck Confl
Warm Springs-Yoakim	Yoakim Bridge	Yulupa
Yoakim-Lambert	Yoakim Bridge	Lambert Bridge
Lambert-Mouth	Lambert Bridge	Dry Ck Mouth
Dry Ck-Windsor	Dry Ck Mouth	Windsor
Windsor-Mirabel	Windsor	Mirabel Park
Copeland-Stony Pt	Copeland	Stony Pt
Stony Pt-Todd Rd	Stony Pt	Tood Rd
Colgan Upper-Lower	Colgan Ck	Hopland
Todd-Sebastopol	Tood Rd	Sebastopol
Sebastopol-Timber Hill	Sebastopol	Timber Hill
Yulupa-Santa Rosa Ck	Yulupa	Santa Rosa Ck
Santa Rosa-Willowside	Santa Rosa Ck	Willowside
Willowside-Timber Hill	Willowside	Timber Hill
Timber Hill-Denner	Timber Hill	Denner Ranch
Denner-Mirabel	Denner Ranch	Mirabel Heights
Mirabel Heights-Mirabel Park	Mirabel Heights	Mirabel Park
Mirabel-Hacienda	Mirabel Park	Hacienda
Hacienda-Johnsons	Hacienda	Johnsons Beach
Johnsons-Duncans Mills	Johnsons Beach	Ducans Mills
Cazadero-Duncans Mills	Cazadero-Austin	Ducans Mills
Duncans Mills-Jenner	Ducans Mills	Windsor

Figure K.16 HMS Reach to Stream Editor – By Junctions Tab – Completed

## K.3.2 By Streams

To edit the geographic location of HEC-HMS reach elements by stream:

- From the HEC-WAT main window (Figure K.1), from the **Edit** menu, point to **HMS**, click **Reach To Stream Mapping**.
- The **HMS Reach to Stream Editor** will open (Figure K.17). This editor is not from HEC-HMS, but from HEC-WAT. Since the current version of HEC-HMS does not recognize the coordinate system that HEC-WAT has for a study, this editor allows the user to enter information that will give the HEC-HMS reach element the correct geographic location on the schematic.

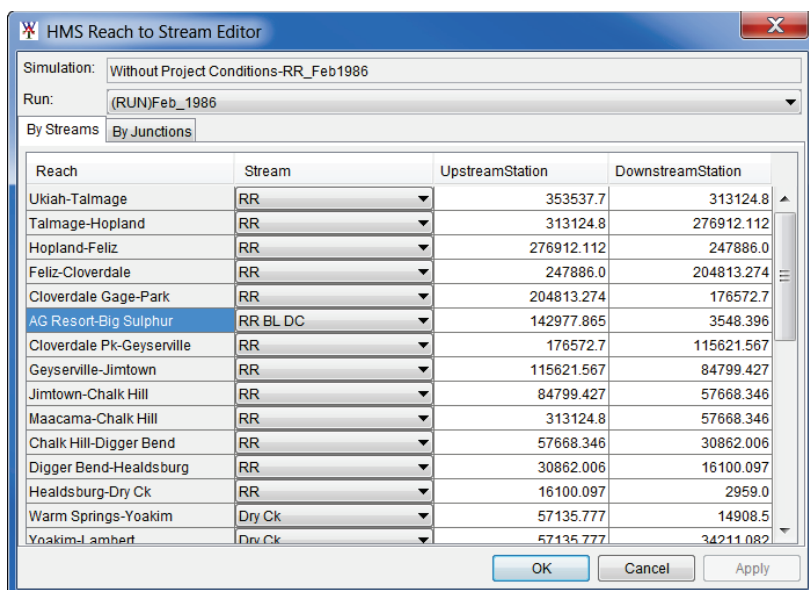


Figure K.17 HMS Reach to Stream Editor – By Streams Tab

3. An HEC-WAT simulation must be displayed in a map window on the HEC-WAT main window (Figure K.18). The active simulation name is displayed in the **Simulation** box (Figure K.17). For example, in Figure K.17, the HEC-WAT simulation is *Without Project Conditions-RR\_Feb1986*. From the **Maps** tab (similar to Figure K.8), turn off all of the appropriate map layers for the simulation map window. When this is done, the map windows displays (Figure K.18) the HMS graphical elements for the HMS model alternative and the HEC-WAT simulation. The user should review the map windows to see if any HMS reaches are not displaying or are in the wrong location.

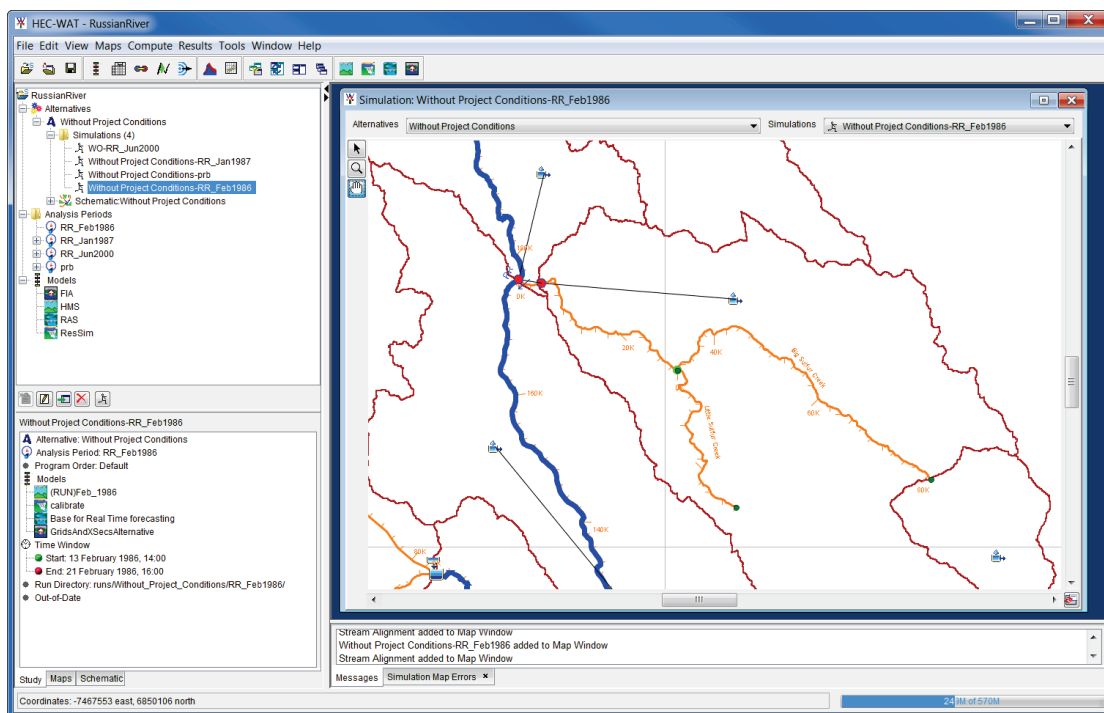

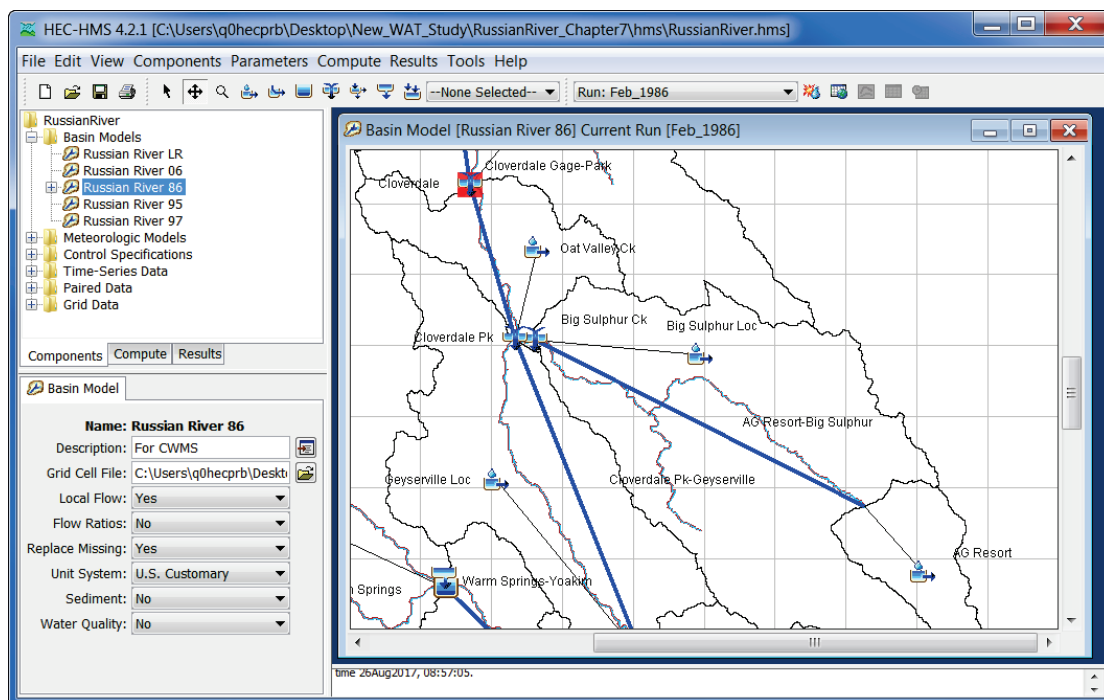



Figure K.18 HEC-WAT Main Window – Simulation Map Window

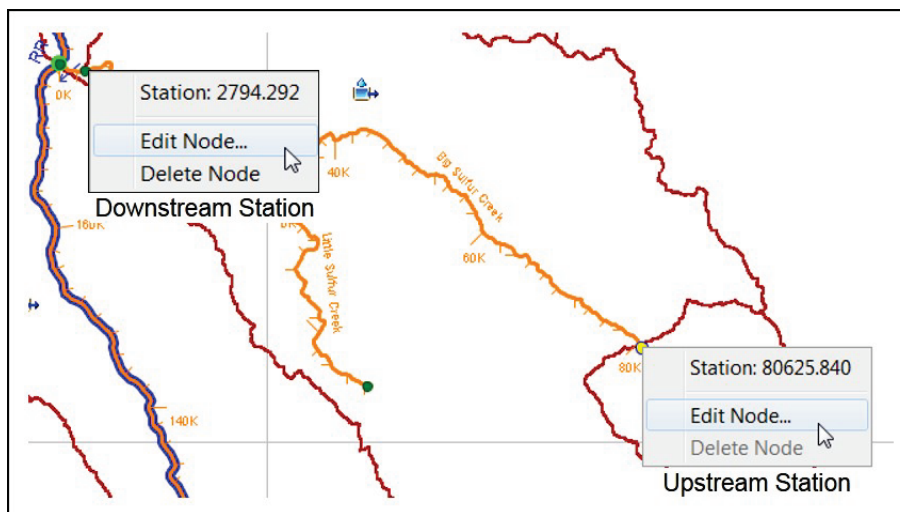
- To assist in verifying the upstream and downstream junctions for a reach, from the HEC-WAT main window (Figure K.18), from the **Programs Toolbar**, click , the HEC-HMS main window will open (Figure K.19). From study tree, from the **Basin Models** folder (Figure K.19), double click on the correct HMS basin model (i.e., *Russian River 86*). A map window will display the HMS graphical elements of the selected HMS basin model (Figure K.19). The user should take some time and familiarize themselves with the HMS model alternative and reach and junction locations.



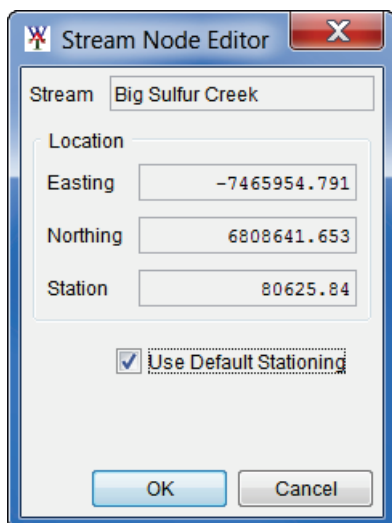
**Figure K.19** HEC-HMS Main Window

- Both the HEC-WAT and HEC-HMS map windows should be zoomed-in to the same location. For the example given here, Figure K.18, the user has already provided stationing for the HMS junctions and has mapped upstream and downstream junctions to most of the HMS reaches. There are five HMS reaches that still need to be modified so that the HMS reaches will display correctly on the HEC-WAT schematic.
- After reviewing the map windows (Figures K.18 and K.19), from the **HMS Reach to Stream Editor** (Figure K.17), from the table for a **Reach** (e.g., *AG Resort-Big Sulphur*), from the **Stream** list (Figure K.17), select the correct stream (e.g., *Big Sulfur Creek*). By viewing the HEC-WAT **Map Window** (Figure K.18), the user can determine the stream name.
- To determine the upstream station, compare the two map windows, the user should be able to locate the upstream station. For example, in Figure K.20, the upstream station is located at the end point of *Big Sulfur Creek*. From the HEC-WAT map window, select  (**Stream Node Tool**), right-click on the green circle, from the shortcut menu click **Edit Node**, the **Stream Node Editor** will open (Figure K.21).





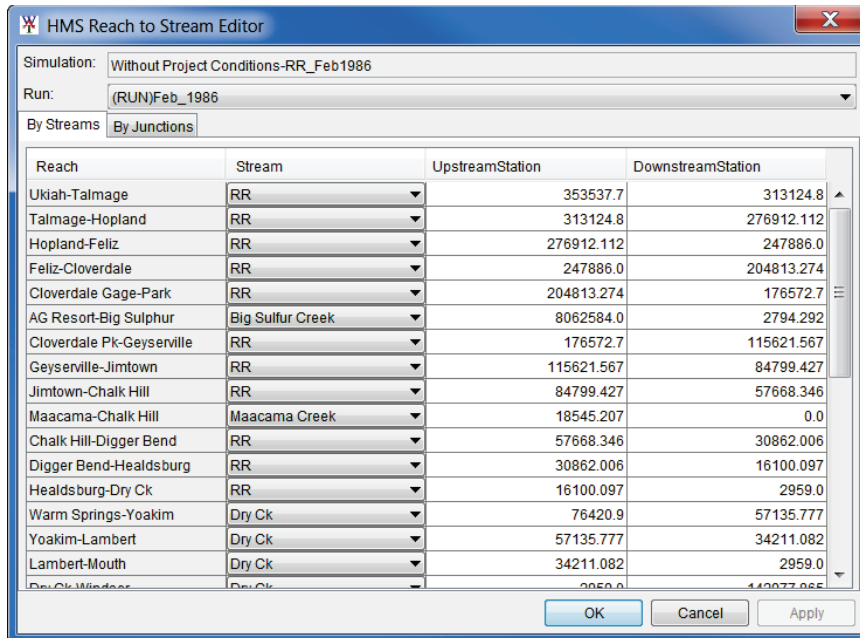
**Figure K.20** Stream Junction Editor – Upstream and Downstream Stations



**Figure K.21** Stream Node Editor

8. In the **Station** box (Figure K.21), the stream station for the selected upstream station is displayed (i.e., 80625.84). From the **HMS Reach to Stream Editor** (Figure K.17), from the **UpstreamStation** cell for the selected HMS reach, enter the stream station.
9. To determine the downstream station, the user should be able to compare the two map windows. For example, in Figure K.20 (upper left corner), the downstream station is just above the confluence of two streams. The user will need to create a stream node at that location (Appendix F, Section F.3.2). Right-click on the green circle (Figure K.20, upper left corner), from the shortcut menu click **Edit Node**, the **Stream Node Editor** will open (Figure K.21).
10. From the **Station** box (Figure K.21), the stream station for the selected downstream station is displayed (i.e., 2794.292). From the **HMS Reach to Stream Editor** (Figure K.17), from the **DownstreamStation** cell for the selected HMS reach, enter the stream station.

11. Once the stream station has been entered into the **HMS Reach to Stream Editor** (Figure K.22), the user will need to remove the stream node/junction from the schematic. This has to be done, because any changes to the stream station will affect an HEC-ResSim model alternative.

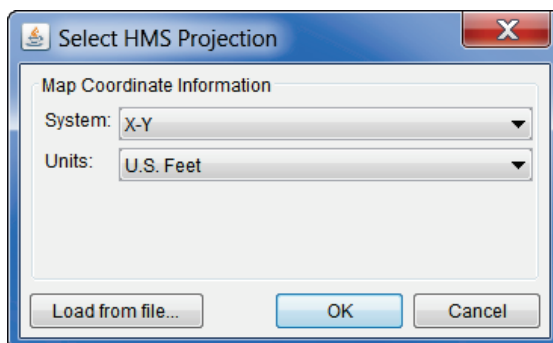


**Figure K.22** HMS Reach to Stream Editor - Completed

12. For this particular example, the user will need to perform Steps 6 through 10 for four more reaches. Once all reaches have been provided the correct stationing, click **Apply** (Figure K.21). When the **HMS Reach to Stream Editor** (Figure K.10) is complete, click **OK**, the **HMS Reach to Stream Editor** (Figure K.10) will close.

## K.4 Coordinate Information

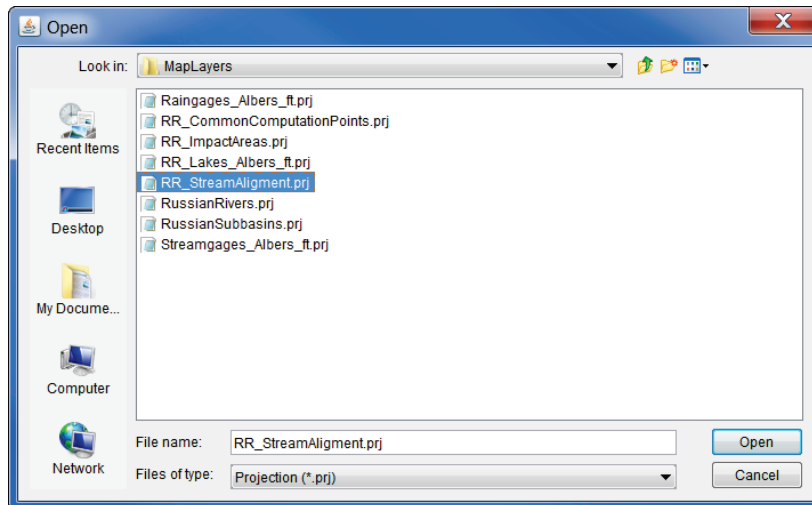
HEC-HMS graphic elements could have problems displaying correctly if the HEC-HMS model alternative is in a different coordinate system. To correct this issue, from the **Edit** menu, point to **HMS**, click **Coordinate Information**, the **Select HMS Projection** dialog box will open (Figure K. 23).



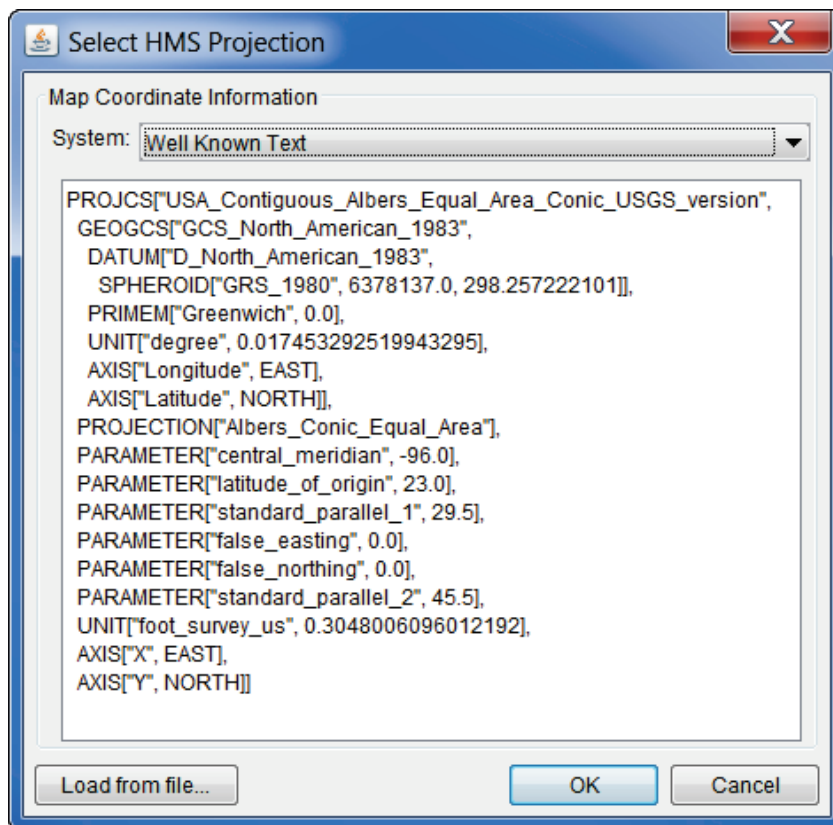
**Figure K.23** Select HMS Projection Dialog Box



1. From the **Select HMS Projection Dialog Box** (Figure K.23), click **Load from file** (lower left corner); an **Open** browser (Figure K.24) will open. Browse to where the map layer containing the correct projection is stored. Click **Open**, the **Select HMS Projection** dialog box will open (Figure K.25). The **Select HMS Projection** dialog box contains information about the projected coordinate system (Figure K.25). Click **OK**, the **Select HMS Projection** dialog box will close (Figure K.25).



**Figure K.24** Open Browser



**Figure K.25** Select HMS Projection Dialog Box

2. The projection of the HMS model alternative is now set to the correct coordinate system.



# Appendix L

## Editing Model Data

### L.1 Overview

HEC-WAT provides a framework that streamlines and integrates a study using software applications commonly used within USACE. The software applications are directly accessible from within HEC-WAT, which allows the user to edit individual model alternative data directly from the individual software applications. This flexibility is accomplished through the use of a "plug-in" (HEC-WAT Technical Reference Manual; not available for Version 1.0 release) that has been built for each piece of software. The plug-in allows HEC-WAT and the individual software applications to communicate with minimal specific code being needed by HEC-WAT or the individual software application.

From HEC-WAT the user has several options on editing model data. The user can open the user interface of the individual software applications that edit the model data by clicking the appropriate software button from the **Programs Toolbar** (Chapter 3, Section 3.2.1) of the HEC-WAT main window (Figure L.1). Also from the HEC-WAT main window, from the **Study Tree**, on the **Study Pane** (Chapter 3, Section 3.2.2), right-click on a simulation, from the shortcut menu, point to **Edit Model**, and then click on the model alternative to edit.

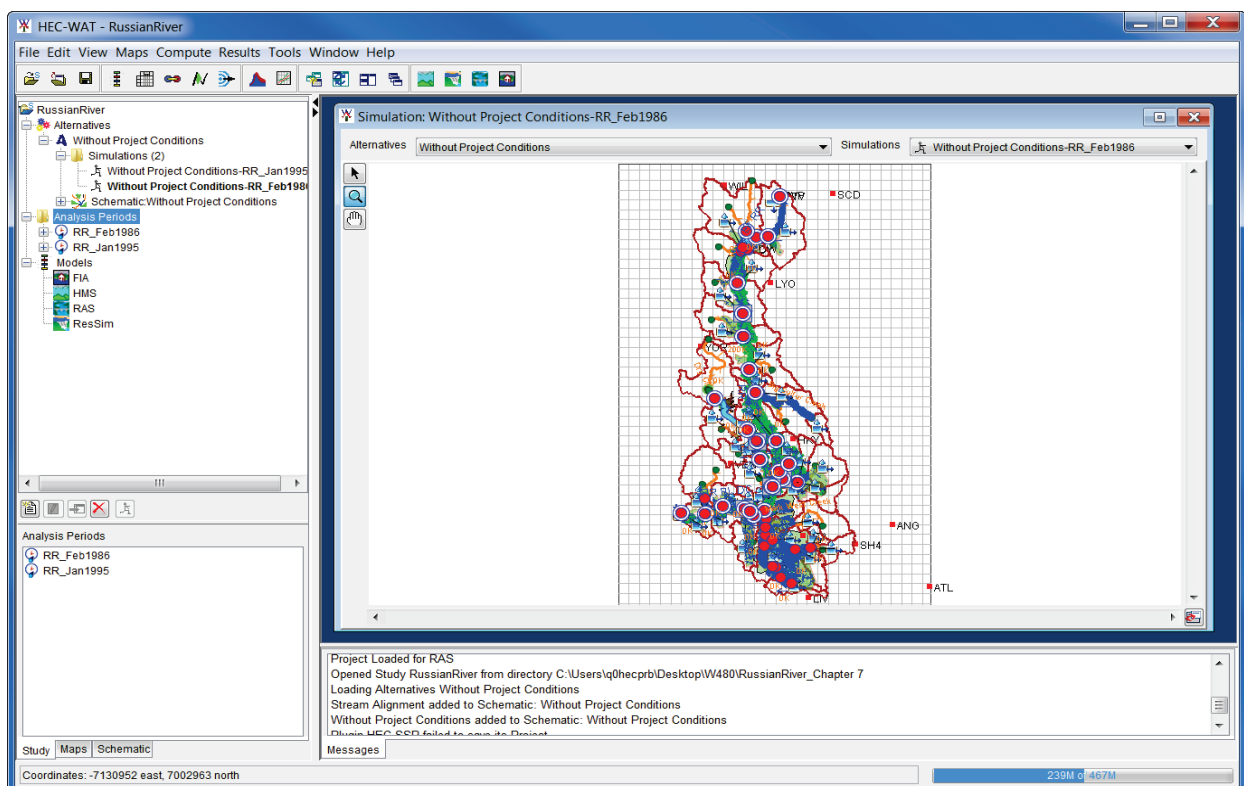


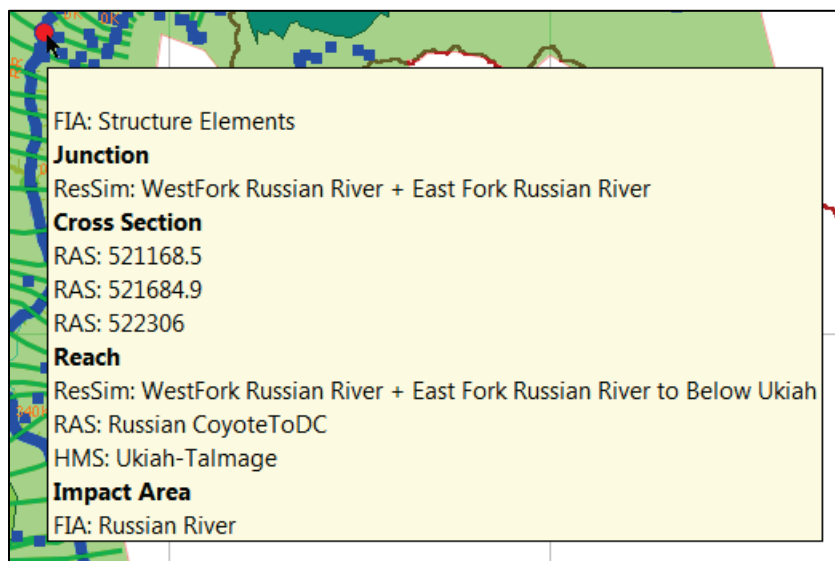
Figure L.1 HEC-WAT Main Window

From the **Study Tree**, from the **Simulations** folder, select a simulation, in the **Content Pane** (Figure L.1), under **Models**, the model alternatives for the selected simulation will display. Right-click on a model alternative, from the shortcut menu, click **Edit Model**, the user can then edit the select model alternative. Finally, from the HEC-WAT main window (Figure L.1) from the **Edit** menu, from the software application item, the user can access the main window of the selected software applications or individual editors from the software application. For example, from the **Edit** menu, point to RAS, click Open RAS, and the HEC-RAS main window will open.

This appendix will focus on accessing specific editors from the available software applications, from within HEC-WAT. These editors can be accessed interactively from the schematic (Section L.2) or from the HEC-WAT main window (Section L.3).

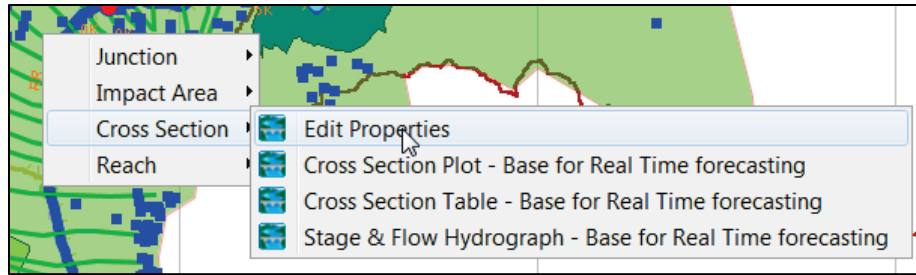
## L.2 Schematic

From the active simulation map window you can access software application specific editors from the model elements that are available on a map window. When hovering over a model element, a tooltip will appear (Figure L.2) which lists what model information is available for that particular model element. For example, in Figure L.2 at the junction there is possible information from ResSim, also, there is a cross section and a reach element in the area that is recognized by ResSim, HMS, and RAS. Also, there is structures and an impact area near the junction that are recognized by FIA.



**Figure L.2** ToolTip Information from Schematic (Simulation Map Window)

To access model specific editors, right-click on a model element, a shortcut menu (Figure L.3) will appear which provides access to the available software application editors. HEC-WAT searches for all available model elements in the area that the user has right-clicked on, so the shortcut menu will usually display all the model elements that were found in that area. For example, in Figure L.3, right-clicking at a cross section, HEC-WAT has found four model elements in the area of that cross section. To access the editor specific for the cross section, from the shortcut menu, point to **Cross Section**, click **Edit Properties**, the **Cross Section Data Editor** from RAS will open.



**Figure L.3** Model Element Shortcut Menus


The following sections will cover the available models editors for the default HEC-WAT software applications.

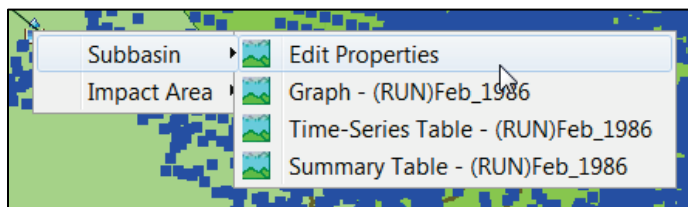
## L.2.1 HMS

Whether right-clicking on a subbasin element, junction element, reach element, reservoir element, or sink element, from the schematic there are various HMS model editors that can be accessed. The following section describes those editors.


### Subbasin Element

To edit HMS model data at a subbasin:

1. From the simulation map window, right-click on an HMS subbasin model element (  ) on the schematic, a shortcut menu will display (Figure L.4). From the shortcut menu, point to **Subbasin**, click **Edit Properties**.



**Figure L.4** Subbasin Element Shortcut Menu

2. The HMS editor for subbasins will open (Figure L.5). This editor allows the user to change parameters that are specific to an HMS subbasin. For further detail on this editor, reference the HEC-HMS User's Manual.
3. To close the HMS editor for subbasins (Figure L.5) click .

### Routing Reach Element

1. From the simulation map window, right-click on an HMS routing reach model element (blue line) on the schematic, a shortcut menu will display (Figure L.6). From the shortcut menu, point to **Reach**, since there is more than reach element available (i.e., HMS, ResSim, RAS), point to **Edit Properties**, click on the available HMS model alternative (e.g., (RUN)Feb\_1986-Chalk Hill-Digger Bend).

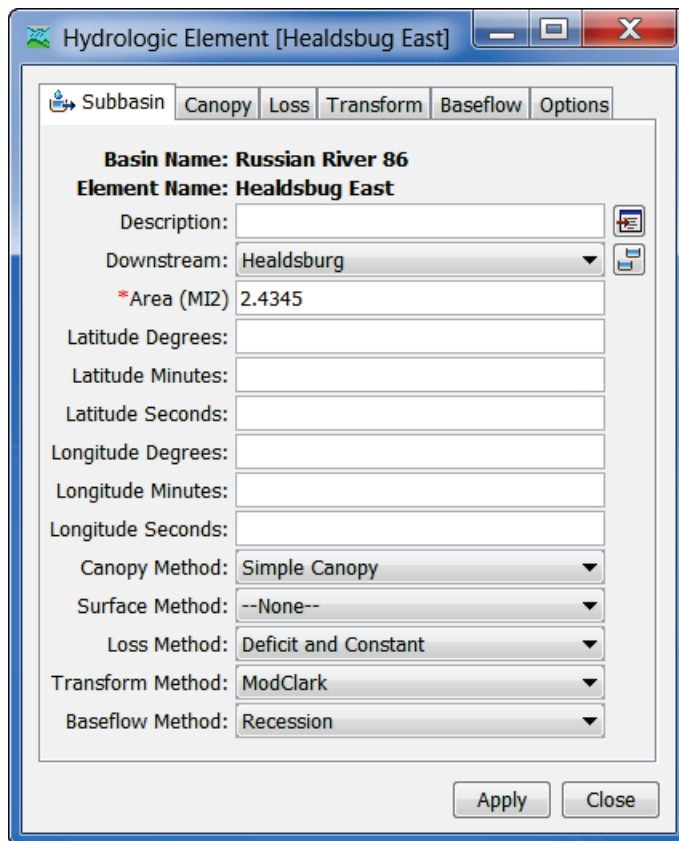


Figure L.5 HEC-HMS Editor - Subbasin

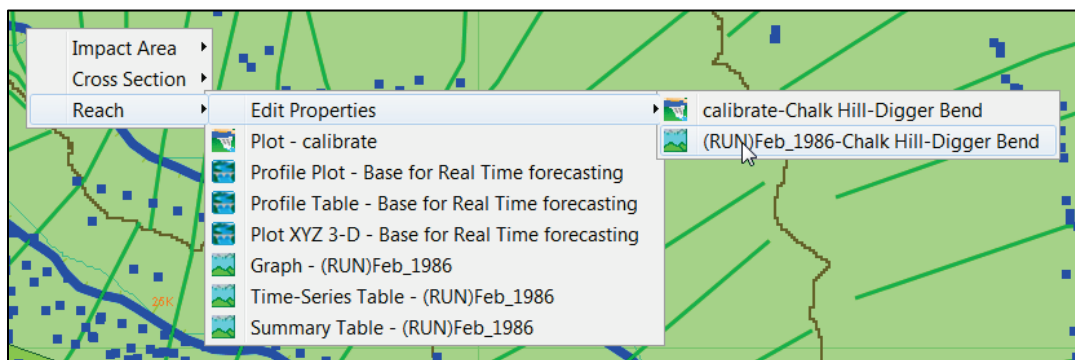


Figure L.6 Routing Reach Element Shortcut Menu

2. The HMS editor for a routing reach will open (Figure L.7). This editor allows the user to change parameters that are specific to an HMS routing reach. For further detail on this editor, reference the HEC-HMS User's Manual.
3. To close the HMS editor for routing reaches (Figure L.7) click

## Junction Element

1. From the simulation map window, right-click on an HMS junction model element on the schematic (red circle), a shortcut menu will appear (Figure L.8). From the shortcut menu click **Edit Properties**.

