

Technical Documentation Version 8.0

User Interface



Center for Advanced Decision Support for
Water and Environmental Systems (CADSWES)
UNIVERSITY OF COLORADO **BOULDER**

These documents are copyrighted by the Regents of the University of Colorado. No part of this document may be reproduced, stored in a retrieval system, or transmitted in any form or by any means electronic, mechanical, recording or otherwise without the prior written consent of The University of Colorado. All rights are reserved by The University of Colorado.

The University of Colorado makes no warranty of any kind with respect to the completeness or accuracy of this document. The University of Colorado may make improvements and/or changes in the product(s) and/or programs described within this document at any time and without notice.

Contents

1. Workspace 1

General Workspace Features 1
- Workspace Display Mode 2
  - Full Mode 3
  - Compact Mode 4
- Icon Colors 4
- Send Workspace to Back 5
- Font and Text Size 6
- Toolbar and Workspace Buttons 6
- Object Viewer Button 7
- RPL Set Buttons 7
- Right-click Context Menu 8
- Lock Icon Position Controls 9
- Show Commas in Numbers 9
- Add Text or Add Image 9
- Output Canvas Items and Animation Controls 10
- Slot Cache 11
- Clearing the Workspace 11

Model Navigation 11
- Zooming on the Workspace 11
- Locator View 12
- In-view Locator 13
- Scrolling 14
- Simulation Object List 14
- Initial Workspace Appearance 16
- Workspace Cursor Modes 19
  - Selection Mode 19
  - Pan Mode 19
- Closing All Dialogs 19

Canvas or Workspace Views 20
- Simulation View 21
  - Canvas Properties 21
  - Background Image 21
- Accounting View 23
- Geospatial View 24
  - Introduction to GIS Concepts 24
  - Object Coordinates 25
  - Getting Started With the Geospatial View 28
  - Geospatial Canvas Configuration Dialog 34

Objects on the Workspace 41

Object Palette 41
Opening an Object 42
Selecting Objects 43
Deleting Objects From the Workspace 43
Moving Objects on the Workspace 43
Enabling and Disabling Dispatching 43
Object Clusters 44
Creating a Cluster 46
Operations on a Cluster 46
Opening a Cluster 47
Importing and Exporting Objects 48
Export 48
Import 49
Export and Import Tips 50
Links on the Workspace 51
Display Groups 51
Link Groups 52
Selecting Links 55
Predefined Link Groups 55
Supply Groups 55
Account Groups 56
Object Groups 57
Exporting and Printing Model Images 57
Exporting Model Images 58
Printing Model Images 58
2. Model File Management 59
Loading Models 59
Opening Models With the File Chooser 59
Reloading Models 60
Saving Models 61
Saving Output Values 62
Saving Output Options 62
Precision for Outputs 62
Naming Conventions 63
Compressing Model Files 63
Backup Files Created When Saving Manually 63
Automatic Backup Save 64
Automatic Backup Save Interval 65
Automatic Backup Save Directory 65
Open Automatic Backup Save Model Menu Item 65
Backup File Name 66
Model History and Comments 66
Last Save 66
Run History 66
Comments 67

Locking Models **68**
Model Comparison Tool **68**
Model Comparison Use Case 68
Accessing the Model Comparison Tool 69
Selecting Models to Compare 70
Tour of the Model Comparison Tool 78
Models Panel 78
Comparison Results Panel 79
Search and Filter Tools 80
Selected Property 81
Plots 82
How the Model Comparison Tool Works 82
RiverWare Packages **83**
Saving a Package 84
Opening a Package 86

3. Units **89**

Standard Units **89**
Display Units **90**
Unit Schemes **91**
Frequently Asked Questions (FAQs) 92
Working With Unit Schemes 94
Creating and Deleting 94
Activating 95
Sharing Schemes Using Import and Export 95
Defining a Scheme 95
Editing Attributes 95
Creating Exceptions 96
Updating Old Models With the Transitional Scheme 98
Changing Display Units on Slot Values 98
Repairing Incorrect Units of Slot Values 99
Unit-specific Calculations **99**
Exponentiation 99
Time Units 100
Unit-dependent Calculations 100
Unit Converter Dialog **101**
Converting Numeric Values 101
Converting DateTime Values to Numeric Values 102

4. Object Dialogs **105**

Object Viewer and Open Object Dialogs **105**
Opening the Object Viewer 105
Arranging Tabs 107
Undocking Objects 107
Redocking Objects 108

Closing an Object 108
Closing the Viewer 108
Using Object Dialogs 109
Naming an Object 109
Slots Tab 110
Slots Tab Tour 110
Sorting Slots 112
Filtering Slots 113
Creating Custom Slots 114
Slot Groups 116
Copy and Paste Slots 119
Copy Slots to Objects 120
Move Slots to Object 122
Methods Tab 123
Selecting Methods 124
Memory Allocation for Method-specific Slots 124
Method Dependencies 125
Selecting Methods on Multiple Objects 125
Accounts Tab 125
Accounting Methods Tab 125
Attributes Tab 126
Description Tab 126
Aggregate Objects 127
AggObject Dialogs 127
Viewing Element Slots and Methods 128
Object Attributes 128
Object Attributes Manager 129
Define Attributes and Values 129
Import and Export Attributes and Values 131
Edit Attributes on Objects 131
Accessing Attributes from RPL 133
Multiple Object Method Selector 133
Usage Overview 133
Accessing the Dialog 134
Dialog Overview 135
Object List 135
Adding Objects 135
Removing Objects 136
Filtering Objects 136
Selecting Objects 136
Selecting a Method Category 137
Determining Which Objects Have a Category Activated 137
Determining the Currently Active Method 138
Selecting a New Method 138
Confirming Changes 138
Selecting Object Level Accounting Methods (OLAMs) 139

Setting the Execution Time of OLAMs 141
Special Support for Copy Slot to Slot Inflow: Set Target Account List Slot 142

5. Slots 145

Simulation and Custom Slots 145

Slot Dialogs 146

Opening a Slot 146
Sample Slot Dialogs 146
Slot Dialog Functionality 147
Closing a Slot 149
Slot Descriptions 149
Searching Slot Descriptions 151
Creating and Configuring Slots 152
Configure Slot Dialog 153

Menus on the Slot Dialog 155

File Menu 155
Edit Menu 155
Row Menu 159
Column Menu 160
View Menu 161
Adjust Menu 163

Types of Slots 163

Series Slots 166
Slot Dialog and Slot Viewer 166
Slot Viewer Functionality 168
Series Slot Dialog Functionality 170
Configure Slot Dialog Functionality 175
Series Display Compression 180
Flags on the Timestep I/O Menu 184
Finding Inputs 192
Series Slots With Expression 193
Configuration 194
Building Expressions 199
Diagnostics for Expression Slots 199
Text Series Slots 200
Agg Series Slots 201
Configuration 202
Other Options 202
Integer-indexed Series and Agg Series Slots 203
Series Slots With Periodic Input 203
Slot Creation 205
Slot Configuration 205
Multi Slots 206
Table Slots 207
Configuration 207
Source Slots 209

Statistical Table Slots 209
Creating a Statistical Table Slot 209
Configuring a Statistical Table Slot 210
Evaluating a Statistical Table Slot 211
Analyzing a Statistical Table Slot 212
Plotting a Statistical Table Slot 212
Statistical Functions 214
Table Series Slot 224
Periodic Slots 225
Configuration Options 225
Display of Dates 226
Headers 228
Referencing Periodic Slots in RPL 229
Scalar Slots 230
Scalar Slots With Expression 231
Mass Balance Summary Slots 232
Creating a Mass Balance Summary Slot 234
Configuring a Mass Balance Summary Slot 234
Display Operations 240
Other Display Operations 243
Dependent RPL Expression Slot Support 247
Computation 249
Persistence 250
Time Aggregation Series Slots 250
Configuration Settings 253
Creating Similar Time Aggregation Series Slots for Different Objects 255
Time Disaggregation Series Slots 256
Configuration Settings 258
Creating Similar Time Disaggregation Series Slots for Different Objects 259
List Slots 259
Global Slot Configuration 260
Selecting Slots to Configure 261
Global Slot Configuration Options 262
General 262
Optimization 262
Applying Global Slot Changes 263
Global Slot Configuration Example 264
DateTime Values in Slots 265
Adding a Slot with DateTime Values 265
Partial DateTime Editor 269
Access to DateTime Values Using RPL 271
Conversion of DateTimes to Numeric Values 271
Notes on Series Slots 272
Notes Overview 272
Notes 272
Note Groups 273

Displaying and Editing Notes 273
Creating Notes 275
Note Group Manager Dialog 276
Note Groups Panel 277
Notes Panel 278
Slots Panel 278
Apply Note to Slots Dialog 279
Collected Notes on Expression Slots 280
Accounting Multi Slot Notes 282
Importing and Exporting Notes Using Text Files 284
Exporting Notes Using DMIs 284
Finding Slot References 284
Find Slot References Dialog 285
Selecting Slots to Search 286
Selecting Areas to Search 287
Deleting Slots 288
Slot Sets 288
Slot Set Manager 288
Static Slot Sets 290
Dynamic Slot Sets 291
Referencing Slot Sets 292
Using Slot Sets When Selecting Slots 292
Using Slot Sets in RPL and DMIs 293

6. Run Control 295

Controllers 295
Controller-specific Parameters 296
Simulation Run Parameters 296
Rulebased Simulation Run Parameters 297
Accounting 299
Timestep 299
Run Times 300
Making a Run 301
Aborted Run 303
Synchronization 303
Synchronize From Run Control 303
Synchronization Control Dialog 306

7. Selector Dialogs 307

Selector Features 307
Displaying Items and Filtering 308
Making a Selection 308
Selecting Objects 309
Show Object Types in an Option Menu 310
All Objects and No Objects 311

Selecting Slots 311
Creating a Selection 312
Use Slot Set 316
Selecting Accounts 317
Selecting Slots on Accounts 318
Selecting Supplies 319
Wildcards 321
Examples 321
Finding Slots in a Model 321
Adding Objects to a Subbasin 322
Creating a Name Map of All Reservoir.Inflow Slots 323

8. System Control Table (SCT) 325

SCT Tabs 325
Data in the SCT 326
SCT Overview 327
SCT Menu Bar 327
File Menu 328
Edit Menu 329
Slots Menu 330
Aggregation Menu 331
View Menu 332
Config Menu 333
DMI Menu 334
Run Menu 334
Scripts Menu 334
Diagnostic Menu 335
Status Area 336
Go To Menu 337
SCT Configuration Settings 337
General Tab 338
Horizontal Time Tab 339
Vertical Time Tab 340
User-configurable Fonts 341
Toolbar Tab 342
Summary Tab 343
Flags Tab 344
Custom Cell Colors 344
Color Tab 346
Series Slots Tab 346
Slots and Slot Dividers 347
Slots 347
Dividers 348
Slot Names and Slot Labels 349
Numeric Values 350

Alt Units Toggle 350
Custom Cell Colors 351
Notes on Series 352
Timesteps 353
Timestep Aggregation 354
Detail Cells and (Aggregation) Summary Cells 355
Summary Functions 355
Custom Aggregation Rows 356
Slot Reference Rows 357
Custom Summary Row Behavior 357
Hiding Row Values 358
Axis Orientation 358
Vertical Timestep Axis Orientation 359
Horizontal Timestep Axis Orientation 360
Copy and Paste 360
Copy and Paste 360
Copy and Paste as Input 361
Export Copy and Import Paste 361
Integer Indexed SCTs 361
Edit Series Slot List Tab 363
Adding, Deleting, and Moving Slots 364
Adding Slots and Dividers 366
Organize Slots 367
Create Similar Groups Operation 368
Edit Multiple Slot Labels 370
Configure Color Alerts 371
Copying thresholds to other slots 373
Scalar and Other Slots Tabs: Slot Lists 373
Sorting and Reordering Slots 374
Compress Columns Checkbox 375
Scalar Slots tab 376
Other Slots Tab 378
Object Grid Tab 379
Object Grid Configuration 380
Row and Column Configuration 380
Cell Object Configuration 381
Cell Slot List Configuration 381
Cell Operations 383
Cell Context Menu 384
Display Settings 385
How To Configure the SCT 386
Lock or Unlock the SCT Configuration 386
Add Slots, Sheet Tabs, and Slot Dividers 387
Remove Slots and Slot Dividers 389
Move Slots and Slot Dividers 389
Create a new SCT from a Series Sheet tab 390

Change a Slot's Summary Function 390
Show or Hide (Aggregation) Summaries 392
Show or Hide Details 393
Configure Row and Column Headers 394
Adjust Column Widths 394
Change SCT Flag and Other Colors 395
Apply Custom Colors to Slot/Timestep Cells 395
Apply Color Alerts Based on Slot Values 397
Change Ornamentations 397
Change the Aggregation Interval 398
Ornamentation of Hidden Pre- and Post-Run Timesteps 399
Use the Default Configuration 399

How To Manipulate Data to Model Operations 399
Set a Single Value 400
Set Multiple Values 400
Set Slot Value over Time Range 400
Interpolation 401
Adjust Values 402
Clear Values 402
Set a Flag 403
Set a Target Operation 404
Copy a Single Value to One or Many Timesteps 404
Copy Multiple Values 405
Copy a Timeslice Across All Slots 406
Copy a Whole Slot 407
Copy/Paste Data to/from the Clipboard (e.g., to Excel). 408
Copy Data 408
Paste Data 409

How To Print, Plot, and Export Data 409
Printing 409
Plotting 410
Exporting Data 410

9. Subbasins 411

Subbasin Manager 411
Creating New Subbasins 412
Adding and Removing Subbasin Members 413
Viewing an Object's Subbasin Memberships 413
Selecting Objects Belonging to a Subbasin 414
Computational Subbasin 415

Chapter 1
Workspace

The Workspace is the main RiverWare window and the main interface used to view, run, and investigate the model.

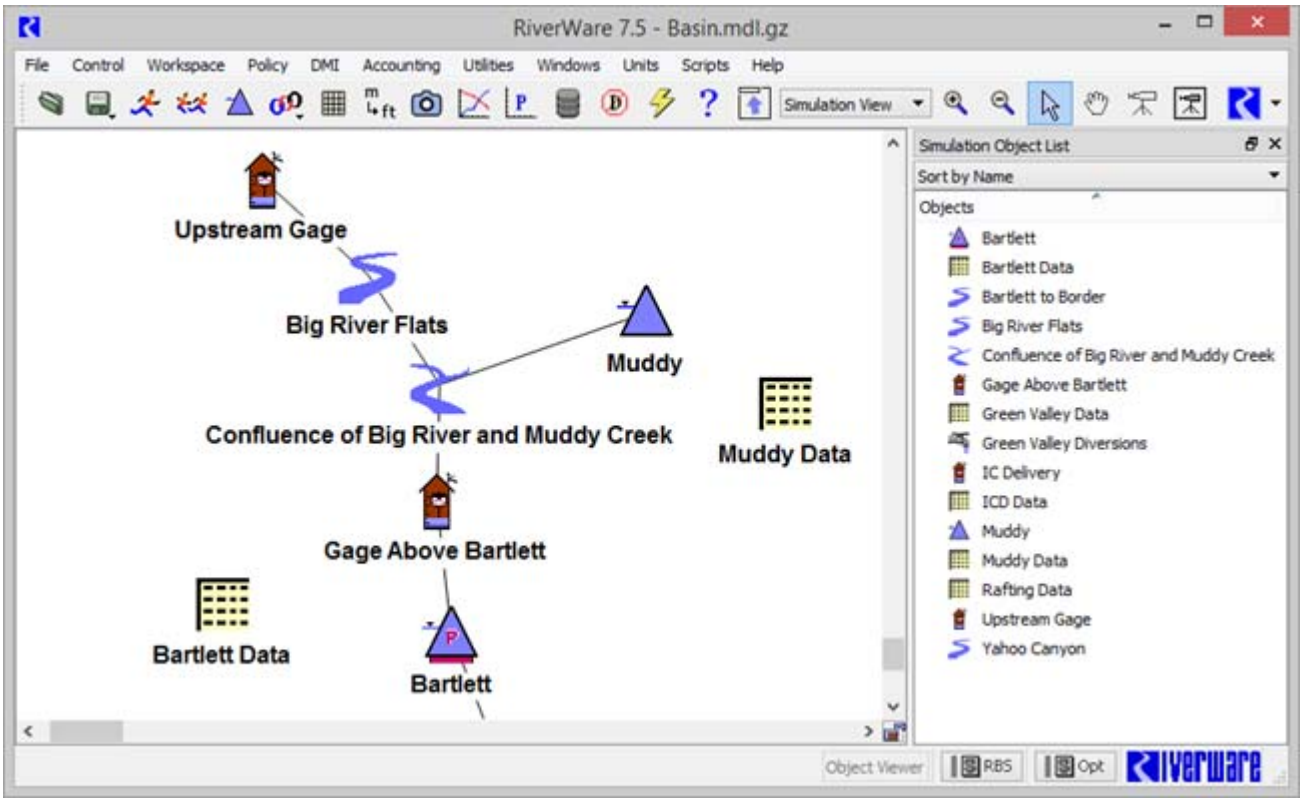
Topics

- General Workspace Features, page 1
- Model Navigation, page 11
- Canvas or Workspace Views, page 20
- Objects on the Workspace, page 41
- Links on the Workspace, page 51
- Display Groups, page 51
- Exporting and Printing Model Images, page 57

General Workspace Features

The workspace features a main menu bar in which the various functions of RiverWare are organized into menus. The workspace also contains a dockable toolbar featuring shortcut buttons to some key RiverWare operations and utilities. There is also a dockable object listview window of all the objects on the workspace. A screenshot of the workspace is shown in Figure 1.1.

Figure 1.1 Screenshot of a Sample Workspace



Workspace Display Mode

The workspace supports two modes

1. Full mode shows everything, including the canvas view, toolbar buttons, docked windows, title bar, menus, and status bar.
2. Compact mode shows only the title bar, menus, toolbar (if enabled), and status bar.

Typically, Full mode is used when building a model or investigating objects on the workspace. Compact mode is used when you don't need to see the canvas views and you want to use the toolbar buttons and menus to run a script, execute a run or look at outputs. In this approach, some users will open RiverWare, detach the Object List and then switch to Compact mode to provide a more efficient use of screen space.

To switch between the two modes:

- Use the Windows, and then **Toggle Workspace Display Mode** menu
- Use the keyboard shortcut Ctrl+T
- Click on the toolbar buttons shown in Figure 1.2

Figure 1.2 Screenshot of Toggle Workspace Display Mode toolbar buttons



The following sections describe each mode.

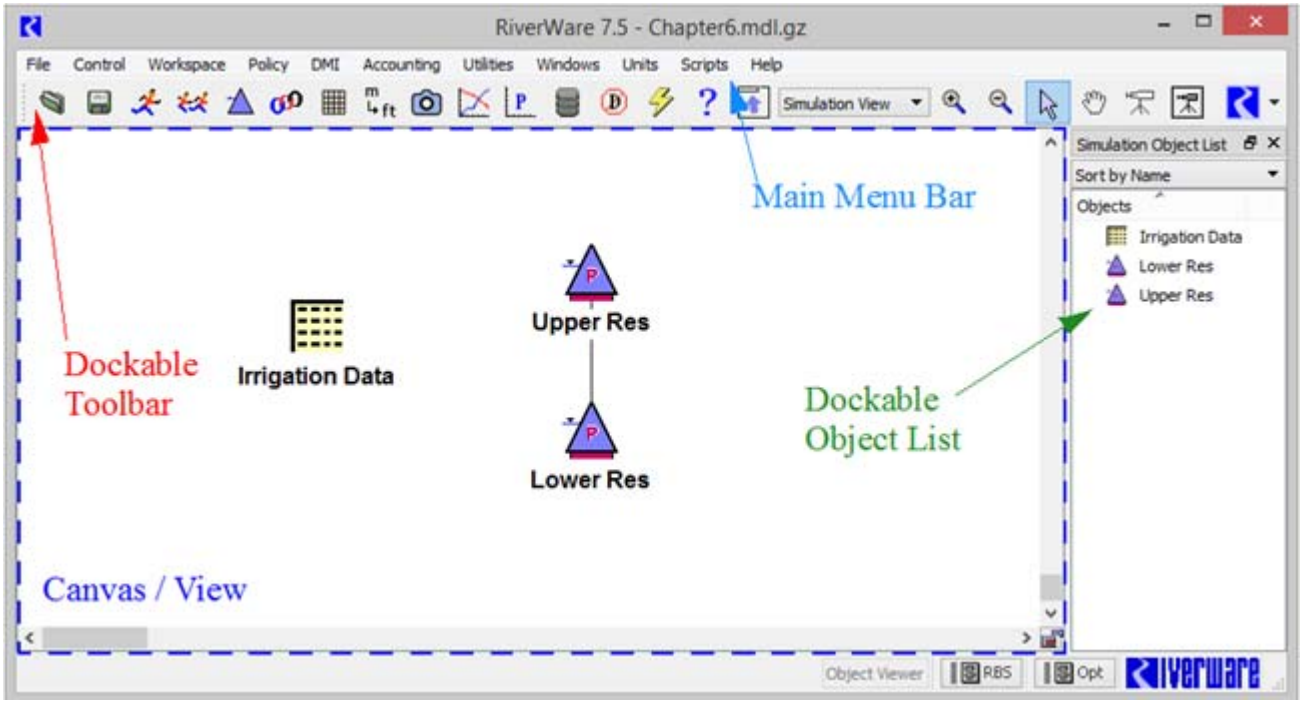
Full Mode

When the canvas is shown if Full mode, the canvas views are shown along with the menus, toolbar, dockable windows, and status bar. This is the default and primary view of the simulation space where models are built and modified. In the workspace, a model is graphically represented as a network of objects with links connecting the objects. The workspace allows for exploration of the model through the following viewing options:

- A zooming interface including toolbar buttons like, zoom, pan, and the locator views.
- Tooltips providing information about objects and links.
- Scrolling bars to pan across the model. The scroll bars can be used to view different regions of the workspace. The default locations of the scroll bars are the lower corners of the workspace.
- The ability to select multiple objects by selecting a region of the workspace or to select single objects.
- A dockable window displaying a list of all objects on the workspace.The dockable windows can be moved to new positions on the workspace or completely detached from the workspace by selecting the raised grey lines (the handle) of the window and dragging it to a new position. If you undock and/or close the toolbar or object list, you can reshow them using the **Windows,** then **Show Simulation Object List, Show Toolbar,** or **Show Animation Controls** menus.
- The ability to resize the workspace to display a larger or smaller region of the canvas/view.

Figure 1.3 shows a view of the workspace in Full mode.

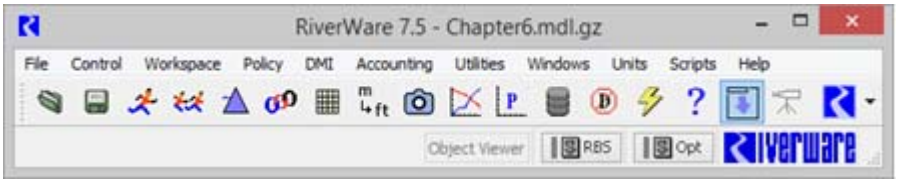
Figure 1.3 Screenshot of the workspace in Full mode



Compact Mode

"Compact" display mode shows only the title bar, menus, toolbar (if enabled), and status bar. In other words, the Compact display mode hides the canvas/views, Simulation Object List (if shown and docked within the workspace), and Animation controls (if shown and docked within the workspace). Figure 1.4 shows a view of the workspace in Compact mode.

Figure 1.4 Screenshot of the workspace in Compact mode

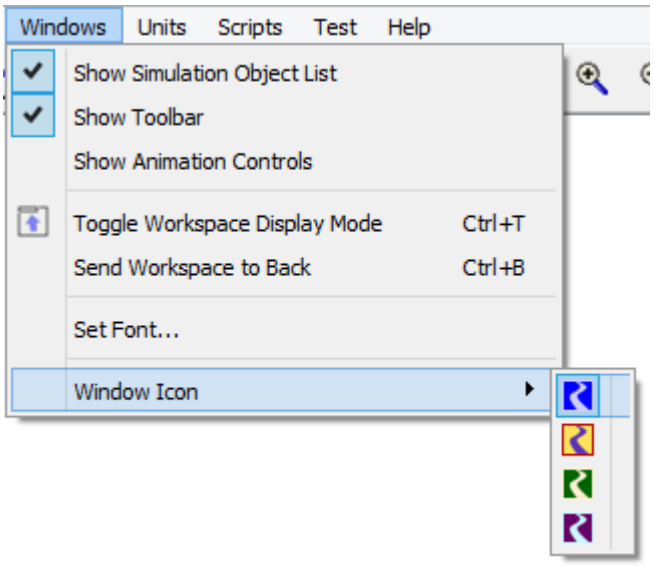


Icon Colors

You can select the icon that is shown at the left of the title bar on all windows associated with the RiverWare session. The ability to control the color of the RiverWare icon is particularly useful when you are comparing two models in two separate sessions of RiverWare. There are two ways to change the icon:

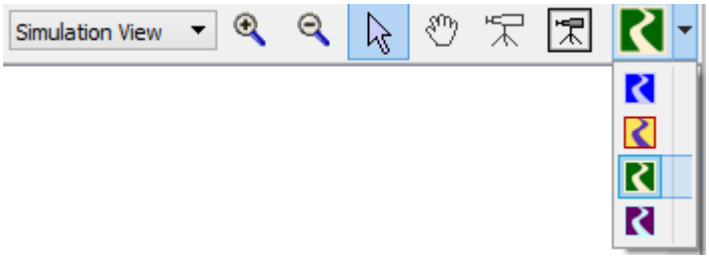
- Use the **Windows**, then **Window Icon** menu to select from the four options as shown in Figure 1.5

Figure 1.5 Windows menu showing Window Icon choices



- Click on the icon on the right of the tool bar and choose from the four options.

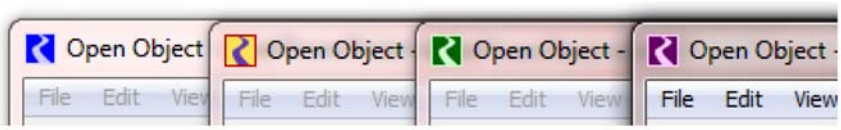
Figure 1.6 Toolbar icon showing window icon choices.



Then all windows and the task bar will use the selected icon. The selected icon color is saved in the model file.

Figure 1.5, Figure 1.6 and Figure 1.7 show the available icons.

Figure 1.7 Screenshot showing the four windows icon choices



Send Workspace to Back

Sometimes the workspace can obscure other dialogs that you may wish to see. When this happens, you can use the **Send Workspace to Back** operation to force the Workspace window to be displayed behind any other overlapping window. The action is available in the following ways:

- Use the menu **Windows**, and then **Send Workspace to Back**

- Use the keyboard shortcut: Ctrl+B

Font and Text Size

The font, size and style used for menus, lists and other text can be changed from the **Utilities,** then **Windows,** then **Set Font** menu. Following are limitations with this feature:

- The font setting is only changed during a single RiverWare session. It does not persist between sessions; this may be changed in the future.
- The font setting does not affect the following:
  - Workspace canvas text (i.e. object names). Canvas fonts can be changed from the workspace canvas properties; see "Canvas Properties" on page 21 for details.
  - Existing SCTs. Fonts on the SCT can be changed in the SCT **Configuration** menu; see "User-configurable Fonts" on page 341 for details. New SCTs will inherent the font specified for the windows/dialogs.
  - RiverWare Policy Language expressions. Fonts for RPL expressions can be configured from the RPL Layout Editor; see "Colors" in *RiverWare Policy Language (RPL)* for details.
- Various fonts seem to work well in RiverWare if they are reasonably sized but some dialogs don't display extreme-sized fonts.

Toolbar and Workspace Buttons

The toolbar in RiverWare is dockable, meaning it can be moved from one side of the workspace to the other or exist as an independent dialog. Table 1.1 summarizes the Workspace buttons.

Table 1.1

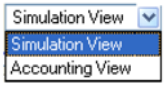
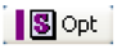
Icon	Action	Icon	Action
	Load a model		Open the Model Run Analysis tool
	Save a model - The button opens a model that gives you a choice to either Save or Save As.		Close Dialogs
	Open the Run Control Dialog		Open the Help file
	Open the Multiple Run Control Dialog		Toggle between Compact and Full Workspace display mode
	Open the Object Palette		Switch between the Simulation View, Geospatial View and the Accounting View (if Accounting is enabled)

Table 1.1 (Continued)

Icon	Action	Icon	Action
	Open the Smart Linker or Edit Links dialog		Zoom in
	Load a SCT		Zoom out
	Open the Unit Converter		Selection Mode
	Open the Snapshot Manager		Pan Mode. Use the middle mouse button to temporarily enter pan model from Selection Mode.
	Open the Output Manager		In-view Locator Mode
	Open an empty plot dialog		Show Locator Window
	Show the Object Viewer, if populated		Show the loaded RBS ruleset
	Open the DMI manager		Show the loaded optimization goal set;

Object Viewer Button

The Object Viewer button allows for quick access to the Object Viewer with previously opened objects. It is disabled if there are no objects shown in the viewer. See "Object Viewer and Open Object Dialogs" on page 105 for details.

RPL Set Buttons

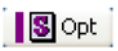
The workspace has buttons on the bottom of the dialog to show the loaded RBS ruleset  or optimization goal set . The bar is colored (red for RBS, purple for Opt) when there is a loaded set, grey when there isn't. In Figure 1.8, there is a loaded RBS ruleset, but no loaded Opt goal set. Select one of the buttons (when loaded) to raise the loaded set to the top.

Figure 1.8



Also shown are color-coded icons for the following:

- Ruleset, goal set, or global function set opened from a file
- Embedded sets (OLAM, expression slots, Init rules, Iterative MRM) that contain at least one group



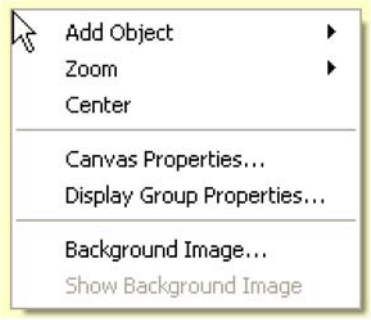
Hover over any icon for a tooltip indicating the location or click to open that set. Also, the sets are still available through the **Policy** menu. See "About RPL Sets" in *RiverWare Policy Language (RPL)* for the color code for sets.

Right-click Context Menu

The Simulation Workspace right-click context menu (when not selecting a simulation object icon) has the following options.

- **Add Object.** Add an object
- **Zoom.** Choose the desired zoom level
- **Center.** Centers the visible Workspace area on the clicked point.
- **Canvas Properties;** Canvas Properties, page 21
- **Display Group Properties;** Display Groups, page 51
- **Add Text.** Add text to the workspace; Add Text or Add Image, page 9.
- **Add Image.** Add an Image to the workspace; Add Text or Add Image, page 9.
- **Background Image. B**rings up a new Background Image Configuration dialog; Background Image, page 21
- **Show Background Image** (a checkbox). Either shows or hides the configured background image. This item is enabled only if a background image is configured. This checkbox state is also represented as a checkbox in the Background Image Configuration dialog; Background Image, page 21

- **Object Coordinates** (Geospatial view only). Shows the geospatial coordinates for the objects on the workspace.



Lock Icon Position Controls

The moving of Simulation Object icons on the Workspace can be disabled by locking icon positions as follows:

- Select the **Lock Icon** button in the corner between the two Workspace scrollbars.
- Select **Workspace**, then **Lock Object Positions**.



Show Commas in Numbers

RiverWare provides the option to show commas as a thousands separator in slot values (slot dialogs, SCT, accounts, and exchanges) and numeric values entered into a RPL expressions. Commas are shown by default but can be turned off by selecting the Workspace, then **Show Commas in Numbers** option. When the option is selected, all values will update automatically.

Add Text or Add Image

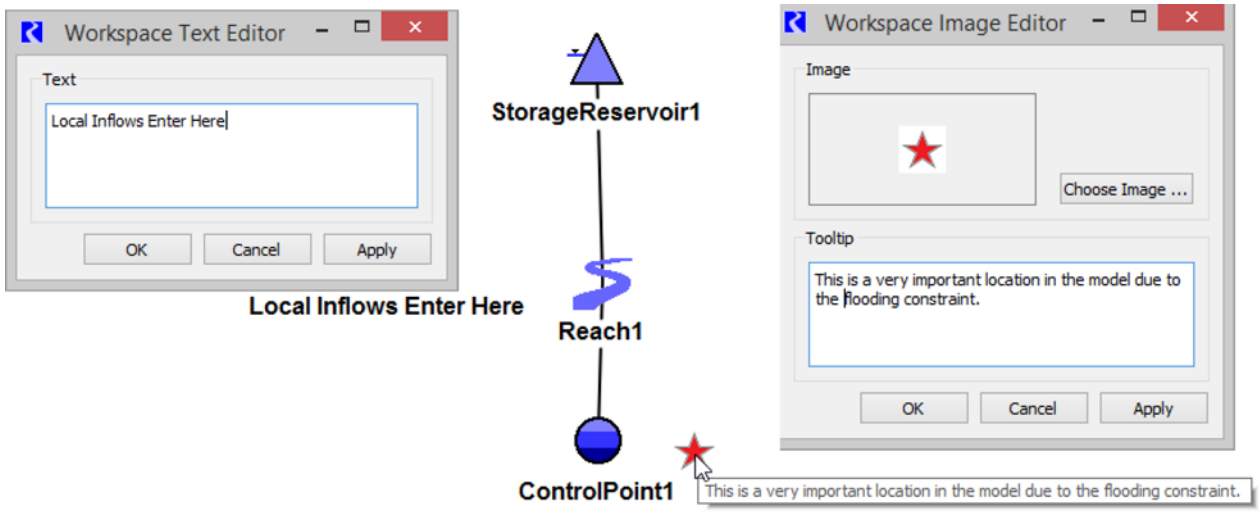
Often users find that they may wish to annotate their workspace with text or image files. To do so, use the right-click context menu and select **Add Text** or **Add Image**. This opens a dialog where you can specify the text or an image, respectively. The image on the left shows the text editor and the resulting text below it. Figure 1.9 shows the image editor with a small image shown. Also shown is the tooltip for the specified text. This is the text you see when you hover over the image.

> **Note:** Both text and images are not selectable on the workspace, but you can move them individually. Also, right-click the text/image to **Edit** and **Delete** or delete the item.

These are supported separately on the Simulation and Accounting views, but not the Geospatial view.

Images are saved in the model file and will increase the model file size. GIF, PNG, or JPG images are supported.

Figure 1.9



Output Canvas Items and Animation Controls

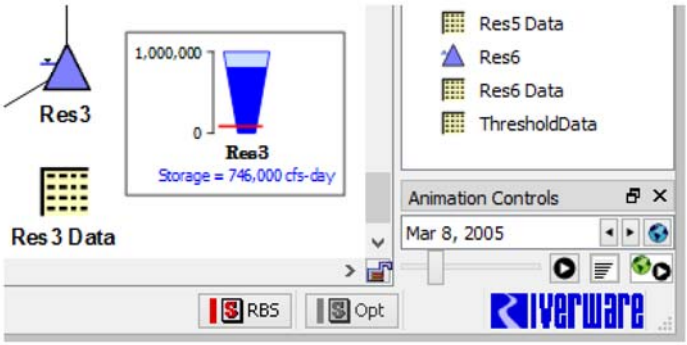
The Output Canvas allows you to create spatially distributed output visualization diagrams. You can show the following items from an Output Canvas directly on the Simulation and/or Geospatial Views. See "Showing Canvas Items on the Workspace" in *Output Utilities and Data Visualization* for details.

- Teacups
- Charts
- Text
- Flow lines
- Canvas lines

When items are shown on workspace views, an additional panel of Animation Controls is shown below the Simulation Object List, as shown in Figure 1.10. See "Animation" in *Output Utilities and Data Visualization* for details on the controls.

Like other dockable windows, this panel can be pulled off the workspace to its own dialog, docked on the left side of the workspace or closed. To redisplay the panel, use the **Utilities,** then **Windows,** then **Show Animation Controls** menu.

Figure 1.10



Slot Cache

The Slot Cache provides a temporary copy of series slot values. The cache is created from the Workspace, then **Create Slot Cache m**enu. Within the run range, all visible series slots (except those on Data Objects that are not optimization variables, exchanges, supplies, and those slots with different step size than the run) are copied to the cache when this menu is operated. These values can be accessed using RPL predefined functions SlotCacheValue and SlotCacheValueByCol. They are typically used during an optimization run for certain *Seed Method* parameters. The cache values are not saved in the model file.

Manually clear the Slot Cache using the **Workspace,** then **Clear Slot Cache** option.

> **Note:** The slot cache is under development. Contact `riverware-support@colorado.edu` for more information and the current status of this feature.

Clearing the Workspace

All objects can be cleared from the workspace by selecting **Workspace,** then **Clear Workspace**. A confirmation dialog appears warning that all objects on workspace will be removed. All rulesets will also be cleared and any unsaved changes will be lost.

Model Navigation

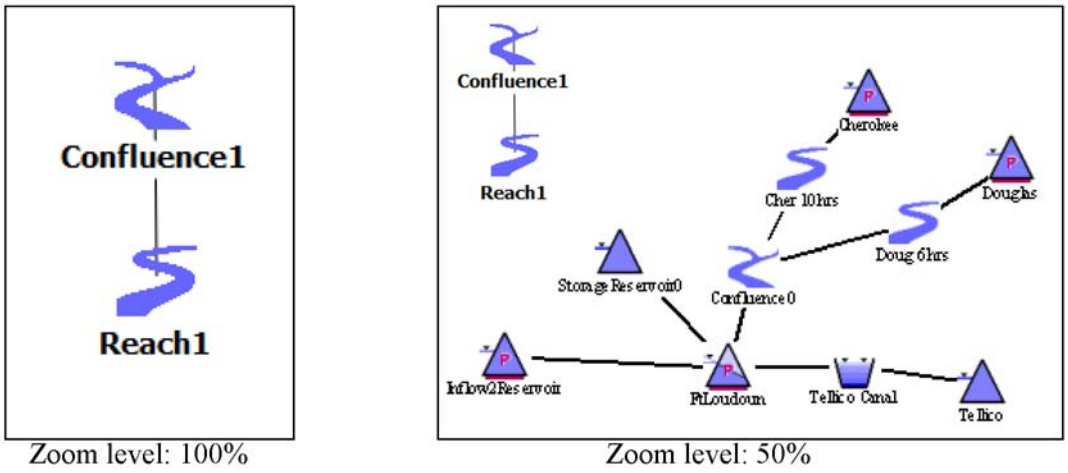
Large models can rarely be viewed in their entirety on the workspace, making it difficult to locate objects. There are, however, multiple ways of navigating through a model on the workspace or locating particular objects within a model. These methods are described in greater detail below.

Zooming on the Workspace

The zoom features can be accessed by selecting the **Zoom** buttons on the toolbar   or by right-clicking the workspace.

At 100% zoom level, object icons are shown in their natural size of 40x40 pixels. When zooming out, e.g. to 50%, to expose a broader area of the workspace, the object icons and labels are also zoomed out and their size is reduced. When zooming in beyond the 100%, icons, labels and links remain their natural size (100%) instead of becoming larger (or thicker links). This allows you to expose more detail of background images around closely clustered objects without showing large icons. This implementation of *smart zooming* affects only the Simulation and Geospatial views.

Figure 1.11



Locator View

An overview of a model can be accessed with the locator view. The locator view displays the entire workspace on a miniature scale. The locator view is accessed as follows:

- Select the **Locator** button from the workspace toolbar.



- Select **Workspace,** then **Open Locator** from the menu bar.

The rectangle represents the current displayed portion of the workspace. Dragging the rectangle to different regions of the model in the locator view will cause that region to be displayed on the workspace.

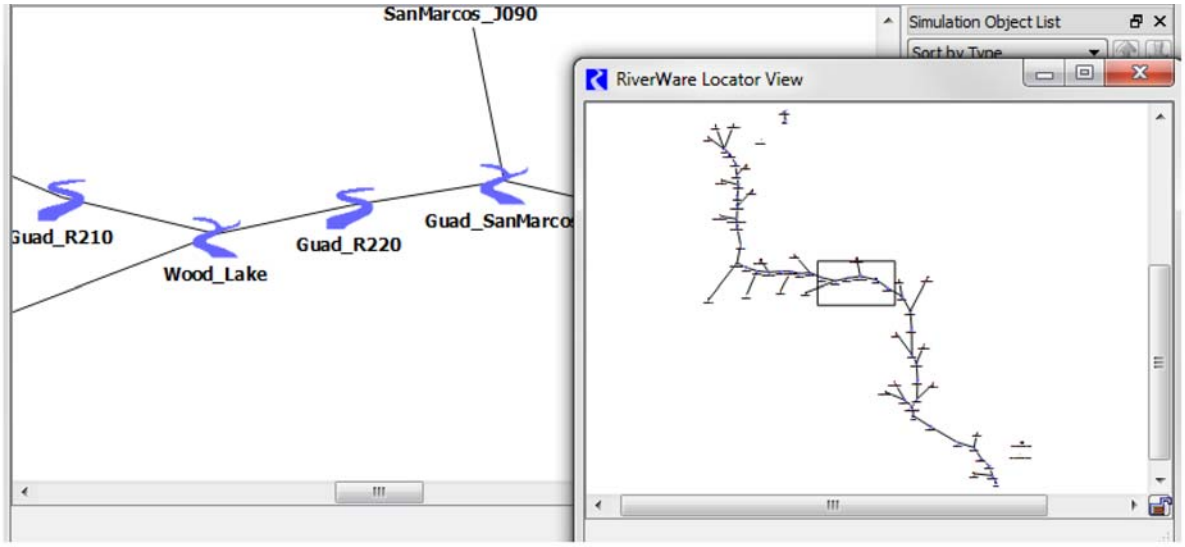
A status bar shows the name of the Simulation Object near the cursor. This functions even while dragging the inscribed rectangle.

The Locator View implements a Context Menu (right-click) with the following options:

- **Center**. Centers the inscribed rectangle at the clicked position. This is useful especially if the inscribed rectangle (representing the visible area of the workspace) is not visible within the Locator View—that would occur if the workspace is currently scrolled to an area which doesn't contain any Simulation Object icons.
- **Rescale**. Recomputes the Locator View scale, e.g. if Simulation Objects have been added to the Workspace.

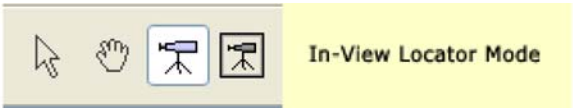
Note: There is a known limitation of the Locator Window. When the workspace view is zoomed in beyond 100%, object icons and their associated text labels, are unconditionally drawn at their normal size. This is unfortunately true also of those features, as they appear in the Locator Window and therefore look much larger then they should.

Figure 1.12



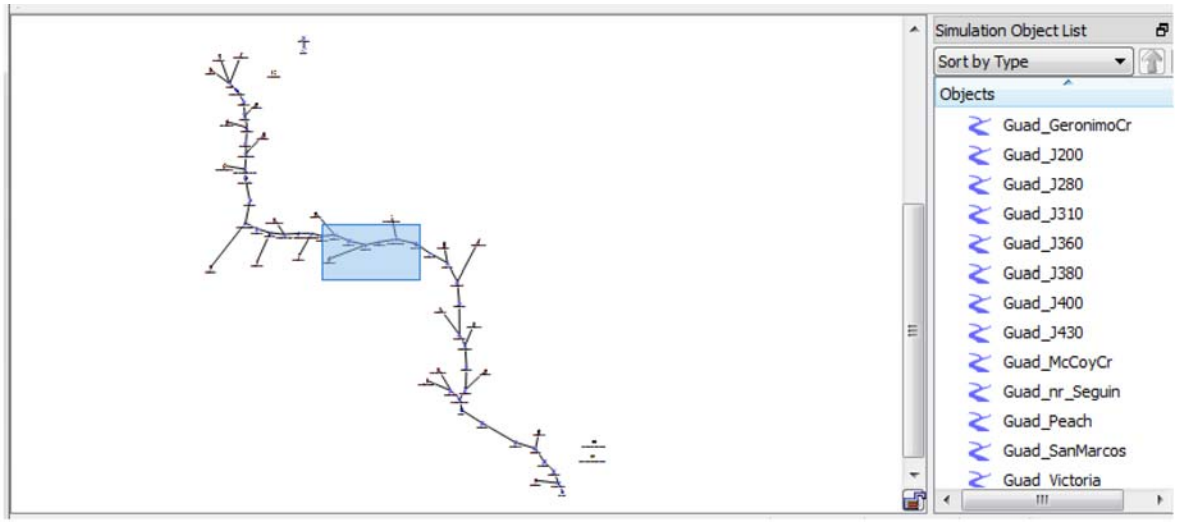
In-view Locator

In-view Locator Mode is an alternative to the separate Locator View.



Selecting this mode causes the workspace to temporarily rescale to show the scope of all of the simulation objects on the workspace. The rectangular region of the normally visible area (at the currently set zoom level) is shown as a shaded rectangle. Drag the shaded rectangle to a new area and upon releasing the button, the workspace is positioned at the new area at the previous zoom level. This allows you to quickly snap to a different area in your model.

Figure 1.13

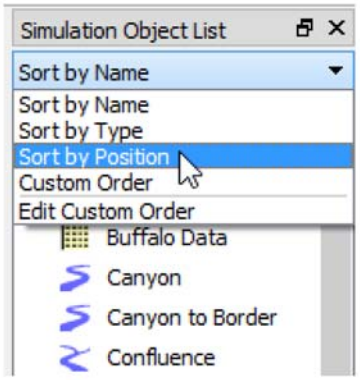


Scrolling

If a model is not particularly large or is familiar, it is possible to move to the desired region of the model using the scroll bars. By default, the scroll bars are located in the lower corners of the workspace. Adjusting the scroll bars will pan the model to the desired location. Also, you can use the middle button to temporarily enter Pan Mode to pan through the workspace.

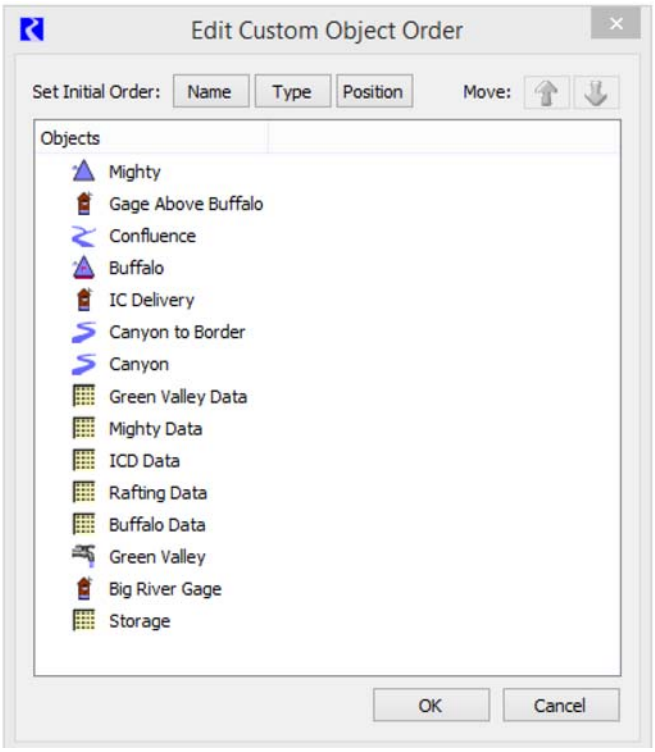
Simulation Object List

The dockable object list window provides the most comprehensive means of locating a specific object within a model. The object list window can be detached from the workspace and be positioned at a desired location. If you undock and/or close the object list, you can show it using the **Utilities,** then **Windows,** then **Show Simulation Object List** menu. Selecting the desired object in the listview window automatically selects the object on the workspace. Right-clicking an object allows you to open the object without scrolling the workspace.



Objects in the list window can be organized by Name, Type, Position or a Custom Order. Objects are further organized in ascending or descending order by selecting the column label.

The Custom Order is defined using the **Edit Custom Order** menu. The Edit Custom Object Order dialog is shown:

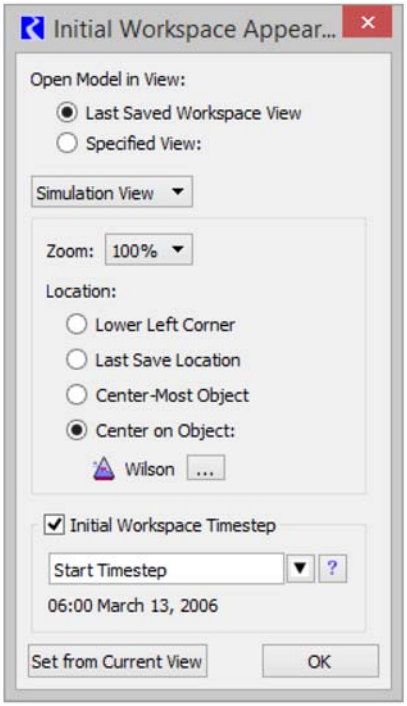


Set an initial order using the **Name**, **Type**, or **Position** buttons. Then select one or more objects by selecting an object and then using Shift or Ctrl key and selecting another object. Drag and drop or use the up and down arrow buttons to rearrange. When you click OK, this order is preserved as the custom order and is shown on the Object List.

> **Note:** This custom order can be used in the Model Run Analysis utility (see "Sorting" in *Debugging and Analysis* and Object Coordinate utility (see "Object Coordinates" on page 25). In those dialogs, choose the Custom from Workspace sort order.

Initial Workspace Appearance

You can configure the workspace appearance when the model is first opened in terms of the view, zoom, and scroll location. On the workspace, use the **Workspace**, then **Initial Appearance** menu. The Initial Workspace Appearance dialog opens.



First, choose one of the following:

- **Last Saved Workspace View** (default). The view at the time of the last model save is shown on model load.
- **Specified View**: Specify a particular view to show when the model is opened.

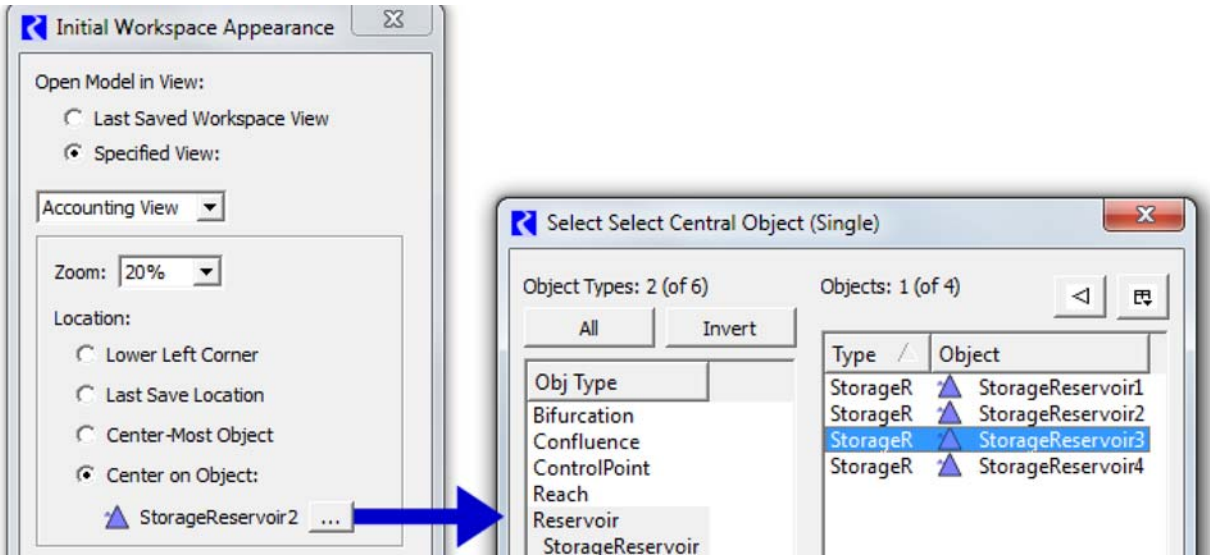
Then, for each of the three workspace views, **Simulation**, **Accounting** (when enabled), and **Geospatial**, specify the zoom level and scroll location to use. Each view maintains these setting separately. For the location, select between one of the following methods to specify where to scroll:

- **Lower Left Corner**. Initially scroll to the lower left corner.
- **Last Save Location**. Initially scroll to the workspace coordinates (center of the visible area) as last saved.

  Note: The size of the workspace window remains as is and is not affected by these options.
- **Center-Most Object.** Scroll to the center of the workspace objects, that is, the object which is closest to the average workspace view location of all object icons.
- **Center on Object.** Scroll so a specified object is at the center of the workspace. When this option is selected, use the button to bring up the object selector to specify the center object. Figure 1.14 illustrates.

  Note: When centering on an object, if the object is near one of the edges, the view is scrolled such that the object is visible, but not actually centered.

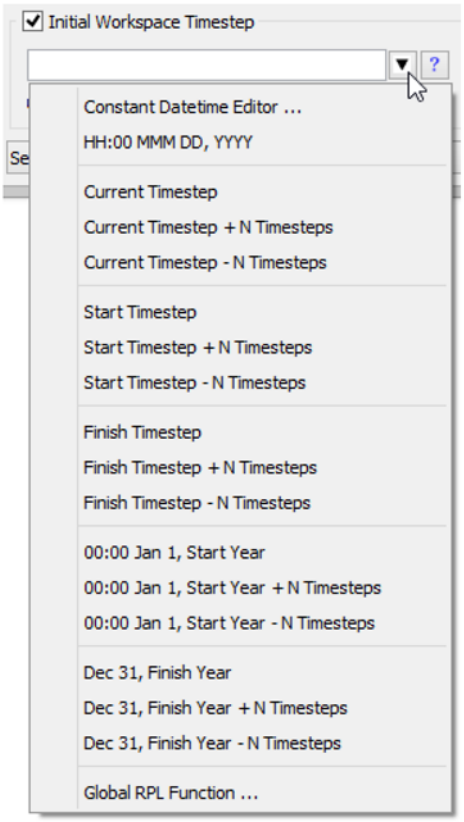
Figure 1.14



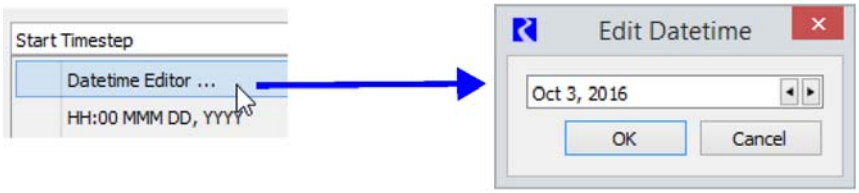
- **Initial Workspace Timestep**. The last option is the **Initial Workspace Timestep**. Define a constant or symbolic DateTime to which the model should scroll when first opened. When loading a model file containing this specification, the date is evaluated and all windows are Global Time Scrolled to that date.

The DateTime can be specified explicitly or symbolically as RPL DATETIMES; see "DATETIME" in *RiverWare Policy Language (RPL)* for details. Text below the editor field indicates the actual DateTime of the entered symbolic time text (if it is valid), or the status if it is not valid. You can also use the menu to specify one of the common DateTimes. Some of these are expressions which must be edited to become valid, e.g. by replacing "N"

with a nonnegative integer and the HH:00 MMM DD, YYYY formula, where you substitute the hour, month, day and year.



The **Datetime Editor** option opens a separate dialog to specify the DateTime using a selector configured for the model's timestep size.



The **Global RPL Function** option opens a Function Selector to select a RPL function in the Expression Slot or Global Function Set.

> **Note:** The selected function must have a return type of DATETIME, and must not have any arguments.

Select **Help** (question mark icon button) on the right side of the symbolic DateTime editor to show a description of symbolic DateTime representations.

- **Set from Current View**. Select the **Set from Current View** button to use the current workspace setting This has the following effects:
  - The **View Selection** combo box is set to the workspace current view.

– The **Zoom** box is set the current view's zoom level.

– The **Location** setting is set to Last Save Location.

Select the **OK** button to apply changes and close the dialog. Shift-click the **OK** button to apply the currently shown settings in this dialog to the workspace.

Workspace Cursor Modes

The Workspace has two cursor selection modes. These define the effect of clicking and dragging on the workspace.



Selection Mode

Selection Mode is used for selecting and repositioning Simulation Object icons on the workspace.

Multiple icons can be selected by dragging a rectangle over the icons (with the drag operation started *off* any icon). Selecting an icon while holding down the Control key toggles the icon in or out of the selected set.

A set of selected icons can be moved together by starting the icon drag *on* one of the selected icons. An icon move operation can be aborted by hitting the Esc (escape) key *before* releasing the button.

Pan Mode

Pan Mode allows the user to move or pan the workspace canvas within the visible workspace area.

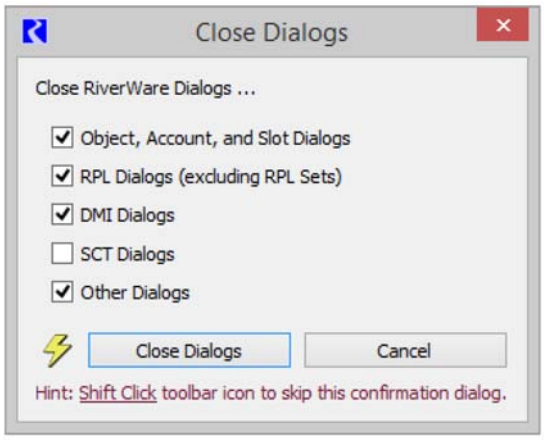
Use the middle mouse button to temporary enter Pan Mode from Selection Mode.

Closing All Dialogs

All opened dialogs can be closed at once using the Close Dialogs feature.  When this button is clicked, the Close Dialogs dialog opens. The dialog allows the user to select the types of dialogs that should be closed (all are selected by default) including the following:

- Object, Account, and Slots
- RPL Dialogs (the highest RPL Set editors do not close)
- DMI Dialogs
- SCT Dialogs

- Other Dialogs



Then the **Close Dialogs** button closes the selected types. This utility never closes the Workspace. In addition, the following types of dialogs are just minimized instead of being closed:

- RPL Set editors. Actually closing those dialogs would also remove the RPL Sets from the RiverWare session.
- SCTs not yet associated with (i.e. saved as) an SCT file.

As the text in the dialog shows, the user can also **Shift-Click** the  button and it will close all the dialogs without first seeing the Close Dialogs window.

> **Note:** This tool is particularly useful when the user has opened many slot, object, or account dialogs and they wish to close all of them. If the user cannot even find the workspace in order to do this action, there is a menu option on most of those dialogs to **File**, then **Show Workspace.** Once the workspace is shown, the lightning bolt can be used to close all the dialogs.

Canvas or Workspace Views

The canvas is the region within the workspace in which models are built and displayed. These canvas is shown when in Full mode, but not shown in Compact mode, as described in "Workspace Display Mode" on page 2.

There are three versions of the canvas which display different *Views* of the objects and connection. The Simulation View displays a schematic of the basin; objects are linked together to form a network. The Accounting View (when accounting is enabled) shows a similar schematic, but each object is displayed as a rectangle which contains all the accounts on that object. The third view, the Geospatial View, displays objects at their actual locations on a georeferenced background map. Because of the differences in how the network is displayed in each view, there are different configuration options for each canvas. The following sections describe each canvas and the configuration options.

> **Note:** Each canvas is configured separately. Although the configuration dialogs are the same for the Simulation and Accounting Views, their settings are not shared. Thus, you can configure each independently.

Simulation View

The Simulation View displays a schematic of the basin; objects are represented by icons and are linked together to form a network.

> **Note:** The Simulation View was the original view in RiverWare. As such, most of the screenshots in the RiverWare documentation reference this view when describing models.

Canvas Properties

The canvas properties dialog is accessed as follows:

- From the menu, select **Workspace,** then **Canvas Properties**.
- Right-click the workspace and select **Canvas Properties**.

This dialog allows you to change the following attributes of the canvas:

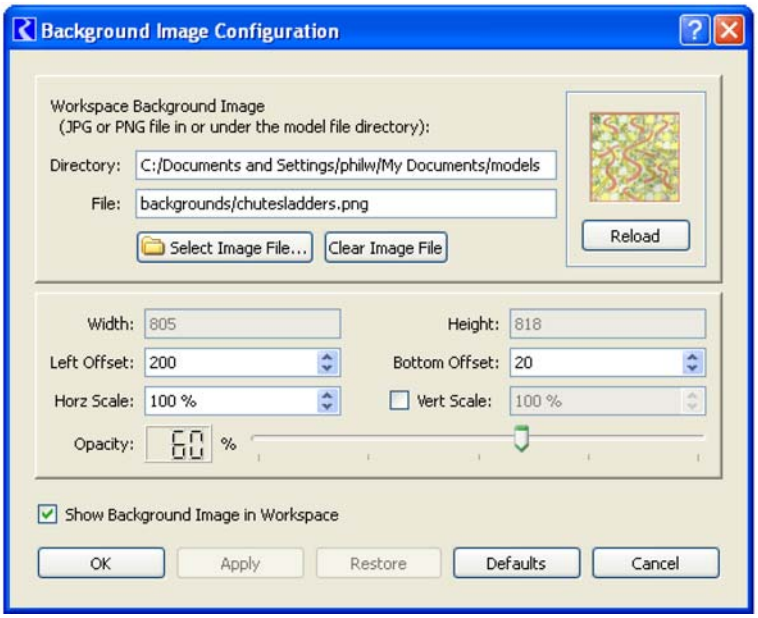
- **Canvas Width**. Number of pixels
- **Canvas Height**. Number of pixels
- **Set Background Color.** The selected color is saved in the model file.
- **Set Text Color**
- **Set Canvas Font** including the style and size

Background Image

The Simulation Workspace supports the ability to show an image loaded from an image file (JPEG or PNG) as the background. The utility is accessed by right-selecting the workspace and choosing **Background Image**.

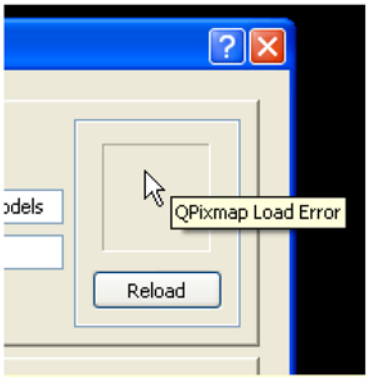
The path of the selected image is preserved in the model file (if the model file is saved after configuring the background image). When loading a model with a configured background image file, if the background image file

does not actually exist at the recorded path, the model loads without a problem, and the currently-invalid image file path is retained.



If the selected image file does not represent a valid, supported image file format, the thumbnail (small image preview) will be blank, and the Tooltip on the thumbnail will indicate an error. Figure 1.15 illustrates.

Figure 1.15



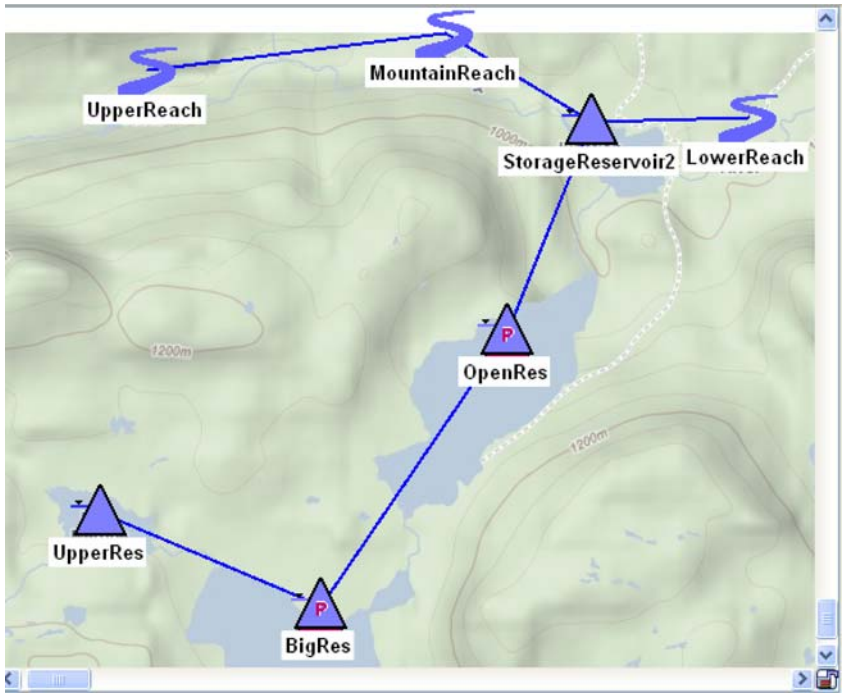
Configurable background image properties include the following:

- The image file path (to a JPG or PNG image file).
- The left offset of the image—number of pixels from the left side of the workspace.
- The bottom offset of the image—the number of pixels from the bottom of the workspace.
- The horizontal scale. (100% represents full image scale).
- An optionally independent vertical scale. (100% represents full image scale). If an independent vertical scale is not specified, the configured horizontal scale is used also for the vertical dimension.

- An opacity factor, as a percentage. Zero percent is completely transparent (invisible). 100% is complete opacity, which generally is too opaque unless the actual image is already *faded*.
- A toggle indicating whether the background image should actually be shown. This has the same state as the similar toggle in the workspace context menu.

A typical use of a background image is a map. This works well if you can reasonably position the icons at approximate positions and/or you do not have or wish to use geospatial coordinate data. But, georeferencing is available on the Geospatial View; see "Geospatial View" on page 24 for details.

Figure 1.16



Accounting View

If Accounting is enabled, the accounting network is displayed in the Accounting View, and can be selected by the option menu on the toolbar. The accounting view provides a representation of the physical objects, as well as the accounts on those objects where the network can be displayed without occluding or modifying the original physical network.

General configuration of the accounting view is identical to the Simulation View. See "Canvas Properties" on page 21 for details.

Note: The settings are independent, not shared.

See "Accounting Network" in *Accounting* for details on the Workspace Accounting View.

Geospatial View

The Geospatial View of the workspace provides a spatially coherent display of the modeled basin by associating a map projection and its Cartesian coordinate system with the view. Users locate objects and a background map image in this coordinate system, allowing RiverWare to display a schematic view of the modeled basin overlaid in registry with the map. That is, RiverWare objects are displayed at their location on the map. By providing an intuitive and information-rich view of a basin, the Geospatial view complements the Simulation and Accounting views of the workspace.

Following are key features of the Geospatial View.

- The Geospatial canvas has an associated map projection and location (rectangular extent) within the projection's coordinate system.
- A map image with a known location in the coordinate system can be displayed in the background layer of the view.
- Images can be georeferenced interactively or automatically via metadata contained within the image file or an accompanying world file.
- The background image (map) can be changed to another with the same projection without requiring any change to the spatial locations (geospatial view coordinates) of the objects.
- Objects are georeferenced (given spatial coordinates) and displayed at that location.
- A distinction is made between an object's *display* and *actual* spatial coordinates.
- Object coordinates can be shared between models and external GIS applications.
- Additional control over the schematic view is provided including sizing and labeling of the icons.
- The coordinates of the cursor in the map projection are continuously presented in the status bar. When available, geographic coordinates (lat/long) are displayed as well.

Introduction to GIS Concepts

Graphical information systems (GISs) support storage, analysis, and display of spatial data. This section introduces some basic GIS terminology and concepts which are relevant to the Geospatial View.

Locations on the spherical earth are most often represented as a pair of coordinates representing latitude and longitude. For some applications, a third coordinate representing an elevation relative to mean sea level is also used. To display a part of the curved surface of the earth on a flat surface necessarily requires a projection, and GIS systems typically represent flat display locations as Cartesian coordinates in a plane onto which the surface of the globe has been projected.

Several standards have been developed to provide agreed-upon coordinate systems for a given area. These standard coordinate systems define a set of map projections which together cover the target area. One common coordinate system which covers the globe is the Universal Transverse Mercator (UTM) coordinate system. This system defines a projection for the northern and southern areas of each of 60 longitudinal zones spanning the globe. For example, in the projection UTM Zone 11 North, the coordinates eastings = 397,800 m, northings = 4,922,900 m, corresponds to a location in central Oregon, USA.

Another standard coordinate system is the State Plane coordinate system which defines a set of projections for the United States. In this system, each state is divided into one or more zones, so a location is specified by a state, zone designation, and x, y coordinates.

> **Note:** A standard coordinate system defines a mathematical coordinate system corresponding to each projection of a set of projections; when these two uses of the term *coordinate system* would be confusing, we use the term to refer to the standard, and use the term *projection* or *map projection* for the component (mathematical) coordinate systems.

Coordinates, whether they be geographic (latitude and longitude) or correspond to a map projection, are specific to a datum. A datum is a reference surface and surveyed coordinates for a set of actual points and lines. Examples of common datums include the North American Datum of 1983 (NAD83) and the World Geodetic System of 1984 (WGS84).

The Geospatial View has a map projection associated with it, and everything displayed in that view (e.g., object icons, background image) needs to be displayed in that projection. Because RiverWare assumes that a single projection is shared between the Geospatial View, the object coordinates, and the map, RiverWare does not need to know the mathematical details of that projection. However, if these details are provided to RiverWare (typically by providing a background image which contains metadata describing the image's projection), then RiverWare can translate projected coordinates to geographic coordinates, and display these coordinates where appropriate.

Object Coordinates

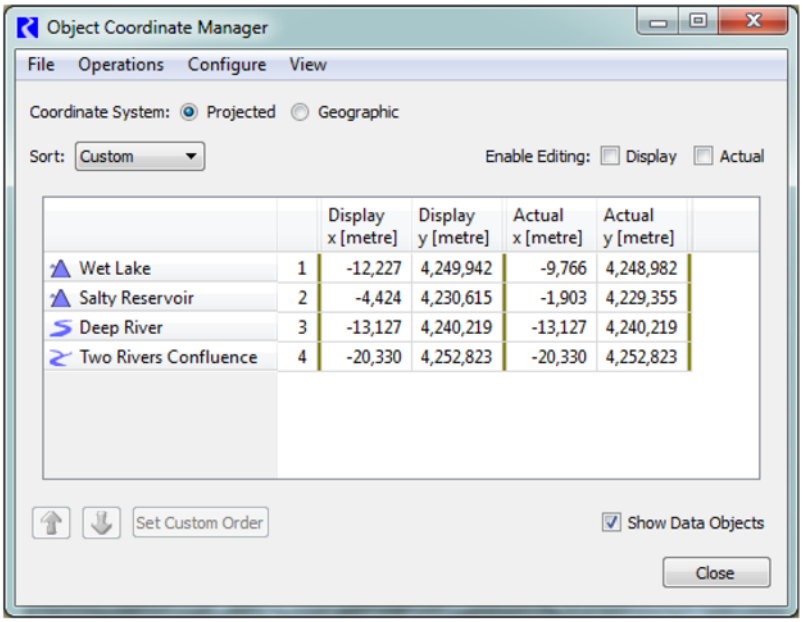
To support the Geospatial View of the workspace, RiverWare associates coordinates in the view's projected coordinates system with each object on the workspace. To provide more flexibility for the user, RiverWare supports both Actual and Display spatial coordinates. Actual coordinates are the static coordinates of the object which may come from other sources. The display coordinates are the location where the object is shown on the geospatial view. Often the display coordinates differ from the actual coordinates because the object was moved slightly for less icon clustering or better display.

When an object is created, it is placed at the point of creation in the current view and given locations in the other two views based on its location in the current view. Objects can be moved in any view, and in the Geospatial View this will change the display spatial coordinates. This view also provides the following additional mechanisms to edit or specify spatial coordinates:

- The Object Coordinate Manager dialog displays spatial coordinates for all objects in a single dialog. This dialog supports editing of individual values as well as cut/paste/copy (see section below for more details). This also provide a mechanism to facilitate reconciliation of an object's actual and display spatial coordinates.
- Import the Actual Coordinates from an ESRI shape file.

Following is a description of the Object Coordinate Manager Dialog which is used to edit/view object coordinates. The Object Coordinate Manager is non-modal and accessed by right-selecting the main workspace (in the Geospatial View) and then selecting **Object Coordinates**.

The Object Coordinate Manager dialog displays both the display and actual spatial coordinates for all workspace objects. This dialog supports editing of individual fields as well as cut/paste/copy. For each object, both the display and actual spatial coordinates are displayed.



Following are operations that you can perform through the dialog.

- **Select Coordinate system.** Coordinates are displayed for either the projected or geographic coordinate system. If the canvas has not been configured with full projection information, then RiverWare can not convert to geographic coordinates and this option is disabled.
- **Sort**. Objects in the table can be sorted using the Sort menu. There are options to sort by Object Type, Object Name, Display X or Y, Actual X or Y, Custom and Custom from Workspace. To use the Custom sort, highlight one or more objects and use the blue up and down arrows to sort the objects. The **Custom from Workspace** sort option is defined on the workspace Object List; see "Simulation Object List" on page 14.
- **Editing**. Values in the dialog are only editable when the appropriate **Enable Editing** toggle is selected. Then, double-click a value and type in a new number.
- **Show Data Objects**. The **Show Data Objects** toggle allows you to specify whether you wish to see data objects.
- **Show on Workspace**. Select one or more objects, then right-click and select **Show on Workspace** to highlight and select the objects on the workspace.
- **Copy Display/Actual Coordinates to the other**. The **Operations** menu has options to Copy Display Coordinates to Actual Coordinates and Copy Actual Coordinates to Display Coordinates. This allows you to move coordinates easily between the display and actual.

  Note: These operations copy *all* values in the column, not the selected ones. When you do this operation, it may overwrite data. Thus, a warning dialog is provided for you to confirm or cancel the operation.

- **Export Copy/Import Paste Values**. You can copy or paste any values to or from the system clipboard and then to or from external text or Excel files or back to this dialog. This gives you a lot of flexibility in how you move data.

  Note: When you copy and paste values, it is operating on the selected values in the sort order as it is displayed. There is also an **Export Copy with the Object Names** option to also export the RiverWare object name. These operations are available from the right-click context menu.

- **Importing/Exporting Coordinates**. Import and export spatial coordinates through the ESRI shape file format. In this context, the shape file format is a collection of three files with different suffixes:

  – .shp - objects represented as points.

  – .shx - indices into .shp file

  – .dbf - object attributes (initially object name and object type)

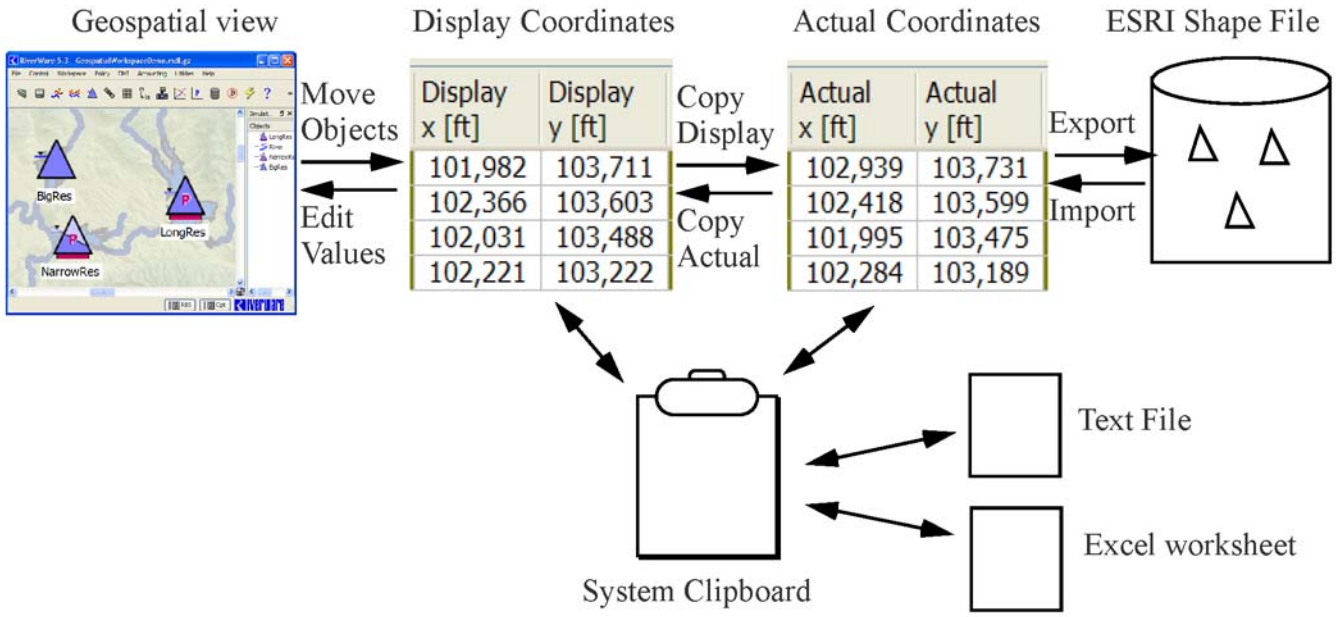
  RiverWare supports export of the spatial coordinates of all or selected objects. When coordinates are imported, the user will be warned that the existing coordinates will be overwritten and notified when coordinates for unknown objects are encountered.

  Note: Both export and import use the projected coordinate system.

Figure 1.17 illustrates the possible movement of coordinate data within RiverWare.

Note: Any operation using the system clipboard involves a Copy, Cut, and Paste, which involves Export Copy and Import Paste within RiverWare.

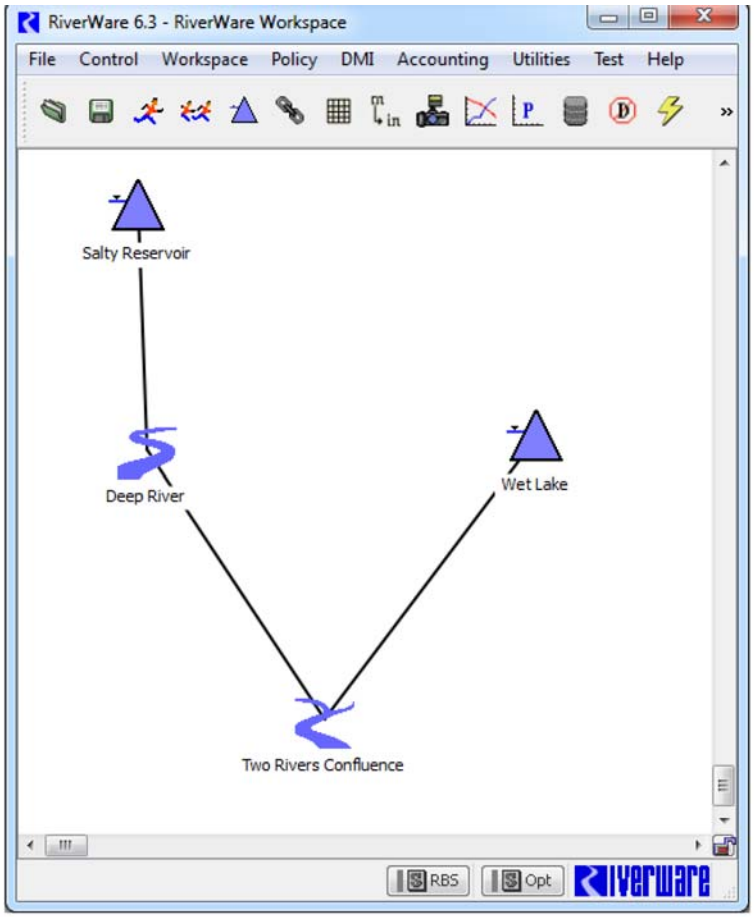
Figure 1.17 Data operations in the Object Coordinate Manager dialog



Getting Started With the Geospatial View

This section describes how you might begin to use the Geospatial View with an existing model which to this point has made use of only the Simulation and/or Accounting Views. Figure 1.18 shows the workspace Simulation View for the model we will be using to illustrate this process.

Figure 1.18 Simulation view of example model



1. Acquire a map of the basin.

   As discussed above, the Geospatial View is most useful when you have a basin map with projection information. Such maps can be exported from a GIS application or acquired from a map provider. For example, one can download maps for the U.S.A. in a variety of formats from the USGS National Map web site (http://nationalmap.gov).

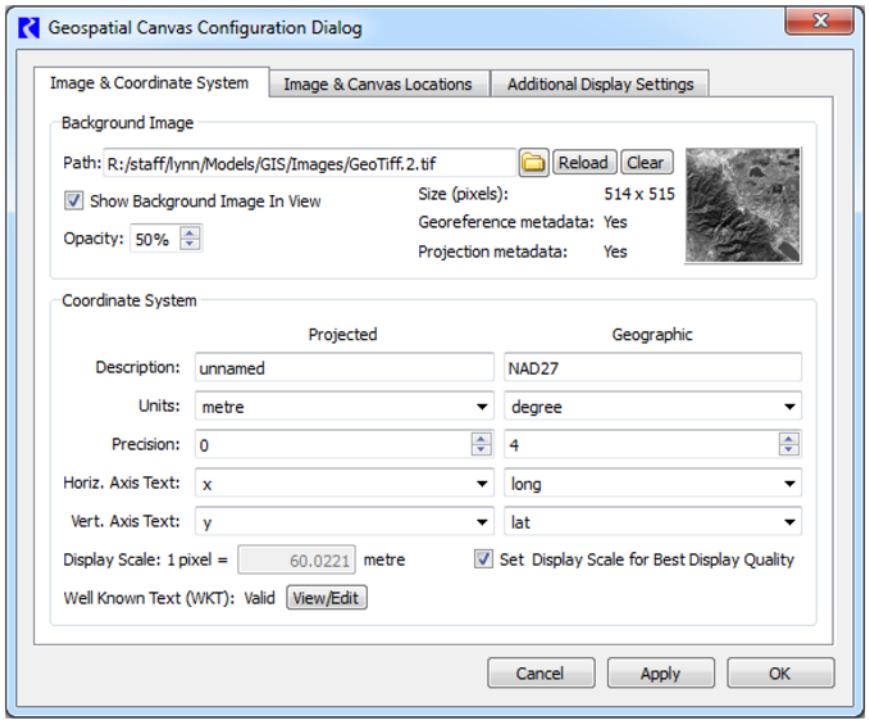
2. Switch to the Geospatial View.

   Initially the positions of the objects in this view will be based on their original placement in another view. Also, at this point, the canvas will have a default configuration and the object coordinates in the default coordinate system (which equates one unit of distance with one display pixel) will likely be orders of magnitude off of their true coordinates in any actual coordinate system. In our example, the southernmost reservoir (Salty Reservoir) is at the northernmost position, and object coordinates are in the range 100-400.

3. Load the map.

   Continuing with our example, open the Geospatial Canvas Configuration dialog and select a GeoTIFF image.

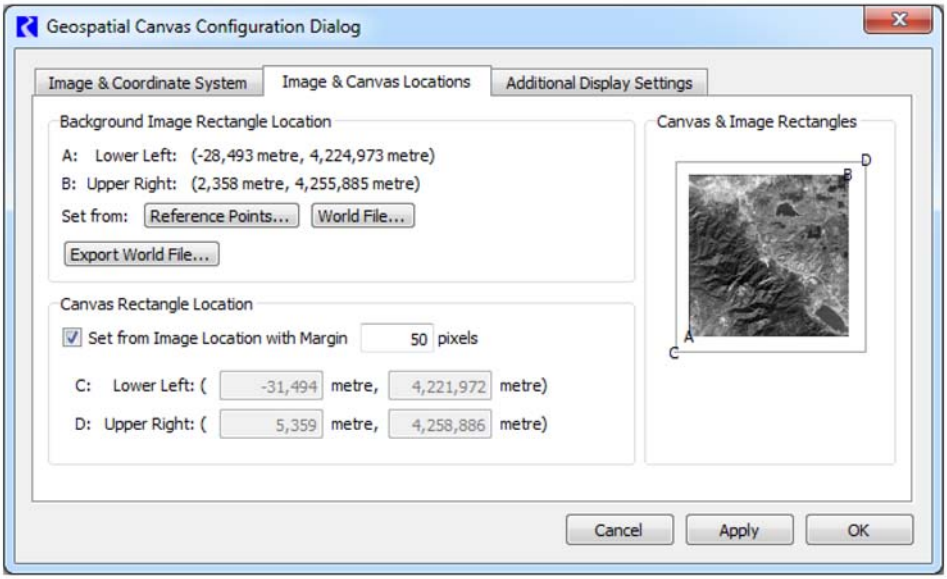
Figure 1.19 Geospatial Canvas Configuration dialog for sample model



Note: There are many supported formats but common ones include GeoTIFF, JPG2000, and MrSID.

As illustrated in Figure 1.20, this is a 514 x 515 pixel image with projection metadata. While the projected coordinate system is not named in the metadata, the geographic coordinate system (datum) on which the projection is based, is NAD27.

Figure 1.20 Geospatial Canvas Configuration dialog for sample model



4. Adjust the Canvas.

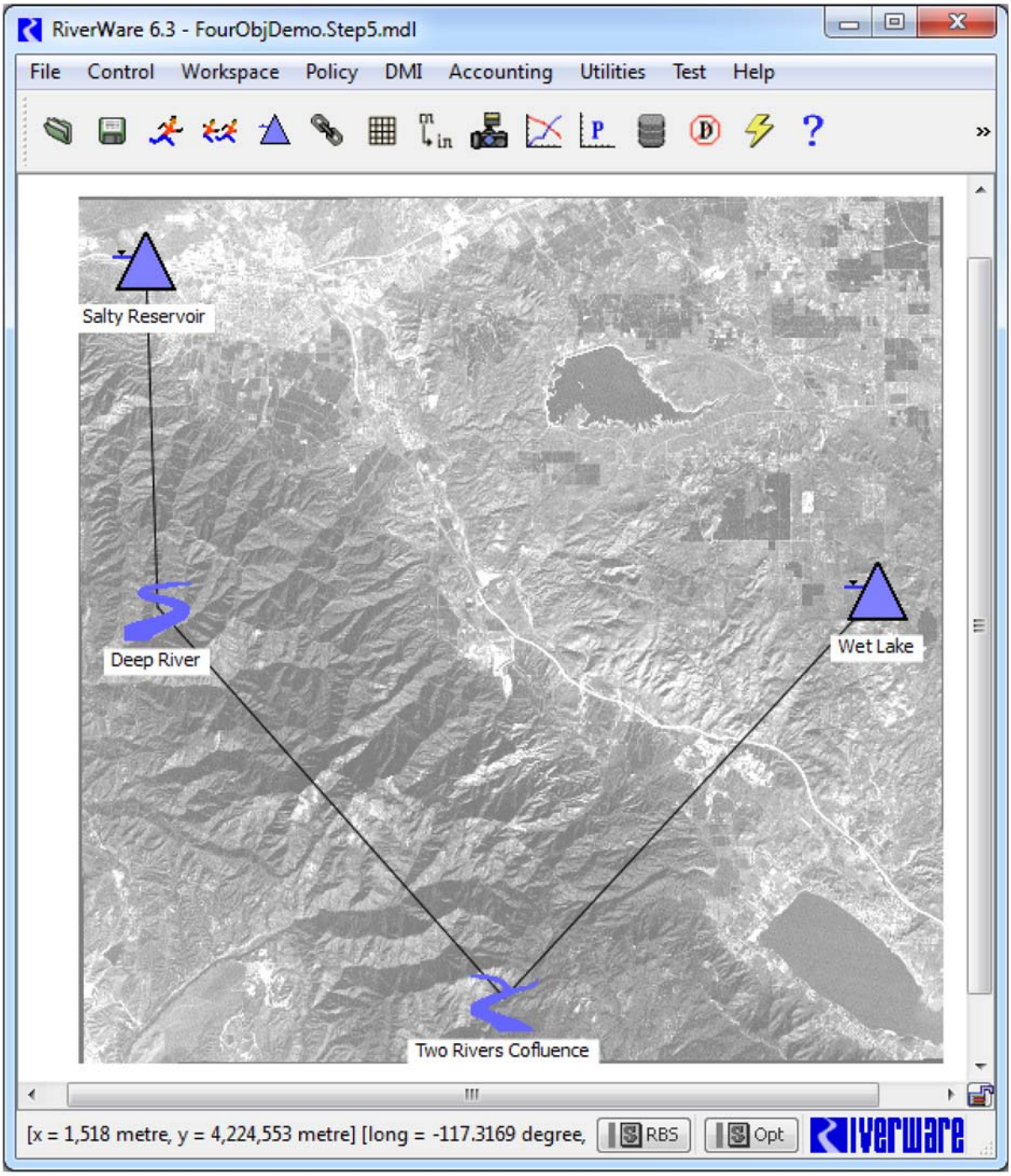
   By selecting the **Image & Canvas Locations** tab, we see the location of the image in the projected coordinate system, and we can adjust the canvas size if necessary. By default the canvas is automatically sized to be slightly bigger than the image, which works well for this model.

5. Apply changes.

   At this point you have established the basics of the configuration and can apply your changes by selecting **OK**. Since the default object coordinates are in the hundreds but the image rectangle y coordinates are in the 4000 km range, the objects are not on the canvas as we it is newly configured. Figure 1.21 illustrates the Geospatial View after applying our changes and letting RiverWare automatically place the objects on the canvas.

   Note: The status text in the lower left corner of the dialog now shows the location of the cursor coordinates in both the projected and geographic coordinate systems.

Figure 1.21 Geospatial Canvas after importing image

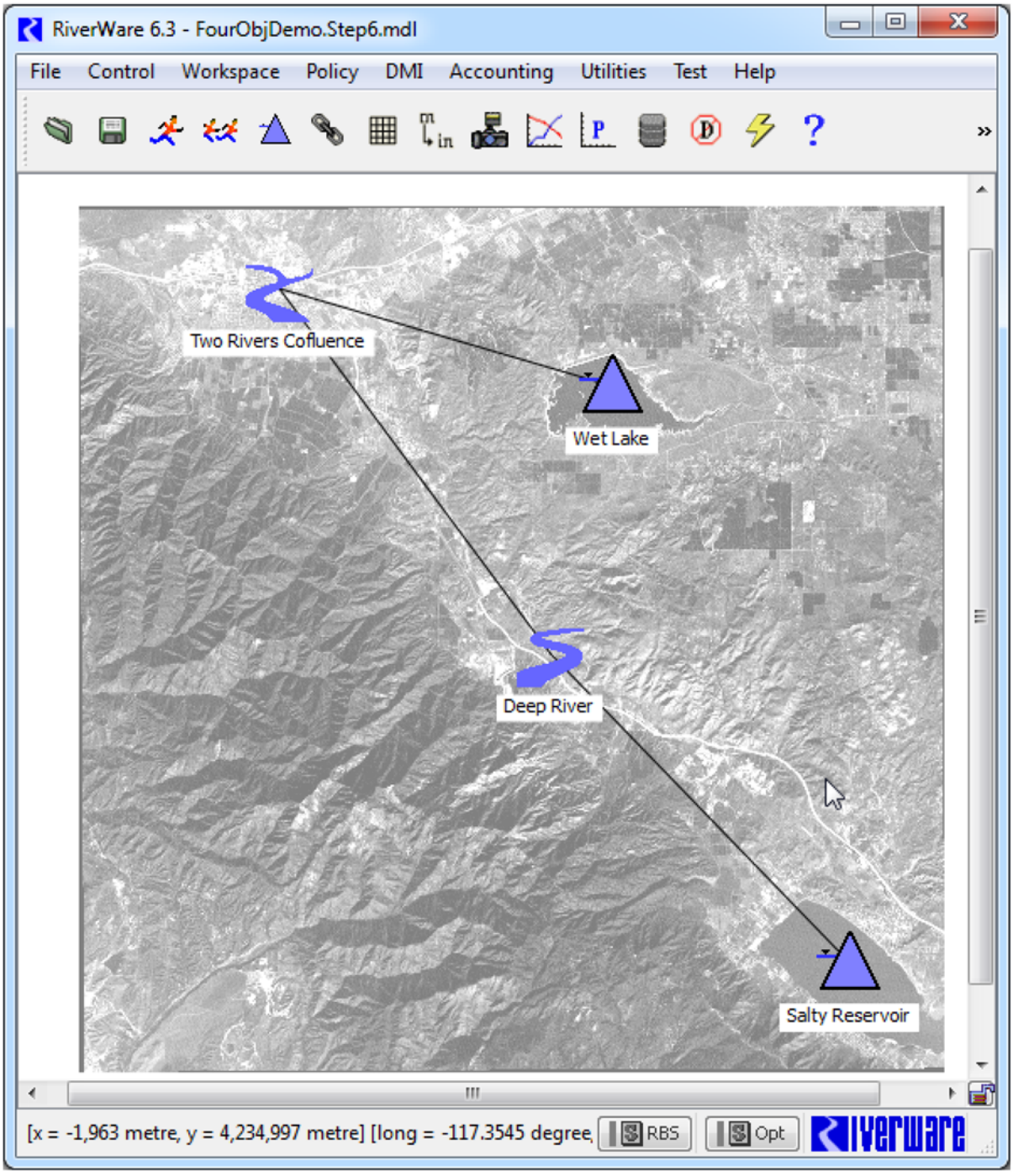


6. Position the objects.

   All the objects are on the canvas, but they are not at their true locations. If you knew their coordinates in the projected coordinate system, you could use the Object Coordinate Manager to place them, but for most purpos-

es, placing them by hand in the workspace is adequate. Figure 1.22 shows the workspace after placing the objects at their approximate locations on the map.

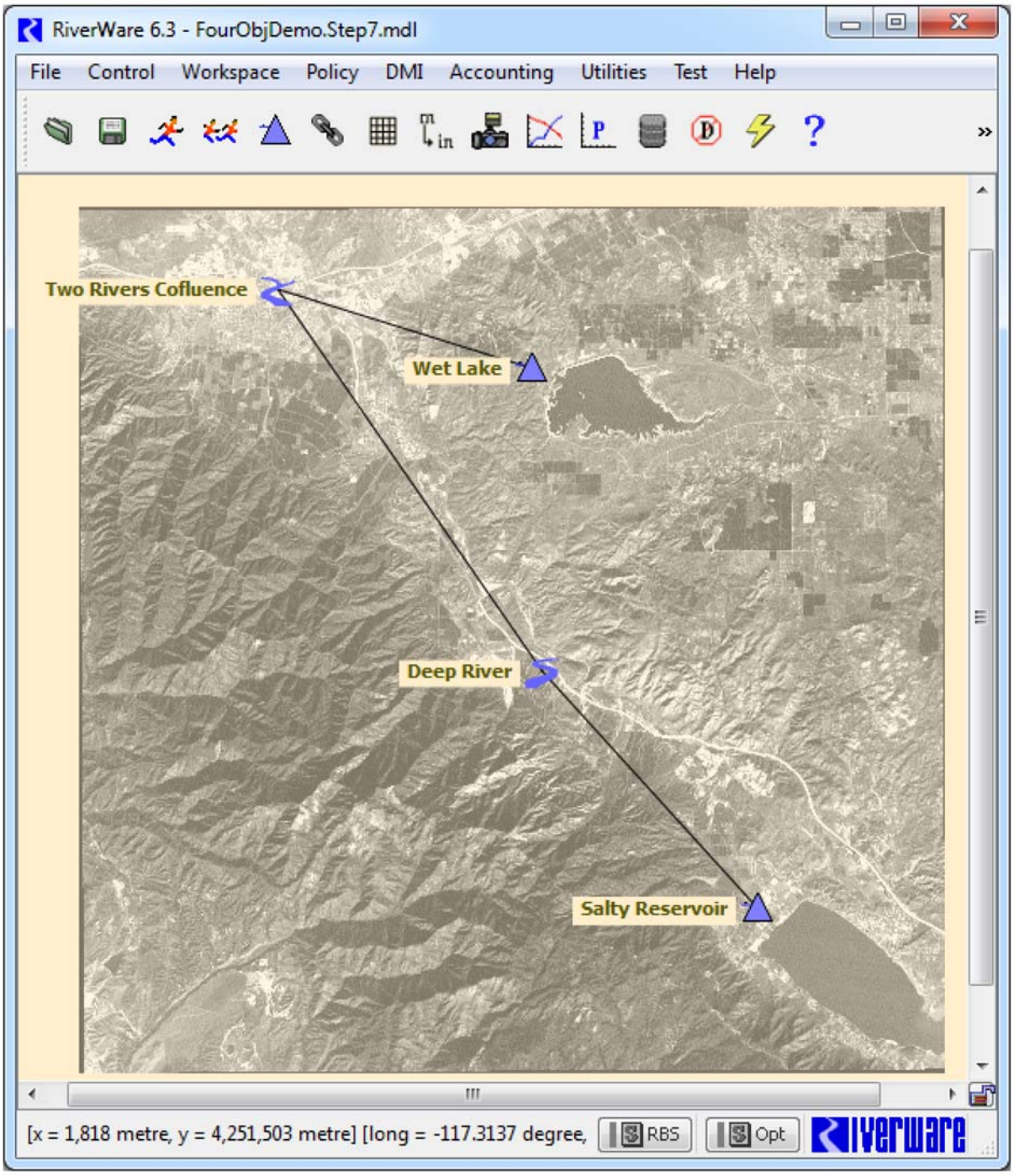
Figure 1.22 Geospatial Canvas after moving objects



7. Refine the Configuration.

For this small, low resolution image, the RiverWare icons tend to obscure the map. To improve the display, you can return to the canvas configuration dialog and adjust controls in the **Additional Display Settings** tab. Figure 1.23 shows the workspace after tinkering with the background color, font, and label orientation, and then adjusting the icon positions further.

Figure 1.23 Geospatial Canvas after adjusting settings



Geospatial Canvas Configuration Dialog

The Geospatial View is most useful when a basin map exists which can be located (georeferenced) in a known projection system. If this information is not available, consider using the Simulation View with a background image.

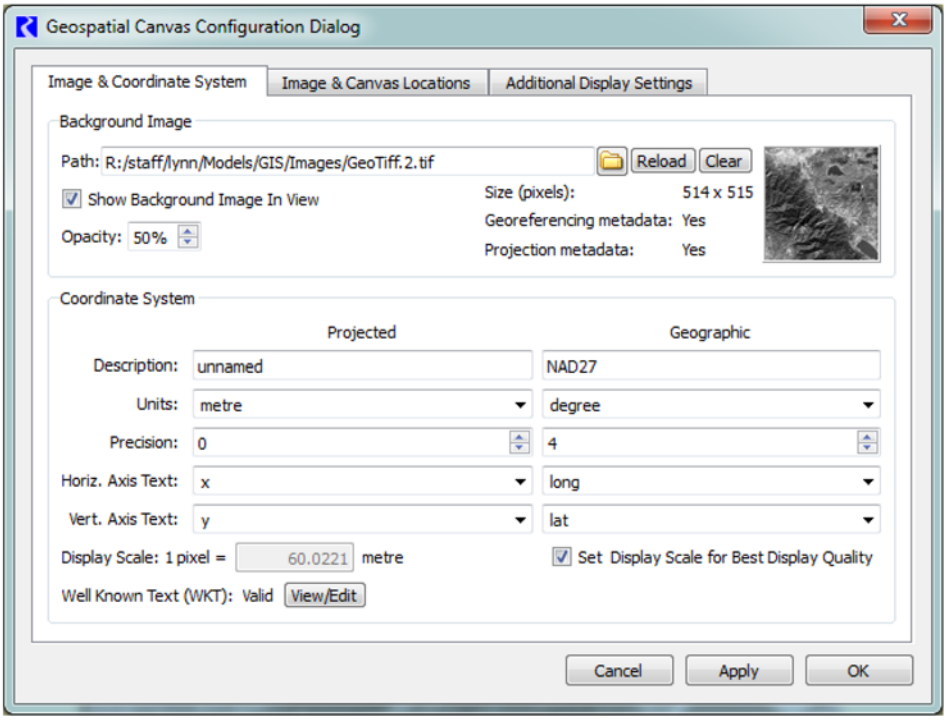
The Geospatial Canvas Configuration Dialog allows you to specify information about your georeferenced image and how it relates to the RiverWare workspace. It is accessed as follows:

- Right-click the geospatial workspace and select **Canvas Properties**.
- Select **Workspace**, then **Canvas Properties** when the Geospatial View is shown.

We will discuss each of the Geospatial Canvas Configuration Dialog tabs in turn.

Image & Coordinate System Tab

This portion of the dialog describes the background image and the projected and geographic coordinate systems associated with that image (and the Geospatial View in general).



Background Image

Image files are specified by full path names with environment variable expansion. Environment variables are specified using the $PATH syntax. If the image changes outside of RiverWare you may need to reload it using the **Reload** button.

Of the many image formats supported by RiverWare[1], the most common are JPEG, PNG, JPEG 2000, GeoTIFF, and MrSID.When an image is loaded, RiverWare checks for the presence of two type of useful metadata:

- Georeference. Location of the image in its projection.

- Projection. Description of the projection in WKT (well known text) format.

If present, these data are used to set appropriate aspects of the configuration. Some image formats support the embedding of these metadata in the image file itself (e.g., GeoTIFF, JPEG 2000, and MrSID), but RiverWare also checks for a co-located file with a suffix indicating that it contains image metadata. For example, RiverWare will look for an associated file in the world file format, a plain text file format developed by ESRI for georeferencing raster map images.

A valid world file contains six lines, each containing a floating point value, denoted here by the letters A to F. These values define an affine transformation from pixel coordinates to projection coordinates in the form:

$$x_1 = Ax + By + C$$

$$y_1 = Dx + Ey + F$$

where:

- x_1 = calculated x-coordinate of the projection location
- y_1 = calculated y-coordinate of the projection location
- x = column number of a pixel in the image
- y = row number of a pixel in the image
- A = x-scale; dimension of a pixel in map units in x direction
- B, D = rotation terms
- C, F = translation terms; x, y map coordinates of the center of the upper left pixel
- E = negative of y-scale; dimension of a pixel in map units in y direction

For many GIS applications, creating an image with a world file is relatively straightforward. For example, to do this in ArcMap 10.0, select **File**, then **Export Map**, then select the **Write World File** checkbox in the dialog. On the other hand, when this is not possible, the world file format is simple enough that it can be created by hand with a text editor.

The Geospatial View currently supports only images with unrotated, square pixels, thus not all map images can be displayed as background images. If metadata indicate that these assumptions are violated, RiverWare will notify the user at image load time.

Following are additional controls and information contained in this section of the dialog:

- Checkbox indicating whether to **Show Background Image in View**.
- Integer indicating the percent **Opacity** with which to display the image
- Labels indicating the presence or absence of georeference and projection image metadata.

COORDINATE SYSTEM

This panel displays information about the projected and geographic coordinate systems associated with the Geospatial View.

1. RiverWare uses the GDAL open source library to read image files. This library supports over 100 raster data formats, though many of these formats are not suitable for background images because they do not contain color rendering information.

- **Description**. Textual description of the coordinate system. This could include a technical description of the coordinate system such as “UTM NAD83 Zone 11N”, but RiverWare will not make any assumptions about the description contents.
- **Units**. Text describing the units of the coordinate system. These are not limited to the units supported for slot values because these are used for display purposes only.
- **Precision**. Number of digits to the right of the decimal point with which to display coordinates.
- **Horiz. Axis**. Label associated with the horizontal dimension of the coordinate system. For the projected coordinate system, this is usually “x” or “Easting” but you can also select <custom> and enter your own text. For geographic coordinate systems, this is usually “long” or “longitude”.
- **Vert. Axis**. Label associated with the vertical dimension of the coordinate system. It is usually “y” or “Nothing” but you can also select <custom> and enter your own text.
- **Display Scale**. Projection units per pixel used for displaying the canvas on the screen at a zoom factor of 100%. This setting relates the projection to the screen display of the canvas. When the **Set Display Scale for Best Quality Display** box is checked, RiverWare sets this automatically, usually using the display scale which leads one pixel in the background image to be displayed as one pixel on the screen.

  Note: RiverWare uses a single display scale for both vertical and horizontal dimensions.
- **Well Known Text (WKT)**. Indicates whether full projection information is available in the WKT format and allows this text to be view and edited. Typically this description will be set automatically from image metadata, but if the image does not contain this information, it can be provided interactively.

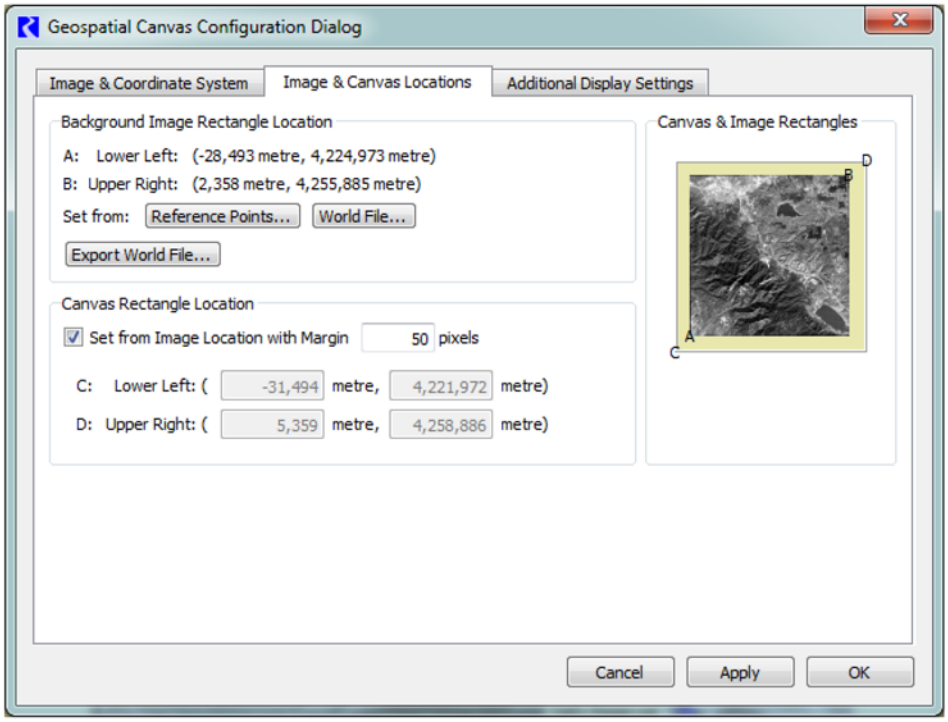
You can either set these fields interactively or, if the appropriate image projection metadata is present, RiverWare will set them automatically.

> **Note:** If the fields are set automatically, it is possible to override the values set from metadata, but they will be reset if the image (and metadata) is reloaded. A preferable approach would be to correct the metadata to contain the desired information.

The geographic coordinate system portion of this panel is only relevant when full projection information is present, typically part of the projection metadata. When this information is not present, this portion of the panel is disabled.

Image & Canvas Locations Tab

This panels displays information about the locations of the background image and canvas in the projected coordinate system.



Background Image Rectangle Location

To display the background image at the proper location on the canvas, RiverWare needs to know its location in the projected coordinate system (i.e., the image must be georeferenced). There are two alternatives for providing this information if RiverWare did find it when the image was loaded. One is to select the **Set from: World File** button. RiverWare will then present a file chooser dialog for specifying the world file containing the image's georeferencing information. This option is appropriate when an appropriate world file exists, but it is either not co-located with the image or has an unusual name that prevents RiverWare from discovering it.

If no metadata is available, then another option is to provide coordinates for two specific locations in the map, in which case RiverWare will use these reference point coordinates to compute projection coordinates for the full image. To provide this information to RiverWare, select the **Set from: Reference Points** button. This opens the Image Location Dialog which displays a view of your image. For this utility, a reference point is a location for which you know the coordinates and you can locate in the image. Only 2 reference points are needed to locate the image in the projection coordinate system.

As shown in Figure 1.24, you perform the following steps.

1. Locate a reference points in the image. Use the zooming tools to get as close as possible to the first reference location. Select the  button and then select the image to locate the first reference point one. Zoom/Scroll to

the second reference location. Select the second button  and select the image to locate the second reference point.

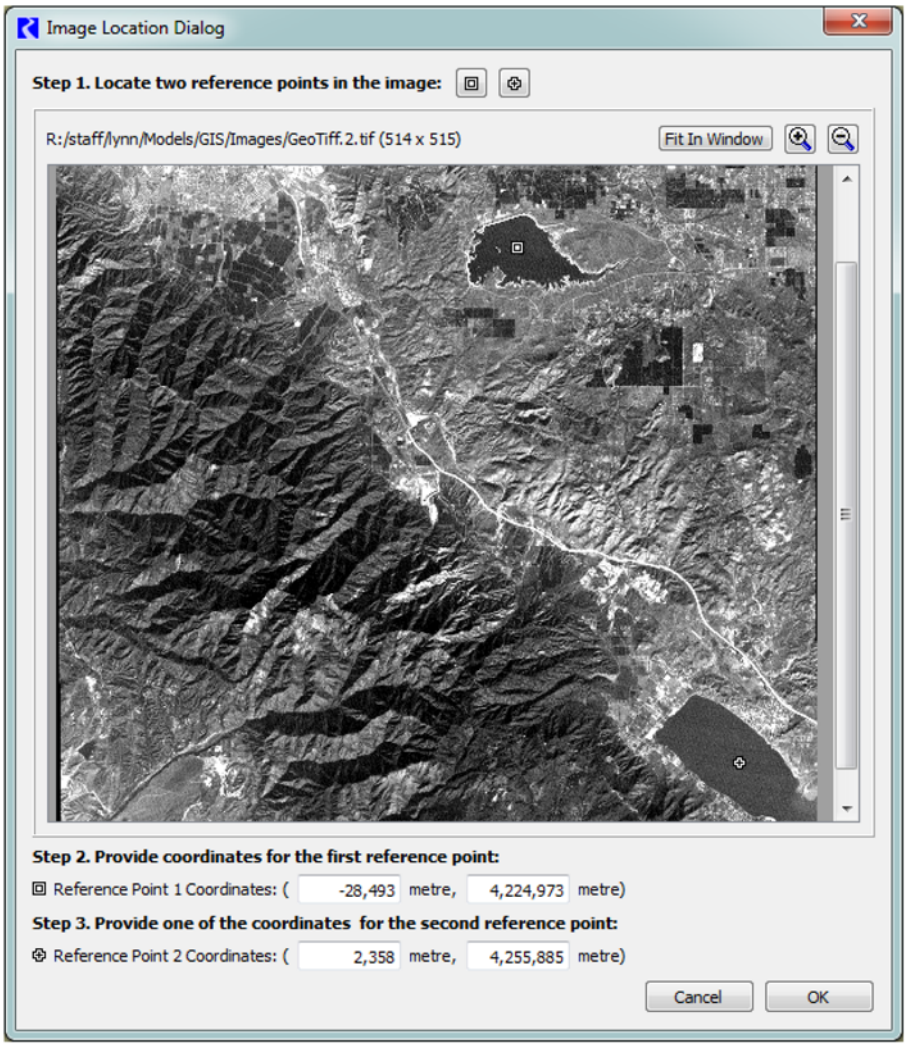
2. For the first reference point corresponding to  enter the coordinates in the dialog.

3. For the second reference point corresponding to  enter either the x or y coordinate; the other coordinate will be computed by RiverWare.

4. Click **OK** to confirm the entry and close the dialog.

If you have set the background image rectangle location interactively, you can export the corresponding georeferencing information by selecting the **Export World File** button. RiverWare will allow you to select a file name and write the background image's georeferencing information to that file in the world file format. This file can then be used to automatically register the image within other RiverWare models or with any application that can supports the world file format.

Figure 1.24 Geospatial view Image Location dialog



Canvas Rectangle Location

In the Canvas Rectangle Location area, you specify where the canvas rectangle lies in the projection's coordinate system, by giving the coordinates of the lower left and upper right corners of that rectangle. Checking the **Set from Background Image withe Margin** checkbox will cause RiverWare to automatically compute the canvas location to be that of the Background Image with an optional margin added to each side. Clearing this box allows you to interactively enter three coordinates of the canvas location (the remaining coordinate will be computed by RiverWare based on the other three). Care should be taken here to enter a canvas location that includes that of the image.

Canvas and Image Rectangles

This panel provides a high-level view of the canvas and image rectangles, drawn as rectangles whose size and relationship to each other matches that defined in the Background Image Rectangle Location and Canvas Rectangle Location panels. The locations of each coordinate (A, B, C, and D) are shown in the thumbnail.

Additional Display Settings Tab

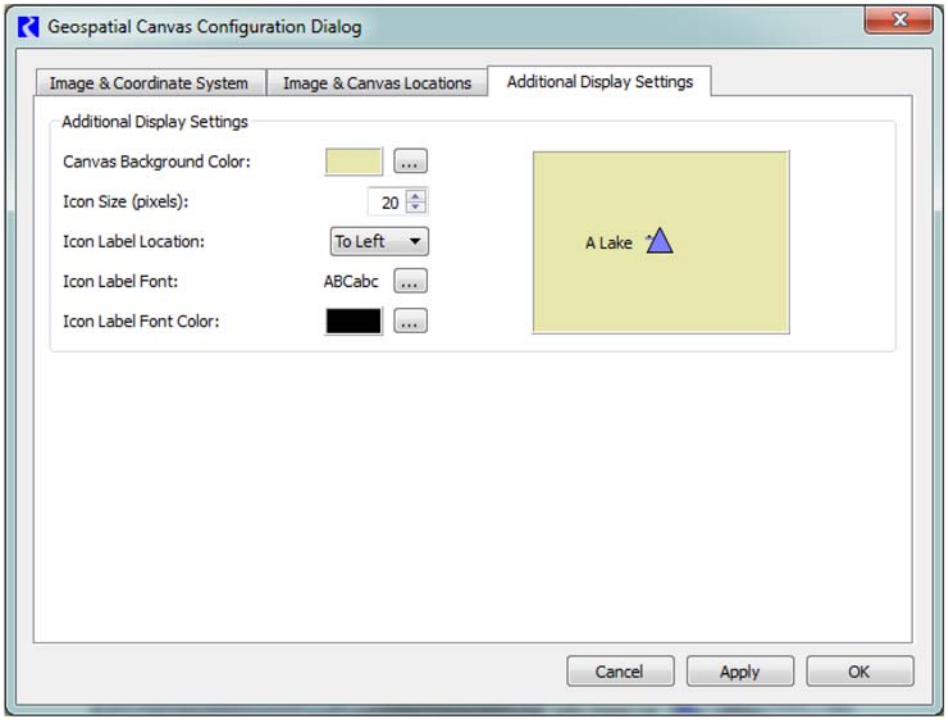
In this tab, you can specify additional display settings for the geospatial workspace, as follows:

- **Canvas Background Color**. Select the button to bring up a color chooser.
- **Icon Size**. Enter a new value for the RiverWare icon size at 100% zoom factor.

  Note: The standard size is 40 pixels. Currently, this setting is *global* for the geospatial canvas. In the future, this may be changed to a per-object setting.
- **Icon Label Location**. Select the location of the label: below, above, left, right of the object.

  Note: **No Label** is an option. Currently, this setting is *global* for the geospatial canvas. In the future, this may be changed to a per-object setting.
- **Icon Label Font**. Provide a font and size for the label text.
- **Icon Label Font Color**. Select a color for the object label text.

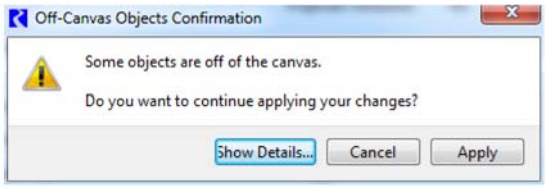
All selections in this frame are applied to the sample reservoir icon immediately, but are applied to your workspace when the **OK** or **Apply** button is selected.



Applying Configuration Changes

When you are satisfied with the configuration and would like to apply it to the Geospatial View, select **OK** or **Apply** at the bottom of the dialog. This will apply changes from all tabs of the dialog (**OK** will also close the dialog). If the current spatial coordinates of one or more object do not fall within the configured canvas boundaries, you will be prompted with the warning dialog shown. A detailed explanation can be shown, basically explaining that RiverWare expects all objects to be displayed on the canvas, and that continuing the apply operation will cause RiverWare to automatically reposition those objects so that they are on the canvas. This is a reasonable thing to do

if this is the first time an image and coordinate system information has been configured for this view. Once the new configuration has been applied the Geospatial View, you can then refine the positions of the object (by direct manipulation with the workspace or using the Object Coordinate Manager, described below). On the other hand, the objects could have correct coordinates for the coordinates system but are off of the canvas due to unintended changes to the canvas location, in which case you should cancel the apply operation and correct any problems.



Following are some strategies for dealing with overlapping icons which is sometimes called *icon clustering*.

- Use smaller icons and place labels to one side or the other.
- Give clustered objects *display* spatial coordinates that allow for a clear display, deviating somewhat from their *actual* coordinates as necessary.

Objects on the Workspace

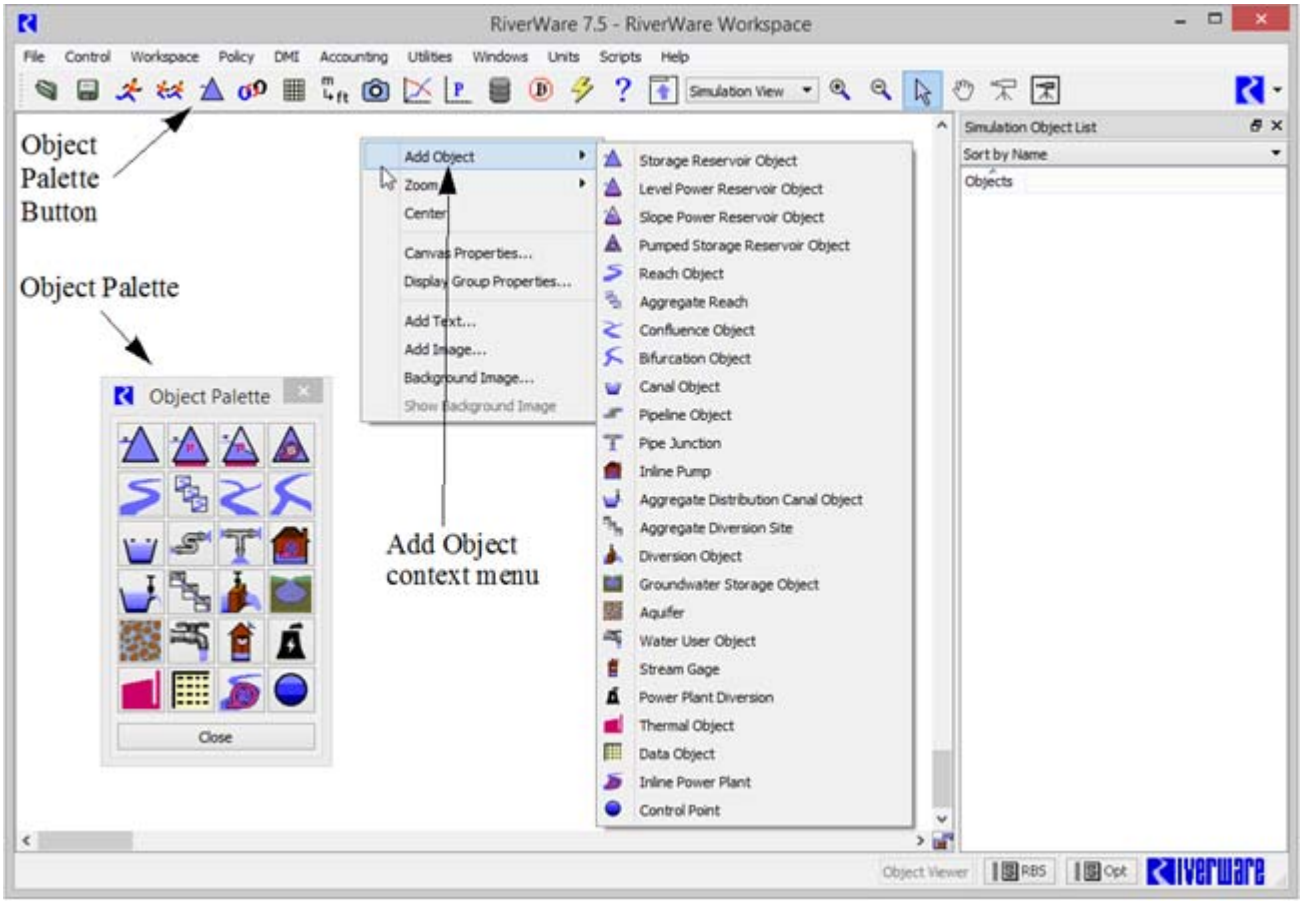
The workspace displays the objects representing features in the basin. The object icons are a convenient way to visualize the physical layout of a modeled system. These objects also contain the data and the physical process algorithms that drive the simulation. This section describes how to manage objects on the workspace.

Object Palette

Objects are added to the workspace using the object palette. The Palette contains all of the available object types used to represent features of a river basin. It is the source from which objects are instantiated on the workspace. To place objects on the workspace, drag them off the object palette and place them in the desired location on the workspace. You can access the Object Palette as follows:

- Select the **Object Palette** button on the main toolbar. 
- Select **Workspace,** then **Objects,** then **Object Palette** from the menu bar.

- Right-click the workspace. This will bring up a small window with the option to **Add Object**. Selecting the **Add Object** option opens a list of all objects. Selecting the desired object will place it on the workspace.



An object is created by selecting its icon and dragging it off the Palette onto the workspace. At the time an object is created, the first timestep and timestep size in Series Slots are matched to the Run Control run time settings. The slots show display attributes (Units, Scale, Precision, and Format); see "Unit Schemes" on page 91 for details. Default user methods are also selected for new objects. Slots associated with the selected controller and Methods are allocated in memory. See "Object Types" in *Objects and Methods* for details on each type of object.

Opening an Object

To open an object to see its slots, method selections, accounts, and description:

- Double-click the icon on the workspace, or
- Double-click the object icon in the workspace object list.

This displays the Object Viewer. See "Object Viewer and Open Object Dialogs" on page 105 for details.

Selecting Objects

Objects can be selected for various reasons such as moving them, deleting them, or adding them to a subbasin. Once an object or group of objects has been selected, it will be highlighted both on the workspace and in the dockable list window.

The following are ways to select an object on the workspace:

- Select the object's icon.
- Draw a rectangle around the object. To select multiple objects at the same time, draw a rectangle around a group of objects.
- Control-clicking an object toggles the object in and out of the selection
- Shift-clicking and dragging a rectangle adds objects to the selection.
- Right-clicking an object (to show its context menu) also adds the object to the selection.
- Selecting the object in the object list. Control and Shift-clicking allow selection of multiple objects in the list window.

Deleting Objects From the Workspace

Deleting objects from the workspace by selecting one or more objects, then right-clicking one of them. Select **Delete Object** from the menu. A confirmation dialog appears to inform that the selected objects will be removed from workspace.

This deletion can also be accomplished by selecting one or more objects and pushing the **Delete** key or by selecting the objects and then from the main menu select **Workspace,** then **Objects,** then **Delete Selected Object(s)**. In both cases, confirmation is still required.

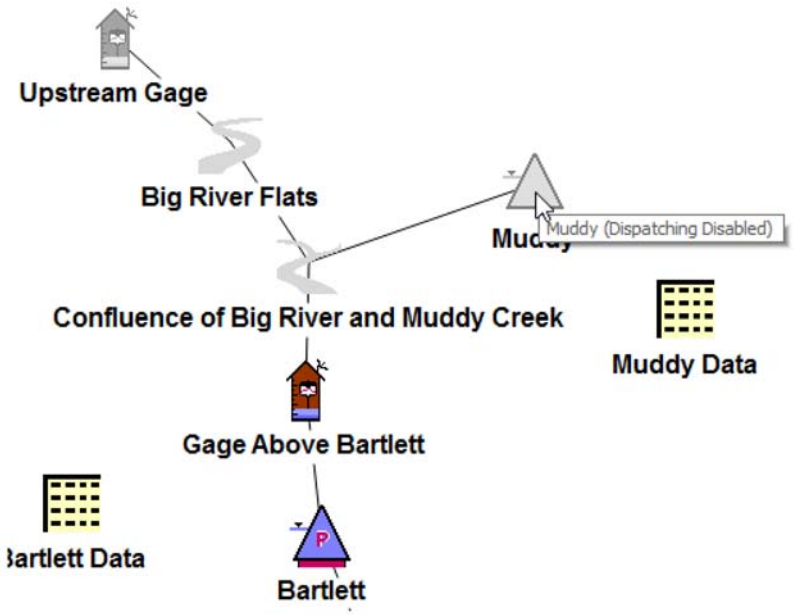
Moving Objects on the Workspace

An object can be moved by selecting it and holding down the button while dragging the object to the desired location. This will readjust the links to the object as well. A set of selected objects can be moved while maintaining their relative positions. The selected objects remain visible on the workspace during the move. Moving objects will change the Display Coordinates on the Geospatial view but will not change the Actual Coordinates; see "Object Coordinates" on page 25 for details.

Enabling and Disabling Dispatching

Objects on the workspace are shown grey when dispatching is disabled. Tooltips indicate the state as well. A sample is shown in Figure 1.25. In this state, the objects will not dispatch, but they will still execute beginning of run checks. Enable or disable dispatching by right-clicking the selected objects and selecting **Enable/Disable Dispatching**. See "Disabling Dispatching" in *Debugging and Analysis* for details.

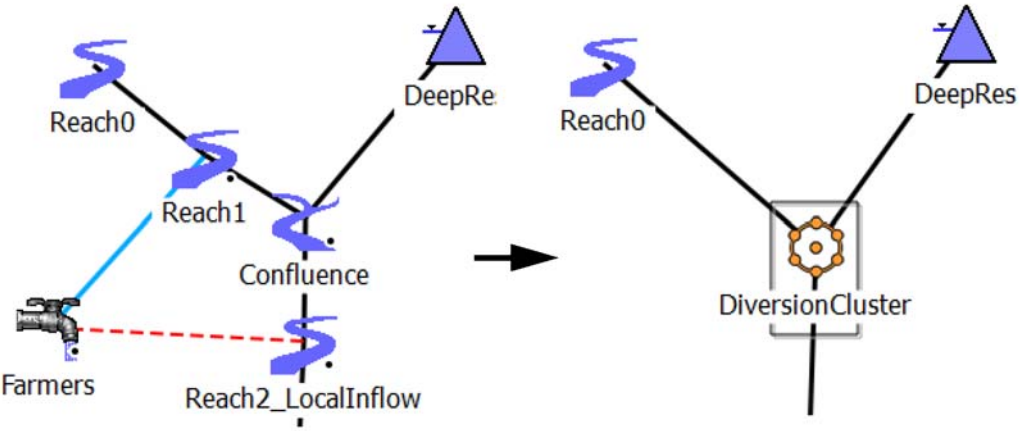
Figure 1.25



Object Clusters

Object Clusters allow you to group together simulation objects on the workspace and show only a single icon.

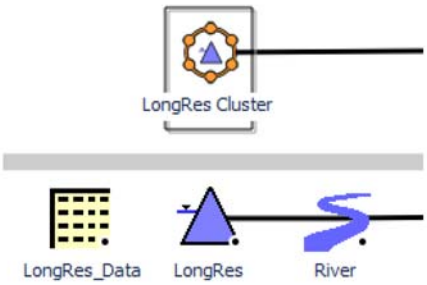
Figure 1.26



Clusters have the following properties:

- Clusters are display-only; they have no effect on the model solution.
- Clusters are supported on the Simulation and Geospatial Views. They are not supported in the Accounting View.
- Clusters can contain any simulation objects which appear on the workspace, except other clusters.

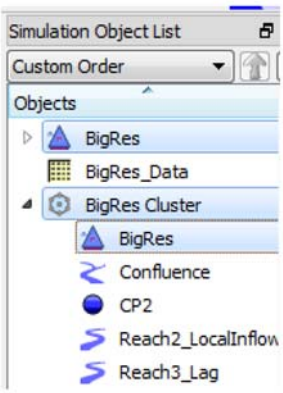
- A simulation object can be a member of only one cluster.
- Adding a simulation object to a cluster does not effect the object's locations within any of the workspace views.
- For any cluster, you can switch between the following display options:
  - Displaying the cluster icon with either the default orange dot or the icon for any member object. See image to the right.
  - Displaying the individual member objects' icons with a black dot in the bottom-right area of the icon indicating it is part of a cluster.
- When the cluster icon is shown, links between objects in the cluster and objects outside of the cluster are drawn to the cluster icon.



- Cluster settings are independent between the Simulation and Geospatial view. For example, a cluster can be shown with a cluster icon in the Geospatial View and with individual member object icons in the Simulation View.
- An item for each cluster appears as a top-level item in the Simulation Object List. Each cluster item has a tree view showing each of its member simulation objects. A particular object can appear twice in the list.

  Note: In Figure 1.27, “BigRes” (a level power reservoir) appears twice.
- On the workspace, hover over the cluster to see a tooltip with a list of the member objects.

Figure 1.27



Following is more information on how to create and use Clusters.

Creating a Cluster

To create a new cluster, select one or more simulation object icons on the Simulation or Geospatial workspace and do one of the following:

- Right-click one of those selected object icons and select **Add to Object Cluster**, then **New** menu.
- Use the **Workspace,** then **Object Clusters,** then **Add to Object Cluster,** then **New** menu on the workspace.

If any of the selected simulation objects are already in a cluster, the **Add to Object Cluster** context operation is instead presented as **Move to Object Cluster.** This operation is used to move objects from one cluster to another.

Note: An object can be in only one cluster.

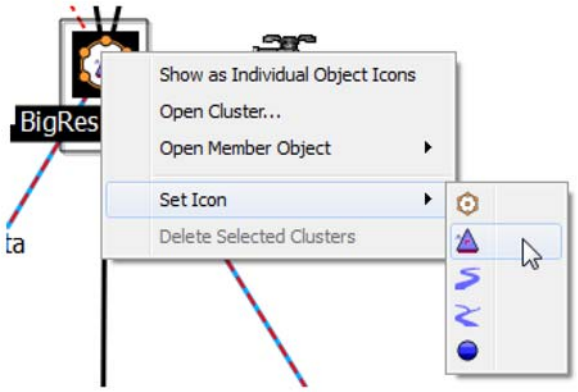
Operations on a Cluster

In general, to modify a cluster you can either right-click the cluster on the workspace, right-click the cluster in the Object List, or select the cluster and use the **Workspace**, then **Object Cluster** menu.

Following explains the various options, depending on the selection and the menu chosen, as follows:

- **Show as Individual Object Icons**. Shows the member object icons and hide the cluster icon. Each object will show a black dot in the lower right indicating it is part of a cluster.
- **Show as Single Icon** or **Show as Object Cluster**. Shows the cluster icon and hides the member object icons.
- **Open** or **Open Cluster.** Shows the Open Object Cluster dialog; see "Opening a Cluster" on page 47.
- **Open Member Object**. Shows a menu of the member objects. Selecting one of those objects opens that object's Open Object Dialog.
- **Set Icon**. Select the icon to use in the center of the cluster's icon. A cluster's context menu's **Set Icon** menu presents each of the member objects' icon, as shown in Figure 1.28. Select one of these items to set the small icon in the middle of the cluster icon.

Figure 1.28



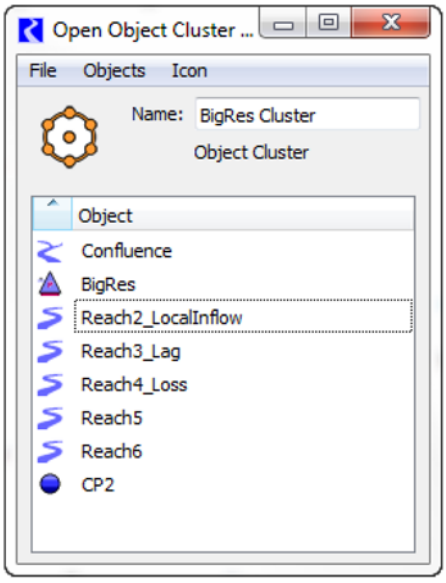
- **Delete Cluster / Delete Selected Cluster**. Delete the cluster, showing the individual members' icons. The member objects are displayed in their original positions with their icons displayed. You must confirm this operation.

- **Remove (Selected Objects) From Cluster**. Remove the selected member objects from their containing cluster. Their icons will be shown on the workspace as usual.
- **Add Selected Objects to Cluster**. From the **Workspace**, then **Object Cluster** menu, you can choose this option to add the selected objects to the specified cluster.

Opening a Cluster

To see a list of the objects in a cluster, use one of the following methods to open the cluster.

- Double-click a cluster's **Workspace** icon.
- Double-click a cluster's **Simulation Object List** item.
- Select **Open Cluster** in a cluster's workspace icon context menu.
- Select **Open** in a cluster's Workspace Object List item context menu.



The Open Cluster Dialog shows the member objects in a list. Sort by object type or object name by selecting the column header. From this dialog, you can do the following:

- Rename the cluster using the **Name** field.
- Use the **Objects** menu to open the selected object.
- Use the **Objects** menu to add simulation objects to the cluster using the object selector dialog.
- Use the **Objects** menu to remove selected member objects from the cluster.
- Use the **Icon** menu to set the cluster's icon to the default cluster icon  or a cluster icon containing a small version of the selected object.
- Open any of the member objects by double-clicking them.

Most of these operations are also available by right-clicking an object/cluster in the Simulation Object List.

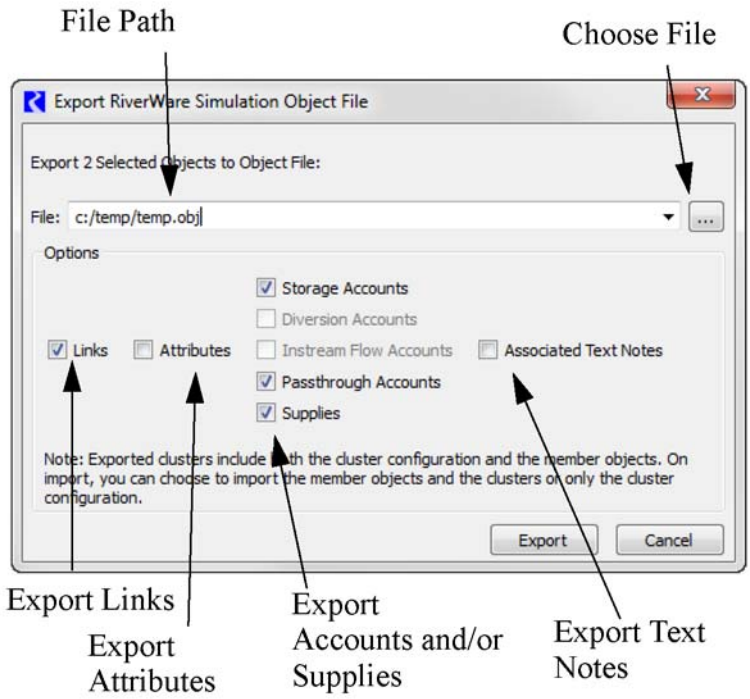
Importing and Exporting Objects

Objects can be exported to a file and then imported into the same or another model. Exporting one or more objects includes exporting slot data, method selections and optionally links, accounts and supplies. Objects can be imported and exported to and from the workspace as follows.

Export

To export, first select, one or more objects. Then select **Workspace**, then **Objects,** then **Export Object** from the main workspace. The user is then presented with the Export RiverWare Simulation Object File dialog, which is used to specify how the objects should be exported and to which file the objects should be written. Figure 1.29 illustrates.

Figure 1.29



The following options are available for exporting depending on the model and possibly the selected objects' components.

- **Links**. Specify whether to write Links between slots.
- **Attributes**. Object attributes defined on the Attributes Manager and selected on the object's Attributes tab can be optionally exported.
- **Accounts**. In an accounting model, select the type of accounts to export: Storage, Diversion, Instream Flow, and/or Passthrough accounts.

- **Supplies**. In an accounting model, specify whether supplies should be exported.
- **Text Notes**. Specify whether to write Associated Text Notes. See "Notes on Series Slots" on page 272 for details on notes.

  As noted on the dialog, when the objects are part of an Object Clusters, both the cluster configuration and member objects are exported. When you import, you can choose whether to import objects and configuration or just the cluster configuration. See "Import" on page 49 for details.

When exporting objects and links, only those links between exported objects will be written. Similarly, only those supplies between exported accounts will be written. In addition, the following are *not* exported:

- Subbasin membership of exported objects
- Computational subbasins
- Workspace display groups including Link, Object, Supply, and Account Groups
- Accounting exchanges including paybacks
- Accounting user defined object level methods - These may be exported separately from the RPL set.