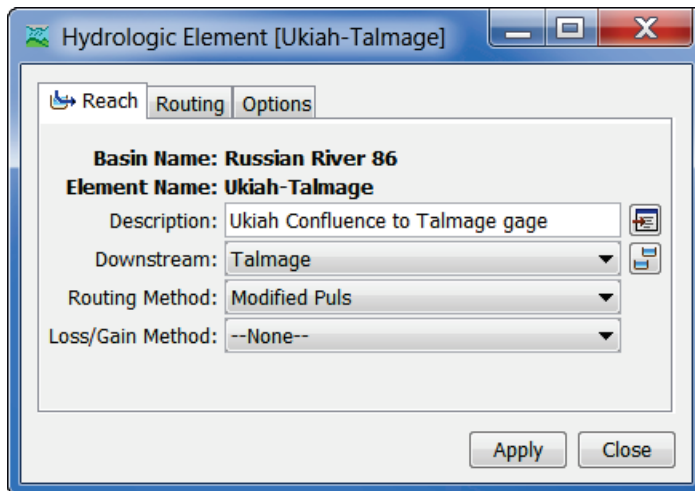


Figure L.7 HEC-HMS Editor – Routing Reach

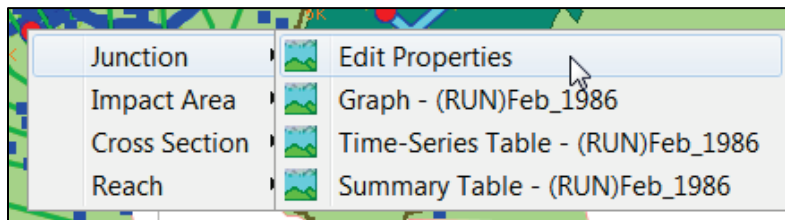


Figure L.8 Junction Element Shortcut Menu

- The HMS editor for a junction will open (Figure L.9). This editor allows the user to change parameters that are specific to an HMS junction. For further detail on this editor, reference the HEC-HMS User's Manual.

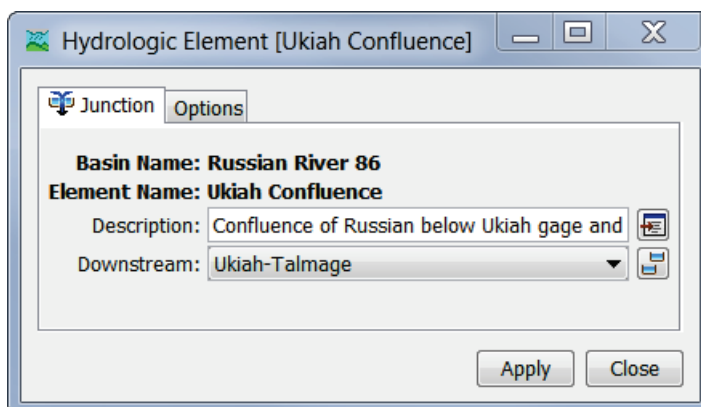
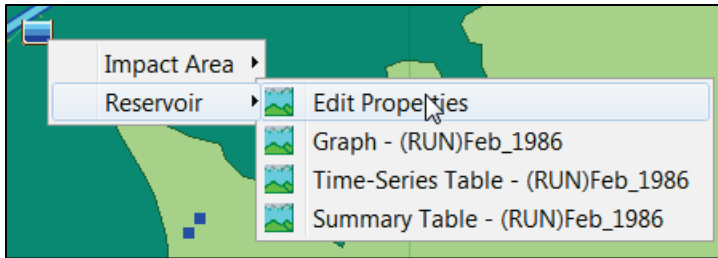


Figure L.9 HEC-HMS Editor - Junction


- To close the HMS editor for junctions (Figure L.9) click

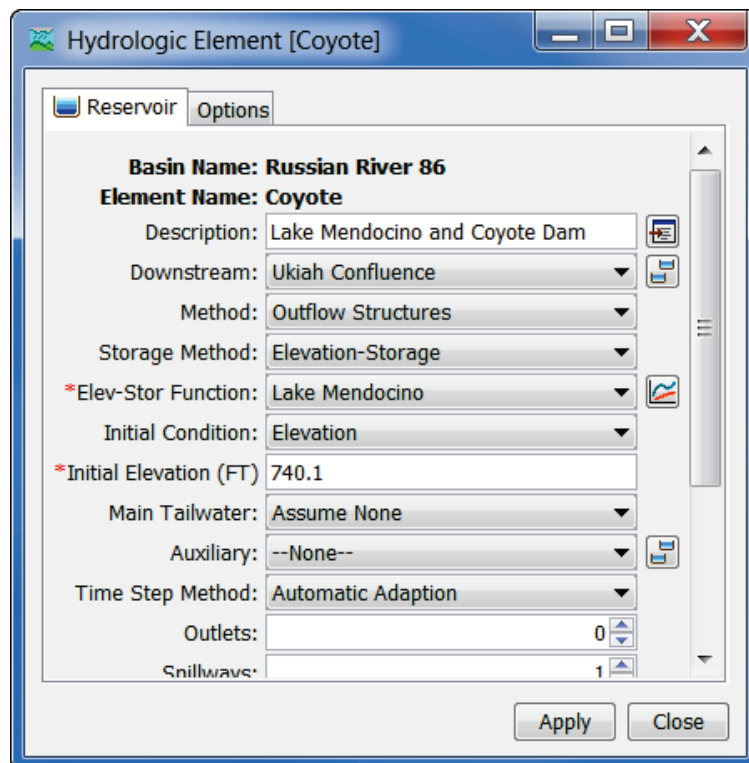
## Reservoir Element

- From the simulation map window, right-click on an HMS reservoir model element on the schematic (), a shortcut menu will appear (Figure L.10). From the shortcut menu click **Edit Properties**.



**Figure L.10** Reservoir Element Shortcut Menu

2. The HMS editor for a junction will open (Figure L.11). This editor allows the user to change parameters that are specific to an HMS reservoir. For further detail on this editor, reference the HEC-HMS User's Manual.
3. To close the HMS editor for reservoirs (Figure L.11) click .



**Figure L.11** HEC-HMS Editor - Reservoir

## L.2.2 ResSim

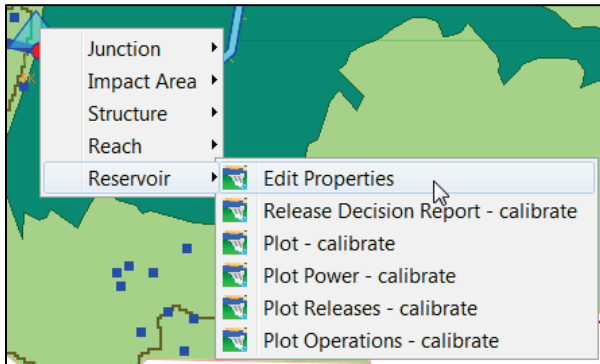
Whether right-clicking on a reservoir element, junction element, or reach element, from the schematic there are various HEC-ResSim model editors that are accessible. The following section describes those editors.

### Reservoir Element

To edit ResSim model data at a reservoir:

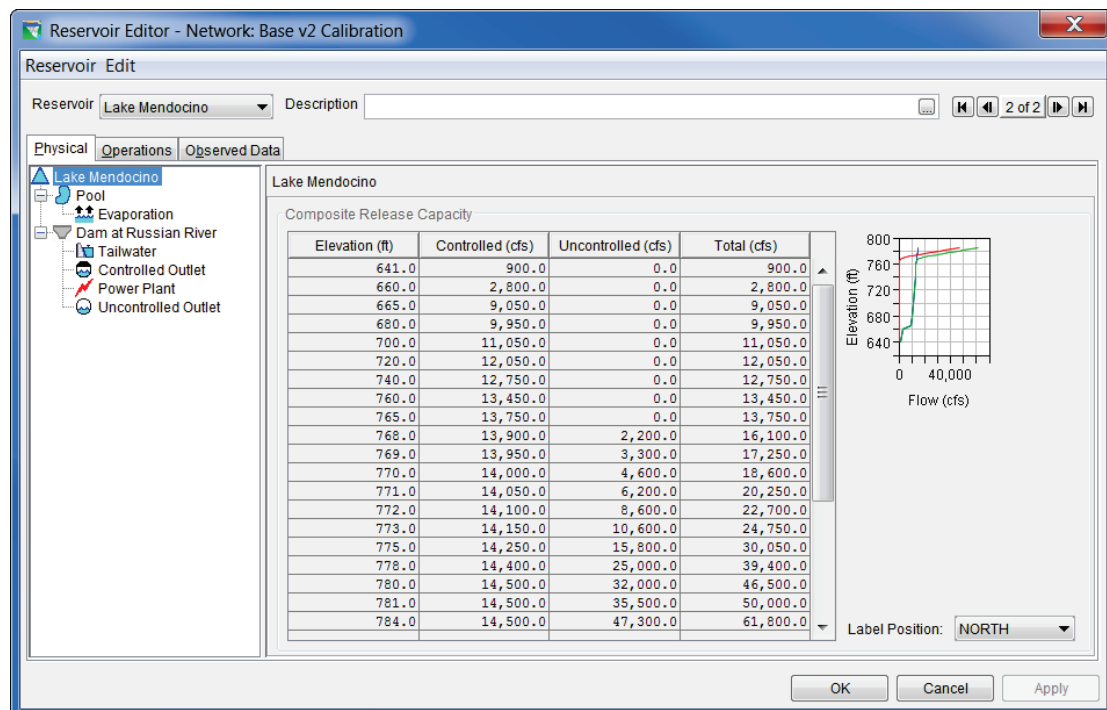


1. From the simulation map window, right-click on a reservoir model element (cyan triangle) on the schematic, a shortcut menu will appear (Figure L.12). From the shortcut menu, point to **Reservoir**, click **Edit Properties**.



**Figure L.12** Reservoir Element Shortcut Menu

2. The ResSim **Reservoir Editor** will open (Figure L.13). This editor allows the user to change physical data requirements for the reservoir, change the operation sets for a reservoir, and specify observed data if needed. For further detail on this editor, reference the ResSim User's Manual.



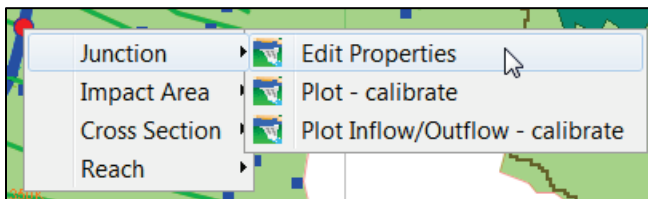
**Figure L.13** HEC-ResSim – Reservoir Editor

3. Click **OK**, the ResSim **Reservoir Editor** (Figure L.13) will close.

## Junction Element

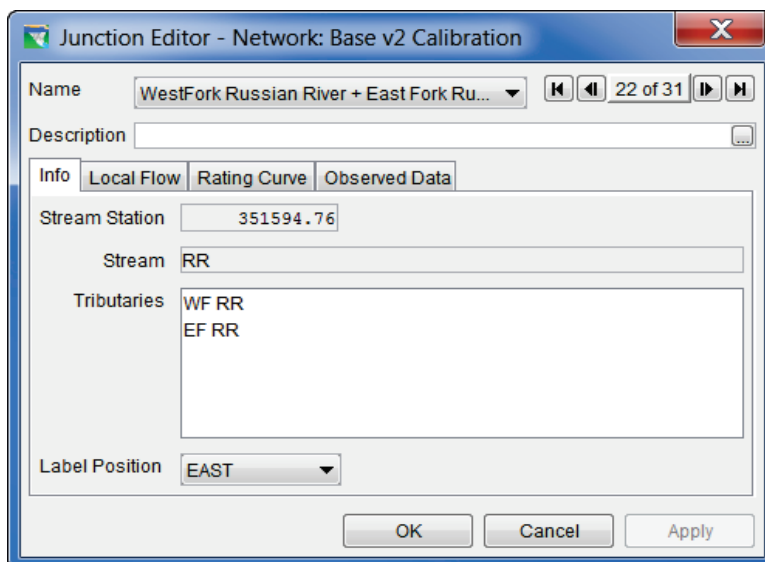
To edit ResSim model data at a junction:

1. From the simulation map window, right-click on a junction model element (red circle) on the schematic, a shortcut menu will appear (Figure L.14). From the shortcut menu, point to **Junction**, click **Edit Properties**.



**Figure L.14** Junction Element Shortcut Menu

2. The ResSim **Junction Editor** will open (Figure L.15). This editor allows the user to change information about a ResSim junction, add local flow and a rating curve, and if needed add information about observed data. For further detail on this editor, reference the HEC-ResSim User's Manual.



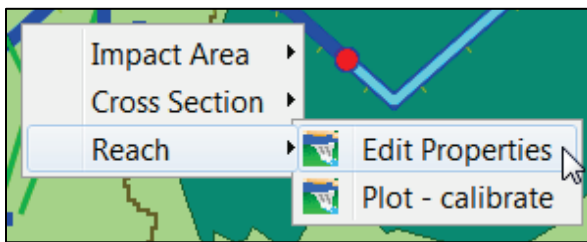
**Figure L.15** HEC-ResSim – Junction Editor

3. Click **OK**, the ResSim **Junction Editor** (Figure L.15) will close.

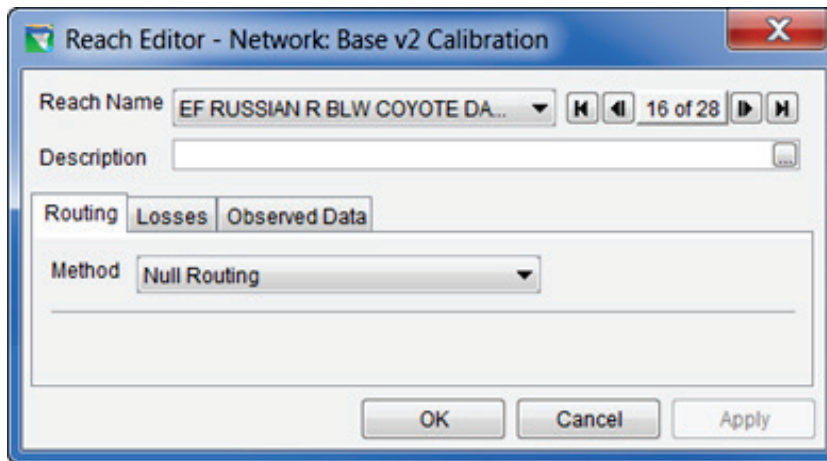
## Routing Reach Element

To edit ResSim model data at a routing reach:

1. From the simulation map window, right-click on a routing reach model element (blue line) on the schematic, a shortcut menu will appear (Figure L.16). From the shortcut menu, point to **Reach**, click **Edit Properties**.
2. The ResSim **Reach Editor** will open (Figure L.17). This editor allows the user to change information about a ResSim reach, add/change routing information, edit information about losses for the reach, and if needed add information about observed data. For further detail on this editor, reference the HEC-ResSim User's Manual.



**Figure L.16** Reach Element Shortcut Menu



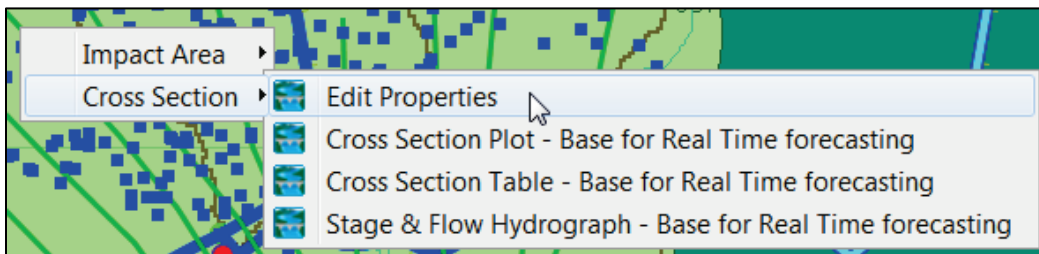
**Figure L.17** HEC-ResSim – Reach Editor

3. Click **OK**, the ResSim **Reach Editor** (Figure L.17) will close.

## L.2.3 HEC-RAS – Cross Section

To edit RAS model data at a cross section:

1. From the simulation map window, right-click on a cross section model element (green line) on the schematic, a shortcut menu will appear (Figure L.18). From the shortcut menu, point to **Cross Section**, click **Edit Properties**.



**Figure L.18** Cross Section Element Shortcut Menu

2. The RAS **Cross Section Data Editor** will open (Figure L.19). This editor allows the user to change information about a RAS cross section, add/change Manning's n values, edit cross section coordinates, and edit other information regarding a cross section. For further detail on this editor, reference the HEC-RAS User's Manual.

- From the **Exit** menu, click **Exit Cross Section Editor**, the **Cross Section Data Editor** (Figure L.19) will close.

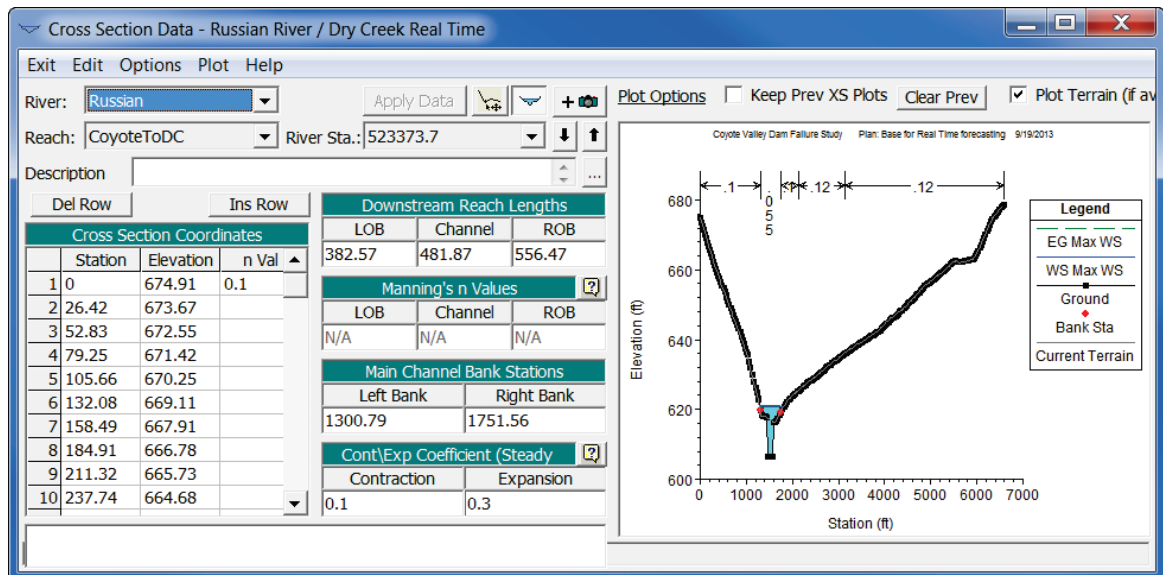


Figure L.19 HEC-RAS – Cross Section Editor

## L.2.4 FIA

Whether right-clicking on a reservoir element or a structure element, from the schematic there are various HEC-FIA model editors that are accessible. The following section describes those editors.

### Impact Area

To edit FIA model data at an impact area:

- From the simulation map window, right-click on an impact area model element (green polygon) on the schematic, a shortcut menu will appear (Figure L.20). From the shortcut menu click **Edit Properties**.

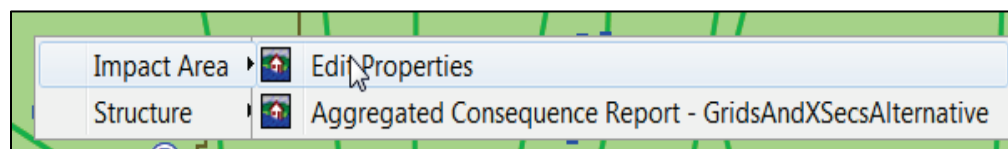
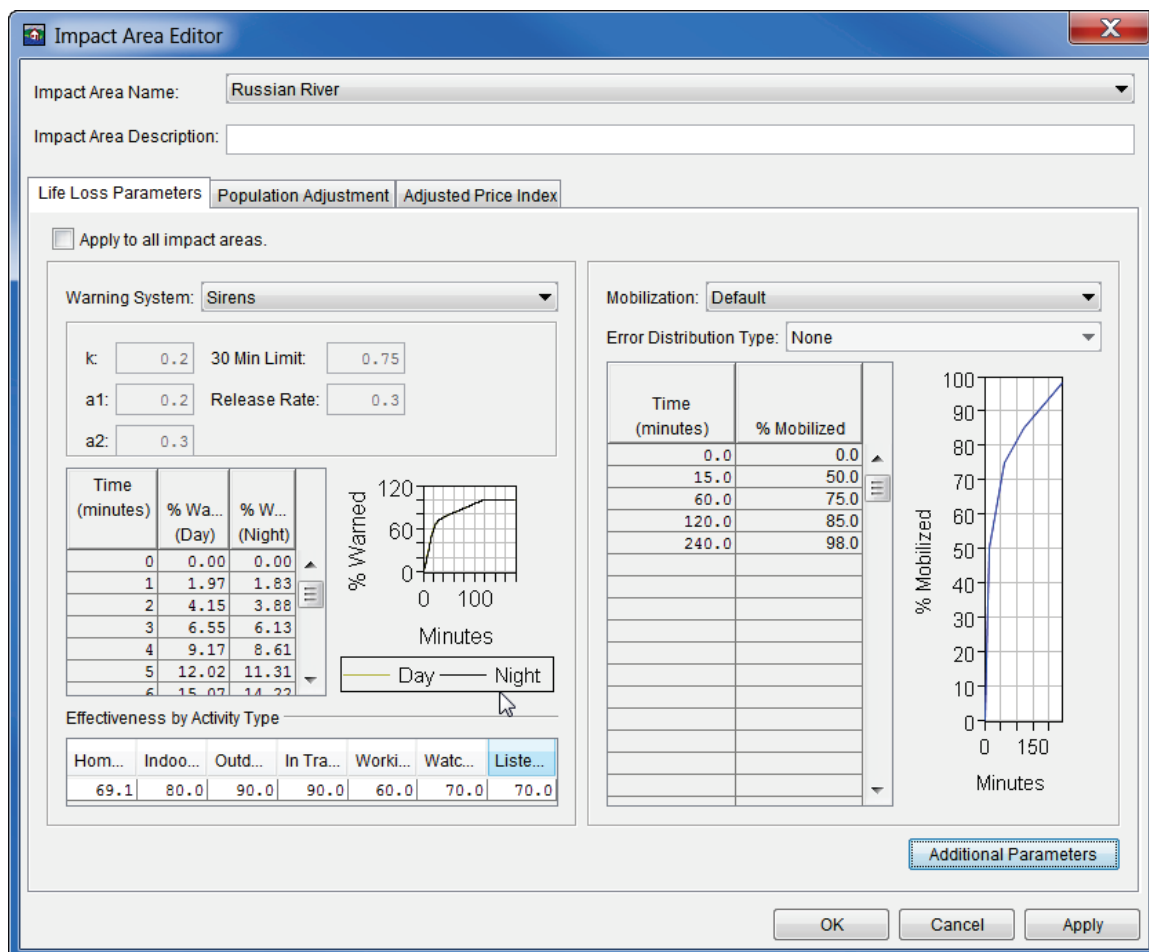


Figure L.20 Impact Area Element Shortcut Menu

- The FIA **Impact Area Editor** will open (Figure L.21). This editor allows the user to change information about impact area description, life loss parameters, population adjustment, and the adjusted price index. For further detail on this editor, reference the HEC-FIA User's Manual.
- Click **OK**, the HEC-FIA **Impact Area Editor** (Figure L.21) will close.

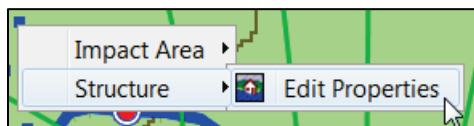
## Structure

To edit FIA model data at a structure:



**Figure L.21** HEC-FIA – Impact Area Editor

1. From the simulation map window, right-click on a structure model element (blue square) on the schematic, a shortcut menu will appear (Figure L.22). From the shortcut menu click **Edit Properties**.



**Figure L.22** Structure Element Shortcut Menu

2. The FIA **Structure Editor** will open (Figure L.23). This editor allows the user to change information about a structure's location, occupancy type data, structure value, content value, first floor elevation, foundation height, ground elevation, and lethality zone parameter data. For further detail on this editor, reference the HEC-FIA User's Manual.
3. Click **OK**, the HEC-FIA **Structure Editor** (Figure L.23) will close.

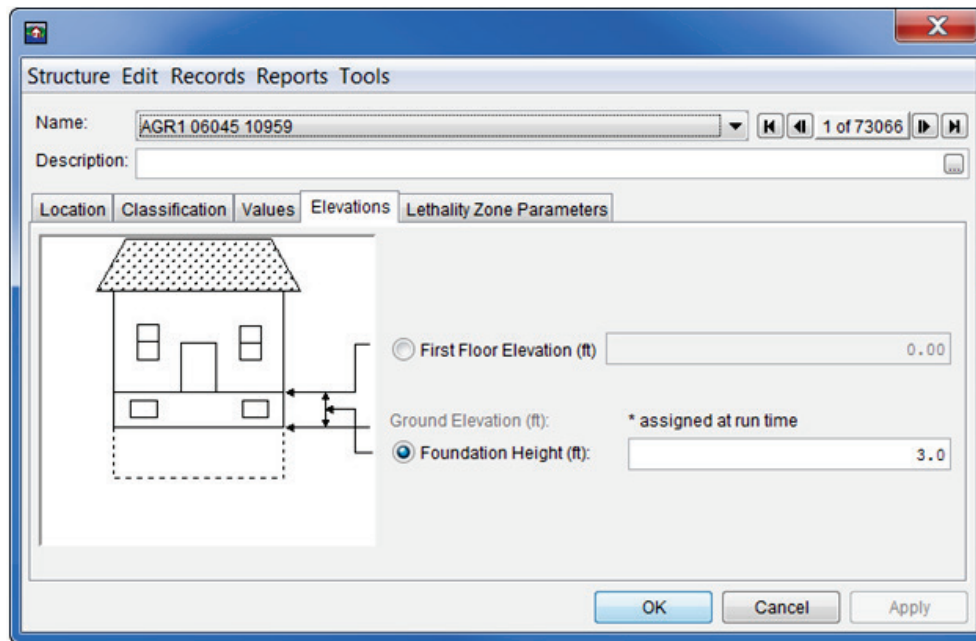


Figure L.23 HEC-FIA – Structure Editor

## L.3 Edit Menu

From the menu bar of the main HEC-WAT window, click **Edit** (Figure L.24), from this menu the user can access various editors or parts of a software application's interface that are specific to the software applications included in the program order for a study. For example, in Figure L.24, point to **HMS**, the available commands allow the user to interact with the HEC-HMS software application and access parts of the HEC-HMS interface like the **Basin Model** tab. The following sections provide an overview of the available editors. For more detail you will need to visit the user's manuals associated with each piece of software.

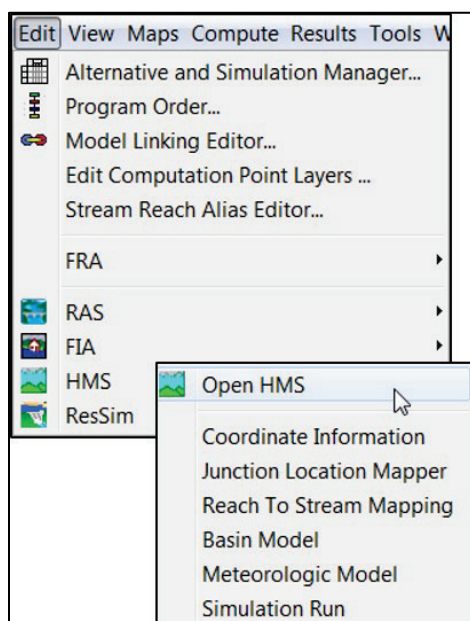


Figure L.24 Edit Menu – HMS

## L.3.1 HEC-HMS

From the HEC-WAT main window (Figure L.1), from the **Edit** menu, point to **HMS** (Figure L.24), click **Open HMS**. The HEC-HMS software application will open and the HEC-HMS main window will display (Figure L.25). The user can modify existing HEC-HMS models or create new HEC-HMS model components, once the user is finished and the model has been saved, the HEC-HMS model information is stored in the HEC-WAT study directory, under the *hms* folder. The rest of this section provides an overview of the HEC-HMS interface that is directly available from the HEC-WAT framework.

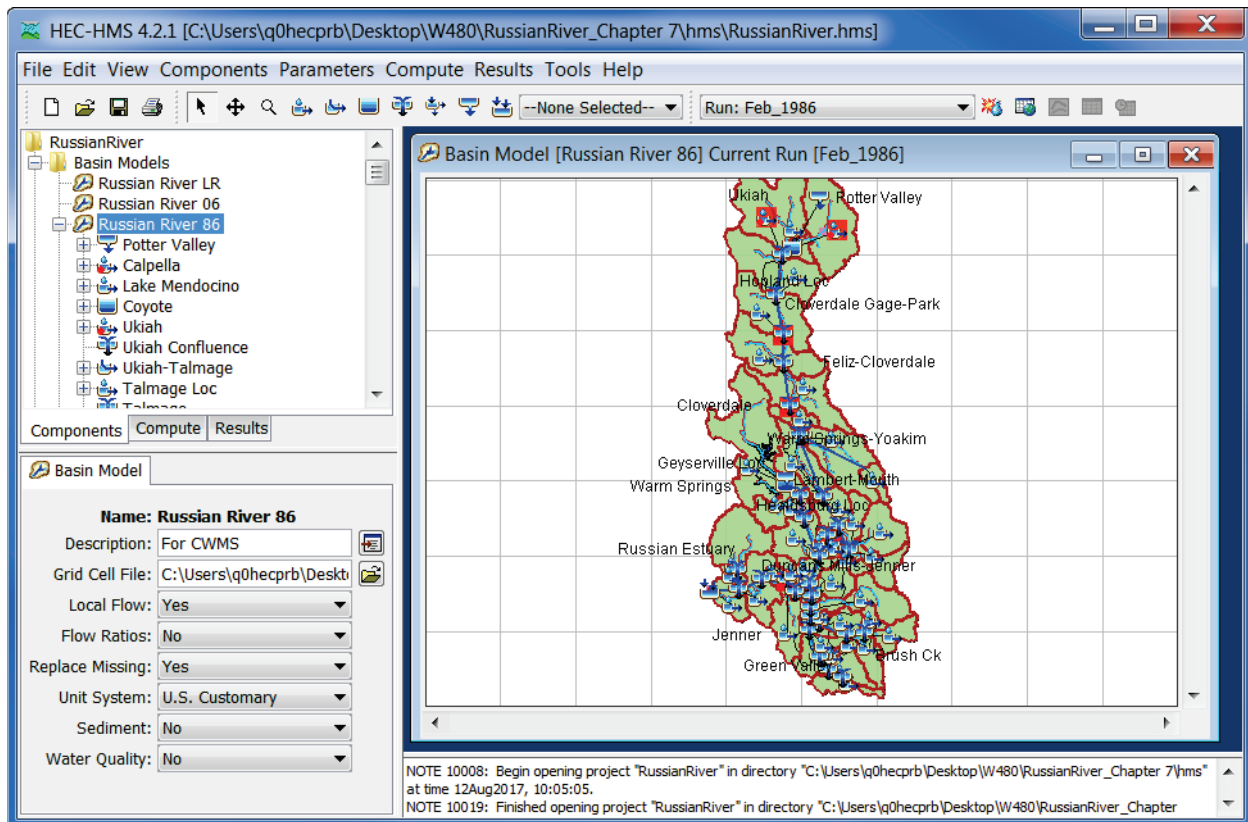


Figure L.25 HEC-HMS Main Window – Basin Model Tab

## Basin Model

To edit HMS model data for a basin:

1. From the WAT main window, from the **Edit** menu (Figure L.24), point to **HMS**, click **Basin Model**.
2. The HEC-HMS main window will open with the **Basin Model** tab displayed (Figure L.25). This tab allows the user to change parameters that are specific to an HMS basin. For further detail on this editor, reference the HEC-HMS User's Manual.
3. From the **File** menu, click **Exit**, the HEC-HMS main window will close (Figure L.25).



## Meteorologic Model

To edit the HMS meteorologic model for a study:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.25), point to **HMS**, click **Meteorologic Model**.
2. The HEC-HMS main window will open with the **Meteorology Model** tab displayed (Figure L.26). This tab allows the user to edit parameters that have been defined for the meteorologic model. For further detail on this editor, reference the HEC-HMS User's Manual.

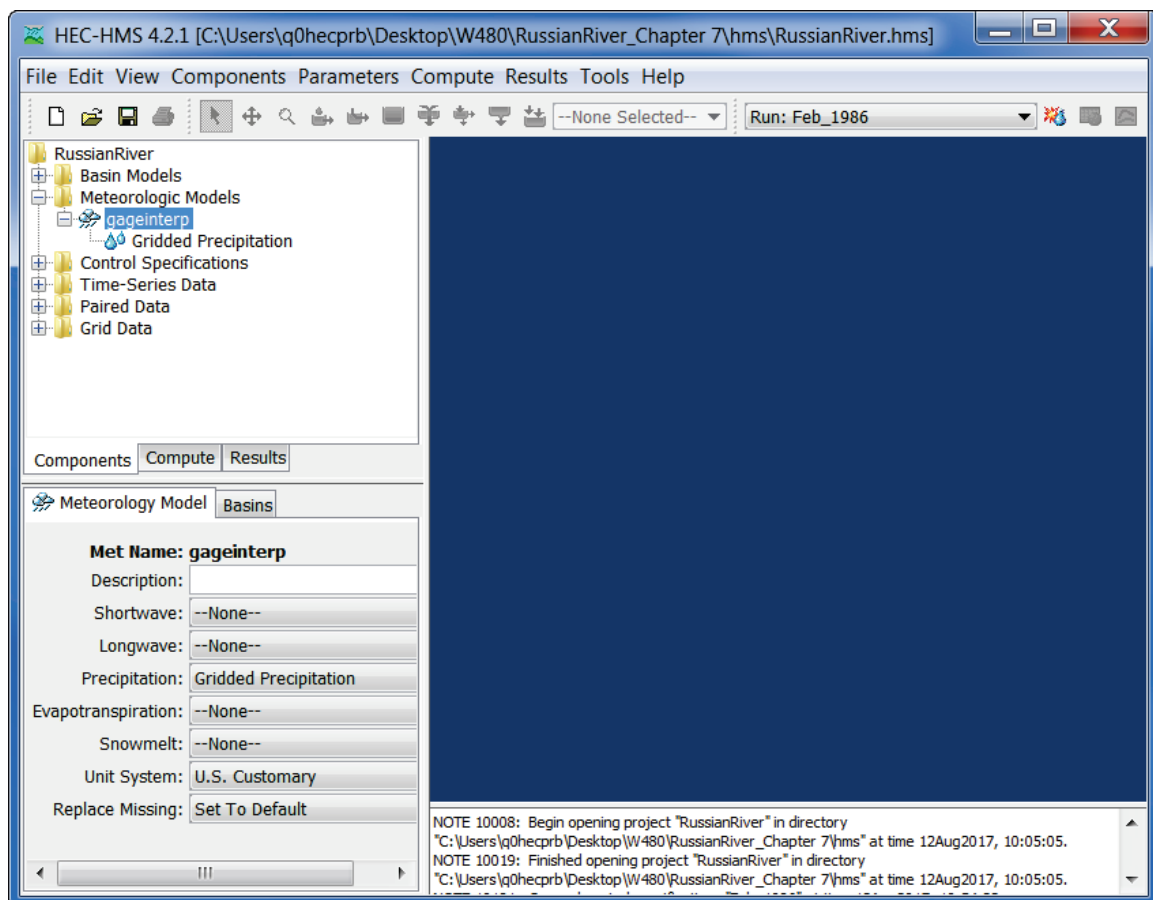


Figure L.26 HEC-HMS Main Window – Meteorology Model Tab

3. From the **File** menu, click **Exit**, the HEC-HMS main window will close (Figure L.26).

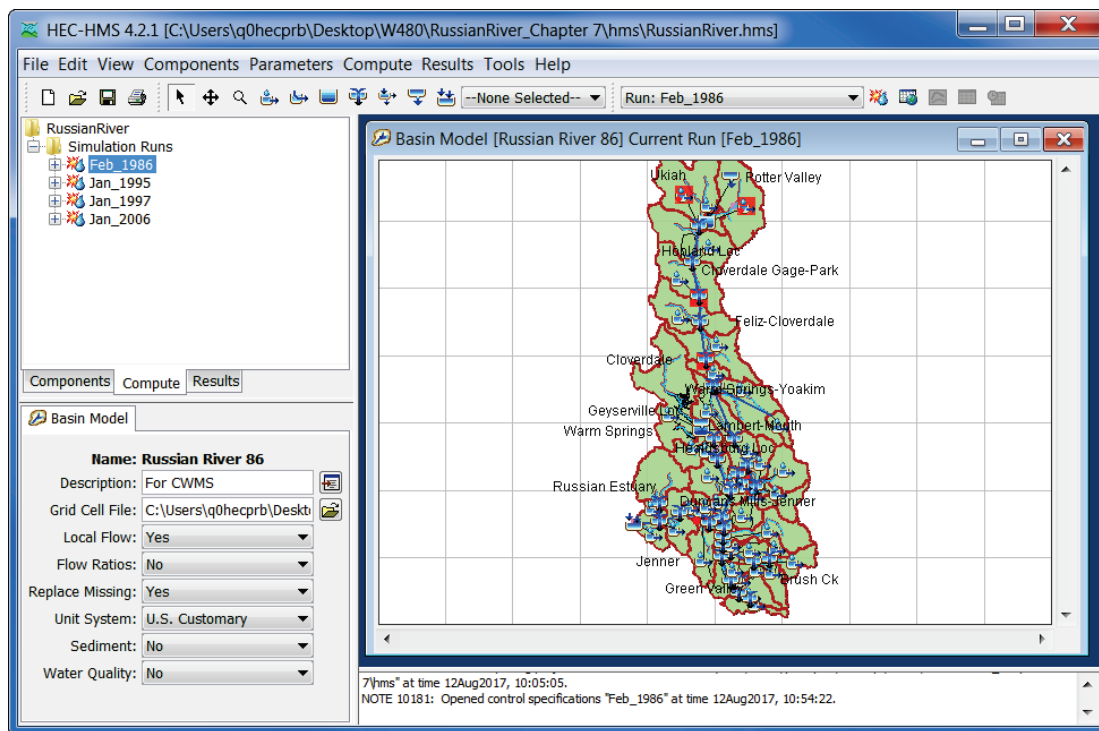
## Simulation Run

To edit the defined parameters for an HMS simulation:

1. From the WAT main window, from the **Edit** menu (Figure L.24), point to **HMS**, click **Simulation Run**.



- The HEC-HMS main window will open with the **Compute** tab displayed (Figure L.27). This tab allows the user to edit parameters that have been defined for an HMS simulation run. For further detail on this editor, reference the HEC-HMS User's Manual.