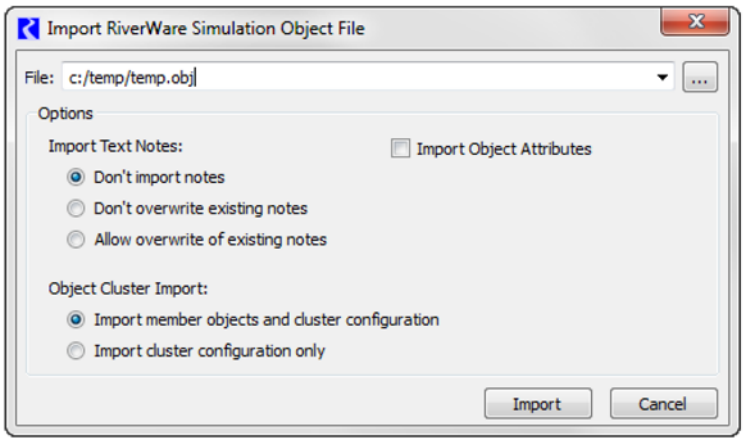
  Note: Method selection is exported on objects. It is important to export/import the object level accounting methods first as imported objects cannot reference methods that do not exist in the model
- For snapshots data objects, the reference to the original slot. When plotting slots and their snapshots from the output manager, the output manager cannot automatically plot a slot and its imported snapshots.

Import

To import, use the **Workspace**, then **Objects,** then **Import Object** menu from the RiverWare workspace. On import, the objects will have the same name as the original object unless an object by the same name already exists in the model. In this case, an integer is added to the object's name. The following options are available on import.

- Specify whether text notes should be imported, as follows. See "Notes on Series Slots" on page 272 for details on text notes.
  - **Don't import notes**
  - Import but **Don't overwrite existing notes**
  - Import and **Allow overwrite of existing notes**
- Specify a selection for Object Cluster Import, as follows:
  - **Import member objects and cluster configuration**
  - **Import cluster configuration only**

- Specify whether to **Import Object Attributes**.



Imported objects are automatically selected (highlighted). Typically the user will then move all of the imported objects immediately to the desired location by dragging them on the workspace. This is especially true if they are on top of other objects. While the objects are still selected, it may be useful to create a subbasin of these objects so they may be easily selected later. See "Creating New Subbasins" on page 412 for instructions on creating a subbasin from the selected objects.

Following are the limitations when importing objects. Objects are similar to model files, they can only be imported in models that have the same or higher version number, e.g. an object exported from a RiverWare 5.0 model can only be imported into RiverWare 5.0, 5.1, etc.

On import, the objects will be placed at the same coordinates as the objects in the model from which they were exported in both the simulation and accounting views. If the workspace is too small to accommodate these new objects, the workspace will grow to exactly fit the imported objects (including a small border).

> **Note:** Before RiverWare 5.0, the coordinates of the objects on the accounting workspace were not exported. Therefore, if these objects are imported, they will be placed in the default location.

When an object or supply is imported and the name already exists in the model, the newly imported objects will be renamed by adding a number to the end of the name. The supplies will then be renamed using the default supply naming convention, "Object# Account to Object# Account". A warning message is posted. If this new name is not available, because of multiple supplies between the same two accounts, the word "DUPL" is added to the end of the supply name to make it unique. These supply names can be changed from the account configuration. Accounts should not need to be renamed as account names are not unique only the object names are.

Export and Import Tips

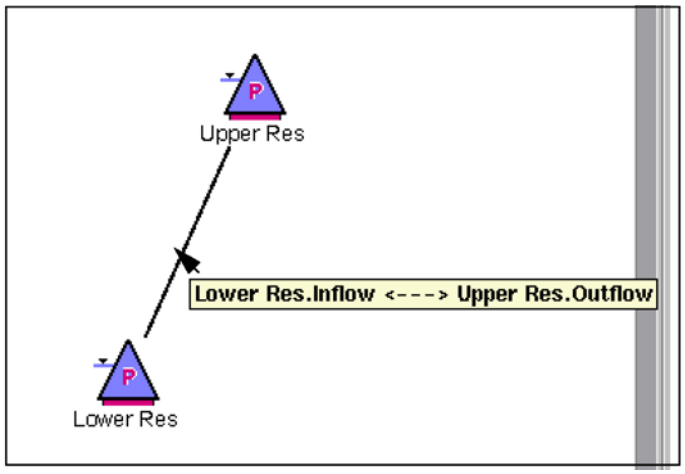
There are a number of scenarios in which import/export of objects could be useful. One such example is when a team of modelers wish to break up a model and have various people work on different components. Following are some tips for this process.

Each team member would take the full model and then pare it down to the desired objects, do the modeling work and then recombine the pieces into one model. To pare down a model, it is typically better to delete unused objects than to export and import the desired objects into another model. By deleting objects, the Run Control parameters--run range, timestep length, controller, settings--are preserved. Also, the output devices, DMIs, object level accounting methods are then available in the pared down model.

To then recombine the model with the original, it is best to delete the objects from the original model and then import the new objects from the pared down version(s). This prevents naming conflicts and having to rename newly imported objects.

Links on the Workspace

Links are the connections between slots on objects which pass information during a simulation run. They propagate a value from a slot on one object to a slot on a different object. Several links may exist between different slots on two objects, but only one line is represented on the workspace. By hovering over the link, all the linked slots are displayed in a tooltip.



There are three utilities for viewing, creating and deleting links: Context Menus, Smart Linker, and Edit Links dialog. See "Editing Links" in *Model Building Quick Start* for details.

Display Groups

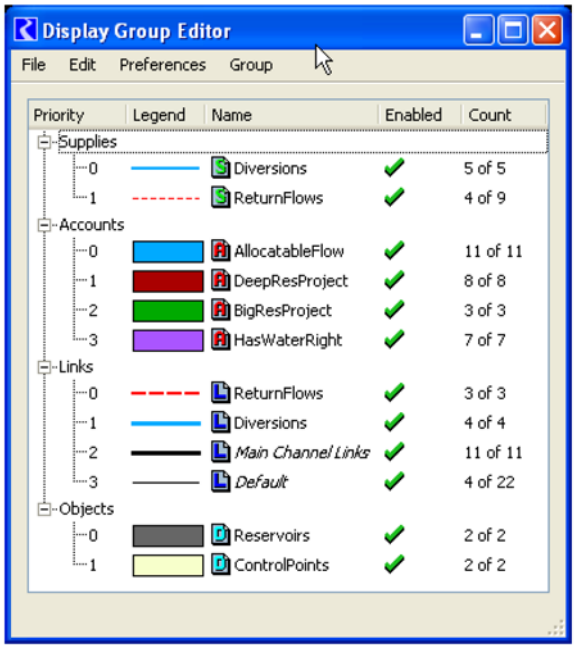
The appearance of links, objects, accounts, and supplies on the workspace can be manipulated using the Display Group Editor. The dialog is accessed as follows:

- Select **Workspace,** then **Display Group Properties**.
- Right-click the workspace and select **Display Group Properties**.

This brings up a window with the option to select **Display Group Properties.**The Display Group Editor provides the ability to create groups of links, groups of objects, and if accounting is enabled, groups of supplies and groups of accounts. The display properties and the membership of a group can be changed by double-clicking that group. The membership of the groups need not be mutually exclusive. The groups are prioritized. For example, if two link groups contain the same link, the group highest in the list (lowest priority number) will be used to set the display properties of that link. Display groups can be enabled and disabled by selecting the checkmark in the **Enabled** column.

The Count column provides information on the number of items in the group of the form XX of YY, where YY is the number of items in the group's set selection, and XX is the number of those items which are governed by that group (i.e. not currently governed by an enabled, superior group).

> **Note:** The counts are not automatically updated if you delete objects, accounts, links, or supplies. The counts can be updated manually with the **Groups,** then **Update Item Counts** menu item. They are also updated when the Display Group Editor dialog box is redisplayed.



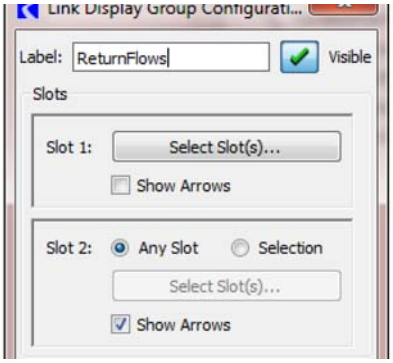
Link Groups

A link group can be created by selecting **Group,** then **Add Link Group** in the Display Group Editor. Double-clicking the new link group entry will bring up the Link Display Group Configuration dialog. Provide a name that will be shown in the Link Group Editor.

In the top part of the dialog, you specify the slots on either end of the links. Select **Select Slot(s)** in the Slot 1 area to specify the first set of slots. You can use filters and other selection mechanisms to quickly choose a large number of slots. Either leave the Slot 2 as **Any Slot** or specify slots using the selector. Example 1.1 provides an example. See "Selector Features" on page 307 for details.

You can then choose to show arrow heads on either end of the links using the **Show Arrows** option.

Note: The ordering of the slot selections is important if want to show arrows.

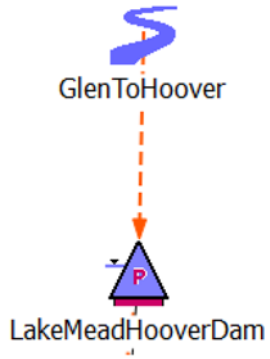


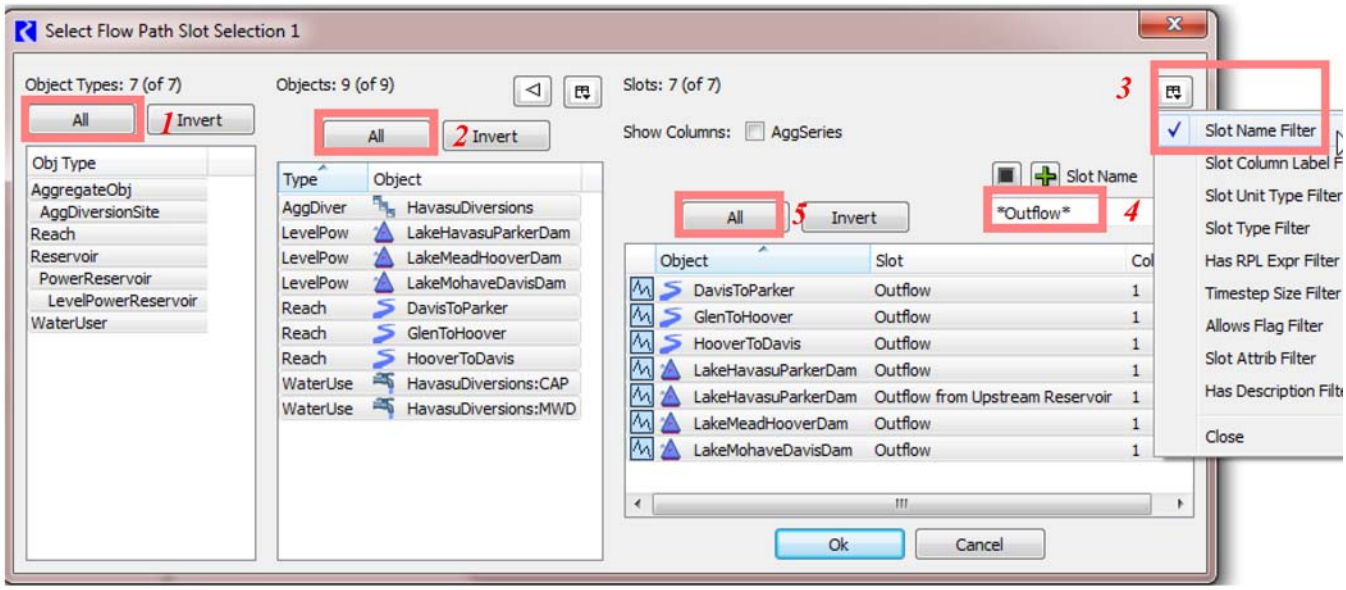
Example 1.1

Use the following steps to show arrows from all Outflows to all Inflows (i.e. the flow path). Figure 1.30 illustrates.

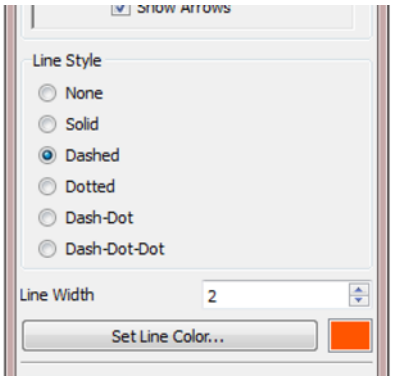
1. Select **All** Object Types.
2. Select **All** Objects.
3. Select **Slot Name Filter**.
4. Enter `*Outflow*`.
5. Select **All**.
6. Select **Ok**. Use the **Any Slot** option or choose only Inflow slots.

Figure 1.30





In the bottom portion of the dialog, you can control the Line Style, Line Width, and Line Color of the links.

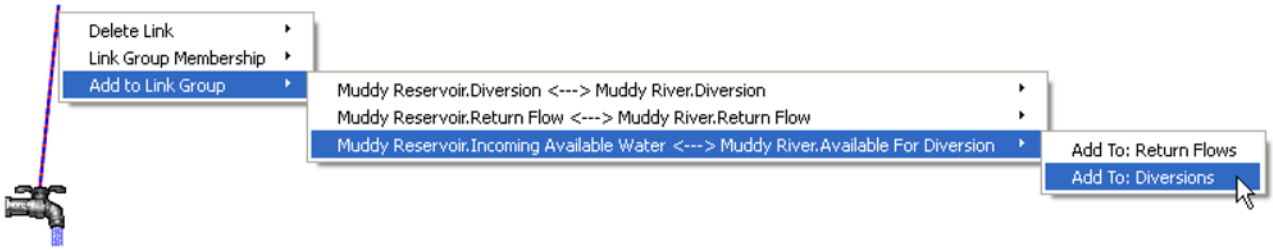


Selecting Links

From the Workspace, a link can be added to link group by right-clicking the link(s) between two objects, hovering over the **Add to Link Group** option, hovering over the desired link (there can be multiple links on the same line between two objects), and selecting the desired **Add to:** <link group>.

Equivalently, links can be added to a link group within the Display Group Editor. This approach allows multiple links to be added to a link group at once. By double-clicking the desired link group, the Link Display Group Configuration window is opened. The slot on one end of the link is selected by selecting Select Slot(s) in the Slot 1 field. If the **Any Slot** toggle is selected in the Slot 2 field then all links to any of the slots listed in the Slot 1 field will be associated with the display group. While the Link Display Group Configuration dialog does not display the links associated with a particular group, the slot selector dialog *remembers* the selected links. Therefore, the user can view the links associated with a group by selecting the **Select Slots(s)** button. To make a more specific selection of links, slots can be selected in the Slot 2 field if the **Selection** toggle is enabled. Only those links that are connected to a slot in the Slot 1 field *and* the Slot 2 field will be associated with the display group.

Figure 1.31



Predefined Link Groups

Two predefined link groups are provided for all models: Main Channel Links, and Default. The Main Channel Links group contains all links between main channel upstream slots and main channel downstream slots. The Default link group contains all links on the workspace.

Supply Groups

Supply groups are active only if accounting is enabled. A supply group can be created by selecting **Group,** then **Add Supply Group** in the Display Group Editor. Double-clicking the new supply group entry will bring up the Supply Display Group Configuration dialog. The membership of the group and the line style, color, and width of

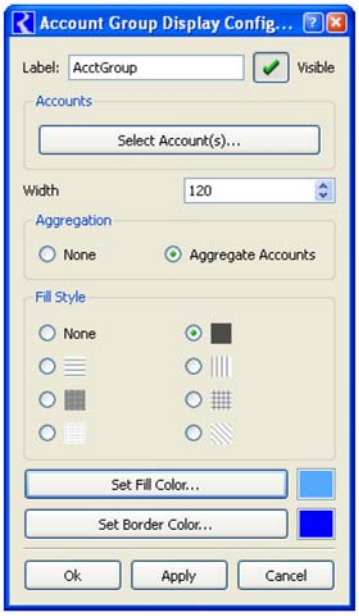
the group members can be set with this dialog. The membership of the group is controlled by selecting the **Select Supply(s)** button. See "Supply Groups" in *Accounting* for details on Supply Groups.



Account Groups

Account groups are active only if accounting is enabled. An account group can be created by selecting **Group,** then **Add Account Group** in the Display Group Editor. Double-clicking the new account group entry will bring up the Account Display Group Configuration dialog. The membership of the group and the fill style, fill color, account width, account aggregation, and border color of the group members can be set with this dialog. The membership of the group is controlled by selecting the **Select Account(s)** button. If account aggregation is selected, the selected accounts, on a particular simulation object, will be collapsed into one icon. The icon will appear as a *stacked* group of accounts to indicate the presence of more than one account. An account can also be added to an Account Display Group by right-clicking the account on the workspace, hovering over **Add to Account Group**, and selecting the desired Account Display Group. If the account is already a member of an Account Display Group, this option will

be replaced with **Account Group Membership.** Hovering over this option will show the display group to which the account belongs. See "Account Groups" in *Accounting* for details on Account Groups.



Object Groups

The display options associated with object groups apply to both the Simulation View and the Accounting View of the RiverWare workspace (some options apply only to accounting). An object group can be created by selecting **Group,** then **Add Object Group** in the Display Group Editor. Double-clicking the new object group entry will bring up the Object Display Group Configuration dialog. The membership of the group and the fill style, fill color, visibility, drawing layer, and border color of the group members can be set with this dialog. The membership of the group is controlled by selecting the **Select Objects(s)** button.

An object can also be added to an Object Display Group by right-clicking the object on the workspace, hovering over **Add to Object Group**, and selecting the desired Object Display Group. If the object is already a member of an Object Display Group, this option will be replaced with **Object Group Membership.** Hovering over this option will show the display group to which the object belongs. The fill style, fill color, and border color apply only to objects in the Accounting View as indicated in the Object Display Group Configuration dialog. The Drawing Layer option is useful when simulation objects are stacked on top of each other on the workspace. The user can control the order of the layering or stacking by specifying the Drawing Layer. Objects with a higher priority Drawing Layer (lower numerical value) will be displayed on top of objects with a lower priority Drawing Layer.

Exporting and Printing Model Images

It is possible to export or print an image of the workspace for use in presentations or other graphic applications.

Exporting Model Images

Selecting **File,** then **Export Workspace** Image brings up the options to export the entire workspace image or only the visible portion of the workspace. The image can be saved in the following formats: PNG, BMP, JPG, PMB, PGM, PPM, XMP, or XMB. It is also possible to specify image resolution, width, and height in the export dialog.

In general, users will get the best results if they use PNG instead of JPG. PNG is very much like GIF, but has an open specification. (GIF is proprietary). JPG is lossy, but best for images with a lot of continuous variation. GIF and PNG are non-lossy for images with a limited number of colors (no more than 256 colors, which is the case with RiverWare workspace images, for the most part), and they compress really well for images with large blocks of solid color (also an attribute of the workspace). Also, GIF and PNG are much cleaner for the purpose of workspace and plot images. With JPEG, the user may see jagged edges.

Printing Model Images

The print option prints the entire workspace image. To print the workspace, select **File,** then **Print,** which brings up the Setup Printer dialog. In this dialog, various printing options can be selected.

Chapter 2
Model File Management

RiverWare models are saved as text files with or without compression. These files could be viewed and edited with a text editor outside of RiverWare, but their complexity and frequent format changes make direct editing difficult and dangerous. CADSWES neither recommends nor supports direct editing of model files.

Topics

- Loading Models, page 59
- Saving Models, page 61
- Locking Models, page 68
- Model Comparison Tool, page 68
- RiverWare Packages, page 83

Loading Models

Loading a new model clears any existing model on the workspace after prompting the user for verification. In the case of a blank workspace, no verification is needed.

Opening Models With the File Chooser

To load a model, select **File**, then **Open Model** from the main workspace menu bar or select **Open Model File**.  on the toolbar. A File Chooser dialog appears.

The file chooser filters by commonly used file extensions for Model Files, as follows:

- Model Files: *mdl, *.mdl.gz *.rw and *.rw.gz (default)
- gzip Files (*.gz)
- All *

For RPL sets, the filters include the following:

- Ruleset files (*.rls, *.rls.gz)
- Goal Set files (*.opt, *opt.gz)
- Global function sets (*.gfs, *gfs.gz)

- gzip files (*.gz)
- All (*)

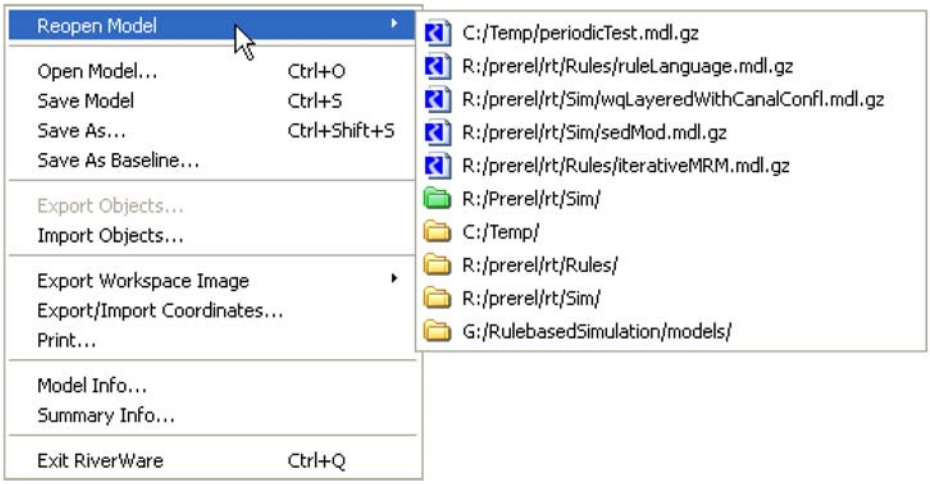
In addition, the user can use asterisks (*) as wildcards in the File name to further filter. Once a file has been selected and the **Open** button has been selected, the cursor turns into an hourglass while the model is loading. Once the model is loaded a diagnostic window pops up with information regarding the date and time when the model was last saved, by whom the model was saved, and which version (release) of RiverWare.

If the model is configured to display background images in one or more of the Workspace views, then after the model is loaded, RiverWare reads and displays the background image files. While RiverWare is loading these images, a gray *placeholder* background is displayed in the appropriate views and an animated Busy icon is shown at the bottom of the Workspace. All of the usual workspace interaction is still possible while images are being loaded.

Note: For many background images, the loading process is so brief that it is not noticeable.

Reloading Models

On the Workspace, selecting **File**, then **Reopen Model** gives the user previously opened models and directories. This is a quick and easy way to reopen a model. For rulesets there are options to **Reopen** and **Reopen and Load** previously viewed rulesets.



Listed in this menu are previously opened models and a list of recently accessed directories. Selecting a directory item (shown with a yellow folder icon) opens up a file chooser initialized to the specified directory. Also shown is a single user-configured default directory (for the specific type of file), based on an environment variable. This directory is shown as a green folder. If this is defined, the file chooser opened using the **File**, then **Open** menu will open to that default directory the first time within a RiverWare session. Table 2.1 lists supported environment variables.

Table 2.1

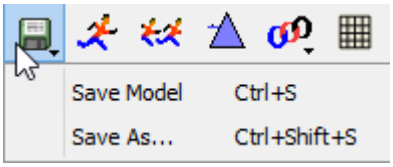
Type of File	Environment Variable
Model Files	RIVERWARE_DFLT_MODEL_DIR
Rulesets (RPL)	RIVERWARE_DFLT_RULESET_DIR
Optimization Rulesets	RIVERWARE_DFLT_OPTSET_DIR
SCT Files	RIVERWARE_DFLT_SCT_DIR

Saving Models

There are three ways to save a model in RiverWare: the default **Save**, **Save As**, and **Save As Baseline**.

Save

The **Save** command saves the current model with the same name and in the same directory as it was last opened or saved. Use the Save button and then Save Model.

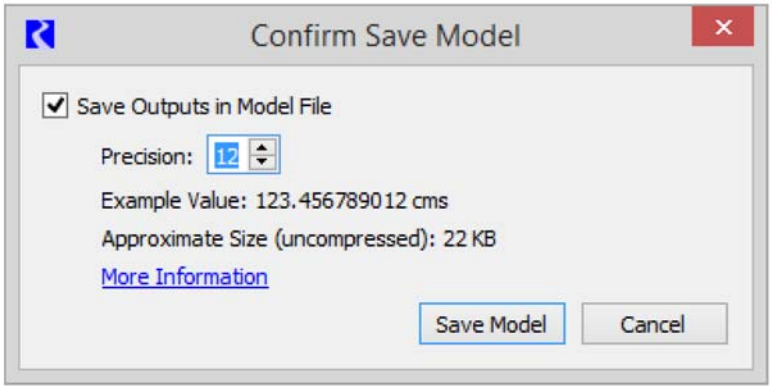


Save As

The **Save As** command invokes a file chooser to select a new name and/or directory into which to save the current workspace. Once a Save As has been performed, any subsequent Save will use the same file name and directory until a new model is loaded, the RiverWare session ends, or a new Save As overrides it.

Use the Save button and then Save As.

When using **Save As**, after you specify the file, a confirmation will allow you to specify whether to **Save Outputs in the Model File** and the **Precision** with which to save outputs. See "Saving Output Values" on page 62 for details.



Save As Baseline

The **Save As Baseline** option is used to create an unalterable baseline model for generating alternate simulation scenarios with the Scenario Manager. Creating alternate scenarios is described in greater detail in the Scenario Manager section.

Note: You can save a model for use in the RiverWare Interactive Scenario Explorer (RiverWISE) using the **Export to RiverWISE** option. See "RiverWare Export to RiverWISE" in *RiverWISE Model Developer's Guide* for details.

Saving Output Values

As models can be large and take up significant disk space, several options are available for minimizing the saved model size.

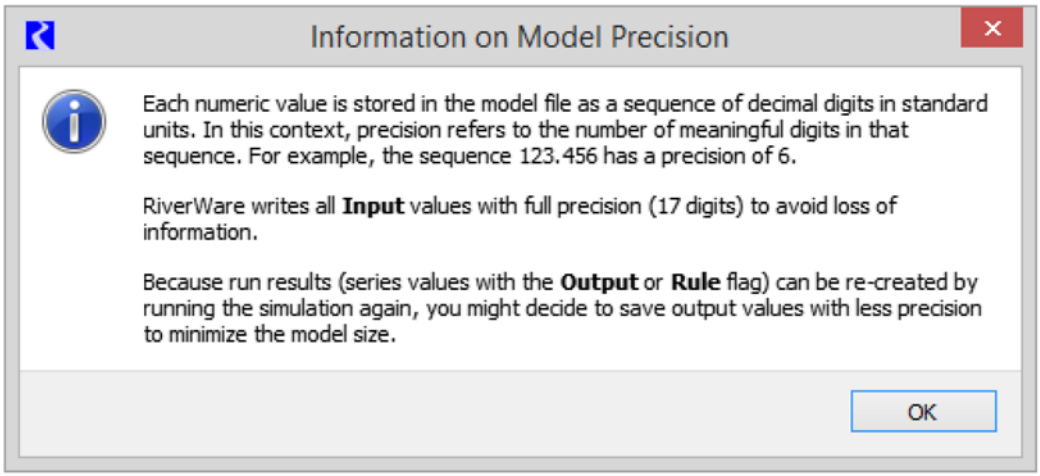
Saving Output Options

One option is whether or not to save the model with its calculated output values (series values with the **Output** or **Rule** flag). The model file size is greatly reduced if the output values are not saved. This is the recommended option for saving small, frequently run models. Since only the input values are required to reproduce a run, the output may be regenerated by re-running the simulation once the model has been re-loaded. But, if your model is large or takes a long time to run, you will likely want to save results, so that you can look at output values without re-running. Only Save As prompts for whether or not to save output values. The selected choice is then applied for all subsequent Saves until a new model is loaded, the RiverWare session ends, or a new Save As overrides it. The default Save behavior for a new session or model is to save output values. All series slot values with the **Input** flag (**I**, **Z** or **i** flag) and all values on non-series slots are always saved in the model file with full precision (17 digits).

Precision for Outputs

Precision refers to the number of meaningful digits in a numeric value. In the Save As confirmation, if you select the option to **Save Outputs in the Model File**, you will also have the option to set the **Precision** with which to save output values. You can save outputs with 1 to 17 digits of precision. Saving with higher precision will increase model size. In the interface, select the **More Information** link for additional information about precision. All series

slot values with the **Input** flag (**I**, **Z** or **i** flag) and all values on non-series slots are always saved in the model file with full precision (17 digits).



Naming Conventions

Although there is no required extension for RiverWare model files, the `.mdl` extension is often used to identify a file as a model file, and a `.rls` extension is used to identify a ruleset file.

Further, files that end in the `.mdl` extension will display the RiverWare model file icon in windows explorer. Double-selecting the icon will open the latest installed version of RiverWare and load that model.



Compressing Model Files

Model files may be automatically compressed when they are saved by giving their file name a `.gz` extension (the gnu zip compression). When the model is re-loaded, the extension is detected, and the file is uncompressed automatically. Thus, the `.mdl.gz` extension is often used to identify a file as a model file and a `.rls.gz` extension is used to identify a ruleset file when compression is desired.

In Windows, the association between RiverWare and the `.gz` file extension has not been made because of the general nature of the `.gz` extension,. You can manually associate `.gz` files with RiverWare so that RiverWare will automatically open when you double-click a `.gz` file. To do this, right-click a `.gz` file and select **Properties**. Then select the **Change** button and select RiverWare from the list of files.

Backup Files Created When Saving Manually

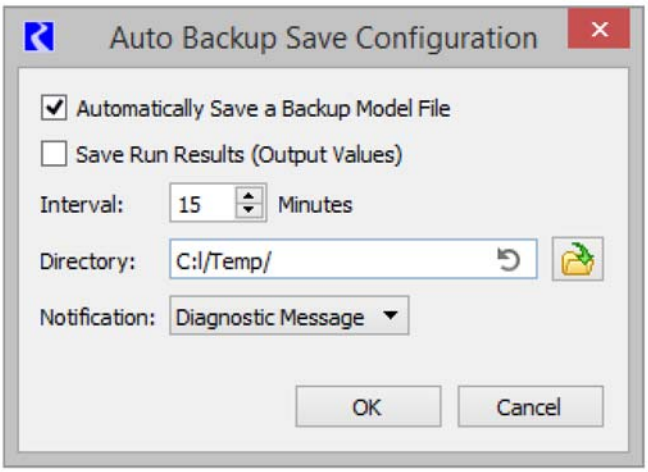
The first time a model is saved to an existing file, a backup of the original file is made. This prevents data loss if an overwrite is unintentional or the save process fails and the model is corrupted. The backup file has the same name as the original with a `.bak` extension. A single backup file is made for each model. When upgrading to a newer version of RiverWare, the backup model file name will contain the previous RiverWare version number to the

model file (e.g., SampleModel.6.5.mdl.gz). This ensures that there will be a model file compatible with RiverWare version 6.5 until the user explicitly removes it.

Automatic Backup Save

The automatic backup save utility saves a backup file in a temporary directory at a defined interval. It is strictly a backup save of the model file, and it never overwrites the model open currently.

The feature is configured from the workspace **File**, then **Automatic Backup Save Configuration** menu item, which opens the Automatic Backup Save Configuration dialog.



From the dialog, you configure the following:

- Whether the model file should be Automatic Backup Saved. If unchecked, the remaining fields are irrelevant.
- Whether the Automatic Backup Saved backup file should contain run results (output values).
- The Automatic Backup Save interval. See “Automatic Backup Save Interval” on page 65 for details.
- The Automatic Backup Save directory, by default the user's temporary directory. See “Automatic Backup Save Directory” on page 65 for details.
- The Automatic Backup Save notification:
  - **None**. RiverWare beeps at the beginning of the Automatic Backup Save and provides no further notification.
  - **Diagnostic Message**. RiverWare beeps at the beginning of the Automatic Backup Save and displays a diagnostic message upon its successful completion. A single message is posted in green if successful.
  - **Status Dialog**. RiverWare opens a notification window at the beginning of the Automatic Backup Save and closes the window upon its successful completion. If the Automatic Backup Save is unsuccessful the notification window remains open and displays the error.

In all cases, if the Automatic Backup Save is unsuccessful an error message is displayed and Automatic Backup Save is disabled (with a red highlight message in the diagnostics):

```
Auto-saving the model file failed: Cannot open "C:\Bad\Directory\Model.mdl" for
writing: No such file or directory
```

```
Automatic Backup Save has been disabled for model file(s)
```

If you want to see additional messages on the automatic backup save process, turn on **Workspace**, then **Model Load/Save** diagnostic category.

Automatic Backup Save Interval

RiverWare performs activities during which an Automatic Backup Save is not appropriate, for example during a simulation. If an Automatic Backup Save comes due during such an activity the Automatic Backup Save feature enters retry mode:

- The **Automatic Backup Save** interval is set to one minute.
- Within a minute of the activity's completion the model file is Automatic Backup Saved.
- The **Automatic Backup Save** interval is restored to its configured value.

Automatic Backup Save Directory

By default the Automatic Backup Save directory is the user's temporary directory. On recent versions of Windows this is:

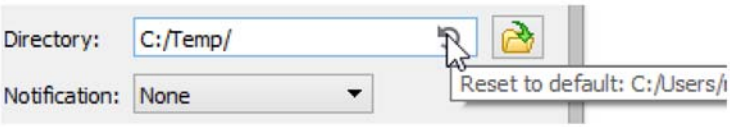
```
C:\Users\<user name>\AppData\Local\Temp
```

It's unlikely a user will have write permission for another user's temporary directory. To facilitate sharing models, if a user loads a model file with Automatic Backup Save enabled and doesn't have write permission for the Automatic Backup Save directory, the Automatic Backup Save directory is changed to the user's temporary directory (with a green highlight diagnostic message):

```
Automatic Backup Save directory has been changed to: C:/Users/Voltaire/AppData/
Local/Temp/
```

Finally, because the Automatic Backup Save directory might not be obvious to all users, the configuration dialog has a **Reset** button, which resets the Automatic Backup Save directory to the user's temporary directory, as shown in Figure 2.1.

Figure 2.1



Open Automatic Backup Save Model Menu Item

If the model file has been Automatic Backup Saved, the backup file can be opened by selecting the **File**, then **Open Automatic Backup Save Model** menu item. (If the model file hasn't been Automatic Backup Saved, the menu item is hidden.) This is equivalent to selecting the **File**, then **Open Model** menu item, navigating to the Automatic Backup Save directory and selecting the backup file.

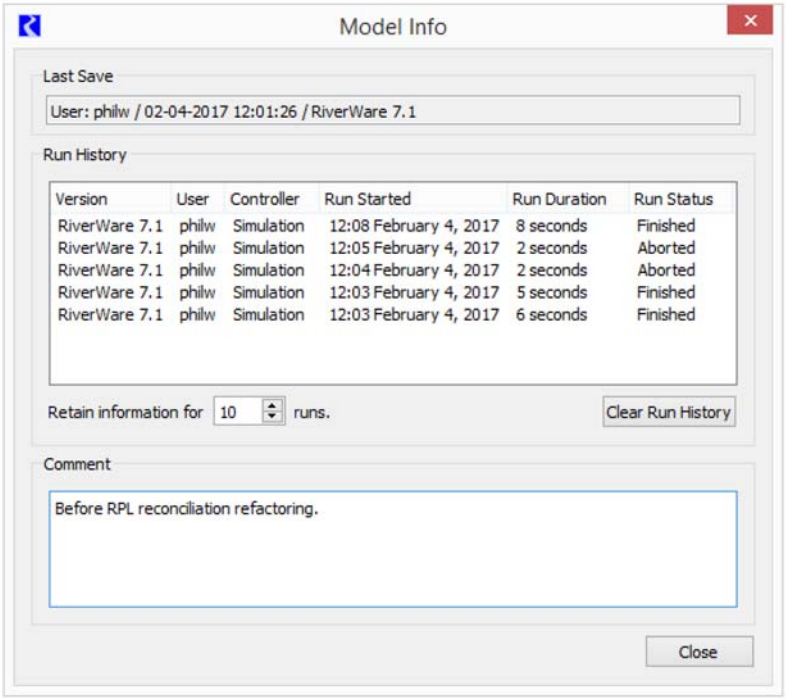
Backup File Name

If the model file name ends with either `.mdl` or `.mdl.gz`, the extension is preserved and the backup file name is <file name>.~1~.mdl or <file name>.~1~.mdl.gz. Otherwise the backup file name is <file name>.~1~. If there is not a model file loaded from a named file, the backup file name is Workspace.~1~.

Model History and Comments

When a model is loaded, a diagnostic window opens with the Model Save History. The model save history appears as a brown diagnostic message with information regarding the date and time when the model was last saved, the username of person who save the model, and the RiverWare version in which the model was last saved. The last save is part of the Model File Information and is stored with the model file when a model is saved. The model save history is automatically updated each time a model is saved.

The save history is also accessible within the Model Info dialog accessed by selecting **File**, then **Model Info** from the main RiverWare workspace. This dialog includes the Last Save, Run History and Comment.



Last Save

The Last Save shows a single line, as information for only the last save operation. This text can be selected and copied to the system clipboard.

Run History

The Run History panel lists a user specified number of run history records including

- Version
- User
- Controller used
- Time the run was started
- Run duration
- Run status

You can control how many run history records to save in the **Retain information for N runs** field. This panel has a **Clear Run History** operation to clear all of the records. Because the records are saved in the model file, specifying a large number of runs to save will make the model file larger. Clearing these can recover that space.

> **Note:** Since run history items are stored in the model file, items for runs performed since the model load will be retained in the model file only if the model is subsequently re-saved.

The Run History panel allows you to right-click and **Copy selected items** to the system clipboard. When you paste, you can either paste in a standard formatted (i.e. HTML table) or unformatted tabular form. Figure 2.2 shows a sample of the paste results for an email program.

Figure 2.2



Version	User	Controller	Run Started	Run Duration	Run Status
RiverWare 7.1	philw	Simulation	12:08 February 4, 2017	8 seconds	Finished
RiverWare 7.1	philw	Simulation	12:05 February 4, 2017	2 seconds	Aborted
RiverWare 7.1	philw	Simulation	12:04 February 4, 2017	2 seconds	Aborted
RiverWare 7.1	philw	Simulation	12:03 February 4, 2017	5 seconds	Finished


```
+---------------+-------+------------+------------------------+--------------+------------+
| Version       | User  | Controller | Run Started            | Run Duration | Run Status |
+---------------+-------+------------+------------------------+--------------+------------+
| RiverWare 7.1 | philw | Simulation | 12:08 February 4, 2017 | 8 seconds    | Finished   |
| RiverWare 7.1 | philw | Simulation | 12:05 February 4, 2017 | 2 seconds    | Aborted    |
| RiverWare 7.1 | philw | Simulation | 12:04 February 4, 2017 | 2 seconds    | Aborted    |
| RiverWare 7.1 | philw | Simulation | 12:03 February 4, 2017 | 5 seconds    | Finished   |
+---------------+-------+------------+------------------------+--------------+------------+
```

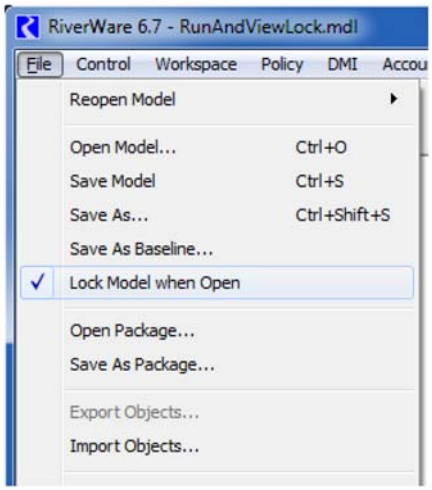
Comments

Enter comments about a model into the Comment section. Like the save history, this information is saved together with the model file. You can write comments or a brief description of a model.

> **Note:** Model Info can be shown in a Model Report using the Model Information (see "Model Information" in *Output Utilities and Data Visualization*) and Run History (see "Run History" in *Output Utilities and Data Visualization*) items.

Locking Models

If more than one user is working on a model, then you may want to lock the model when open to prevent others from simultaneously changing the file. To do this, use the **File**, then **Lock Model when Open** menu item and then *save the model.* Then a lock file is created in the same directory as the model. This lock file is also created when the model is opened.



The person who first opens the model is notified that they have locked the model file, which prevents write access by other instances of RiverWare. The lock file is in the same directory path as the model file and has the name of the model plus the `.lock` extension. When the model is closed, the lock file is automatically removed.

If the model is opened when a lock file already exists, the user is notified that the model file is locked by another instance of RiverWare. The time the lock file was created and the owner of the lock file is shown if that information is available from the system. Then, the model is in a state where the Save functionality is disabled. But, you can still make changes within the opened model and Save As a different name.

Model Comparison Tool

When developing a model, it is often desirable to compare a model to some previous version of the model to identify differences. In addition, comparison tools are essential when multiple people are developing a model or there are multiple versions of a model that are to be merged together.

Model Comparison Use Case

The need for a model comparison tool can be illustrated by the following use case.

1. Bob acquires a copy of the current “official” version of the model file, modifies it, and saves a new model file. The modification process could be lengthy and involve many different sorts of changes, e.g., adding objects and slots, running DMIs, executing runs, interactively changing data, etc.
2. Bob provides the new model file to Susie, who would like to understand the ways in which the new model differs from the original one. A comparison tool helps Susie locate and understand the differences.

3. Having reviewed Bob's changes, Susie might then incorporate some or all of these modifications into a new model and then save this new model as the new official version.

   Note: If only some of Bob's changes are to be incorporated into the official model, or if the official model has changed since Bob originally obtained a copy of it, then Susie cannot simply replace the current official model with the model provided by Bob. Instead Susie should compare Bob's model with the original or updated "official" model to see what has changed and then make those same changes to the original model.

The Model Comparison Tool compares many entities of two models. It looks at the properties of the entities and their values. It then shows the differences and allows you to see which items have changed.

Following are the limitations of the Model Comparison Tool:

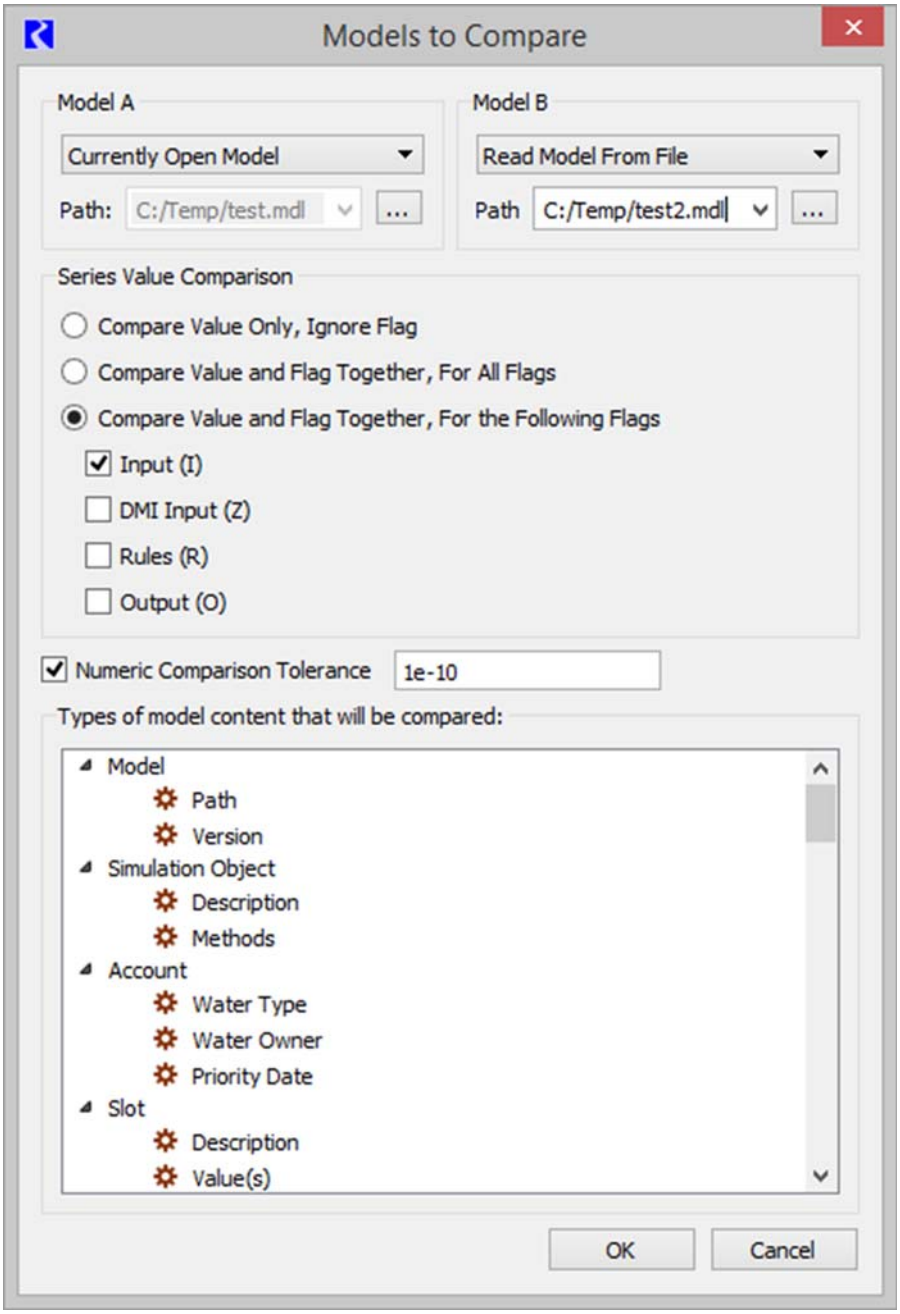
- A subset of model entities are currently compared by this tool. The compared items are shown in the model selection dialog and in Table 2.2. In general, objects, accounts, slots, slot values, DMIs, and RPL Sets saved within the model are compared.
- This tool doesn't support automatic merging but allows you to copy from the selected property values panel and paste into the opened model.

Accessing the Model Comparison Tool

From the RiverWare workspace, select **Utilities**, then **Model Comparison Tool**.

Selecting Models to Compare

The tool opens and shows a dialog where you specify the two models to compare.



The two models are referred to as Model A and Model B. For both models, choose one of the following:

- **Currently Open Model**. Choose the currently opened model, including any changes made since last saving the model.

- **Read Model from File**. Choose a model on the file system. Use the ellipsis button to open a file chooser to select the model.

The middle portion of the dialog shows which entities and properties in the model file will be compared. In general, objects, accounts, slots, slot values, and RPL Sets embedded within the model are compared.

> **Note:** This is a small subset of entities/properties in the model file. For example the path of the two models is compared, but the run timestep is currently not compared. The list of content will be expanded in future releases.

All RPL sets saved or embedded in the model file are automatically compared including:

- Expression Slot Set
- Global Function Set (when saved in the model as described "Save Location" in *RiverWare Policy Language (RPL)*)
- Initialization Rules
- Iterative MRM Ruleset
- Object Level Accounting Method Set
- Optimization Goal Set (when saved in the model as described "Save Location" in *RiverWare Policy Language (RPL)*)
- Rulebased Simulation (RBS) Ruleset (when saved in the model as described "Save Location" in *RiverWare Policy Language (RPL)*)

Those saved as separate files are not compared with this tool, but can be compared using the RPL Set Comparison tool.

Table 2.2 provides a description of each entity compared, and for each of the entities, the properties that are considered.

> **Note:** Not all entities of a given type will have all of the properties, e.g., not all slots have expressions.

Table 2.2 Description of content and properties compared by the Model Comparison Utility

Entity	Properties
Model	• Path - The location of the model on the file system are compared as text. • Version - The RiverWare version from the last save.
Simulation Object	• Description - The text description as shown on the Open Object dialog's Description tab are compared as text. • Methods - The user-selectable methods, shown on the object's **Methods** tab are compared as text. **Note:** The tool compares all categories and methods, whether they are visible or not (perhaps because they are specific to a certain controller or dependent on other methods/categories). They are listed alphabetically by category.
Account	• Water Type - For each account, the Water Type is compared. • Water Owner - For each account, the Water Owner is compared. • Priority Date - For each account, the Priority Date is compared.

Table 2.2 Description of content and properties compared by the Model Comparison Utility

Entity	Properties
Slot	• Description - For each slot, the description is compared as text. • Value(s) - The values of slots are compared using the tolerance described below. The slot values are shown in the appropriate format based on the type of slot. For tables, periodic and scalar slots, the values are compared using the full precision in standard values on the slots. For series slots, the comparison uses the setting shown in the Series Value Comparison, described in the next section. **Note:** Some slot types or values may not display exactly as shown in RiverWare dialogs. For example, values using the DateTime unit type are compared but the values shown are the numeric encoding. This will show you a difference and you can look at the slot for the actual DateTime value. • Expressions - For expression slots, the RPL expression is compared.
DMI Manager	DMIs are compared in a hierarchical structure. The DMI Manager is the top level item and contains: • Locked Status - Is the DMI locked? Yes/No compared as text. • Show Progress - Will the DMI Progress dialog be displayed? Yes/No compared as text. • Show Status - Will the DMI Status dialog be displayed? Yes/No compared as text.
Control File-Executable DMI	These items correlate directly to the Control File-Executable DMI dialog. All content is compared as text and toggles are shown as Yes or No. • Name - the DMI name is compared as text • Input or Output - the DMI input/output type is compared as text. • Confirm Warnings - Does the DMI confirm warnings, compared as Yes/No. • Record Invocations - Yes or No, compared as text • Control File - The control file is compared • Executable - The executable and path are compared as text. • Allow Spaces in File Paths - Yes or No • Limit Output Range to Run Range - Yes or No • Line Ending - - Native, windows, or unix • Active User Parameters - Only the active user parameters are compared as text.
Trace Directory DMI	These items correlate directly to the Trace Directory DMI dialog. All content is compared as text and toggles are shown as Yes or No. • Name - the DMI name is compared as text • Input or Output - the DMI input/output type is compared as text. • Confirm Warnings - Does the DMI confirm warnings, compared as Yes/No. • Record Invocations - Yes or No, compared as text • Allow Spaces in File Paths - Yes or No • Limit Output Range to Run Range - Yes or No • Line Ending - Native, windows, or unix • Top Level Directory - The file path is compared as text. • Control File - The control file (sometimes called a control file template) is compared. • Single Trace Number - The trace number used for a single run.

Table 2.2 Description of content and properties compared by the Model Comparison Utility

Entity	Properties
Database DMI	The properties for a Database DMI show a hierarchical structure displaying the following item: • Name - the DMI name is compared as text • Input or Output • Confirm Warning - Yes or No • Record Invocations - Yes or No • User Parameters - Compared as text
> Dataset	Then, there is a sub item for each referenced Dataset • Name - The name of the referenced dataset. • Type - Either DSS, HDB, or Excel • Enabled - Yes or No
> > Slot Selection	Then, there is another sub item for each referenced Slot selection: • Selection Label - The label shown for this slot selection • Enabled - On or off • Begin Timestep • End Timestep • Slot List - The expanded list of slots for this slot selection
Database Group	• Name - The group name is compared as text. • Comment - Comments are compared as text • Members - The names of DMIs contained in the group are compared as text.
DMI Year Mapping Group	• Name - The group name is compared as text. • Comment - Comments are compared as text • Members - The names of DMIs contained in the group are compared as text. • Map Years - The list of map years is compared.
DMI Parameter	• Name - The parameter name is compared as text. • Minimum Value - The minimum value is compared. • Maximum Value - The maximum value is compared. • List Items - The list of possible values is compare as text.

Table 2.2 Description of content and properties compared by the Model Comparison Utility

Entity	Properties
DSS Dataset	These items correlate directly to the DSS Dataset dialog. All content is compared as text and toggles are shown as Yes or No. • Name • Name Map • Missing Value Preference • Missing Value Replacement • Unit Preference • Unit List • Read Table Behavior • DSS File • DSS Path • Data Type List
Excel Dataset	These items correlate directly to the Excel Dataset dialog. All content is compared as text and toggles are shown as Yes or No. • Name • Name Map • Missing Value Preference • Missing Value Replacement • Unit Preference • Unit List • Connection Process • Workbook • Slot Mapping • Header Specification • Header Orientation • Ranges on Same Worksheet • Worksheet • Apply Header Offset • Header Offset • Apply Range Offset • Range Offset • Run Name Type • Single Run Name • Use Begin Timestep • Use Units

Table 2.2 Description of content and properties compared by the Model Comparison Utility

Entity	Properties
HDB Dataset	These items correlate directly to the HDB Dataset dialog. All content is compared as text and toggles are shown as Yes or No. • Name • Name Map • Missing Value Preference • Missing Value Replacement • Unit Preference • Unit List • Group Slots • Database Name • Table Type • Mapping ID • Model ID • Model Run ID • Runtime Model Run ID • Ensemble ID • Runtime Ensemble ID • Ensemble Agency ID • Ensemble Trace ID • Use Water Year Table • Use Overwrite Flag • Read Validation Character
Name Map	• Name - The name is compared • Display Order - The ordering of the name maps are compared.
RPL Set (for all sets that are saved within the model file)	• Name - The set names are compared as text. • Agenda Order - The agenda order (1,2,3... or ... 3,2,1) are compared as text. • Description - The set description is compared as text. • Precision - The set precision is compared as a numeric value. • Is Global? - Is this set a global functions set. • External Documentation - The external documentation toggle is compared as text.
Utility Group (as part of a RPL set saved within the model)	• Name - The group names are compared as text. • Description - The group description is compared as text. • Notes - The group notes are compared as text. • Is Enabled - The enabled/disabled setting is compared. • Names Color - The colors used for the group name is compared as a color value. • External Documentation - The external documentation toggle is compared as text.

Table 2.2 Description of content and properties compared by the Model Comparison Utility

Entity	Properties
Policy Group (as part of a RPL set saved within the model)	• Name - The group names are compared as text. • Description - The group description is compared as text. • Notes - The group notes are compared as text. • Is Enabled - The enabled/disabled setting is compared. • Names Color - The colors used for the group name is compared as a color value. • External Documentation - The external documentation toggle is compared as text.
Report Group (as part of a RPL set saved within the model)	• Name - The group names are compared as text. • Description - The group description is compared as text. • Notes - The group notes are compared as text. • Is Enabled - The enabled/disabled setting is compared. • Names Color - The colors used for the group name is compared as a color value. • External Documentation - The external documentation toggle is compared as text.
Rule, Goal Method (as part of a RPL set saved within the model)	• Name - The rule names are compared as text. • Priority - The rule priority values are compared. • Description - The rule description is compared as text. • Notes - The notes are compared as text. • Is Enabled - The enabled/disabled setting is compared as true or false. • Execution Constraint - The execution constraints are compared as RPL items. • Pre-Execution DMI Name - The pre-execution DMI names are compared as text. • Post-Execution DMI Name - The post-execution DMI names are compared as text. • External Documentation - The external documentation toggle is compared as text. • Stop on NaN - The Stop on NaN settings are compared as true or false. • Names Color - The colors used for the rule name is compared as a color value. • Statements - The RPL statements are compared as RPL items.

Table 2.2 Description of content and properties compared by the Model Comparison Utility

Entity	Properties
Function (as part of a RPL set saved within the model)	• Name - The function names are compared as text. • Description - The function description is compared as text. • Notes - The group notes are compared as text. • Is Enabled - The enabled/disabled setting is compared. • Arguments - The functions' set of arguments are compared as text. • Return Type - The functions' return type (NUMERIC, BOOLEAN, etc) are compared as text. • Diagnostic Units - The Display Function Diagnostics Scale/Units is compared as text. • Pre-Execution Diagnostics - The pre-execution diagnostic toggle is compared as true or false. • Post-Execution Diagnostics - The post-execution diagnostic toggle is compared as true or false. • Is Time Varying - The toggle for Time Varying is compared. • External Documentation - The external documentation toggle is compared as text. • Post-Execution Checks - The functions' Post-Execution Checks are compared as RPL expressions. • Names Color - The colors used for the function name is compared as a color value. • Body - The RPL expressions are compared as RPL items.
Report Item (as part of a RPL set embedded in the model)	• Name - The item names are compared as text. • Item Type - The type of the item (rule, function, object, slot, etc) are compared • Item Parent - The items parent (i.e for a slot, which object is it on) are compared. • Names Color - The colors used for the item name is compared as a color value. • External Documentation - The external documentation toggle is compared as text.

In the Series Value Comparison region, specify how series data values should be compared. The following choices are available:

- Compare Value Only, Ignore Flag: Compare series values, regardless of the flag. For example, if slot 1 has 100.0 (I) in Model A, but 100 (R) in Model B, no difference will be reported.
- Compare Value and Flag Together, For All Flags: Compare series values and flags. For example, if slot 1 has 100.0 (I) in Model A, but 100 (R) in Model B, a difference will be reported.
- Compare Value and Flag Together, For the Following Flags: Compare series values and flags but only for the specified flags. For example, if slot 1 has 100.0 (I) in Model A, but 100 (R) in Model B, no difference will be reported unless the I or R flag check boxes are selected. Choose which flags to compare: Input (I), DMI Input (Z), Rule (R), or Output (O).

If desired, specify an absolute tolerance for numeric comparisons in the **Numeric Comparison Tolerance** field. The value 1e-10 is used by default to avoid flagging as different those values with very small differences that occur due to machine precision.

When finished, select **OK**. The tool then performs the comparison and the main Model Comparison Tool is then shown.

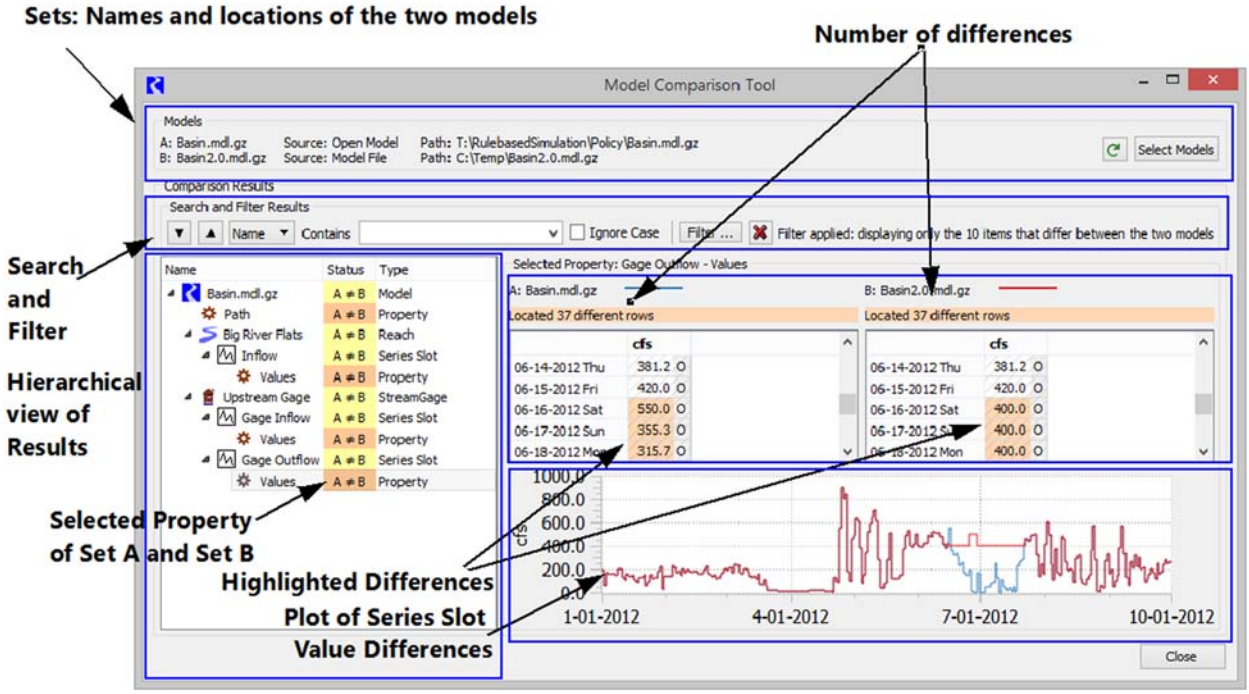
> **Note:** The comparison happens when the selection dialog is confirmed or the **Refresh** button is selected. Afterwards, the tool displays the results of that comparison, which might no longer apply if you have since changed the workspace or deleted the file.

Tour of the Model Comparison Tool

The Model Comparison Tool contains four main areas, as shown in Figure 2.3.

- The Models panel shows the names, sources and paths of the selected models.
- The hierarchical view of results area shows the comparison results. This shows where there are differences between the two models.
- The Search and Filter tools allows for searching and filtering of the results.
- The Selected Property panel shows the property (if any) for the currently selected item in the comparison results view. This shows the differences are highlighted in orange.
- When a series slot's values are selected, a plot is also shown. Data from Model A is shown with a blue line, while model B data is shown in red. A legend above the data reinforces the color usage.

Figure 2.3 Screenshot of the Model Comparison Tool showing the main areas of the tool.



The following sections describe these areas and how to use the tool.

Models Panel

The Models panel shows information about the models that were compared, including, for each model, the name (usually the file name), the source (i.e., whether it was the currently opened model or read from a file), and the full file system path. Use the **Select Models** button to choose different models and initiate another comparison. This opens the Models to Compare dialog; see "Selecting Models to Compare" on page 70.

Recompute the differences between the two models by clicking on the green circular arrow.  This is useful if you make changes to Model A or B.

> **Note:** When the models are selected, the Model Comparison Tool compares the specified models. See "How the Model Comparison Tool Works" on page 82 for details. If you make changes to one of the chosen models, it is not immediately reflected in the comparison tool. Use the **Recompute Differences** button  to update the status in the tool.

Comparison Results Panel

The Comparison Results panel shows a hierarchical view of the results of the comparison. The hierarchy is based on the structures of the two model. For example, objects contain slots as children entities. Aggregate objects have object elements as their children. Objects and slots are listed in alphabetical order within the hierarchy level.

Double-clicking an object or slot item will open the appropriate dialog to view the version of that entity, if one of the models compared was the open model.

Columns include the Name, Status and Type. The Model, Objects, and Slots show their particular icon. The Status column shows the results of the comparison. Table 2.3 lists the possible status values and their meanings.

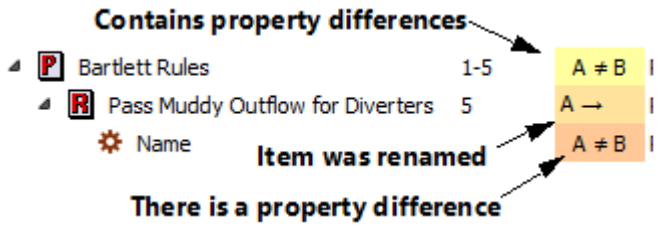
Table 2.3 Definition of the Status values shown in the Model Comparison Tool

Status	Meaning
A = B	The item is identical in Models A and B.
A ≠ B	The item is different in Models A and B.
A	The item exists in model A but not in Model B.
B	The item exists in Model B but not in Model A.
A -->	The item exists here in Model A and elsewhere in Model B and/or the item has been renamed.
<-- B	The item exists here is Model B and elsewhere in Model A and/or the item has been renamed.

The Type column lists the type of that row: either a Model, Simulation Object (type of object), Type of Slot, Account, DMI item, RPL item or property. The comparison tool ultimately compares Properties of the items, not the items themselves. In the **Status** column, the color indicates the following meaning. This is also shown in Figure 2.4:

- Yellow indicates that the item *contains* properties and that within the item there are differences in properties.
- A light orange shading indicates the item's Name property has changed; that is, the item has been renamed. When an item has been renamed (not copied/pasted or moved), the item will show up twice in the list, once with the name used in model A (the status shows "A ->") and once with the name used in model B (the status shows "<- B").
- The darker orange color indicates that the value of the property is different.

Figure 2.4 Legend for Status column colors



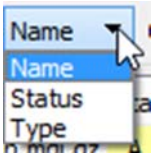
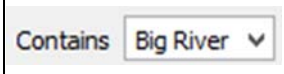
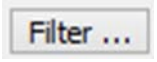
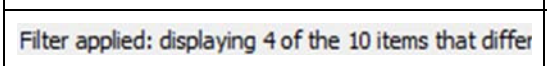
Search and Filter Tools

You can search, in either direction, for specific content in any of the three columns (Name, Status, or Type). Use the drop-down menu to specify in which column to search. Type a string into the search field.

Also, the filtering: users now have more powerful mechanisms for limiting the items displayed in the comparison results tree. Previously, there was a single filter control which allowed users to limit the display to items that were not the same in both models. A new filter dialog was created which contains this checkbox as well as controls for limiting displayed items to those with a specific name, comparison status, or type.

Table 2.4 describes the search and filter buttons in the Comparison Results panel.

Table 2.4 Search and Filter options shown in the Model Comparison Tool

Button	Text	Meaning
	Next Match	Select the next item that matches the search criteria.
	Previous Match	Select the previous item that matches the search criteria
	Search Column	Choose in which column you wish to search.
	Search Content	Type in the search criteria. Use the arrow menu to select previously entered items.
	Ignore Case	Check the box to ignore case when searching. When unchecked, case is considered.
	Filter...	Open a dialog where filters can be applied. This opens the Model Comparison Tool Display Filters dialog; see “Filter Settings” on page 81
	Cancel	Remove all filters.
	Filter Status	Text is shown noting that there are filters applied and the number of items shown.

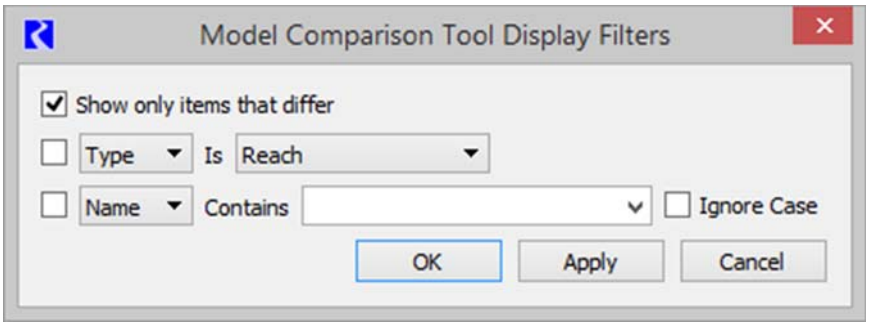
Filter Settings

When displaying results for a large model, there can be many differences. Use the **Filter** button to set up filters to only see desired items. As shown in Figure 2.5, the following types of filters can be applied:

- Show only items that differ
- Two additional filters that can be configured. Options include
  - **Name**: Filter on the Name column to only show results containing the specified text. Choose to Ignore Case if desired.
  - **Type**: Filter on the Type column. The drop-down menu shows the Types that are available in the results.
  - **Status**: Filter on the Status. The menu shows the status values listed in Table 2.3.

When a filter is applied, the status in the Search and Filters status is updated. To remove a filter, select the red **X**.

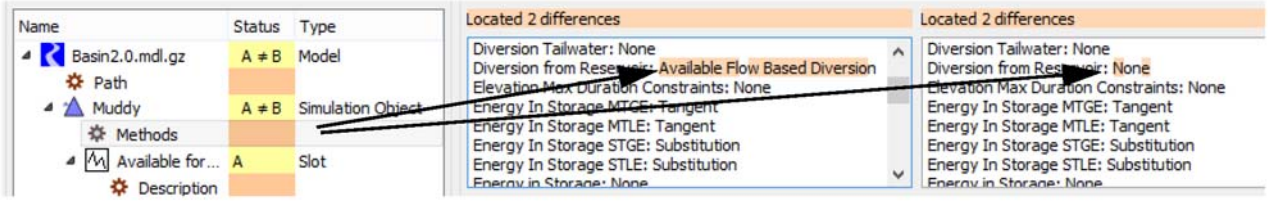
Figure 2.5 Model Comparison Tool Display Filters



Selected Property

The Selected Property panel shows the values for the selected property where applicable. If a yellow row (Model, Object, Slot, etc.) is selected, a note is shown that “No Property Selected”. Only property values are shown in these views. When a **Property** row is selected, the panel shows the values for that property. Depending on which property is selected, its value will be displayed as text, a table of slot value, possibly including a plot, or as a RPL expression. For example, in Figure 2.6, there are differences in the Methods on Muddy reservoir. Selecting the Methods row shows the differences in the Selected Properties area. (This is a character by character comparison of the text, hence there are two differences identified.)