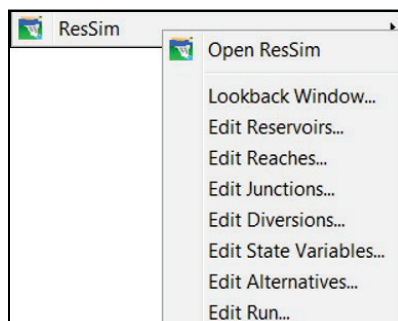


**Figure L.27** HEC-HMS Main Window – Basin Model Tab – Simulation Runs

- From the **File** menu, click **Exit**, the HEC-HMS main window will close (Figure L.26).

### L.3.2 HEC-ResSim

From the HEC-WAT main window (Figure L.1), from the **Edit** menu, point to **ResSim** (Figure L.28), click **Open ResSim**. The HEC-ResSim software application will execute and the HEC-ResSim main window will display (Figure L.29). The user can modify existing HEC-ResSim model components or create new HEC-ResSim model components, once the user is finished and data has been saved, the HEC-ResSim model information is stored in the HEC-WAT study directory, under the *rss* folder. The rest of this section provides an overview of the HEC-ResSim editors that are directly available from the HEC-WAT framework.



**Figure L.28** Edit Menu – ResSim

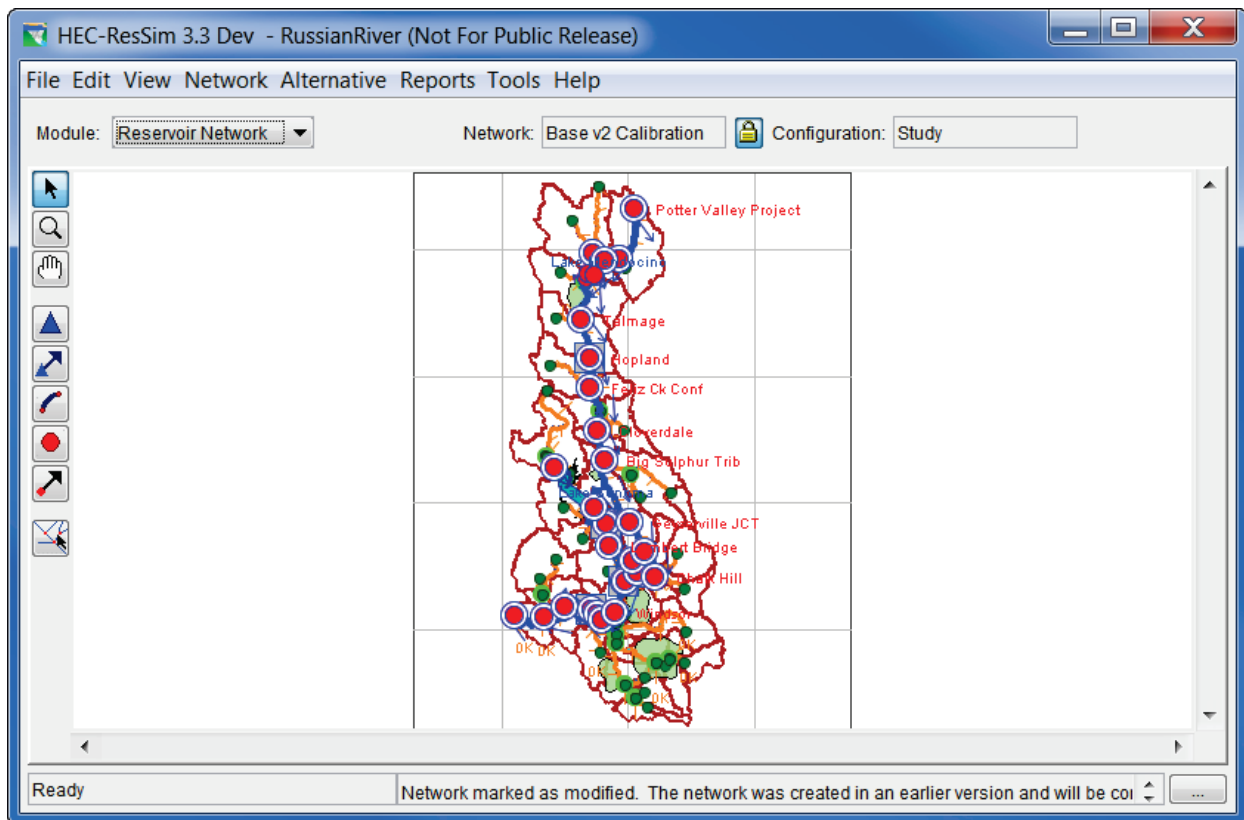


Figure L.29 HEC-ResSim Main Window

## Edit Reservoirs

To edit HEC-ResSim model data at a reservoir:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.28), point to **ResSim**, click **Edit Reservoirs**.
2. The HEC-ResSim **Reservoir Editor** will open (Figure L.13). This editor allows the user to change physical data requirements for the reservoir, change the operation sets for a reservoir, and specify observed data if needed. For further detail on this editor, reference the HEC-ResSim User's Manual.
3. Click **OK**, the HEC-ResSim **Reservoir Editor** (Figure L.13) will close.

## Edit Reaches

To edit HEC-ResSim model data at a reach:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.28), point to **ResSim**, click **Edit Reaches**.
2. The HEC-ResSim **Reach Editor** will open (Figure L.17). This editor allows the user to change information about a ResSim reach, add/change routing information, edit

information about losses for the reach, and if needed add information about observed data. For further detail on this editor, reference the HEC-ResSim User's Manual.

3. Click **OK**, the **Reach Editor** (Figure L.17) will close.

## Edit Junctions

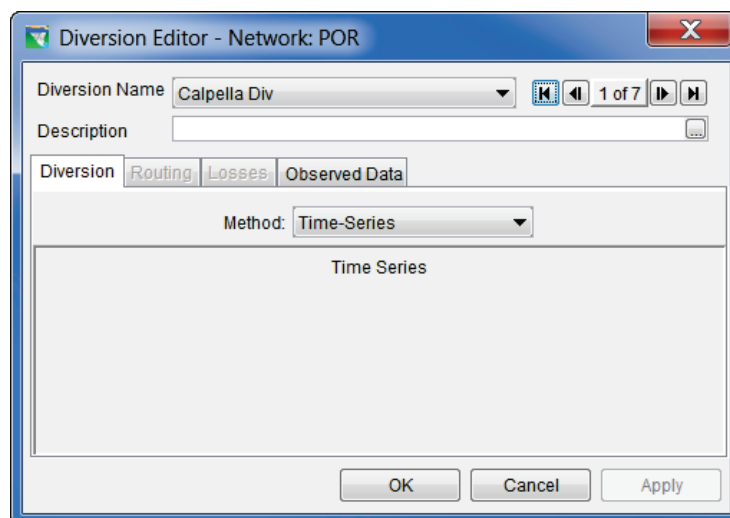
To edit HEC-ResSim model data at a junction:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.28), point to **ResSim**, click **Edit Junctions**.
2. The HEC-ResSim **Junction Editor** will open (Figure L.15). This editor allows the user to change information about a ResSim junction, add local flow and a rating curve, and if needed add information about observed data. For further detail on this editor, reference the HEC-ResSim User's Manual.
3. Click **OK**, the **Diversion Editor** (Figure L.15) will close.

## Edit Diversions

To edit HEC-ResSim model data at a diversion:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.28), point to **ResSim**, click **Edit Diversions**.
2. The HEC-ResSim **Diversion Editor** will open (Figure L.30). This editor allows the user to change information about a ResSim diversion, for further details on this editor, reference the HEC-ResSim User's Manual.



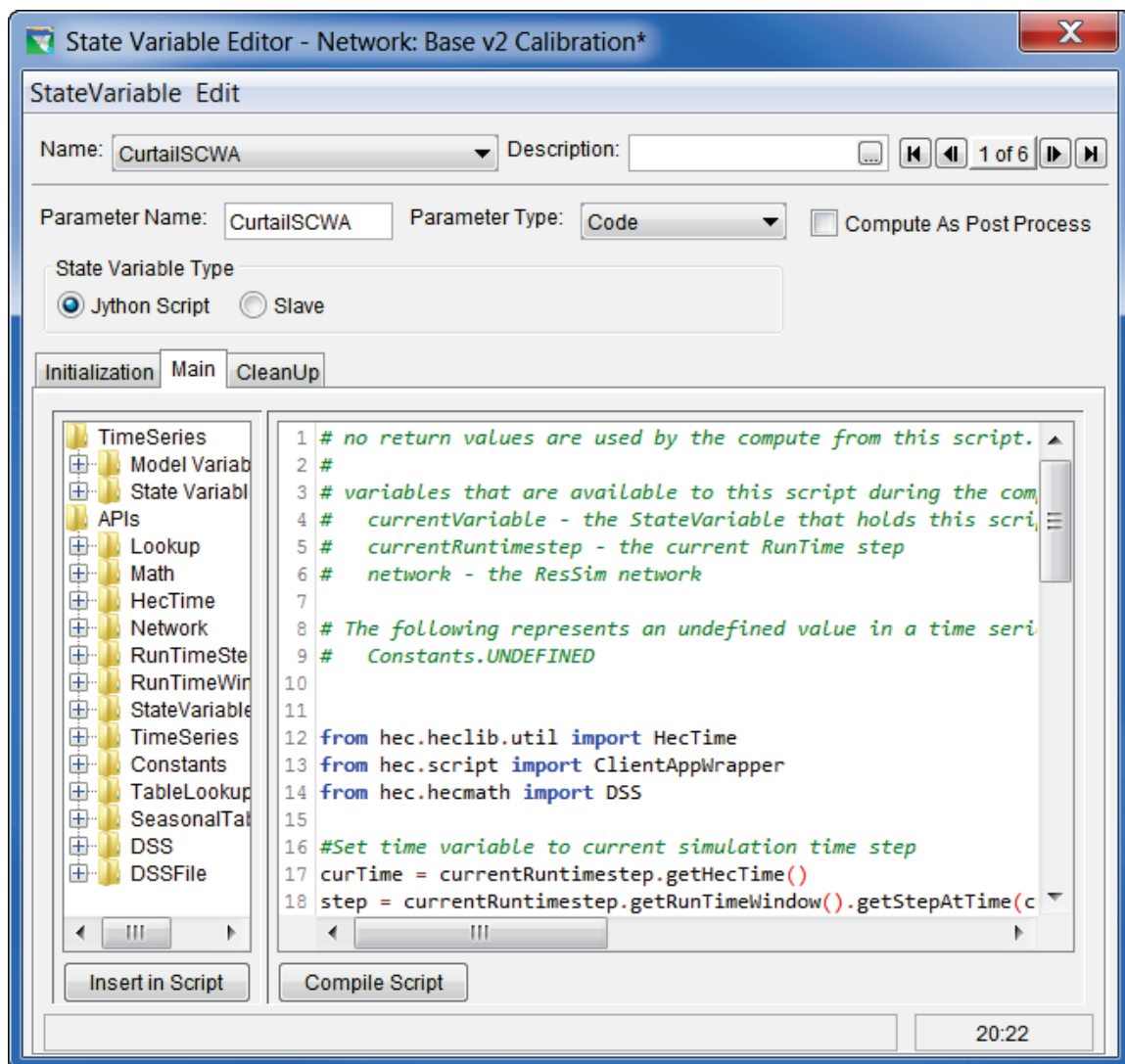
**Figure L.30** HEC-ResSim – Diversion Editor

3. Click **OK**, the **Diversion Editor** (Figure L.30) will close.

## Edit State Variables

To edit HEC-ResSim state variables:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.28), point to **ResSim**, click **Edit State Variables**.
2. The HEC-ResSim **State Variable Editor** will open (Figure L.31). This editor allows the user to modify information about a state variable that has been created for the HEC-ResSim model. For further detail on this editor, reference the HEC-ResSim User's Manual.



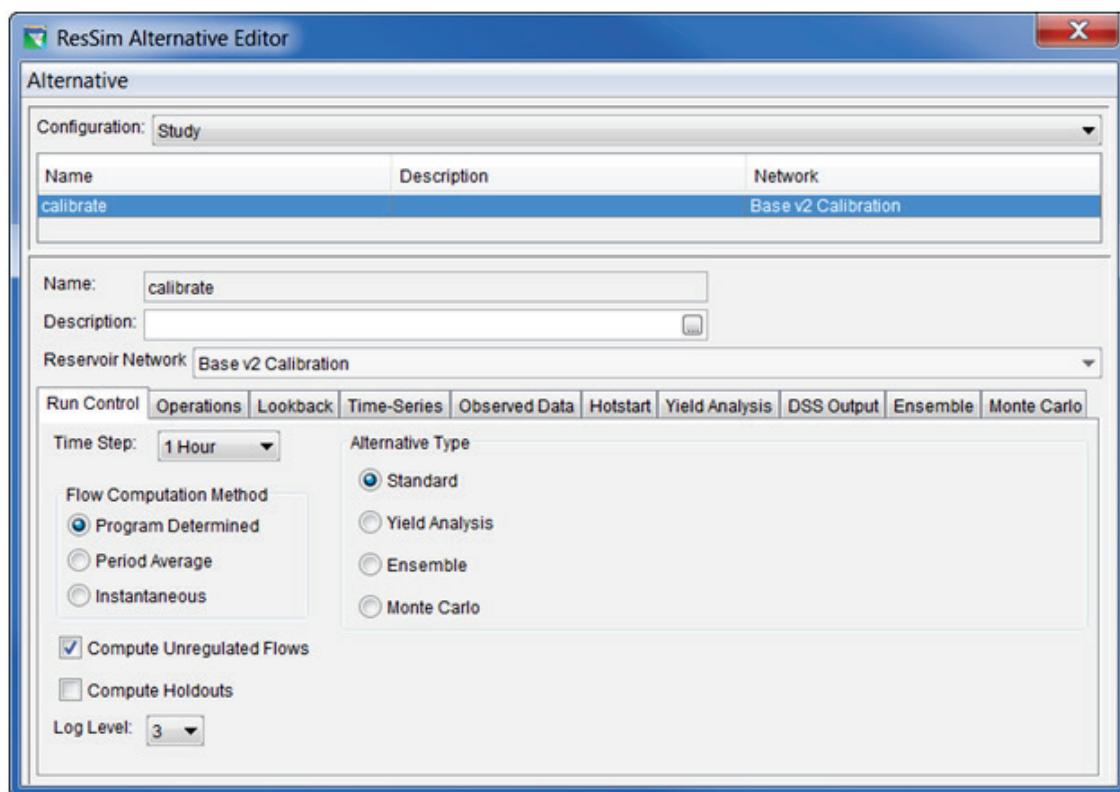
**Figure L.31** HEC-ResSim – State Variable Editor

3. Click **OK**, the **State Variable Editor** (Figure L.31) will close.

## Edit Alternatives

To edit HEC-ResSim alternatives:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.28), point to **ResSim**, click **Edit Alternatives**.
2. The **ResSim Alternative Editor** will open (Figure L.32). This editor allows the user to modify the run control information for the selected HEC-ResSim model alternative; adjust data for operations, lookback, time-series, and observed data; and, various other alternative based options. For further detail on this editor, reference the HEC-ResSim User's Manual.

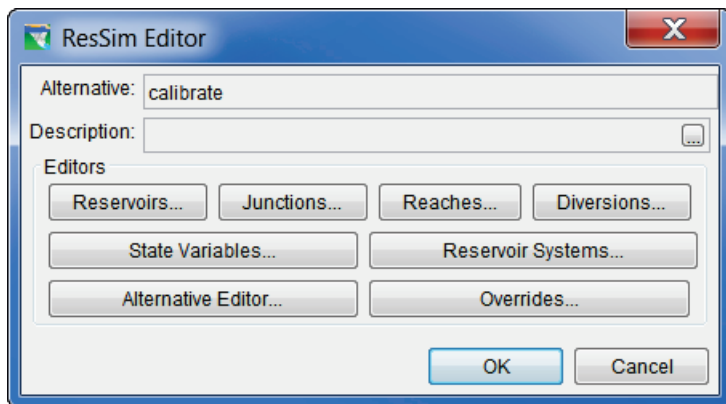


**Figure L.32** HEC-ResSim – Alternative Editor

3. From the **Alternative** menu, click **Close**, the **ResSim Alternative Editor** (Figure L.32) will close.

## Edit Run

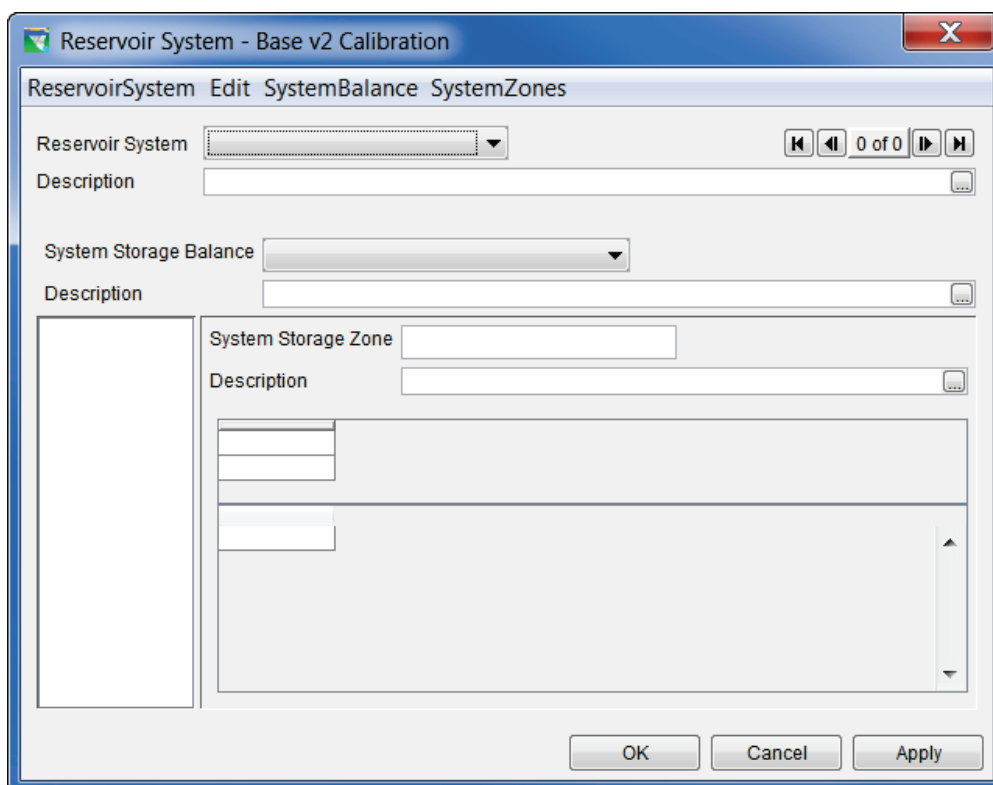
From the HEC-WAT main window, from the **Edit** menu (Figure L.28), point to **ResSim**, click **Edit Run**. The **ResSim Editor** will open (Figure L.33). This editor provides the user with a convenient way to access all HEC-ResSim editors for an HEC-ResSim model alternative. For further detail on this editor, reference the HEC-ResSim User's Manual. Click **OK**, the **ResSim Editor** (Figure L.33) will close.



**Figure L.33** HEC-ResSim - ResSim Editor

## ResSim Editor - Reservoir Systems

From the **Reservoir System** dialog box (Figure L.34), HEC-ResSim allows the user to define the reservoirs in a study area as a system of how the reservoirs work and operate together. Further details of this capability are available in the HEC-ResSim User's manual.



**Figure L.34** HEC-ResSim – Reservoir System Dialog Box

## ResSim Editor - Overrides

The HEC-ResSim Overrides interface (Figure L.33) is not available in HEC-WAT Version 1.0. This capability will be available in the next HEC-WAT version. For further details on this capability, refer to the HEC-ResSim User's manual.

### L.3.3 HEC-RAS

From the HEC-WAT main window (Figure L.1), from the **Edit** menu, point to **RAS** (Figure L.35), click **Open RAS**. The HEC-RAS software application will open and the HEC-RAS main window will display (Figure L.36). The user can modify existing HEC-RAS model components or create new HEC-RAS model components, once the user is finished and data has been saved, the HEC-RAS model information is stored in the HEC-WAT study directory, under the *ras* folder. The rest of this section provides an overview of the HEC-RAS editors that are directly available from the HEC-WAT framework.

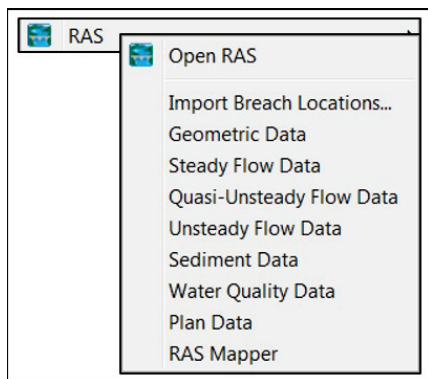


Figure L.35 Edit Menu – RAS

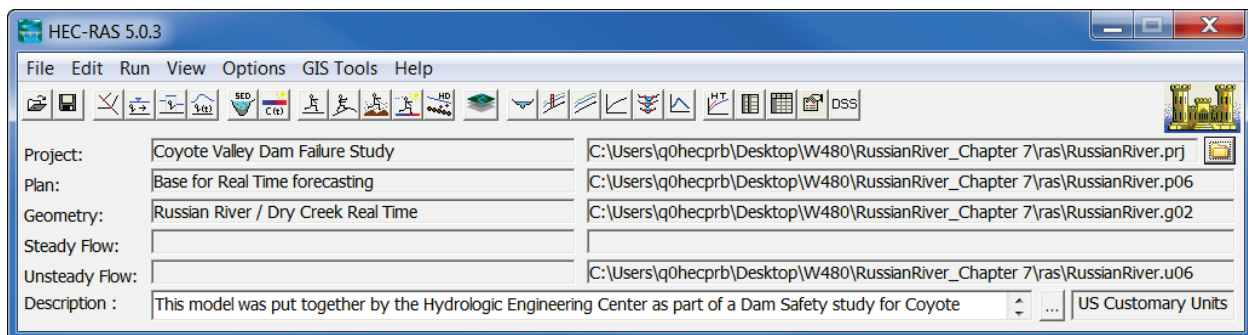


Figure L.36 HEC-RAS Main Window

## Geometric Data

To edit geometric data associated with a RAS model alternative:

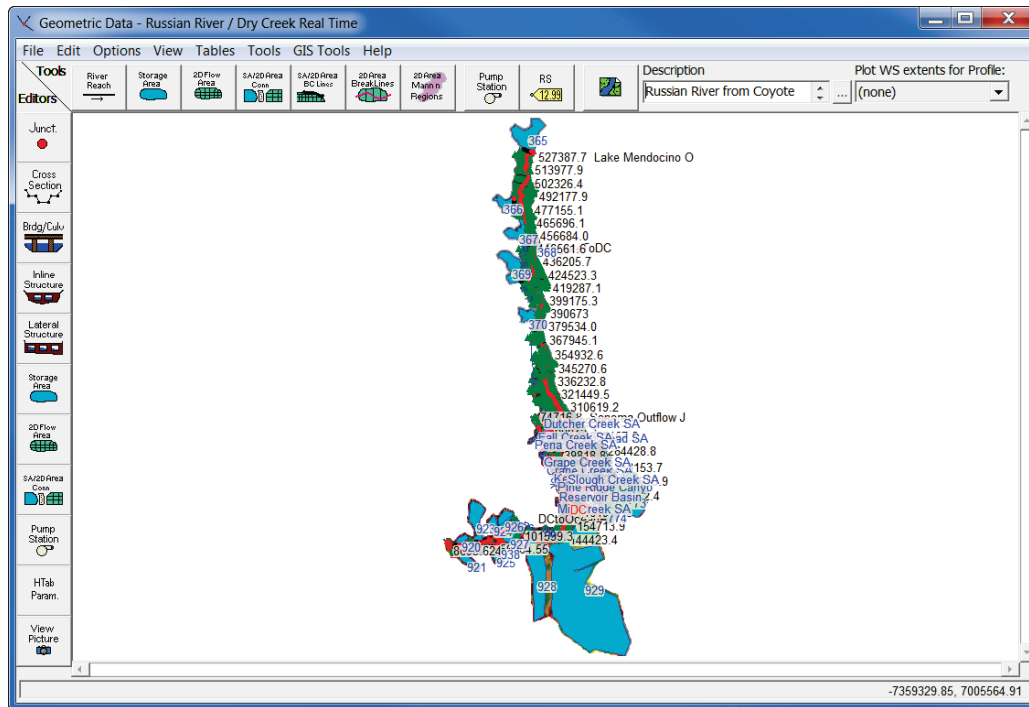
1. From the HEC-WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **Geometric Data**.
2. The **RAS Geometric Data Editor** will open (Figure L.37). This editor allows the user to edit parameters that have been defined for the geometric data for a RAS model alternative. For further detail on this editor, reference the HEC-RAS User's Manual.
3. From the **File** menu, click **Exit Geometry Data Editor**, the **RAS Geometric Data Editor** (Figure L.37) will close.



## Steady Flow Data

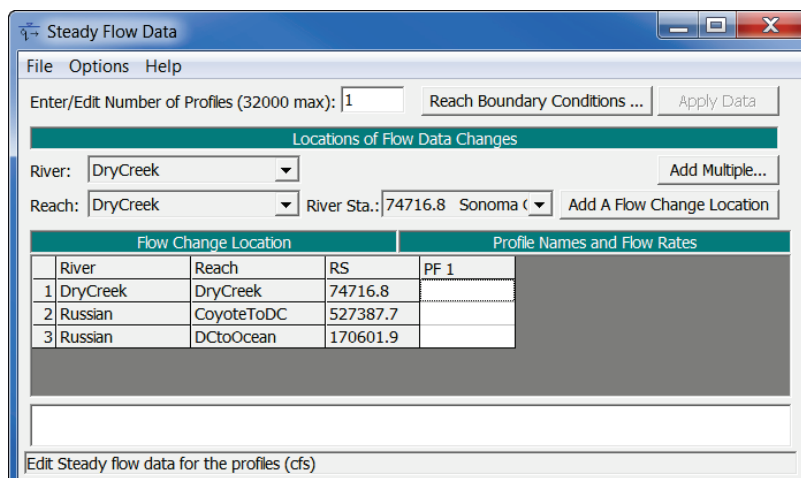
To edit steady flow data associated with a RAS steady flow model alternative:

1. From the WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **Steady Flow Data**.



**Figure L.37** HEC-RAS – Geometric Data Editor

2. The **RAS Steady Flow Data Editor** will open (Figure L.38). This editor allows the user to edit boundary conditions that have been defined for the steady flow data for a RAS model alternative. For further detail on this editor, reference the HEC-RAS User's Manual.



**Figure L.38** HEC-RAS – Steady Flow Data Editor

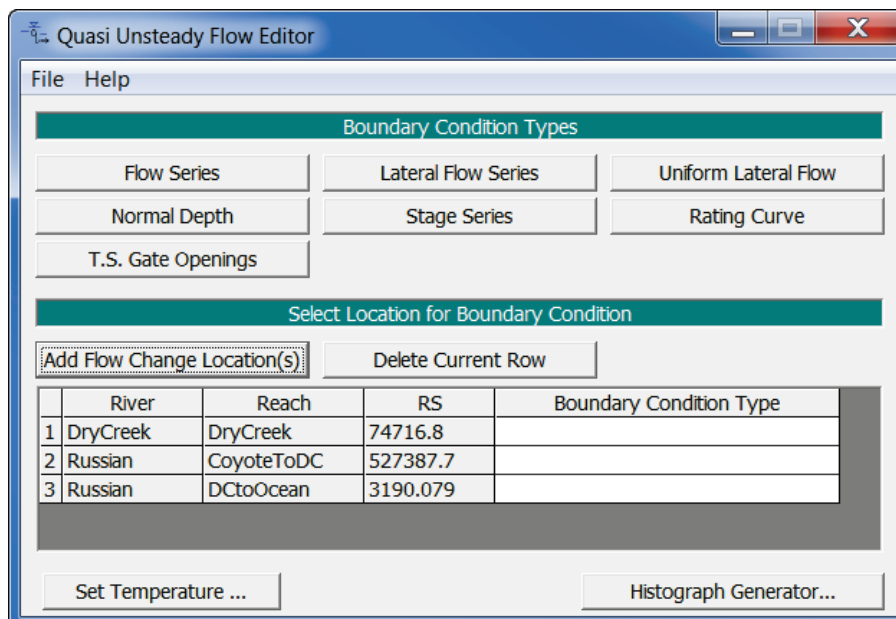


- From the **File** menu, click **Exit Flow Data Editor**, the RAS Steady Flow Data Editor (Figure L.38) will close.


## Quasi-Unsteady Flow Data

To edit quasi-unsteady flow data associated with a RAS unsteady flow model alternative:

- From the WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **Quasi-Unsteady Flow Data**.
- The RAS **Quasi Unsteady Flow Editor** will open (Figure L.39). This editor allows the user to edit boundary conditions that have been defined for the quasi-unsteady flow data for a RAS unsteady flow model alternative. For further detail on this editor, reference the HEC-RAS User's Manual.



**Figure L.39** HEC-RAS – Quasi Unsteady Flow Editor

- To close the RAS **Quasi Unsteady Flow Editor** (Figure L.39) click .

## Unsteady Flow Data

To edit unsteady flow data associated with a RAS unsteady flow model alternative:

- From the HEC-WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **Unsteady Flow Data**.
- The RAS **Unsteady Flow Editor** will open (Figure L.40). This editor allows the user to edit boundary and initial conditions that have been defined for the unsteady flow data for a RAS unsteady flow model alternative. For further detail on this editor, reference the HEC-RAS User's Manual.

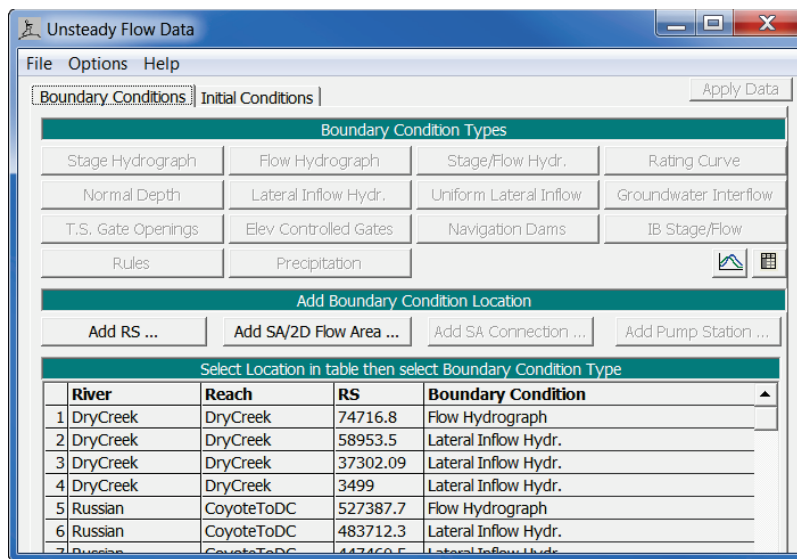


Figure L.40 HEC-RAS –Unsteady Flow Data Editor

- From the **File** menu, click **Exit**, the RAS **Unsteady Flow Editor** (Figure L.40) will close.

## Sediment Data

To edit sediment data associated with a RAS model alternative:

- From the HEC-WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **Sediment Data**.
- The HEC-RAS **Sediment Data Editor** will open (see Figure L.41). This editor allows you to edit parameters and boundary conditions that have been defined for the sediment data for a RAS model alternative. For further detail on this editor, reference the HEC-RAS User's Manual.

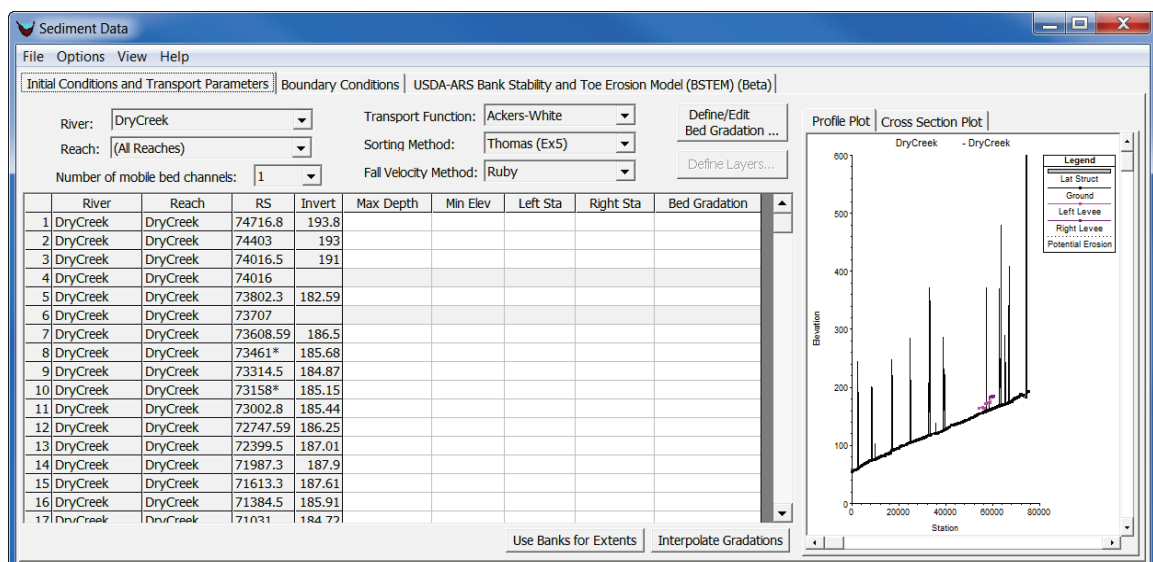


Figure L.41 HEC-RAS –Sediment Data Editor

3. From the **File** menu, click **Exit**, the RAS **Sediment Data Editor** (Figure L.41) will close.

## Water Quality Data

To edit water quality data associated with a RAS model alternative:

1. From the WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **Water Quality Data**.
2. The RAS **Water Quality Data Editor** will open (Figure L.42). This editor allows you to edit parameters that have been defined for the water quality data for a RAS model alternative. For further detail on this editor, reference the HEC-RAS User's Manual.
3. From the **File** menu, click **Exit**, the RAS **Water Quality Data Editor** (Figure L.42) will close.

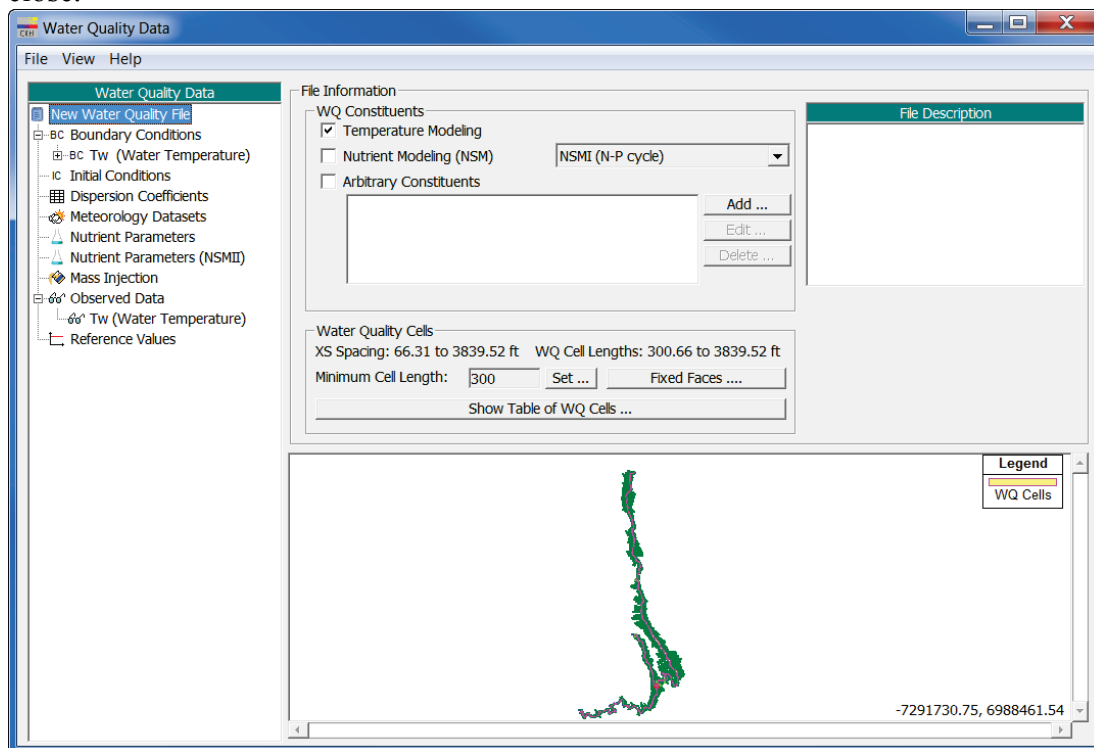
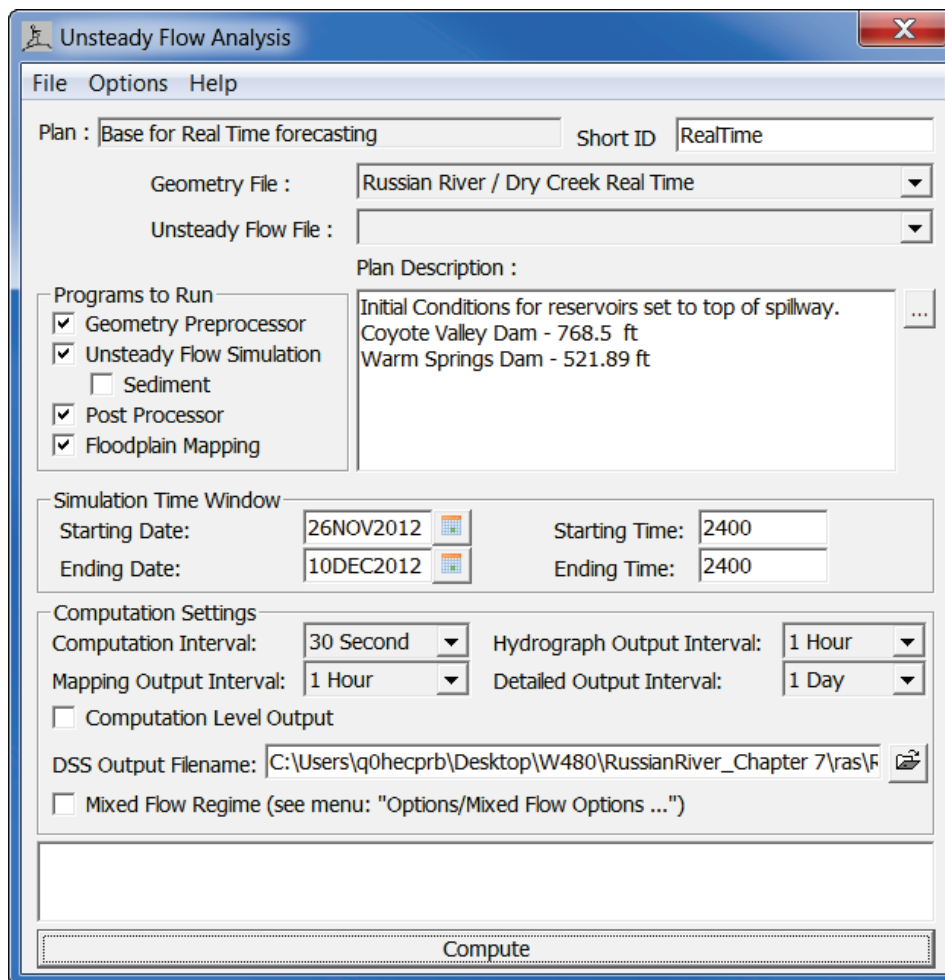


Figure L.42 HEC-RAS – Water Quality Data Editor

## Plan Data

To edit plan data associated with a RAS model alternative:

1. From the WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **Plan Data**.
2. The RAS **Unsteady Flow Analysis Editor** will open (Figure L.43). This editor allows the user to edit information that has been defined for the plan data for a RAS model alternative. For further detail on this editor, reference the HEC-RAS User's Manual.



**Figure L.43** HEC-RAS – Unsteady Flow Analysis Editor

3. From the **File** menu, click **Exit**, the RAS **Unsteady Flow Editor** (Figure L.43) will close.

## RAS Mapper

HEC-RAS has the capability to perform inundation mapping of water surface profile results directly from HEC-RAS. RAS Mapper is a tool within the HEC-RAS that creates inundation mapping by using the HEC-RAS geometry data and computed water surface profiles from an HEC-RAS compute. To access RAS Mapper:

1. From the WAT main window, from the **Edit** menu (Figure L.35), point to **RAS**, click **RAS Mapper**.
2. The **RAS Mapper** dialog box will open (Figure L.44). From this dialog box the user can setup the necessary information in RAS Mapper to create inundation maps, velocity maps, and depth grids. For further detail on this editor, reference the HEC-RAS User's Manual.
3. From the **File** menu, click **Exit**, the **RAS Mapper** dialog box will close (Figure L.44).

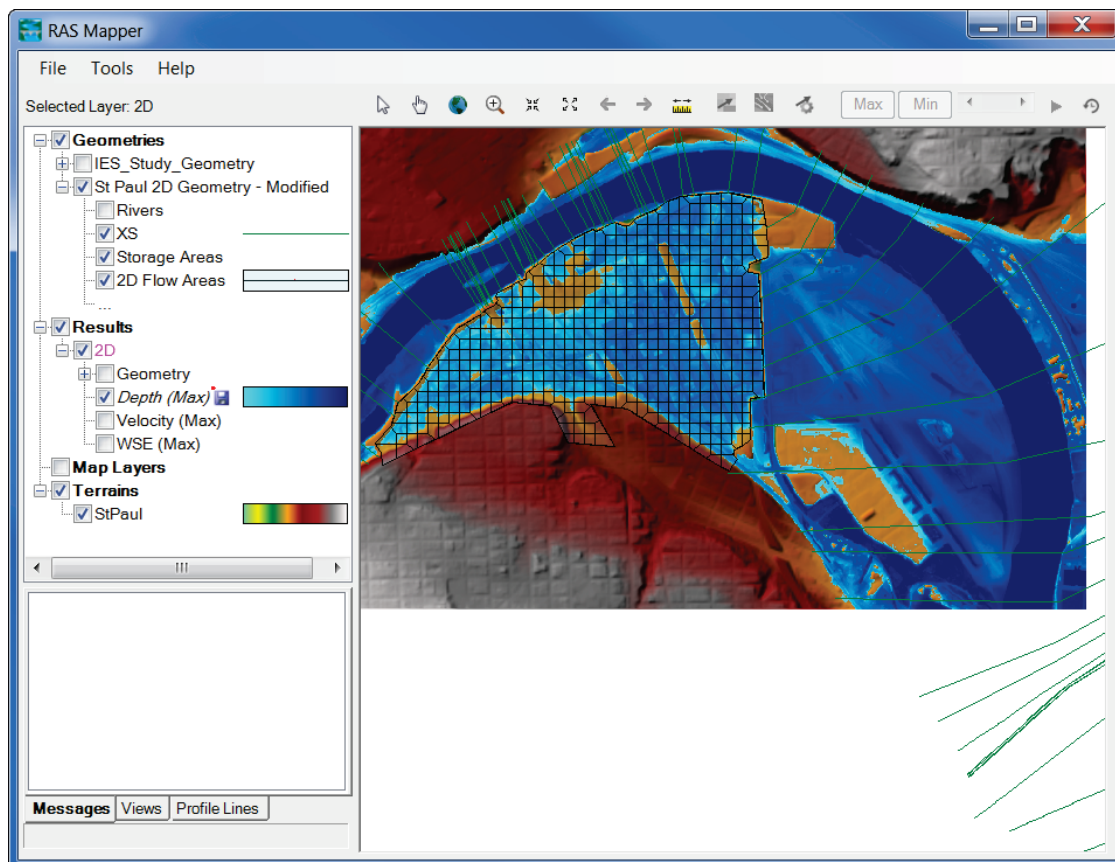


Figure L.44 HEC-RAS – RAS Mapper Dialog Box

### L.3.4 FIA

From the HEC-WAT main window (Figure L.1), from the **Edit** menu, point to **FIA** (Figure L.45), click **Open FIA**. The HEC-FIA software application will execute and the HEC-FIA main window will display (Figure L.46). The user can modify existing HEC-FIA components model or create new HEC-FIA model components, once the user is finished and data has been saved, the HEC-FIA model information is stored in the HEC-WAT study directory, under the *fia* folder. The rest of this section provides an overview of the HEC-FIA editors that are directly available from the HEC-WAT framework.

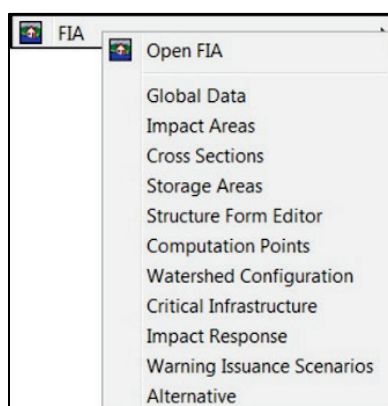


Figure L.45 Edit Menu – FIA

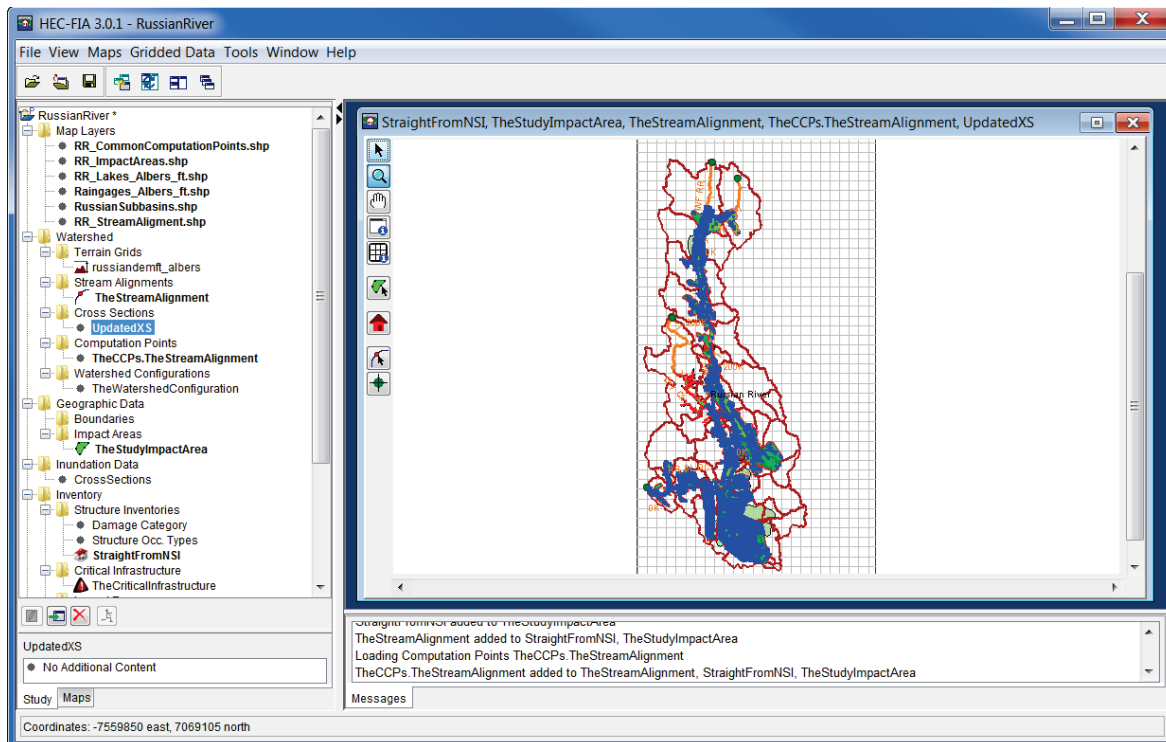


Figure L.46 HEC-FIA Main Window

## Global Data Editor

To edit the global data associated with an HEC-FIA model alternative:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.45), point to **FIA**, click **Global Data**.
2. The HEC-FIA **Global Data Editor** will open (Figure L.47). This editor allows the user to edit the global data that has been defined for an FIA model alternative. For further detail on this editor, reference the HEC-FIA User's Manual.

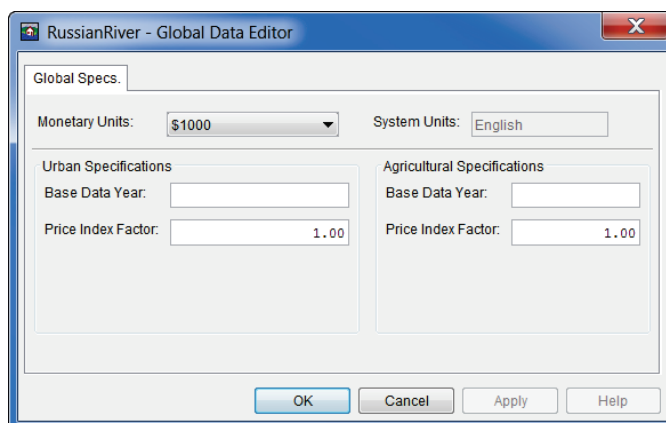


Figure L.47 HEC-FIA – Global Data Editor

3. Click **OK**, the HEC-FIA **Global Data Editor** (Figure L.46) will close.

## Impact Area Editor

To edit impact area data associated with an HEC-FIA model alternative:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.45), point to **FIA**, click **Impact Areas**.
2. The HEC-FIA **Impact Area Editor** will open (Figure L.21). This editor allows the user to change information about impact area description, life loss parameters, population adjustment, and the adjusted price index. For further detail on this editor, reference the HEC-FIA User's Manual.
3. Click **OK**, the HEC-FIA **Impact Area Editor** (Figure L.21) will close.

## Structure Editor

To edit data associated with a structure:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.45), point to **FIA**, click **Structure Form Editor**.
2. The HEC-FIA **Structure Form Editor** will open (Figure L.48). This editor allows the user to edit individual structures that are part of the FIA model alternative. For further detail on this editor, reference the HEC-FIA User's Manual.

**Figure L.48** HEC-FIA – Structure Form Editor

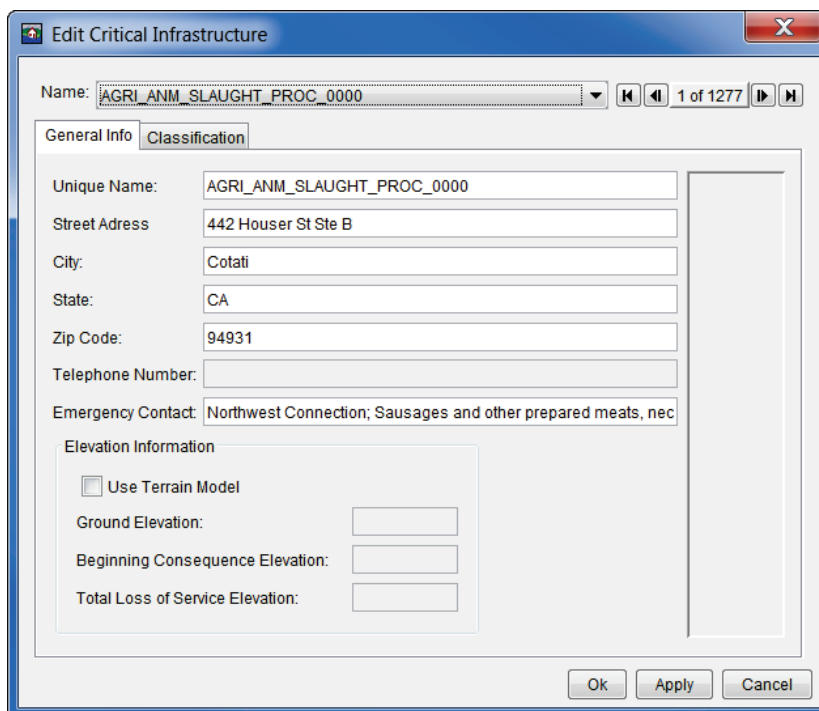
3. Click **OK**, the HEC-FIA **Structure Form Editor** will close (Figure L.48).



## Critical Infrastructure

To edit data associated with the HEC-FIA critical infrastructure option:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.45), point to **FIA**, click **Critical Infrastructure**.
2. The HEC-FIA **Critical Infrastructure** dialog box (Figure L.49). This editor allows the user to edit information related to the critical infrastructure option of HEC-FIA. For further detail on this editor, reference the HEC-FIA User's Manual.
3. Click **OK**, the HEC-FIA **Critical Infrastructure** dialog box will close (Figure L.49).



**Figure L.49** HEC-FIA – Critical Infrastructure Dialog Box

## Warning Issuance Scenarios

To edit data associated with the HEC-FIA warning issuance scenario option:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.45), point to **FIA**, click **Warning Issuance Scenarios**.
2. The HEC-FIA **Warning Issuance Scenarios** dialog box (Figure L.50). This editor allows the user to edit information related to the warning issuance scenario option of HEC-FIA. For further detail on this editor, reference the HEC-FIA User's Manual.
3. Click **OK**, the HEC-FIA **Warning Issuance Scenarios** dialog box will close (Figure L.50).



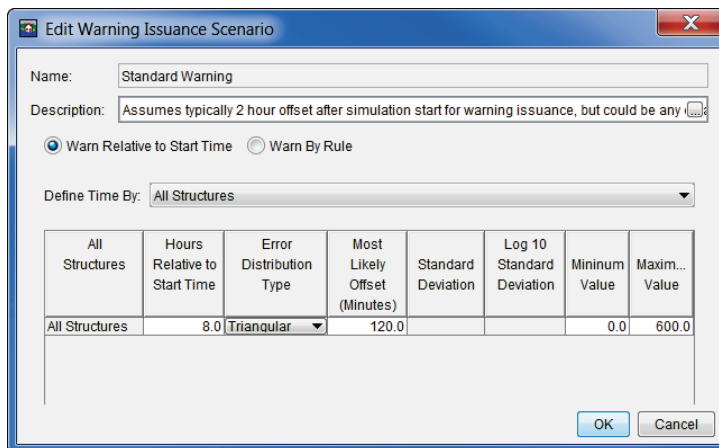


Figure L.50 HEC-FIA – Warning Issuance Scenarios Dialog Box

## Alternative Editor

To edit the setup options associated with an HEC-FIA alternative:

1. From the HEC-WAT main window, from the **Edit** menu (Figure L.45), point to **FIA**, click **Alternative**.
2. The HEC-FIA **Alternative Editor** (Figure L.51). This editor allows the user to edit the setup options associated with an HEC-FIA alternative. For further detail on this editor, reference the HEC-FIA User's Manual.

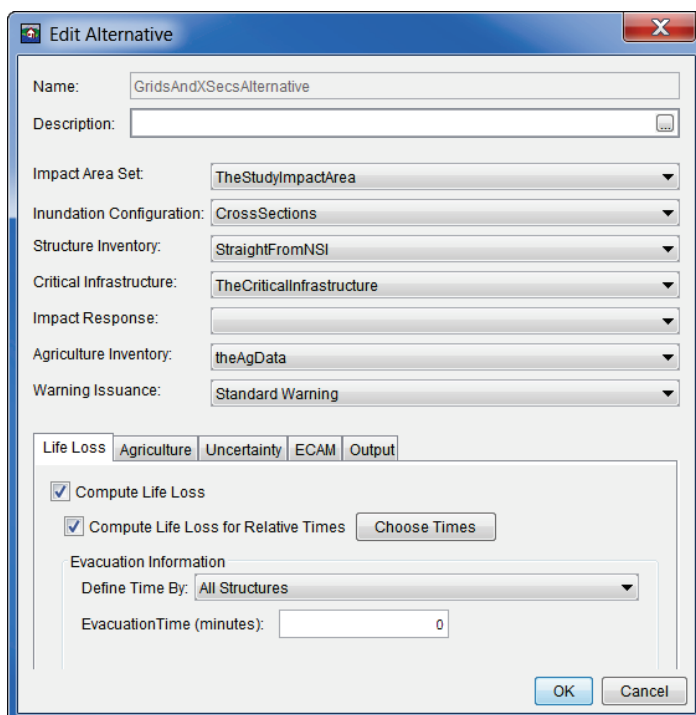
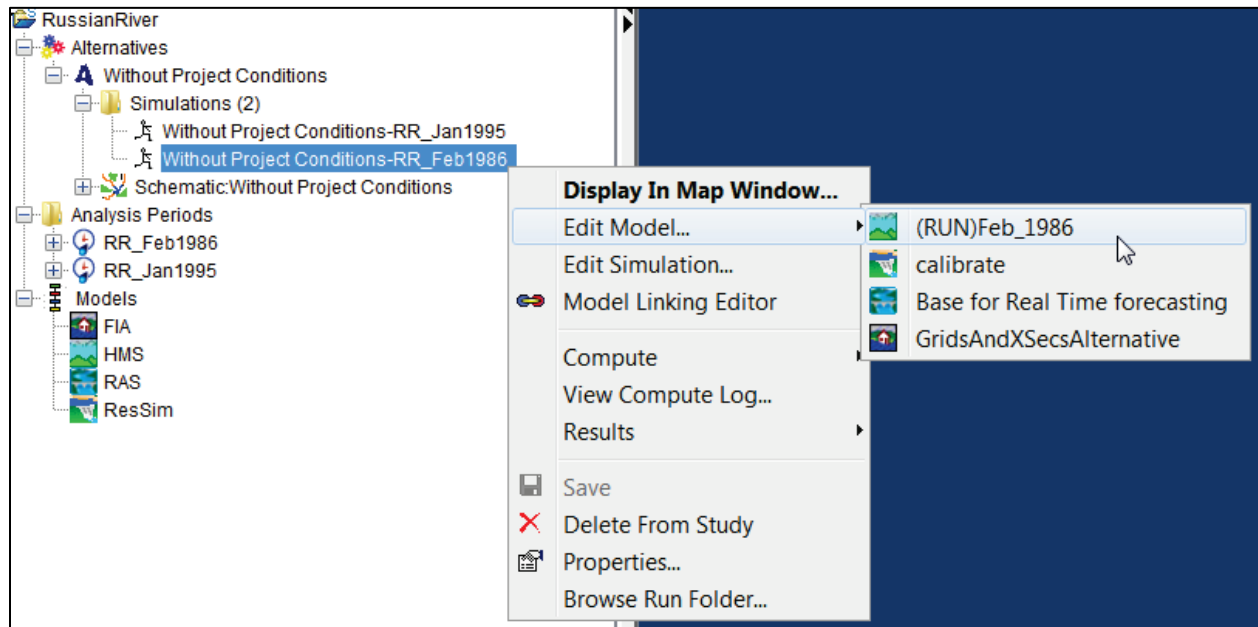


Figure L.51 HEC-FIA – Alternative Editor

3. Click **OK**, the HEC-FIA **Alternative Editor** will close (Figure L.51).

## L.4 Study Tree and Content Pane

From either the **Study Tree** or **Content Pane** of the HEC-WAT main window (Figure L.1), with an HEC-WAT simulation selected, the user can also edit model alternatives. From the **Study Tree**, from the **Simulations** folder, right-click on a simulation, from the shortcut menu (Figure L.52), point to **Edit Model**, click on a model alternative.



**Figure L.52** Study Tree - Simulation Shortcut Menu – Edit Model

When selecting an HEC-HMS or an HEC-RAS model alternative, the user will get the respective software application's main window (Figures L.25 and L.36). However, when selecting an HEC-ResSim model alternative, the **ResSim Editor** will open (Figure L.33), and when selecting an HEC-FIA model alternative, the **Alternative Editor** will open (Figure L.51).

From the **Content Pane**, under the models folder, right click on a model alternative. From the shortcut menu, click **Edit Model**. When selecting an HEC-HMS or an HEC-RAS model alternative, the user will get the respective software application's main window (Figures L.25 and L.36). However, when selecting an HEC-ResSim model alternative, the **ResSim Editor** will open (Figure L.33), and when selecting an HEC-FIA model alternative, the **Alternative Editor** will open (Figure L.51).

# Appendix M

## Plots

Plots offer an array of information that will assist a user when reviewing results in HEC-WAT. Other software applications (i.e., HEC-HMS) have their own plotting capabilities, which were presented in Appendix L. HEC-WAT does have data displayed graphically, and the plotting capabilities are based on the plotting capability available in HEC-DSSVue. This appendix covers some of the capabilities of plots within HEC-WAT. For further details, review the HEC-DSSVue User's Manual.

### M.1 Plot Window

The **Plot** window provides tools that facilitate the viewing of results. The main window and the different components for the **Plot** window are illustrated in Figure M.1. The **Title Bar** contains the name of the plot type (i.e., Frequency Viewer, Hydrographs, etc.).

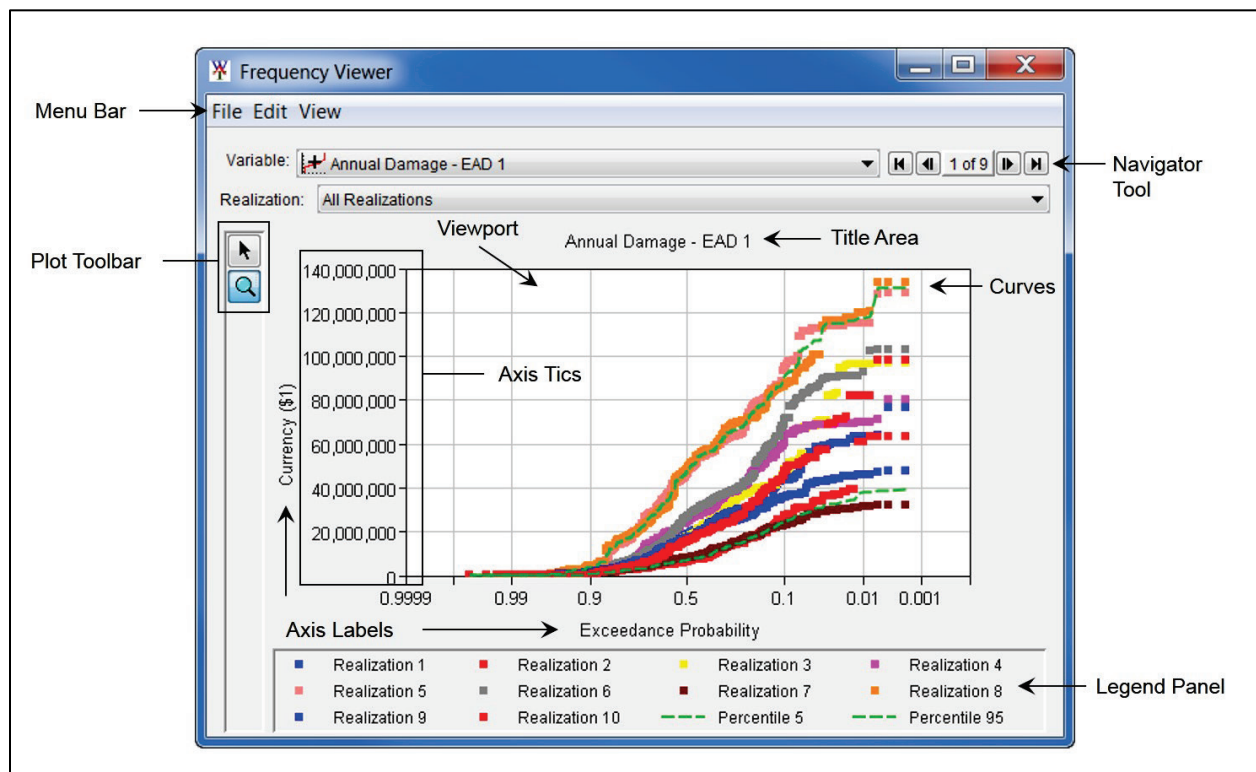


Figure M.1 Plot Window

### M.2 Menu Bar

Following is an overview of the **Menu Bar** (Figure M.1) for the **Plot** window. The commands available from the menus will facilitate the viewing and customizing of plots.

- File** From this menu the user can view the plotted data in a tabular format; save the plot as a graphics file; save a template; use a template; save user selected specifications; copy the plot to the clipboard, and print the plot. Available commands are: **Tabulate, Save As, Save Template, Apply Template, Save Specifications, Print, Page Setup, Print Preview, Print Multiple, and Close.**
- Edit** From this menu the user can customize the plot. Available commands are: **Plot Properties, Configure Plot Layout, Default Line Styles, and Default Plot Properties.**
- View** From this menu the user can have the plot window always on top of the desktop; choose to use line styles; zoom out; placement of the legend; and, hide the legend. Available commands are: **Always On Top, Use Line Styles, Zoom to all, Legend Placement, and Hide Legend.**

## M.3 Tools

The **Tools** appear in a toolbar on the left side of the **Plot** window (Figure M.1). The tools change the appearance of the mouse, as well as the functionality of the mouse:



### Pointer/Selector Tool

With the **Pointer/Selector Tool**, the user can access shortcut menus that allow customization of plots using the plot editing tools.



### Zoom Tool

The **Zoom Tool** allows the user to view data closely at a specific time. To zoom in, hold the mouse button down and outline the area the user wants to enlarge. To zoom out, click the right mouse button (right-click). The zoom out is done by a factor of two and positions the clicked location at the center of the display area.

## M.4 Customizing Plots – Plot Window

From a **Plot** window there are several areas (Figure M.1) that allow the user to configure default properties for all plots as well as customize individual plots. Figure M.1 shows the plot areas that can be configured. Some configuration items being discussed in this section are available from the **Edit** menu, which will be discussed in Section M.5.

**Title Area** Modify/create the title to individual plots.

**Marker** Add markers on the X- and Y-axes and customize the appearance of these markers.

**Curve** Customize the appearance of curves (line or point), add labels, specify symbols to indicate quality or missing values; hide or remove a curve, and create, hide or remove callouts.

**Spacer** Specify the distance between viewports, between a viewport and the legend, and the width of side margins.

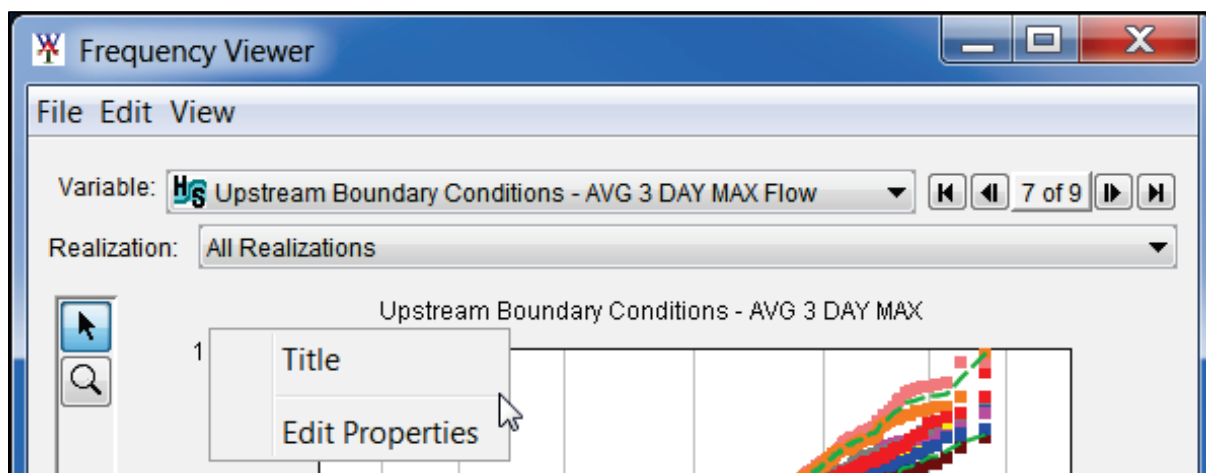
**Viewport** Customize the border around the viewport, the background color and pattern, and the appearance of gridlines. The user can also specify the number, size, and content of viewports.

**Axis** Specify either a linear or log axis type; specify the axis scale; customize tic marks; and, customize the axis labels.

**Legend** Customize the legend by adding a title and specifying whether the legend appears below or to the right of the plot.