Figure 2.6 Model Comparison Tool results with Selected Property highlighted



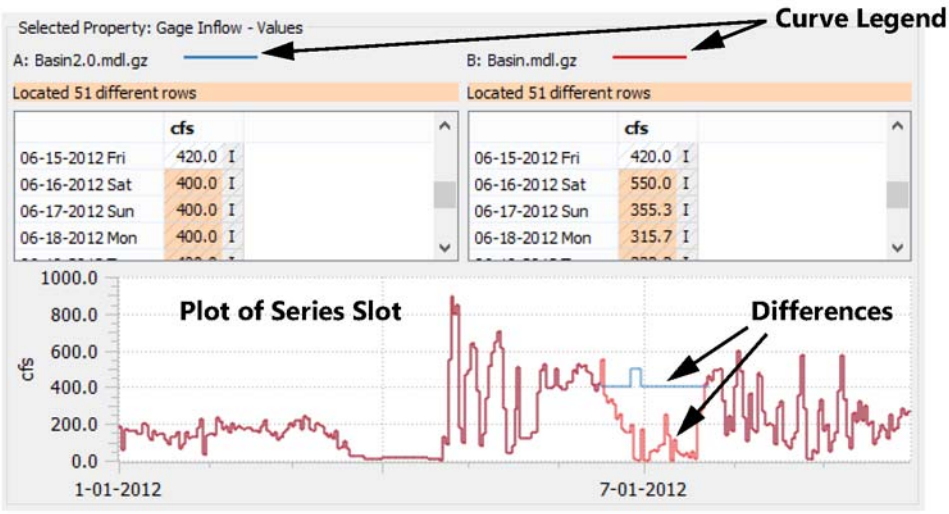
Right-click the property values and choose **Copy** to copy the data to the system buffer. This works for both text differences and slot values. You can paste these to an email, document, or spreadsheet.

Plots

When Values for a series slot are selected, a plot is shown within the Selected Properties panel. The plot shows the entire set of data with two lines, one for each model. Model A data is shown in blue, while Model B data is shown in red. A legend is shown above the data. Figure 2.7 illustrates.

Right-click the plot area for options to Auto-Scale, Zoom, Move, Copy Plot Image, Export Image, or Print. Draw a rectangle on the plot to zoom in.

Figure 2.7 Model Comparison Results with a plot of numerical differences shown.



How the Model Comparison Tool Works

In RiverWare, only one model can be loaded at a time. To be able to compare two models, RiverWare must create in-memory representations of the two sets of data and values to be compared. If Model A is the opened model, then RiverWare needs to read Model B and then create representations of values that can be compared. To do so, RiverWare synchronously executes the following batch RiverWare process.

1. Loads the model file.
2. Creates a representation of the model.
3. Writes that representation to a file.
4. The original RiverWare instance then reads the file into memory.
5. It repeats the same steps for the other model, if necessary.
6. With both sets of information in memory, RiverWare can then compare the properties and values and present the results in the tool.

   Note: Because of this process, comparing large models can take a long time to load the model, write a representation of the data, and then read that data back into RiverWare.

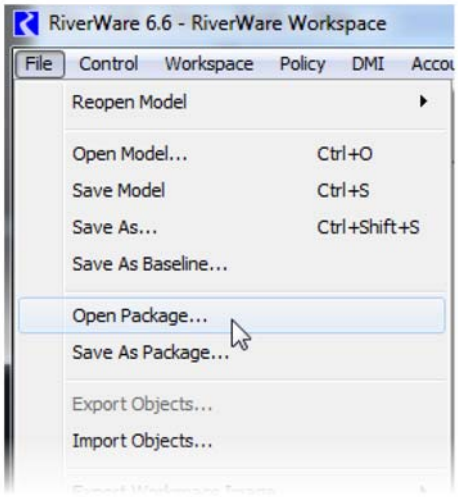
RiverWare Packages

A model and associated files can be grouped together and saved as a RiverWare *package*. These always contain a model file and can also contain ancillary files including the following:

- Rulesets
- Global Functions Sets
- Optimization Goal Sets
- System Control Tables (SCTs)
- Workspace Images

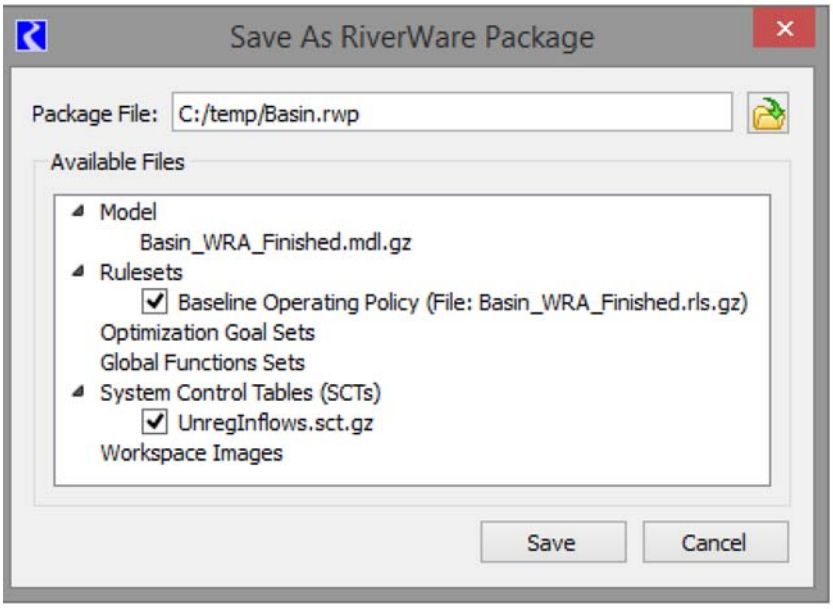
A package is used to group the files together into one file and compress them. This functionality is often used to share a set of files with other users. For example, you can package all the files used with a model and send them to a co-worker. The co-worker opens the package to create all the files in the destination directory and then RiverWare automatically opens them.

Packages are accessed through the Workspace **File** menu. The **Save As Package** and **Open Package** menus on the workspace **File** menu allow you to work with packages.



Saving a Package

Use the **Save As Package** menu to save a set of files together as a package. This opens the Save As RiverWare Package dialog where you specify the package file name. Use the  button to use a file chooser or type in a file path and name. Also, choose the components to include. By default, all available files will be checked.



The model is not checkable and is always included in the package. This includes the model file and any RPL sets that have been configured to be saved into the model file itself. See "Save Location" in *RiverWare Policy Language (RPL)* for details on embedding sets in a model.

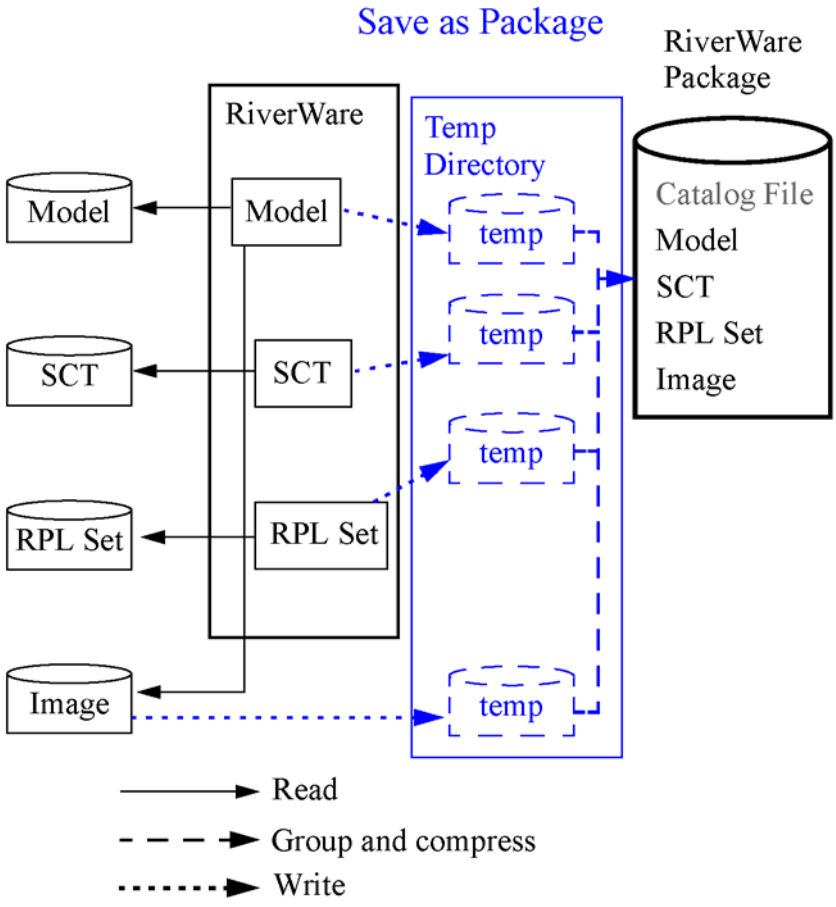
RPL sets (Rulesets, Goalsets, and Global Functions Sets) that are open and that have been saved as files will be listed as individual options for inclusion in the package. If a set has been created, but not saved to a file, you will get a warning message that the set must be saved to be available in the list.

SCTs that are open and that have been saved as files will be listed for inclusion in the package under the SCT category. You can individually select whether or not to include each SCT from the list. If an SCT has been created, but not saved to a file, you will get a warning message that the SCT must be saved to be available in the list.

If simulation, accounting, or geospatial images are used in the model, they are available as options for inclusion in the model package.

In creating the package, all selected files will be saved to a temporary directory for packaging, as shown in Figure 2.8. When packaging is completed, these files and the temporary directory will be deleted, leaving just the specified package file.

Figure 2.8

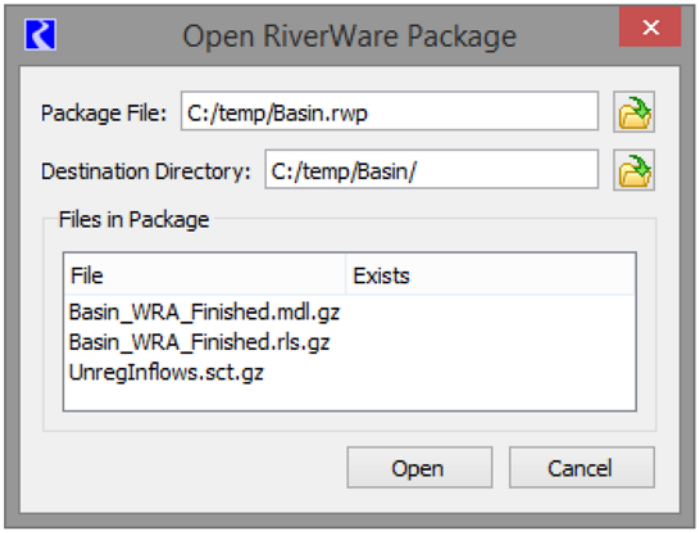


Note: Although not mandatory, CADSWES recommends using the `.rwp` extension to represent RiverWare packages.

If you have made changes to any of these items since they were last saved to files, the copies made for the package will include these changes, but the original files will not. You must save them in normal RiverWare operation to save the changes to the individual files. But, creating a package saves everything as it currently appears in the session without affecting any of the individual files on disk.

Opening a Package

Use the **Open Package** option in the workspace **File** menu to unpacks all the files and then open those files into the RiverWare session. This menu opens the Open RiverWare Package dialog, in which you specify the package file to open and a destination directory to which the files will be unpacked.



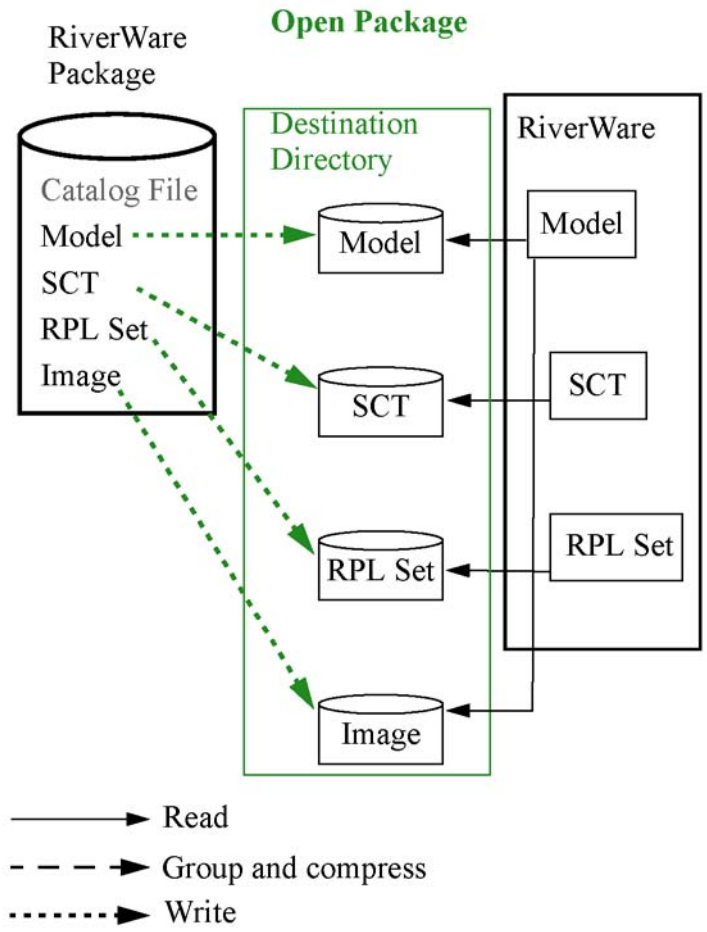
The package file can be chosen via a file chooser  or the name can be typed into the **Package File** line (environment variables are supported). Similarly, the directory where the files will be opened to can also be specified by selection or by typing.

Once the package file is chosen, a default Destination Directory is shown, which consists of a subdirectory using the name of the package. Change the directory as desired.

The Files in Package list displays the names of the files that are in the package. If files corresponding to these names already exist in the specified **Destination Directory**, this will be indicated with Yes in the Exists column of the list. If any of the files currently exist, the message at the bottom appears warning that the existing files will be overwritten when opening the package.

When the package is opened, files in the package will be extracted to the specified directory. The model file will be loaded, and RPL sets and SCT files will be opened. If a RPL set was loaded when the package was saved, it will be reloaded when the package is opened. The workspace images loaded with the model will now have the extracted image files as their source. Extracted files are persistent in their directory even after the RiverWare session is closed, so are just like any other set of RiverWare files. The files can be repackaged at any time into the same, or a different package file using the Save as Package functionality described above. See Figure 2.9.

Figure 2.9


RiverWare
Package
Open Package
Destination
Directory
RiverWare
Catalog File
Model
SCT
RPL Set
Image
Model
SCT
RPL Set
Image
Model
SCT
RPL Set
Read
Group and compress
Write

Chapter 2
Model File Management

Chapter 3
Units

This section describes the following uses of units in RiverWare.

- Standard, internal units in which calculations are performed
- Unit Schemes which allow you to define one or more systems of display units
- A utility to convert the units of values

Topics

- Standard Units, page 89
- Display Units, page 90
- Unit Schemes, page 91
- Unit-specific Calculations, page 99
- Unit Converter Dialog, page 101

Standard Units

In RiverWare, all calculations are performed in standard or internal units. Table 3.1 lists the internal (standard) units for some common unit types.

Table 3.1

Unit Type	RiverWare *Internal* Unit	Display Value
Flow	meter^3 / second	cms
Volume	meter^3	m3
Length	meter	m
Area	meter^2	m2
Time	hour	hour
Energy	megawatt hour	MWH
Power	megawatt	MW
Velocity	meter / second	m/s
Mass	gram	g
Concentration	gram / meter^3	g/m3

The standard units for all unit types can be viewed in the Unit List dialog. From the **Units** menu in the main RiverWare workspace, select **List Available Units.** At the bottom left of the resulting Units List dialog, there is a check box to **Show only units that are present on the workspace**. Uncheck the box to show all available unit types. The first unit listed for each unit type is the standard unit for that type.

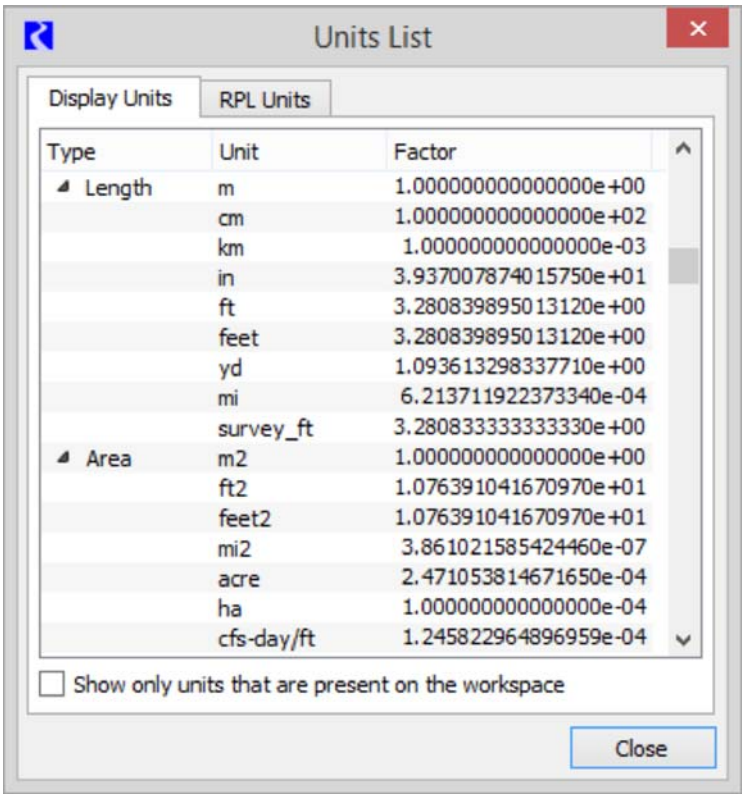
Display Units

You can configure any value in RiverWare to be displayed in units other than the standard units. The display units are user-selectable for each set of data. They may be changed at any time through the Unit Scheme (see Unit Schemes, page 91), or for an individual slot, through the **Slot Configuration** menu; see "Configure Slot Dialog" on page 153.

When data is entered or imported, the values should be in the slot's display units. This means that you must change the display units to match the units of incoming data *before* entering or importing data.

You can view all available display units in RiverWare along with their conversion factors in the Units List dialog; see Figure 3.1. From the **Units** menu in the main RiverWare workspace, select **List Available Units.** All of the available display units are shown on the Display Units tab. At the bottom left of the Units List dialog, there is a check box to **Show only units that are present on the workspace**. Uncheck the box to show all available units and their conversion factors. The Units List dialog also has a RPL Units tab that shows all of the unit components that can be used to construct units in RPL expressions. For more details on RPL units, see "Units in RPL" in *RiverWare Policy Language (RPL)*. You can also view the conversion factors for units by using the Unit Converter; see Unit Converter Dialog, page 101 for details.

Figure 3.1 Units List dialog



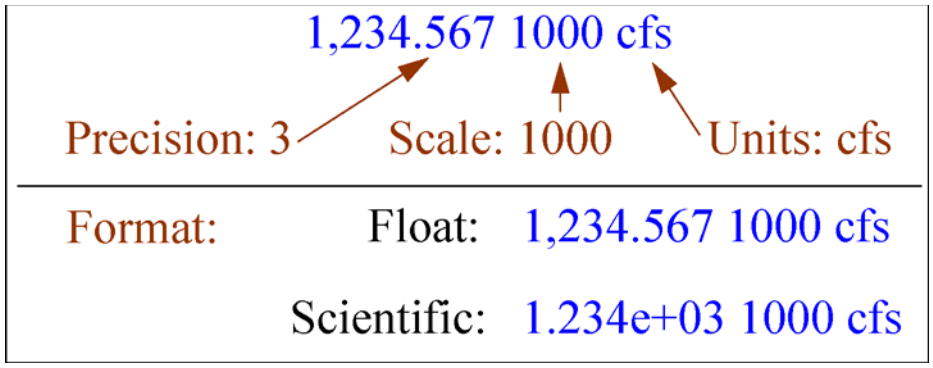
Unit Schemes

A Unit Scheme describes how you want to display numeric slot values in terms of the following display attributes:

- Units
- Scale
- Precision
- Format

Figure 3.2 identifies the attributes.

Figure 3.2



Note: Schemes provide settings for Units, Scale, Format, and Precision. In this document these are collectively referred to as *units*. For example, it says that the slot units are displayed using the settings and rules for the scheme. Remember, this also includes scale, format and precision even though it is not explicitly written.

You can view and edit the Unit Scheme definitions and easily switch between the Unit Scheme in use. For example, you may wish to develop a model using cfs, acre-feet, and ft, but you wish to show the model result to international stakeholders who wish to see results in m3/year, 1000 m3, and m. Create two Unit Schemes with the desired user units and easily toggle between the two schemes depending on who is viewing the model.

Following are some features of Unit Schemes.

- The currently active unit scheme is used everywhere a slot value is displayed, at all times. This includes the slots, objects, and accounts interface, SCTs, diagnostics, RPL debugging, and output devices like plots and model reports.
- Every unit scheme is complete for every Unit Type. It describes how every slot value shall be displayed. Associated with every valid unit type is the desired set of display attributes called a Unit Type Rule.
- You can create exceptions to the Unit Type Rules to display different attributes for the following:
  - A slot with the given name. These are called *Slot Name Exceptions* and apply to slots on any object or a specific object type.
  - A specific object and slot (and column if necessary). This is called a *Slot Exception*.
- When a model saved with RiverWare version 6.3 or earlier is loaded, a *transitional* unit scheme is created which replicates the display of slot values in the prior version.
- Each DMI continues to use the specifications contained within the DMI to interpret the units and scale of input values and to determine the desired units, scale, precision and format of output values. When the DMI does not contain such a specification, the currently active scheme will be used, though the user will be warned that this is happening and encouraged to specify the units within the DMI.

Frequently Asked Questions (FAQs)

Figure 3.3 lists frequently asked questions (FAQs) and short answers, followed by links to more information.

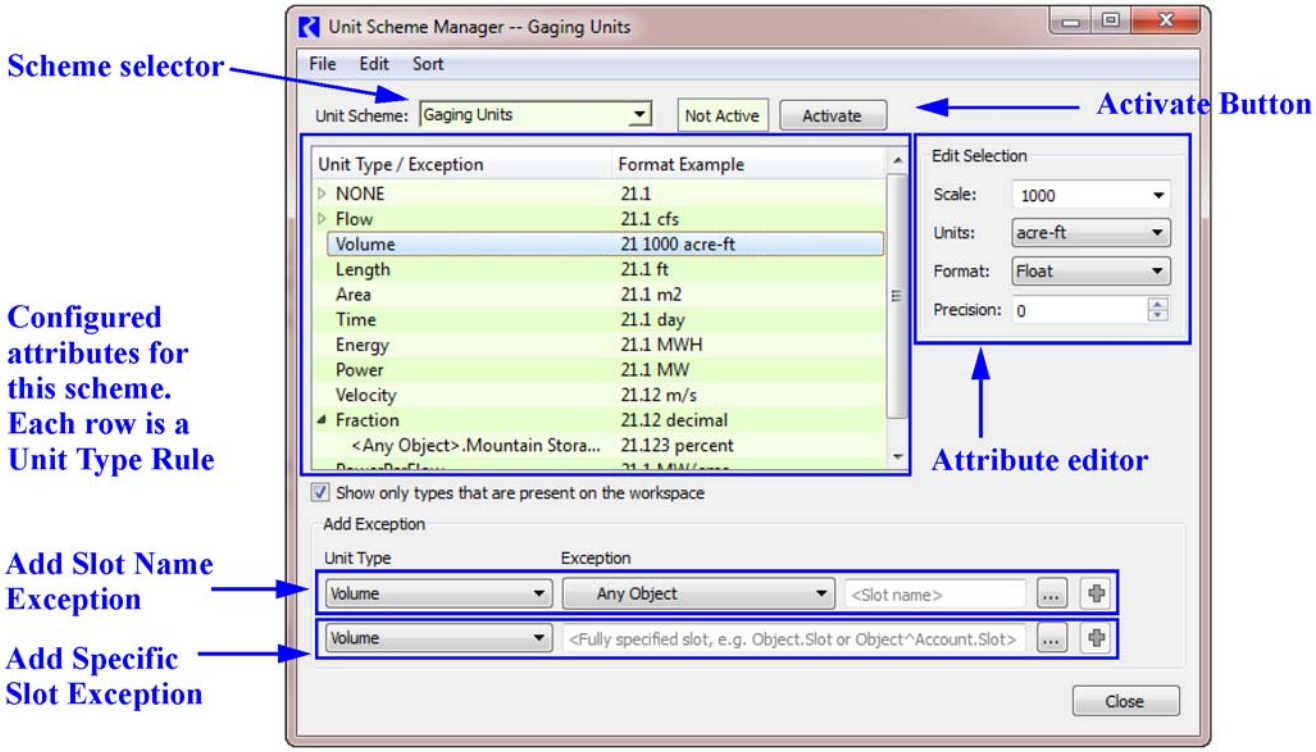
Table 3.2

Question	Answer	Links
What are Unit Schemes?	A Unit Scheme describes how you want to display numeric slot values in terms of four display attributes: units, scale, precision, and format.	Unit Schemes, page 91
To what parts of RiverWare do they apply?	Anywhere a numeric value is displayed. This includes, slots, objects, account, SCT, plots, output devices, reports, RPL debugger, diagnostics	Unit Schemes, page 91
How do I switch between schemes?	From the workspace, open the Unit Scheme Manager using the **Units**, then **Unit Scheme Manager**. From the Unit Scheme pulldown menu, choose a new scheme and click Activate	Activating, page 95
What if I want one slot to show units that are different than the rest of the scheme?	You can create exceptions to the scheme that apply to a group of slots of the same name or one specific slot.	Creating Exceptions, page 96
Can I change the display units from the slot dialog itself?	Yes, when you change the units from a slot, you automatically create a Slot Exception.	Changing Display Units on Slot Values, page 98
Can I show Flow slots as a Volume and vice versa?	Yes, for flow series slots, the slot or SCT dialog has a Flow/Vol button on the toolbar. Some relevant volume slots, like Evaporation, also show the button. You can create slot name unit scheme exceptions for both the Flow and Volume unit type for a particular slot, if desired.	Alt Units button, page 172 and Displayable as Flow Checkbox, page 176
How do I fix a slot's units, without changing the displayed values?	Change the units from the Open Slot and choose to **Repair incorrect Units**.	Repairing Incorrect Units of Slot Values, page 99
I'm starting a new model, how do I set up the units I want?	Create a new scheme with the units you want. It is easy to create or change this scheme at any time, so there is little need to do it as the first step in model building.	Creating and Deleting, page 94 Editing Attributes, page 95
Will existing models (saved before 6.3) have the same units?	Yes, when an older model is loaded and it has no scheme, a *transitional* scheme is created to represent the units used in the saved model.	Updating Old Models With the Transitional Scheme, page 98
If I change the units or activate a different scheme, will I get the same results? Do some computations or methods depend on specific units?	In general, RiverWare does all calculation in internal units, changing the scheme will not affect underlying results. There are a few methods that depend on slot units. Click the link for more information.	Unit-specific Calculations, page 99
Can I share schemes between two models?	Yes, **Export** the scheme from one model and **Import** it into another model.	Sharing Schemes Using Import and Export, page 95

Working With Unit Schemes

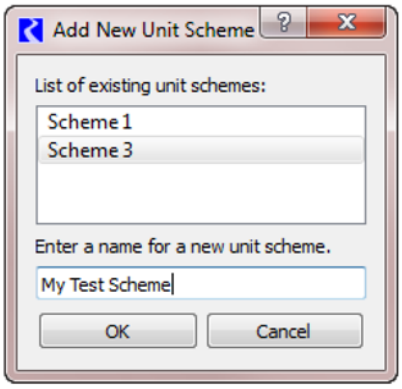
Figure 3.3 identifies the main areas of the Unit Scheme Manager.

Figure 3.3



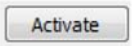
Creating and Deleting

Create a New, Duplicate, Rename or Delete the current scheme from the **File** menu. When creating a new scheme, renaming or duplicating an existing scheme, the Add New Unit Scheme dialog will open where you can specify the new name.



To delete a scheme, choose the desired scheme from the pulldown and then choose **File,** then **Delete Scheme**.

Activating

A scheme must be activated before any of the display attributes change. Activate a scheme by choosing the desired scheme and clicking the **Activate** button. 

Once you activate a scheme, all slot values are then shown using the attribute settings and the rules for that scheme. In the Unit Scheme Manager, the rows are shown in a pink color. An scheme that is not active is shown in a green color.

Values are always converted to the new units. See Repairing Incorrect Units of Slot Values, page 99 for instructions on fixing values that were imported into a slot with the incorrect display units.

Sharing Schemes Using Import and Export

Schemes from one model can be exported to a file, and then imported into another model. Select the desired scheme and then perform the following steps.

1. Use the **File,** then **Export** menu to export the scheme. Specify a file name.
2. In the second model, open the Unit Scheme Manager and choose the **File,** then **Import** menu. Choose the file specified.

The exported file is saved as an XML representation of the unit scheme.

Defining a Scheme

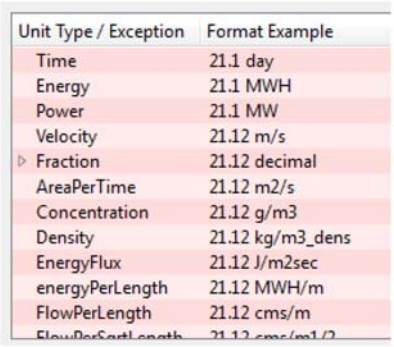
This section shows how to actually define the scheme. It consists of two parts, editing the attributes (setting the units, scale, precision, format) and creating exceptions to the Unit Type rule.

Editing Attributes

The table view shows each of the Unit Types in RiverWare. Those not in use in the model are hidden when the **Show only types that are present on the workspace** toggle is checked. You can show them by clearing the box.



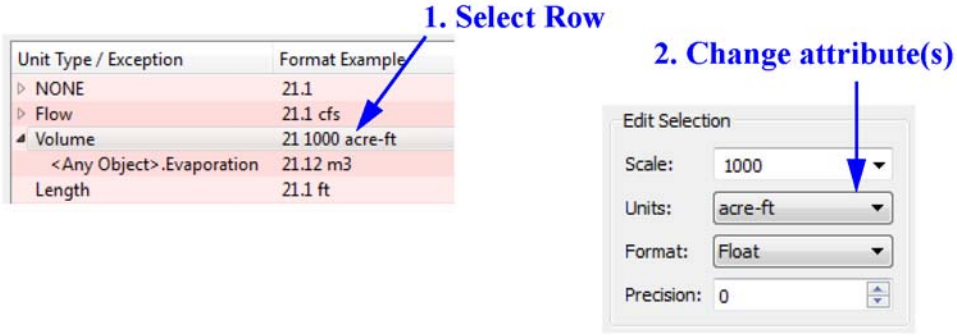
Each row in the table then represents a Unit Type Rule. That is, for that unit type, it defines how numeric values will be displayed. The attributes are not show explicitly, but are shown through the Format Example. E.g., 21.1 1000 cfs indicates a flow unit type will have a unit of cfs, a scale of 1000, a format of float, and a precision of 1.



Use the following steps to set an attribute.

1. Select a row in the tree view.
2. Edit one of the four attributes.

   Changes are applied immediately.



Creating Exceptions

You may wish to have a slot display units that are different than other slots of that same Unit Type. For example, you maw wish to show your Reservoir.Evaporation in “acre-ft” while displaying Storages and other VOLUMES in “1000 acre-feet”. Or more specifically, maybe you want to show the Evaporation for FlatReservoir.Evaporation in 100 acre-feet. Both of these are possible by creating Exceptions to the Unit Type rule. You can create exceptions to the Unit Type Rules in the Add Exception portion of the dialog at the bottom.

Slot Name Exceptions

Each exception applies to a specific Unit Type. Choose that first from the pulldown list. Specify a slot name and optionally the object type. These rules apply to slots on any object or a specific object type. Enter or choose a

slot name using the chooser. Remember, this is any slot that matches that name on that type of object. Once specified, click the green **Plus** button to add it to the scheme  .

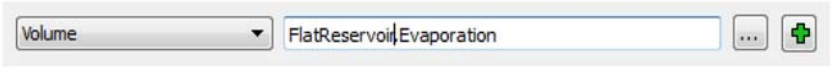


Following are examples of Slot Name Exceptions:

- <Any Object>.Evaporation
- <Reservoir>.Storage
- <Reach>.LagTime
- <Storage Reservoir>.Elevation Volume Table col=0
- <Storage Account>.Gain Loss

Slot Exception

Each exception applies to a specific Unit Type. Choose that first from the pulldown list. Specify a particular object.slot (and column if necessary). Type in or choose one or more fully specified slot (and column) using the chooser. Remember, this is a specific slot (or column on that slot). Once specified, click the green **Plus** button to add it to the scheme  . If you selected multiple slots, a slot exception is created for each slot.



Following are examples of Slot Name Exceptions:

- Mead.Evaporation
- DreamLake.Seasonal Inflow Coefficients col = 2
- BigReservoir^City.Storage

Note: When you configure an individual slot, you are actually creating a Slot Exception for that slot within the currently active Unit Scheme; see "Configure Slot Dialog" on page 153 for details. After making the change in the slot, you can go to the unit scheme and see that exception.

Adding the two exception described at the beginning of this section to the scheme would add rows to the table as sub items to the specified Unit Type Rule (in this case it was Volume). You then set the attributes for each of the rules; see Editing Attributes, page 95 for details. Figure 3.4 shows the result.

Note: When multiple rules apply to a slot, the most specific rule applies.

Figure 3.4



Updating Old Models With the Transitional Scheme

What if you have an old model (saved prior to version 6.3) and it has slots displayed exactly as you like? Do you need to spend hours creating a scheme to match this? When a model saved in a previous version is first loaded, RiverWare will create a Transitional scheme that represents the user units defined in the model.

The transitional unit scheme has the following characteristics:

- It is complete, i.e., covers all unit types.
- It describes the existing slot configurations, that is, this scheme displays all slots as configured in the model file.
- It is compact, i.e., has the minimum number of unit scheme rules.

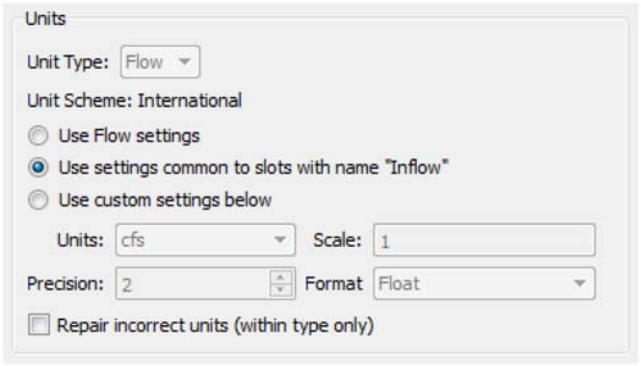
During model load, the unit manager loops over all of the slots and determines which set of display unit is most common for each unit type. That becomes the attributes for the Unit Type Rule. It then adds Unit Scheme Exceptions in increasing specificity until all slots are covered by the scheme. For equivalent units like “feet” vs “ft”, the most commonly used one is used throughout. Exceptions are not created for the other.

It is likely that many existing models will contain unintentional slot configurations which would show up as unique rules in the model transition scheme, typically with narrow applicability. For example, the most common unit might be 1.11 cfs, but then there are many instances of 1.123 cfs. Likely you just want the first one. To fix this, go into the Unit Scheme and remove the exception. Since the rules define exceptions to scheme, to get rid of the unusual cases, you need to *delete* the exception.

Changing Display Units on Slot Values

So you can make exceptions from the scheme, but you can also create them from the slot configuration. Yes, you can open a slot’s configuration dialog from the **View,** then **Configure** menu, you will get a dialog similar to Figure 3.5

Figure 3.5



The dialog lists the unit type and the active scheme. You can then choose one of the following options:

- **Use Flow settings**.Use the Unit type rule.
- **Use settings common to slots with the name “Inflow”**. Use a previously configured unit name exception.

- **Use custom settings below**. Modify the units for just this slot. When you do this action, you are actually creating a Slot Exception for that slot within the currently active Unit Scheme. After making the change in the slot's configuration, you can go to the unit scheme and see that exception.

As you change the selection, the unit settings for that toggle are shown in the Unit/Scale/Precision Format areas.

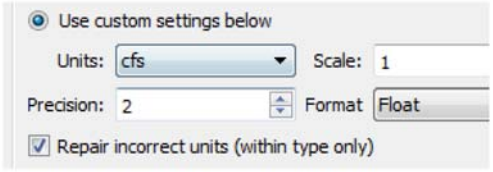
See "Configure Slot Dialog" on page 153 for details about slot configuration.

Repairing Incorrect Units of Slot Values

Sometimes you enter values into a slot (by typing or importing) but then realize that the slot's display units were not what you expected. For example, you want to enter 100cfs into a slot so you type it in. But, then notice the slot is showing the flows in cms, when you meant to enter them in cfs. So now the slot has a value of 100cms = 3531.5cfs. How do you fix this without re-entering the values?

To change the display units without changing the value displayed, you change the slot's units from the slot using the **View,** then **Configure** menu. Configure that you wish to use custom settings, then change the units. Check the **Repair incorrect units (within type only)** box. When you apply the change and the confirmation dialog, the units will change, but the displayed values will not.

> **Note:** Technically, when the **Repair** box is checked, the underlying values do change. In the example above they change from 100cms = 3531.5cfs to 100cfs = 2.83cms. But, it appears that the displayed value stays the same.



Unit-specific Calculations

In general, RiverWare does calculations in internal units. Changing the scheme will not affect underlying results. But, there are a few methods that depend on one or more slot units. The methods are described, organized by the category of calculation.

Exponentiation

For the methods in Table 3.3, a change in the units can produce different results due to calculations that use user-units in combination with a user-input exponent with units of NONE.

Table 3.3

Object	Category	User Method	Link, in Objects
Groundwater Storage	Groundwater Outflow	Exponential Flow	"Exponential Flow"
Groundwater Storage	Deep Percolation	Exponential Percolation	"Exponential Percolation"

Table 3.3

Object	Category	User Method	Link, in Objects
Reach	Reach Evaporation	Inflow Exponent Pan Evaporation	"Inflow Exponent Pan Evaporation"
Reach	Reach Seepage	Seepage and Riparian CU Loss	"Seepage and Riparian Consumptive Use Loss"
Reservoir	Sediment	CRSS Sediment	"CRSS Sediment"

Time Units

If the model timestep is 1 Month, the lag time slots for the methods in Table 3.4 must have TIME units of "month" or an error will occur.

Table 3.4

Object	Category	User Method	Link, in Objects
Reach	Routing	Time Lag	"Time Lag"
Reach	Routing	Variable Time Lag	"Variable Time Lag"
Reach	Drain Elevation	Stage Elevation Interpolation	"Stage Elevation Interpolation"

Similarly, in one or more table slots for the methods in Table 3.5, the TIME unit must be "day" in the first column or an error will occur.

Table 3.5

Object	Category	User Method	Link, in Objects
Reach	Gain Loss	Interpolated Flow Gain Loss	"Interpolated Flow Gain Loss"
Reach	Routing	Variable Time Lag	"Variable Time Lag"

Unit-dependent Calculations

The methods in Table 3.6 convert values to specific units for calculations. These calculations also use user-input parameter values with units of NONE. Changing the unit scheme should not change the results from these methods, but you must know the units used in order to set the parameter values appropriately.

Table 3.6

Object	Category	User Method	Link, in Objects
Reach	Routing	Storage Routing	"Storage Routing"
Reach	Routing	Variable Storage Routing	"Variable Storage Routing"
Reach	Depth to Flow	Power Function	"Power Function"
Distribution Canal	Flow Routing	Storage Time	"Storage Time Routing"
Distribution Canal	Flow Routing	Variable Storage Time	"Variable Time Storage Routing"

Table 3.6

Object	Category	User Method	Link, in Objects
Reservoir	Sediment Transport	Perm Pool Sed (Pre2000)	
Reservoir	Sediment Transport	Total Vol Sed (Post2000)	

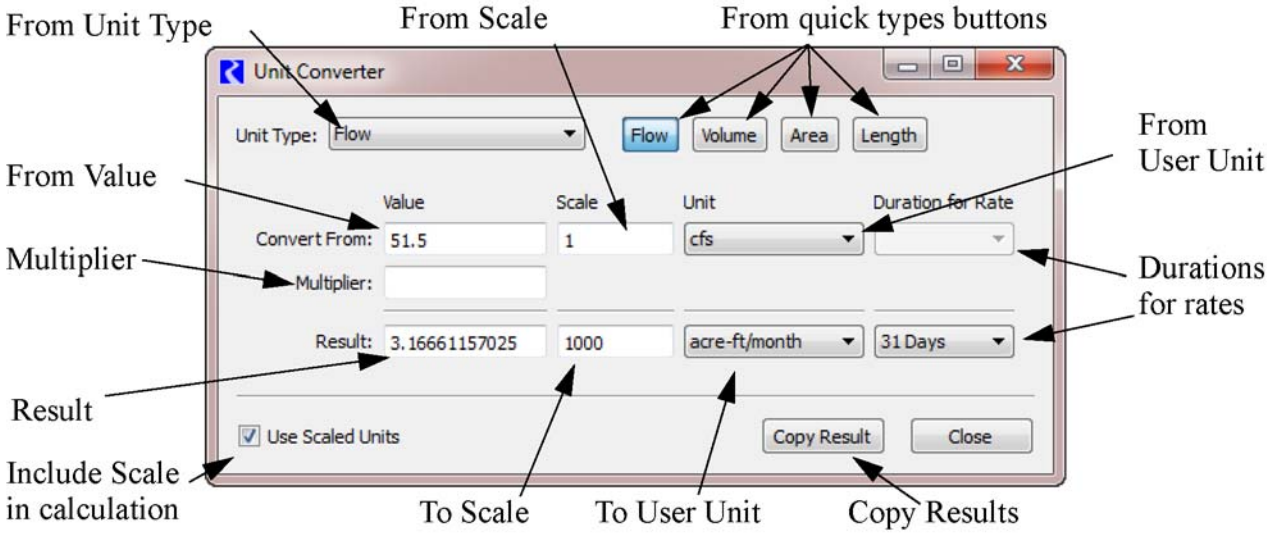
Unit Converter Dialog

The Unit Converter utility is a small calculator on the workspace which converts values using the same conversion factors used internally by RiverWare. To access the dialog, from the main workspace, select **Units**, then **Unit Converter**.

Converting Numeric Values

Figure 3.6 shows the Unit Converter dialog with all of the features displayed for numeric values.

Figure 3.6



Following is the basic order in which the dialog is used and the options available.

1. **Unit Type**. Select the unit type for which the calculation should be done. Use the quick types buttons to select one of the four common types (Flow, Volume, Area, or Length) or use the pull-down menu to choose one of the less common types.
2. **Value**. Input a value to **Convert From** in the text box
3. **Scale**. Specify whether on not to use scale in either the from value or the result by toggling on the **Include Scaled Units** check box. When this box is checked, the Scale area is displayed. Then, enter a scale in the either of the two **Scale** text boxes.
4. **Unit**. Specify the user unit using the pull-down menu for both the from line and the result line. The unit menu contain all of the units of the selected type.

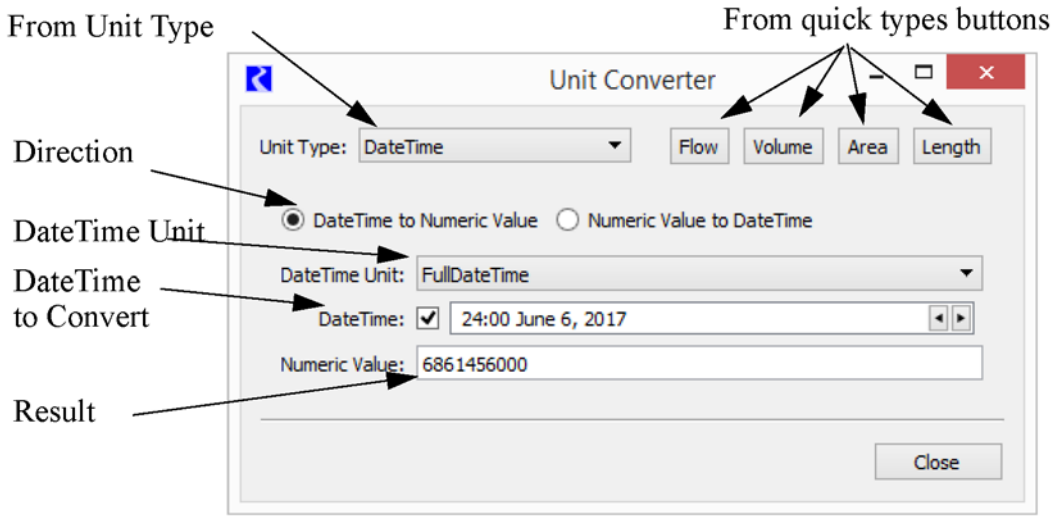
5. **Duration for Rates**. For units that include a rate (e.g. acre-feet/month) where the time scale is not constant (i.e. 1 Month or 1 Year), specify the duration. For monthly rates, select 28, 29, 30, or 31 days. For yearly rates, the specify 365 or 366 days.
6. **Multiplier**. Optionally enter a multiplier. The from value is converted to the units of the result and then multiplied by the **Multiplier**.
7. **Result**. The result is calculated immediately based on the specified input. The value which appears in the **Result** text field is now in terms of the new units, scale, and any specified multiplier.
8. **Copy Result**. You may wish to copy the result to the clipboard. Click the **Copy Results** button to copy the numerical value only. Hold down Shift and click **Copy Result** to copy the result and its scaled units.

The Unit Converter uses the conversion factors specified in the Units List dialog. To open the Units List dialog, from the **Units** menu in the main RiverWare workspace, select **List Available Units.** At the bottom left of the resulting Units List dialog, there is a check box to **Show only units that are present on the workspace**. Uncheck the box to show all available units and their conversion factors.

Converting DateTime Values to Numeric Values

Slots can store DateTime values; see "DateTime Values in Slots" on page 265 for details. Internally, the dates are stored as numeric values. Sometimes, it is useful to convert the DateTime values shown to their encoded numbers. The Unit Converter provides one way to do this. Figure 3.7 shows the Unit Converter dialog with all the features displayed for DateTime values.

Figure 3.7



When DateTime is the selected unit type, a different set of controls as shown.

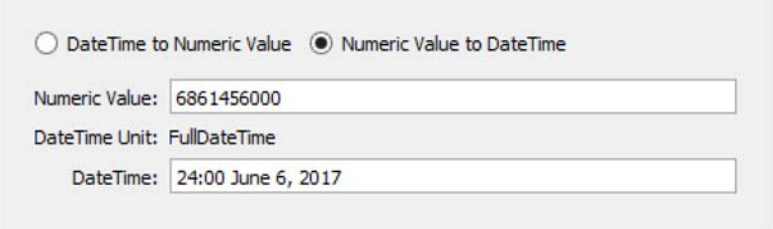
Indicate the direction of the conversion by selecting one of the following options:

- **DateTime to Numeric Value**
- **Numeric Value to DateTime**

Following is the basic order in which the dialog is used and the options available.

1. In the **DateTime to Numeric Value** direction (shown in Figure 3.7), select the DateTime Unit (one of which is FullDateTime—fully specified absolute dates and times). The selected unit determines which controls are presented according to the relevant parts of a DateTime value. In the FullDateTime case, an additional checkbox switches between a conventional DateTime entry box to individual DateTime part controls.
2. When the **Numeric Value to DateTime** option is selected (shown in Figure 3.8), enter a numeric value (often you would copy/paste this as needed), and both the DateTime unit and value are displayed for that value.

Figure 3.8



In both modes, the result is automatically computed as the inputs are modified. The result is selectable and copyable from the result field.

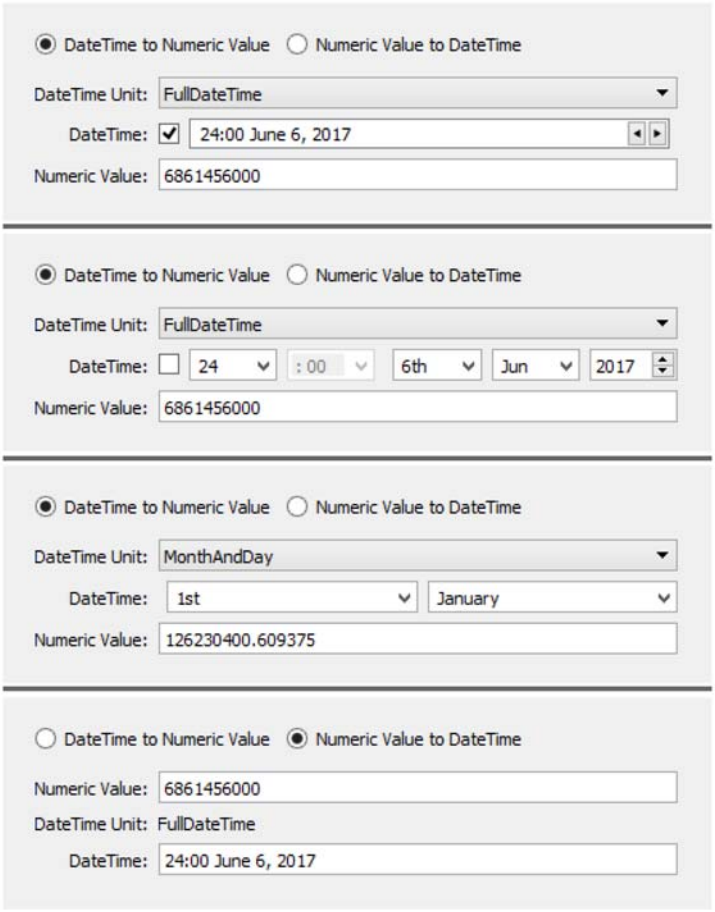
RiverWare supports the following units for the DateTime unit type:

- FullDateTime
- Month
- MonthAndDay
- TimeOfYear
- DayOfMonth
- TimeOfMonth
- TimeOfDay
- Year

Figure 3.9 shows units and controls.

> **Note:** DateTime values are stored in slots as floating point numbers. The integer part is the number of seconds since the beginning of 1800 (or, as RiverWare presents this, December 31, 1799, 24:00). For ordinary FullDateTimes, the fractional part is zero. Otherwise, the fractional part encodes which partial date time information is relevant. Year, Month, Day, Hour, Minutes, and Seconds.

Figure 3.9


DateTime to Numeric Value
Numeric Value to DateTime
DateTime Unit: FullDateTime
DateTime: 24:00 June 6, 2017
Numeric Value: 6861456000
DateTime to Numeric Value
Numeric Value to DateTime
DateTime Unit: FullDateTime
DateTime: 24 :00 6th Jun 2017
Numeric Value: 6861456000
DateTime to Numeric Value
Numeric Value to DateTime
DateTime Unit: MonthAndDay
DateTime: 1st January
Numeric Value: 126230400.609375
DateTime to Numeric Value
Numeric Value to DateTime
Numeric Value: 6861456000
DateTime Unit: FullDateTime
DateTime: 24:00 June 6, 2017

Chapter 4
Object Dialogs

The objects on the RiverWare workspace represent the physical layout of a modeled system. These objects contain the data and the physical process algorithms used in the simulation. To access the data and methods (functions) that define an object, use the Object Viewer and/or the Open Object dialog.

Topics

- Object Viewer and Open Object Dialogs, page 105
- Using Object Dialogs, page 109
- Aggregate Objects, page 127
- Object Attributes, page 128
- Multiple Object Method Selector, page 133

Object Viewer and Open Object Dialogs

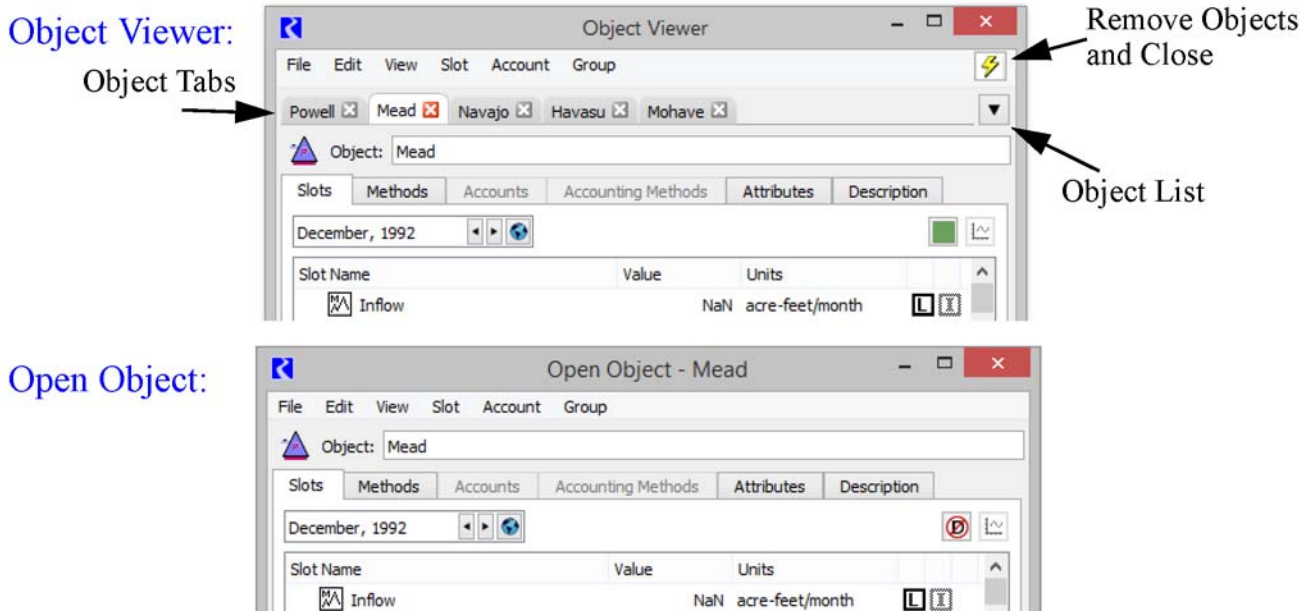
This section describes the user interface for the Object Viewer and Open Object dialogs, and then presents a tool used to select methods on multiple objects. Additional information on display of objects on the workspace can be found as follows:

- Adding, selecting, and deleting objects. See "Objects on the Workspace" on page 41.
- Importing and exporting of objects and links. See "Importing and Exporting Objects" on page 48.
- Display groups allow you to change how objects are labeled, their layer and the color and line properties on the accounting workspace. See "Display Groups" on page 51.
- Clustering objects together into a single icon on the workspace. See "Object Clusters" on page 44.

Opening the Object Viewer

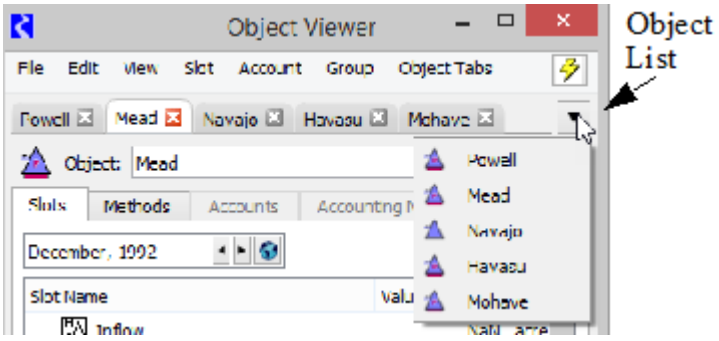
Open an object by double-clicking its object icon on the workspace, or by selecting the name in the workspace object list. By default, the Object Viewer is shown with a tab for the Object. Figure 4.1 shows both an Object Viewer and Open Object dialog.

Figure 4.1



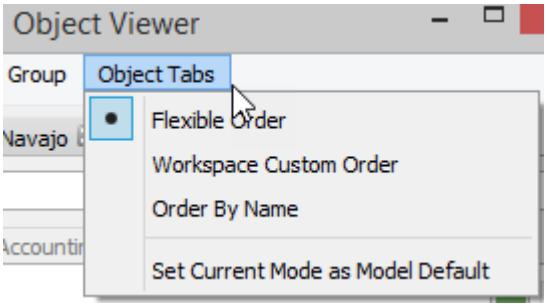
Note: The menu bar options will be the same. They are dynamically updated in the Viewer based on the object selected.

The Object Viewer is the default dialog used to look at an object. It is convenient, as all objects open in the one dialog. Select the tabs to switch between objects. Or use the **Object List** menu on the right of the tabs. This is particularly useful if you have many objects in the viewer.



Arranging Tabs

There are three modes to arrange the object tabs in the viewer as selected in the **Object Tabs** menu:



- Flexible Order: Tabs can be rearranged in any order. Drag the tabs left and right to rearrange them. New object tabs are appended to the right of existing tabs.
- Workspace Custom Ordering: Object tabs are ordered left to right using the custom object order from the workspace's Simulation Object list. See "Simulation Object List" on page 14 for more information on the Simulation Object List.
- Order By Name: Object tabs are ordered left to right in case-insensitive lexical order.

  Tip: A confirmation dialog is presented if you reorders the tab when not in Flexible Ordering mode. You have the choice to either cancel the move or switch to Flexible mode. You can still drag objects off and undock object in Workspace Custom or Order by Name mode.

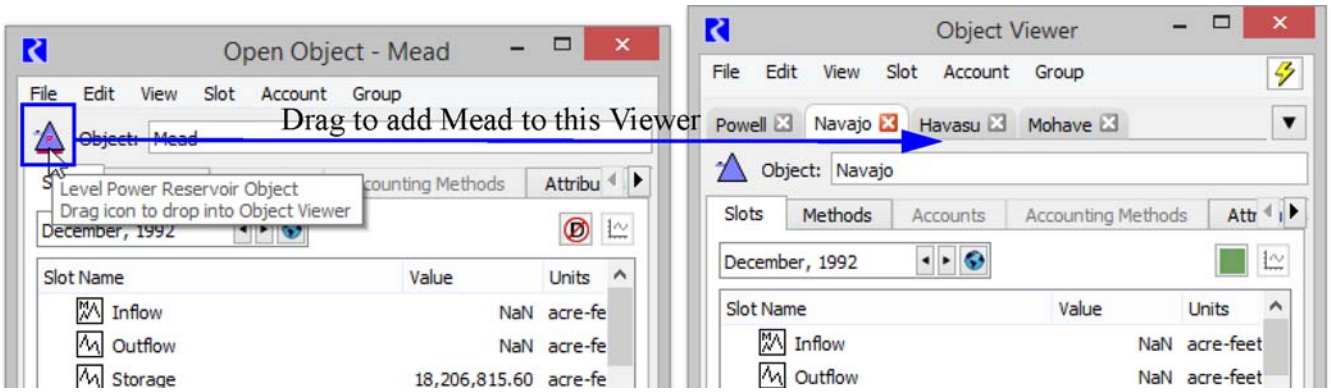
In addition, in the **Object Tabs** menu, use the menu **Set Current Mode as Model Default** to set the current mode as the model default. This setting will be saved with the model file.

Undocking Objects

To look at two objects at once, drag the tab off the viewer to create an Open Object dialog for that object. Or use the **File**, then **Undock Object** menu or **File Undock all Objects**.

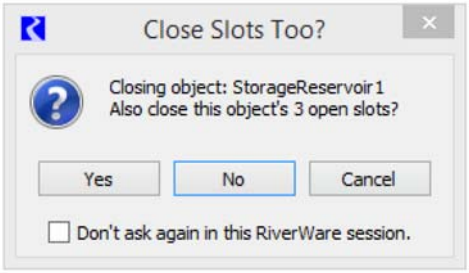
Redocking Objects

To move an Open Object dialog back onto the viewer, grab the Object icon and drag it anywhere onto the Viewer. A new tab will be created. Or use the **File**, then **Dock In Object Viewer** menu.



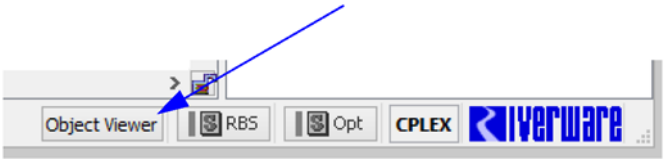
Closing an Object

Use the red **X** on the tab to close an object tab that is on the viewer. If you also have slots from that object shown in either the Slot Viewer or separate dialogs, you will be prompted with a confirmation asking if you want to close those slots too.

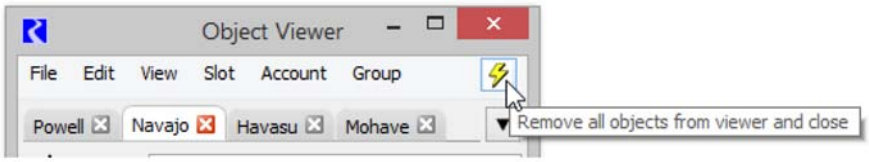


Closing the Viewer

Select the red **X** on the viewer dialog to close the viewer. This will close the dialog, but all objects will remain in the viewer. Reopen the viewer and show the previously opened objects selecting the **Object Viewer** button in the lower right of the workspace.



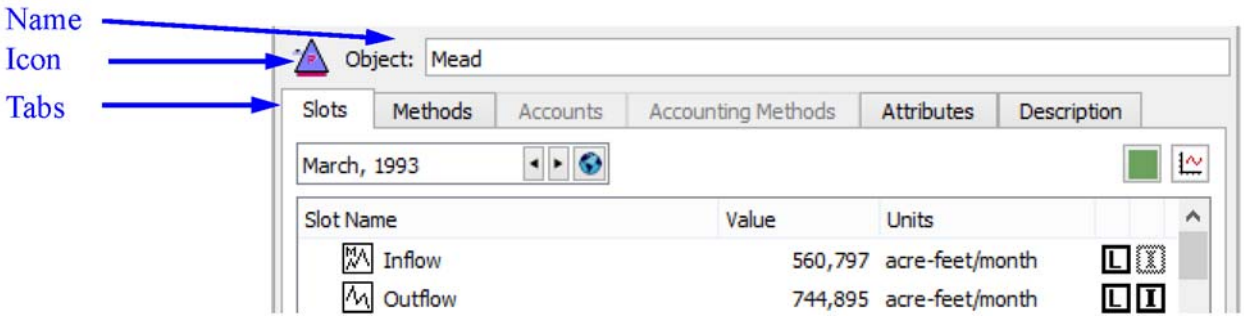
Select the **Remove All Objects**, yellow lightning bolt button to remove all objects from Viewer and close.



Using Object Dialogs

Regardless of whether you use the Object Viewer or individual Open Object dialog, the content is the same. All objects use the same format.

Figure 4.2



The dialog is organized by the following tabs:

- **Slots:** numerical model data
- **Methods:** user-selectable algorithms that represent physical and other processes
- **Accounts** (when enabled): containers to track water type or ownership
- **Accounting Methods** (when enabled): methods that correspond to water type or ownership
- **Attributes:** optional user defined attributes and values representing meta data for the object
- **Description**: optional text description of the object.

Naming an Object

You can change the name of any object by selecting the **Object Name** text field.

- User defined names may be any combination of letters, numbers, spaces and underscores, but no other characters. Names are case-sensitive and are not limited in length, but excessively long names will be displayed in their entirety, making the workspace visually cluttered.

  Note: If you are renaming an object whose old name appears in RPL sets, a dialog asks if you want to search RPL sets for the old name and optionally replace occurrences with the new name. Entering Yes will bring up the RPL Search and Replace dialog with the results of a search for the old name in all

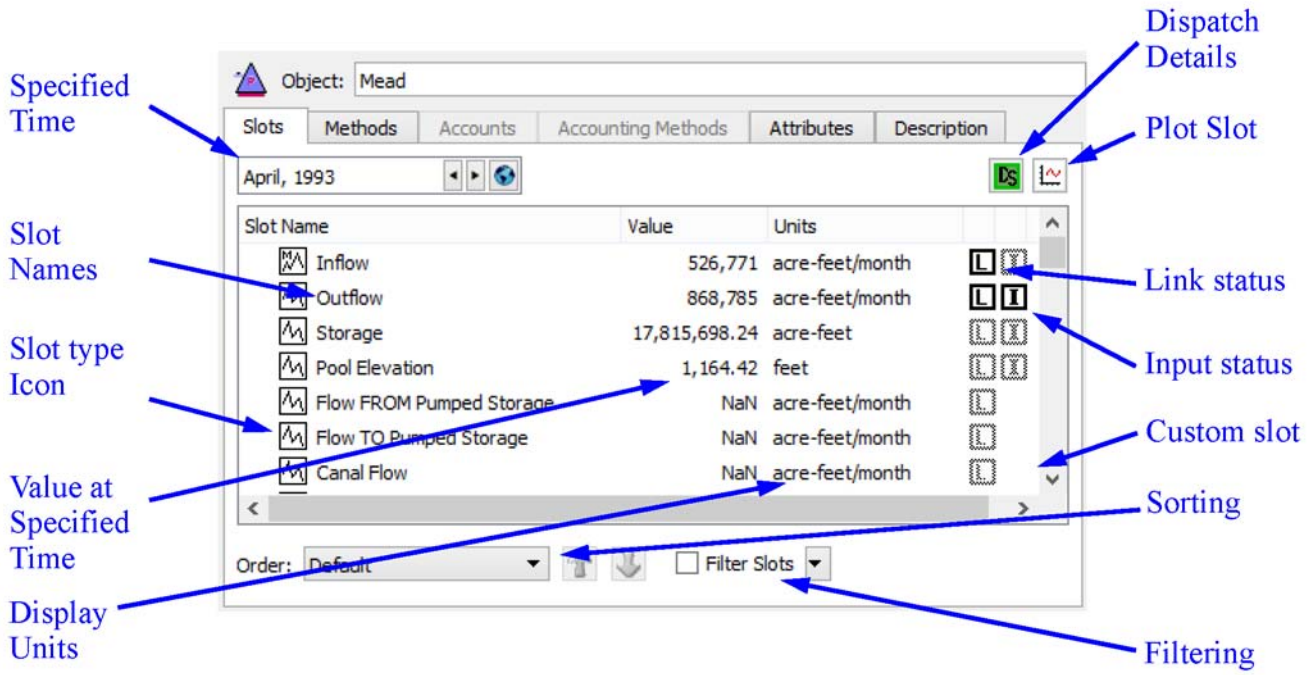
RPL sets and with the new name filled into the **Replace with** field. You can examine the occurrences and choose to replace some or all of them with the new name.

Slots Tab

The **Slots** tab contains information about each of the object's slots. This information may include the slot Type, Value, and Status information.

The order of the slots is user configurable and can be saved with the model file; see "Sorting Slots" on page 112 for details.

Figure 4.3



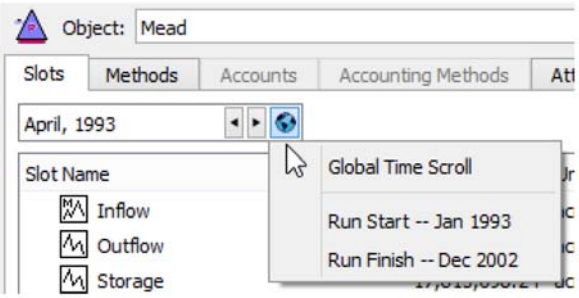
Slots Tab Tour

Following is a description of all of the pieces of the **Slots** tab.

Specified Time

The DateTime spinner allows you to choose the date at which values are displayed in the slot list. The right arrow advances forward in time while the left arrow goes backward in time. Select the **Globe** icon and select

Global Time Scroll to scroll all dialogs that reference a model timestep (E.g. slots, objects, plots, and model run analysis) to that date.



Slot Names

The names of simulations slots are predetermined and cannot be changed. Custom slots, which you can create on any object can be named as desired.