## M.4.1 Shortcut Menus

Using the **Pointer/Selector** tool (Section M.3), right-click on an element or on an area of a plot window (Figure M.1) where enhancing/modify the plot might need to occur. A shortcut menu will appear (Figure M.2), with the possible commands:



**Figure M.2** Plot Window – Element/Area Shortcut Menu Example

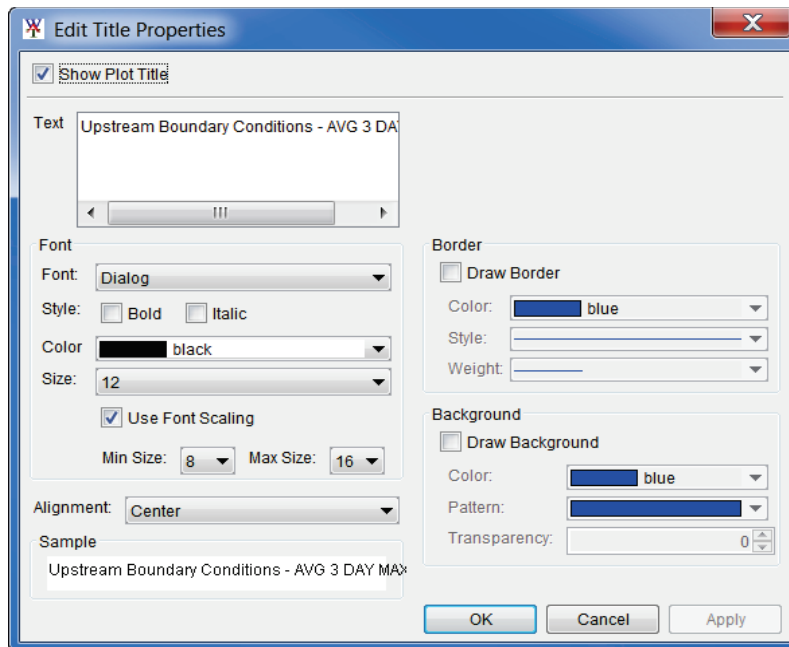
**Title, Axis Label, etc.** informational; name of element/area of a plot window

**Edit Properties** Displays the property editor for the select element/area of a plot window.

## M.4.2 Plot - Title

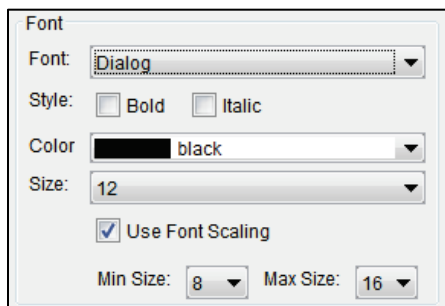
To create/modify a title for a plot:

1. Right-click on a plot window where the title is displayed or would be displayed (Figure M.2). From the shortcut menu, click **Edit Properties**.
2. The **Edit Title Properties** dialog box will open (Figure M.3).



**Figure M.3** Edit Title Properties Dialog Box

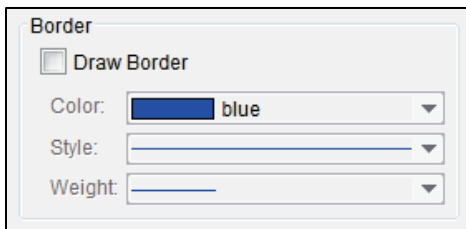
3. To have the title of the plot display in the plot window, select **Show Plot Title** (Figure M3.), click **Apply**. The title from the **Text** box (Figure M.3) will display.
4. From the **Text** box (Figure M.3), enter the title for the plot, click **Apply**. The title from the **Text** box (Figure M.3) will display.
5. From the **Font** box (Figure M.4), from the **Font** list, the user can select a font type for the plot. The user can choose to have the text, displayed bolded or italicized by select either **Bold** or **Italic** (Figure M.4) from the **Font** box. From the **Color** list (Figure M.4) the user can have the title display in a selected color. From the **Size** list (Figure M.4), the user can set the size of font for the plot. The **Use Font Scaling** option (Figure M.4) allows for the font size to adjust when the plot window is being resized. The scaling of the font is set in the **Min Size** list and the **Max Size** list.



**Figure M.4** Edit Title Properties Dialog Box – Font Box

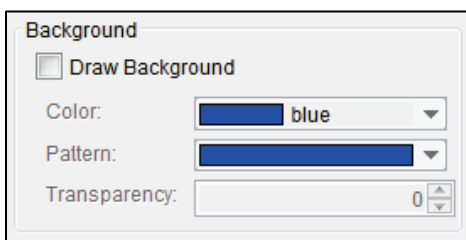
6. From the **Alignment** list (Figure M.3) the user can center; right justify; or, left justify the title on the plot window.
7. The **Sample** box (Figure M.3) provides a preview of the plot title.

- From the **Border** box (Figure M.5), the user has the option to draw a border around the title. Click **Draw Border** (Figure M.5), the user can select the color, style, and weight of the border, click **Apply**. A border as defined will display around the title.



**Figure M.5** Edit Title Properties Dialog Box – Border Box

- From the **Background** box (Figure M.6), the user has the option to incorporate a background as part of the title. Click **Draw Background** (Figure M.6), the user can select the color, pattern, and set the transparency of the background, click **Apply**. The title area of the plot will display with a background as defined.



**Figure M.6** Edit Title Properties Dialog Box – Background Box

### M.4.3 Plot - Markers

#### Create a Marker

To create a marker line for a plot:

- Right-click on a plot window where a marker needs to be added (Figure M.7). From the shortcut menu, point to **Add Marker** (Figure M.7), click on which axis the marker line should be placed – **On X-Axis** or **On Y-Axis**.
- An **Input** message window will open (Figure M.8), asking the user if the value is correct. This value defaults to the location that the user pointed to on the plot area, for either the X-axis or Y-axis. The user can change the value, but that means the maker line will be drawn somewhere else. Click **OK**, the **Input** message window will close (Figure M.8) and the marker line will display on the plot.

To create a marker point for a plot:

- Right-click on a plot window where a marker needs to be added (Figure M.7). From the shortcut menu, click to **Add Marker Point** (Figure M.7).

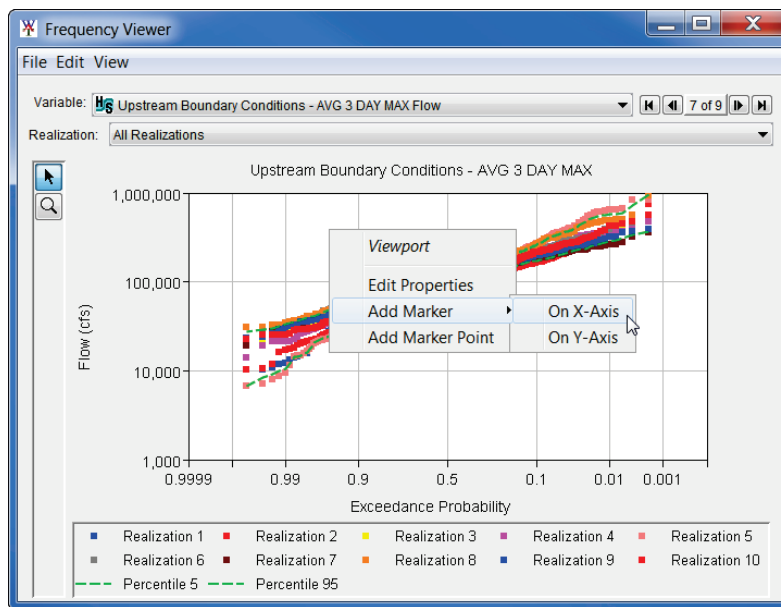


Figure M.7 Plot – Viewport Shortcut Menu

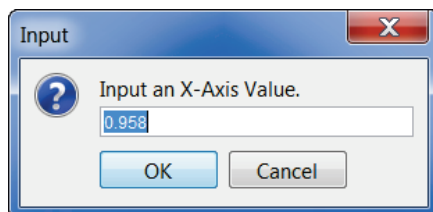


Figure M.8 Input Message Window

2. A **Point Location** dialog box will open (Figure M.9), displaying the X-axis value and the Y-axis value of where the user pointed to on the plot. The user can change the values, but that means the marker point will be drawn somewhere else. Click **OK**, the **Point Location** dialog box will close (Figure M.9) and the marker point will display on the plot.

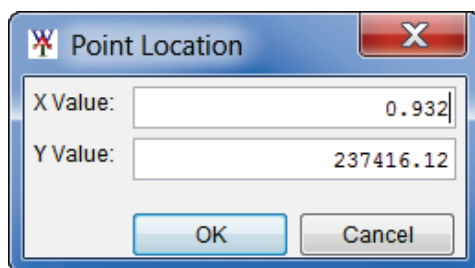


Figure M.9 Point Location Dialog Box

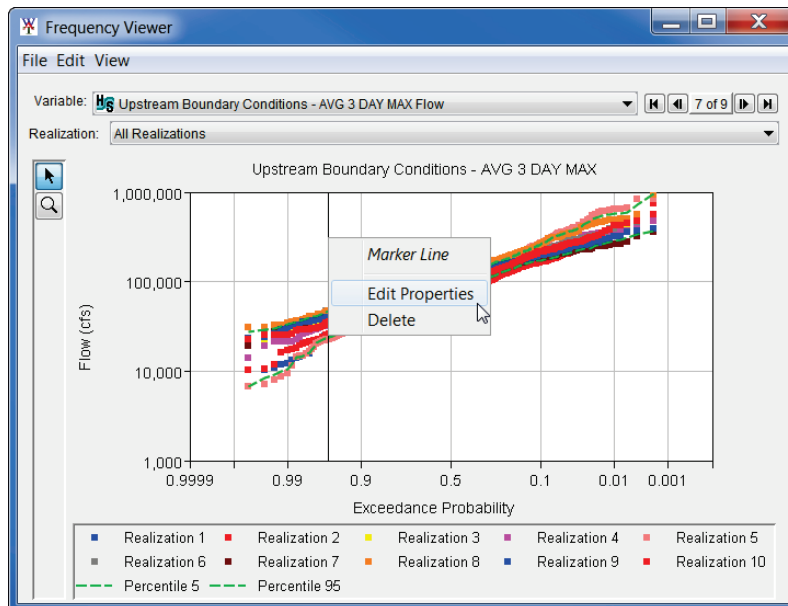
3. Click **Apply**, either the marker line or point will display on the plot.

## Edit a Marker

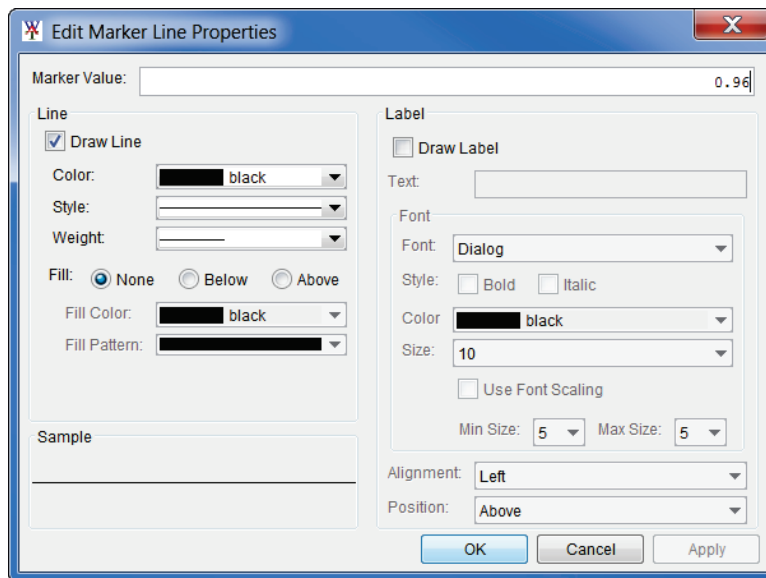
Edit a marker line:



1. Right-click on a marker line from a plot window (Figure M.10). From the shortcut menu, click **Edit Properties** (Figure M.10), the **Edit Marker Line Properties** dialog box will open (Figure M.11).



**Figure M.10** Plot – Marker Line Shortcut Menu



**Figure M.11** Edit Marker Line Plot Dialog Box

2. The **Marker Value** (Figure M.11) of the marker line is displayed.
3. From the **Line** box (Figure M.11), **Draw Line** should be selected so that the marker line will be displayed on the plot (Figure M.10). The user can select the color, style, and weight of the marker line from the **Line** box (Figure M.11). Also, the marker line can have a fill associated with it. The user can choose to have the fill **Below** (to left of the marker line) or **Above** (to the right of the marker line). The **Sample** box (Figure M.11) will give the user a preview of the modifications to the marker line.

4. From the **Label** box (Figure M.11), the user can choose to display a label for the marker by selecting **Draw Label** (Figure M.11). The user can provide a label for the marker, by entering information in the **Text** box (Figure M.11). From the **Font** box (Figure M.4), from the **Font** list, the user can select a font type for the plot. From the **Color** list (Figure M.4) the user can have the label for the marker display in a selected color. The user can choose to have the text, displayed bolded or italicized by select either **Bold** or **Italic** (Figure M.4) from the **Font** box. From the **Size** list (Figure M.4), the user can set the size of font for the plot. The **Use Font Scaling** option (Figure M.4) allows for the font size to adjust when the plot window is being resized. The scaling of the font is set in the **Min Size** list and the **Max Size** list.
5. From the **Alignment** list (Figure M.11) the user can center; right justify; or, left justify the marker label on the plot window.
6. From the **Position** list (Figure M.11) the user can position the label **Above**, **Below** or **Center** on the marker.

Edit a marker point:

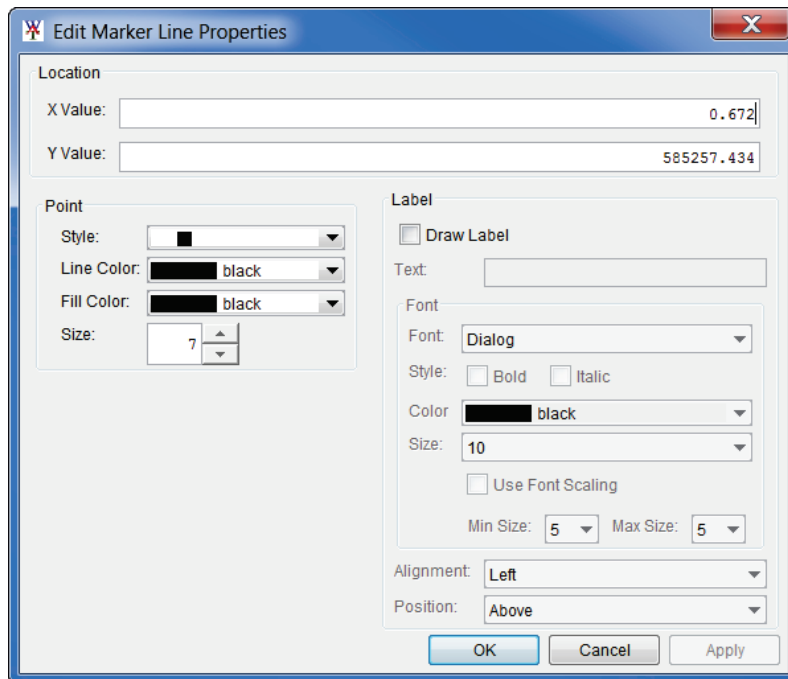
1. Right-click on a marker point from a plot window (Figure M.12). From the shortcut menu, click **Edit Properties** (Figure M.10), the **Edit Marker Line Properties** dialog box will open (Figure M.13).



**Figure M.12** Plot – Marker Point Shortcut Menu

2. The **Location** box (Figure M.13) displays the X- and Y-values of the marker point.
3. From the **Point** box (Figure M.13), the user can select the style, line color, fill color, and the size of the marker point.

4. The **Label** box, **Alignment** list, and the **Position** list (Figure M.13) are same as Items 4 through 6 for a marker line.



**Figure M.13** Edit Marker Line Plot Dialog Box – Marker Point

## Delete a Marker

To delete a marker line or point, right-click on a marker line (Figure M.10) or point (Figure M.12) from the plot window. From either shortcut menu, click **Delete**, the selected marker line or point will be deleted from the plot window.

## M.4.4 Plot – Curve

### Customize Curves

To customize curves on a plot:

1. Right-click on a curve in a plot window (Figure M.14), from the shortcut menu, click **Edit Properties** (Figure M.14), the **curve name Properties** dialog box will open (Figure M.15). In Figure M.14, there are three curves displayed, and each of those curves has a shortcut menu, which displays the label (label is generated from the DSS record associated with the curve) associated with the curve.
2. For the selected curve to display on the plot window, click **Draw Curve** (Figure M.15); and for the selected curve to appear in the legend of the plot window, click **Show in Legend** (Figure M.15). Click **Remove Curve** (Figure M.15), if the user wishes to have the selected curve no longer display in the plot window (option not functional in HEC-WAT Version 1.0).

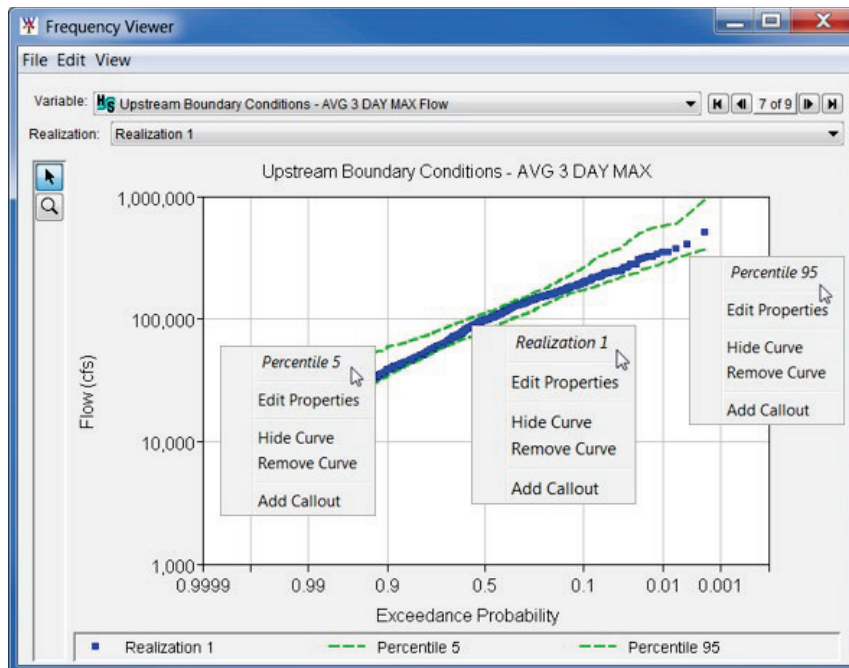


Figure M.14 Plot – Curve Shortcut Menu

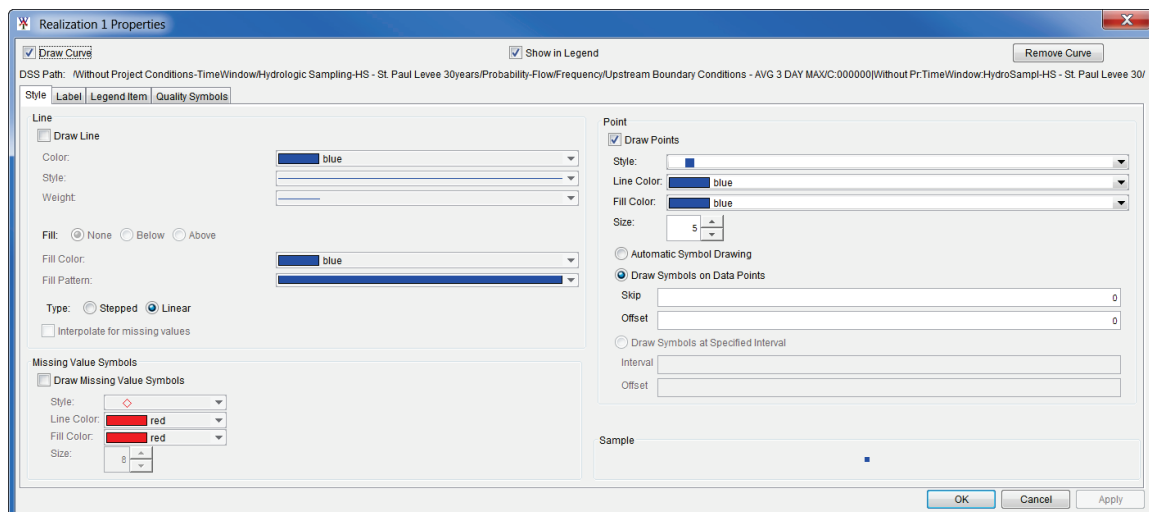


Figure M.15 curve name Properties Dialog Box

3. The **curve name Properties** dialog box (Figure M.15) allows the user to customize the style, label, and the legend item associated with the selected curve. The user can also add quality symbols to the selected curve. The following section discuss each of the tabs associated with the **curve name Properties** dialog box (Figure M.15).

## Style Tab

- a. From the **Line** box (Figure M.15), if the user wishes to the curve to be a line, select **Draw Line** (Figure M.15), the curve will be displayed on the plot as a line. The user can select the color, style, and weight of the line from the **Line** box (Figure M.15). Also, the line can have a fill, the user can choose to have the fill **Below** or **Above** the

line (Figure M.15). The **Type** of the line can be **Stepped** or **Linear** (Figure M.15) will give the user a preview of the modifications to the marker line. If there are missing values, to create a "smoother curve", click **Interpolate for Missing Values** (Figure M.15). Click **Apply**, the line displayed is now a smoother curve.

- b. From the **Point** box (Figure M.16), if the user wishes to the curve to be a series of points, select **Draw Point** (Figure M.16), the curve will be displayed on the plot as a series of points. The user can select the style of the point, line color of the point, fill color of the point, and the size of the point from the **Point** box (Figure M.16). By default a point is drawn for each data point on the curve (**Draw Symbols on Data Points**), the user can **Skip** data points or set an **Offset** for the data points (Figure M.16). If the user wants to display a "smoother curve of points" select **Automatic Symbol Drawing** (Figure M.16). The **Sample** box (Figure M.16) provides the user with a preview of the defined point.

**Figure M.16** *curve name* Properties Dialog Box – Style Tab – Point Box

- c. The **Missing Value Symbols** box (Figure M.17) allows the user to display any missing values for the curve. Click **Draw Missing Value Symbols** (Figure M.17), if there is any data related to the selected curve that is marked missing, the defined symbol will display on the plot. The user can select the style, line color, fill color, and the size of the missing value symbol from the **Missing Value Symbols** box (Figure M.17).

**Figure M.17** *curve name* Properties Dialog Box – Style Tab – Missing Value Symbols Box

## Label Tab

From the **Label** tab (Figure M.15), if the user wishes to a label for the curve to display on the plot, click **Show Label** (Figure M.18). In the **Label Text** box (Figure M.18) is the default label that is created from the DSS record that represents the selected curve. The user can edit the label in the **Label Text** box (Figure M.18). From the **Alignment** list (Figure M.18), the label can be centered, right or left justified on the selected curve. From the **Position** list (Figure M.18), the label can be positioned above, below, or centered on the selected curve.

**Figure M.18** *curve name* Properties Dialog Box – Label Tab

## Legend Item Tab

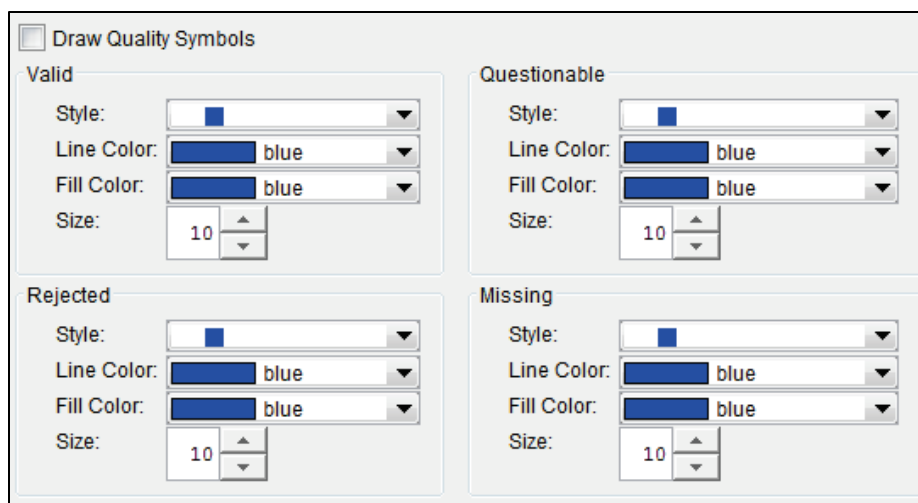
- a. From the **Legend Item** tab (Figure M.15), if the user wishes to modify the selected curve's legend label, enter new information in the **Text** box (Figure M.19).

**Figure M.19** *curve name* Properties Dialog Box – Legend Item Tab – Text Box

- b. From the **Border** box (Figure M.5), the user has the option to draw a border around the selected curve's legend item. Click **Draw Border** (Figure M.5), the user can select the color, style, and weight of the border, click **Apply**. A border as defined will display around the selected curve's legend item.
- c. From the **Background** box (Figure M.6), the user has the option to incorporate a background as part of the selected curve's legend item. Click **Draw Background** (Figure M.6), the user can select the color, pattern, and set the transparency of the background, click **Apply**. The selected curve's legend item of the plot will display with a background as defined.

## Quality Symbols Tab

From the **Quality Symbols** tab (Figure M.15), if the user wants to display information about data quality symbols related to the selected curve, select **Draw Quality Symbols** (Figure M.20). Click **Apply**, the defined data quality symbols will display on the



**Figure M.20** *curve name* Properties Dialog Box – Quality Symbols Tab

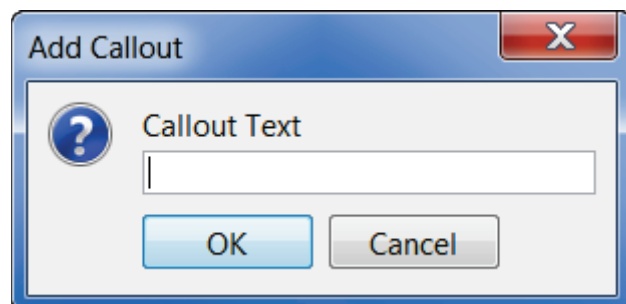
selected curve on the plot. There are four data quality types available – **Valid**, **Questionable**, **Rejected**, and **Missing** (Figure M.20). For each of the data quality types the user can set the style, line color, fill color, and the size of the symbol that will represent the different data quality types.

## Hide/Show a Curve

The user can select a curve that for reporting purposes might not need to be displayed. From a plot window (Figure M.14), right-click on a curve, from the shortcut menu, click **Hide Curve** (Figure M.14), the selected curve will no longer be displayed in the plot. To display the curve again, right-click on the area where the curve originally displayed, from the shortcut menu click **Show Curve**. The selected curve now displays on the plot.

## Add a Callout to a Curve

A callout is an annotation or additional information about the curves or points on a curve that are display in a plot. Right-click on a curve, from the shortcut menu (Figure M.14), a user can add a callout by clicking **Add Callout** (Figure M.14). The **Add Callout** message window will open (Figure M.21), in the **Callout Text** box, the user can enter the required information. Click **OK**, the **Add Callout** message window will close (Figure M.21), and the callout will display on the plot along the selected curve.



**Figure M.21** Add Callout Message Window

## Hide/Show Callouts

For reporting purposes, callouts for a selected curve might not need to be displayed. From a plot window (Figure M.14), right-click on a curve, from the shortcut menu, click **Hide Callouts**, from the selected curve, callouts will no longer display in the plot. To display callouts again, right-click on the curve where the callouts originally displayed, from the shortcut menu click **Show Callouts**. From the selected curve the callouts now display on the plot.

## Clear Callouts

Callouts for a selected curve can be deleted, from a plot window (Figure M.14), right-click on a curve, from the shortcut menu, click **Clear Callouts**, from the selected curve, all callouts have been deleted.

### M.4.5 Plot - Spacers

Spacers specify the distance between viewports, between a viewport and the legend, and the width of side margins. From a plot window, right-click on the space between the title and the plot (viewport), from the shortcut menu (Figure M.22), click **Edit Properties**. The **Edit Space Properties** dialog box will open (Figure M.23), from the **Size in Pixels** box, enter a number that will increase/decrease the distance between the title and the plot. Click **OK**, the **Edit Space Properties** dialog box will close (Figure M.23), and the modification to the spacer will have been adjusted.

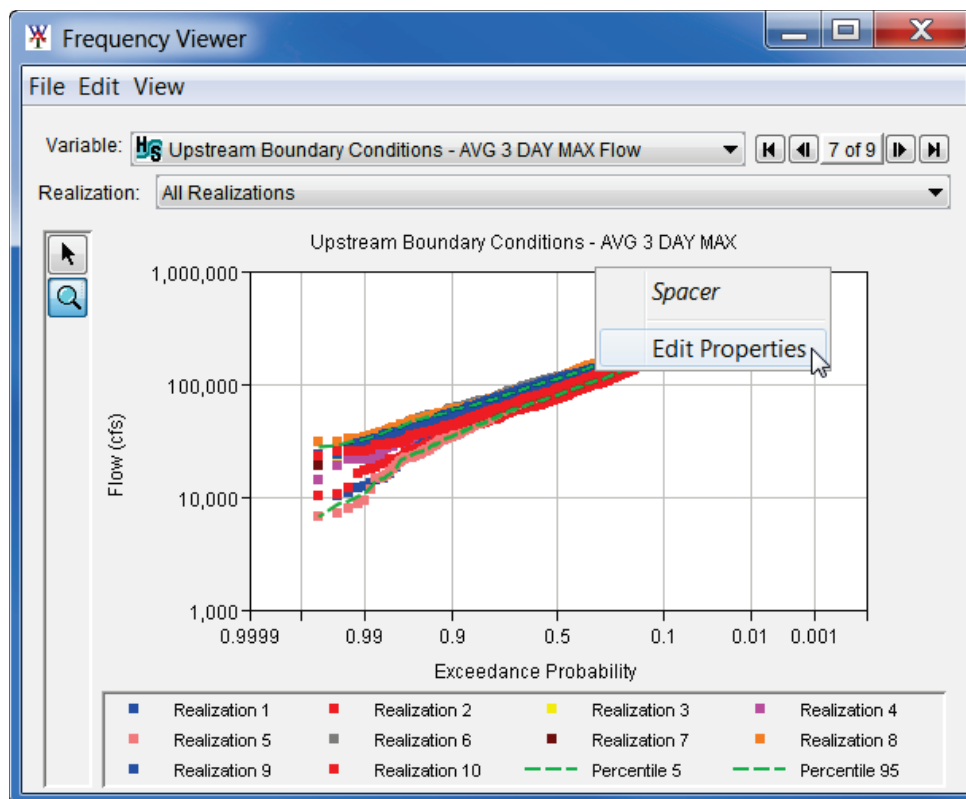


Figure M.22 Plot – Spacer Shortcut Menu



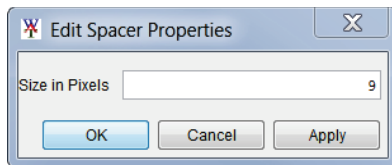


Figure M.23 Edit Space Properties Dialog Box

## M.4.6 Plot - Viewport

Viewport is the polygon viewing region of a plot where the grid containing the curves are displayed. From the plot window, right-click in the grid area of the plot, from the shortcut menu (Figure M.24), right click **Edit Properties**, the **Viewport Properties** dialog box will open (Figure M.25).

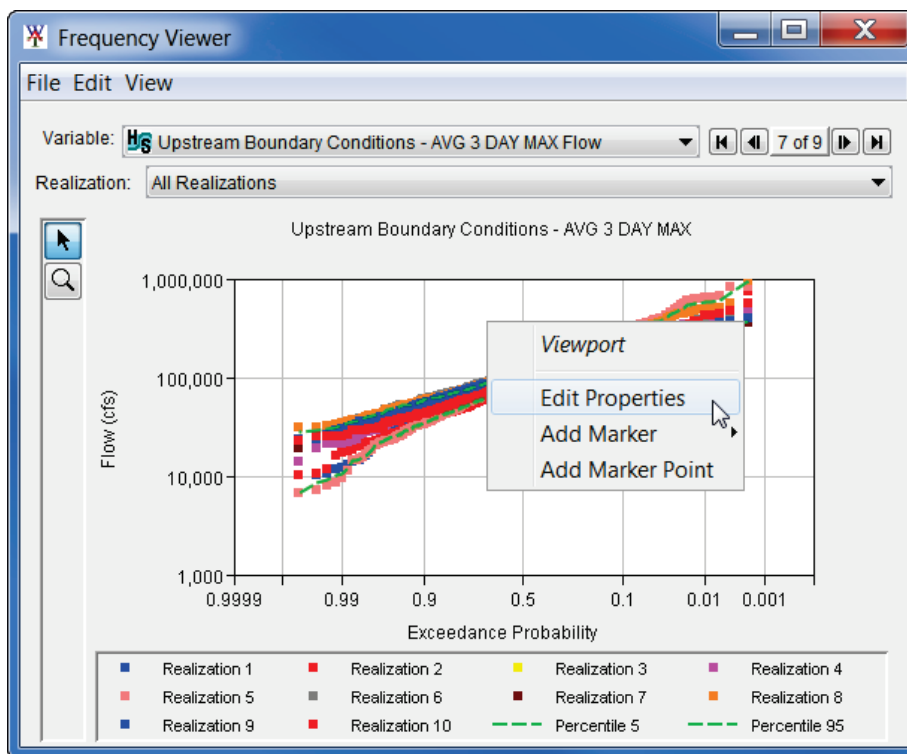


Figure M.24 Plot – Viewport Shortcut Menu

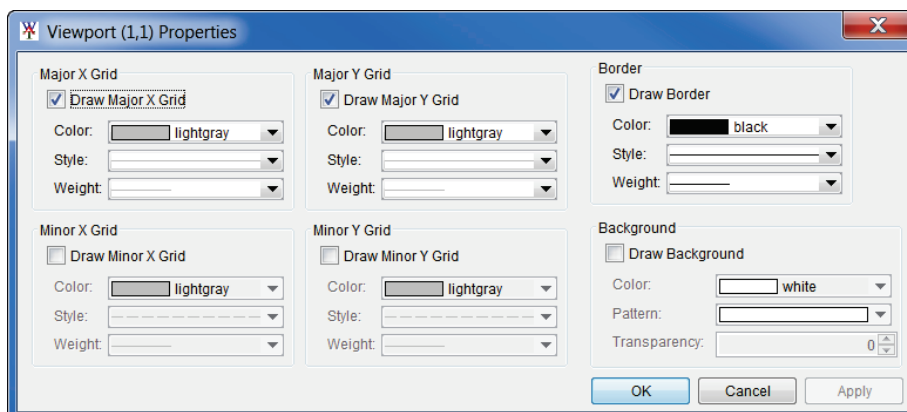


Figure M.25 Viewport Properties Dialog Box

From the **Viewport Properties** dialog box (Figure M.25), there are four boxes that are concerned with the grid – **Major X Grid**, **Minor X Grid**, **Major Y Grid**, and **Minor Y Grid** (Figure M.26). The user can set the color, style, and weight for each of the grid settings. By default, the Major X- and Y-grids are set to display, if the user wants to have the minor X- and Y- grids display, the user would select **Draw Minor X Grid** and **Draw Minor Y Grid** (Figure M.26). Click **Apply**, and the minor gridlines will display in the plot.

**Figure M.26** Viewport Properties Dialog Box - Gridlines

From the **Border** box (Figure M.5), by default a border around the viewport area is drawn. The user can choose to not to have a border around the plot; select the color, style, and weight of the border.

From the **Background** box (Figure M.6), the user has the option to incorporate a background as part of the plot. Click **Draw Background** (Figure M.6), the user can select the color, pattern, and set the transparency of the background, click **Apply**. The plot will display with a background as defined.

## M.4.7 Plot – X- and Y-Axis

For the X- and Y-axes, the user can create/modify the individual axis label; change the font attributes; add a border; add a background color; adjust the scalability of the label; reverse the axes; switch the axes (does not work in Version 1.0 of HEC-WAT); display major and/or minor tick marks; and, set the axis type.

### Axis Label

From the plot window, right-click on the axis label of a plot (X or Y), from the shortcut menu (Figure M.27), right click **Edit Properties**, the **Viewport – Axis Label Properties** dialog box will open (Figure M.28).

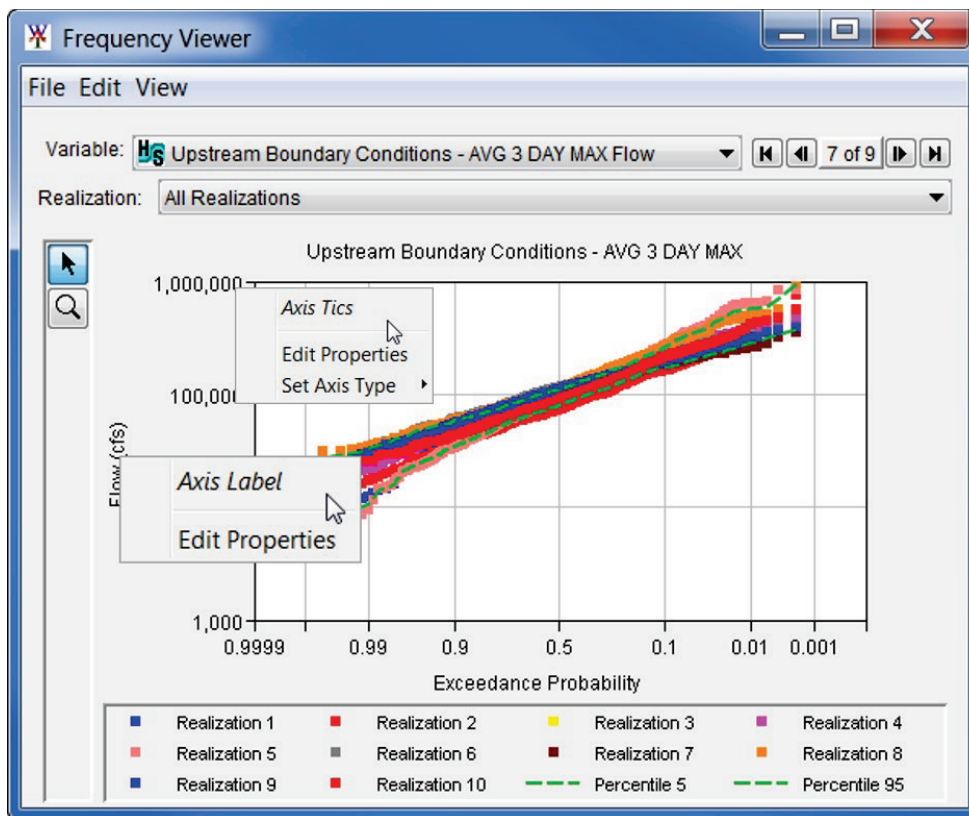


Figure M.27 Axis Label and Tics Shortcut Menus

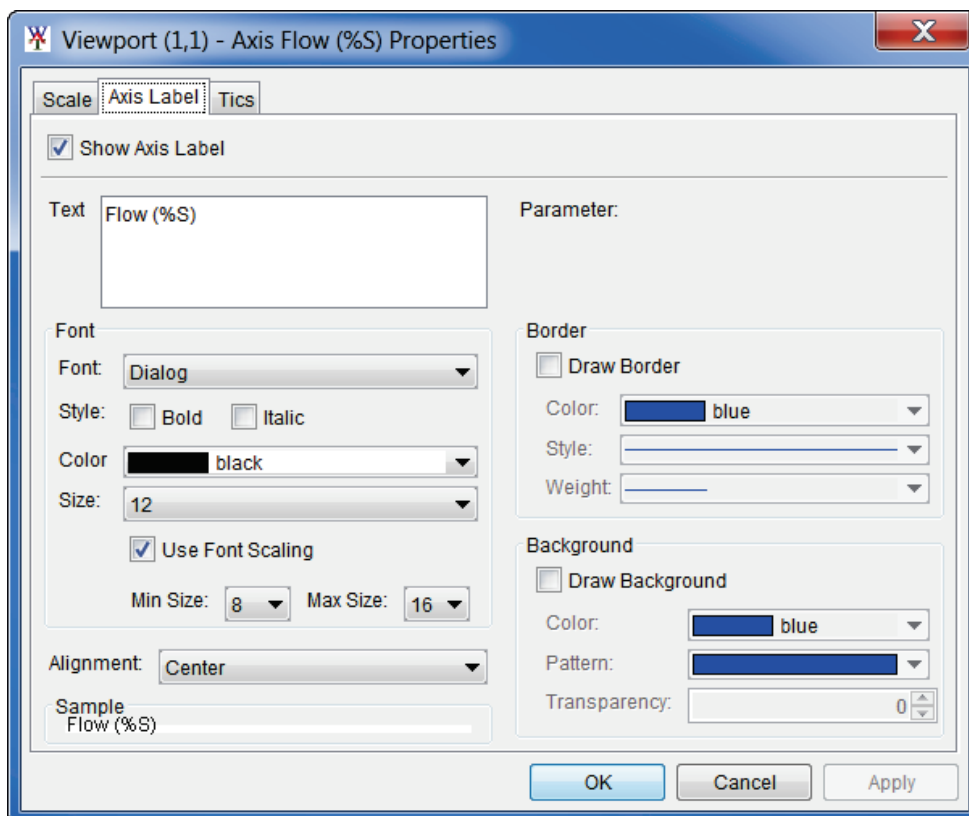


Figure M.28 Viewport – Axis Label Properties Dialog Box

## Axis Label Tab

- From the default tab – **Axis Label** (Figure M.28), **Show Axis Label** displays an axis title (Figure M.28). The user can define the title by entering information in the **Text** box (Figure M.28). Click **Apply**, the title of an axis will display.
- From the **Font** box (Figure M.4), from the **Font** list, the user can select a font type for the selected axis label. The user can choose to have the selected axis label, displayed bolded or italicized by select either **Bold** or **Italic** (Figure M.4) from the **Font** box. From the **Color** list (Figure M.4) the user can have the selected axis label display in a selected color. From the **Size** list (Figure M.4), the user can set the size of font for the selected axis label. The **Use Font Scaling** option (Figure M.4) allows for the font size to adjust when the plot window is being resized. The scaling of the font is set in the **Min Size** list and the **Max Size** list.
- From the **Border** box (Figure M.5), the user has the option to draw a border around the selected axis label. Click **Draw Border** (Figure M.5), the user can select the color, style, and weight of the border, click **Apply**. A border as defined will display around the selected axis label.
- From the **Background** box (Figure M.6), the user has the option to incorporate a background as part of the selected axis label. Click **Draw Background** (Figure M.6), the user can select the color, pattern, and set the transparency of the background, click **Apply**. The selected axis label will display with a background as defined.

## Scale Tab

From the **Scale** tab (Figure M.29), by default scaling of the axes and the axes tic marks is set to **Auto**, all scaling items have a check mark by the description. If the user wishes to set scaling, click an item (check mark no longer displays), and enter a new scaling factor for the item. Click **Apply**, and the new scaling for the axes and the axes tic marks is available. By selecting **Reverse (invert) Axis** (Figure M.29) the user can invert the axes in the plot. The **Switch X and Y Axis** (Figure M.29) is not functional in HEC-WAT Version 1.0.

Item	Value
Maximum:	1000000
Minimum:	1000
View Maximum:	1000000
View Minimum:	1000
Major Tic Interval:	2
Minor Tic Interval:	0.5
Reverse (Invert) Axis	
Switch X and Y Axis	

**Figure M.29** Viewport – Axis Label Properties Dialog Box – Scale Tab

## Tics Tab

From the **Tic** tab (Figure M.30), by default major tick marks are set – **Use major tick marks**. If the user wants the minor tick marks to display, click **Use minor tick marks** (figure M.30). In either sub tab – **Major Tics** or **Minor Tics** the user can display the tick labels by selecting **Show Tic Labels** (Figure M.30). From the **Font** box (Figure M.4), from the **Font** list, the user can select a font type for the tick labels. The user can choose to have the tick labels displayed bolded or italicized by selecting either **Bold** or **Italic** (Figure M.4) from the **Font** box. From the **Color** list (Figure M.4) the user can have the tick labels display in a selected color. From the **Size** list (Figure M.4), the user can set the size of font for the tick labels. The **Use Font Scaling** option (Figure M.4) allows for the font size to adjust when the plot window is being resized. The scaling of the font is set in the **Min Size** list and the **Max Size** list.

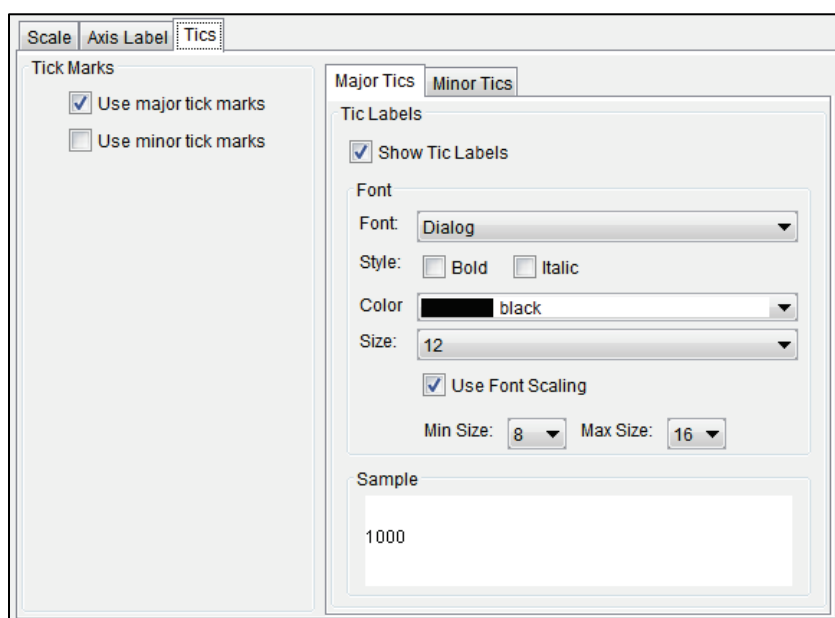


Figure M.30 Viewport – Axis Label Properties Dialog Box – Tics Tab

## Axis Tics

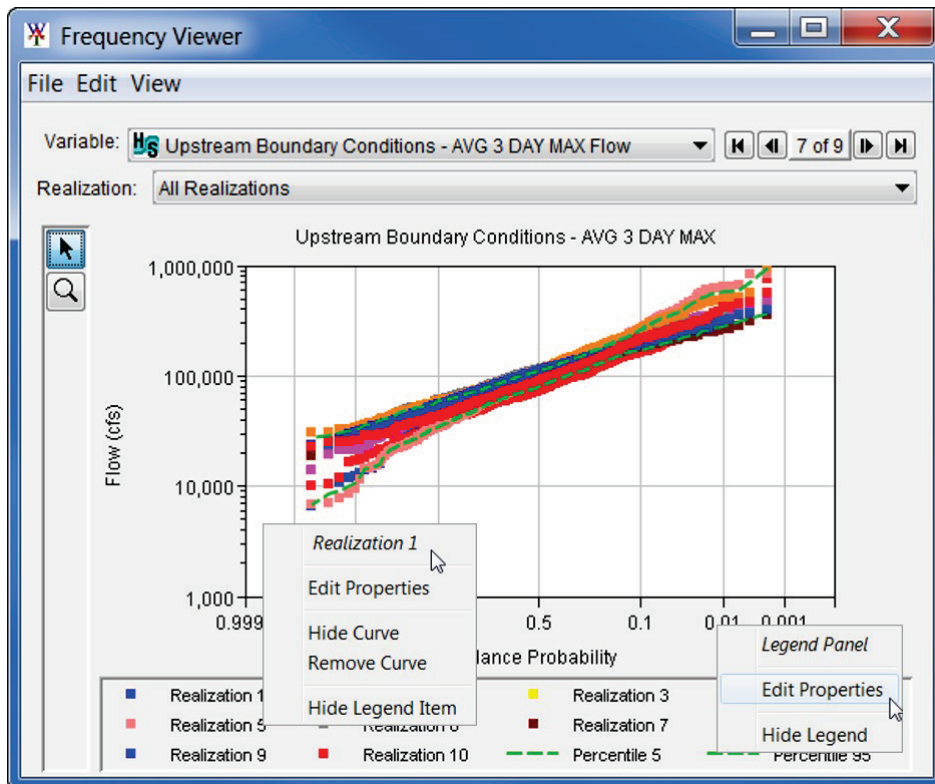
From the plot window, right-click on an axis tic label, from the shortcut menu (Figure M.27), right click **Edit Properties**, the **Viewport – Axis Label Properties** dialog box will open (Figure M.28). The user can change the axis type, from the shortcut menu (Figure M.27), point to **Set Axis Type**, click **Linear Axis** (in Figure M.27 the axis type is **Log Axis**). The plot will now display as a linear plot. To change the plot to a log plot, from the shortcut menu (Figure M.27), point to **Set Axis Type**, click **Log Axis**

### M.4.8 Plot – Legend

The legend provides the user with information about the items displayed in the plot. The user can modify the legend panel and the customize curves that displayed in the legend.

## Legend Panel

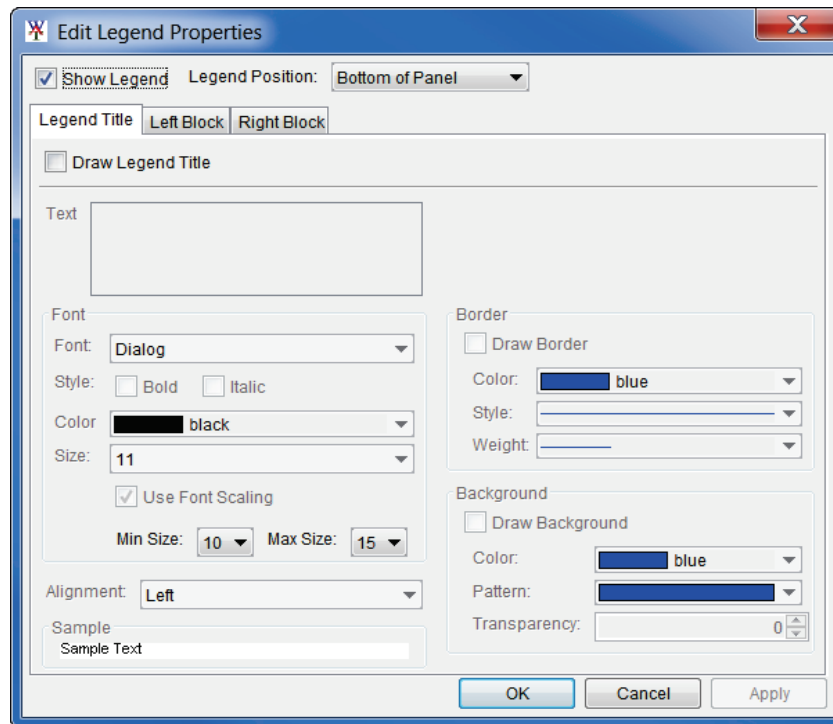
The **Legend Panel** on (Figure M.31) contains information about the items displayed in the plot. From the plot window, right-click in the legend panel, from the shortcut menu (Figure M.31), right click **Edit Properties**, the **Edit Legend Properties** dialog box will open (Figure M.32). By default the legend panel displays, click **Show Legend** (check mark no longer displays) and the legend panel will no longer display. The user can also position the legend panel from the **Legend Position** list.



**Figure M.31** Legend Panel and Legend Items Shortcut Menus

## Legend Title Tab

- From the default tab – **Legend Title** (Figure M.32), the user can add a title to the legend panel. Click **Draw Legend Title** (Figure M.32), in the **Text** box the user can enter the information for the legend panel title. Click **Apply**, the title will display in the legend panel
- From the **Font** box (Figure M.4), from the **Font** list, the user can select a font type for the legend title. The user can choose to have the legend title displayed bolded or italicized by select either **Bold** or **Italic** (Figure M.4) from the **Font** box. From the **Color** list (Figure M.4) the user can have the legend title display in a selected color. From the **Size** list (Figure M.4), the user can set the size of font for the legend title. The **Use Font Scaling** option (Figure M.4) allows for the font size to adjust when the plot window is being resized. The scaling of the font is set in the **Min Size** list and the **Max Size** list.



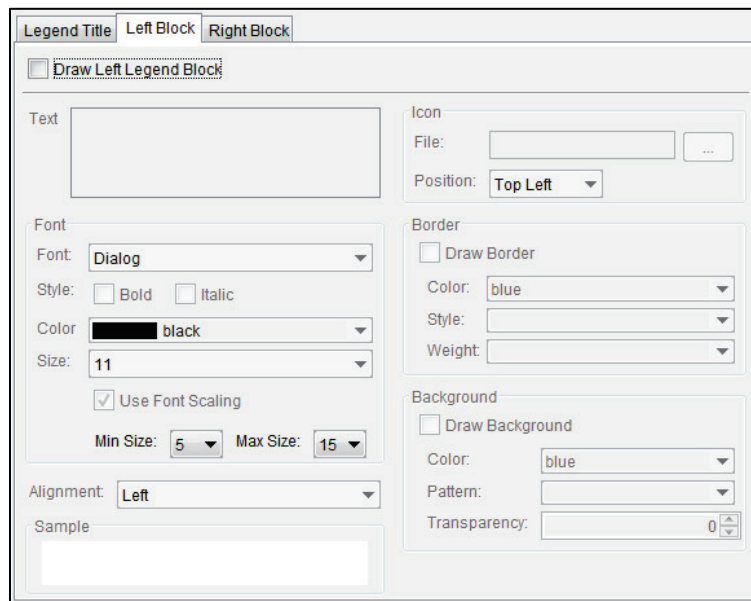
**Figure M.32** Edit Legend Properties Dialog Box

- c. From the **Border** box (Figure M.5), the user has the option to draw a border around the selected legend title. Click **Draw Border** (Figure M.5), the user can select the color, style, and weight of the border, click **Apply**. A border as defined will display around the legend title.
- d. From the **Background** box (Figure M.6), the user has the option to incorporate a background as part of the legend title. Click **Draw Background** (Figure M.6), the user can select the color, pattern, and set the transparency of the background, click **Apply**. The legend title will display with a background as defined.


## Left/Right Block Tabs

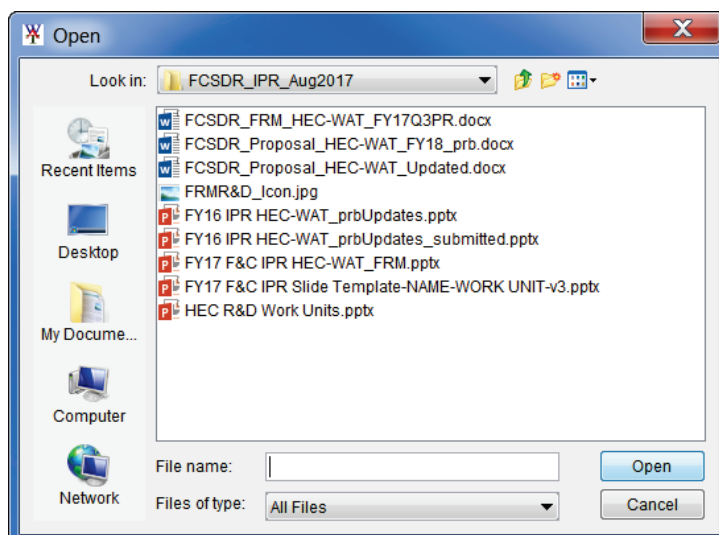
- a. From the **Left Block** or **Right Block** tabs (Figure M.33), the user can add a block to the left or right of the legend panel. To display the blocks the user clicks **Draw Left Legend Block/Draw Right Legend Block** (Figure M.33), click **Apply**. On the left/right side of the legend panel a block will be displayed. The user can add text to the block, by entering information into the **Text** box (Figure M.33)
- b. From the **Font** box (Figure M.4), from the **Font** list, the user can select a font type for the legend panel block text. The user can choose to have the legend panel block text displayed bolded or italicized by select either **Bold** or **Italic** (Figure M.4) from the **Font** box. From the **Color** list (Figure M.4) the user can have the legend panel block text display in a selected color. From the **Size** list (Figure M.4), the user can set the size of font for the legend panel block text. The **Use Font Scaling** option (Figure M.4) allows for the font size to adjust when the plot window is being resized. The scaling of the font is set in the **Min Size** list and the **Max Size** list.





**Figure M.33** Edit Legend Properties Dialog Box – Left/Right Block Tabs

- c. From the **Icon** box (Figure M.33), the user add a graphics file to a legend panel block. Next to the **File** box (Figure M.22), click , an **Open Browser** will open (Figure M.34). Browse to the location of a graphics file, select the file, click **Open**, the **Open Browser** will close (Figure M.34). In the **File** box (Figure M.33), the location and name of the selected file will be displayed. Click **Apply**, the selected graphic will display in the legend panel block. Be sure to size the graphic before adding it to the legend panel block.



**Figure M.34** Open Browser

- d. From the **Border** box (Figure M.5), the user has the option to draw a border around the legend panel block. Click **Draw Border** (Figure M.5), the user can select the color, style, and weight of the border, click **Apply**. A border as defined will display around the legend panel block.



- e. From the **Background** box (Figure M.6), the user has the option to incorporate a background as part of the legend panel block. Click **Draw Background** (Figure M.6), the user can select the color, pattern, and set the transparency of the background, click **Apply**. The legend panel block will display with a background as defined.

## Legend Panel – Customizing Curves

From the **Legend Panel** (Figure M.31), right-click on a curve label, from the shortcut menu (Figure M.31), right click **Edit Properties**, the **Curve Properties** dialog box will open (Figure M.15). Section M.4.4, Custom Curves, describes the various option available to a user for customizing curves.

## M.5 Customizing Plots – Edit Menu

If the user does not want to customize plots from the plot, from a plot window, from the Edit menu, click **Plot Properties**. The **Plot Properties** dialog box will open (Figure M.35), from seven tabs allows the user to configure multiple display properties of an individual plot. The properties and options available from the **Plot Properties** dialog box (Figure M.35) are detailed in Section M.4. The **Layout** tab (Figure M.35) is available for the user to set the plot window size, add a background color to the panel around the plot, and set the space size in pixels. Before adjusting any of the options, please review the HEC-DSSVue User's Manual.

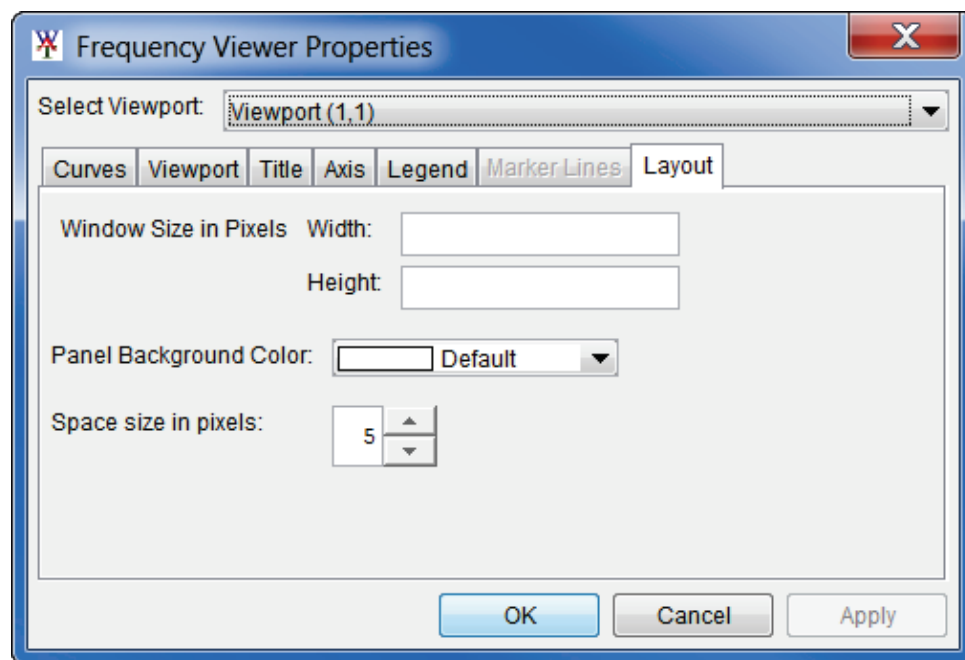


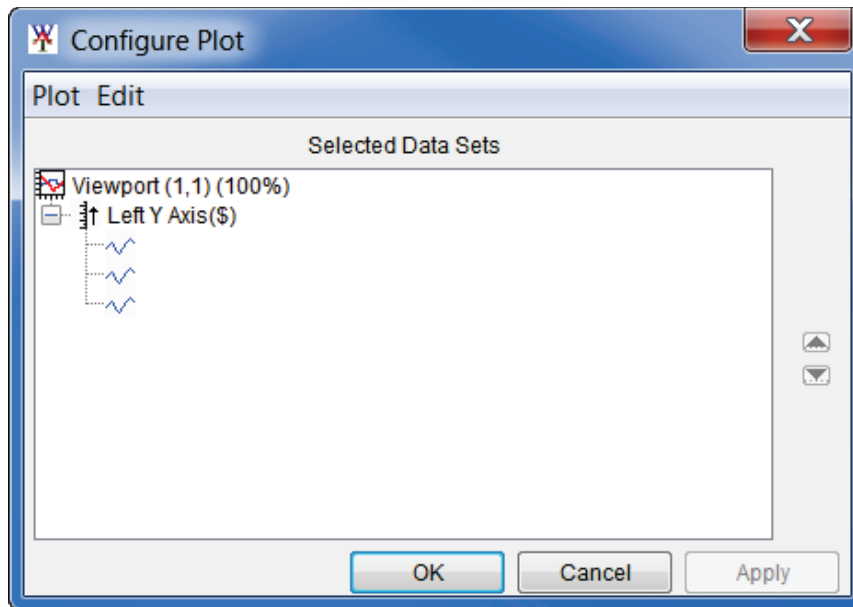
Figure M.35 Frequency Viewer Properties Dialog Box – Layout Tab

## M.6 Configure Plot Layout

The user can customize the layout of an individual plot, available options are: adding and removing axes, arrange the order of viewports, add and remove viewports, and set the weight of viewports. The plot components are displayed in a tree structure.

To add a viewport to an individual plot:

1. From the plot window, from the Edit menu, click **Configure Plot Layout**. The **Configure Plot** dialog box will open (Figure M.36).



**Figure M.36** Configure Plot Dialog Box

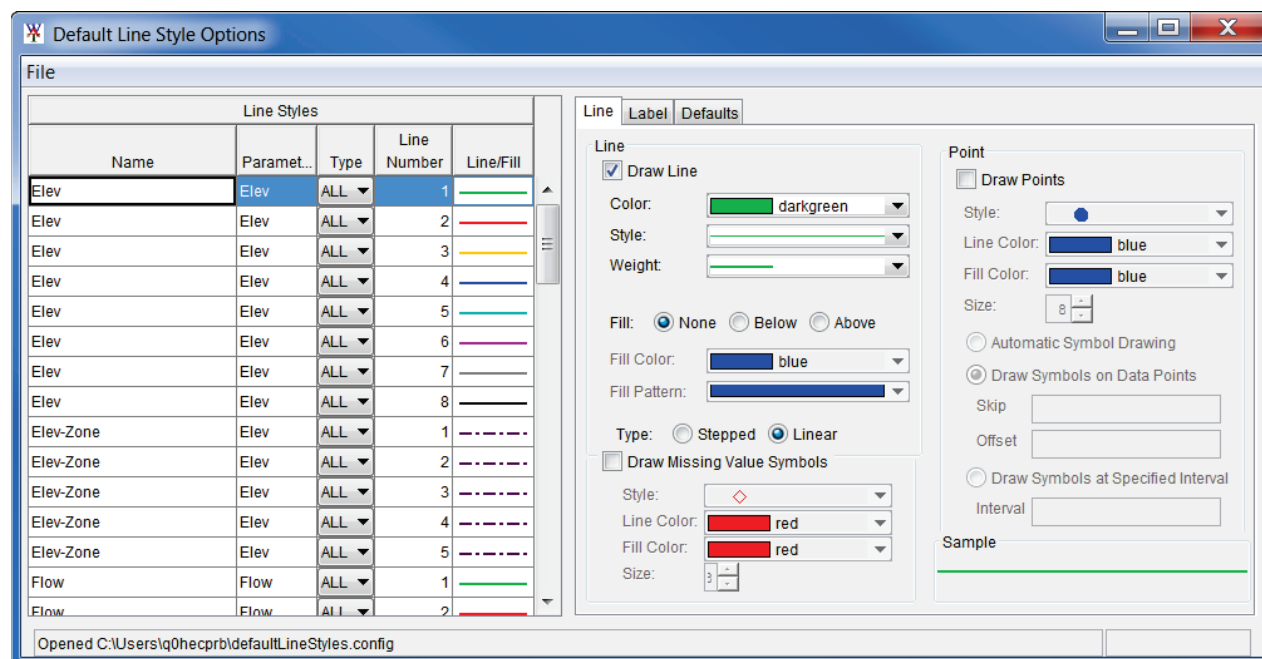
2. From **Edit** menu, click **Add Viewport**. A new viewport will be added to the bottom of the tree on the Configure Plot dialog box (Figure M.37).
3. The user can now add data from one of the other viewports to the new viewport. If data is not added, the new viewport will not be saved. Select a curve from one of the existing viewports, using the down move arrow, move the curve to the new viewport.
4. Click **Apply**, the plot will now have an additional viewport that displays the curve that was moved.
5. Click **OK**, the **Configure Plot Editor** (Figure M.36) will close, and the plot will display the changes that were made.

## M.7 All Plots

The user can customize all the plots for an entire HEC-WAT study. From the **Plot** window (Figure M.1), from the **Edit** menu, there are two commands - **Default Line Styles** and **Default Plot Properties**. These commands allow a user to customize all new plot windows that will be accessed in a study.

### M.7.1 Default Line Style Options

The **Default Line Style Options** dialog box (Figure M.37) is specifically for adjusting the curves (lines) in all of the plots for a study. From this dialog box, the user can add curve (line)



**Figure M.37** Default Line Style Options Dialog Box

types; change the color and fill of the curves (lines); and, add labels for the curves (lines) for all plots in a study. For more detailed information on **Default Line Style Options** dialog box, refer to the HEC-DSSVue User's Manual (Chapter 5).

From the **Line** tab (Figure M.37) the user can set the color, style, and weight for curves (lines) in all plots. If the curves have points, the user can adjust the style, color, and fill color for the points on curves in all plots.

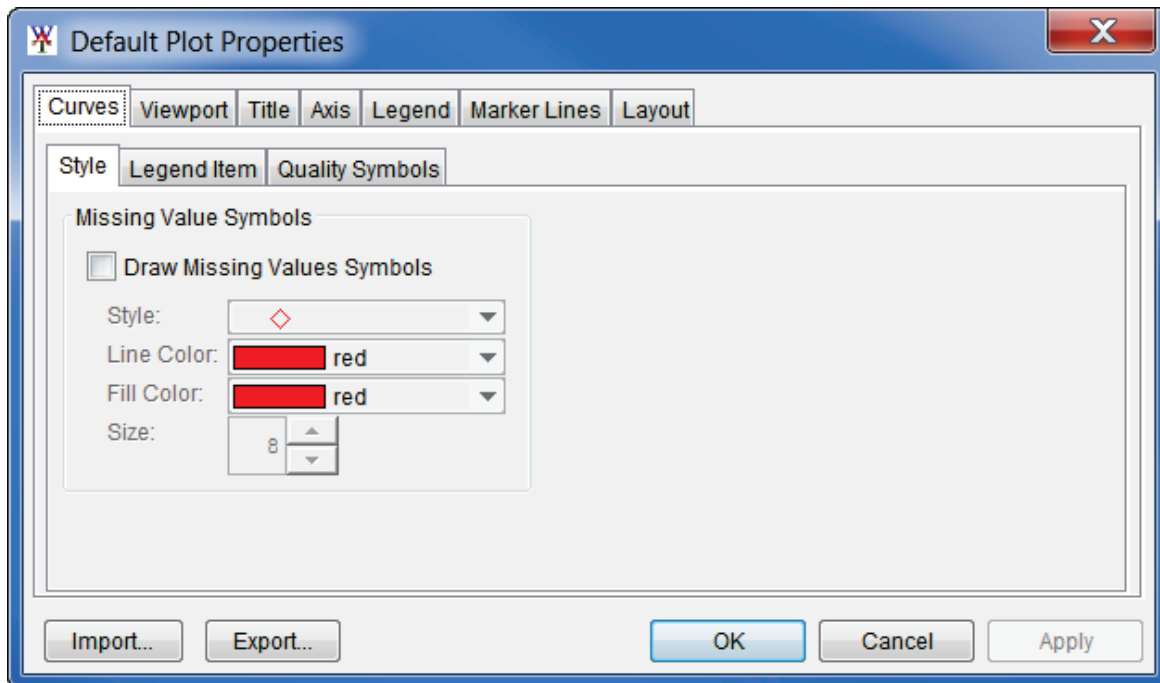
From the **Default Line Style Options** dialog box (Figure M.37) labels can be added to the curves and adjust the position of the label (**Label** tab) for all plots. The user can manually adjust the maximum and minimum values for the X-axis, set viewport weight, and reverse the X-axis (**Defaults** tab) for certain curve types such as *Precip*.

## M.7.2 Default Plot Properties

The **Default Plot Properties** dialog box (Figure M.38) allows the configuration of all of plot properties related to the active study. The worksheets for this dialog box allow a user to make adjustment to the viewport; modify/create a title for all plots; adjust grids; modify/add axis labels; marker lines; change the color of the plot background; change the layout of the legend, and adjust the layout of the plots. The properties and options available from the **Default Plot Properties** dialog box (Figure M.38) are detailed in Section M.4.

## M.8 HEC-DSSVue User's Manual

There are many more options available from the HEC-WAT plot windows. Please review the HEC-DSSVue User's Manual for further details on the available options.




**Figure M.38** Default Plot Properties Dialog Box

# Appendix N

## Printing and Copying Data

Plots and tables in HEC-WAT offer detailed views of data and model results that the user can print or copy and paste into other applications. In addition, the user can print reports generated by the individual models. The following sections provide information by the individual models available from HEC-WAT on printing and copying data.

### N.1 HEC-HMS

From an HEC-HMS plot the user is able to print the plot. For example, from an HEC-HMS plot result (Figure N.1), click **Print** . A **Print** dialog box will open (Figure N.2). The user can select the printer; set properties for the print job; print to a file; setup the pages; and adjust appearance settings. When everything is setup, click **Print**, the **Print** dialog box (Figure N.2) will close, and the HEC-HMS plot is printed.