Slot Type Icons

Different types of slots are used for representing different types of data. The icons in the type column indicate the type of the slot. See "Types of Slots" on page 163 for descriptions of the types of slots.

Slot Value

The Value field of the Slot List displays the value at the specified time in the slot. The value is displayed with the format selected by the user. When an object is first created, its values are all NaN (not-a-number).

Slot Units

The units shown are defined in the active Unit Scheme for that slot.

Dispatch Details

The **Dispatch Details** icon and button  displays the status of dispatching for the given object at the specified timestep (not including rule effects). Hover over the button to see a tooltip that summarizes the dispatch behavior. Select the button to open the model run analysis Dispatch Behavior Details for the given object; see "Dispatch Behavior Details Dialogs" in *Debugging and Analysis* for details. **Shift-Click** the button to show the Special Results Details; see "Model Run Analysis—Special Results Details Dialog" in *USACE-SWD Modeling Techniques* for details.

Plot Button

The **Plot** button  opens a plot dialog to display the values in the selected slots.

Link Status

The Link Status indicator is bold when the slot is linked to another slot. Only timeseries slots may be linked; therefore, only timeseries slots display the Link Status.

Input Status

The Input Status indicator is bold when at the value at that timestep is flagged as an input. Only timeseries slots may have input flag; therefore, only timeseries slots display the Input Status.

Custom Slot indicator

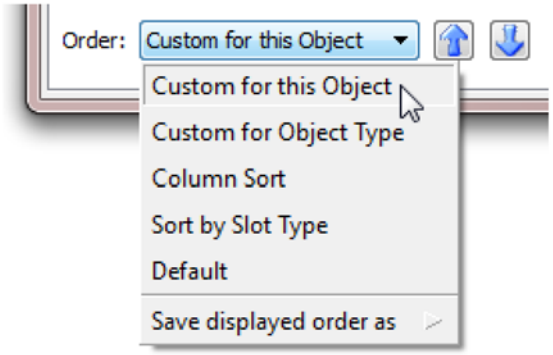
The custom slot icon  is shown when the slot is custom (i.e. created by a user). Simulation slots do not have any icon in this column. In addition, custom slot icons have a pale yellow background. 

Sorting Slots

Following are the options for sorting and filtering slots.

Sorting Options

In the **Slots** tab, the following sorting orders are supported as shown in the **Order** menu at the bottom of the tab.



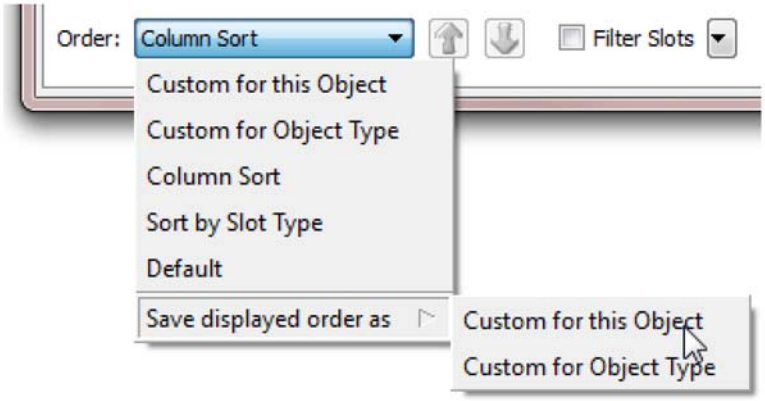
- **Custom for this Object.** Show a custom order for this object only. In this mode, the up and down arrows  are enabled and you can re-arrange slots. Select one or more slots, then select the arrows to move them up or down.
- **Custom for this Object Type**. Show the custom order defined for objects of this type, i.e. Storage Reservoir, Reach, Water User.
- **Column Sort**. Sort the slots alphabetically/numerically by column. In this mode, the column headers are enabled. Select any header to rearrange by that parameter. If you select a column header in any other mode, it will automatically switch to **Column Sort** order and then sort by that column.
- **Sort by Slot Type**. Group slots of the same type together and show Slot Groups together.
- **Default**. Use the internally defined slot order.

Saving the Order as Custom

There are two custom orders you can define and use, one for this object and one for objects of this type. You can only rearrange slots in the Custom for this Object mode. But you can save any order to either of these custom orders. At the bottom of the **Order** menu is a sub menu **Save displayed order as**. The options are as follows:

- **Custom for this Object**
- **Custom for Object Type**

When an object opens, it first tries to use the Custom for this Object order if defined, then the Custom for Object Type order if defined, and finally, it uses the Default order if neither of the other two are defined.



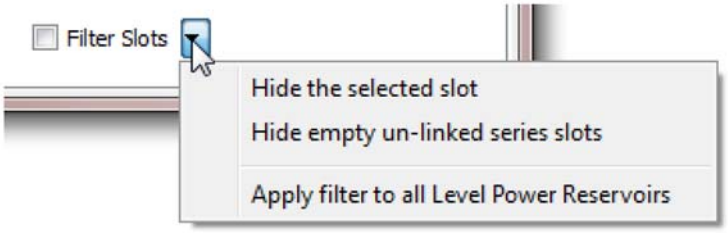
Filtering Slots

Like the sorting mechanism, filtering allows you to create a more meaningful view of the slots on the object. Filtering allows you to hide the slots you do not wish to see, perhaps because you are not using them. Filtering is controlled by two controls on the lower right part of the **Slots** tab, the check box and the menu.

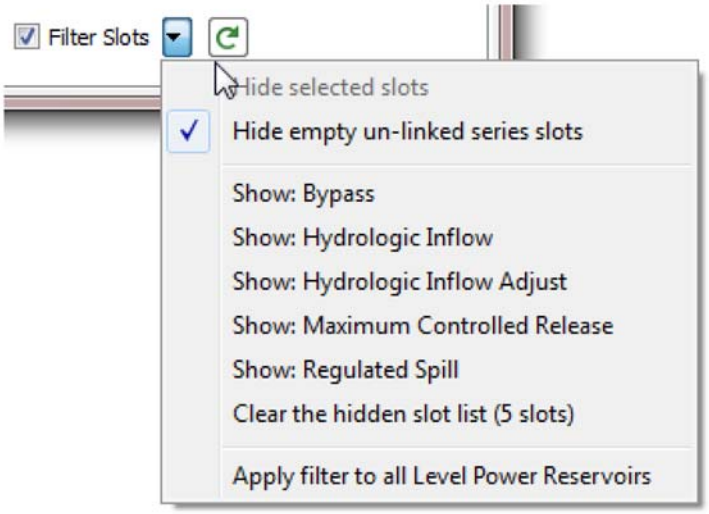
The **Filter Slots** check box enables and disables the filtering. This immediately conveys whether some slots are hidden, and provides an easy way to temporarily show all slots without losing the configured show/hide states for the slots.

The **Filter Slots** menu defines how you wish to filter, as follows:

- **Hide Selected Slots** operation can be applied to the selected set of slots.
- **Hide empty un-linked series slots** will hide all series slots that do not have any values (i.e. NaNs only).



Once either of these options is chosen, the menu will say what is hidden and allow you to reveal all or some of the slots.



Use the **Show: <slot>** menu to reveal the slot. Use the **Clear the hidden slot list** menu to reveal all of these slots.

Select the **Hide empty un-linked series slots** to show these hidden slots.

Since this option depends on the values in the slots, there is a **Refresh** button to update the dialog. 

Finally, the **Apply filter to All <objects>** operation applies the filter settings to all objects of that type. This, along with the custom sort order described above, is a convenient way to make all objects of the same type appear the same.

Creating Custom Slots

The **Slot** menu and the right-click **Add Slot** menu has the following options to create custom slots:

- Add Series Slot
- Add Series Slot with Expression
- Add Integer Indexed Series Slots
- Add AggSeries Slot
- Add Integer Indexed AggSeries Slot
- Add Series Slot with Periodic Input
- Add Table Slot
- Add Statistical Table Slot
- Add Periodic Slot, Text Headers
- Add Periodic Slot, Numeric Headers

- Add Scalar Slot
- Add Scalar Slot with Expression
- Add Mass Balance Summary
- Add Time Aggregation Series Slot

Creating and Configuring Series Slots

Series slots are created through the **Slot**, then **Add Series Slot** menu. Custom Series slots on a Object can be linked to any linkable slot on the workspace. See "Series Slots" on page 166 for details.

Creating and Configuring Table Slots

You can add a table slot of any dimension and units. See "Table Slots" on page 207 for details.

Creating and Configuring Statistical Table Slots

Statistical table slots allow you to specify a statistical function, such as a flow duration curve, which is computed at the end of a run using the data in the slot(s). This statistical analysis data can then be plotted or exported to another application.

See "Statistical Table Slots" on page 209 for details.

Creating and Configuring Periodic Slots

Periodic slots are used to represent data which repeats at regular time intervals. An example might be a set of evaporation coefficients for a reservoir. The rate of evaporation varies with such factors as temperature and wind speed, factors which vary seasonally. It is natural to assume that this variation is the same for each year. If this sort of data were entered into a series slot, then the same data would need to be repeated every year. This would be impractical and inconvenient for the user. On the other hand, if this data were entered in to a table slot, then the data would lose the time element associated with each value. This would make it difficult to look up or interpolate values with respect to time. The periodic slot meets the needs not met by these other slots.

You can create two different types of periodic slots, slots with text headers for the columns and slots with numeric headers for the columns.Select **View**, then **Configure** to configure the periodic slot. See "Periodic Slots" on page 225 for details.

Creating Expression Slots

Expression slots are computational expressions that contain other slot names as variables. They are used to calculate quantities such as "combined Storage of all Reservoirs", "weekly average Outflow of Hoover Dam", or "the ratio of Hydrologic Inflow to Reach Inflow at selected structures". To add a Series slot with expression, select **Slot**, then **Add Series Slot with Expression.** To add a Scalar slot with expression, select **Slot**, then **Add Scalar Slot with Expression.** See "Series Slots With Expression" on page 193 for details.

Creating Mass Balance Summaries

The Mass Balance Summary slot is a user-defined hierarchy of series slot collections used to check (i.e. sum) mass balance across many objects. The collections are themselves series slots representing the sum of the contained

slots. These slots can be used within RPL expressions and any other place where series slots are used. See "Mass Balance Summary Slots" on page 232 for details.

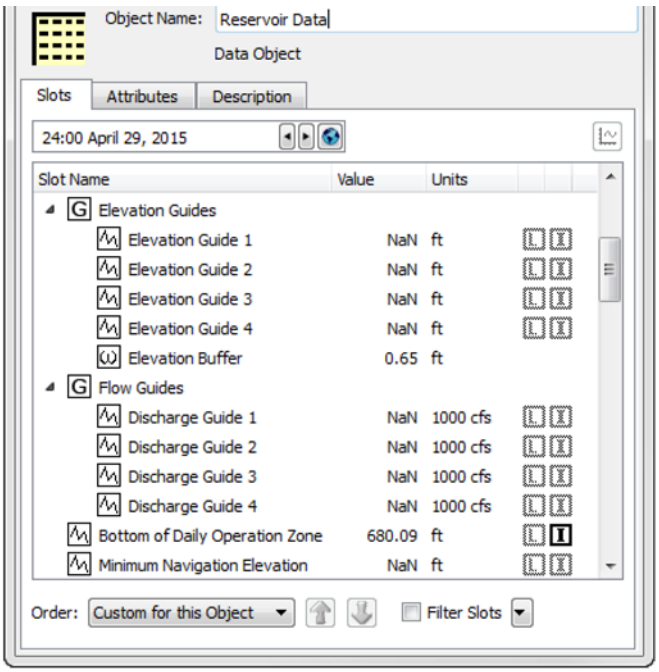
Creating Time Aggregation Series Slots

Time Aggregation Series Slots temporally aggregate other series slot. See "Time Aggregation Series Slots" on page 250 for details.

Slot Groups

Slots (on non aggregate objects) can be grouped together within the Open Object dialog in named Slot Groups. Slot group items are indicated with a boxed **[G]** icon. Any slot can be in at most one slot group.

Figure 4.4



Slot groups do not change the relationship between a slot and its containing object -- the slot is still functionally, and internally, contained directly within the object. The complete name of the slot does not change when moving the slot into and out from a slot group. Slot names and slot group names on any particular object are unique. That is, no slot and slot group on a particular object can have the same name. Also, it is not possible for slots in distinct groups on the same object to have the same name.

Showing Slot Groups

Slot Groups can be shown or hidden as follows:

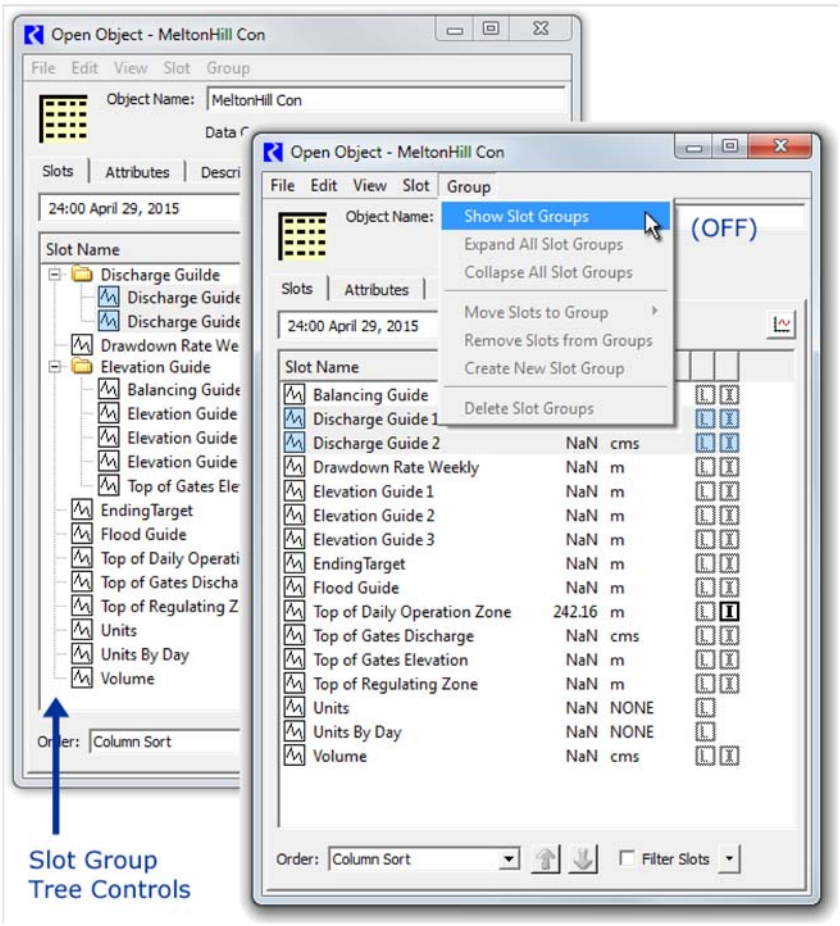
- Select **Group**, then **Show Slot Groups**.
- Right-click **Show Slot Groups**.

When the **Show Slot Groups** checkbox is cleared, slots are presented in the traditional way, as a single-level list of slot items.

> **Note:** The state of this toggle is **Global** within the RiverWare session. Turning the **Show Slot Groups** checkbox on or off changes all Open Object dialogs for objects. This setting is saved in the RiverWare model file.

When Slot Groups are not shown, The *tree* ornamentation is hidden. Sorting of slots by name (e.g. after selecting the Slot Name column header) is done without regard to placement of slots within slot groups. Other operations in the Group menu are disabled.

Figure 4.5



When Slot Groups are shown, the **Group,** then **Expand All Slot Groups** and **Group,** then **Collapse All Slot Groups** menu items open or close all slot group tree items, respectively.

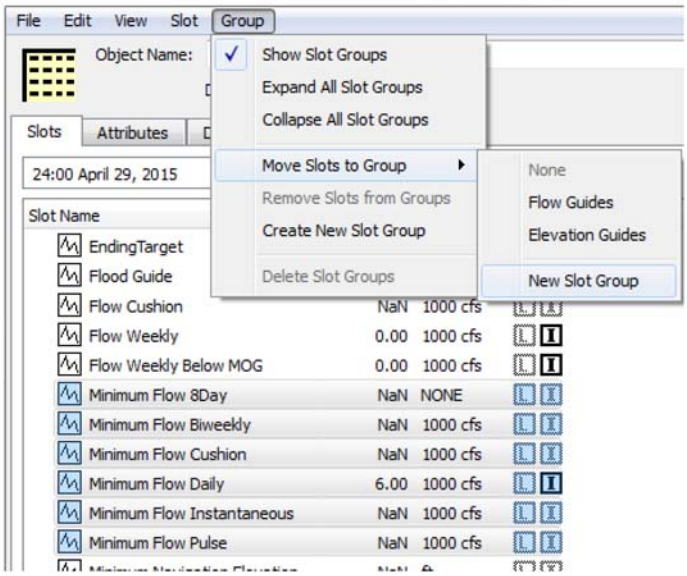
> **Note:** When shown, Slot Groups are shown in the **Slots** tab according to the selected sorting Order presented at the bottom of the dialog. You can sort them alphabetically, by slot type and group, or through the custom sorting. See "Sorting Slots" on page 112 for descriptions of these options.

Creating Slot Groups and Adding Slots

There are two ways to create a slot group:

1. Select one or more slots, then use the right-click context menu or the Group menu and choose **Move Slots to Group,** then **New Slot Group.** Then change the name of the new group as desired.

Figure 4.6



2. Use the **Group,** then **Create New Slot Group** menu. Then change the name of the new group as desired. Then select some slots and choose **Move Slots to Group** and choose the new group.

The new group name must be distinct from the names of all slots and other slot groups on the object, and cannot be None.

Removing Slots from a Group

There are two ways to remove a slot from a group:

1. Select the slot(s) to remove and use the right-click context menu or **Group** menu and select **Remove Slots from Groups**.
2. Select the slot(s) to remove and select **Move Slots to Group,** then **None**.

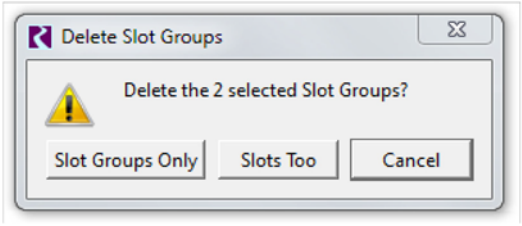
In both cases, the slot is removed from the group but continues to exist on the object.

Deleting Slot Groups and Slots

To remove or delete a Slot Group, select the group and choose **Delete Slot Groups** from either the right-click context menu or the **Group** menu. A confirmation dialog opens with the following choices:

- **Slot Groups Only**. Deletes only the group but not any slots.
- **Slots Too**. Delete the group and all slots within the selected groups.
- **Cancel**. Cancel the deletion operation.

Figure 4.7



Using Slot Groups

The following Slot menu operations also operate on slot groups, when selected.

Copy Slot Groups

The Copy Slot Groups operation copies the currently selected slot groups and containing slots to the system clipboard. Those slot groups them become available to be pasted within the same object, or in the Open Object dialog for a different object.

Paste Slot Groups

The Paste Slot Groups operation pastes the Slot Clipboard's slot groups into the object. If the object already has a slot group with the name of a slot group in the clipboard, then that existing slot group instance is used as the target for the paste operation -- i.e. that existing slot group will receive the slots from the analogous slot group in the clipboard. When pasting slots from a copied slot group, if slots having the same name already exist on the destination object, slightly differently named slots (copies) will be created from the copied slot group -- a distinct four-digit numeric number will be added to slot names, after having removed trailing digits, spaces, and underscore characters. After the paste operation, only the newly created slot groups and slots will be selected within the Open Object Dialog's slot list.

Duplicate Slot Groups

Whereas the Paste Slot Group operation always uses an existing slot group having the copied group's name, the Duplicate Slot Groups operation always creates new, slightly differently named, slot groups from the currently selected slot groups. It also copies the groups' slots, which are also given modified names.

Copy Slot Groups to Objects

This operation is a high-level copy operation; see “Copy Slots to Objects” on page 120 for details.

Move Slot Groups to Object

See “Move Slots to Object” on page 122 for a description of this option.

Copy and Paste Slots

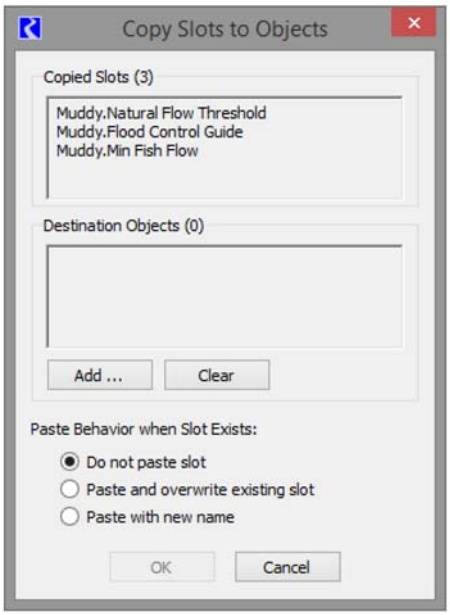
Slots on any object (and slot groups) can be copied and then pasted to another object. With one or more slots selected, use the **Slot,** then C**opy Slots** (**Ctrl-C**) and **Slot,** then **Paste Slots** (Ctrl-V) menu to do this copy and paste action.

In addition, for a single object, you can use the **Slot,** then **Duplicate Slots** menu to create a duplicate of the slots, with slightly different names. The pasted custom slot name change consists of a different set of four digits at the end of the slot name. When modifying a slot name to insure uniqueness, all trailing digits, spaces, and underscores are first removed from the slot name, and an underscore and four digits are then appended.

Copy Slots to Objects

This section describes a high level utility that allows you to copy selected slots (and Slot Groups; see "Slot Groups" on page 116) and paste copies to multiple specified objects. This is particularly useful if you have consistent custom slots on simulation objects or data objects. For example, you may have 20 reservoirs and each has custom slots that contain policy or summary data. This utility allows you to configure or update one set of slots and then copy and paste the slots to all 20 reservoirs. Options are provided to specify to overwrite existing slots or add new slots.

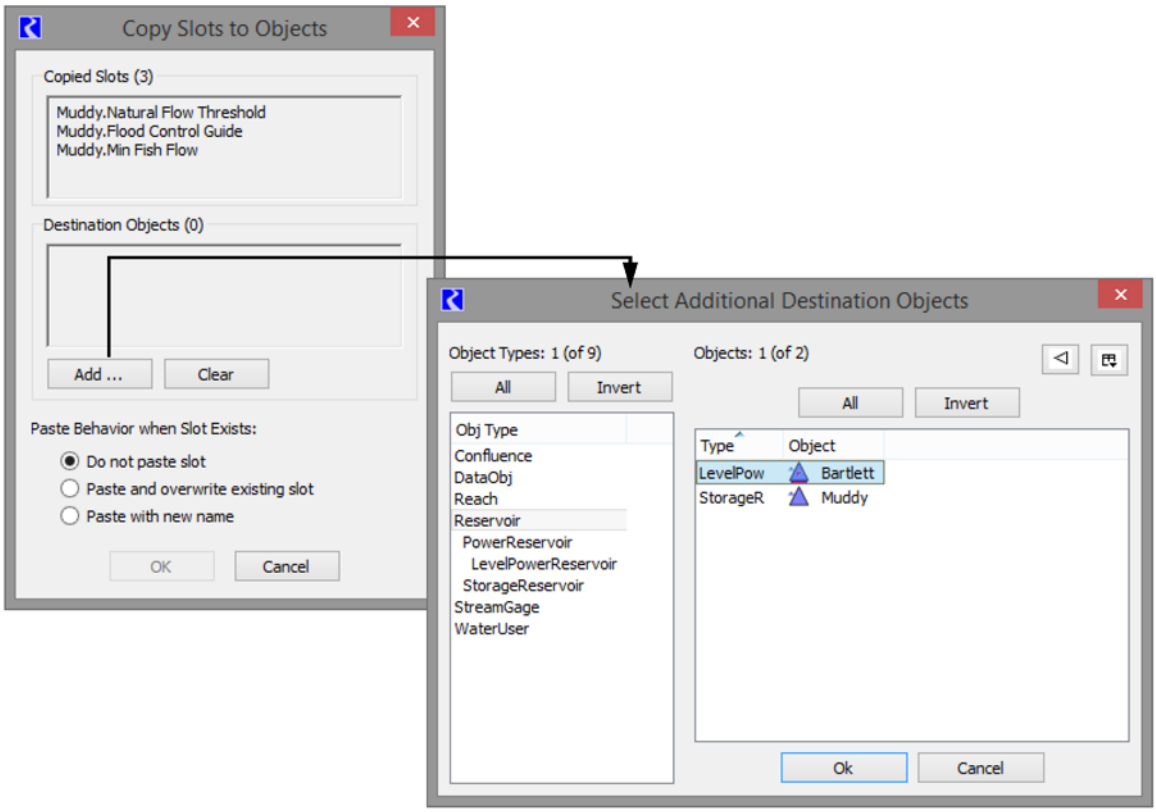
To use the tool, select **Slots** (or **Slot Groups**) on the Open Object dialog **Slots** tab. Then, use the **Slot,** then **Copy Slots to Objects** menu. The Copy Slots to Objects dialog appears.



The upper portion shows the slots that will be copied. The middle box shows the **Destination Objects.**

Select the **Add** button to choose a set of Destination Objects, as shown in Figure 4.8.

Figure 4.8



Select **Clear** to erase that list and start over. The **Include object name** check box is shown only when copying slots from a simulation object (e.g. a from a Reservoir). For the conventional Paste Slots operation, slots which were copied from a simulation object, the newly created (pasted) slots have names starting with the original simulation object's name. But when slots had been instead copied from a Data Object, the name of that data object is not pre-pended to the new slots' names. Selecting **Include Object Name** allows modification of the behavior of the Paste Slots operation.

Figure 4.9

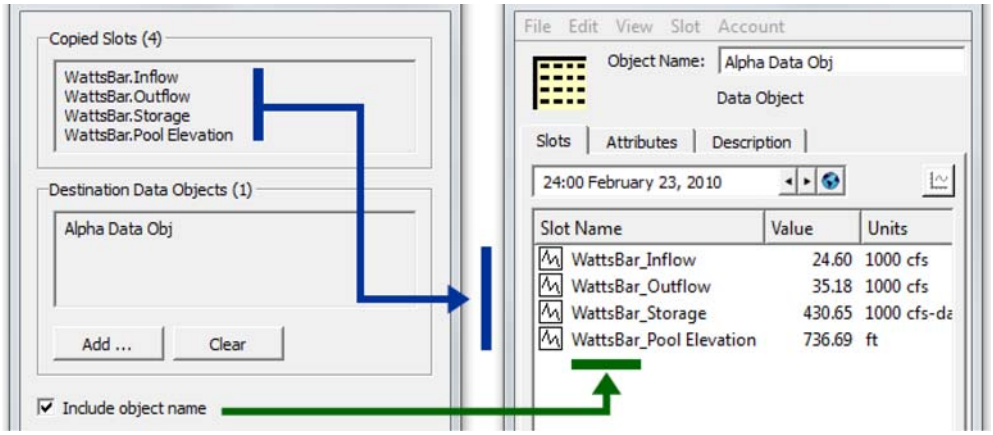
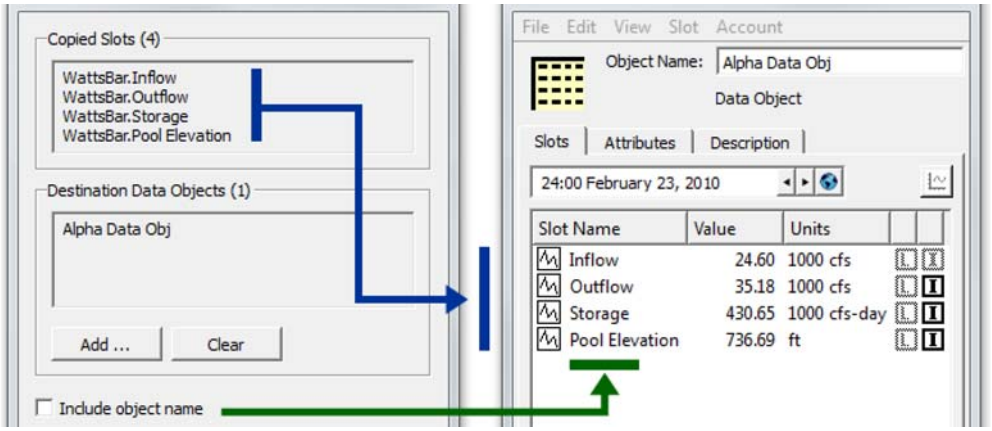


Figure 4.10



The lower part of the dialog lets you choose what to do when a slot of the same name exists on the destination object. The **Paste Behavior when Slot Exists** buttons control the behavior when a destination object already has a slot with the name of the copied slot (taking into account the **Include Object Name** option described above). It supports the following options:

- **Do not paste slot.** Leave existing matching slot on destination object intact.
- **Paste and overwrite existing slot.** Replace existing matching slot on destination object with copied slot.
- **Paste with new name**. Add a new copy of slot to the destination object with a new slot name.

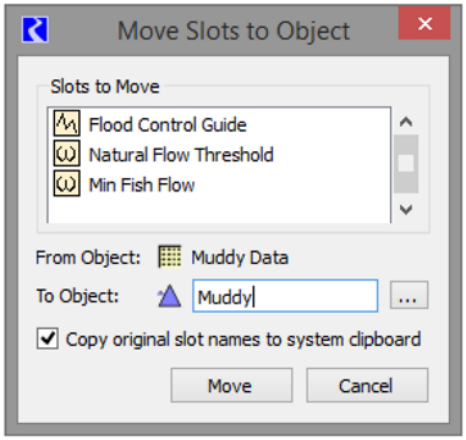
Selecting **OK** performs the Copy Slots to Objects operation, as configured within the dialog. This shows a popup dialog indicating the result of the operation.

Note: Simulation slots cannot be overwritten.

Move Slots to Object

This section describes a utility that allows you to move selected custom slots (and Slot Groups; see “Slot Groups” on page 116) to a specified object. The move operation will cut the original slots and paste it to the new object.This is particularly useful to move custom slots from a data object to a simulation object.

Figure 4.11



To use the tool, select one or more custom slots (or Slot Groups) on the Open Object dialog **Slots** tab. Then, use the **Slot,** then **Move Slots to Object** menu. The dialog to the right opens.

The upper portion shows a list of the slots that will be moved. The middle area shows the **From Object** and the **To Object**.

Select the **Chooser** button  to choose a single destination object.

The **Copy original slot names to system clipboard** checkbox indicates whether the list of slot names (i.e. Object.Slot) is copied to the System Clipboard.

When ready, select the **Move** button. A confirmation dialog is presented. Once confirmed, the cut and paste sequence is performed and then the destination object's dialog is shown with the slots selected.

If the slot name already exists on the destination object, the move operation is aborted and no slots are moved (none are created and none are deleted).

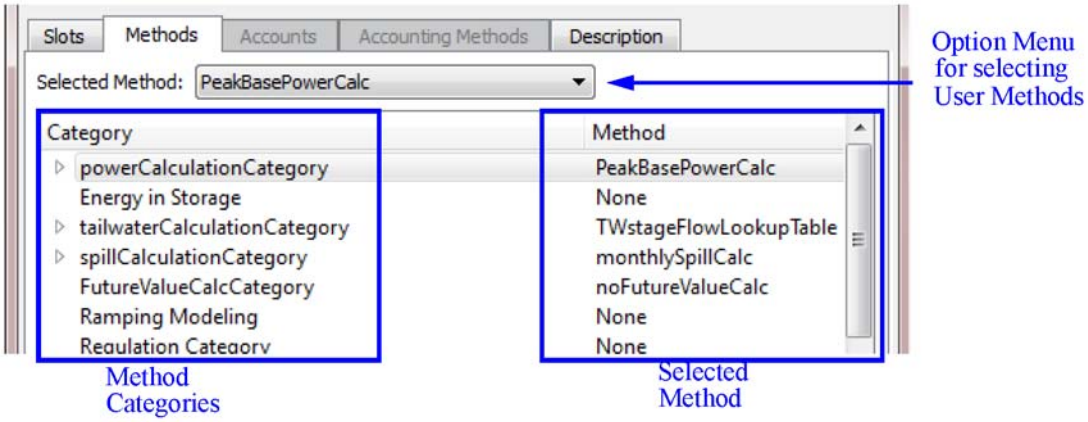
> **Note:** When you move slots from one object to another, references to the slot on the original object may be broken. For example, RPL sets, DMIs, Scripts, and Model Reports may need to be modified. There is currently no automatic support to update the slot reference but the slot names can be copied to the system clipboard and you can use that as a guide. Search for each of the slots in the respective utilities and update accordingly.

Methods Tab

User Methods allow each object's physical process calculations to be customized. User Method Categories are defined for calculations such as evaporation, bank storage, power generation, spill, routing, tailwater and canal flow. Each Method Category contains one or more User Methods. For example, the Power Calculation Category contains many different methods for calculating Power. Some of these are general methods, designed for a variety of users. Others have been developed using custom calculations to meet the needs of particular groups, such as the LCR Power method which is used on the Lower Colorado Daily model.

The **Methods** display contains a scrollable list of Method Categories on the left and the corresponding selected User Method for each category on the right.

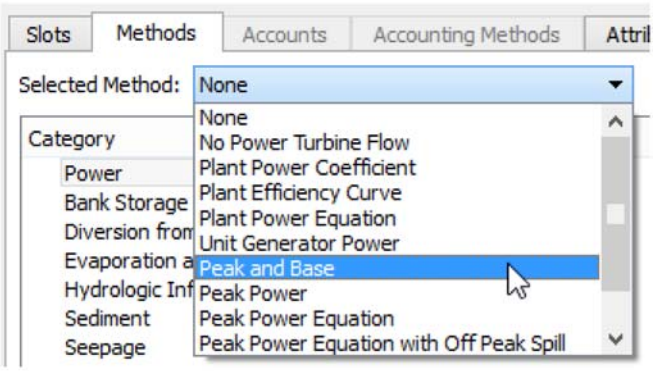
Figure 4.12



Selecting Methods

Objects are configured to represent the features in your basin using methods. These are selected from the **Methods** tab of the **Open Object** dialog. All of the user methods available within a Category can be viewed by selecting the Category and selecting the **Selected Method** pull down menu.

Figure 4.13

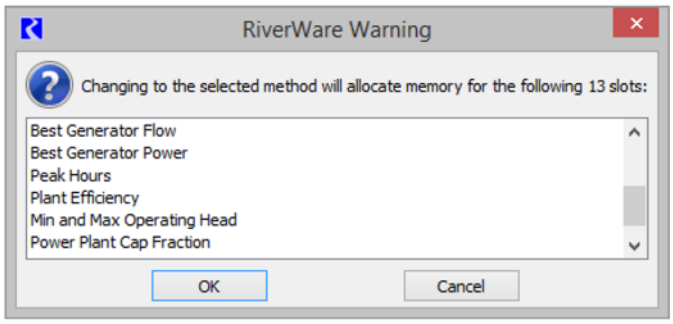


Memory Allocation for Method-specific Slots

Many user methods have special data needs beyond the general data needs of the object. In order to keep the size of the model in memory to a minimum, memory is allocated only for slots which are needed; i.e., general slots required by the object or slots associated with the Methods which have been selected. For example, all reservoirs need Inflow, Outflow and Storage slots. However, the list of slots associated with hydropower generation depends on which User Method is selected in the Power category.

To avoid allocating memory unnecessarily, the default User Method for all categories is an default method which has no slots and performs no calculations. Sometimes the empty default method is *not* a valid choice; you must select another method for simulation to proceed normally. For some categories, the empty method is a valid choice.

Figure 4.14



Method Dependencies

Some categories and user methods are not always available, as their availability depends on the other user methods that have been selected. For example, available user methods in the Power Release category depend on which method is selected in the Power category.

Selecting Methods on Multiple Objects

To select the same method on multiple objects, use the Multiple Object Method Selector by right-clicking a category and selecting **Show in the Multiple Object Method Selector.** See "Multiple Object Method Selector" on page 133 for details on using the selector.

Accounts Tab

When Accounting is enabled, the Accounts display contains a scrollable list of Accounts that reside on the object. To switch to the Accounts view, select the **Accounts** tab or select **View,** then A**ccounts**. The display of the main portion of the dialog changes to the Accounts view. See "Accounting Network" in *Accounting* for a description of the Accounts view.

Accounting Methods Tab

When accounting is enabled and an accounting controller is selected, the **Accounting Methods** tab is added to the Open Object dialog. It displays the following which can then be changed by the user:

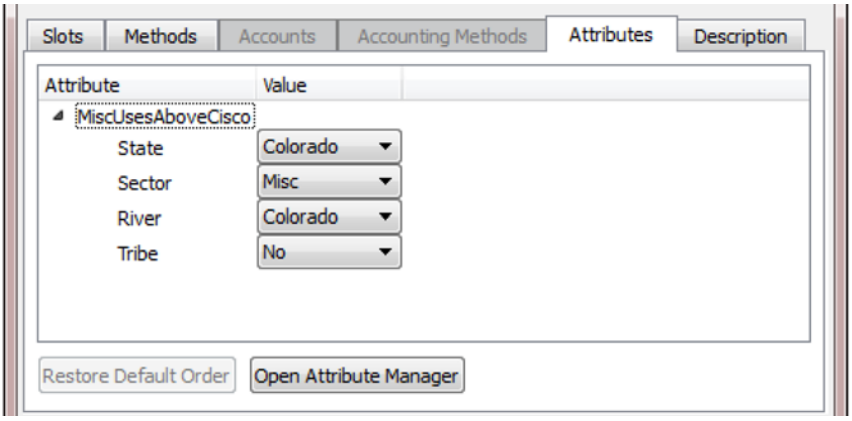
- Available categories
- Selected method for each category
- Execution time

See "Selecting OLAMs and Execution Time" in *Accounting* for details on this tab.

Attributes Tab

The Open Object dialog displays attributes and values on the **Attributes** tab. The tab has one row per Attribute defined for that type of object.

Figure 4.15



Attributes are defined in the Object Attribute Manager; see "Object Attributes Manager" on page 129 for details.

Use one of the following methods to open the Object Attribute Manager:

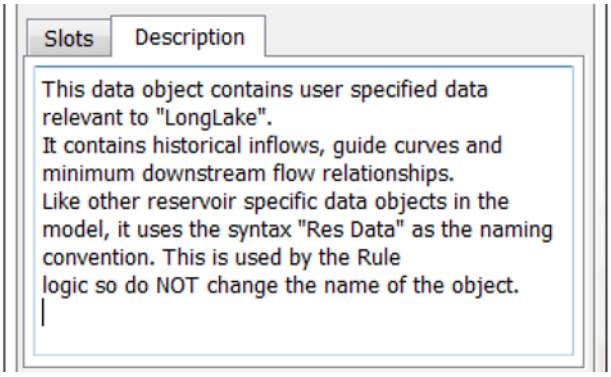
- The **Open Attribute Manager** button,
- **View**, then **Object Attributes Manager** menu, or
- Right-click context menu to open the Object Attributes Manager.

The row lists the Attribute name and the value. A menu on the row allows you to select a different value for that attribute. No apply is necessary. To modify or view attributes on many objects, use the **Edit Attributes on Objects** menu; see "Edit Attributes on Objects" on page 131 for details. Use the **View**, then **Edit Attributes on Objects** menu (or right-click context menu) to open that dialog.

Description Tab

The **Description** tab allows you to enter a description of the object. Select the **Description** tab to open the description area.

Figure 4.16



The normal cut, copy, paste (to the system clipboard) are available.

You can also enter a description of each slot on the object. See “Slot Descriptions” on page 149 for details.

Aggregate Objects

RiverWare has three types of aggregate object (AggObjects): t

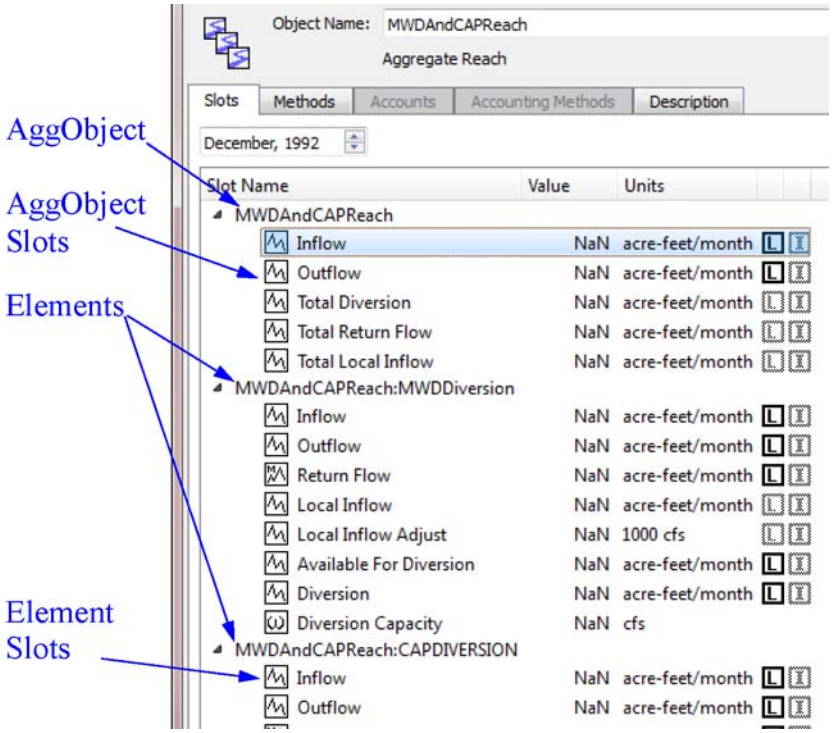
- Aggregate Reach (AggReach), which contains one or more element Reach objects
- Aggregate Diversion Site (AggDiversionSite), which contains zero or more element Water User objects
- Aggregate Distribution Canal (AggDistributionCanal), which contains one or more element Distribution Canal objects.

The aggregate object manages the linking structure of its elements and may also manage the solution methods for the elements. The AggDiversionSite has object solution methods independent of the behavior of its elements and may, therefore, stand alone.

AggObject Dialogs

The Open Object dialog for the AggObjects contains tree-views for both the Slots and Methods displays, where element objects are added and accessed. Also, the main menu bar has two additional items, **Elements** and **Link Structure** (the **Link Structure** item is not available for AggReaches or AggDistributionCanals). The first item listed is always the Aggregate Object itself. The remaining items (below the Aggregate Object) are the elements.

Figure 4.17



Viewing Element Slots and Methods

The slots or methods specific to the element objects are viewed in the lower portion of the Open Object dialog by selecting the tree-view triangle to the left of the element name. If the Open Object dialog is in the Slots display, the tree-view shows the slots associated with the elements. If **Methods** is selected, the tree-view shows the method categories for the elements, if any exist.

Note: Slot groups are not allowed on aggregate objects.

Object Attributes

Object Attributes are user defined Object meta data that allow you to define an Attribute for one or more types of objects. You then define values and assign those value to specific objects. For example, you might have 300 water users in your system. With this functionality, you can define, for example, a “Use” attribute and a “Jurisdiction” attribute. Then you can specify for each water user, its Use, i.e. Municipal, Industrial, or Agricultural, and its Jurisdiction, i.e. “Local”, “State”, “Federal”, etc. Each Attribute and Value is user defined and customized, both the text that you use and which objects types and specific objects to which they apply.

You can use attributes and values in user defined RPL expression and data analysis. For example, you could write an expression that sums up all diversions that represent the Municipal, Local uses. Or compute all depletions by a particular State.

Following is a bulleted list of features of attributes:

- There can be many attributes defined in a model, each has one or more possible values. A particular object can have zero or more attributes, but for each attribute, only ONE value is possible.
- An Attribute can be specific to one or more classes of objects (reach, water user, storage reservoir) including all objects.
- Attributes and values are strings.
- Attributes and Values are defined in the Attribute Manager.
- Values can be assigned from either the Edit Attributes on Objects or the Open Object dialog.
- Attributes and values are displayed on the Open Object dialog.
- Attributes and values accessible from RPL.
- The Selector dialogs have a filter to assist with selecting objects: **Has Attribute Value**.
- You can export/import the attributes and values from one RiverWare model to another.

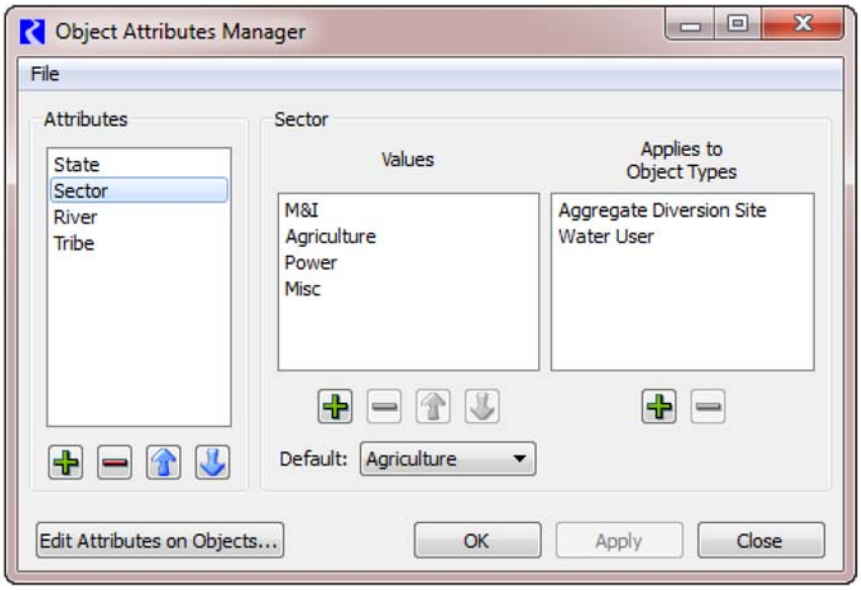
This document discusses the Object Attribute Manager and Edit Attributes on Objects dialogs.

Object Attributes Manager

The Object Attributes Manager is accessible from each Open Object dialog and from the **Workspace**, then **Objects**, then **Object Attributes Manager** menu. The purpose of this dialog is creating, deleting, and otherwise managing attributes and their values. The function of applying values to multiple objects is provided by the Edit Attributes on Objects dialog; see "Edit Attributes on Objects" on page 131 for details.

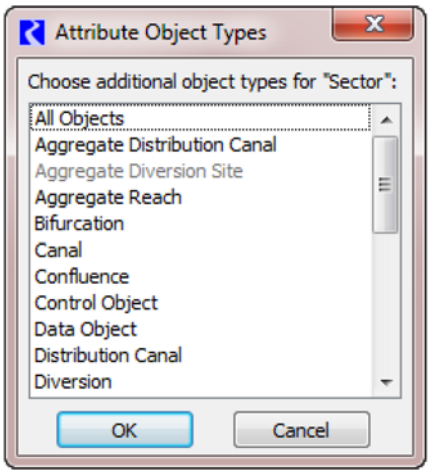
Define Attributes and Values

The Object Attributes Manager is used to define attributes and their legal values. There is no limit to the number of attributes or number of values for a given attribute.



The dialog has three main areas as described right to left.

- Attributes. Add or delete an attribute using + and - buttons. Rename by double-clicking the name. Move the selected items up or down within the list with the arrow buttons.
- Values. Define the legal values for each attribute. For the selected attribute, the center list shows the legal values. Add or delete a value using + and - buttons. Rename by double-clicking the name. Move the selected items up or down within the list with the arrow buttons. The **Default** menu is used to specify the default value for new objects or the first time you apply the attribute to a set of objects. There is no automatic or predefined NULL or NONE value. You must create this if desired. The empty string is not allowed as a value.
- Applies to Object Types. For the selected Attribute, add or remove the object types to which this attribute applies using the + and - buttons. Object Types are always listed in alphabetical order. The first one is All Objects.

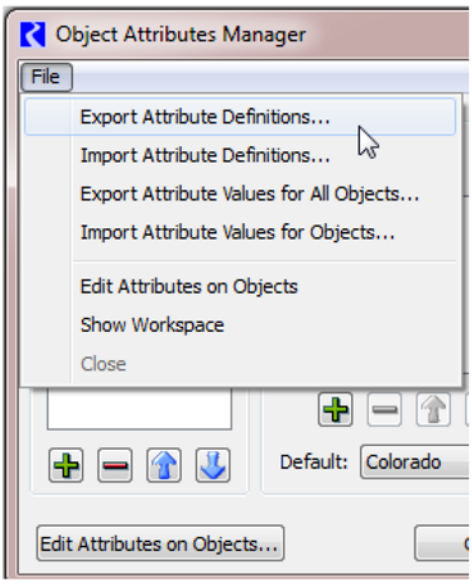


Additionally, if any of the selected set of values (to be removed) are currently used on any objects, a warning message will be displayed indicating which values are used and the number of objects using them.

Right-click context menus allow you to add and delete functions, as well as copy and paste (for text to and from the system clipboard).

Import and Export Attributes and Values

Sometimes, you may wish to move attributes and values from one model to another. Use the Import and Export features on the Object Attributes Manager.



The following is a description of the actions in the **File** menu for importing and exporting.

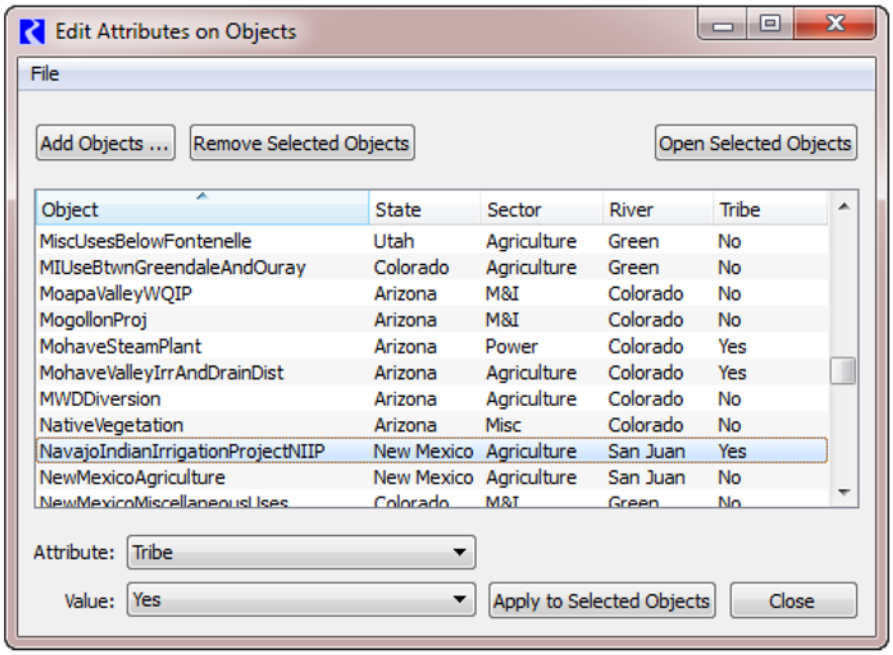
- **Export Attribute Definitions**. Export only the attribute definitions including the Attributes, legal values, and the possible objects types on which they can be used.
- **Import Attribute Definitions.** Import the attribute definitions that were exported.
- **Export Attribute Values for All Objects/** Export the Attribute values specified on each object. For example, this would export that LakeA has the value Colorado for the State attribute.
- **Import Attribute Values for Objects.** Import the attribute values that were exported.

To copy all attributes and values from one model to another model that has no attributes defined, you would need to export both the definitions and values. Then in the new model, import the definitions first and then the values.

Edit Attributes on Objects

The Edit Attributes on Objects dialog displays the attributes and value for a selection of objects, and supports applying new values to all or some of those objects. Figure 4.18 illustrates the tool.

Figure 4.18



The following features are supported:

- Add objects to the list of objects by selecting the **Add Objects** button. Use the selector filter **Has Attribute Value** to find objects that already have the desired Attribute/Values. See "Selecting Objects" on page 309 for details.
- Each object is added as a row in the table.
- Remove the selected objects in the list by selecting the **Remove Selected Objects** button.
- Use the **Open Selected Objects** button to open the selected set of objects to their Attributes tab.
- Each column represents an attribute defined in the model. The values are then shown on each row. If an attribute does not apply to a selected object, the cell is blank.
- Columns are sortable and rearrange-able.
- Use the right-click context menu to copy a list of objects, attributes, values to the system clipboard.

To change the value of a particular attribute for one or more objects shown in the dialog,

1. Highlight/select the desired objects.
2. Select an Attribute and the new Value from the menus at the bottom of the dialog. In this example screenshot, we have chosen the State attribute and want to assign the specified objects to have the Colorado Value.
3. Select **Apply to Selected Objects** to apply that value to those selected objects.

The change is immediate.



Accessing Attributes from RPL

To access Attribute and Value information from RPL, use the following predefined functions:

- ObjectAttributeValue - Get the value (as a string) for the specified Attribute on the specified Object. See "ObjectAttributeValue" in *RiverWare Policy Language (RPL)*.
- ObjectHasAttributeValue - Return a Boolean of whether the particular Object has the specified Attribute Value. See "ObjectHasAttributeValue" in *RiverWare Policy Language (RPL)*.
- ObjectsFromAttributeValue - Get a list of all of the objects that have the specified value for the specified attribute. See "ObjectsFromAttributeValue" in *RiverWare Policy Language (RPL)*.

Multiple Object Method Selector

Before the Multiple Object Method Selector dialog box was available, a user had to select methods from the Open Object dialog for each object. For example, if a new engineering method was developed for use for all reservoirs in basin, a user would have to select this new method on each Reservoir object. For large models, this could be a tedious and time-consuming task. The purpose of the Multiple Object Method Selector is to allow the user to set an engineering method for a group of objects from a single dialog.

All objects of the same type do not necessarily have the same engineering methods or method categories available. For example, it is not always possible for a user to select a given method on *all* Level Power Reservoirs. The currently selected engineering methods on an object determine the currently available methods and method categories.

To overcome these difficulties, this dialog indicates which objects have a given method *category* available and therefore which objects will need to be re-configured in order to make the given category available. The dialog similarly indicates which engineering *methods* are available on each object for a given category. Once an engineering category and method is selected, the dialog only changes the engineering method on objects which have the desired category and method available.

Usage Overview

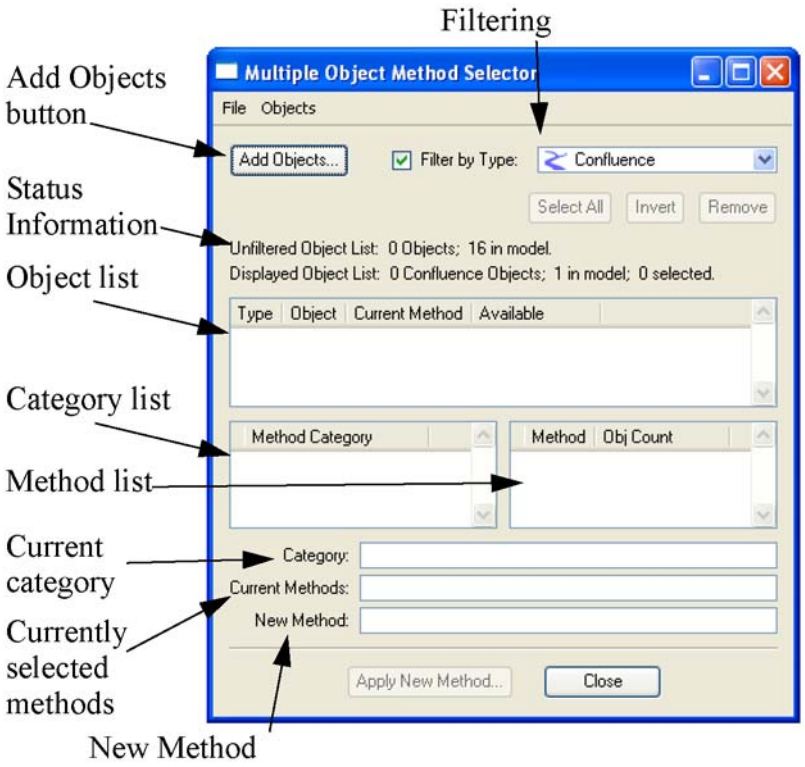
- Open the Multiple Object Method Selector from the main RiverWare workspace by selecting **Workspace**, then **Objects**, then **Select Methods on Objects**.
- Add objects to the object list by selecting the **Add Objects** button, then select objects in the object selector and select **Ok**.
- Optionally, filter the objects by type.

- Highlight the desired objects to which a new method should apply.
- Select a category from the category list.
- Verify that the category is available on the desired objects by inspecting the Current Method column in the object list.
- Select a new method from the method list.
- Verify that the selected method is available on all desired objects by inspecting the Available column in the object list.
- Apply the new method to the highlighted objects by selecting the **Apply New Method** button.
- Verify that the objects listed in the confirmation dialog are the objects you intend to affect, and select **OK**.

Accessing the Dialog

The dialog is invoked from the main RiverWare workspace using the menu sequence: **Workspace**, then **Objects**, then **Select Methods on Objects**. This displays a blank Multiple Object Method Selector dialog.

Figure 4.19



It is also possible to bring up the dialog from the **Open Object**, **Methods** tab by right-clicking a row and then selecting **Show in the Multiple Object Method Selector**. In this case, the selected object is added to the object list and the selected category and method are already highlighted.

Dialog Overview

Selecting methods on multiple objects consists of the following steps:

1. Select a group of objects.
2. Select a method category.
3. Select a new engineering method.

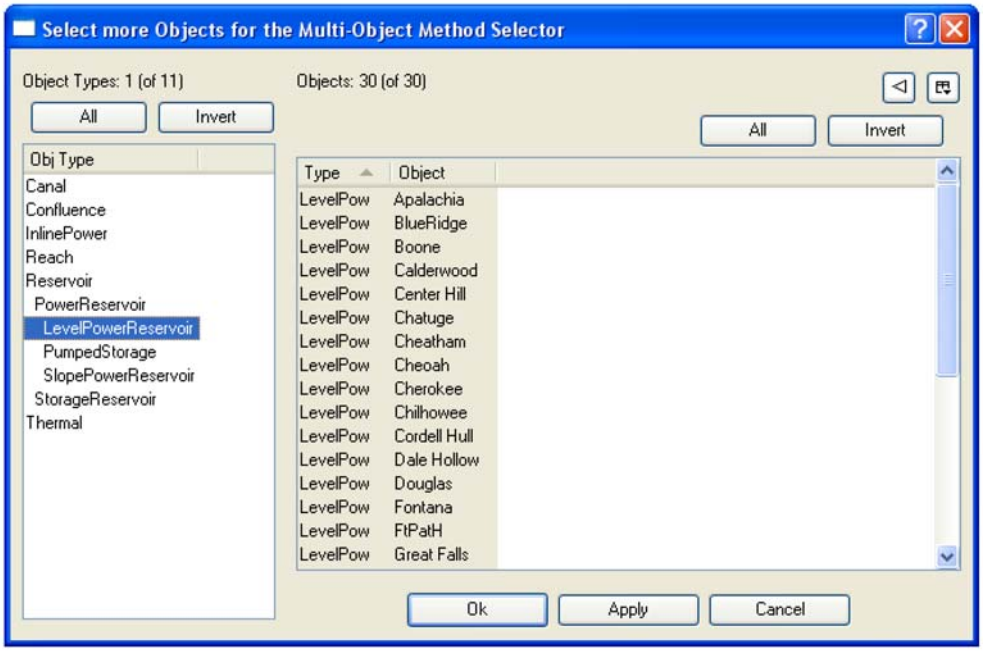
These steps are accomplished using the three sections of the dialog. The dialog is designed so that the user progresses from top to bottom with each successive task. From top to bottom, we will refer to these sections as: Object List, Category List, and Method list.

Object List

The selection of new methods is performed on the selected objects in the list of objects. This list is created/edited by the user by adding/removing objects, filtering, and finally making a selection.

Adding Objects

Adding objects is accomplished using the selector. This dialog is displayed using the **Add Objects** button or the corresponding menu item: **Objects**, then **Invoke Object Selector**.



Use of this dialog proceeds from left to right. The user first selects an Object Type. This populates the list of objects of the given type in the Objects list. Multiple object types can be selected simultaneously by pressing **Ctrl** while selecting the object types.

Objects in this list can be filtered using the standard object filters: **Object Name Filter**, **Has Accounts Filter**, and **In Subbasin Filter**. The user then selects objects from this list. This can be done with the following methods:

- Manually selecting individual objects;
- Selecting multiple objects by **Ctrl** on the keyboard and selecting multiple objects with the mouse;
- Selecting all the objects in the list by selecting the **All** button under the Object list in the dialog.

Once the desired set of objects has been selected, the **OK** or **Apply** button adds the objects to the list in the Multiple Object Method Selector. See "Selecting Objects" on page 309 for details on using the selector.

If after adding objects to the Multiple Object Method Selector, more objects need to be added, the object selector can be invoked again. Objects are appended to the current object set in the Multiple Object Method Selector.

> **Note:** The list of objects added using the selector is called the *unfiltered* list and can contain many different types of objects.
>
> **Note:** Regarding aggregate objects, parent aggregate objects and their child segment objects appear as separate items in this object selector dialog. The parent object will appear as an object of the aggregate type. The child objects will appear as objects of their individual type. For example, an AggReach with 2 child/segment objects are treated as follows: the parent object is an object of type AggReach; the 2 child objects are objects of type Reach. They can each be added by selecting the given type then the given object.

Removing Objects

A user removes objects by selecting one or more objects in the list and then clicks the **Remove** button or all objects can be removed using the menu item: **Objects**, then **Remove All Objects**.

Filtering Objects

When the user adds objects to the list using the **Add Objects** button and the selector, the user is able to select multiple types of objects. Applying new methods is specific to a type of object, e.g. Reach methods do not apply to Reservoirs. If the user adds multiple types of objects, every method category for all object types will be added to the list. It is frequently overwhelming to sort through the various user methods to find the desired method. To avoid this, the object filter can be used to only show objects by type. Select the checkbox to **Filter by Type,** then select a type of object from the menu. Abstract object types like Reservoir or Power Reservoir can be selected. Now only the objects matching that type are shown in the list. This is now called the *filtered* list.

> **Note:** If you wish to switch object types, the original list of objects added remains as the non-filtered list. Select a new filter type (including disabling the toggle) to show a different set of objects. The status of the number of objects in the filtered and unfiltered objects lists is shown on the dialog. This filtering functionality allows users to add all the objects in a subbasin or geographic region, then select methods on each type of object without losing the list of objects in the subbasin.

Selecting Objects

Application of a new method is performed on the objects selected in the object list, not all of the objects displayed. You can use the following methods to select objects:

- Manually select individual objects.
- Select multiple objects by highlighting multiple objects or use the <Control> key on the keyboard.
- Select all the objects in the list by selecting **All** under the Object list in the dialog.

- Invert the selection using the **Invert** button.

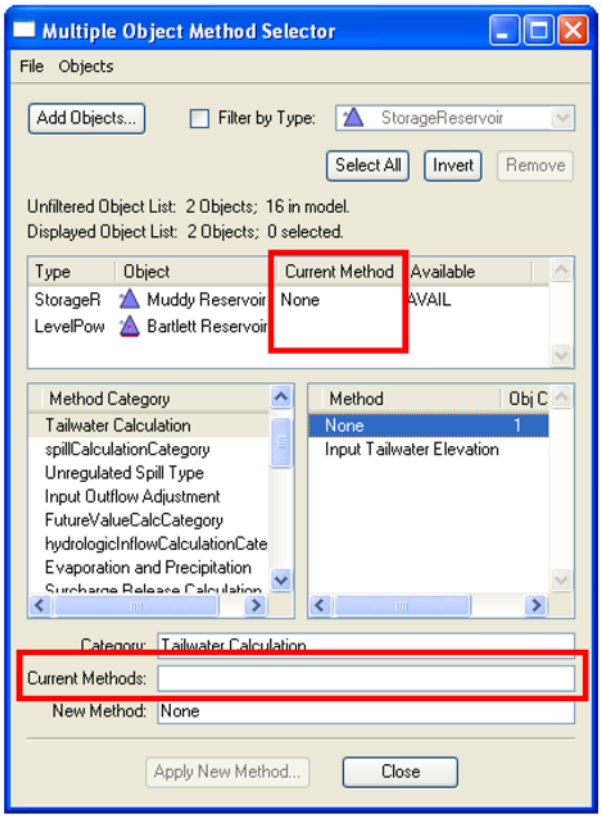
Any new method selection will be applied only to the selected objects.

Selecting a Method Category

Once objects have been added to the object list, the category list will be updated to display the *union* of all active categories on the selected objects. It is important to understand that this list displays the union, so some objects may not have a given category available.

Note: Object Level Accounting Methods are shown with a grey background.

Selecting a category selects the category. When a category is selected the object list and method selection controls are updated to display information about the selected category.



Determining Which Objects Have a Category Activated

When a category is selected, the object list displays which objects have the selected category available. The third column in the object list, Current Method, is one of the following:

- Empty - indicating that the selected category is not available on this object
- Displays a method name - indicating that the selected category is available, and that the displayed method is the currently active method for the category on this object.

The user should scroll through the object list, looking for empty values in the third column. This information is useful when the user intends to set a common method on all the objects in the set. In this case, the user can quickly determine which objects need to be reconfigured to make the desired category available.

Determining the Currently Active Method

Information about the currently active method is contained in two places in the dialog: the Current Method column in the object list, as discussed previously, and the **Current Methods** text box in the method selection section. The Current Methods line displays a comma-separated set of selected method for all the objects in the set.

Selecting a New Method

Once a category has been selected, the user can select a new method for this category. The new method is selected from the list of methods in the right pane. Once a method is selected, it is added to the New Method line at the bottom of the dialog.

Like method categories, methods may not be active on some objects, even though their category is active. The method list displays the *union* of all methods available on the selected objects that have this category active. Since some methods may not be available on all objects, the object list displays whether a given method is available on each object. Once the user has selected a new method from the method list, the objects list is updated. The forth column in the object list, Available, now displays the text AVAIL if the selected method is available on the given object, or display nothing if the method is not available on the object.

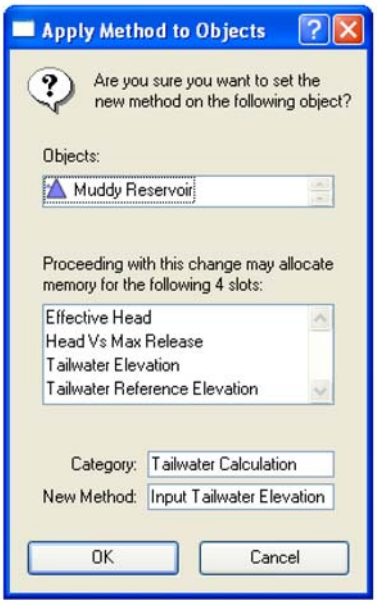
Once a method has been selected the user should scroll through the object list to determine which objects can have the new method activated. Any method with AVAIL in the Available column are allowed to have the new method activated. If this column is empty for an object, the object will not be affected if this new method is applied.

Unlike the OpenObject dialog, selecting a method from this menu does not immediately set the method on all affected objects. Instead, the user must select the **Apply New Method** button to change the method on the objects. This **Apply New Method** button remains inactive until a new method has been selected from the menu, at which time it will be enabled. Selecting **Apply New Method** will set this method as the active method on *highlighted* objects in the object list with this category and method available.

Confirming Changes

After the new method has been applied using the **Apply New Method** button, a confirmation dialog appears. This dialog lists all the objects which will have this new method activated. This is the selected objects the list that have the desired category and method available. Canceling this dialog will prevent the method from being changed on any of the objects. Also, the dialog informs the user of the new slots which may be instantiated when this new

engineering method is activated. Canceling this dialog will prevent the method from being changed on any of the objects.



Once the confirmation dialogs have been accepted, the objects will be modified. A busy cursor indicates that the methods are being changed. For a large set of objects this operation can take some time.