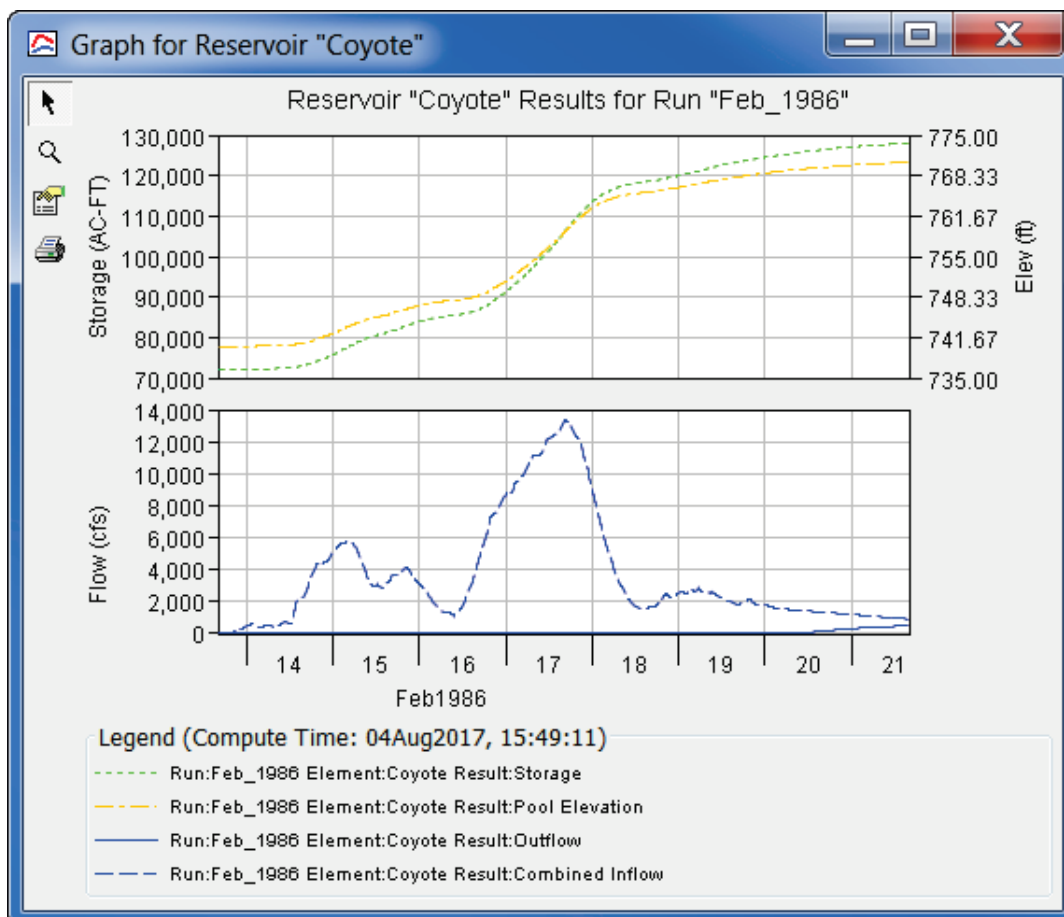


Figure N.1 HEC-HMS Plot Results

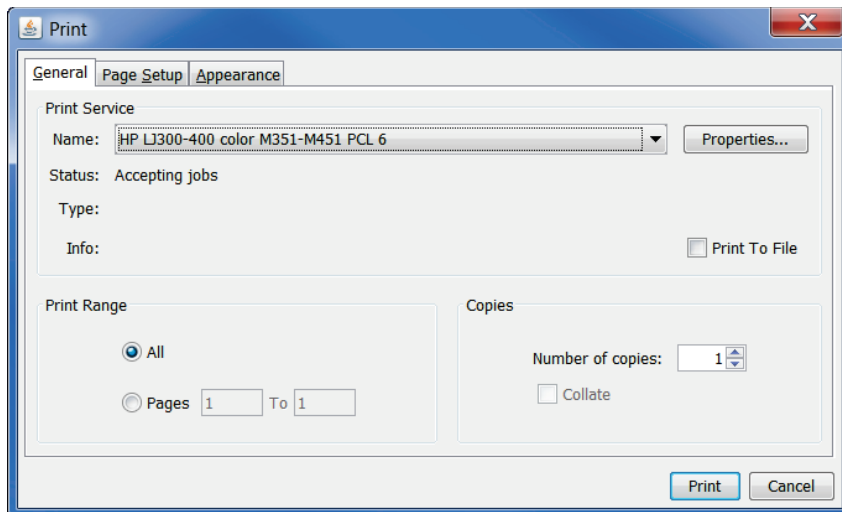


Figure N.2 HEC-HMS - Print Dialog Box

## N.2 HEC-RAS

### N.2.1 Printing

#### Plots

To print an HEC-RAS plot, for example, from a **Cross Section Plot** dialog box (Figure N.3), from the **File** menu, click **Print**. The **Print Options** dialog box will open (Figure N.4). From this dialog box the user can select a printer, select orientation, set margins, set printer scaling, and other additional options. There are other options, for further information see the HEC-RAS User's Manual.

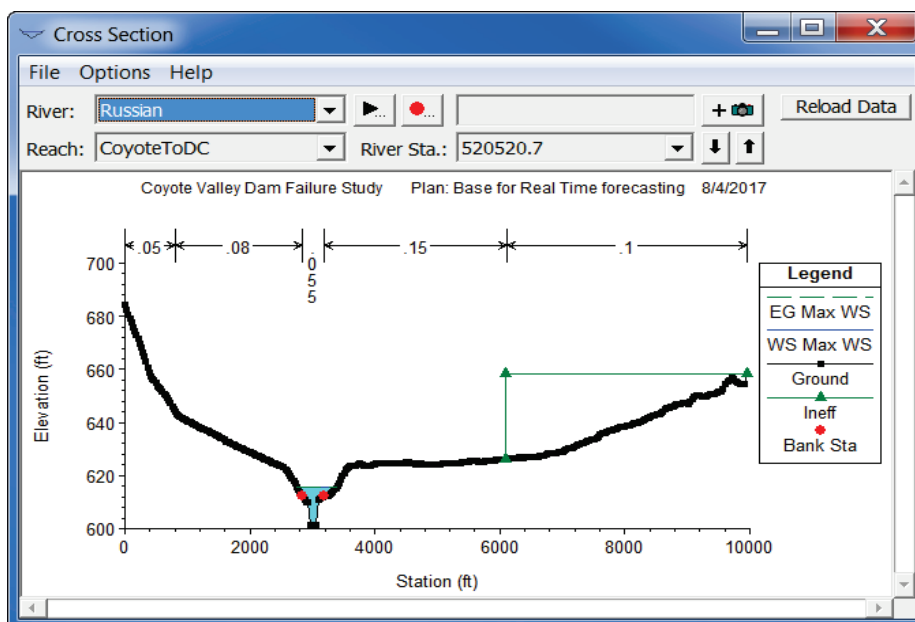
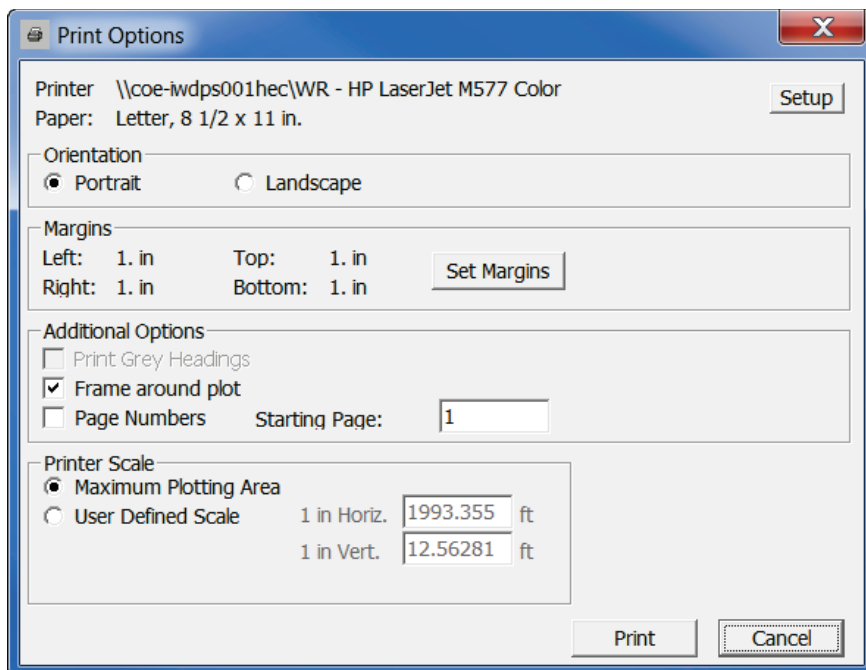


Figure N.3 HEC-RAS - Cross Section Plot Dialog Box



**Figure N.4** Print Options Dialog Box – HEC-RAS Plot

Click **Print**, the **Print Options** dialog box (Figure N.4) will close. A copy of the plot will be sent to the selected printer.

## Tables

To print a RAS table, for example from a **Profile Output Table – Standard Table 1** dialog box (Figure N.5), from the **File** menu, click **Print**. A **Print Options** dialog box will open (Figure N.4) which is very similar to the **Print Options** dialog box for RAS plots. The user can select a printer, select orientation, set margins, set options for the table, and additional options. There are other options for further information see the HEC-RAS User's Manual.

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top V (ft)
DryCreek	74716.8 Sonoma Outflow J	Max WS	3506.01	193.80	202.91		203.48	0.003298	6.06	578.95	48
DryCreek	74403	Max WS	3502.86	193.00	200.88		201.86	0.007165	7.98	439.16	38
DryCreek	74016.5	Max WS	3500.77	191.00	199.18		199.82	0.003484	6.40	547.16	8
DryCreek	74016	Lat Struct									
DryCreek	73802.3	Max WS	3500.00	182.59	199.20	189.39	199.26	0.000267	1.99	1761.12	18
DryCreek	73707	Bridge									
DryCreek	73608.59	Max WS	3500.00	186.50	198.45		198.76	0.001545	4.43	789.59	14
DryCreek	73461*	Max WS	3499.54	185.68	198.35		198.56	0.001206	3.64	962.01	16
DryCreek	73314.5	Max WS	3499.01	184.87	198.17		198.38	0.001292	3.67	952.20	17
DryCreek	73158*	Max WS	3498.40	185.15	198.03		198.21	0.000970	3.30	1032.51	19

Total flow in cross section.

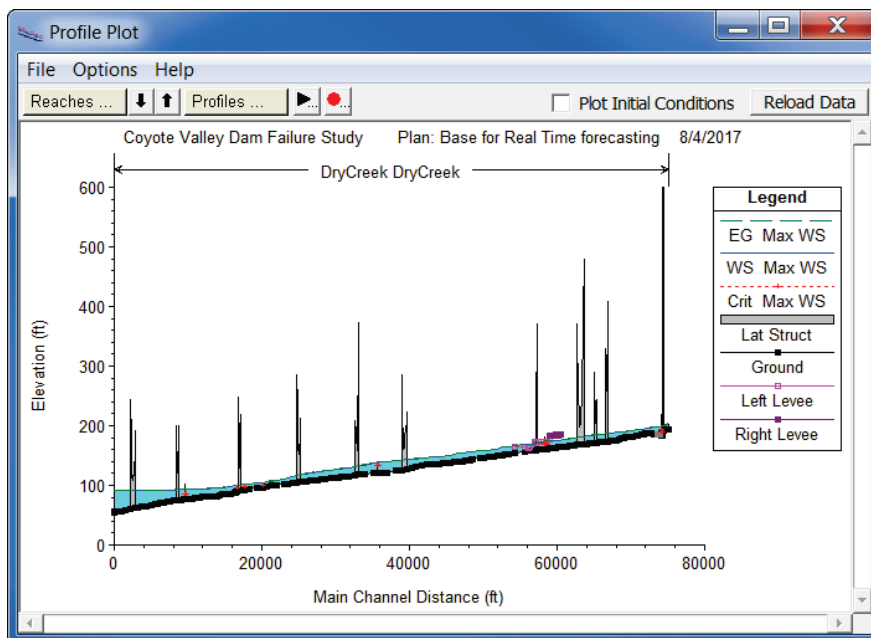
**Figure N.5** HEC-RAS - Profile Output Table – Standard Table 1 Dialog Box

Click **Print**, the **Print Options** dialog box (Figure N.4) will close. A copy of a RAS table will be sent to the selected printer.

## N.2.2 Copying

### Plots

In HEC-RAS there are several copying processes associated with a plot. The first is copying the plot to the clipboard for use in other programs as a graphic. The graphic is a picture, which is easily copied into most programs. For example, from a **Profile Plot** dialog box (Figure N.6), from the **File** menu, click **Copy Plot to Clipboard**. The contents for the display area on the **Profile Plot** dialog box (Figure N.6) will be copied to the clipboard and is available for pasting into other programs.

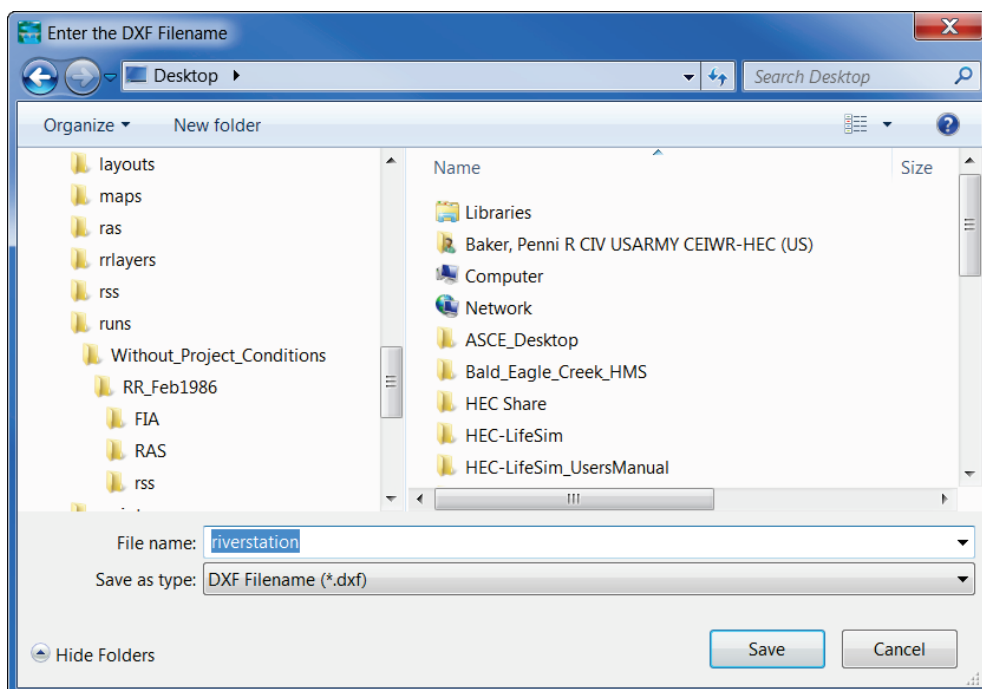


**Figure N.6** HEC-RAS - Profile Plot Dialog Box

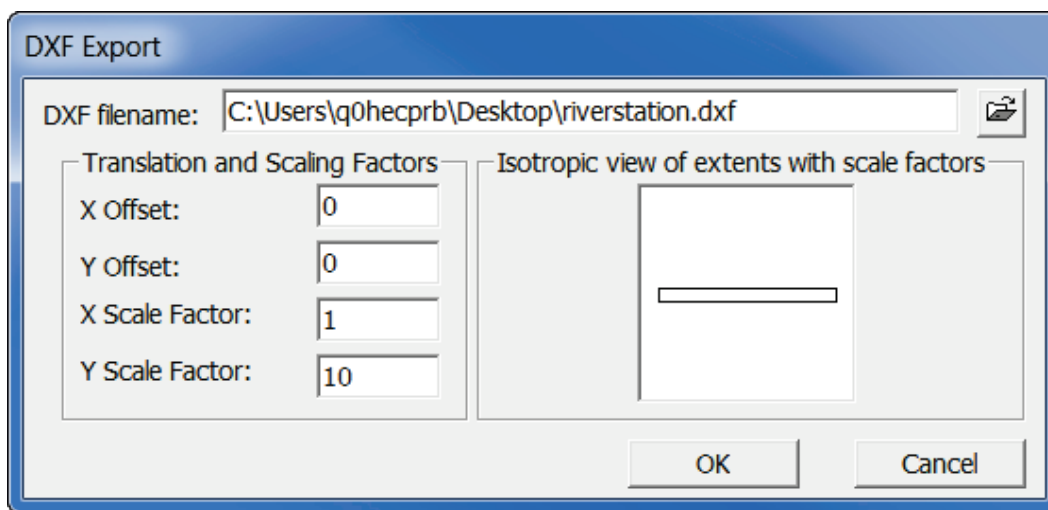
Another way is to copy the data of a plot to the clipboard. The data is copied to the clipboard in a tab delimited format, which is easily pasted into an Excel® spreadsheet for example. For example, from a **Profile Plot** dialog box (Figure N.6), from the **File** menu, click **Copy Values to Clipboard**. The data values that represent the plot on the **Profile Plot** dialog box (Figure N.6) will be copied to the clipboard and is available for pasting into other programs.

The last way to copy RAS plot data, is to create an AutoCAD file – DXF. The DXF format is a vector-based graphic and is commonly used for data export from other Computer-Aided Design (CAD) and GIS program (Chapter 5, Section 5.2.1). For example, from a **Profile Plot** dialog box (Figure N.6), from the **File** menu, click **Write DXF File**. An **Enter the DXF Filename Browser** will open (Figure N.7). The user should search for a location to save the file and provide a name in the **File name** box. Click **Save**, the **Enter the DXF Filename Browser** will close (Figure N.7) and the **DXF Export** dialog box will open (Figure N.8). The user will need to





**Figure N.7** HEC-RAS - Enter the DXF Filename Browser



**Figure N.8** HEC-RAS - DXF Export Dialog Box

enter a filename (default name for a cross section plot is *riverstation.dxf*), and adjust some other settings (see HEC-RAS User's Manual for further details) if needed. Click **OK**, the **DXF Export** dialog box (Figure N.7) will close, and a message window will appear informing the user that the DXF file has been created. Click **OK**, the message box will close and the DXF will have been created.

## Cross Section Table

From an HEC-RAS cross section table the user can copy the data and headings to the clipboard in a tab delimited format, which can be easily pasted in to an Excel® spreadsheet for example. For example, from a **Cross Section Output** dialog box (Figure N.9), from the **File** menu, click

Plan: Without Pr:RR\_Feb1986:RAS-Base for Real Time for DryCreek DryCreek RS: 48393.41 Profile: Max WS

E.G. Elev (ft)	155.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.17	Wt. n-Val.	0.040	0.045	0.040
W.S. Elev (ft)	155.19	Reach Len. (ft)	420.67	345.49	329.22
Crit W.S. (ft)		Flow Area (sq ft)	49.70	2091.35	304.28
E.G. Slope (ft/ft)	0.001268	Area (sq ft)	49.70	2091.35	304.28
Q Total (cfs)	7455.05	Flow (cfs)	40.26	7009.52	405.28
Top Width (ft)	838.25	Top Width (ft)	104.70	431.19	302.36
Vel Total (ft/s)	3.05	Avg. Vel. (ft/s)	0.81	3.35	1.33
Max Chl Dpth (ft)	14.07	Hydr. Depth (ft)	0.47	4.85	1.01
Conv. Total (cfs)	209364.9	Conv. (cfs)	1130.6	196852.7	11381.7
Length Wtd. (ft)	345.74	Wetted Per. (ft)	104.71	434.54	302.37
Min Ch El (ft)	141.12	Shear (lb/sq ft)	0.04	0.38	0.08
Alpha	1.15	Stream Power (lb/ft s)	0.03	1.28	0.11
Frctn Loss (ft)	0.42	Cum Volume (acre-ft)	361.96	3381.14	243.96
C & E Loss (ft)		Cum SA (acres)	126.06	392.44	50.22

Errors, Warnings and Notes

Select Profile

**Figure N.9** HEC-RAS - Cross Section Output Dialog Box

**Copy to Clipboard (Data and Headings).** The data values and headings from the table on the **Cross Section Output** dialog box (Figure N.9) will be copied to the clipboard and is available for pasting into other programs.

## Profile Table

From an HEC-RAS profile table the user can copy the data and headings to the clipboard, data only to the clipboard, or create a text file. To copy items to the clipboard, for example, from a **Profile Output Table –Standard Table 1** dialog box (Figure N.5), from the **File** menu, click **Copy to Clipboard (Data and Headings)** or **Copy to Clipboard (Data Only)**. Either way the data values and/or headings from the table are copied to the clipboard in a tab delimited format which can be easily pasted into an Excel® spreadsheet.

To create a text file of an HEC-RAS profile table, for example from a **Profile Output Table –Standard Table 1** (Figure N.5), from the **File** menu, click **Write to Text File**. An **Enter Filename** browser will open (Figure N.10). Select where you want the file copied to and enter a filename. Click **Save**, the **Enter Filename** browser (Figure N.10) will close and the file will be created.

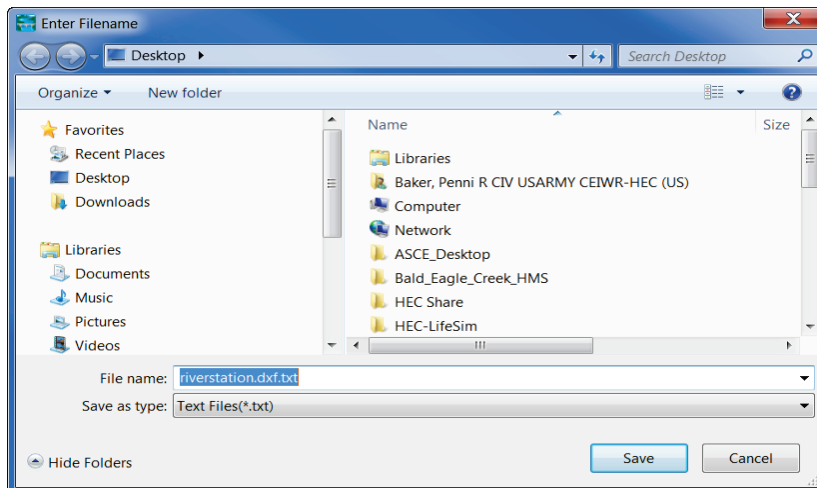


Figure N.10 HEC-RAS – Enter Filename Browser

## N.3 HEC-ResSim

### N.3.1 Plots

Plots provide a graphical representation of your data. From the **Plot Window** (Figure N.11) the user can view the plot, as well as print, save as a graphics file, copy the contents of the **Plot Window** to the clipboard, and save the properties of the plot to a template to be used by other plots. Following is an overview of the menu bar of the **Plot Window**. The commands available from the menus are:

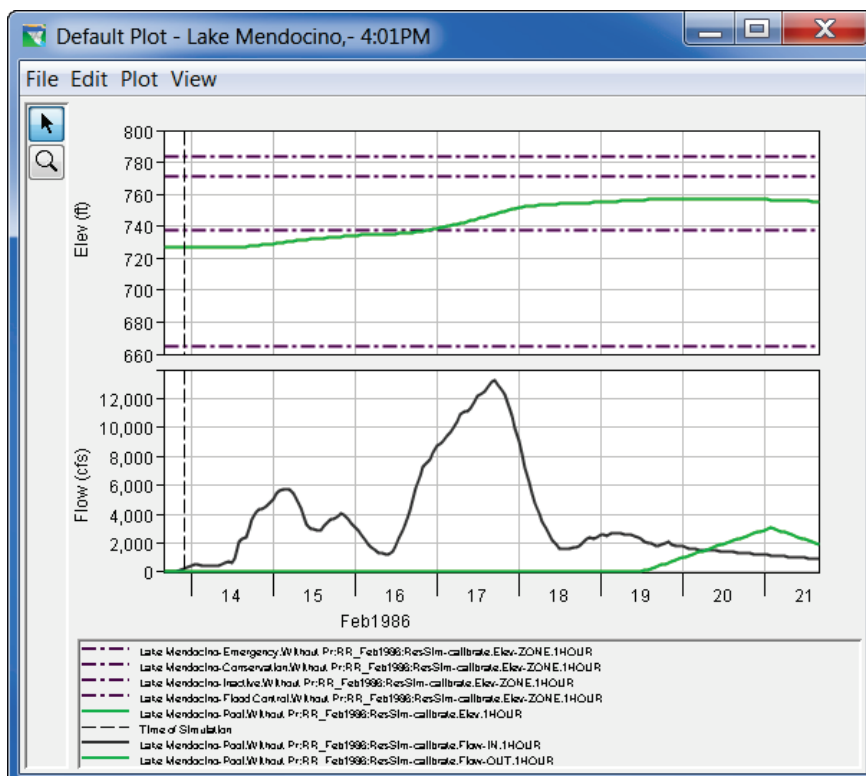


Figure N.11 HEC-ResSim Plot Window

- File** From this menu you can view the plotted data in a tabular format, save the plot as a graphics file, save a template, use a template, copy the plot to the clipboard, and print the plot. Available commands are: **Tabulate, Save As, Save Template, Apply Template, Save Specification, Print, Page Setup, Print Preview, Print Multiple, and Close.**
- Edit** From this menu you can customize the plot. Available commands are: **Plot Properties, Default Line Styles, and Default Plot Properties.**
- Plot** From this menu you can customize the layout of an individual plot, and save a plot type. Available commands are: **Select Variables, Open Plot Type and Save Plot Type.**
- View** From this menu you can have the plot window always on top of your desktop, and you can choose to use line styles. Available commands are: **Always On Top, Use Line Styles, and Zoom to all.**

The **Tools** appear in a toolbar on the left side of the **Plot** window (Figure N.1). The tools change the appearance of the mouse, as well as the functionality of the mouse:



#### **Pointer/Selector Tool**

With the **Pointer/Selector Tool**, the user can access shortcut menus that allow customization of plots using the plot editing tools.



#### **Zoom Tool**

The **Zoom Tool** allows the user to view data closely at a specific time. To zoom in, hold the mouse button down and outline the area the user wants to enlarge. To zoom out, click the right mouse button (right-click). The zoom out is done by a factor of two and positions the clicked location at the center of the display area.

## **Save As**

The **Save As** command allows the user to save the active plot to a graphics file. HEC-ResSim has four possible formats: Windows Metafile (\*.wmf), Postscript (\*.ps), JPEG (\*.jpg, \*.jpeg), and Portable Network Graphics (\*.png).

To create a graphics file:

1. On the **File** menu, click **Save As**, the **Save** browser will open (Figure N.12).
2. Find the location where to save the graphics file.
3. Enter a name for the file in the **File name** box.

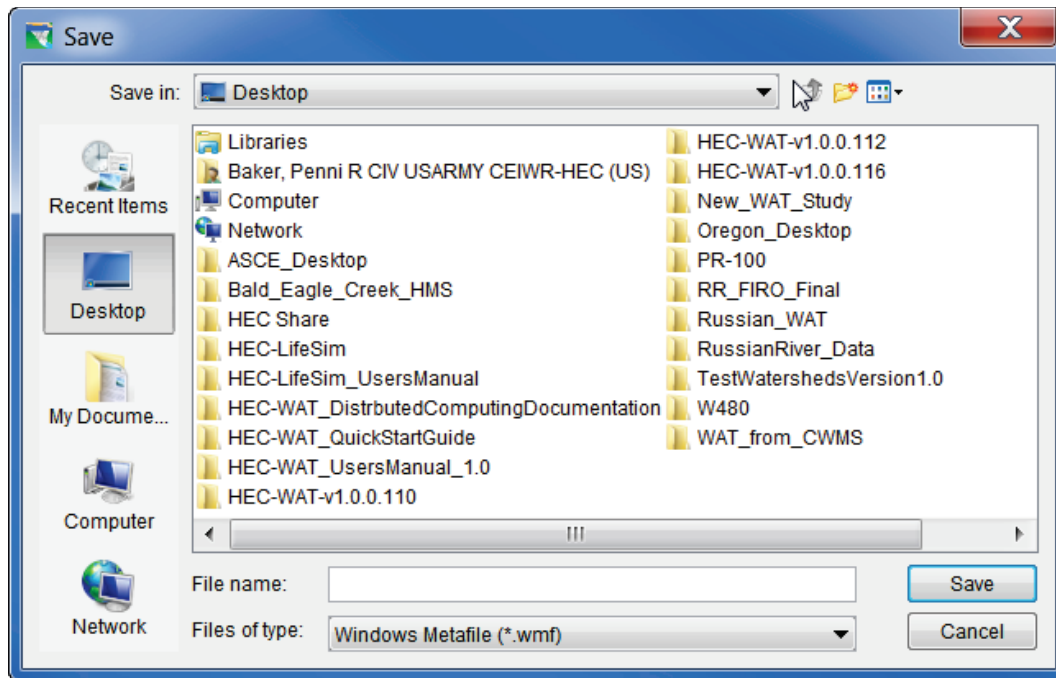


Figure N.12 Save Browser

4. From the **Files of type** list, select the type of graphics file you wish to create.
5. Click **Save**, a file with the appropriate extension will be created in the selected location. The file will contain the contents of the **Plot Window** (Figure N.11).

## Copy to Clipboard

The **Copy to Clipboard** command will copy the contents of the **Plot Window** to the clipboard. Once the copy is complete, the user can paste the plot as an image into other applications.

## Print Commands

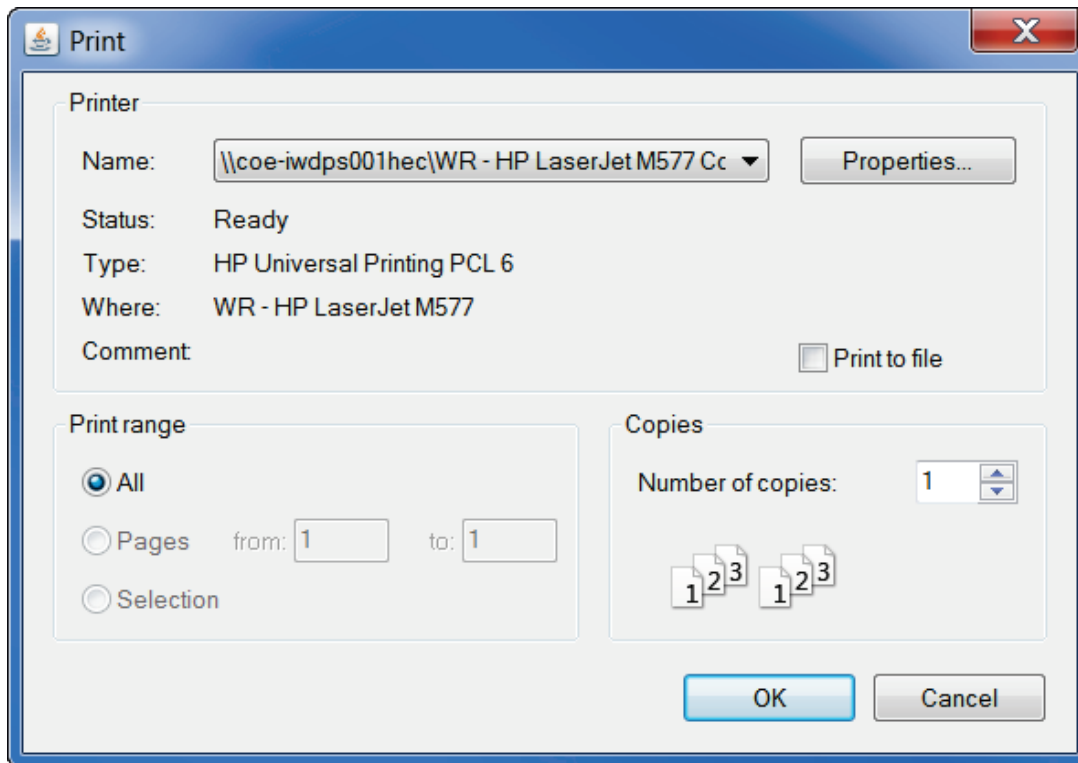
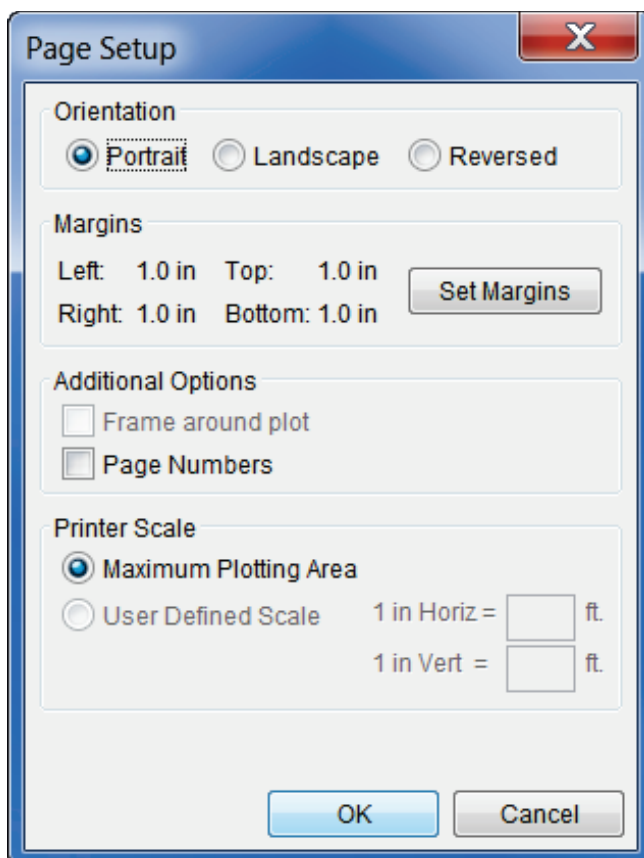
The **Plot Window** (Figure N.11) provides the user with several different commands to setup the printing process and to print.

### Print

The **Print** command opens a standard system **Print** dialog box (Figure N.13). From the dialog box the user can select the printer, choose to print to a file, and the number of copies to print. Click **OK**, the **Print** dialog box will close and the plot will print to the selected printer.

## Page Setup

The **Page Setup** command opens the **Page Setup** dialog box (Figure N.14). When using this dialog box, the user can setup the format of the printed page. Following is a list of the available options:

**Figure N.13** HEC-ResSim - Print Dialog Box**Figure N.14** HEC- ResSim - Page Setup Dialog Box

### Orientation

By default, the page will be printed in **Portrait**. In addition, you can choose to print in **Landscape** or **Reversed** (does not work in HEC-WAT Version 1.0).

### Margins

The default margin settings are displayed in the **Margins** area of the **Page Setup** dialog box. If you want to set the margins, click **Set Margins**, the **Printer Margins** dialog box (Figure N.15) will open. From this dialog box, you can adjust the top, left, bottom, and right margins.

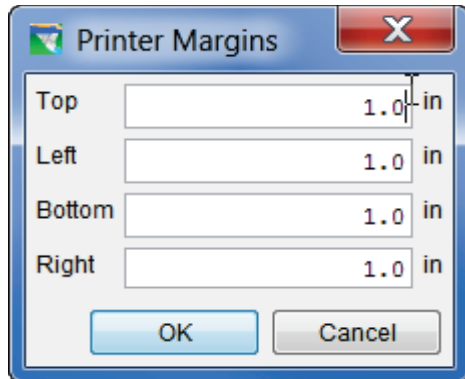


Figure N.15 HEC- ResSim – Printer Margins Dialog Box

### Additional Options

If you would like page numbers included on your printed page, select the **Page Numbers** check box (Figure N.14). The **Frame around plot** option is not available in HEC-WAT Version 1.0.

### Printer Scale

The default option is **Maximum Plotting Area**, and in Version 1.0 of HEC-WAT, is the only available option.

## Print Preview

The **Print Preview** command opens the **Preview** dialog box (Figure N.16). From this dialog box, the user can view the plot, adjust the scaling of the plot, and print the plot. The **Print** command automatically prints the plot to the default system printer.

## Print Multiple

The **Print Multiple** command opens the **Print Multiple** dialog box (Figure N.17). To be able to print multiple plots the user must have opened multiple individual plot windows. The open plots are listed in the **Available Plots** list of the **Print Multiple** dialog box. To select plots to be printed on one page, double-click on a plot name in the **Available Plots** list. The plot name will move to the **Selected Plots** list. The user can adjust the way the plots are arranged on a page, horizontally or vertically. Use the **Number Across** or **Number Down** sliders. The grid to the right of the sliders reflects your choices. From the **File** menu, the **Page Setup** and **Print Preview** commands are available.