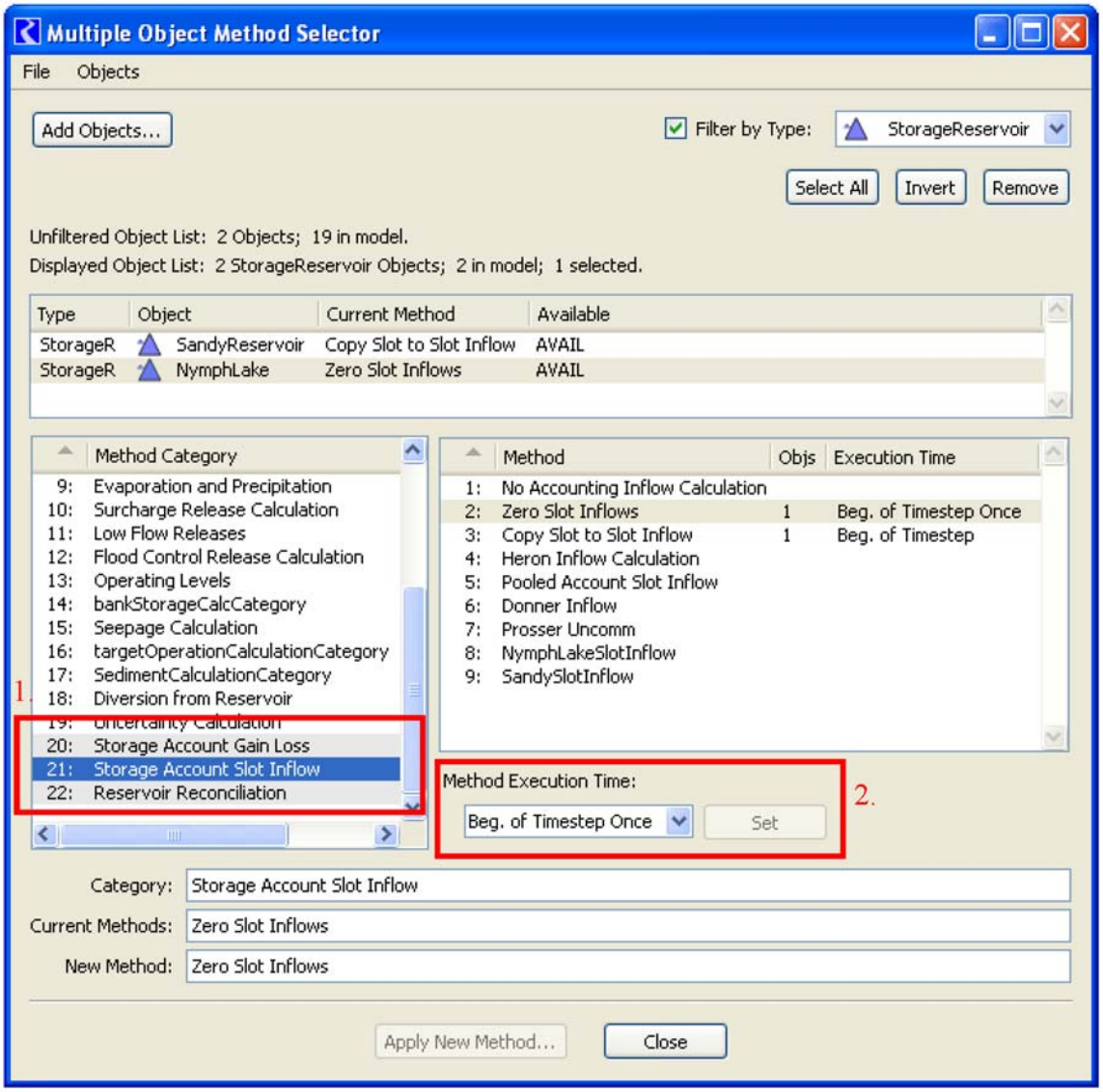
Once the methods have been changed, the Multiple Object Method Selector dialog will be updated to display the new methods on the objects. A quick inspection of the object list shows that the method has been changed on the objects with this category and method available.

Selecting Object Level Accounting Methods (OLAMs)

The Multi-Object Method Selector dialog can be also used to select Object Level Accounting Methods (OLAMs). See "Object-level Accounting Methods (OLAMs)" in *Accounting* for details on OLAMs. Figure 4.20 shows aspects of this dialog specific to OLAMs.

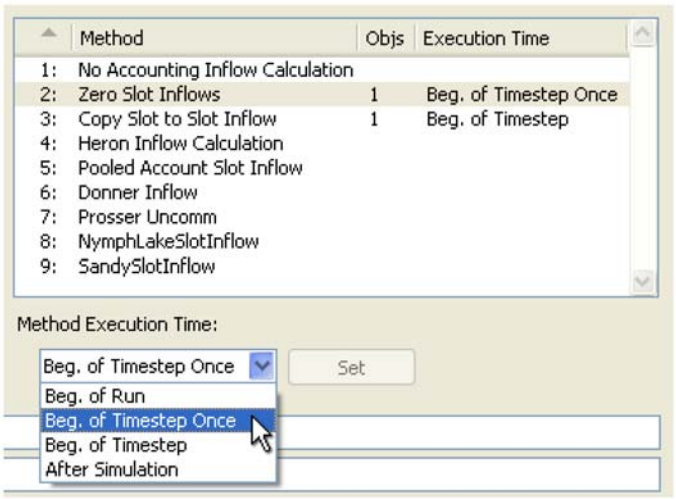
- OLAM category items are shown with a grey background. In Figure 4.20, see the bottom three rows in the method category list.
- When an OLAM category is selected, additional controls are shown below the method list. In Figure 4.20, see the **Method Execution Time** selector and **Set** button. These controls are described on the following pages.

Figure 4.20


Multiple Object Method Selector
File
Objects
Add Objects...
Filter by Type:
StorageReservoir
Select All
Invert
Remove
Unfiltered Object List: 2 Objects; 19 in model.
Displayed Object List: 2 StorageReservoir Objects; 2 in model; 1 selected.
Type
Object
Current Method
Available
StorageR
SandyReservoir
Copy Slot to Slot Inflow
AVAIL
StorageR
NymphLake
Zero Slot Inflows
AVAIL
Method Category
9: Evaporation and Precipitation
10: Surcharge Release Calculation
11: Low Flow Releases
12: Flood Control Release Calculation
13: Operating Levels
14: bankStorageCalcCategory
15: Seepage Calculation
16: targetOperationCalculationCategory
17: SedimentCalculationCategory
18: Diversion from Reservoir
20: Storage Account Gain Loss
21: Storage Account Slot Inflow
22: Reservoir Reconciliation
1.
Method
Objs
Execution Time
1: No Accounting Inflow Calculation
2: Zero Slot Inflows 1 Beg. of Timestep Once
3: Copy Slot to Slot Inflow 1 Beg. of Timestep
4: Heron Inflow Calculation
5: Pooled Account Slot Inflow
6: Donner Inflow
7: Prosser Uncomm
8: NymphLakeSlotInflow
9: SandySlotInflow
Method Execution Time:
Beg. of Timestep Once
Set
2.
Category:
Storage Account Slot Inflow
Current Methods:
Zero Slot Inflows
New Method:
Zero Slot Inflows
Apply New Method...
Close

Setting the Execution Time of OLAMs

When an object level accounting category is selected, that category's method options are shown in the methods list (shown here).



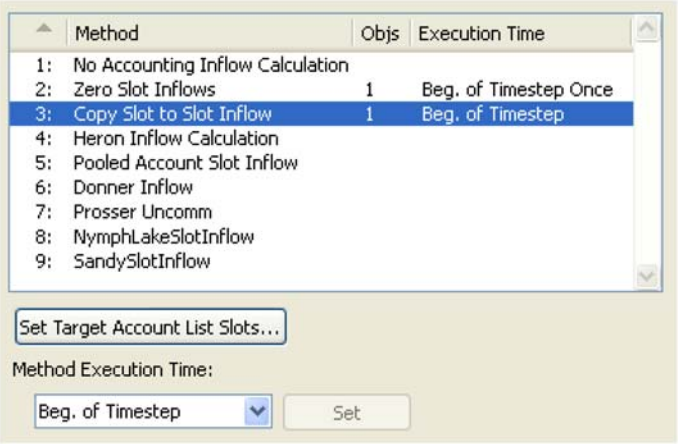
When selecting a method item selected on at least one simulation object, the Method Execution Time combo box is set to the indicated execution time -- or, if multiple execution times are indicated for that method item, one of those several execution times are used. You can selected a different execution time in the combo box. See "Execution of OLAMs" in *Accounting* for details on execution times.

In this dialog, there are two ways of setting the execution time of OLAM methods:

- By selecting the **Set** button next to the Method Execution Time selector. This effects the methods on the objects currently having that method setting.
- By selecting the **Apply New Method** button at the bottom of this dialog. (See previous page). This simultaneously sets the selected method item on the selected objects AND sets the execution times of those methods.

Special Support for Copy Slot to Slot Inflow: Set Target Account List Slot

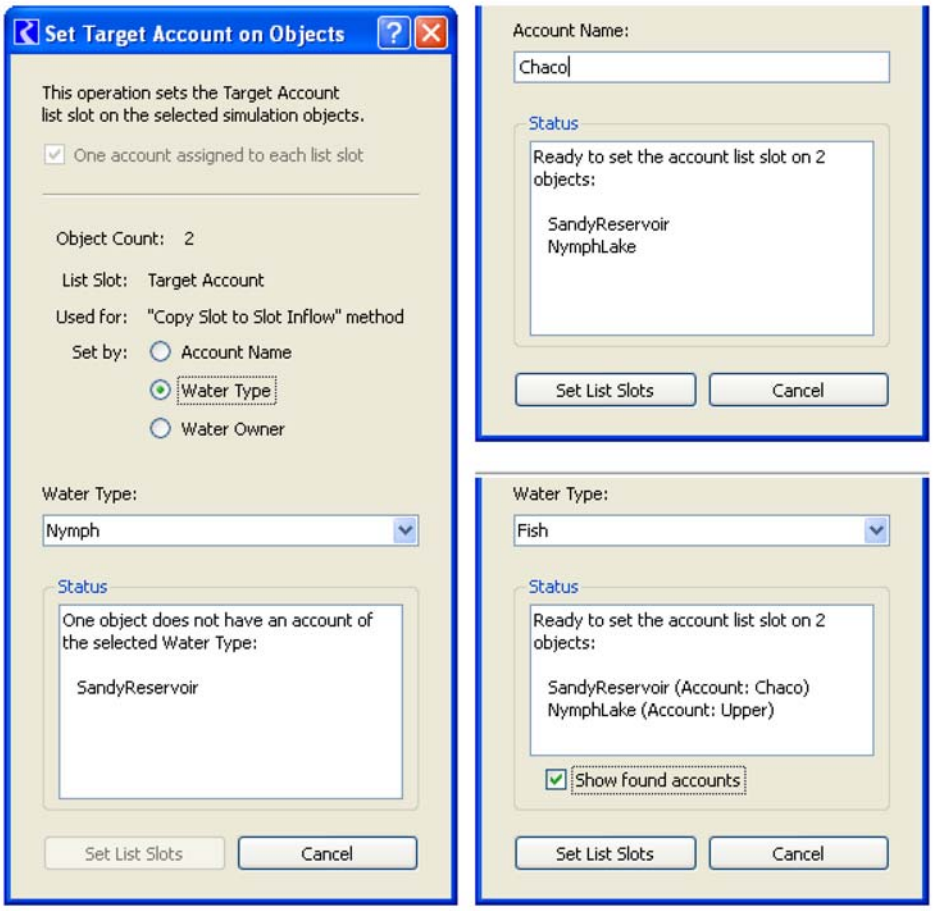
The Multiple Object Method Selector also has special features for the Copy Slot to Slot Info OLAM; see "Copy Slot to Slot Inflows" in *Accounting* for details.



When that method is selected, the **Set Target Account List Slots** button is shown below the methods list. This button is enabled if any objects currently have the **Copy Slot to Slot Info** method selected. Selecting this button brings up the new Set Target Account on Objects dialog.

The Set Target Account on Objects dialog operates on each simulation object being editing in the Multi-Object Method Selector which has the Copy Slot to Slot Inflow method selected.

Figure 4.21



The user selects one of three criteria for choosing an Account on each simulation object to be assigned to that object's Target Account List Slot:

- Account Name
- Water Type
- Water Owner

There must be exactly one Account on each object matching the criteria. This information is displayed in the Status area.

In the case of the Set List Slots operation being ready (i.e. exactly one Account matching the entered criteria for each simulation object), the Status panel enumerates the simulation objects; see Figure 4.21. Otherwise, the Status panel enumerates the simulation objects which either have no Accounts matching the criteria, or have more than one Account matching the criteria. Additionally, when the Water Type or Water Owner criteria are selected, the names of the matching Accounts can optionally be shown.

Selecting the **Set List Slots** button, when enabled, assigns the object Target Account List Slots and closes the dialog.

Chapter 4
Object Dialogs

Chapter 5
Slots

Slots are variables, or the primary data storage containers on an object. In the Object Viewer (or Open Object) dialog, the slot list shows all of the data associated with the object. This includes both required input data, calculated output timeseries data, input tabular data, and input coefficients for the various physical process calculations.

Topics

- Simulation and Custom Slots, page 145
- Slot Dialogs, page 146
- Menus on the Slot Dialog, page 155
- Types of Slots, page 163
- Global Slot Configuration, page 260
- DateTime Values in Slots, page 265
- Notes on Series Slots, page 272
- Finding Slot References, page 284
- Slot Sets, page 288

Simulation and Custom Slots

The list of slots may change depending on the user methods that are selected and when custom slots are added. The distinction is as follows.

Simulation slots

A part of the simulation object as either general slots or through a user method. The names of Simulation Slots are predetermined by the object and cannot be changed. Simulation slots have a white background in the icon.



Custom slots

Created by the user on a simulation or data object. Custom slots have a pale yellow background on the icon.



Slot Dialogs

The data for a particular slot is shown in either the Slot Viewer or the Open Slot dialog. Both dialogs are introduced in the following section.

Opening a Slot

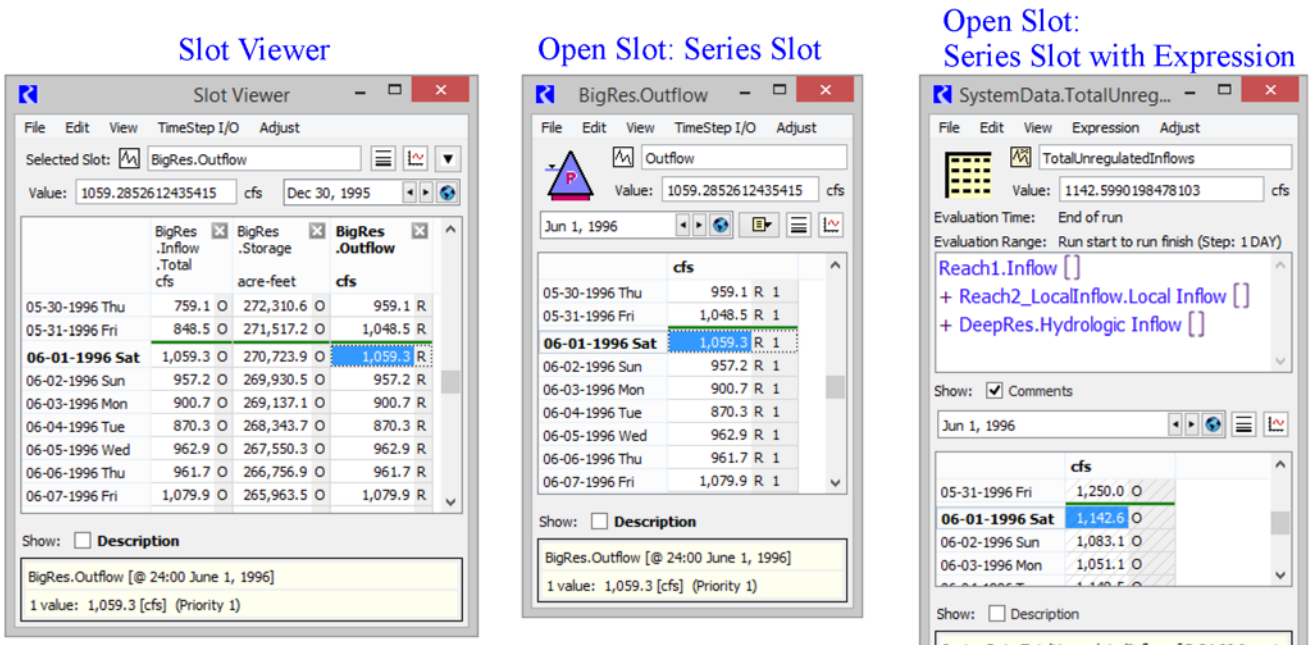
Use one of the following methods to open a slot:

- In the Object Viewer (or Open Object) **Slots** or **Methods** tab, do one of the following:
  - Double-click the slot row name.
  - Right-click a slot's row, and use the **Open Slot** context menu.
  - Highlight a slot's row, and select **Slot**, then **Open Slots** from the command menu bar.
  - Highlight a slot's row, and press **Ctrl-O**.
- From the main workspace, use the **Workspace**, then **Slots**, then **Open Slot** menu.

Sample Slot Dialogs

When you open a slot, the dialog that opens depends on the slot type. Figure 5.1 shows sample slot dialogs for series slots.

Figure 5.1 Screenshots of three sample Series Slot dialogs

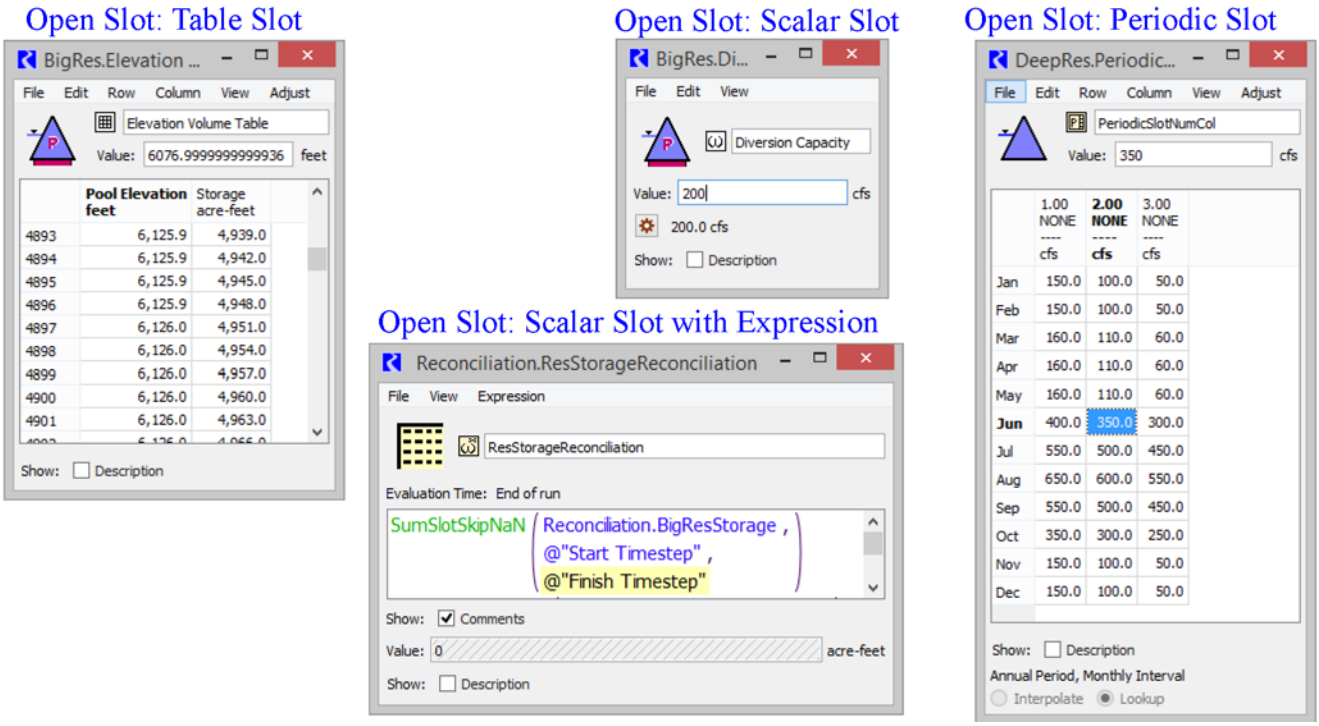


The series slot dialogs look similar.

Note: Most series slots will open in the Slot Viewer to show the data. You can drag the column off the viewer to see the slot in its own dialog. See "Slot Viewer Functionality" on page 168 for details.

Figure 5.2 shows sample Table, Scalar, and Periodic slots.

Figure 5.2 Screenshot of sample Table, Scalar and Periodic slot dialogs

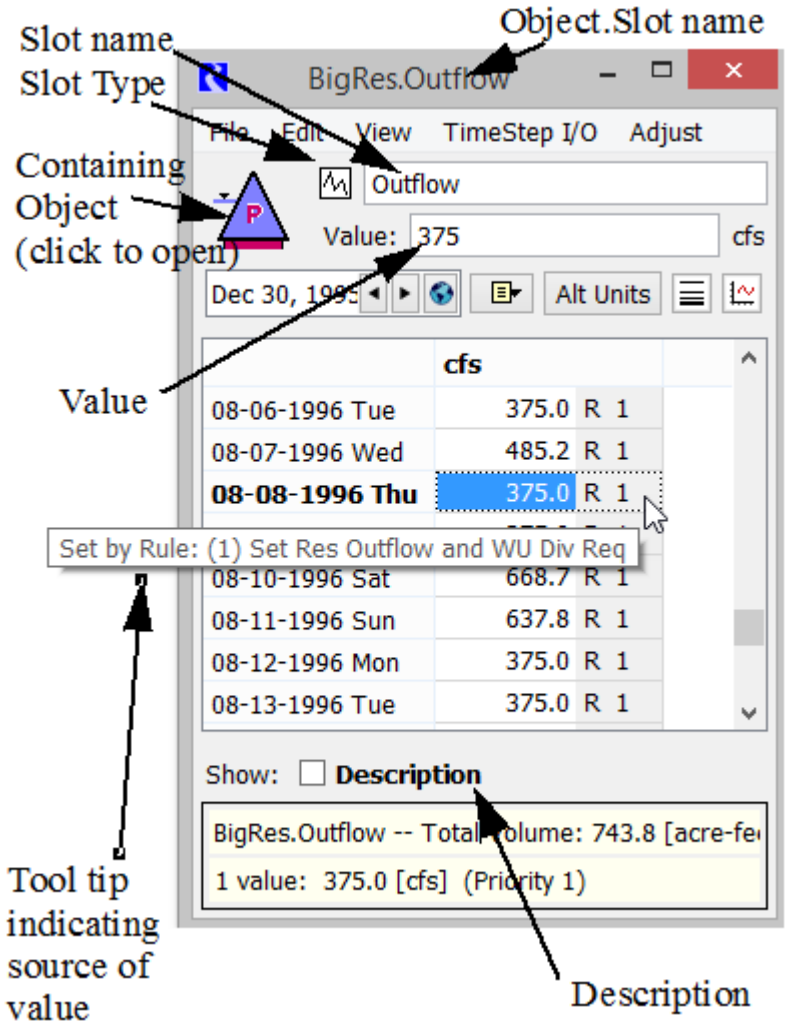


Again, you can see the similarity in the various slot dialogs. As a result, this document will present general slot functionality and then describe slot specific functionality.

Slot Dialog Functionality

Figure 5.3 shows a sample Open Slot dialog for a series slot. Although other types of slots have different options, most of the slots have similar menus, look, and feel.

Figure 5.3 Annotated screenshot of a slot dialog



Functionality is essentially the same for either the Open Slot or the Slot Viewer; see "Slot Viewer Functionality" on page 168 for details.

This section first describes the general Open Slot layout and menu options. Then each individual type of slot is presented later with further information on type specific configuration options.

The open slot contains the following:

- The title of the Open Slot dialog is the Object.Slot name.
- The slot name is repeated in a text field below the menu bar. On custom slots, you can change the name of the slot by editing this text field.

  Note: If you are renaming a custom slot whose old name appears in RPL sets, a dialog asks if you want to search RPL sets for the old name and optionally replace occurrences with the new name. Answering Yes will bring up the RPL Search and Replace dialog with the results of a search for the old name in all RPL sets and with the new name filled into the **Replace with** field. You can examine the occurrences and choose to replace some or all of them with the new name.

- The type of slot is displayed by an icon. See “Types of Slots” on page 163 for a list of the icons.
- The containing object’s icon is shown. Selecting this icon will open the object.
- The Value field shows up to 15 digits of precision of the highlighted cell and the units. The user can type a value directly in here or in the cell.
- Tooltips on the cells indicate the rule or DMI that set or triggered a solution; see “Tooltips” on page 174.
- The **Description** checkbox shows a text description of the slot; see “Slot Descriptions” on page 149.

Closing a Slot

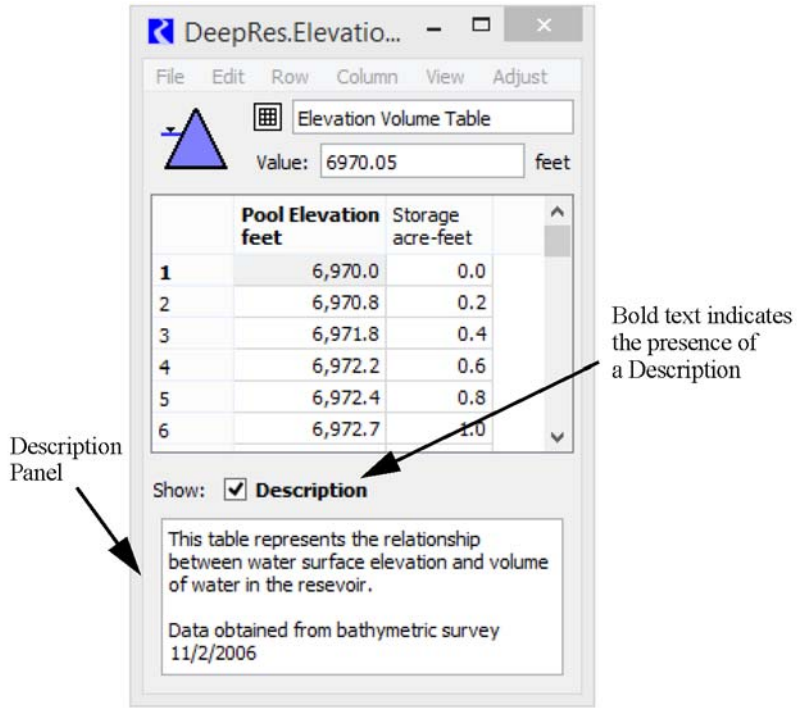
Use one of the following methods to close an Open Slot dialog:

- Select **File**, then **Close Window**.
- Press **Ctrl-W** when the window is active.
- Select the red **X i**n the upper-right corner of the dialog.
- Double-click the RiverWare icon in the upper-left corner of the dialog.
- From the main workspace, select **Workspace**, then **Slots**, then **Close All Slots** menu item to close all Open Slot dialogs.
- From the Slot Viewer, select the **X** on the slot’s column.

Slot Descriptions

On all slots, you can specify a text description. The description is accessed from the **View**, then **Add (or Show) Description** menu or though the **Description** checkbox. When this option is selected, a panel is added that provides a text box in which you can type the description. Figure 5.4 shows a sample dialog for a table slot with the Description panel displayed.

Figure 5.4



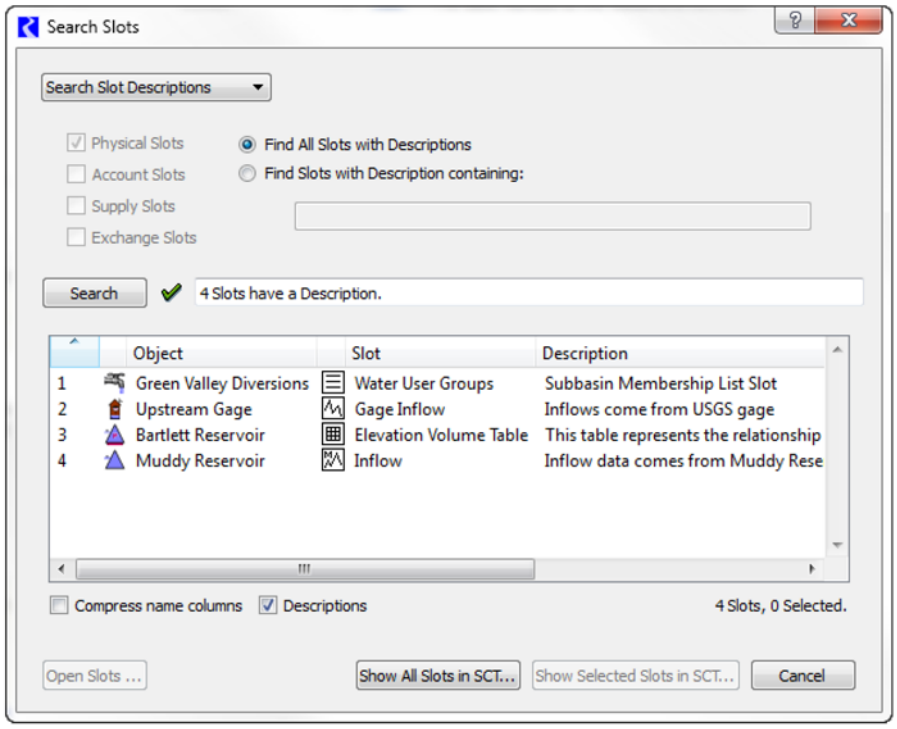
When there is a description, the word Description is bold in the dialog. If there is no description, the word Description is dimmed.

You can also hover over the word Description to get the first 140 characters of the description as a tooltip.

> **Note:** You can configure your preferences on whether or not to show Descriptions using Slot Dialog Display Preferences; see "Slot Dialog Display Preferences" on page 161.

Searching Slot Descriptions

The Search Slot Descriptions utility can be used to find slots that have a description or specific keywords in their description. It is accessed from the RiverWare Workspace using the **Workspace**, then **Slots**, then **Find Descriptions** menu. The Search Slots dialog appears.



This dialog provides the following options:

- **Find All Slots with Descriptions**. Find any slot that has a description.
- **Find Slots with Descriptions containing**. Find slots that have descriptions that contain the specified text. The search is not case sensitive.

You can limit the search to the specified types of slots including physical, account, supply or exchange slots. When any of the search input controls are changed, the Green Check icon turns into a Red “X”, and the search summary description is grayed out. Select the **Search** button to perform a new search.

This dialog has a **Descriptions** checkbox below the slot list. Turning on this checkbox replaces several slot attribute columns with a Descriptions column showing up to 150 characters of each Slot's description.

Turning on the **Compress name columns** checkbox replaces the distinct columns for object name, Account name and Slot name with a single “complete” slot name column.

Several context menu (right-click) operations are available within the slot list:

- Open Slot. Show the open slot dialog for the chosen slot item.
- Open Object. Show the object dialog for the chosen slot item (if applicable).
- Copy Slots. Put the selected slot items into the slot clipboard, e.g. to paste into an output (manager) device slot list.

Buttons along the bottom of the dialog provide these functions:

- **Open Slots**. Separate open slot dialogs are shown for each of the selected items in the list. If more than four (4) slots are selected, then a query dialog box is shown confirming the operation with a message similar to the following: “Do you want to show 421 Open Slot dialogs?”.

  Note: All shown open slot dialogs may be hidden with the **Workspace**, then **Slots**, then **Close All Slots** menu operation.

- **Show All Slots in SCT**. All slots in the list (regardless of item selection) are shown in a new SCT dialog, and the dialog is closed.
- **Show Selected Slots in SCT**. Selected slots in the slot list are shown in a new SCT dialog, and the dialog is closed.
- **Cancel**. The dialog is closed.

The dialog can also be used to find input values on series slots. See “Finding Inputs” on page 192 for details.

Creating and Configuring Slots

Custom slots can be created on any type of object (except snapshot data objects). You can create various types of series, tables, periodic tables, statistical tables, scalar and expression slots. See “Types of Slots” on page 163 for details. The user is *not* able to create Multi Slots, Table Series Slots or List Slots.

The main menu bar on the Object Viewer (or Open Object) dialog has a **Slot** menu (or in the context-sensitive menu activated by right-clicking the slot list area) which includes the following commands.

- Add Series Slot
- Add Series Slot with Expression
- Add Integer Indexed Series Slots
- Add AggSeries Slot
- Add Integer Indexed AggSeries Slot
- Add Series Slot with Periodic Input
- Add Table Slot
- Add Statistical Table Slot
- Add Periodic Slot, Text Headers
- Add Periodic Slot, Numeric Headers
- Add Scalar Slot
- Add Scalar Slot with Expression
- Add Mass Balance Summary; see “Creating a Mass Balance Summary Slot” on page 234.
- Add Time Aggregation Series Slot
- Add Time Disaggregation Series Slot

After the slot is created, the following steps should be taken:

1. Open the newly created slot by double-clicking it.
2. Rename the slot by typing directly in the **Name** field.
3. Use the Configure menu option (and the subsequent dialog) to set the unit type, display format, and convergence criteria. See "Configure Slot Dialog" on page 153 for details.
4. On series, consider revising the time series range, if necessary, prior to adding data into the series. On table slots, consider setting the number of rows and columns and changing the row or column labels.
5. On non-aggregate objects, slots can be organized into user defined groups. See "Slot Groups" on page 116 for details on this utility. In addition, slots and groups can be copied and pasted to other objects. See "Copy Slots to Objects" on page 120 for details on this action.

Configure Slot Dialog

The Configure Slot dialog is opened by selecting **View**, then **Configure** in the Open Slot dialog. Depending on the type of slot opened, the dialog could appear a slightly different. For example, the portion of the dialog showing the Upper Bounds and Lower Bound is only displayed for Series Slots. See "Types of Slots" on page 163 for details about slot type differences.

> **Note:** To configure Bounds or Convergence on multiple slots at one time, use the Configure Existing Slots dialog; see "Global Slot Configuration" on page 260.

Values are Integers

The **Values are integers** check box allows you to specify that values in this slot are intended to be integers and should be displayed as such. When checked, the display precision is set to 0 and cannot be changed. Some slots associated with objects' methods have this toggle checked and cannot be changed.

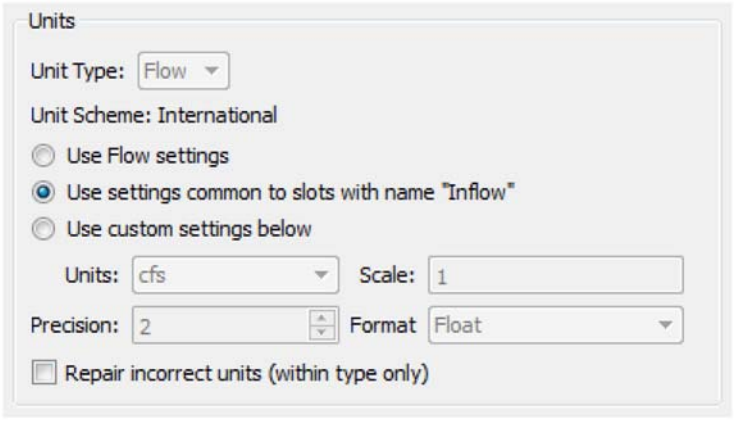
> **Note:** When the **Values are integers** box is checked, the values are still stored internally with full precision and are used with full precision in all computations. The **Values are integers** option only affects the display precision.

Units

Units (Unit/Scale/Precision/Format) are controlled by the Unit Scheme, which presents a comprehensive view of how numeric values are displayed in RiverWare (see "Unit Schemes" on page 91 for details). The units on slots are therefore controlled by the Unit Schemes. But you can configure the units via exceptions in the Unit Scheme Manager or from the slot itself. This section describes the configuration options on the slot. See "Creating Exceptions" on page 96 for details on exceptions.

The Configure Slot dialog lists the unit type and the active scheme. On custom slots, you can change the unit type. On simulation slots, the type is fixed. You can then choose one of the options:

- **Use Flow settings**. Use the Unit type rule, i.e. use the generic setting associated with that unit type.



- **Use settings common to slots with the name "Inflow"**. Use a previously configured unit name exception that defines how slots with the same name should be displayed.
- **Use custom settings below**. Modify the units for just this slot. When you do this action, you are actually creating a Slot Exception for that slot within the currently active Unit Scheme. After making the change in the slot's configuration, you can go to the unit scheme and see that exception.

As you change the selection, the unit settings for that toggle are shown in the Unit/Scale/Precision Format areas.

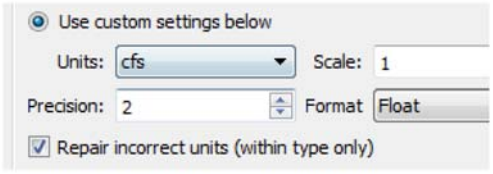
Note: Regarding the **Show Commas in Numbers** option. On slots, commas are shown by default as a thousands separator. This is a global setting that is specified from the **Workspace**, then **Show Commas in Numbers** menu on the workspace. See "Show Commas in Numbers" on page 9 for details.

Repair incorrect units

Caution: Take care when using this feature to avoid corrupting data.

Sometimes you enter values into a slot (by typing or importing) but then realize that the slot's display units were not what you expected. For example, you want to enter 100cfs into a slot so you type it in. But, then notice the slot is showing the flows in cms, when you meant to enter them in cfs. So now the slot has a value of 100cms = 3531.5cfs. How do you fix this without reentering the values?

To change the display units without changing the value displayed, you change the slot's units from the slot using the **View**, then **Configure** menu. Configure that you wish to use custom settings, then change the units. Check the **Repair incorrect units (within type only)** box. When you apply the change and the confirmation dialog, the units will change, but the displayed values will not. This feature can be used to correct data which were accidentally imported or entered with the wrong display units selected.



Menus on the Slot Dialog

Following is a general description of the menus for the Slot dialog. See "Types of Slots" on page 163 for descriptions of each slot type.

File Menu

The functionality available from the **File** menu depends on the slot type. In general, this menu is used to do the following activities.

Import (fixed or resize) and Export (display or model precision)

Large sets of data may be imported into, and exported from the Open Slot dialog. Exported data are written to a text file in tab-separated format. Imported data may be tab or space-separated. Exported values are written in the display units and either the precision currently specified in the Open Slot dialog (**Display Precision**) or the entire internal precision (**Model Precision**). Likewise, imported data are assumed to be in the same units as the Open Slot dialog. The entire precision of an imported value will be preserved, although only the selected display precision is shown. **Import Fixed Size** always maintains the existing number of rows in the slot and truncates incoming data if the data file contains more rows than the slot. **Import Fixed Size** leaves existing data after the imported data if the data file contains fewer rows than the slot. **Import Resize** automatically expands the slot, if necessary, to match incoming data. For a table slot, **Import Resize** shrinks the number of rows in the slot to match the incoming data. For a series slot, **Import Resize** leaves existing data after the imported data if the data file contains fewer rows than the slot.

Plot

Open a new plot with the given slot.

Print Expression

On expression slots, print the expression.

SCT

Add the series slot to an existing SCT or create a new SCT with the slot.

Show Workspace

Bring the workspace to the top of the screen.

Close Window

Close the window.

Edit Menu

The **Edit** menu is available on series, table, periodic and list slots and is used to change the number of rows or columns, and to change values in the slot.

Cut/Copy/Paste

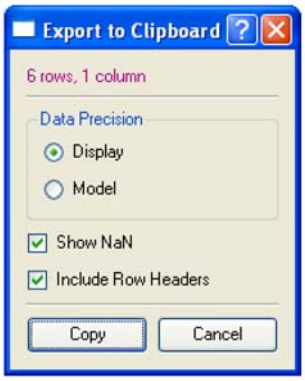
There are options to cut/copy/paste data from the highlighted cells. These use an internal clipboard and cannot be copied or pasted from other applications. The Export Copy and Import Paste options allow you to use the system clipboard.

Paste as Input

Paste from the internal clipboard and set the Input flag.

Export Copy

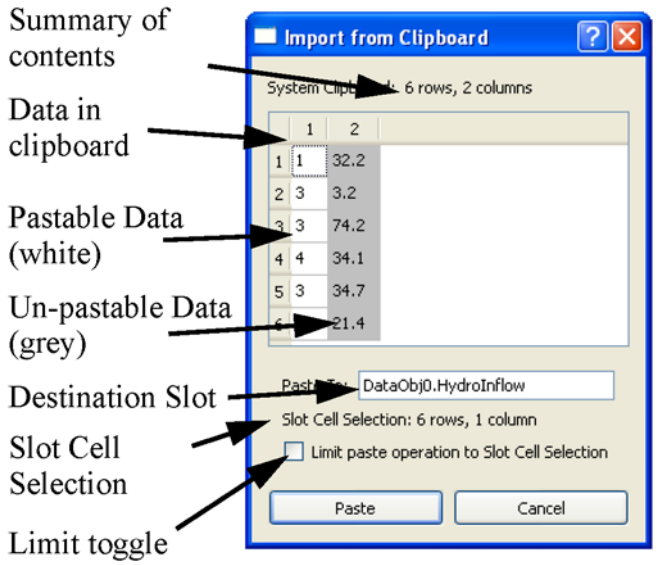
The **Export Copy** menu option is used to export the selected data to the operating system's clipboard for use in other applications, like Excel. When the user selects this option, an Export to Clipboard dialog opens. This dialog allows the user to choose the precision, either **Display** or **Model**, whether to **Show NaN** (or copy them as blanks) and whether to **Include the Row Headers**. It also provides information on the number of rows and columns that will be exported. Selecting **Copy** adds the selected data to the operating system's clipboard while **Cancel** stops the operation.



Import Paste

The **Import Paste** menu is used to paste data from the operating system's clipboard into the slot. For example, the user can copy a selection of cells from Excel or a column of data from a text file and Import Paste it directly into the slot. After copying the data, the user selects one or more cells of the slot and then selects **Import Paste**. An Import from Clipboard dialog similar to Figure 5.5 is shown. This dialog displays the contents of the system clipboard and provides options and information on the paste operation.

Figure 5.5

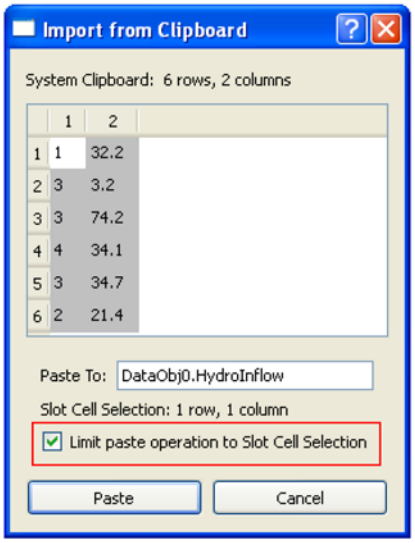


The contents of the clipboard will show data that can be copied (white) and data that cannot be copied (grey). Data cannot be copied if it does not fit in the content of the cell selection. For example, if the data in the clipboard has multiple columns and the cell is a single series slot, the second column of data cannot be copied, as shown in the Figure 5.5.

Also, the user can choose to **Limit paste operation to Slot Cell Selection** by selecting the checkbox. This limits the paste to only affect those cells in the slot that were selected. This selection is shown in the Slot Cell Selection line. For example, if only one cell in the slot is selected, but the clipboard contains two rows of data as above, all but the first cell are dimmed. In the example in Figure 5.5, only the value of "1" will be pasted. If the number of values in the clipboard is larger than slot selection, but the limiting operation is not checked, the paste will import all data and will add the necessary rows to the slot.

Note: An import will not add columns to the slot.

Figure 5.6



Insert/Append/Delete

The **Edit** menu contains options to Insert, Append, and/or Delete rows or columns from the slot, depending on the type and use of the slot.

Clear All Outputs

On series slots, this option can be used to clear all the Outputs.

Note: All outputs are cleared at the beginning of a run.

Fill Values Below

The Fill Values Below option is used to copy and paste the selected cell to all rows below. This will overwrite any existing data after the confirmation menu is selected.

Replace NaNs Below

The Replace NaNs Below option is used to replace only NaN with the selected values. Any existing data will not be overwritten.

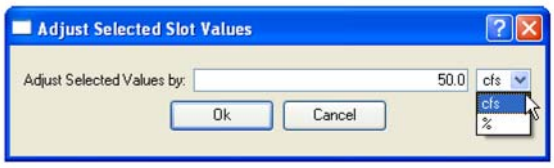
Interpolate

The Interpolate option is used to interpolate between two known values within a column. It only works on a selection when the first and last value in the selection have values. The option will interpolate between the two values and change all the values to have the Input flag.

Adjust Values

One or more values selected in a slot can be adjusted using the **Adjust Values** item available from the **Edit** menu of slot dialogs. When the user selects **Adjust Values** RiverWare opens a modal Adjust Slot Values dialog which allows the user to provide the amount by which the selected slot values should be adjusted. Values may be adjusted by a percentage, or if all of the values have the same units, by a fixed increment in user units. After

entering the adjustment value the user then applies that value to the selected values by selecting the **Ok** button or cancels the operation by selecting the **Cancel** button.



The adjustment is equal to adding a certain amount to the existing value(s) or multiplying by a percentage. The user may specify a positive or negative quantity.

Note: The percentage option increases the existing amount by adding a specified percentage of that amount.

For example if the values 10.0 and 100.0 acre-ft/month are selected and the user enters 10 acre-ft/month into the Adjust Slot Values Dialog and selects **Ok**, then the values will be changed to 20.0 and 110.0. If the user enters 10%, the values will be changed to 11.0 and 110.0.

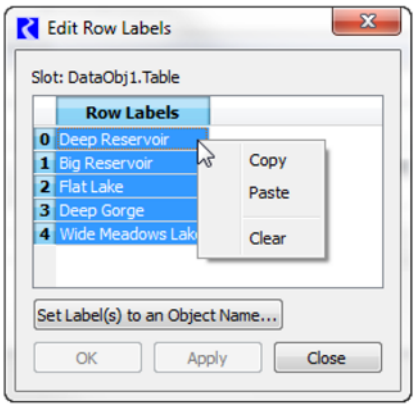
Tip: It is easy to select all cells in a column by selecting the header for that column.

Row Menu

On table and periodic slots, the **Row** menu is used to configure the rows.

Edit Row Labels

Change the Row Label. All row labels can be configured at once in the dialog. The labels can also be set to object names using the **Set Label(s) to an Object Name** button. Use right-click context menus to copy and paste from the system clipboard.



Insert Copied Rows

Insert Copied Rows from the internal clipboard

Insert New Row

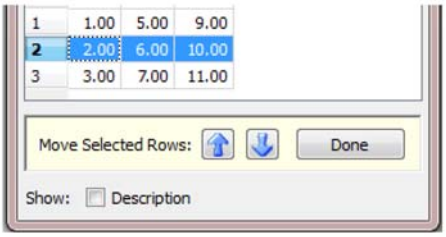
Insert a new row above the selected row

Append New Row

Append a new row at the bottom.

Move Rows

The **Move Rows** menu opens a panel at the bottom of the dialog which allows you to move the selected row (or multiple selected rows) up or down. When finished, select the **Done** button. This option is only available on custom table slots.



Delete Rows

Delete the selected rows

Delete Rows Below

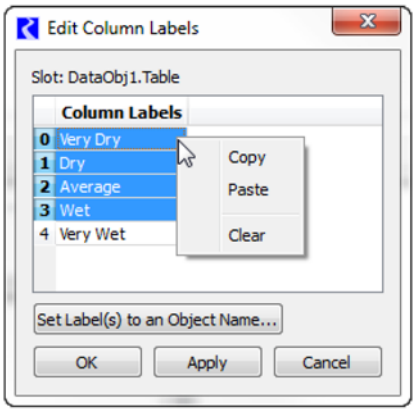
Delete all rows below the selected row

Column Menu

On some table and periodic slots (such as on custom slots), the user can add or delete columns to the table. The **Column** menu is used to do this and change column labels.

Edit Column Labels

Change the Column Label. All column labels can be configured at once in the dialog. The labels can also be set to object names using the **Set Label(s) to an Object Name** button. Use right-click context menus to copy and paste from the system clipboard.



Set Number of Columns

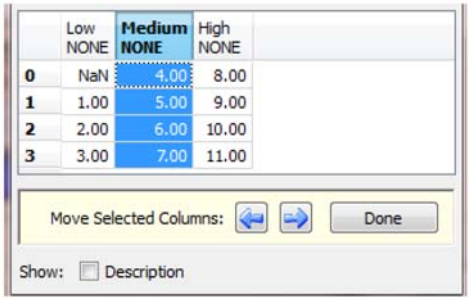
Set the number of columns.

Append Column

Add a column to the end.

Move Column

The **Move Column** menu opens a panel at the bottom of the dialog which allows you to move the selected column (or multiple selected columns) to the right or left. When finished, select the **Done** button. This option is only available on custom table and periodic slots.



Delete Column and Delete Last Column

Delete the selected column or last column, respectively.

Set Dimensions

Set the number of rows and column on the slot

View Menu

The **View** menu provides the following options.

Configure

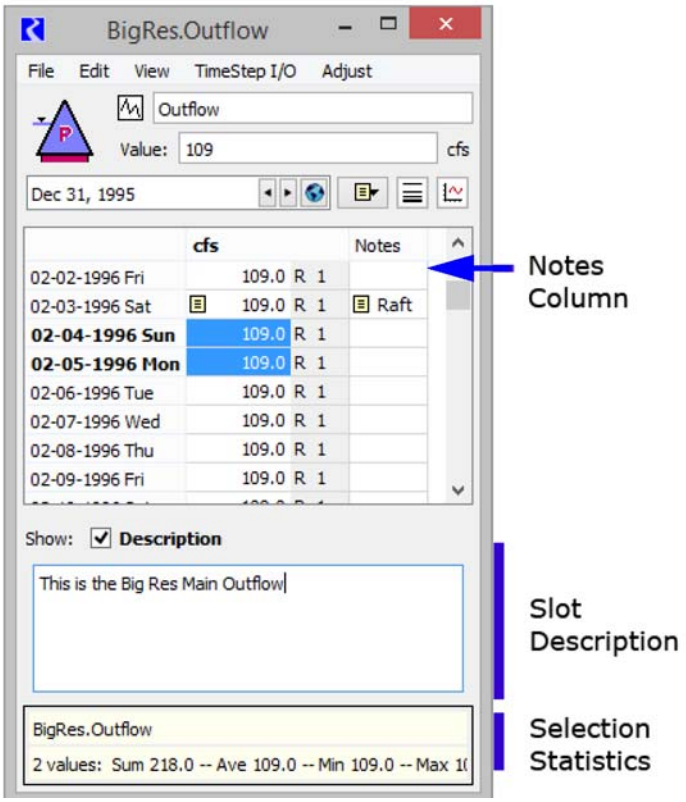
The Configure Slot dialog is opened by selecting **View**, then **Configure** in the Open Slot dialog. Depending on the type of slot opened, the dialog could appear a slightly different. For example, the portion of the dialog showing the Upper Bounds and Lower Bound is only displayed for Series Slots.

> **Note:** To configure Bounds or Convergence on multiple slots at one time, use the Configure Existing Slots dialog; see "Global Slot Configuration" on page 260.

Slot Dialog Display Preferences

Slot dialogs have settings that allow you to configure which features are visible when the slot is opened. This allows you to specify if you want to see Selection Statistics, Description, and the Notes column. This section

describes the preferences, saved with the model, which are applied each time a slot dialog is opened. Not that these are strictly preferences, you can still show or hide each feature using the controls or menus.



The Slot Dialog Display Preferences is accessible from two places:

- From the main RiverWare workspace, use the **Workspace**, then **Slots**, then **Slot Dialog Display Preferences** menu.
- From the Slot Viewer, use the **View**, then **Slot Dialog Display Preferences** menu.

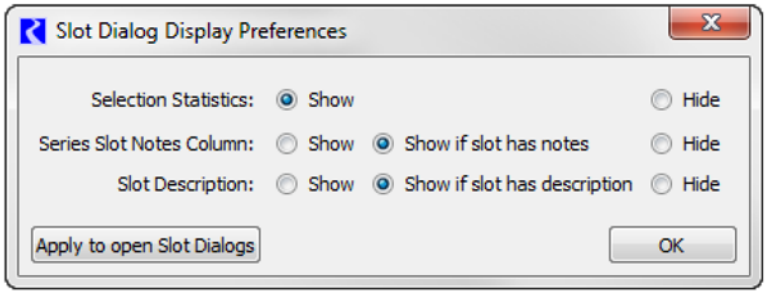
The Slot Dialog Display Preferences dialog consists of the following items:

- Selection Statistics. **Show** or **Hide**. Currently, Selection Statistics are supported only on series slots.
- Series Slot Notes Column. **Show**, **Hide** or **Show if slot has Notes**.
- Slot Description. **Show**, **Hide**, or **Show if slot has description** provided by the user.

As an added feature, the preferences can be immediately applied to all currently open slot dialogs by selecting the **Apply to open Slots Dialog**.

Note: When a series slot opens in the Slot Viewer, the preferences are applied to the first slot. If that slot has a description and the preferences say to “Show if slot has description”, the Description panel

will be shown. But if the next slot shown doesn't have a description, then the Description panel will remain open.



Go To Next NaN

The **View**, then **Go To Next NaN** menu navigates to the next NaN (Not A Number) in the slot. The search always goes first down the column (timesteps), then through the subsequent columns.

The **Ctrl-Shit-N** keyboard shortcut also executes the search.

Adjust Menu

The **Adjust** menu, available on series and table slots, is used to change the display size of the columns in the slot. Users can manually resize columns by dragging the dividers between the column headers. The following five operations are also available in the Adjust menu:

Set Column Widths

Set all data columns to the width of the single selected column.

Grow Columns to Fit Data

Expand, but do not shrink, the columns to fit the widest numeric value displayed in the corresponding columns.

Fit Columns to Data

Resize all data columns to fit the widest numeric value displayed in the corresponding columns.

Fit Columns to Headers and Data

Resize all data columns to fit the larger of the text in the corresponding column headers or the widest numeric value displayed in the corresponding columns.

Fit Columns to Headers

Resize all data columns to fit the text in the corresponding column headers.

Types of Slots

This section presents a description of the different types of slots and how they are used for representing different types of data. Select a link for full details on how to view, create, and edit that type of slot.

Table 5.1

Name	Icon	Type	Description
Series Slot Series Slots, page 166		Series	A single timeseries of values. These slots may be linked with another Series Slot. Input data in Series Slots controls the simulation solution, and all simulation output data are written to Series Slots. Custom slots can be linked to any linkable slot on the workspace.
Series Slot with Expression Series Slots With Expression, page 193		Series	A specialized Series Slot whose value is computed from a user-defined arithmetic expression possibly containing other slot names as variables. They are used to calculate quantities such as “combined Storage of all Reservoirs.”
Text Series Slot Text Series Slots, page 200		Series	A specialized Series Slot whose values are text strings instead of numerical data. They are used to store annotations or strings.
Integer Indexed Series Slot Integer-indexed Series and Agg Series Slots, page 203		Series	A specialized series slot that is indexed by an integer number instead of a date.
Agg Series Slot Agg Series Slots, page 201		Series	A specialized Series Slot that is an aggregation of one or more Series Slots which are independent of one another. They are used to group together similar series of data.
Integer Indexed Agg Series Slot Integer-indexed Series and Agg Series Slots, page 203		Series	An Agg series slot that is indexed by an integer number instead of a date.
Series Slot with Periodic Input Series Slots With Periodic Input, page 203		Series	A Series Slot with Periodic Input is technically a series slot, but you can optionally input data in the same format as a periodic slot. When entered periodically, the slot automatically fills out the series values.
Multi Slot Multi Slots, page 206		Series	A specialized Series Slot aggregating one or more Series Slots. The value in the first Series Slot column is the sum of the values in all of the other Series Slot columns (other slots to which they are linked). New Series Slot columns are automatically added when a link is made to the Multi Slot.

Table 5.1

Name	Icon	Type	Description
Table Slot Table Slots, page 207		Table	A two or three-dimensional table of values for representing one or more functional relationships. Each column stores a variable with its own unit type and name. Rows are numbered beginning with 0. Both rows and columns can be referenced by using an index (0, 1, 2 . . . n) or using a label string. For a three-dimensional table lookup to be successful, column 1 must contain blocks of equal values which increase down the table, and column 2 must contain monotonically increasing values within each block of values from column 1. A two-dimensional table only requires monotonically increasing values in its first column. Table functionality includes accessing values beginning with the table indexes and accessing a column index beginning with row index and table value.
Statistical Table Slot Statistical Table Slots, page 209		Table	A specialized table slot allowing the user to specify a statistical function, such as flow duration curve, which is computed at the end of a run using the data in specified model slot(s). This statistical analysis data can then be plotted or exported.
Table Series Slot Table Series Slot, page 224		Table	A specialized table slot whose rows correspond to time values. This slot contains limited timeseries functionality thus making it more efficient, performance wise than Series Slots. It is commonly used for writing and reading large amounts of data. It is primarily used within user methods; you cannot create them as custom slots.
Periodic Slot Periodic Slots, page 225		Table	A specialized table slot, the periodic slot is used to hold data that repeats over a specified time period. For example, a set of monthly evaporation coefficients for a reservoir (the same every year), could be held in a periodic slot. The timeseries associated with the data can vary (1 Hour, 1 Day, 1 Month, etc.) as well as the period over which the data repeats. The periodic slot can also handle irregular timeseries and can have either text or numeric column headings.
Scalar Slot Scalar Slots, page 230		Scalar	The scalar slot is used to hold a single piece of numeric data that will not vary with time. The scalar slot is a one-row, one-column table slot.
Scalar Slot with Expression Scalar Slots With Expression, page 231		Scalar	A scalar slot whose value is computed from a user-defined arithmetic expression. The expression can contain values from other slots as variables.

Table 5.1

Name	Icon	Type	Description
Mass Balance Summary Mass Balance Summary Slots, page 232		Mass Balance Summary	The mass balance summary slot is a user-defined hierarchy of series slot collections used to check mass balance across many objects.
Time Aggregation Series Slots Time Aggregation Series Slots, page 250		Series	Time Aggregation Series Slots temporally aggregate any other single series slot. It can be recomputed manually or automatically at the end of a run.
Time Disaggregation Series Slots Time Disaggregation Series Slots, page 256		Series	Time Disaggregation Series Slots temporally disaggregate any other single series slot using either a step or interpolation function. It can be recomputed manually or automatically at the end of a run.
List Slot List Slots, page 259		List	The list slot is used in certain user methods to specify a list of objects or slots associated with that method. The user cannot add custom List Slots.

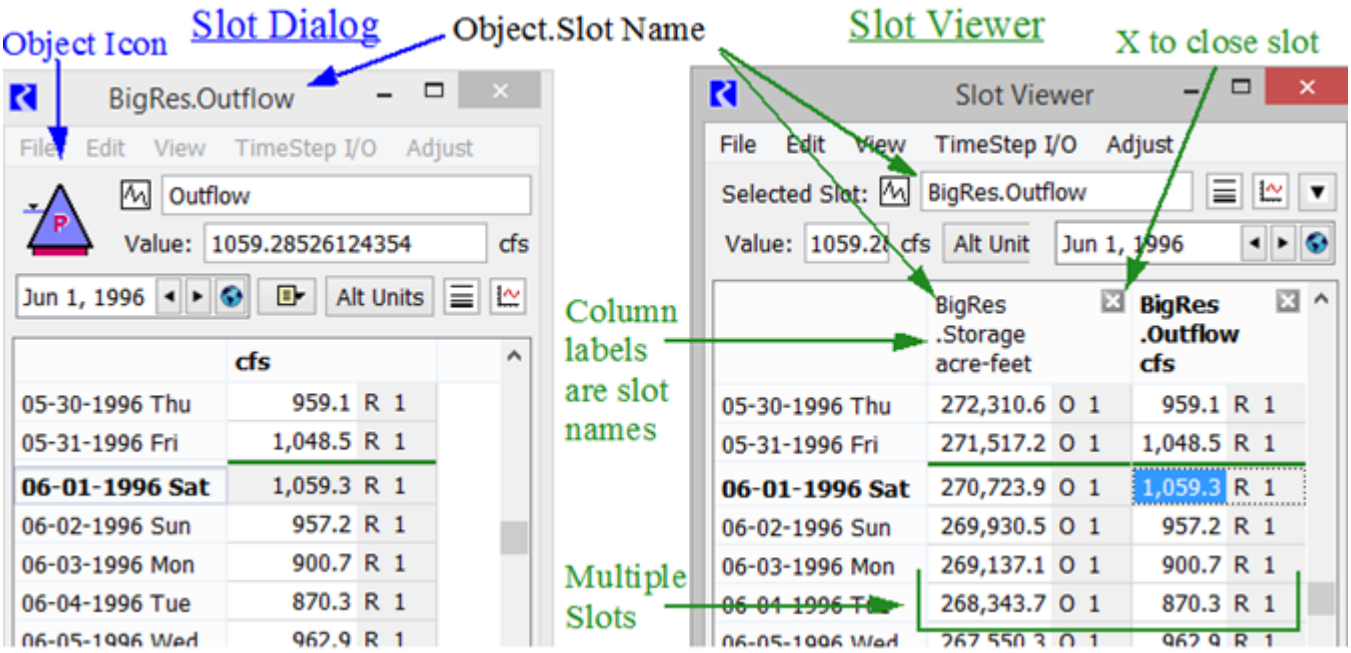
Series Slots

There are several types of time series slots with various column configurations. Since all of these slot types contain rows that correspond to the series of data, they will be referred to collectively as series slots. Most series slots open automatically in the Slot Viewer. Any slot shown in the viewer can be detached from the viewer and shown in its own Slot dialog by dragging the column off the viewer.

Slot Dialog and Slot Viewer

Figure 5.7 highlights the differences between the individual Slot dialog and the Slot Viewer.

Figure 5.7 Screenshot comparing a Slot Dialog and the Slot Viewer



How many of each dialog are there?

There is only one Slot Viewer per model. There can be many Slot dialogs.

What types of slots are shown?

There is a Slot dialog for each type of slot. The Slot Viewer only shows series slots that have the same timestep as the Run Control.

Which slots will open in the Slot Viewer?

The Slot Viewer only shows series slots that have the same timestep as the Run Control. Standard Series slots, Text Series slots, Series Slots with Periodic Input, and Multi slots with a single subslot open automatically in the Slot Viewer. Multi slots with two or more subslots and Expression slots open in their own Slot dialog but can be docked in the Slot Viewer. Agg Series slots with two or more columns, series slots with a timestep different from the Run Control and all other types of slots (Periodic, Table, Scalar) can only be shown in their own Slot dialog.

Can the two types of dialogs interact?

From the Slot Viewer, you can drag a slot off of the viewer to become a single Slot dialog. You can then drag the slot icon on the series slot and drop it on the Slot Viewer to redock it. See "Slot Viewer Functionality" on page 168 for details.

Where can I find more information?

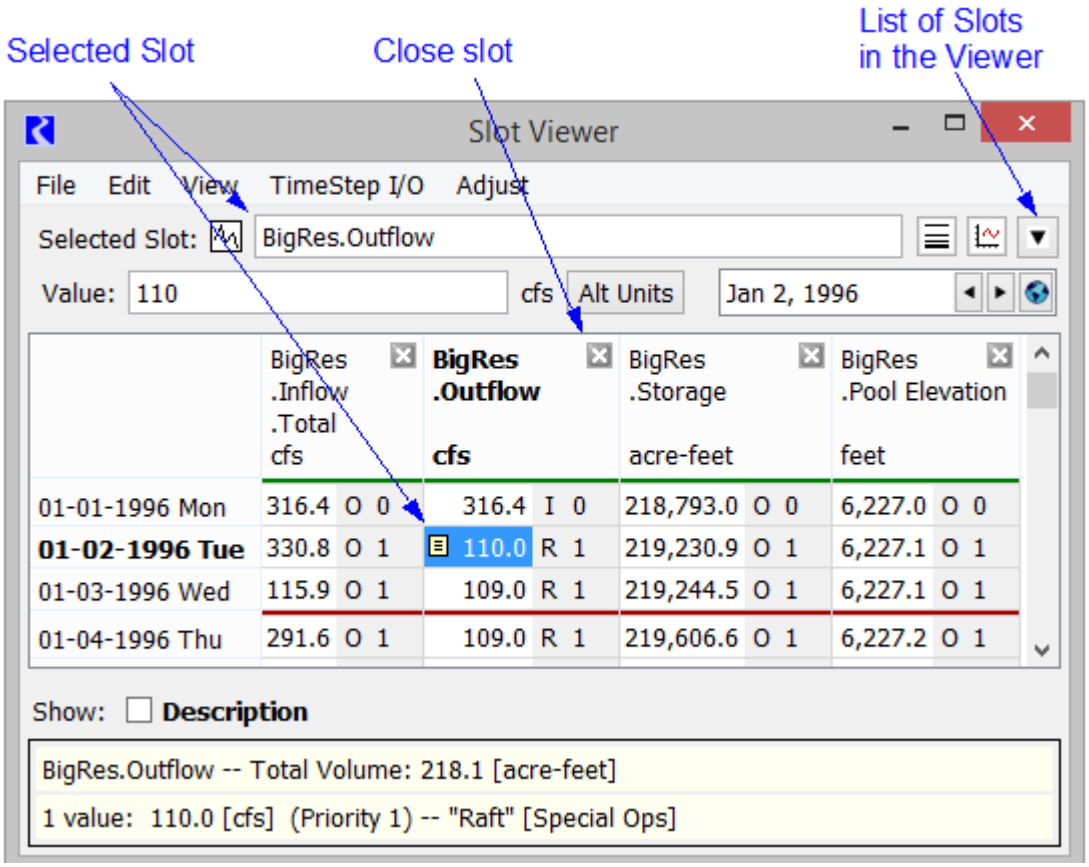
See "Slot Dialog Functionality" on page 147 and "Slot Viewer Functionality" on page 168.

Slot Viewer Functionality

The Slot Viewer is an ad hoc tool to view multiple series slots in a single dialog. There is only one Slot Viewer per model. The slots shown and order is not persistent in any way on the viewer. Each time a Series Slot is opened from anywhere in RiverWare, it is added as a column to the Slot Viewer. From the Slot Viewer, any slot can be shown also in the slot's conventional Slot dialog.

Figure 5.8 shows the Slot Viewer showing four slots on BigRes. The Slot Viewer shows different menus based on the selected slot. Highlight cells in a single column (or the entire column) to select a slot. If you highlight cells in multiple columns, the Selected Slot is blank and many of the menu options are disabled.

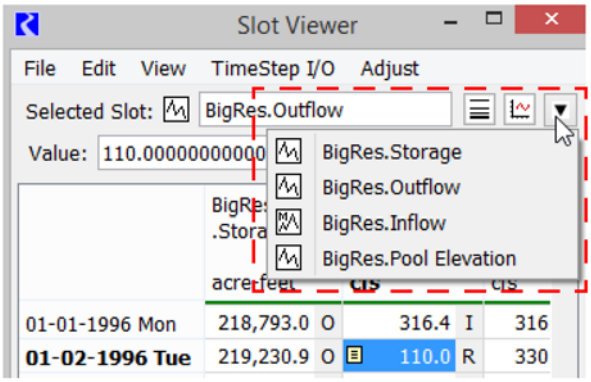
Figure 5.8 Screenshot of a Slot Viewer with annotations



Following are the Slot Viewer specific actions:

- Rearrange Columns. Drag a column header to rearrange columns.
- Undock a single slot:
  - Drag a column off of the Viewer to show the slot in its own dialog.
  - Right-click the column header and choose **Show In Slot Dialog**.
  - Use the **File**, then **Undock Selected Slot(s)** menu.
- Undock all Slots. Use the **File**, then **Undock All Slots** to show all of the slots in their own dialog.

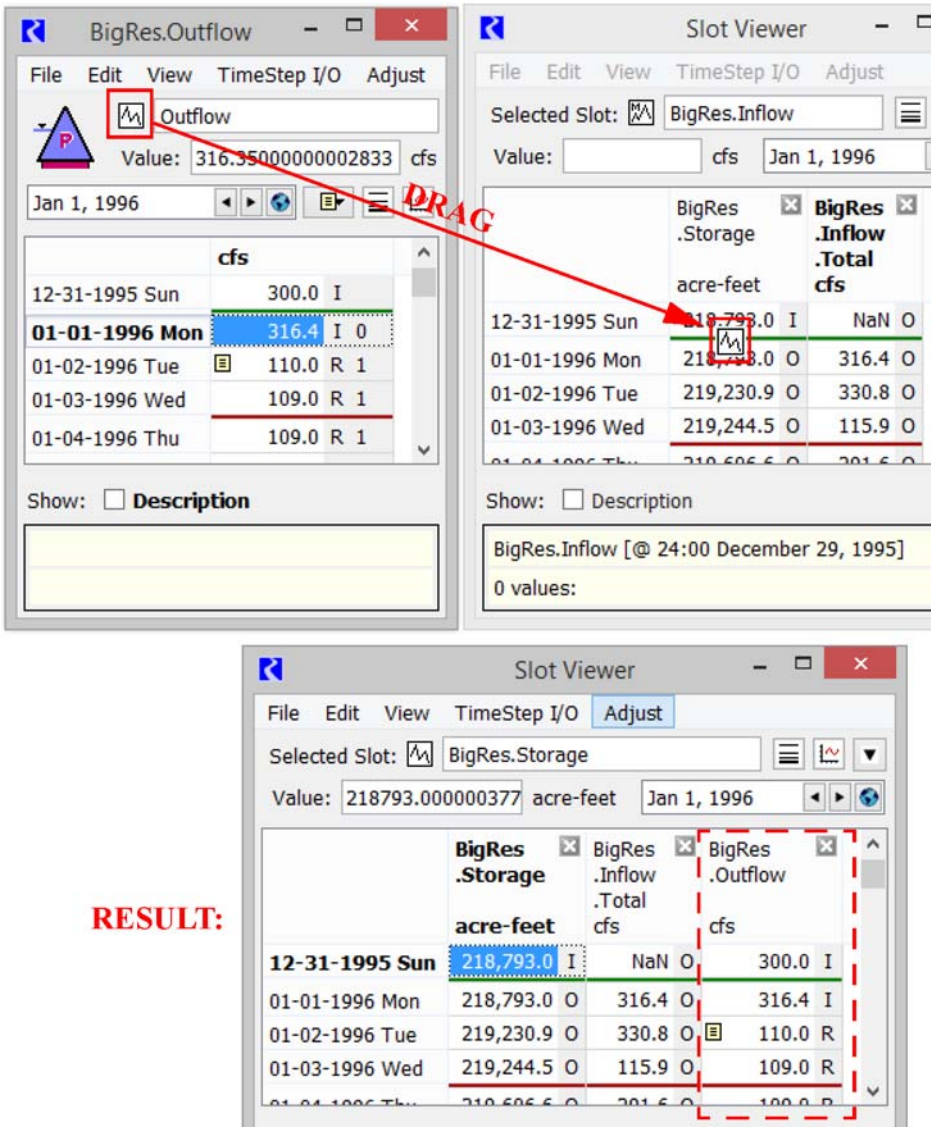
- Navigate to a slot. Use the scroll bars to scroll left/right to find the slot or use the down arrow menu to list all of the slots in the viewer. Select the desired slot to select and scroll to that slot.



- Close Slots
  - Select the X at the top right of the slot column.
  - Select one or more slots. Then use the **File**, then **Remove Selected Slot(s)** menu.

To *dock* a slot onto a Slot Viewer, drag the slot's icon anywhere on the viewer. Figure 5.9 shows the icon that you should drag and the result. Alternatively, use the **File**, then **Dock in Slot Viewer** menu.

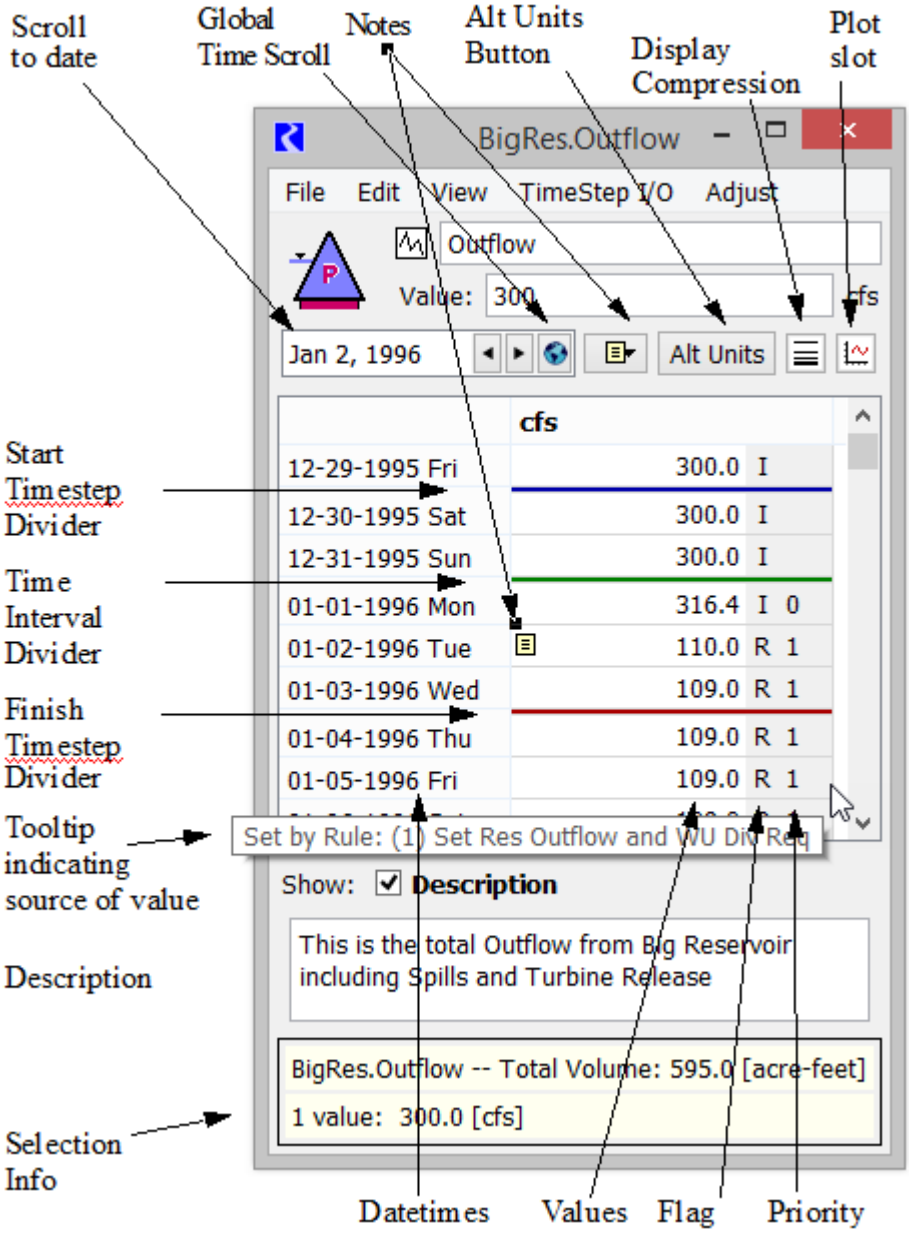
Figure 5.9



Series Slot Dialog Functionality

Figure 5.10 shows the key areas of a series slot. There is a DateTime selector and scroll button used to scroll to the given date. Icons and buttons are used to show display compression, show notes, and to Plot the slot. The DateTimes are shown as the row headings, the data values are shown in the cells, and each cell's value has a flag. Bold, green separators are automatically created based on the timestep of the slot. For example, in a slot with a 1 Day timestep, separators are placed between months. In 6 Hour slot, days are separated. Also, there is a blue divider between the initial and start timestep. There is a red divider after the finish timestep.

Figure 5.10 Annotated Screenshot of a Series Slot dialog



Data

Time series data are displayed with one value per row where each row represents a timestep. A scroll bar along the right side of the field is used to view the entire set of data. Each row contains the full date and time, a status flag, and the slot value at that time. A slot value which shows NaN (Not a Number) represents an unsolved variable.

The values that appear in the Open Slot dialog use the Units for that slot. See "Standard Units" on page 89 for details on Units. See "Configure Slot Dialog" on page 153 for details on configuring slot units.

Timesteps

Timesteps are reported chronologically. If the series is an Integer Indexed series, the rows are indexed by an integer number instead of a timestep.

Editing Slot Values

Conventional editing commands are available for all slots. They allow cutting, pasting, filling and clearing of data.

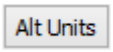
A **Delete** or **Cut** of any timestep except the first shifts data up to replace the lost cell, reassigning values to new timesteps. A **Delete** or **Cut** of the first timestep removes it completely from the series, essentially shifting the start date of the series.

Similarly, **Insert New Cell** or **Insert Copied Cells** when the first timestep is selected adds a new timestep to the beginning of the series. When any other timestep is selected, **Insert New Cell** or **Insert Copied Cells** shifts data down from the added cell, reassigning values to new timesteps.

Priority

In a Rulebased Simulation run, the dialog shows the priority of the slot at the given timestep. This can enable/disabled using the **View**, then **Show Priorities** menu.

Alt Units button

On series slots, an **Alt Units** toggle button 

is shown in the tool bar when the slot displays any of the following:

- A slot with flow unit type
- A slot with volume unit type for certain simulation slots, like reservoir Evaporation
- A custom slot with volume unit type, and configured to show the toggle, as described in "Configure Slot Dialog Functionality" on page 175.

  Note: This button is also shown on the Slot Viewer when there is at least one slot that meets these criteria.

Figure 5.11 Screenshot of the Alt Units options.

As shown in Figure 5.11, the button switches the display between

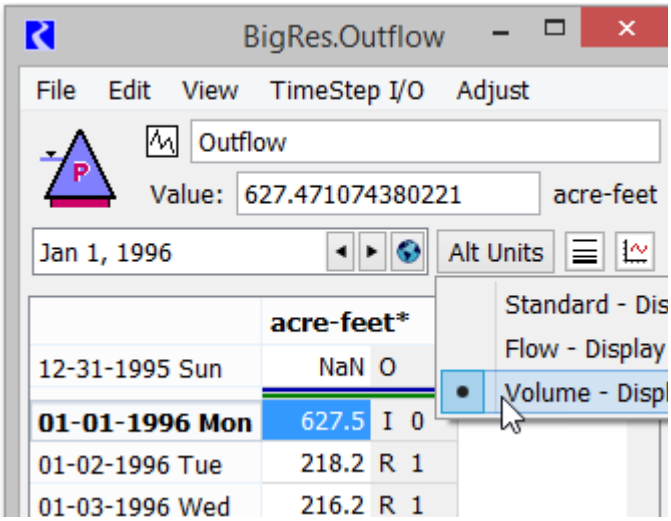
– Standard - Display flows and volumes without conversion

– Flow - Display flow slots as flows and display volumes as flows (as appropriate)

– Volume - Display flow slots as Volumes and display volume slots as volumes.

When a slot is shown with its non-default unit type, an asterisk is shown in the column label as shown in Figure 5.12.

Figure 5.12 Screenshot of flow slot showing values as Volumes. Notice the asterisk by the unit.

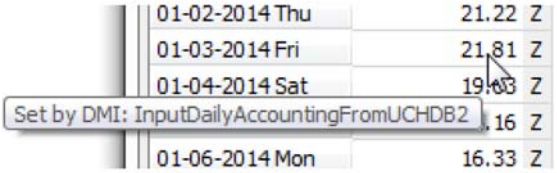


The units for both the default and alternative units are defined by the unit scheme. The unit type will apply unless an exception has been created for the slot. Exceptions can be created for both flows and volume unit types for a particular slot.

Tooltips

Tooltips provide additional information about individual values. In particular, when you hover over a value for which the relevant information is available, one of the following tooltips is displayed:

- Set by DMI. Displayed when the value was set by an input DMI that was configured to record invocations. For example, “Set by DMI: Import Lake Levels”. See “DMI Invocation Manager Dialog” in *Data Management Interface (DMI)* for details on Invocation Records.



- Set by Initialization Rule. Displayed when the value was set by an Initialization Rule. For example, “Set by Initialization Rule. (3) Provide Default Hydrology”.
- Set by Rule. Displayed when the value was set by a rule. For example, “Set by Rule: (18) Long Lake Fishery Releases”.
- Rule. Displayed when the value was solved for as a result of a rule setting a value elsewhere in the system. That is, the value was set during dispatching because a rule set a value somewhere. In this situation, the value has the output flag and the controller's priority which is also the priority of the rule whose execution triggered dispatching. For example, “Rule: (18) Long Lake Fishery Releases”.

For the last three items you can quickly open the rule associated with the value. Right-click and choose to **Open Rule N** from the menu.

Additional information may be shown in the tooltips when an optimization run has been made. Examples of the information are: “Frozen at Lower Bound”, or “Frozen by (3) Minimum Load 47.6% between limits set by 3.1.1.1 and 2.1.1.1.” or “Frozen by (2) Ending Pool Elevation at a limit set by 2.1.1.1”. See “Tooltips on Variables” in *Optimization* for details.

Selection Info Area

Optionally, the Selection Info Area (also called the Summary Area or Selection Statistics) can be shown using the **View**, then **Show Selection Statistics**. This displays information on the selected cells in the Slot including the name or number of slots and then statistics on the selection. Statistics include Sum, Average, Median, Min, Max, Range, and Difference. All, some or none of these may be shown depending on the number of cells selected and the units of those cells. If a single value is selected and that value was solved for or set as a result of a rule in rulebased simulation, the Priority is also shown. Finally, if the values have units of flow, power, or velocity, the selection area also shows the integrated values over time, thus showing the total volume, energy, or length, respectively. The unit scheme units for that unit type are used.

Note: You can configure your preferences on whether or not to show Selection Statistics using **Slot Dialog Display Preferences**; see “Slot Dialog Display Preferences” on page 161.

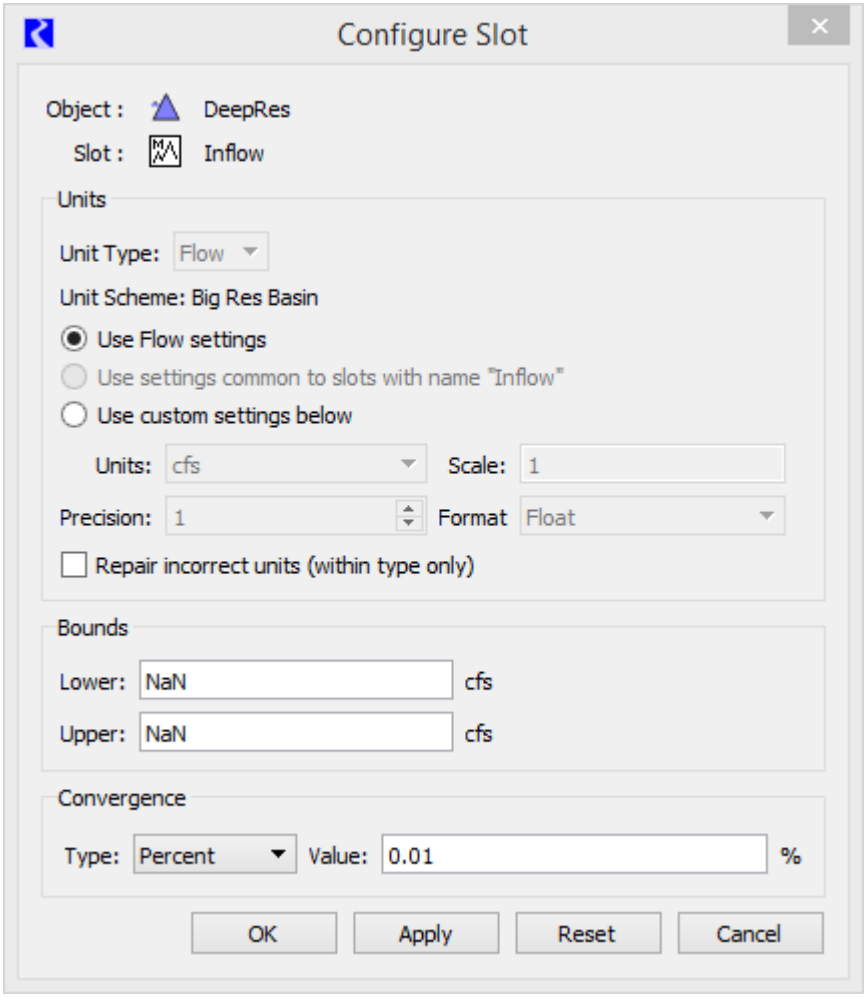
Global Time Scroll

Use the global time scroll button or the right-click context menu to change all date-based dialogs to the selected date. This date is then used for any currently opened dialogs and any that are opened from this point forward.

Configure Slot Dialog Functionality

The Configure Slot dialog, shown in Figure 5.13, is displayed by selecting **View**, then **Configure.** Following are configuration options specific to Series Slots. See “Configure Slot Dialog” on page 153 for details on general configuration.

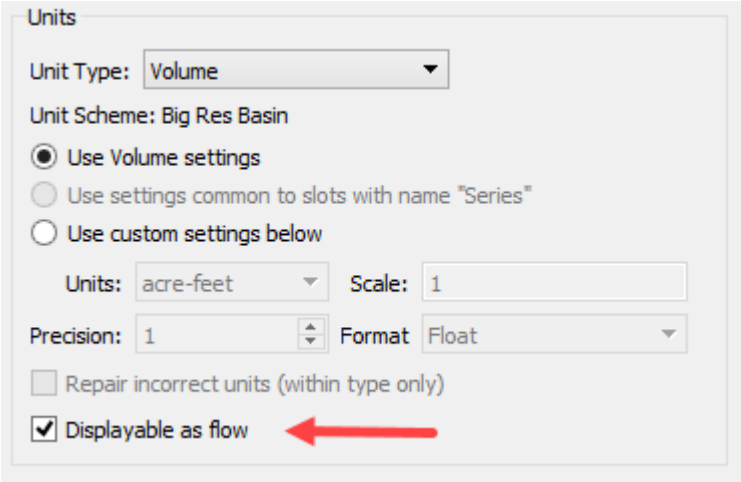
Figure 5.13 Screenshot of the Configure Slots dialog for a series slot



Displayable as Flow Checkbox

As described in "Alt Units button" on page 172, flows slots can always be shown as the volume over the timestep. But only certain simulation slots, with the volume unit, can be shown as flows, like evaporation volume. For custom slots that you create, you can choose for each volume slot whether the Alt Units will apply. When the Unit Type is Volume, the **Displayable as flow** checkbox is shown as noted in Figure 5.14. Check the box indicating this volume can be shown as a flow, using the **Alt Units** button. Leave it unchecked if the volume is not displayable as a flow.

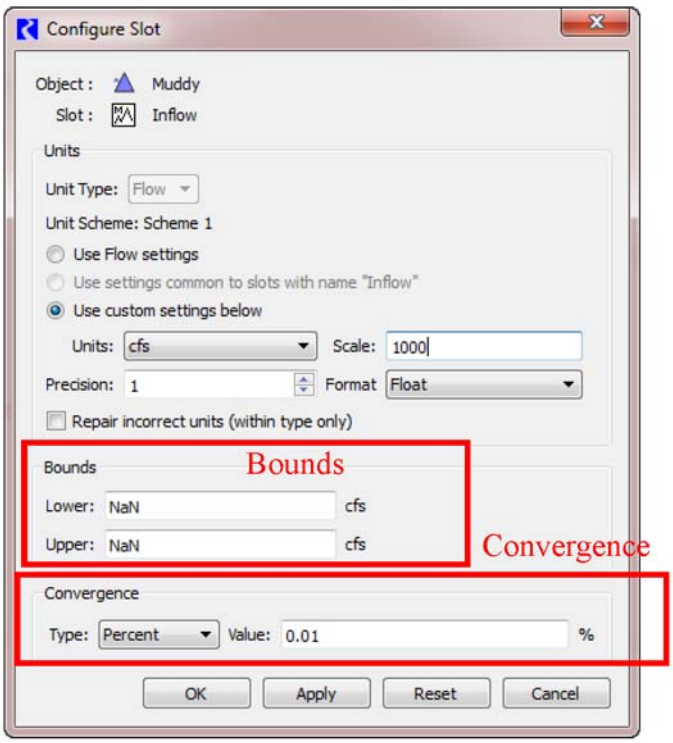
Figure 5.14 Screenshot of Slot Configuration with Displayable as flow setting



Setting Bounds on a Series Slot

Series slots have upper and lower bounds as shown in Figure 5.15. In general, these values are not used by the simulation but are used in optimization. However, there are a few cases where a value can be used by the Object's user methods. For example, the lower bound on Outflow on a Reach object is used to calculate the maximum allowable diversion. If no value is specified, the total Inflow may be diverted.

Figure 5.15 Screenshot of the Configure Slot dialog with Bounds and Convergence highlighted



Optionally, you can show warning messages if values set during Simulation are out of bounds. When warning messages are configured, if the controller sets a value that violates the specified bounds, a warning is issued in the diagnostics window, but the simulation continues. See "Warn when Values are out of Bounds" on page 296.

Setting Convergence

Series slots have convergence settings that can be edited in the lower portion of the Configure Slot dialog as shown in Figure 5.15. A slot can be reset if the new value is not within convergence of the old value and it has not been set more than the maximum number of times. See "Set Value" in *Solution Approaches* for details.

Following are the available convergence criteria.

None

Any new value is considered different than the old value. Convergence is *never* reached.

Example	Convergence?	Explanation
old = 100.00 cms new = 100.001 cms	No	

Absolute

Absolute difference in internal units. The user enters the convergence value in internal units; for example, m, cms, m3.

Convergence is reached as follows:

if $|old - new| \leq convergence_value$

Example	Convergence?	Explanation
old = 100.00 cms new = 100.001 cms convergence value entered = 0.001 cms	Yes	
old = 100.0 cfs new = 100.01 cfs convergence value entered = 0.001 cms	Yes	100 cfs = 2.83168 cms 100.01 cfs = 2.83197 cms 2.83168–2.83197 = -0.00029 0.00029 < 0.001

Percent

Percent difference. The user enters the convergence value as a percentage.

When old and new are non-zero, convergence is reached as follows:

if $\frac{|old - new|}{old} \leq \frac{convergence_value}{100}$

When old or new is zero, convergence is reached as follows:

if $|old - new| \leq 1.1 \times 10^{-12}$

Example	Convergence?	Explanation
old = 100.0 cms new = 100.001 cms convergence value entered = 0.001	Yes	
old = 10.0 cfs new = 10.01 cfs convergence value entered = 0.001	No	$\frac{\lvert 10 - 10.01 \rvert}{10} > \frac{0.001}{100}$

Unit Percent

Absolute difference, in user-specified units. The user enters the convergence value as a percentage, without regard to scale.

Convergence is reached as follows:

`if` $\lvert old - new \rvert \leq \frac{convergence_value}{100}$

Example	Convergence?	Explanation
old = 100.0 cfs new = 100.001 cfs convergence value entered = 0.1% cfs	Yes	
old = 10.0 cfs new = 10.1 cfs convergence value entered = 0.1% cfs	No	$\lvert 10 - 10.1 \rvert > \frac{0.1}{100}$

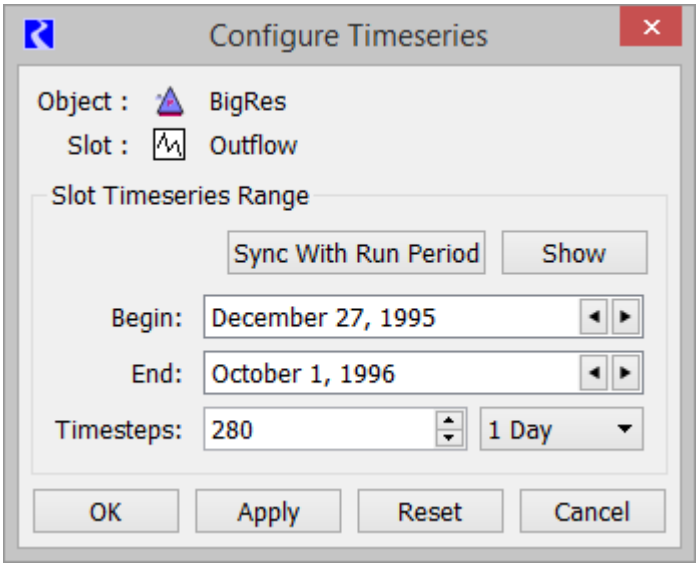
Time Series Range—Series Slot

The default start times and timestep are inherited from the Run Control settings when the object is instantiated. All series slots are initialized with one timestep to minimize model file size. Other rows are added by the user as needed for input or appended at run time when the slot's output values are calculated. You may change the time series range directly through the Time Series Range Dialog.

On Integer Indexed Series, the user is able to change the number of Values but the start, end, and timestep size configuration areas are disabled.

The time series range and timesteps can also be changed by selecting **Sync With Run Control** in the Time Series Range Dialog. This will update the time series range in the slot to match the time series range set in the Run

Control dialog. The default start times and timestep are inherited from the Run Control settings when the object is instantiated.



Linked Slots

In the **View** menu, there is a menu to show **Linked Slots**. When selected, this shows all of the slots to which the given slot is linked.

Show Notes Column and Notes Group Menu

The Show Notes Column and the Notes Group menu are used to display Notes that are associated with a timestep on a series slot. See "Notes on Series Slots" on page 272 for details.

Series Display Compression

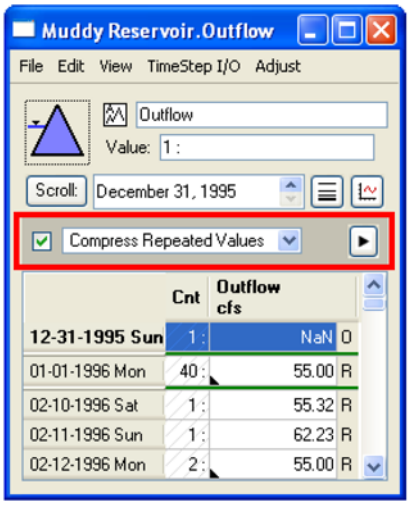
The Series Display Compression utility allows the user to *compress* or hide a particular value, NaNs, both, or any repeated values. This utility is useful for slots that hold data that is often the same value and the user only wishes to see any changes to this standard value. The functionality is available on Series Slots, Agg Series Slots, Multi Slots, and Table Series Slots.

Accessing Series Display Compression

Series Display compression can be accessed from

- Open Slot dialog **View**, then **Series Display Compression** menu.
- **Series Display Compression** icon  on the Open Slot dialog.

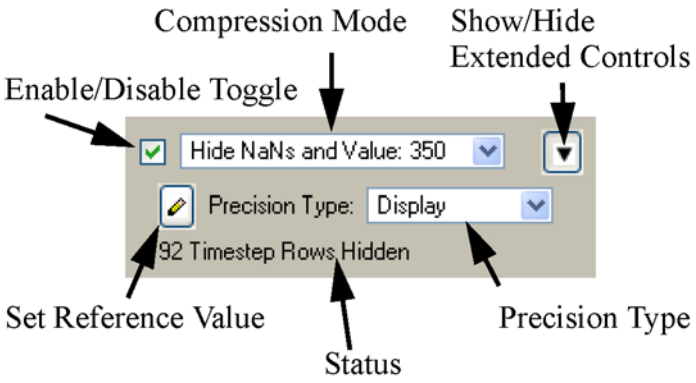
When either of these options are chosen, the Open Slot dialog adds the display compression area between the scroll area and above the column heading.



Configuring Compression

Figure 5.16 identifies the configuration controls. Each control is described in detail.

Figure 5.16



Enable/Disable Toggle

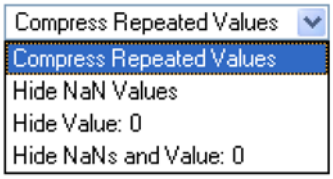
When Series Display Compression is first activated, there is a check mark in the toggle indicating that it is active. This toggle is used to toggle the compression on and off. Thus, the user can configure compression, then toggle it off to view or edit all the values, and then toggle it back on to reenable compression

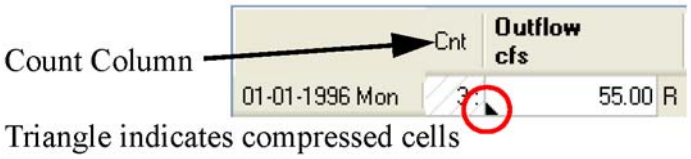
Compression Mode menu

When first activated, the **Compress Repeated Values** option is selected by default in the **Compression Mode** menu. The following modes are available for display compression:

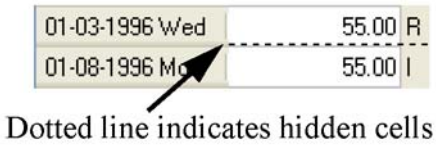
- **Compress Repeated Values**. Any values that are repeated will be compressed into one row. When this option is selected, the repeated values are all compressed into one cell and a count (Cnt) column is added. A

small triangle is added to the lower corner of the cell to indicate that the cell represents repeated values. In the screenshot 3 values of 55cfs are repeated on 1/1/1996. These represent 1/1 through 1/3/1996.





- **Hide NaN Values**. All NaN values will be hidden and a dotted line is shown. For example, NaNs are hidden for 1/4 through 1/7/1996.



- **Hide Value: #**. All values matching the reference value will be hidden and a dotted line is shown. The user can change the value by selecting the **Reference Value** icon and entering a new value.
- **Hide NaNs and Value: #**. All NaN values or values matching the reference value will be hidden and a dotted line will be shown. The user can change the reference value by selecting the **Reference Value** icon and entering a new value.
- **Show Value: #**. All values that match the reference value are shown. NaNs are hidden. The user can change the reference value by selecting the **Reference Value** icon and entering a new value.
- **Show NaNs and Value: #**. All NaNs and values that match the reference value are shown. The user can change the reference value by selecting the **Reference Value** icon and entering a new value.
- **Show Values <= #**. All values less than or equal to the reference value are shown. NaNs are hidden. The user can change the reference value by selecting the **Reference Value** icon and entering a new value
- **Show Values >= #:**All values greater than or equal to the reference value are shown. NaNs are hidden. The user can change the reference value by selecting the **Reference Value** icon and entering a new value

  Note: The above text describes the options and how RiverWare represents each option on the screen. In each case, if the compressed/hidden range contains the automatic green DateTime interval delineations (e.g. Monthly lines on a slot with a 1 Day timestep) those green lines will still be shown.

In the example to the right, two green lines are shown representing the delineation before Feb. 1 and March 1 in this 1 Day timestep slot.



Show/Hide Extended Controls

To the right of the **Compression Mode** menu, the **Show/Hide Extended Controls** button  can be used to further refine how the compression is configured. When this button is selected, additional configuration options are presented, and the arrow points down.

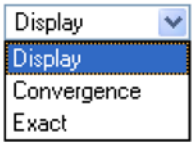
Set Reference Value

When any of the Hide Value or Show Value compression modes are selected, the Set Reference Value icon  become active. Selecting this icon opens a dialog to allow the user to enter a value. Once a new number is entered, the Compression Mode menu options will display that number in the menu. The value does not have a unit associated with it. So if you change the slot's units (via the configuration or through a unit scheme), the reference value will not change.

Precision Type menu

Each of the above compression modes compares a value in a cell to some other value, either a reference value, NaN or the previous timestep's value. For more flexibility, value comparison can be based on either:

- **Display.** The display precision will be used; this is the default. If two numbers appear the same on the screen, they are considered the same.
- **Convergence.** The slot's convergence value will be used to compare the numbers. A number must be within convergence of the other number to be considered the same.
- **Exact**. The internally stored numbers will be compared.



Status information

The Status information will show the number of rows that are hidden or compressed.

Editing Compress and Hidden Values

On the Open Slot dialogs, the user can highlight a number of cells and type a new value that will be entered, as Input, into each selected cells. When Series Display Compression is enabled, the editing of values is treated a differently as follows:

Compressed Repeated Values

If the **Compress Repeated Values** is selected, editing of selected cells will edit any compressed cells. For example, if repeated 33 values are repeated and the user selects the repeated value, types in a new number, all 33 values will be set to that new number.

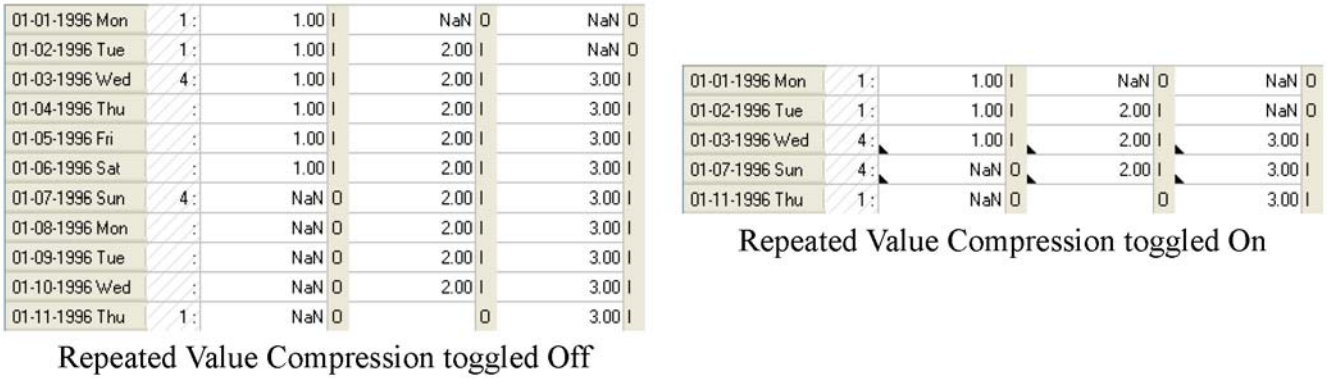
Hidden NaNs or Value

If any of the Hide options are selected, editing of selected cells will not affect hidden cells. Hidden values and NaNs will not be overwritten. But, any cells displayed and selected will be affected by the new value. Also, if the entire column is selected, edits will then apply to all values, whether hidden or not.

Multi-column Slots

On multi-column slots, (Agg Series, Multi Slots, Table Series Slots, and accounting slots), the Series Display Compression will only compress/hide a row if the compression is valid on all columns of the row. In Figure 5.17, repeated value compression only applies to a subset of rows.

Figure 5.17



01-01-1996 Mon	1 :	1.00	I	NaN	O	NaN	O
01-02-1996 Tue	1 :	1.00	I	2.00	I	NaN	O
01-03-1996 Wed	4 :	1.00	I	2.00	I	3.00	I
01-04-1996 Thu	:	1.00	I	2.00	I	3.00	I
01-05-1996 Fri	:	1.00	I	2.00	I	3.00	I
01-06-1996 Sat	:	1.00	I	2.00	I	3.00	I
01-07-1996 Sun	4 :	NaN	O	2.00	I	3.00	I
01-08-1996 Mon	:	NaN	O	2.00	I	3.00	I
01-09-1996 Tue	:	NaN	O	2.00	I	3.00	I
01-10-1996 Wed	:	NaN	O	2.00	I	3.00	I
01-11-1996 Thu	1 :	NaN	O		O	3.00	I

Repeated Value Compression toggled Off

01-01-1996 Mon	1 :	1.00	I	NaN	O	NaN	O
01-02-1996 Tue	1 :	1.00	I	2.00	I	NaN	O
01-03-1996 Wed	4 :	1.00	I	2.00	I	3.00	I
01-07-1996 Sun	4 :	NaN	O	2.00	I	3.00	I
01-11-1996 Thu	1 :	NaN	O		O	3.00	I

Repeated Value Compression toggled On

Note: Only rows 1/3–1/6 and 1/7–1/10 are compressed because the repetition occurs across all columns. Similarly, on multi-column slots, if the user selects the **Hide NaNs and Value** option, it will only hide a row if all three columns have the reference value OR NaN.

Flags on the Timestep I/O Menu

On Series Slots, the **Timestep I/O** menu is used to change the status of the cell's value by changing the flag. Possible flags vary by slot, but may include the following:

- INPUT (I)
- OUTPUT (O)
- DMI INPUT (Z)
- ITERATIVE MRM (i)
- TARGET BEGIN (TB or tb)
- TARGET (T)

- BEST EFFICIENCY (B)
- MAX CAPACITY (M)
- DRIFT (D)
- SURCHARGE RELEASE (S)
- REGULATION DISCHARGE (G)
- UNIT VALUES(U)
- RULE (R)

User-input data are automatically flagged as INPUT, and may not be overwritten by simulation results. Certain values imported by an input DMI are flagged Z for DMI INPUT and are treated identically to INPUT (I) flags. Initialization Rules can also set values with the Z flag. OUTPUT (O) timesteps may contain values calculated during a previous run or toggled from INPUT status. These values are automatically cleared to NaN at the beginning of a simulation run. This guarantees that no previous solutions remain from one run to the next. Simulation results are written to timesteps flagged as OUTPUT, TARGET BEGIN, BEST EFFICIENCY, MAX CAPACITY, SURCHARGE RELEASE, DRIFT and UNIT VALUES. Flags other than OUTPUT and INPUT are only available for certain series slots.

Special Series Slot Flags

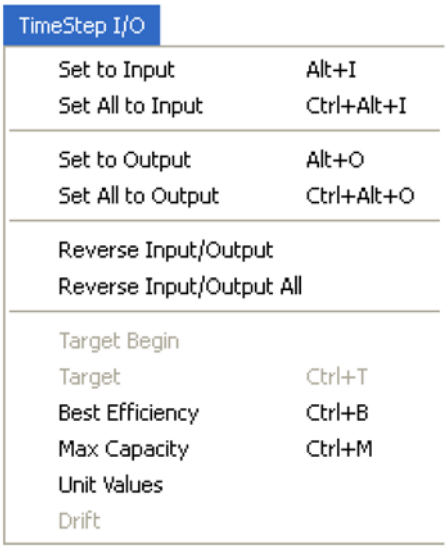
This section describes the use of special flags which may be set on Series Slot timesteps. The flags are typically set by the same mechanisms as INPUT and OUTPUT flags. But, unlike INPUT and OUTPUT flags, each type of special flag is only applicable to one or two slots. All SeriesSlots must have one of the following flags set for every timestep; each flag is indicated by its abbreviation:

- General flags available to all SeriesSlots.
  - I for INPUT
  - O for OUTPUT
  - Z for DMI INPUT. This flag indicates that the value was set by an input DMI or Initialization Rule. See "DMI Invocation Manager Dialog" in *Data Management Interface (DMI)* for details on DMI Invocations. See "Initialization Rules Set" in *RiverWare Policy Language (RPL)* for details on Initialization Rules. In simulation, the Z flag behaves identically to the INPUT (I) flag.
  - R for SET BY RULE. This flag indicates that the value was set directly by a rule.
  - i for ITERATIVE MRM. This flag indicates that the value was set during iterative MRM by an MRM rule. Values with the "i" flag can be overwritten as though it is a "O" flag. Values with the "i" flag are cleared at the beginning of a single run and at the start of an MRM run, but are not cleared between each iterative MRM run. They are considered input during an iterative MRM run.
- Power calculation flags available to Energy slots.
  - B for BEST EFFICIENCY
  - M for MAX CAPACITY
- Maximum Outflow flag available to Outflow slots
  - M for MAX CAPACITY

- Target flags available to Storage and Pool Elevation slots.
  - TB or tb for TARGET BEGIN
  - T for TARGET
- Drift flag available to Regulated Spill and Bypass slots.
  - D for DRIFT
- Surcharge Release flag available to the Surcharge Release slot
  - S for SURCHARGE RELEASE
- Regulation Discharge flag available to the Regulation Discharge slot
  - G for REGULATION DISCHARGE
- Unit Values flag available to Turbine Release and Energy slots on power reservoirs with the Unit Power Table method selected:
  - U for UNIT VALUES

Setting Flags

Flags are set from the Open Slot dialog (or from the SCT). In the Open Slot dialog, a flag is set on the highlighted timestep by selecting the flag from the **Timestep I/O** menu. Flags which are unavailable for that slot will appear dimmed in the menu.



The **Timestep I/O** menu has the following options:

- **Set to Input**. Set selected cells to Input
- **Set All to Input**. Set all cells to Input
- **Set to Output**. Set selected cells to Output
- **Set All to Output**. Set all cells to Output
- **Reverse Input/Output**. Reverse the input and output flags on selected cells

- **Reverse Input/Output All**. Reverse the input and output flags on all the cells
- Set one of the special flags on the selected cells. The following sections describe many of the special flags.

Power Calculation Flags on Energy

BEST EFFICIENCY and MAX CAPACITY flags may be set on Energy timesteps instead of an INPUT Energy request value. These flags are used by the Plant Power Coefficient Release User Method to calculate the most efficient or maximum Energy generation possible for the flagged timestep.

The Plant Power Coefficient Release method uses tables to relate the current Operating Head to the most efficient Turbine Release or maximum allowable Turbine Release. The MAX CAPACITY flag is available for all power method except LCR Power Calc. The BEST EFFICIENCY flag is only valid for the following power methods:

- Plant Power Coefficient
- Plant Efficiency Curve
- Plant Power Equation
- LCR Power Calc
- Unit Power Table

The calculation of the best efficiency Energy generation or max possible Energy generation is an iterative solution. The Outflow required to produce the desired type of Energy affects Tailwater Elevation, which affects Operating Head, which affects the Outflow required to produce the desired Energy. See “Power Release” in *Objects and Methods* for details on this methods.

When an energy value has been calculated using a MAX CAPACITY or BEST EFFICIENCY flag and it is set as a user input for a subsequent run, a warning may be posted that says “Energy request cannot be met on current iteration.” This is due to the way RiverWare solves. When two reservoirs are modeled in series, the Tailwater Elevation of the lower reservoir affects the Operating Head of the upper reservoir. The Outflow of the upper reservoir, in turn, affects the Tailwater Elevation of the lower reservoir. This creates an iterative loop between the Outflow from the upper reservoir, the Tailwater Elevation of the lower reservoir, and the Operating Head of the upper reservoir. When an Energy value is set using either a MAX CAPACITY or a BEST EFFICIENCY flag, the reservoirs iterate over Outflow, Tailwater Elevation, and Operating Head until the values converge. If the Energy value is now set as an input and the model is run again, the Input Energy may not be possible given the Operating Head on the first iteration. If this happens a RiverWare warning is posted but the run does not abort, since the energy value MAY match the Operating Head at a later iteration. The Energy also MAY NOT match the Operating Head at a later iteration. If this occurs, the model will continue running even though the object did not solve. The run will NOT be aborted, but objects may not dispatch because required information was not propagated to them. The user must check the dispatch dialog if they receive the RiverWare warning message given above to make sure the model ran correctly.

Maximum Capacity Flag on Outflow

As demonstrated in the simulation exercise, this flag computes the maximum possible Outflow from a Reservoir on a given timestep. Setting the MAX CAPACITY flag on a Reservoir Outflow slot forces the Outflow to equal the sum of the maximum (Turbine) Release and the maximum Spill.

> **Caution:** Take care when using this flag, as its effects may cause downstream reservoirs to exceed their operating ranges. The use of this flag also depends on having reliable and accurate input tables relating elevation to maximum release and spill.

The MAX CAPACITY flag is set by highlighting a simulation timestep on the Outflow slot of a Reservoir and selecting **Timestep I/O**, then **Max Capacity**. RiverWare places an M at the selected timestep to indicate that the flag is active. This flag is treated as an INPUT, but does not require a value. If a valid Outflow value is present at the flagged timestep, it is ignored in the simulation; a new Outflow value is calculated and displayed at that timestep. This behavior is similar to the Max Capacity and Best Efficiency flags of the Energy slot and the Drift flags of the Regulated Spill and Bypass slots. A Reservoir which has the Outflow Max Capacity flag set may dispatch under any of the "given Outflow" dispatch methods, as follows:

- Solve given Outflow, Pool Elevation for Level Power, Slope Power, and Storage Reservoirs.
- Solve given Outflow, Storage for Level Power, Slope Power, and Storage Reservoirs.
- Solve given Inflow, Outflow for Level Power, Slope Power, Pumped Storage and Storage Reservoirs.

The Outflow Max Capacity flag may NOT be used on reservoirs when solving for Hydrologic Inflow, or when solving a Target Operation.

The Max Capacity solution is iterative. The exact sequence of calculations in each iterative loop is dependent on the type of Reservoir and the selected Spill Calculation Method. In all cases, the maximum Spill and maximum controlled Release are calculated individually, then summed. If the selected Spill Method includes Regulated Spill, the current or previous Pool Elevation is used to look up the maximum Regulated Spill from the Regulated Spill Table. This value is set in the Regulated Spill slot, and the selected Spill Calculation Method is called. Any input Bypass and/or required Unregulated Spill are considered within the Spill Method. Next, the maximum release is calculated. If the Reservoir is a Power Reservoir, the selected Tailwater method is executed to determine the Operating Head. This Operating Head or the Pool Elevation (in the case of Storage Reservoirs) is used to look up the maximum release from the Max Turbine Q table, Max Release table, Max Flow Through Turbines table, or Best Generator Flow table. Finally, the maximum release and the calculated Spill are added to determine the total maximum Outflow. This Outflow is used to mass balance the Reservoir. The iteration is repeated until Convergence is met or Max Iterations is exceeded.

Target Operation Flags

Target Operations are used to calculate a lumped mass balance across several timesteps, in order to exactly meet a user-input TARGET Pool Elevation or Storage value. Three conditions are necessary for a Target Operation to execute successfully:

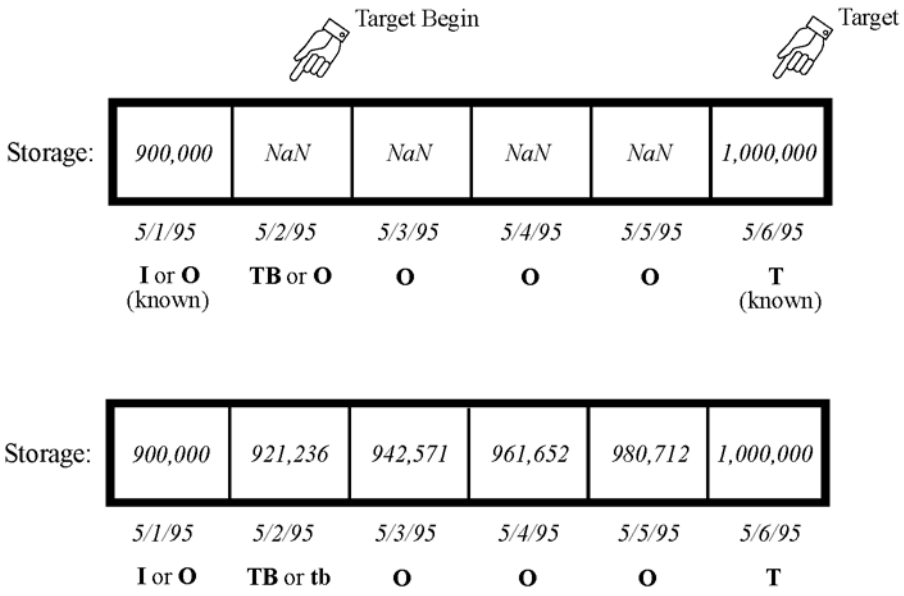
- An initial value must be known at the timestep before the TARGET BEGIN timestep. This value may be INPUT or a known value at the time the Target Operation solves.
- A target Pool Elevation or Storage value must be specified at the TARGET timestep.
- Either Inflow or Outflow must be known for all timesteps in the target range.

Given these conditions, RiverWare calculates the unknown Inflows or Outflows for all of the timesteps within the Target Operation, such that the TARGET value is exactly met.

Timestep Range

When solving a target operation, RiverWare searches backwards from the TARGET time until it finds a valid TARGET BEGIN flag. The Target Operation is solved using the value from the timestep prior to the TARGET BEGIN flag as an initial condition. If the timestep prior to the TARGET BEGIN does not have a valid Storage or Pool Elevation, or a valid input value exists between the TARGET BEGIN and the TARGET, the simulation aborts with an error. Likewise, if the TARGET BEGIN or TARGET timestep already has enough information to dispatch with a different dispatch method, simulation aborts. If no TARGET BEGIN flag is specified, RiverWare searches backwards to the first valid value and solves the Target Operation with this initial condition.

When a beginning of target is assumed in this manner, RiverWare marks the timestep where the Target Operation actually begins with a tb (lowercase) flag in the Open Slot dialog. This flag is treated as an output, and is automatically cleared at the start of the next run. Setting a Target Operation from an SCT generates both the TARGET and TARGET BEGIN flags, and clears any previous Target Operations which overlapped with the new range.



Lumped Mass Balance

To calculate the unknown flow values, RiverWare performs a lumped mass balance over the target range. The required change in Storage is found by subtracting the storage just before the TARGET BEGIN (converted from Pool Elevation in the case of a Pool Elevation TARGET) from the TARGET value (also converted from Pool Elevation in the case of a Pool Elevation TARGET). All of the known Inflows and/or Outflows are then summed to calculate a side flow gain or loss of Storage over the target range. This volume of side flows is then subtracted from the change in Storage required to meet the TARGET value, and the remaining flow volume is distributed equally among the unknown Inflows or Outflows. Equation 5.1 and Equation 5.2 represent these calculations.

$$\text{GainLoss} = \text{Storage(TB-1)} - \text{Storage(T)} + \sum(\text{Inflows} \times \Delta t) - \sum(\text{Outflows} \times \Delta t) \quad \textbf{(5.1)}$$

$$\text{Constant Inflow or Outflow} = \text{GainLoss} / (\text{Number of Undetermined Timesteps} \times \Delta t) \quad \textbf{(5.2)}$$

Redispatching

The setting of flow values on intermediate timesteps of the Target Operation forces the object onto the dispatch queue at those times. The timesteps dispatch with enough information to solve completely (Inflow and Outflow are known for all timesteps.) The only timestep which actually re-dispatches is the TARGET timestep, since a valid previous Storage value is now known.

Spill Drift Flags

Spill DRIFT is used to calculate the Regulated or Bypass Spill over a controlled gate as the reservoir Pool Elevation changes over time. The flag is always considered an input on any timestep where it is set but no value is initially set by the user. In this way, it is similar to the Energy BEST EFFICIENCY and MAX CAPACITY flags. Since DRIFT is considered an INPUT, it may affect over determination of Spill parameters.

The first timestep prior to initiating drift is used to determine a gate index called the Regulated (or Bypass) Drift Index. This index is interpolated from a 3-dimensional Regulated (or Bypass) Spill Index Table, which relates Pool Elevation to Spill for various gate indices. In all subsequent timesteps where the DRIFT flag is set, the same index is used to determine the new Spill. The gate index is maintained throughout the selected time period. At each timestep, the new value of Spill is calculated for the structure based on the current average Pool Elevation.

Surcharge Release Flag

The SURCHARGE RELEASE flag is used to calculate the surcharge or mandatory release from a reservoir during flood control operations. Surcharge releases are meant to evacuate water from that sits above the top of the flood pool. This flag can only be set on the Surcharge Release slot which is only available when the user has selected a Surcharge Release method. The flag is always considered an input on any timestep where it is set but no value is initially set by the user.

Although the SURCHARGE RELEASE flag may be set by selecting **Timestep I/O**, then **Surcharge Release** from the Surcharge Release slot, in practice it should only be set by a rule. When the SURCHARGE RELEASE flag is set, and the inflow to the reservoir is known, the reservoir can dispatch with the Solve given Inflow, Outflow dispatch method. This dispatch method will calculate the forecasted surcharge releases and will set them on both the Surcharge Release and Outflow slots so that they may propagate downstream. The manner in which the forecasted surcharge releases are calculated depends on the method selected in the Surcharge Release category. If you are interested in using one of the surcharge release methods, see "Surcharge Release" in *Objects and Methods* for details.

Regulation Discharge Flag

The REGULATION DISCHARGE flag is used to calculate the regulation discharge at a Control Point. Regulation discharge is used during flood control operations and is defined as the maximum allowable flow in the channel at the control point. This flag should only be set on the Regulation Discharge Calc slot on Control Points. This slot is only available when the user has selected a Flood Control method and a Regulation Discharge method. The flag is always considered an input on any timestep where it is set but no value is initially set by the user. Like the SURCHARGE RELEASE flag, the REGULATION DISCHARGE flag should only be set by a rule. If you are interested in using one of the Regulation Discharge methods, see "Regulation Discharge" in *Objects and Methods* for details.

Unit Values Flag

The UNIT VALUES (U) flag is used to indicate that the user is going to specify unit level values but would like to use those to drive the solution. The UNIT VALUES flag may be set on Energy or Turbine Release on power reservoirs that have the Unit Power Table method selected (see "Unit Power Table" in *Objects and Methods*). If the Unit Power Table method is not selected, an error is issued. This flag is considered a user input but does not require a value (similar to the MAX CAPACITY and BEST EFFICIENCY flag). At the beginning of the run any numeric values are cleared out. The flag can be set directly on the slot, from the SCT or from a Rule.

U Flag on Energy

Thus, if the U flag is set on Energy, one or more Unit Energy subslots must be specified by user input or a rule. When RiverWare runs, it sees that Energy has this flag which is considered an input. If it has enough other information (like Inflow, Storage, or Pool Elevation), the reservoir will be able to dispatch one of the following methods:

- Solve given Energy, Inflow
- Solve given Energy, Storage
- Solve given Energy, Pool Elevation

In addition, Energy can be flagged U, if the reservoir dispatches one of the following methods:

- Solve given Inflow, Outflow
- Solve given Outflow, Pool Elevation
- Solve given Outflow, Storage

These methods do not require Energy to be unknown.

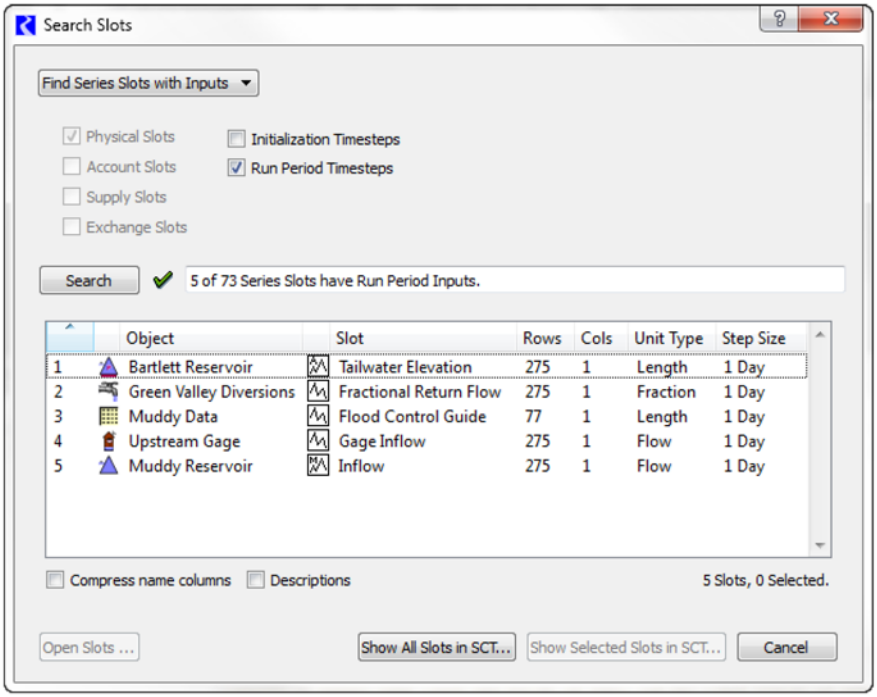
U Flag on Turbine Release

Alternatively, if the U flag is set on Turbine Release, one or more Unit Turbine Release subslots must be specified as user input or by a rule. When RiverWare runs, it sees that Turbine Release has this flag which is considered an input. If it has an Inflow, the reservoir will be able to dispatch the Solve given Inflow Release method.

This flag is specific to the Unit Power Table method; see "Unit Power Table" in *Objects and Methods* for full details on this algorithm.

Finding Inputs

The Find Series Slots with Inputs utility can be used to find values that are input in the model. It is accessed from the RiverWare Workspace using the **Workspace**, then **Slots**, then **Find Inputs** menu**.** The Search Slots dialog appears.



The user has options to filter on the types of series slots on which to look for input values. In a pure simulation model, this is only Physical Slots (i.e. Outflow, Inflow, etc.) If Accounting is enabled, the user may choose to search any or all of the following series slot “domains”:

- Physical Slots
- Account Slots
- Supply Slots
- Exchange Slots

The search may be limited to either **Initialization Timesteps** (before the Run Start timestep) or **Run Period Timesteps** (on or after the Run Start timestep). If both are checked, all series slots having any inputs are found, regardless of where (in time) those Input values are within the slots' time series.

The search operation is performed by selecting the **Search** button. The number of series slots with Input-flagged timesteps, and the total number of series slots matching the checked “domains” are indicated in a status line to the right of the search button. If search criteria is changed (by selecting any of the checkboxes at the top of the dialog), a green check icon  is displayed next to the search button indicating that a new search with the new criteria has yet to be performed. The green check icon is hidden upon performing another search.

The user has the option of showing the slots' object name and account name (if applicable) in separate columns. This is controlled by the **Compress columns** checkbox below the slot list. This is not available if supply slots or exchange slots are shown in the slot list,

Several context menu (right-click) operations are available within the slot list:

- Open Slot. Show the open slot dialog for the picked slot item.
- Open Object. Show the object dialog for the picked slot item (if applicable).
- Copy Slots. Put the selected slot items into the slot clipboard, e.g. to paste into an output (manager) device slot list.

Buttons along the bottom of the dialog provide these functions:

- **Open Slots**. Separate open slot dialogs are shown for each of the selected items in the list. If more than four (4) slots are selected, then a query dialog box is shown confirming the operation with a message like this: “Do you want to show 421 Open Slot dialogs?”.

  Note: All shown open slot dialogs may be hidden with the **Workspace**, then **Slots**, then **Close All Slots** menu operation.
- **Show All Slots in SCT**. All slots in the list (regardless of item selection) are shown in a new SCT dialog, and the **Find Series Slots with Inputs** dialog is closed.
- **Show Selected Slots in SCT**. Selected slots in the slot list are shown in a new SCT dialog, and the **Find Series Slots with Inputs** dialog is closed.
- **Cancel**. The **Find Series Slots with Inputs** dialog is closed.

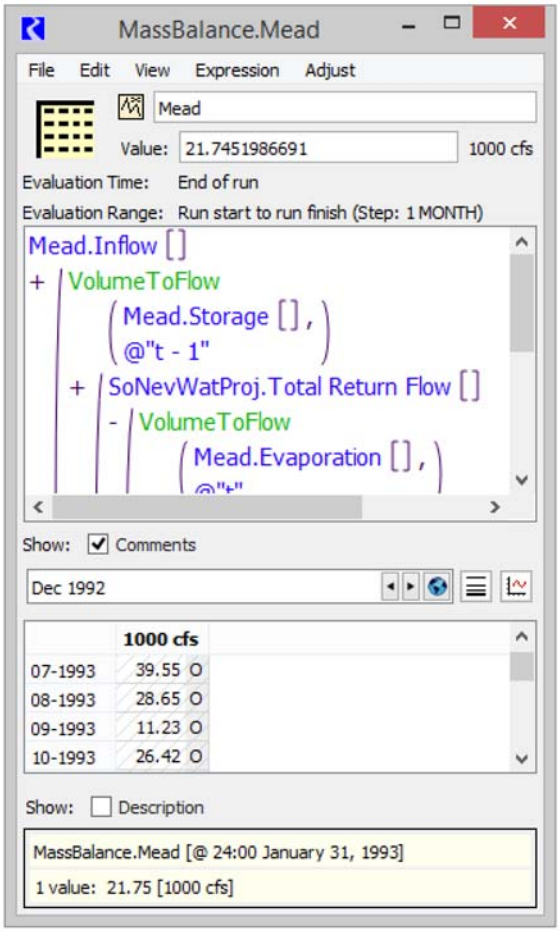
The dialog can also be used to find slot descriptions; see “Slot Descriptions” on page 149 for details.

Series Slots With Expression

Expression slots are computational expressions. The user can either create a **Series Slot with Expression** or a **Scalar Slot with Expression**. They are used to calculate quantities such as “combined Storage of all Reservoirs,” “weekly average Outflow of Hoover Dam,” “the ratio of Hydrologic Inflow to Reach Inflow at selected structures”, or any conceivable expression. To add a Series slot with expression select **Slot**, then **Add Series Slot with Expression**.

Expression slots utilize the RiverWare Policy Language (RPL). RPL is computationally expressive language and has an associated structured editor. Because Expression slots utilize RPL (the same language in which RiverWare rules are written) they may contain simple expressions or complex logic and functions. Anything that may be expressed in a rule may also be evaluated in an Expression slot. The use of RPL also provides dimensional analysis to ensure that units are reconciled throughout the expression.

Note: Ensure that the unit type of the slot is the same as the units to which the expression evaluate.



Configuration

Following is description of the configuration options available for expression slots.

File Menu

On the File menu, the Import options are not available as you cannot import or type data into the slot. The export options are available and can be used to export the calculated data out of the slot. A Print Expression menu option is available to print the expression. This uses the same printing mechanism as other RPL sets; see “Printing” in *RiverWare Policy Language (RPL)* for details.

Edit Menu

On expression slots, the **Edit** menu has options to **Copy** (to the RiverWare clipboard) and **Export Copy** (to the system clipboard). Importing, pasting, and other data editing features are disabled as the expression slot is “output only”.

View Menu

The View Menu on expression slots show the following menu options.

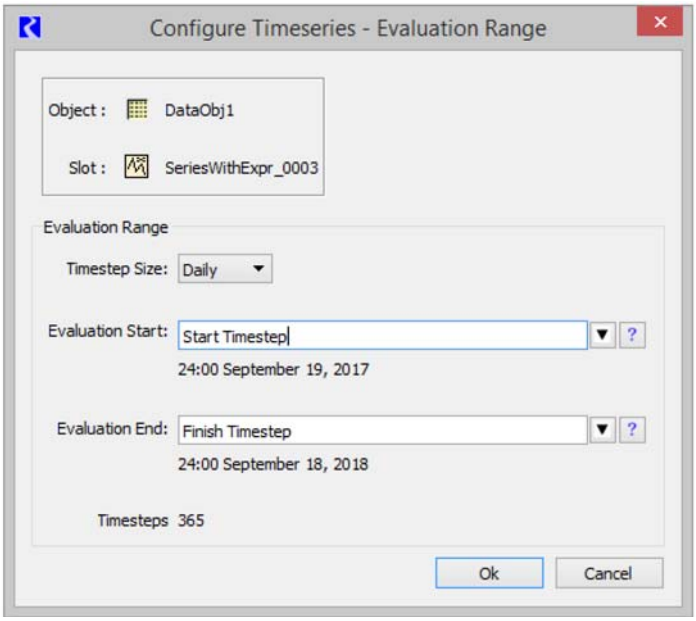
Configure

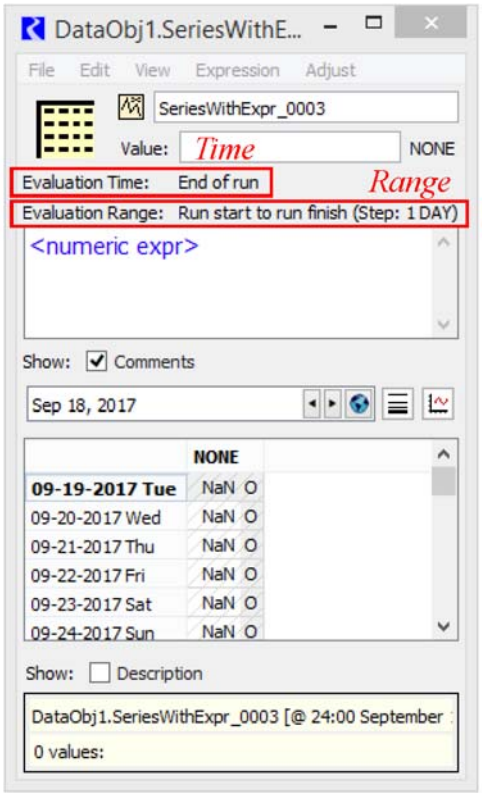
The configuration uses the standard series slot configuration dialog; see "Configure Slot Dialog Functionality" on page 175 for details. You can change the unit type of the expression slot. It must correspond to the unit type of the RPL expression.

Evaluation Range

By default, Expression slots are evaluated for each timestep in the model run (i.e., the range is synchronized with the run control). If you are only interested in the result of an expression for a reduced range of dates or for

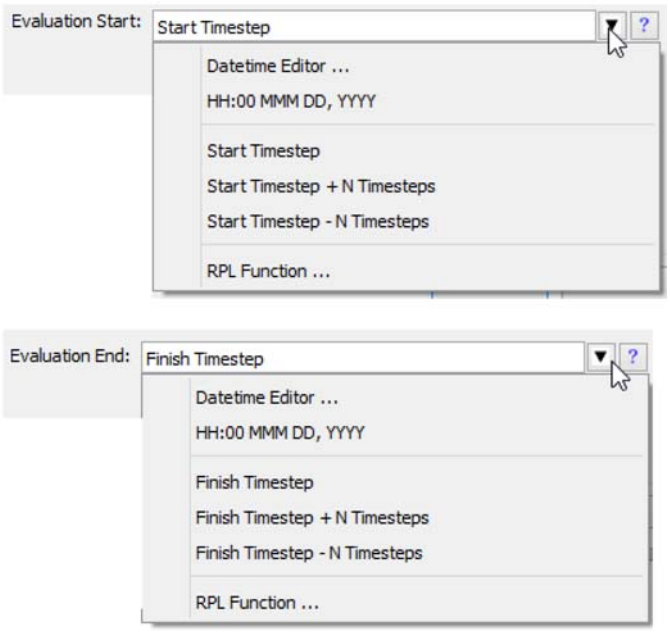
a different timestep, you may select **View**, then **Evaluation Range**, to open the **Configure Timeseries—Evaluation Range** dialog and enter the date range in which you are interested.





The Start and End times can be specified explicitly or symbolically as RPL DATETIMES; see "DATETIME" in *RiverWare Policy Language (RPL)* for details. Text below the editor field indicates the actual DateTime of the entered symbolic time text (if it is valid), or the status if it is not valid. You can also use the menu to specify one of

the common DateTimes. Some of these are expressions that must be edited to become valid, e.g. by replacing “N” with a nonnegative integer and the **HH:00 MMM DD, YYYY** formula, where you substitute the hour, month, day and year.



The **Datetime Editor** option opens a separate dialog to specify the DateTime using a selector configured for the model's timestep size.



The **RPL Function** opens a Function Selector to select a RPL function in the Expression Slot or Global Function Set. The selected function must have a return type of DATETIME, and must not have any arguments.

Select **Help** (question mark icon button) on the right side of the symbolic DateTime editor to show a description of symbolic DateTime representations.

> **Note:** An expression slot does not need to have the same timestep as the run control. For slots with a different timestep than the run, the slot will evaluate for only those timesteps that fall within the run dates. When entering a symbolic date such as “Start Timestep—N Timesteps”, the slot's timestep will be used in the subtraction.

Expression Menu

Show Expression

This toggle is used to show or hide the expression. By default, the expression is shown.

Evaluate

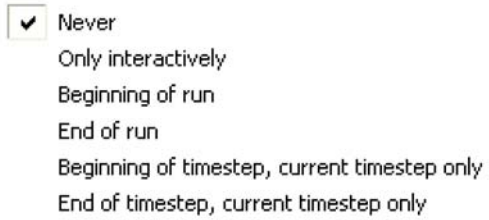
The user can manually evaluate the expression from the **Expression**, then **Evaluate** menu.

Validate

The user can manually verify the expressions validity using the **Expression**, then **Validate** menu.

Evaluation Time

Expression slots can be evaluated at the beginning or end of each simulation run, at the beginning or end of each timestep, never, or interactively on demand. These options are particularly useful for performance when running large models and when evaluating a large number of expression slots. To select when an Expression slot is evaluated select **Expression**, then **Evaluation Time** from the Expression slot menu and select an option. A check mark will be shown next to the selected option.



Note: Unlike rules, expression slots do not reevaluate if dependent slots change, but if the expression slot returns a NaN, the expression slot is put on a list of slots to be re-evaluated during that same evaluation time. The NaN might come from an expression slot that hasn't been evaluated yet, so it should evaluate later, once that expression has had a chance to evaluate. The palette operations IsNaN and NanToZero return a valid value, so do not cause re-evaluation of the expression slot.