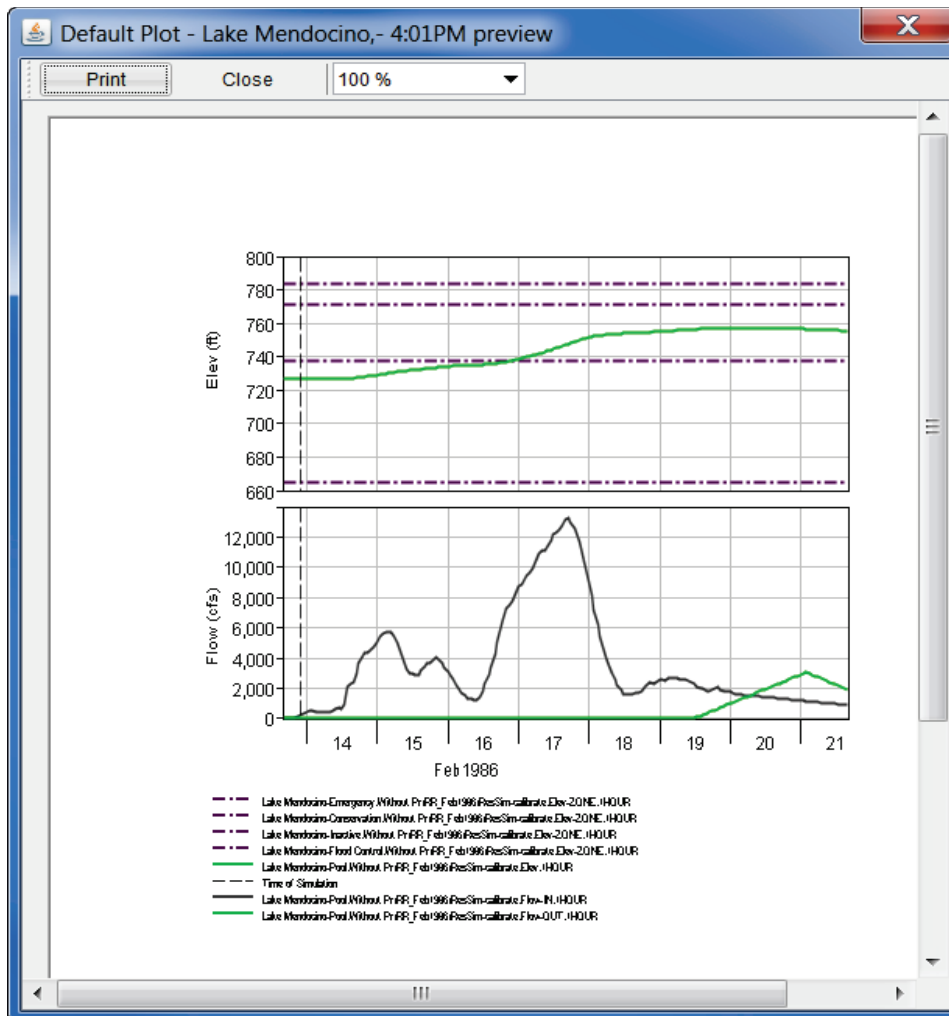


Figure N.16 HEC-ResSim - Preview Dialog Box - Plot

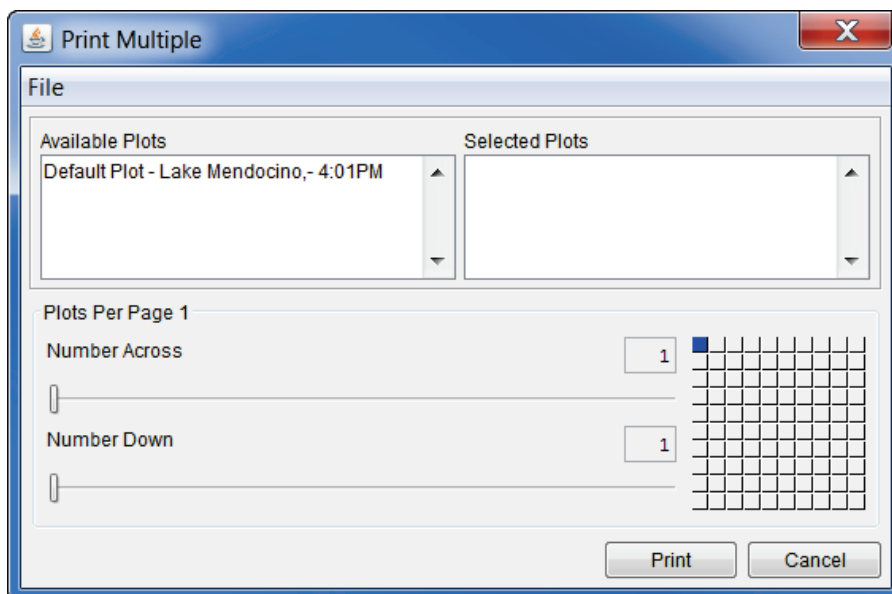
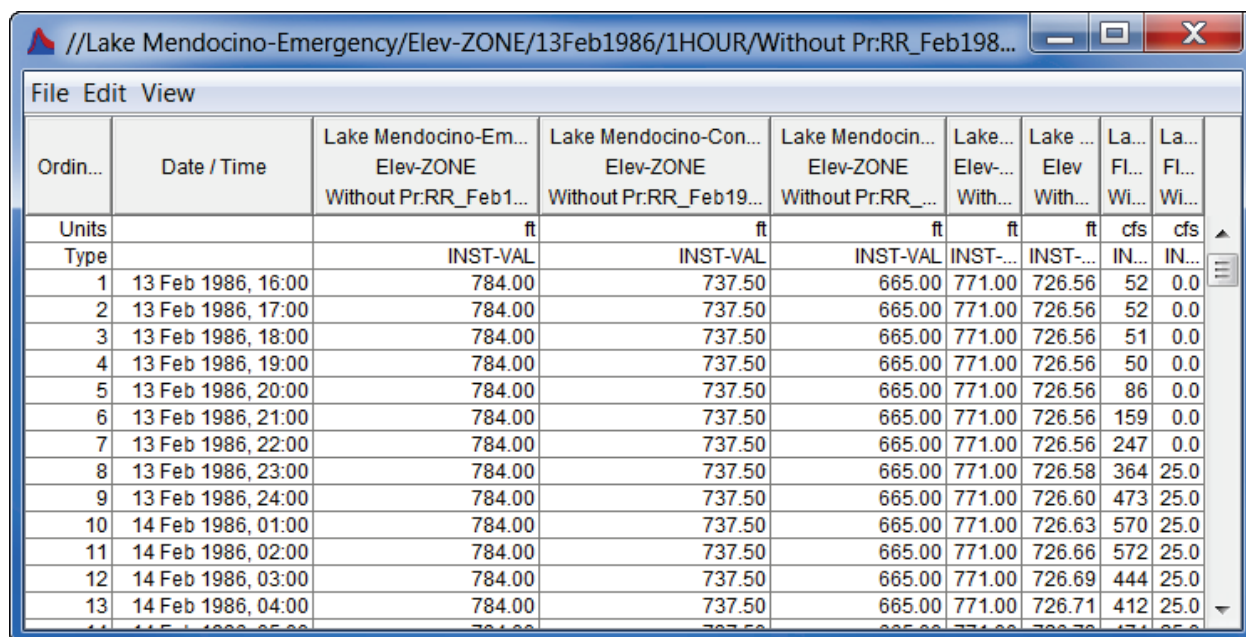


Figure N.17 HEC-ResSim - Print Multiple Dialog Box



## N.3.2 Tables

Tables provide a tabular format of data. From the **Tabulate Window** (Figure N.18) the user can view the data, as well as print the table, copy the selected contents of the **Tabulate Window** to the clipboard, adjust the display of the data, and save the data to an ASCII file. Following is an overview of the menu bar of the **Tabulate Window**. The commands available from the menus are:



Ordin...	Date / Time	Lake Mendocino-Em... Elev-ZONE Without Pr:RR_Feb1...	Lake Mendocino-Con... Elev-ZONE Without Pr:RR_Feb19...	Lake Mendocin... Elev-ZONE Without Pr:RR_...	Lake... Elev-... With...	Lake ... Elev... With...	La... FI... Wi...	La... FI... Wi...
Units		ft	ft	ft	ft	ft	cfs	cfs
Type		INST-VAL	INST-VAL	INST-VAL	INST-...	INST-...	IN...	IN...
1	13 Feb 1986, 16:00	784.00	737.50	665.00	771.00	726.56	52	0.0
2	13 Feb 1986, 17:00	784.00	737.50	665.00	771.00	726.56	52	0.0
3	13 Feb 1986, 18:00	784.00	737.50	665.00	771.00	726.56	51	0.0
4	13 Feb 1986, 19:00	784.00	737.50	665.00	771.00	726.56	50	0.0
5	13 Feb 1986, 20:00	784.00	737.50	665.00	771.00	726.56	86	0.0
6	13 Feb 1986, 21:00	784.00	737.50	665.00	771.00	726.56	159	0.0
7	13 Feb 1986, 22:00	784.00	737.50	665.00	771.00	726.56	247	0.0
8	13 Feb 1986, 23:00	784.00	737.50	665.00	771.00	726.56	364	25.0
9	13 Feb 1986, 24:00	784.00	737.50	665.00	771.00	726.60	473	25.0
10	14 Feb 1986, 01:00	784.00	737.50	665.00	771.00	726.63	570	25.0
11	14 Feb 1986, 02:00	784.00	737.50	665.00	771.00	726.66	572	25.0
12	14 Feb 1986, 03:00	784.00	737.50	665.00	771.00	726.69	444	25.0
13	14 Feb 1986, 04:00	784.00	737.50	665.00	771.00	726.71	412	25.0

Figure N.18 HEC-ResSim - Tabulate Window

- File** From this menu, the user can print the data in a tabular format and view a plot of the data. Available commands are: **Print, Print Preview, Export, Plot, and Close**.
- Edit** From this menu, select data to be copied to the clipboard. Available commands are: **Copy, Select All, Find, and Compare data sets**.
- View** From this menu, the user can control the appearance of the data displayed in the **Tabulate Window**. Available commands are: **Commas, Date and Time Separately, Date with 4 Digit Years, Show Decimal Places** (auto, 1 - 6), and **Show Missing As** (blank, -901.00, M, -M-).

## Copy to Clipboard

To copy data from the **Tabulate Window** (Figure N.18) to the clipboard, there are several ways. To use the **Copy** command from the **Edit** menu, the user must first select the cells in the table that will be copied to the clipboard. If the user wants the whole table, from the **Edit** menu choose **Select All**. If there is, only a certain area the user wishes to copy to the clipboard, from the table click and drag over the cells to be copied, the selection will be highlighted. With either method, then from the **Edit** menu choose **Copy**. The contents will then be copied to the clipboard where the user can paste the data into other applications. In addition, if the user right-

clicks on the table, a shortcut menu will appear which will also allow you to copy data to the clipboard.

## Display Data

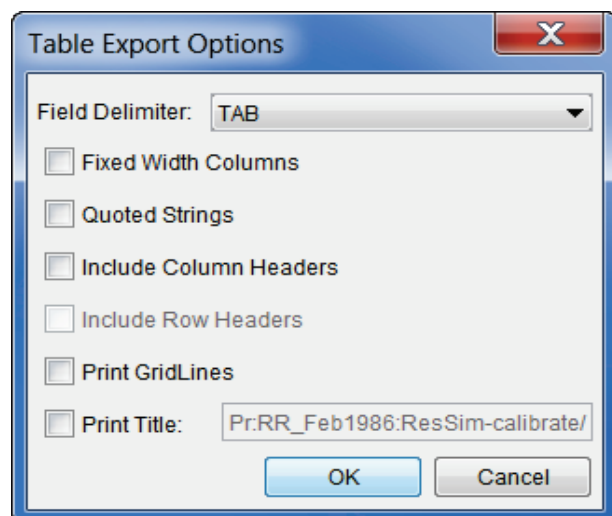
By default, data is displayed with commas and two decimal places. If the user wants to change the way the data is displayed, from the **View** menu there are several options. If user does not want commas displayed, from the **View** menu, click **Commas**.

For time series data the date and time are displayed in the following default format: ddmmyy hhmm. The user can change the way the date and time are displayed. From the **View** menu, click **Date and Time Separately**; the date and time are now displayed in two separate columns in the table. Another way is from the **View** menu, click **Date with 4 Digit Years**; the date and time now displays a four-digit year instead of a two-digit year.

Numbers by default are displayed with two decimal places. If the user wants to see more or less number of decimal places, from the **View** menu, point to **Decimal Places**, and click on the number (zero through 6) of decimal places you would like displayed.

## ASCII File

The user can save the table of data to an ASCII file, right-click on the table. From the shortcut menu, click **Export**; the **Table Export Options** dialog box will open (Figure N.19). From this dialog box, the user can set certain options for the ASCII file.



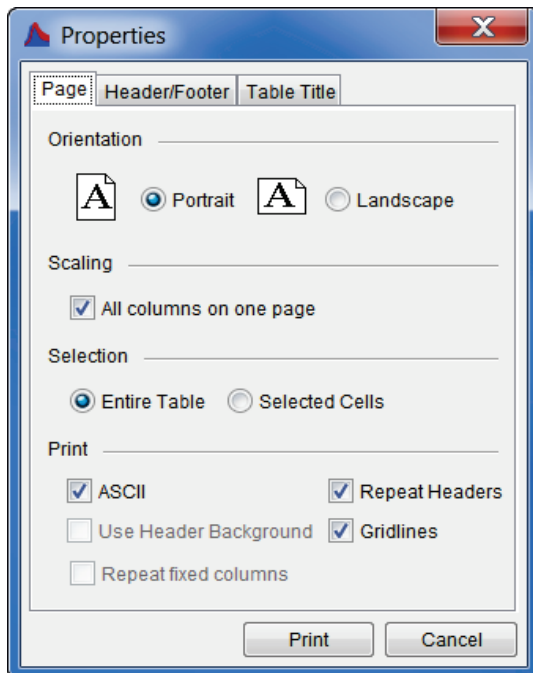
**Figure N.19** HEC-ResSim - Table Export Options Dialog Box

The user can set the delimiter for the file from the **Field Delimiter** list. The hardwired choices are **TAB** (default), **SPACE**, **COMMA**, and **COLON**. The user can also make choices on whether the file contains fixed width columns, strings are set in quotes, whether to include column headers in the file, include gridlines in the file, and whether to include the a title in the file.

When all of the options are set, click **OK**. A **Save** browser will open. Find the location where the file will be saved, and provide a filename. Click **Save**, the file will be created without an extension, since this is an ASCII file, you might want to give the file an extension of .txt.

## Print

The **Print** command opens the **Properties** dialog box will open (Figure N.21). From this dialog box, the user can set up the format of the table for output.



**Figure N.20** HEC-ResSim Properties Dialog Box

From the **Page Tab** (Figure N.20), the user can set the orientation; fit the table to a page, and choose whether to include the entire table or only a selection. In addition, the user can also choose to print the table in ASCII, add headers, add background color to headers (non-ASCII option), and add gridlines.

If the user wants to add header or foot information to the table report, click the **Header/Footer** tab (Figure N.20). From the **Header/Footer Worksheet** enter header or footer information.

The title of the table report defaults to the pathname tag associated with the data. If the user wants to change this title, click the **Table Title Tab**. From the **Table Title Worksheet** enter or change the title, and decide if the title needs to be printed on each page of the report. When everything is set, click **Print**, a standard system **Print** (Figure N.13) dialog box will open.

To preview the table report, right-click on the table, from the shortcut menu click **Print Preview**. A dialog box similar to the **Properties** dialog box (Figure N.20) will open. Setup options for the table report; click **Preview**, and the **Print Preview** dialog box (Figure N.21) will open. From this dialog box, the user can view the table report, adjust the scaling of the report, and print the report. The **Print** command automatically prints the report to the default system printer.

Print Preview

Print Close 100 %

Ordinate	Date / Time	Lake Mendocino-Emer... Elev-ZONE Without Pr:RR_Feb19...	Lake Mendocino-Cons... Elev-ZONE Without Pr:RR_Feb198...	Lake Mendocino... Elev-ZONE Without Pr:RR_F...	Lake ... Elev-... Witho...	Lake ... Elev ... Witho...	La... Flo... Wit...	La... Flo... Wit...
Units		ft	ft	ft	ft	ft	cfs	cfs
Type		INST-VAL	INST-VAL	INST-VAL	INST-	INST-	IN	IN
1	13 Feb 1986, 16:00	784.00	737.50	665.00	771.00	726.56	52	0.0
2	13 Feb 1986, 17:00	784.00	737.50	665.00	771.00	726.56	52	0.0
3	13 Feb 1986, 18:00	784.00	737.50	665.00	771.00	726.56	51	0.0
4	13 Feb 1986, 19:00	784.00	737.50	665.00	771.00	726.56	50	0.0
5	13 Feb 1986, 20:00	784.00	737.50	665.00	771.00	726.56	46	0.0
6	13 Feb 1986, 21:00	784.00	737.50	665.00	771.00	726.56	159	0.0
7	13 Feb 1986, 22:00	784.00	737.50	665.00	771.00	726.56	247	0.0
8	13 Feb 1986, 23:00	784.00	737.50	665.00	771.00	726.56	364	25.0
9	13 Feb 1986, 24:00	784.00	737.50	665.00	771.00	726.60	473	25.0
10	14 Feb 1986, 01:00	784.00	737.50	665.00	771.00	726.63	570	25.0
11	14 Feb 1986, 02:00	784.00	737.50	665.00	771.00	726.66	572	25.0
12	14 Feb 1986, 03:00	784.00	737.50	665.00	771.00	726.69	444	25.0
13	14 Feb 1986, 04:00	784.00	737.50	665.00	771.00	726.71	412	25.0
14	14 Feb 1986, 05:00	784.00	737.50	665.00	771.00	726.73	474	25.0
15	14 Feb 1986, 06:00	784.00	737.50	665.00	771.00	726.75	482	25.0
16	14 Feb 1986, 07:00	784.00	737.50	665.00	771.00	726.78	475	25.0
17	14 Feb 1986, 08:00	784.00	737.50	665.00	771.00	726.80	448	25.0
18	14 Feb 1986, 09:00	784.00	737.50	665.00	771.00	726.83	531	25.0
19	14 Feb 1986, 10:00	784.00	737.50	665.00	771.00	726.86	672	25.0
20	14 Feb 1986, 11:00	784.00	737.50	665.00	771.00	726.90	702	25.0
21	14 Feb 1986, 12:00	784.00	737.50	665.00	771.00	726.93	672	25.0
22	14 Feb 1986, 13:00	784.00	737.50	665.00	771.00	726.97	976	25.0
23	14 Feb 1986, 14:00	784.00	737.50	665.00	771.00	727.06	2.0	25.0
24	14 Feb 1986, 15:00	784.00	737.50	665.00	771.00	727.17	2.2	25.0
25	14 Feb 1986, 16:00	784.00	737.50	665.00	771.00	727.30	2.3	25.0
26	14 Feb 1986, 17:00	784.00	737.50	665.00	771.00	727.44	2.9	25.0
27	14 Feb 1986, 18:00	784.00	737.50	665.00	771.00	727.62	3.6	25.0
28	14 Feb 1986, 19:00	784.00	737.50	665.00	771.00	727.83	4.1	25.0
29	14 Feb 1986, 20:00	784.00	737.50	665.00	771.00	728.06	4.3	25.0
30	14 Feb 1986, 21:00	784.00	737.50	665.00	771.00	728.29	4.3	25.0
31	14 Feb 1986, 22:00	784.00	737.50	665.00	771.00	728.50	4.5	25.0

Figure N.21 HEC-ResSim - Preview Dialog Box - Tables

# Appendix O

## Glossary

This glossary is a collection of definitions from throughout this user's manual, plus definitions of other pertinent terms.

**Acre:** A unit of area in English units used in calculation of agricultural crop damage.

**Activity:** Linked with features and may involve changes to operations or institutional actions.

**Alternative:** A system of structural and/or nonstructural measures, strategies, or programs formulated to alleviate problems or take advantage of specific opportunities associated with water and related land resources in the planning area. An alternative in HEC-WAT is a way to group a schematic with different operations and model parameters. The HEC-WAT creates a base alternative (*Without Project Conditions*) by default.

**Analysis Period:** Defines the time window and events that could be associated with an alternative. Analysis periods are for determining damage and project performance information for specific time periods, such as the base year or the most likely future year. The analysis year results for a plan are also used to perform equivalent annual damage computations. The analysis years are used for all study evaluations. An analysis year represents a static time period or year that the hydrology, hydraulics, and economic data represent. Base year is the first year of the plan operation. The "most likely future year" condition is a development projection for a specific future year; say twenty years out from the base year. It usually is based on the projections of local future development plans.

**Arc Shapefile:** This layer type is the native data structure for the ArcView® GIS program. Shapefiles store non-topological geometry and attribute information for the spatial features of a data set. Usually there are three files: \*.dbf, \*.shp, and \*.shx. The *shp* file contains the shapes (point, polylines, or polygons) that are displayed in the layer. Each shape has a record in the dbf file containing descriptive data called "attributes". The .shx file contains an index that links each shape to its record in the .dbf file.

**ArcInfo® DEM:** This is an ASCII file format representation of a grid generated by ArcInfo®. The file consists of keywords followed by values defining the number of columns, number of rows, lower left corner, cell size, no data value, and each cell value.

**ASCII NetTin:** This is an ASCII file format used to represent a triangulated irregular network (TIN). The TIN data are stored in a simple format that defines the nodes,

edges, and triangles contain in the TIN. This format is common for transferring TIN data between software.

**AutoCAD® DXF:** A Drawing Interchange File (dxf) is created by a Computer-Aided Design (CAD) package, AutoCAD®. This format is a tagged data representation of an AutoCad® drawing file. **Tagged data** is where each data element is preceded by a group code. A **group code** is an integer indicating the type of data element. The file created is a vector-based graphic. The DXF format is commonly used for data export from other CAD and GIS programs.

**CAP:** Continuing Authorities Program; is a group of legislative authorities that give the Corps of Engineers the authority to plan, design, and construct certain types of water resource and ecosystem restoration projects without additional and specific congressional authorization. The following are the most commonly used CAP authorities: Small Flood control Projects (authorized by Section 205 of the 1948 Flood control Act); Emergency Streambank Protection Projects (authorized by Section 14 of the 1946 Flood control Act), Aquatic Ecosystem Restoration (authorized by Section 206 of the 1996 Water Resources Development Act); and, Project Modifications of the Improvement of the Environment (authorized by Section 1135 of the 1986 Water Resources Development Act).

**Channel Modification:** Physical alternation of the channel through re-sizing, re-configuration, or re-vegetation, etc.

**Channel Modification Tool:** Tool to create, delete, rename, and edit channel modifications. A channel modification has to be created on the stream alignment.

**Common Computation Point:** Locations where one model transfers data to another model, a location where results are needed for model development or alternative analysis, or locations where input boundary conditions are to be defined.

**Common Computation Point Tool:** Tool to create, delete, rename, and edit common computation points. See Appendix H for more detail on creating, deleting, renaming, and editing computation points.

**Compute:** Capability within HEC-WAT that allows the user to perform the calculations made available through HEC-WAT. These calculations could be for one or more of the models in an order chosen by the Project Delivery Team (PDT).

Also, a menu where the user can compute individual simulations; compute multiple simulations; compute by individual program; and, view the compute log for the active simulation.

**Content Pane:** Area of the HEC-WAT framework that provides details on the selected HEC-WAT component in the **Study Pane**.

**Desktop Pane:** Area of the HEC-WAT framework where the different map windows available from HEC-WAT will display.

**Diversion:** Removal and redirection of water from its normal course for various reasons, water supply, flood control, or environmental, etc.

**Diversion Tool:** Tool to create, delete, rename, and edit diversions. A diversion has to be started on the stream alignment.

**DXF:** See *AutoCAD® DXF*.

**Easting:** The eastward measured distance in common map projections (X-coordinate).

**Ecosystem Restoration Measure:** Physical modifications or other actions that improve the value and function of an ecosystem (e.g., channel improvements, removal of drainage structures or levees).

**Edit:** A menu where the program order can be set; manipulate alternatives and simulations; link individual model alternatives; and, access the individual program editors.

**Event:** A rainfall and/or flow episode. Normally the event is the time period over which the model will retrieve data and produce results. An occurrence of precipitation/snowmelt that leads to some sort of hydrologic response normally associated with a specific time period. The event can be historical or represent the upper limit of a precipitation runoff response.

**File:** A menu used for study management, printing the active map, and, importing and exporting model alternatives.

**FIA:** Flood Impact Analysis, see *HEC-FIA*.

**Feature:** A physical element that generally requires site construction.

**Flood Damage Reduction Measure :** Can be a physical modification (**structural measures**) designed to reduce the frequency of damaging levels of flood inundation (i.e., reservoirs, levees, channelization measures, walls, etc.); or, it can be an activity (**non-structural measure**) that reduces flood damage without significantly altering the nature or extent of flooding (e.g., flood proofing, relocation of structures, raising structures).

**Floodwall:** A levee/floodwall is manmade barrier built along a stream to provide protection from flooding. A levee/floodwall can reduce flood damage by preventing flood stages from reaching a potential damage area.

**GIS:** Geographic Information System

**Group Code:** In a DXF file an integer indicating the type of data element, see *AutoCAD® DXF*.

**GUI:** Graphical User Interface, designed to make the program easy and efficient to enter data, review output, and make comparisons.

**Hectare:** A unit of area in SI units used in calculation of agricultural crop damage.

**HEC-DSS:** The HEC database management system, HEC Data Storage System, stores data in a convenient manner for inventory, retrieval, and archiving for water resource applications.

**HEC-DSSVue:** The HEC software package, HEC Data Storage System Visual Utility Engine, which provides a graphical user interface for viewing, editing, and manipulating data in HEC-DSS files.

**HEC-FIA:** The HEC software package, HEC Flood Impact Analysis. This software package provides the capability to estimate the impacts and damage associated with flood events and the benefits attributed to flood control projects.

**HEC-HMS:** The HEC software package, HEC Hydrologic Modeling System. This software package is designed to simulate the precipitation-runoff processes of dendritic watershed systems and provides the capability to simulate the hydrologic response in a watershed.

**HEC-RAS:** The HEC software package, HEC River Analysis System. This software package is designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels, that allow the user the capability to perform one-dimensional steady and unsteady flow river hydraulics calculations, sediment transport-mobile bed modeling, and water temperature analysis.

**HEC-ResSim:** The HEC software package, HEC Reservoir System Simulation. This software package provides the capability to simulate the operation of a reservoir or reservoir system for an observed, synthetic or predicted flow event using a defined operation scheme.

**HEC-SSP:** The HEC software package, HEC Statistical Software Package. This software package allows the user to perform statistical analyses of hydrologic data.

**HEC-WAT:** The HEC software package, HEC Watershed Analysis Tools. This software package will provide an interface that will streamline the analytical process using the tools commonly applied by multi-disciplinary teams at USACE offices.

**Help:** A menu that provides access to HEC-WAT documentation and displays current information about HEC-WAT.



**Impact Area:** Is any distinct portion of a study area that is affected by rising or falling stage in a stream, river, lake, or reservoir. The boundaries of an impact area are defined by a closed polygon, and the user characterizes the effects of rising or falling stage by describing the property and population at risk in the area bounded by the polygon.

**Impact Area Tool:** Tool is used to create, edit, delete, and rename, impact areas. See Appendix I for more detail on creating, deleting, renaming, and editing impact areas.

**JRE:** Java Runtime Environment (JRE)

**Layer:** Layers are maps that can be placed as background images behind the workspace. They are optional but do provide significant information. Layers can be many types (\*.dlg, \*.shp (ARC/INFO® or Arc Shapefile), \*.dxf (AutoCAD®), \*.dem).

**Levee :** A levee/floodwall is a manmade barrier built along a stream to provide protection from flooding. A levee/floodwall can reduce flood damage by preventing flood stages from reaching a potential damage area.

**Levee Tool:** Tool to create, delete, rename, and edit levees. See Appendix G for more details on creating, deleting, renaming, and editing levees.

**Map Windows:** A way to graphically display the major components of an HEC-WAT study (stream alignments, schematics, alternatives, simulations). From these map windows the user can create, edit, delete, open model editors, or view results.

**Maps:** A menu where the user can setup map layers and map windows. The user can set spatial properties; zoom the active map window out to its full extents, add map layers, remove map layers, open a new map window, adjust the active map windows properties, save the contents of the active map window as a graphic file, import a stream alignment from an ArcView® shapefile, import impact areas from an ArcView® shapefile, export a stream alignment to an ArcView® shapefile, and, export impact areas to an ArcView® shapefile.

**Measure:** Measures for HEC-WAT include structural/non-structural measures (**flood damage reduction**), and/or ecosystem measures. **Structural measures** are physical modifications designed to reduce the frequency of damaging levels of flood inundation, and include dams with reservoirs, levees, channelization measures, walls, diversion channels, pumps, bridge modifications, and ice-control structures. **Non-structural measures** are activities that reduce flood damage without significantly altering the nature or extent of flooding (e.g., flood proofing, relocation of structures, raising structures). **Ecosystem restoration measures** are physical modifications or other actions that improve the value and function of an ecosystem (e.g., channel improvements, removal of drainage structures or levees).

**Message Pane:** Area of the HEC-WAT framework that contains messages that the HEC-WAT software provides for informational purposes. The information in the **Message**

**Pane** is a record of HEC-WAT software activity, recording the opening of the study, opening map windows, accessing DSS, and many other HEC-WAT activities.

**NED:** National Economic Development; usually referred to as the NED plan, which is the plan USACE is required to compute and report. The NED plan provides the greatest economic benefits. If a plan is recommended, most likely it is the NED plan.

**NexGen:** Next Generation Software Development Project

**Northing:** The northward measured distance in common map projections (Y-coordinate).

**Panes:** Viewing areas of the HEC-WAT main window that allow viewing of HEC-WAT study data.

**Pan Tool:** Tool to move the display area while zoomed in.

**PDT:** Project Delivery Team

**Plan:** A set of one or more flood damage reduction or ecosystem restoration measures or actions designed to operate over a period of time (project life). The plan is inclusive of the entire study area although it may have a flood damage reduction measure for a single damage reach.

**Plug-In:** Provides the ability to access model parameters and view results of a model from HEC-WAT.

**PM:** Project Manager

**Pointer/Selector Tool:** Allows the user to select components for editing and viewing (plots) data or results.

**Project:** A man-made structure for the purpose of reducing flood damage or for ecosystem restoration.

**R&U:** Risk and Uncertainty

**Raster Image:** Generally defined as a rectangular array of sampled values (pixels). Each pixel has one or more number associated with it, generally specifying a color the pixel should be display in. The raster image formats supported by HEC-WAT are JPEG format (\*.jpg) and Graphics Interchange Format (\*.gif). For HEC-WAT to access these file types an \*.img (ASCII text) file must be created by the user outside of HEC-WAT. The file needs to contain the following lines, which need to match the easting and northing parameters stated in the **Map Default Properties for StudyName** dialog box (Chapter 5, Section 5.2.5).

- Rating Curve:** A graphical relationship that yields the stage for a given discharge at a specific location on a stream or river.
- Reservoir:** The impoundment created behind dams, or behind navigation locks and dams. For HEC-WAT a reservoir also includes the dam built on a stream to store water for uses such as navigation, tribal resources, flood damage reduction, fish and wildlife habitat considerations, hydroelectric power generation, recreation use, water quality, water supply, erosion and sedimentation control, and sustaining hydrologic function on lakes and rivers. The releases from a reservoir can reduce flood damage by reducing flood stages.
- Reservoir Tool:** Tool to create, delete, rename, and edit reservoirs. See Appendix G for more detail on creating, deleting, renaming, and editing reservoirs.
- Results:** A menu from which the user can select simulations for comparison; and, view results from HEC-WAT and the individual software applications from within HEC-WAT.
- Risk:** The probability an area will be flooded, resulting in undesirable consequences.
- Risk Analysis:** An approach to evaluation and decision making that explicitly, and to the extent practical, analytically, incorporates considerations of risk and uncertainty in a flood damage reduction study.
- Run:** Capability within HEC-WAT that allows the PDT to select the models to execute for a given event or events.
- Schematic:** In HEC-WAT, a physical representation of the study and it includes: common computation points, impact areas, stream alignment, and flood damage reduction and environmental measures that will be modeled.
- Simulation:** A combination of an analysis period and event(s) associated with an alternative.
- Stage:** The vertical distance in feet (meters) above or below a local or national datum (N.G.V.D. for elevations).
- Stage Hydrograph:** A graphical relationship of stage as a function of time for a certain location.
- Status Bar:** Displays the coordinates of the pointer on a map window. Outside of a map window it reflects the status of the program.
- Stream Alignment:** Represents the stream system in the watershed. The alignment indicates where confluences and bifurcations occur and provides a sense of distance and scale. In HEC-WAT, stream alignments are composed of a series of stream elements. See Appendix F for more detail on creating, deleting, renaming, and editing stream alignments.

- Stream Alignment Properties:** Properties of a stream alignment that include: line width, color of line, font style, etc. See Appendix F for more detail on creating, deleting, renaming, and editing stream alignments.
- Stream Alignment Tool:** Tool is used to create, delete, and edit the stream elements that make up the stream alignments. See Appendix F for more detail on creating, deleting, renaming, and editing stream alignment.
- Stream Element:** Segment of the stream alignment that is composed of vertex points, with the beginning and ending vertex points being stream nodes. Typically begins or ends at a confluence, bifurcation, or at the boundary of the river system. See Appendix F for more detail on creating, deleting, renaming, and editing stream elements.
- Streamgage Records:** Records of the stream elevation or stage taken at a streamgage location.
- Stream Node:** The beginning and ending point for each stream element. Stream nodes are also created where stream elements meet. Also, a stream node can be used to establish stationing for a stream element. See Appendix F for more detail on creating, deleting, renaming, and editing stream nodes.
- Stream Node Tool:** Tool is used to create, delete, and edit stream nodes on the stream alignment. See Appendix F for more detail on creating, deleting, renaming, and editing stream nodes.
- Stream Stationing:** Watershed adopted stations along a stream normally denoted as miles (kilometers) above the mouth of a stream.
- Study:** The basic component of HEC-WAT. An HEC-WAT study defines the watershed or geographic area to be evaluated. The study includes alternative analyses which is the investigation of with and without-project conditions involving hydrology, hydraulics, economics, plan formulation and evaluation. In HEC-WAT, the study also includes all of the necessary information to complete an analysis of a specific geographical area.
- Study Pane:** Area of the HEC-WAT framework that provides an overview of HEC-WAT alternatives, simulations, and analysis periods that have been defined for a study.
- System Units:** This value is used as a label for data entry forms and output reports. Choices are *English* or *Metric*, with the default being *English*.
- Tabs:** Provides different views of the available data in an HEC-WAT study. The user can perform certain operations for a study from the tabs.
- Toolbar:** Provides quick access to the most frequently used options from the HEC-WAT menu bar.

**Tools:** A menu that provides access to DSS data (HEC-DSSVue); provides access to the Statistical Software Package (HEC-SSP); allows the user to view general information about the study; provides options for the HEC-WAT startup and system properties; view HEC-WAT program activity; and, monitor memory usage.

**Top of Levee:** Stage at the top of the levee, floodwall or tidal barrier.

**Uncertainty:** A measure of imprecision of knowledge of parameters and functions used to describe the hydraulic, hydrologic, geotechnical, and economic aspects of a project plan.

**USGS DEM:** The U.S. Geological Survey (USGS) publishes the file format USGS DEM (Digital Elevation Map). A raster file format, DEM files usually contain terrain elevations, but the file format can be used for representing any surface. The format, published by the USGS, allows internal documentation of coordinate system, date of publication, etc. These values are referenced horizontally either to a Universal Transverse Mercator (UTM) projection or to a geographic coordinate system.

**USGS Digital Line Graph:** USGS Digital Line Graphs (DLG) are created from two sources using manual and automated digitizing methods. The two sources are aerial photographs or cartographic sources. DLG files are vector representations of the data. When the HEC-WAT interacts with a *dlg* file it automatically creates a *dlgbin* file for use.

**Vertex Point:** A point with known coordinates on a stream element in the stream alignment.

**View:** A menu that allows the user to setup the HEC-WAT main window; the user can select toolbars and panes; set display unit for plotting and tabulating; and manage layouts for the HEC-WAT main window.

**WAT:** Watershed Analysis Tool, *see HEC-WAT*.

**Watershed:** The total area of land that drains to a common stream system.

**Window:** A menu where the user can control the appearance of the map windows in the **Desktop Pane** of the HEC-WAT main window.

**With Project Conditions:** The economic, performance, and other conditions associated with implementing a flood damage reduction plan. It is compared to the without-project condition. It includes the base-year and static future analysis year periods to determine the equivalent values.

**Without Project Conditions:** Base alternative in HEC-WAT for evaluating the benefits and performance of potential flood damage reduction plans and represents the conditions of the study if no actions are taken. The without project conditions includes the base year conditions and the most likely future year conditions.

**Zoom Tool:** Tool that allows zooming in and out of map windows.

# Appendix P

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