Editing Menu items

The Expression menu is used to build expressions. There are options to **Cut**, **Copy**, **Paste, Delete**, and **Enable** and expression. **Undo** and **Redo** are available to go back or go forward when editing expressions. These are only available when a relevant expression is selected. Finally, there is a menu option to bring up the **Palette** open the **RPL Debugger** and open the **RPL set**.

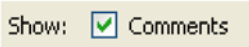
Open RPL Set

The RPL set containing functions used by any expression slot can be opened by **View**, then **Open RPL Set.** All of the functionality associated with a RPL set can be utilized from this RPL set editor such as importing/ exporting, analysis, search and replace, and creating utility groups of functions.

Note: Only functions are shown in the RPL set editor; the expressions on the slots themselves are the equivalent to the rules in a ruleset. See “About RPL Sets” in *RiverWare Policy Language (RPL)* for details on RPL sets. From the RPL set, the user can control the layout using the **Set p Layout** menu. See “Formatting: Display Settings” in *RiverWare Policy Language (RPL)* for details on layouts.

Show Comments

The **Show Comments** menu allows you to hide or show inline RPL comments (added from the palette). There is also a toggle on the slot dialog below the RPL expression that hides/shows the comments. Comments are shown by default. If there are any comments defined, a box is shown around the toggle.



Building Expressions

Expression slots utilize the RPL palette to build expressions. The RPL palette provides a syntax-guided editor designed to assist in the construction of complex syntactically correct expressions within the RiverWare Policy Language environment. The editor works by maintaining a partially constructed expression and allowing the user to manipulate unfinished portions using the palette. Initially, the buttons in the palette are grayed out. When building an expression, the **palette** enables any buttons that could possibly go in a highlighted portion of the expression.

See "Editing a RPL Expression" in *RiverWare Policy Language (RPL)* for details.

Note: For Expression Series Slots, the symbolic DateTime specifications @"Start Timestep" and @"Finish Timestep" refer to the expression slot's evaluation range, not the controller's start or end dates. The predefined functions RunStartDate() and RunEndDate() provide a reference to the controller's start and end dates, respectively. See "RunStartDate and RunEndDate" in *RiverWare Policy Language (RPL)* for details.

Tip: For Expression Slots, you can use the keyword ThisObject to access the containing object. For example, to get the slot named DailyTotals from this object, you could create the following expression:

```
ThisObject. "DailyTotals"[]
```

Diagnostics for Expression Slots

Diagnostics for expression slot evaluation can be configured in the Diagnostics Manager; see "Diagnostics Manager" in *Debugging and Analysis* for details.

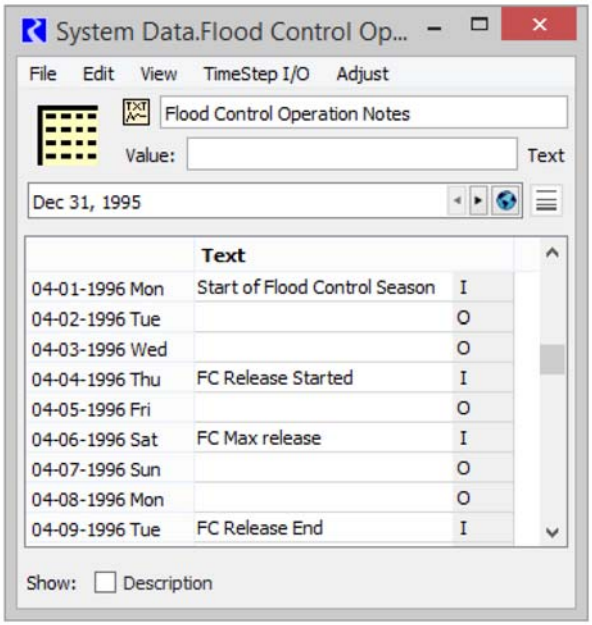
If expression slots are evaluated outside of a run, using the **Expression**, then **Evaluate** menu on the slot or the **Control,** then **Evaluate Expression Slots** menu from the workspace, then diagnostics must be set up using the Workspace diagnostics; see "This document is under development." in *Debugging and Analysis*.

If expression slots are evaluate during a run, either beginning or end of timestep or beginning or end of run, then diagnostics must be set up using Simulation diagnostics (see "Simulation Diagnostics" in *Debugging and Analysis*) or Rulebased Simulation diagnostics (see "Rulebased Simulation Diagnostic Groups" in *Debugging and Analysis*), depending on the selected controller. Within each of those diagnostics configurations, the **Expr. Slot Execution** and **Expr. Slot Function Execution** categories deal with expression slots.

Text Series Slots

The Text Series Slot holds a series of user-specified text strings. Because it is a series slot, it provides much of the required series slot functionality like display, flags, use in SCTs, and input via DMI. Figure 5.18 shows a sample Text Series Slot. It has comments about how the system is operated during Flood Season.

Figure 5.18 Screenshot of a Text Series Slot



> **Note:** Internally, the Text Series Slots is a normal series slot that holds an encoded index which indicates which text string to display. If you try to copy and paste, you will see the encoded number.

The following list provides information on supported functionality:

- The Text Series Slots behaves like other slots in terms of showing/hiding/grouping on the open object dialog. They have a description and other normal slot attributes.
- Text values have normal, I, O, and Z flags. A non-specified value is blank, not NaN.
- Convergence, bounds, and changing units on Text Series Slots is not relevant.
- Import/Export through a DMI is supported via Excel Database DMIs; see "Excel Datasets" in *Data Management Interface (DMI)* for details.
- Text Series Slot values can be displayed and edited in an SCT.
- Text Series Slot values can be read by RPL using the following RPL predefined functions. Samples are shown in Figure 5.19.
  - "TextSlotNumericToString" in *RiverWare Policy Language (RPL)*
  - "GetTextSlotValueAsString" in *RiverWare Policy Language (RPL)*

Figure 5.19 Image of RPL functions accessing a Text Series Slot.



- Text Series Slot values can be set by rulebased simulation rules or initialization rules using the function "StringToTextSlotNumeric" in *RiverWare Policy Language (RPL)*. This function converts a string to a value that can be stored in the slot. The assignment syntax, as shown in Figure 5.20, is as follows:

```
Object.TextSeresSlot[ ] = StringToTextSlotNumeric("Text string to set")
```

Figure 5.20 Image of rule assignment setting a Text Series Slot



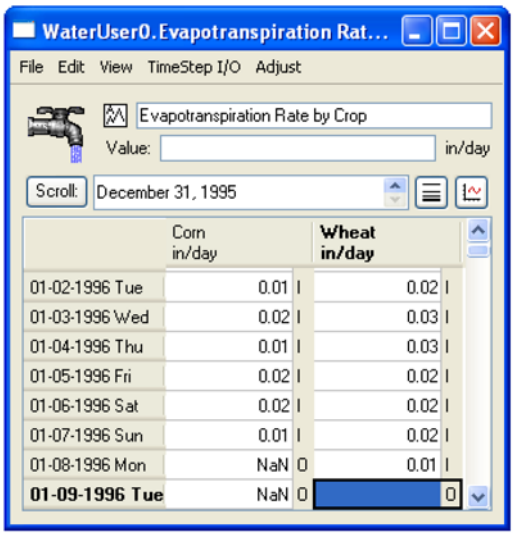
As of version 7.4, the following functionality is *not* supported:

- Import/Export to a text file is not allowed.
- Text Series Slot are not displayable in Model Reports of Tabular Series Slot Reports
- Text Series Slots can not be set by script actions.
- Text Series Slots can not be set by iterative MRM rules or Object Level Accounting Methods.
- Values in Text Series Slots are not shown in plots or other output devices.
- Text is not exportable to Output Devices that are file based like CSV, RDF, netCDF, Excel.
- Text cannot be copied from Excel and Import Pasted into slots or SCTs. You can copy and paste a single text string, but not a range or text.

Agg Series Slots

Aggregate Series Slots (Agg Series) are specialized Series Slot that group together one or more Series Slots which are independent of one another. They are used to group together similar series of data. Agg Series slots are essentially multiple individual series of data. The columns of an Agg Series Slot are often referred to as Sub Slots. Figure 5.21 shows the Evapotranspiration Rate by Crop for two different crops, Corn and Wheat.

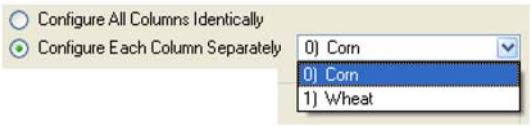
Figure 5.21



Configuration

Following are configuration options specific to Agg Series Slots. See "Configure Slot Dialog" on page 153 for details on general configuration. See "Configure Slot Dialog Functionality" on page 175 for details on Series Slots.

Agg Series slots can be configured such that each column is configured identically or each is configured individually. In the Configuration dialog, there is a toggle to configure the columns identically or separately.



Other Options

Because each column can be configured separately, the time range of each column can be configured to have different start and end dates. The two options allow the columns of the agg series to sync back together:

Max Synch

The **Edit**, then **Max Synch** option will synchronize each column to fully encompass the earliest and latest date displayed on any column of the slot. For example, if column 1 goes from Jan. 1, 1999 to June 1, 1999 and column 2 goes from Feb. 2, 1999 to July 23, 1999, a **Max Synch** will change the range of both columns to be Jan. 1, 1999 to July 23, 1999.

Sync to Column0

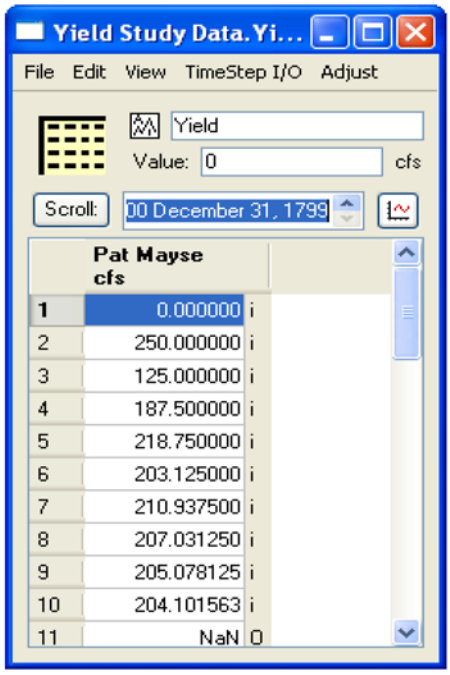
The **Edit**, then **Sync to Column0** option will synchronize each to column to match the first column (i.e. column 0). **O**n the previous paragraphs example, a **Sync to Column0** will change the range of all columns to be Jan. 1, 1999 to June 1, 1999.

Integer-indexed Series and Agg Series Slots

Integer Indexed Series Slots and Integer Indexed Agg Series Slots are specialized types of series slots whose range is associated with their order in the series, rather than with dates. The indices are 1-based; that is, the first value has index 1.

Configuration of Integer Indexed Series Slots is similar to Series Slots, but because the series is incremented by integer, there are a few differences between this type of slot and a standard series slot. See "Configure Slot Dialog Functionality" on page 175 for details.

The **View** menu now has a **Series Range** menu instead of the standard **Timeseries Range** menu option. In the **Series Range** menu (the Configure Series dialog), the Begin, End, and timestep areas are disabled. The user can change the range only by changing the number of values.



Integer Indexed Series slots can be used as a part of the following utilities:

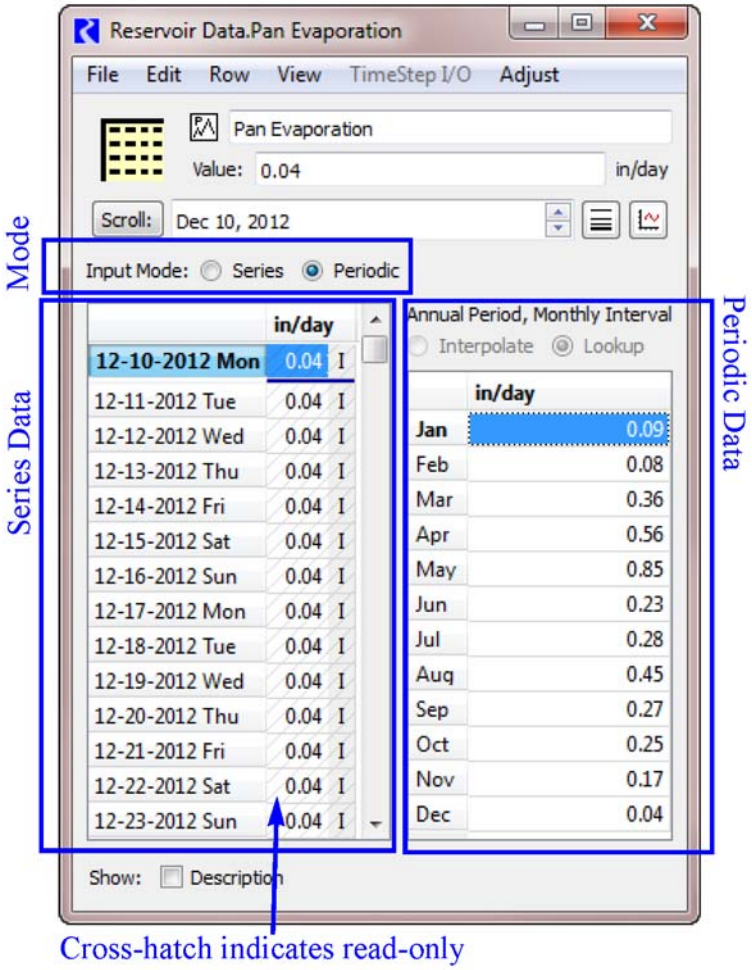
- They are plotted with integer values with units of NONE for the x dimension.
- They can be accessed and set from the RiverWare Policy Language. Integer Indexed Slots are particularly useful in Iterative MRM mode as they can be used to store values for a particular run index.
- They can be displayed on a System Control Table (SCT).

  Note: The SCT can either show standard time series or integer indexed series, but not both.

Series Slots With Periodic Input

Series Slots with Periodic Input allow you to specify either a series of values or a periodic relationship. You can specify data in one of the following Input Modes:

- **Series**. The individual time-series values are directly editable in the slot dialog and in an SCT. In this mode, these slots are functionally equivalent to ordinary series slots.
- **Periodic**. The periodic values are editable and shown in a separate panel. As periodic values are entered, the series values are filled in. As with other periodic slots, you have the choice of several standard periods (e.g. 1 Year, 1 Month, 1 Day), either "irregular" or "regular" intervals within the period, and interpolation or lookup.



Series Slots with Periodic Input behave as ordinary series slots in virtually all ways, including RPL access, plotting, outputs, etc. A minor exception to this is that DMI import operation to these slots is blocked when they are in Periodic input mode.

In general, when switching a Series Slot with Periodic Input from Series to Periodic input mode, the existing series values are lost; they are overwritten with values computed from the periodic input definition. When switching from Periodic to Series input mode, the periodic input values are hidden and become inactive.

The remainder of this section describes creation and editing of these types of slots.

Slot Creation

Series Slots with Periodic Input exist on some engineering objects (particularly the reservoirs) and can be created by the user. From the Object dialog, choose the **Slot**, then **Add Series Slot with Periodic Input** menu item.

Slot Configuration

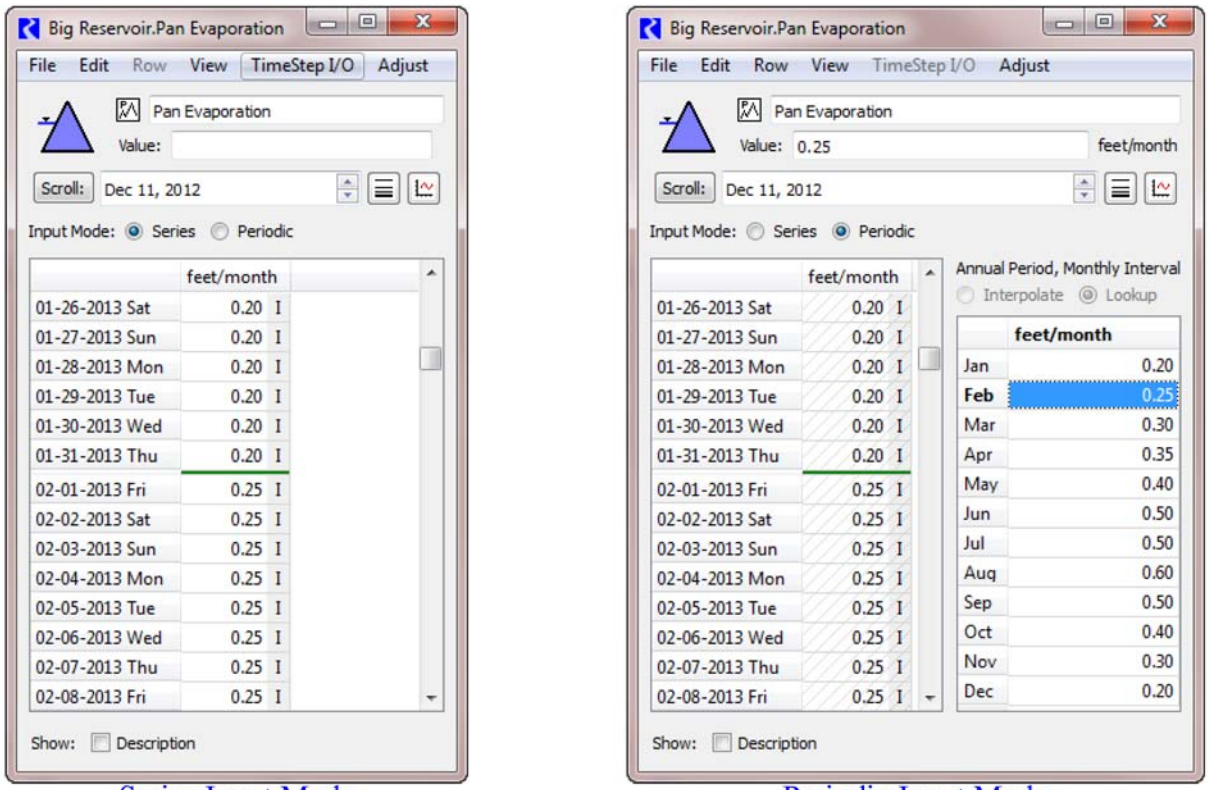
Following are configuration options for this type of slot.

Series Input Mode

Series Slots with Periodic Input start in **Series** input mode where they appear and behave as ordinary series slots. Figure 5.22 shows Series input mode.

The slots are accessed from RPL using standard series syntax, i.e. by DateTime: Slot[ ] or Slot [E].

Figure 5.22



Series Input Mode

Periodic Input Mode

Periodic Input Mode

In **Periodic** input mode, the series data is shown as read-only (cannot be edited), but an editable periodic data panel is shown to the right (see Figure 5.22). Edits and operations on the periodic values immediately cause a recalculation of the series values—assigned as *Inputs* except where periodic values are undefined, in which case

NaNs (flagged as *Outputs*) are shown. Series values are computed for the series slot's currently configured time range.

The periodic configuration is accessible from the **View**, then **Configure Period** menu. See "Periodic Slots" on page 225 for an explanation of the available period, interval, and data interpolation settings. Use the options in the **Row** menu to modify the rows of the periodic table.

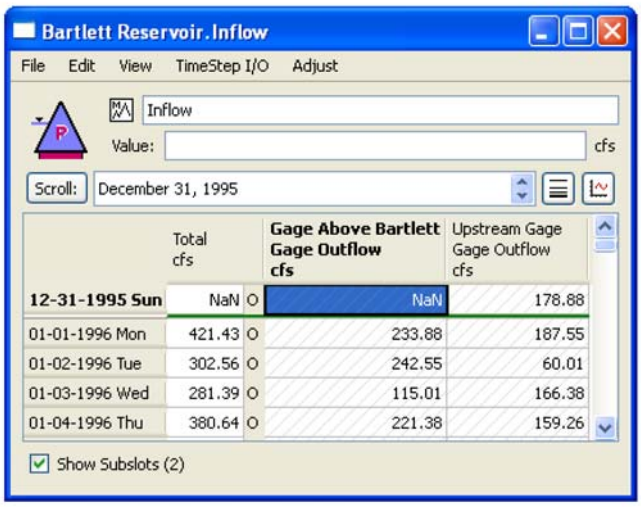
Although they have periodic data, the slots are accessed from RPL using standard series syntax, i.e. by DateTime: Slot[ ] or Slot [E].

Switching Between Series and Periodic Mode

In general, when switching from **Series** input mode to **Periodic** input mode, the series values are overwritten by values computed from the periodic values. When series values are overwritten by periodic data, the you must confirm the warning dialog. No confirmation dialog is shown when switching from Periodic input mode to Series input mode, as there is no loss of data in that change.

Multi Slots

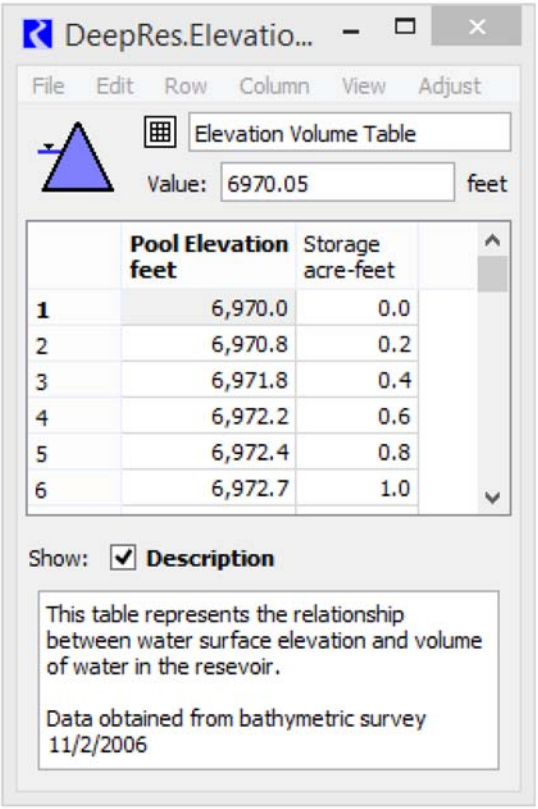
Multi Slots are specialized series slots that automatically sum the values of the slots to which they are linked. In the screenshot, two series slots named **Gage Above Bartlett. Gage Outflow** and **Reach2.Outflow** are linked to the **Bartlett.Inflow** slot. Each of the linked slots appears in a column. The cells for these columns are grey hatched indicating that they are not directly editable from this view. The user should edit these values from the other end of the link. The sum of all linked columns is reported in the **Total** column. The columns of a Multi Slot are often referred to as Sub Slots. All of the sub slots must have the same unit type and user unit although the other end of the link can have a different user unit, conversion is automatic.



Configuration of Multi Slots is similar to Series Slots; see "Configure Slot Dialog Functionality" on page 175. On Multi Slots there is a toggle at the bottom of the dialog that is used to hide or show the subslots. The checkbox is shown only if the Multi Slot has at least one subslot. It is initialized to OFF if the Multi Slot has exactly one subslot, otherwise, it is initialized to ON. This can be useful for subslots that only have one link, hence it really only represents one series of data.

Table Slots

Table Slots are used to store any table of data. They can define a curve (2-Dimensional), a surface (3-Dimensional), or several unrelated sets. A 2-Dimensional table may require monotonically increasing values in its first column, as shown in the Elevation Volume table.

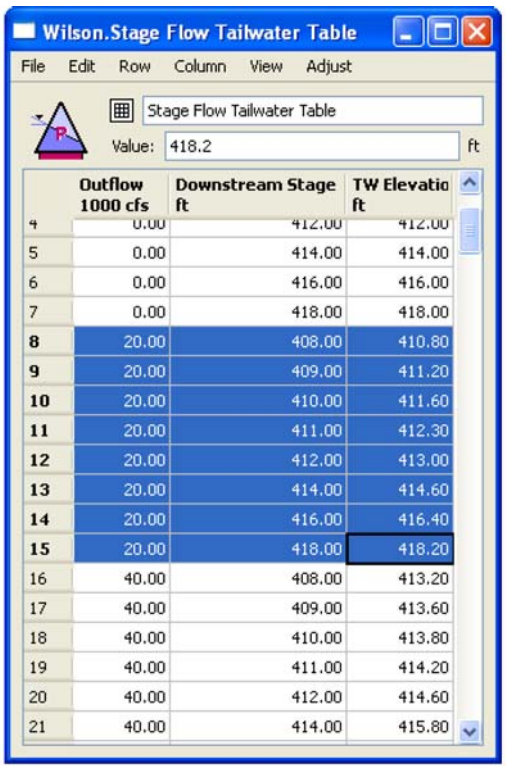


Configuration

See "View Menu" on page 161 for details on configuring Table Slots. Each column of the table has both a Label and a Unit (user units are configurable). On simulation slots, the Rows are labeled by number unless defined otherwise. Both columns and rows are zero-based, i.e. the first column is column 0. On custom slots the user is able to change both the Units, Display Format, Column Labels, and Row Labels. Table Slots can be configured such that each column is configured identically or each is configured individually. In the View menu, there is a menu to Configure Columns Identically or separately using the Configure Column menu on the selected column.

A 3-Dimensional table requires that column 1 contain sets of equal values which increase down the table, and column 2 must contain monotonically increasing values within each set of values from column 1. Column 3 then contains the values to look up for columns 1 and 2. For example, the Stage Flow Tailwater Table is a 3-

Dimensional table relating TW Elevation to the independent variables of reservoir Outflow and Downstream Stage. A set where Outflow is equal to 20,000 cfs is highlighted.



	Outflow 1000 cfs	Downstream Stage ft	TW Elevatio ft
4	0.00	412.00	412.00
5	0.00	414.00	414.00
6	0.00	416.00	416.00
7	0.00	418.00	418.00
8	20.00	408.00	410.80
9	20.00	409.00	411.20
10	20.00	410.00	411.60
11	20.00	411.00	412.30
12	20.00	412.00	413.00
13	20.00	414.00	414.60
14	20.00	416.00	416.40
15	20.00	418.00	418.20
16	40.00	408.00	413.20
17	40.00	409.00	413.60
18	40.00	410.00	413.80
19	40.00	411.00	414.20
20	40.00	412.00	414.60
21	40.00	414.00	415.80

Edit Row Configuration

The user is able to change the number of rows in most tables. This is done through the **Row** menu using the **Insert**/**Append**/**Delete** rows options. Move rows up or down using the **Row**, then **Move Rows** menu (Custom Slots only).

Editing Column Configuration

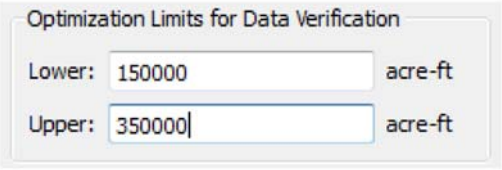
Some Table Slots allow columns to be appended and deleted. This is done to store a variable number of data sets within a single slot. A “block” is defined as the number of columns which must be appended or deleted together. In the case of the Elevation Volume Table, the block size is 2, one column for Pool Elevation and one for Storage (although the user can’t add blocks to this table). When appending or deleting columns from a Table Slot and its dependents, reconfiguring must be done in blocks. The minimum table size is 1 block. The user can change the number of columns using the **Set Number of Columns**, **Append Column**, **Delete Column**, **Delete Last Column**, and **Set Dimensions** menu options from the **Column** menu. Move columns to the right or left using the **Column**, then **Move Columns** menu (custom slots only). The **Column**, then **Set Dimensions** can also be used to change the number of rows and columns at the same time.

Show Column Sum Row

The user is able to show the sum of the column rows using the **View**, then **Show Column Sum** Row menu item. This option adds a special read-only SUM row to the bottom of the column that sums all of the values above (NaNs are assumed to be zero). This feature is especially useful when setting up routing coefficients or factors where the sum of the column must equal 1.0.

Optimization Limits for Data Verification

The Table Slot single-column configuration dialog presents an Optimization Limits for Data Verification panel if the column is configured to support optimization checking limits. See "Create an Optimization Goal Set" in *Optimization* for details.



Source Slots

Some specific scalars and tables have a "Source" slot. When a slot has a source slot, the values are computed from the source slot's values. Thus, the destination slot becomes read-only and displays a cross hatch over the data. The slot also provides a note indicating the source slot used to compute the data. The source slot is typically set/un-set at beginning of run, so you must initialize the run to see the read-only status.

Statistical Table Slots

Statistical table slots allow the user to specify a statistical function, such as a flow duration curve, which is computed at the end of a run using the data in specified model slot(s). This statistical analysis data can then be plotting or exported to another application.

This statistical analysis could be computed using Riverware's existing export or output manager functionality coupled with a third-party analysis application such as Excel. Statistical table slots provides this functionality inside Riverware to allow quick analysis at the end of a run without leaving the Riverware environment.

Creating a Statistical Table Slot

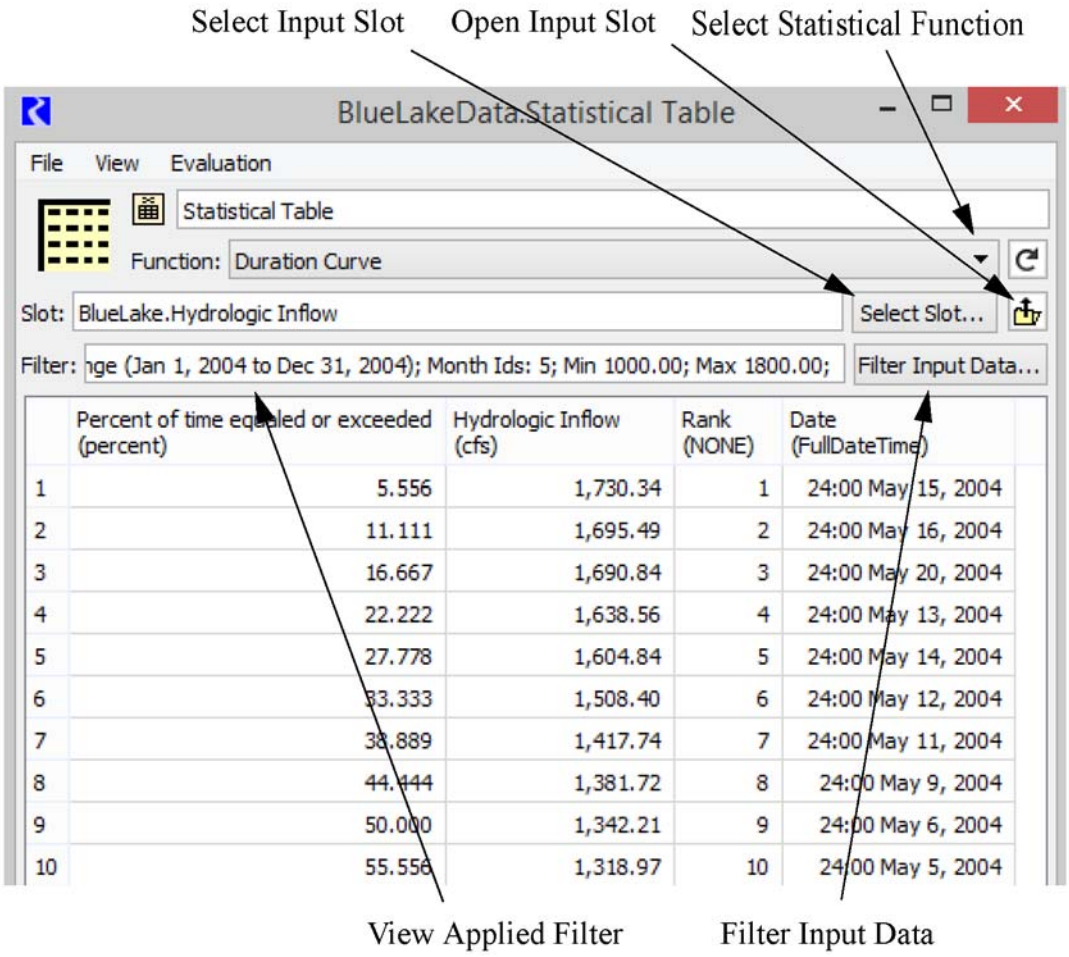
To create a statistical table slot, open the object dialog for a object. From this dialog:

- Select **Slot**, then **Add Statistical Table Slot** from the object's main menu bar.
- Right-click over the slots list and select **Add Slot**, then **Statistical Table Slot** from the context menu.

A statistical table slot will be displayed in the slot list with the **Slot** icon  .

Configuring a Statistical Table Slot

A statistical table slot is configured and viewed using the Statistical Table Slot Dialog. Display this dialog by opening the statistical table slot in the object dialog.



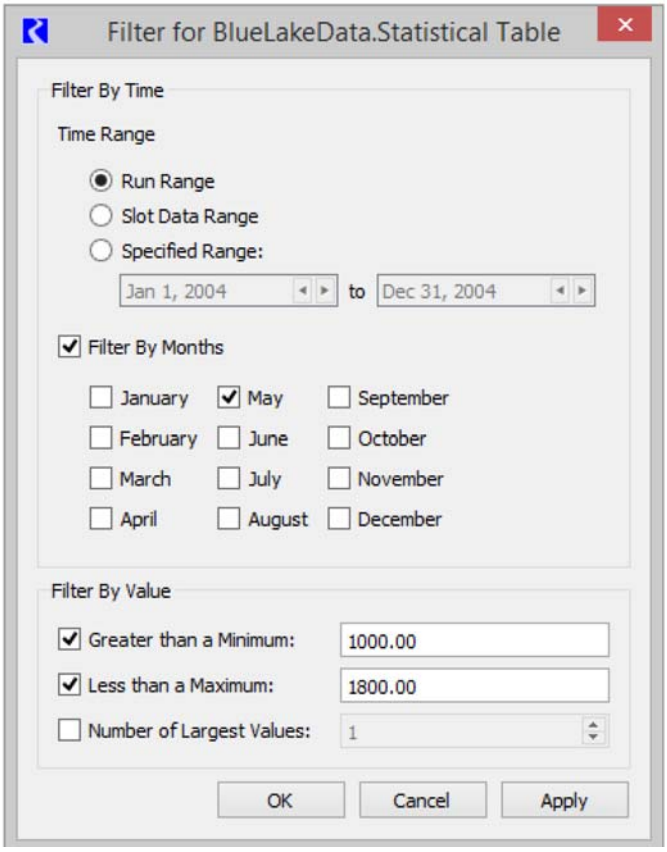
The basic steps in configuring a statistical table slot are:

1. Select the desired statistical function from the **Function** menu. The functions are described "Statistical Functions" on page 214.
2. Select the input slot for the statistical function by pressing the **Select Slot** button. A selected input slot can then be opened by pressing the icon next to the **Select Slot** button.
3. Select any desired filtering of the input data by pressing the **Filter Input Data** button. Data can be filtered as follows:
   - Time Range, select the **Run Range** (default), full **Slot Data Range**, or a **Specified Range**
   - Months, choose the desired months
   - Values **Greater than a Minimum**.
   - Values **Less than a Maximum**.

– A specified **Number of Largest Values**.

Multiple filters can be applied concurrently. A summary of any applied filtering can be viewed on the Statistical Table Slot Dialog in the Filter text window.

4. Specify the display units, scale, and precision for each column in the table by selecting **View**, then **Configure** from the dialog's menu bar.



Evaluating a Statistical Table Slot

By default, all statistical table slots will be cleared at the beginning of the run and evaluated at the end of the run.

- To prevent a statistical table slot from being evaluated at the end of the run select **Evaluation**, then **Disabled** on the dialog's menu bar.

The contents of a statistical table slot can also be cleared and evaluated manually.

- To manually evaluate a statistical table slot select **Evaluation**, then **Evaluate (Alt+E)** from the slot dialog's menu bar.
- To manually clear the contents of a statistical table slot select **Evaluation**, then **Clear** from the slot dialog's menu bar.

Analyzing a Statistical Table Slot

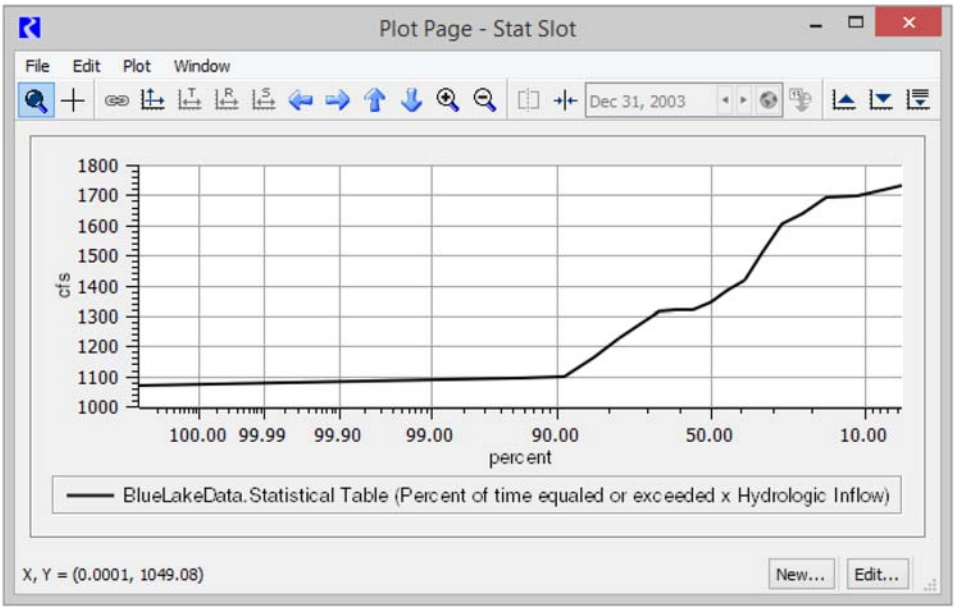
Snapshots can be made of statistical slots to easily preserve and compare their values from different runs.

- To create a snapshot of the statistical slot select **View**, then **Snapshot Mgr (Alt+S)** from the slot dialog's menu bar.
- The snapshot manager dialog will be opened and the statistical slot and its input slot will be added to the manager's slot list if not already present.
- Taking a snapshot creates a data object with copies of all slots that are in the manager's list.
- To preserve the data, the snapshots of statistical slots have all functionality disabled that could change the values of the data in the slot.

Plotting a Statistical Table Slot

The contents of a statistical table slot can be plotted.

- To plot the contents of the statistical table slot select **File**, then **Plot (Ctrl+P)** from the slot dialog's menu bar.
- If the statistical slot has more than 2 columns, a dialog appears to allow specification of which columns to plot (some functions may present a checkbox option for plotting all the result data columns, for example to plot all duration columns from a value duration function). A typical choice would be percent exceedence probabilities versus values. In this case, the percent exceedences will, by default, be plotted on a probability scale as you would see on normal probability paper. On such a scale, normally distributed values will plot as a straight line.



- If desired, the probability axis can be changed to a linear scale by selecting **Edit**, then **Axis Configuration** from the plot dialog's menu bar, then choosing the X-Axis and changing the toggle.
- The axes of the generated plot can also be configured to be logarithmic by selecting **Edit**, then **Axis Configuration** from the plot dialog's menu bar. This can be used, for example, to plot a log-normal representation of the data.

- The configuration of the plot can be saved for quick access by using either the output manager or the **File**, then **Save As** option on the plot dialog.

A statistical slot can be plotted with all of its snapshots.

- To plot the contents of the statistical table slot along with all of its snapshots, select **File**, then **Plot with Snapshots (Alt+P)** from the slot dialog's menu bar.
- If the statistical slot has more than 2 columns, a dialog appears to allow specification of which columns to plot (some functions may provide a checkbox option to plot all the result data columns). The selections are used for the slot as well as for all the snapshots.
- The slot's data and the data in all of its snapshots are plotted on the same graph to allow for an easy visual comparison.
- The axes of the generated plot can be configured to logarithmic scale by selecting **Edit**, then **Axis Configuration** from the plot dialog's menu bar.
- The configuration of this plot can be saved for quick access by using either the output manager or the **File**, then **Save As** option on the plot dialog.

User data input to a table slot can be plotted with a statistical slot.

- Add a table slot by selecting **Slot**, then **Add Table Slot** menu.
- A dialog will appear asking for the number of rows and columns you want in your table slot. You will probably want at least two columns to plot the slot.
- The new table slot with a default name will appear in the slot list. Double-click the new table slot in this list to bring up the table slot's dialog.
- Select **View**, then **Column Labels** from the table slot's dialog. Give the columns heading names in the new dialog that comes up and select **OK**.
- Now select **View**, then **Configure** from the table slot's dialog. Assign Unit Type and User Units to your columns by using the Configure Each Column Separately option.
- Enter the desired data into the cells of the table slot's dialog.
- From a plot of your statistical slot, select **Data**, then **Add Table Curve** from the plot's menu bar.
- From the resulting Curve Configuration dialog, select the **Select Table Slot** button and select the table slot you created above.
- The Curve Configuration dialog will allow you to select what columns you wish to plot on the x and y axes of the plot along with line styles and formats.
- Selecting **OK** on the Curve Configuration dialog will then add your user input data from the table slot onto the plot with the statistical slot.

The contents of the statistical table slot can also be exported to a text file for analysis using an external tool.

- To export the contents of the table slot select **File**, then **Export (Display Precision)** or **File**, then **Export (Model Precision)** from the slot dialog's menu bar.

Statistical Functions

The following statistical functions are provided on RiverWare's statistical table slots.

Duration Curve

	Duration Curve
Input Slot(s)	1 series slot
Column 0	**Label:** Percent of time equaled or exceeded **Unit Type:** Fraction
Column 1	**Label**: [Name of input slot] **Unit Type:** [Unit type of input slot]
Column 2	**Label:** Rank **Unit Type:** None
Column 3	**Label:** Date **Unit Type:** DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Sort all n resulting values in decreasing order. 3. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m = n. 4. Compute the statistical exceedence percentage value (P) for each item using the formula: P = m / n. 5. The final output is the list of: P, the slot values in sorted descending order, rank, and date of the values.

Annual Max Frequency Curve

	Annual Max Frequency Curve
Input Slot(s)	1 series slot
Column 0	**Label:** Max exceedence frequency in percent of years **Unit Type:** Fraction
Column 1	**Label**: [Name of input slot] **Unit Type:** [Unit Type of input slot]

	Annual Max Frequency Curve
Column 2	**Label:** Rank **Unit Type:** None
Column 3	**Label:** Date **Unit Type:** DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Create a list of the maximum annual values for each year within the resulting data. 3. Sort all n annual values in decreasing order. 4. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 5. Compute the statistical exceedence percentage value (P) for each item using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on rank. 6. The final output is the list of: P, the max annual values in sorted descending order, rank, and date of the value.

Annual Min Frequency Curve

	Annual Min Frequency Curve
Input Slot(s)	1 series slot
Column 0	**Label:** Min exceedence frequency in percent of years **Unit Type:** Fraction
Column 1	**Label**: [Name of input slot] **Unit Type:** [Unit Type of input slot]

	Annual Min Frequency Curve
Column 2	**Label:** Rank **Unit Type:** None
Column 3	**Label:** Date **Unit Type:** DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Create a list of the minimum annual values for each year within the resulting data. 3. Sort all n annual values in increasing order. 4. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 5. Compute the statistical exceedence percentage value (P) for each item using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on rank. 6.The final output is the list of: P, the min annual values in sorted ascending order, rank, and date of the value.

Annual Avg Frequency Curve

	Annual Avg Frequency Curve
Input Slot(s)	1 series slot
Column 0	**Label:** Avg exceedence frequency in percent of years **Unit Type:** Fraction
Column 1	**Label**: [Name of input slot] **Unit Type:** [Unit Type of input slot]
Column 2	**Label:** Rank **Unit Type:** None
Column 3	**Label:** Date **Unit Type:** DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Create a list of the average annual values for each year within the resulting data. 3. Sort all n annual values in decreasing order. 4. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 5. Compute the statistical exceedence percentage value (P) for each item using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on rank. 6. The final output is the list of: P, the avg annual values in sorted descending order, rank, and date of the value.

Monthly Maximums By Year

	Monthly Maximums By Year
Input Slot(s)	1 series slot
Column 0	**Label:** Year **Unit Type:** DateTime
Columns 1 - 12	**Label**: [Month] Max **Unit Type:** [Unit Type of input slot]
Column 13	**Label**: Annual Max **Unit Type:** [Unit Type of input slot]
Final Rows	**Labels**: Maximum, Minimum, Average (of the columns) **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and track and save the maximum value for each month and for each year. 3. Generate average maximum values for each month across all years and for the annual maximum across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's maximum, and an annual maximum column.

Monthly Minimums By Year

	Monthly Minimums By Year
Input Slot(s)	1 series slot
Column 0	**Label:** Year **Unit Type:** DateTime
Columns 1 - 12	**Label**: [Month] Min **Unit Type:** [Unit Type of input slot]
Column 13	**Label**: Annual Min **Unit Type:** [Unit Type of input slot]
Final Rows	**Labels**: Maximum, Minimum, Average (of the columns) **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and track and save the minimum value for each month and for each year. 3. Generate average minimum values for each month across all years and for the annual minimum across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's minimum, and an annual minimum column.

Monthly Averages By Year

	Monthly Averages By Year
Input Slot(s)	1 series slot
Column 0	**Label:** Year **Unit Type:** DateTime
Columns 1 - 12	**Label**: [Month] Avg **Unit Type:** [Unit Type of input slot]
Column 13	**Label**: Annual Avg **Unit Type:** [Unit Type of input slot]
Final Rows	**Labels**: Maximum, Minimum, Average (of the columns) **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and calculate and save the average value for each month and for each year. 3. Generate averages from the average values for each month across all years and for the annual average value across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's average, and an annual average column.

Monthly Totals By Year

Note: Totals generated by this function may not make sense for some slots (i.e, flow or storage).

	Monthly Totals By Year
Input Slot(s)	1 series slot
Column 0	**Label:** Year **Unit Type:** DateTime
Columns 1 - 12	**Label**: [Month] Tot **Unit Type:** [Unit Type of input slot]
Column 13	**Label**: Annual Tot **Unit Type:** [Unit Type of input slot]
Final Rows	**Labels**: Maximum, Minimum, Average (of the columns) **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Iterate the data and track and save the total value for each month and for each year. 3. Generate average total values for each month across all years and for the annual total across all years. 4. The final output is a row for each year and final rows for maximums, minimums, and averages across all the years. Columns are the date for the year, a column for each month's total, and an annual total column.

Monthly Medians By Year

	Monthly Medians By Year
Input Slot(s)	1 series slot
Column 0	**Label:** Year **Unit Type:** DateTime
Columns 1 - 12	**Label**: [Month] Med **Unit Type:** [Unit Type of input slot]
Column 13	**Label**: Annual Med **Unit Type:** [Unit Type of input slot]
Final Rows	**Labels**: Maximum, Minimum, Average (of the columns) **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. For each set of data for that month and year, sort the data and select the "middle" value, If there are an even number of values, the median is the mean of two middle values. 4. The final output shows: • A row for each year and a column for each month. • The final column is the median of all values in the year, not just the values for that row. • The final rows show the maximums, minimums, and means across all the years of the median data in the column.

Partial Duration Max Frequency Curve

	Partial Duration Max Frequency Curve
Input Slot(s)	1 series slot
Column 0	**Label:** Max exceedence frequency in percent **Unit Type:** Fraction
Column 1	**Label**: [Name of input slot] **Unit Type:** [Unit Type of input slot]

	Partial Duration Max Frequency Curve
Column 2	**Label:** Rank **Unit Type:** None
Column 3	**Label:** Date **Unit Type:** DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. If user has specified a base value, use it in the call to the partial duration calculation and present all the results generated. 3. If not a user-supplied base value, sort the input values in decreasing order and assume a base equal to the value at position (number of years of input data plus one). Make successive calls to the partial duration calculation with decreasing base values until the number of results equals or exceeds the number of years of data in the input slot. 4. The partial duration calculation tabulates the largest values that are greater than the base value, which are separated by events less than the base value. 5. Sort all n result values in decreasing order. 6. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 7. Compute the statistical exceedence percentage value (P) for each item. For the top half of items, use the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others in the top half are interpolated between these two based on rank. For the bottom half of items, use the formula: $\frac{2m-1}{2n}$ 8. The final output is the list of: P, the max partial duration values in sorted descending order, rank, and date of the value.

Partial Duration Min Frequency Curve

	Partial Duration Min Frequency Curve
Input Slot(s)	1 series slot
Column 0	**Label:** Min exceedence frequency in percent **Unit Type:** Fraction
Column 1	**Label**: [Name of input slot] **Unit Type:** [Unit Type of input slot]

	Partial Duration Min Frequency Curve
Column 2	**Label:** Rank **Unit Type:** None
Column 3	**Label:** Date **Unit Type:** DateTime
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. If user has specified a base value, use it in the call to the partial duration calculation and present all the results generated. 3. If not a user-supplied base value, sort the input values in increasing order and assume a base equal to the value at position (number of years of input data plus one). Make successive calls to the partial duration calculation with increasing base values until the number of results equals or exceeds the number of years of data in the input slot. 4. The partial duration calculation tabulates the smallest values that are less than the base value, which are separated by events greater than the base value. 5. Sort all n result values in increasing order. 6. Assign a rank to each sorted item from 1 to n. The rank of the item is m. For the largest slot value, m=1. For the smallest slot value, m=n. 7. Compute the statistical exceedence percentage value (P) for each item. For the top half of items, use the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others in the top half are interpolated between these two based on rank. For the bottom half of items, use the formula: $\frac{2m-1}{2n}$ 8. The final output is the list of: P, the min partial duration values in sorted ascending order, rank, and date of the value.

Value Duration Max Frequency Curve

	Value Duration Max Frequency Curve
Input Slot(s)	1 series slot

	Value Duration Max Frequency Curve
Column 0	**Label:** Max exceedence frequency in percent of years **Unit Type:** Fraction
Columns 1 - N	**Label**: [Duration represented by column] **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Determine the durations to use in calculation based on timestep of input slot. Currently only implemented for day (1, 2, 3, 5, 7, 19, 15, 60, 90 and 365 day) and month (1, 2, 3, 4, 6 and 12 month) 3. Loop for each duration. 4. For each year, average the slot values over the duration starting with timestep 1, then starting with timestep 2, etc. to generate a set of values over this duration for the year. Take the maximum of this set of values and record this as the single result for the year. 6. Sort all the result values (one for each year) in decreasing order and present as a column of results for this duration. 7. Move on to the next duration. 4. Assign a rank to each row of results from 1 to n. 5. Compute the statistical exceedence percentage value (P) for each row using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on row rank. 6. The final output is the list of: P and a column of results for each duration used.

Value Duration Min Frequency Curve

	Value Duration Min Frequency Curve
Input Slot(s)	1 series slot

	Value Duration Min Frequency Curve
Column 0	**Label:** Min exceedence frequency in percent of years **Unit Type:** Fraction
Columns 1 - N	**Label**: [Duration represented by column] **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Determine the durations to use in calculation based on timestep of input slot. Currently only implemented for day (1, 2, 3, 5, 7, 19, 15, 60, 90 and 365 day) and month (1, 2, 3, 4, 6 and 12 month) 3. Loop for each duration. 4. For each year, average the slot values over the duration starting with timestep 1, then starting with timestep 2, etc. to generate a set of values over this duration for the year. Take the minimum of this set of values and record this as the single result for the year. 6. Sort all the result values (one for each year) in increasing order and present as a column of results for this duration. 7. Move on to the next duration. 4. Assign a rank to each row of results from 1 to n. 5. Compute the statistical exceedence percentage value (P) for each row using the formula: $P_1 = 1 - 0.5^{1/n}$; $P_n = 1 - P_1$; P for all others interpolated between these two based on row rank. 6. The final output is the list of: P and a column of results for each duration used.

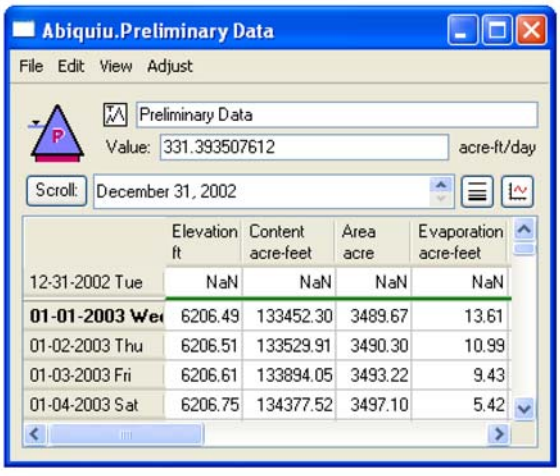
Value Duration Avg Frequency Curve

	Value Duration Avg Frequency Curve
Input Slot(s)	1 series slot

	Value Duration Avg Frequency Curve
Column 0	**Label:** Avg exceedence frequency in percent of years **Unit Type:** Fraction
Columns 1 - N	**Label**: [Duration represented by column] **Unit Type:** [Unit Type of input slot]
Algorithm	1. Filter the input data from the input slot per the user's specifications. 2. Determine the durations to use in calculation based on timestep of input slot. Currently only implemented for day (1, 2, 3, 5, 7, 19, 15, 60, 90 and 365 day) and month (1, 2, 3, 4, 6 and 12 month) 3. Loop for each duration. 4. For each year, average the slot values over the duration starting with timestep 1, then starting with timestep 2, etc. to generate a set of values over this duration for the year. Take the average of this set of values and record this as the single result for the year. 6. Sort all the result values (one for each year) in decreasing order and present as a column of results for this duration. 7. Move on to the next duration. 4. Assign a rank to each row of results from 1 to n. 5. Compute the statistical exceedence percentage value (P) for each row using the formula: $P_1 = 1 - 0.5^{1/n}$; P_n = 1 - P_1 ; P for all others interpolated between these two based on row rank. 6. The final output is the list of: P and a column of results for each duration used.

Table Series Slot

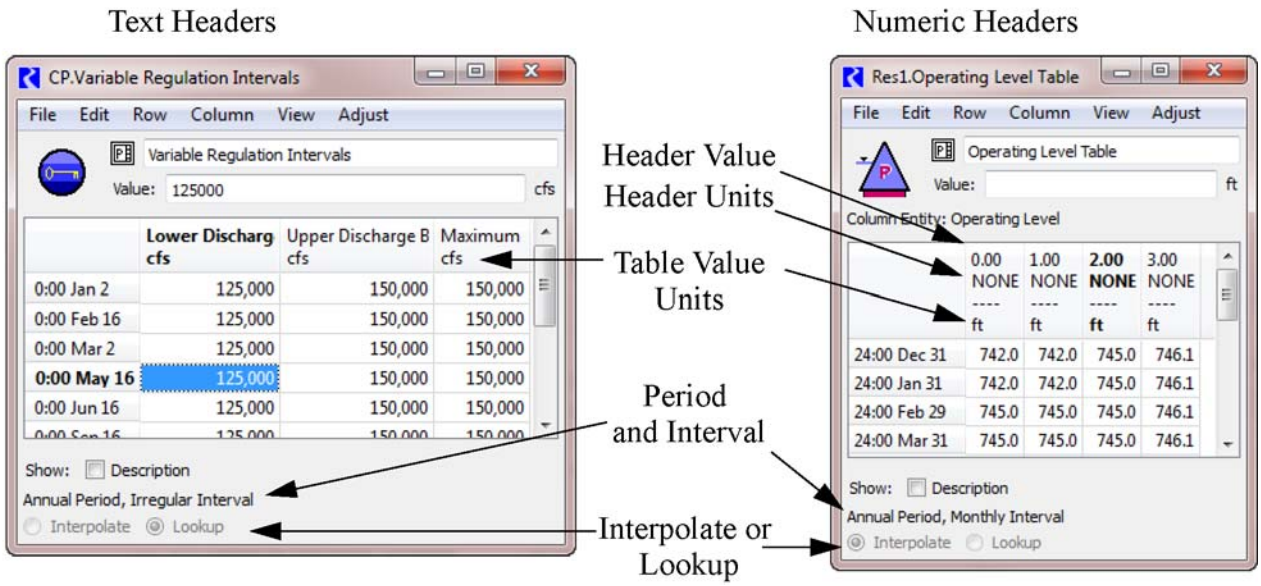
Table Series Slots are a specialized table slot whose rows correspond to timesteps. This slot contains limited timeseries functionality thus making it more efficient than Series Slots. It was created as a way to efficiently write and/or read large amounts of data. Table Series Slots are primarily used within object user methods such as the Muskingum Cunge hydraulic routing methods. These types of slots cannot be created as custom slots.



Periodic Slots

Periodic slots are tables used to represent periodic data which repeats at regular time interval. An example might be a set of evaporation coefficients for a reservoir. The rate of evaporation varies with such factors as temperature and wind speed, factors which vary seasonally. It is natural to assume that this variation is the same for each year. If this sort of data were entered into a series slot, then the same data would need to be repeated every year. This would be impractical and inconvenient for the user. On the other hand, if this data were entered in to a table slot, then the data would lose the time element associated with each value. This would make it difficult to look up or interpolate values with respect to time. The periodic slot solves both of these problems.

Figure 5.23



Configuration Options

Periodic slots are configured in the same way as other slots, by using the **View**, then **Configure** menu.

The upper left portion of the Configure Slot dialog, under the Period section, is used to set the period and interval of the periodic slot. The period can range from 6-hours to several years while the interval depends on the period selected. If the period required is more than 1 year, the **Qty** value should be modified from 1 to the number of years and the **Base** year—the first year in the period—should be defined. Base year can be specified explicitly or symbolically using the menu. If not specified explicitly, they must be edited to become valid, e.g. by replacing the "N" with a nonnegative integer or "YYYY" with a year. Text below the editor field indicates the actual year or indicates the entry is invalid. The **Help** button provides more information on legal DateTimes.

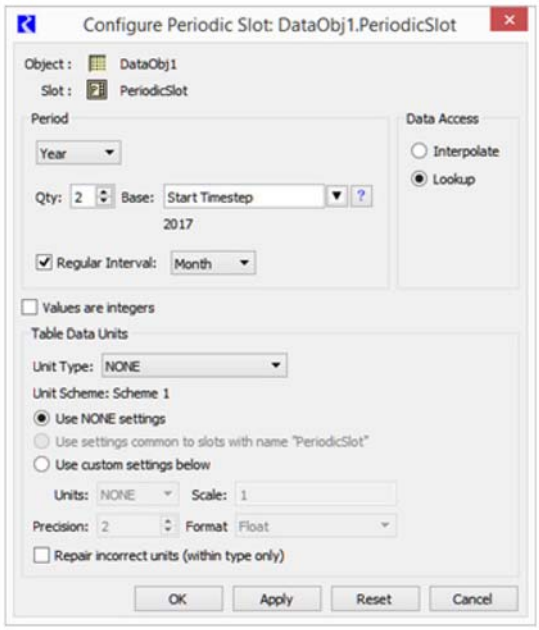
Also notice the checkbox next to **Regular Interval**. If the data interval is not a consistent length of time, the user can clear this option and the periodic slot would then have an irregular interval. The user is then free to configure the rows/timesteps in any fashion. See "Display of Dates" on page 226 for details.

The Data Access section located in the upper right portion of the Configure Slot dialog is used to specify whether or not data should be interpolated or looked up directly when accessing the table at a time that is not specifically listed as a row label. For example, the monthly data is shown for the beginning of each month. If we're in the

middle of the month, should we use that same piece of data, or should we interpolate between the two months? This is a question that would need to be answered on a per model basis, however, the default behavior is a direct lookup.

> **Note:** Slots configured to Lookup use the value in the row that has a DateTime less than or equal to the desired DateTime, and the DateTime in the next row is greater than the desired DateTime. Slots configured to Interpolate, perform a linear interpolation using values whose rows' DateTimes bound the desired DateTime.

Columns can be added/deleted by selecting a column and using the **Column** menu.



Display of Dates

The rows of a periodic slot represent dates and are displayed differently if the interval is Regular or Irregular. This distinction in dates is described below.

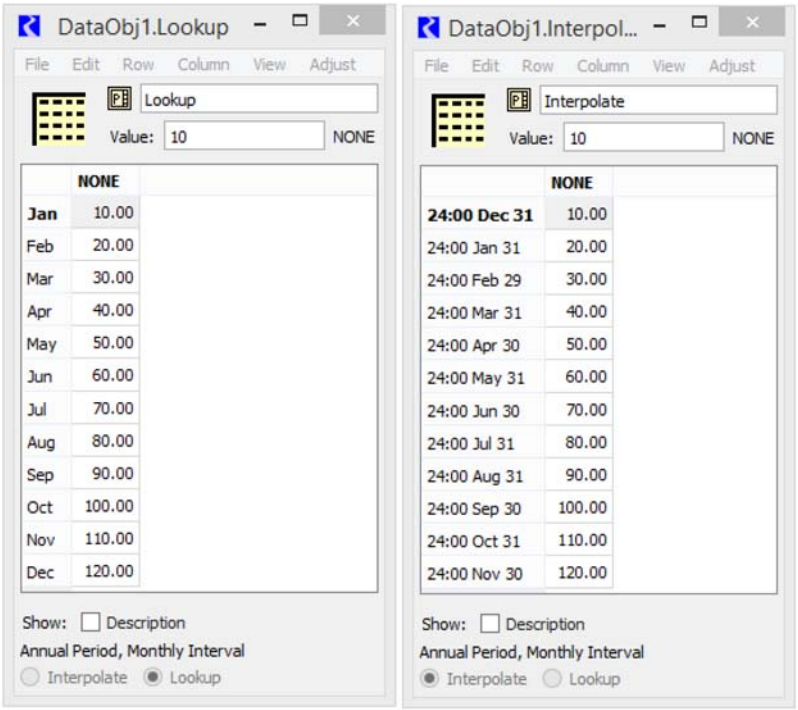
Regular Intervals

Regular Interval periodic slots only show enough information to identify the date. The display is different if the slot is configured to Lookup or Interpolate. When the slot is configured to Lookup, the rows only show the part of the date the changes from one row to the next. Thus, if it is a 1 Month interval, only the month is shown not the hour or day. If it is a 1 Day interval with a 1 Year period, only the day number is shown.

For periodic slots that are configured to Interpolate, the date represents an instant in time that corresponds to the end of a timestep. Thus, for a 1 Month interval, the dates are 24:00 Dec 31, 24:00 Jan1, etc.

> **Note:** Feb 29 is shown in this case but actually behaves as though it is 0:00 March 1.

shows screenshots of a periodic slot that has a Regular Interval of 1 Month.



A. Regular Interval - Lookup B. Regular Interval - Interpolate

When a new periodic slot (Text Headers) is added, this is how it appears. The following table shows some sample results for the slots shown using the specified DateTime.

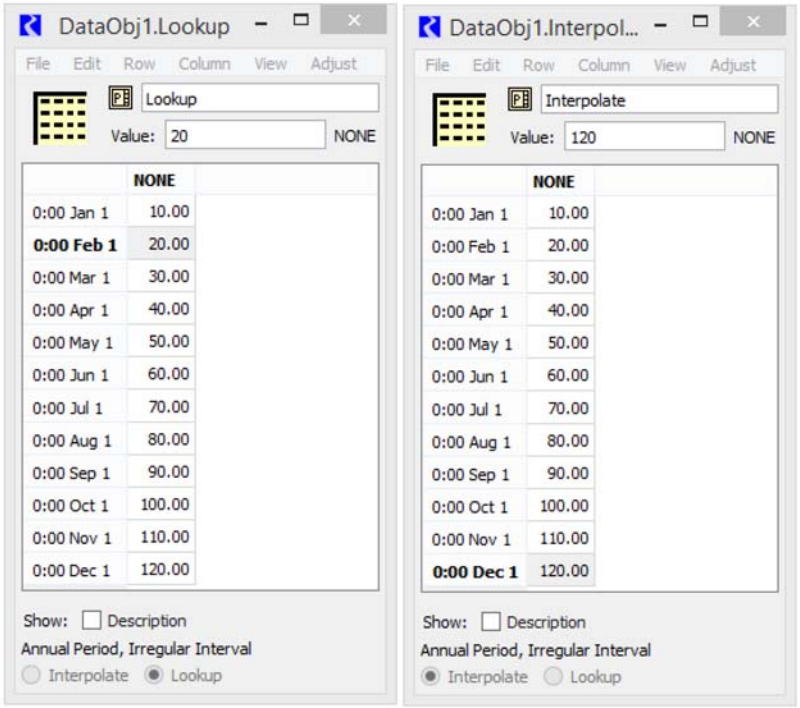
For Regular Intervals, the user cannot add or delete rows. The slot must be converted to an Irregular Interval first.

DateTime	A.Regular Interval: Lookup	B. Regular Interval: Interpolate
24:00 January 13, 2001	10	14.2
24:00 February 23, 2003	20	28.2
24:00 October 21, 2009	100	106.8

Irregular Intervals

For Irregular Intervals, the timestep displayed is an instant in time. The screenshot shows the same slots above converted to an Irregular Interval. Because they have the same rows (displayed differently), the A slots would behave the same and the B slots would behave the same.

The user can add or delete rows from periodic slots with an Irregular Interval using the **Row** menu.



A. Irregular Interval - Lookup B. Irregular Interval - Interpolate

Headers

The user can create the following types of periodic slots:

- With text headers for the columns
- With numeric headers for the columns

Text Headers

In this mode, the periodic slot simply contains columns of data that may or may not be related. There can be no interpolation across columns.To add a periodic slot with Text Headers:

1. Append a periodic slot by selecting **Slots**, then **Add Periodic Slot, Text Headers**.
2. If the columns are to be accessed using text, select **Column**, then **Set Column Label** to add a text header to each of the columns.

Columns of Periodic Slots with Text Headers can be rearranged using the **Column**, then **Move Columns** menu (custom slots only).

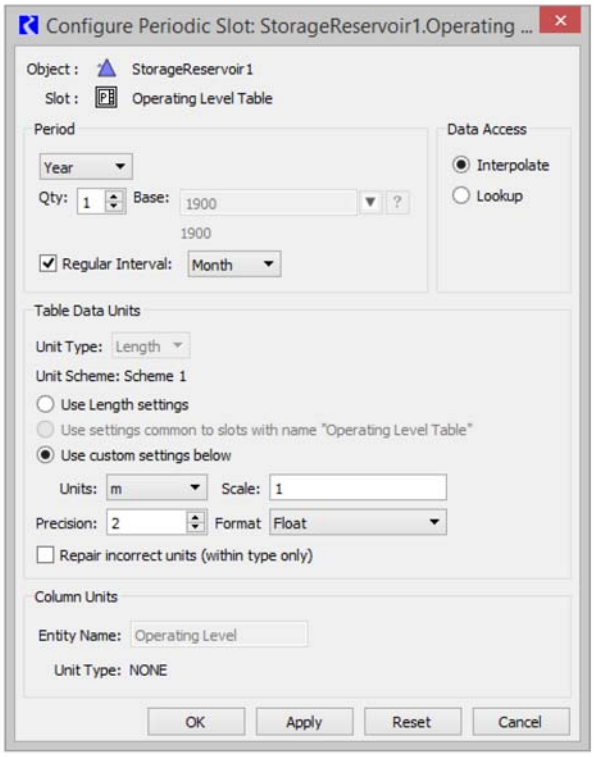
Numeric Headers

Consider a periodic slot containing loss coefficients. The periodic slot may contain loss coefficients that vary not only with time, but also with flow rate in a reach. RiverWare could identify which coefficient to use by indexing the table row using the current time step and the table columns using a flow rate. The user could specify as many

columns as necessary to sufficiently describe the variation of loss coefficients as a function of flow rate. The periodic slot's Column Units would be configured to be flow, perhaps with units of 1000 cfs.

To add a periodic slot with Numeric Headers:

1. Append a periodic slot by selecting **Slots**, then **Add Periodic Slot, Numeric Headers**.
2. Select **View**, then **Configure** to configure the periodic slot



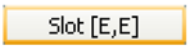
The dialog has a Column Units section. This may be useful if the columns are indexed using numeric header values and the values have some physical (not simply descriptive) significance. The unit specification uses the unit type settings for the active Unit Scheme; see "Editing Attributes" on page 95 for details.

The periodic slot can be used backwards to work from the table values and date outward to define a value associated with the column(s). For example, suppose the periodic slot defines the various pools or phases in a reservoir. The conservation pool may be defined as phase 1 with the first column containing pool elevations defining the conservation pool throughout the year. This first column would have a header of 1.0, meaning phase 1. The flood pool may be phase 2.0 with a second column using 2.0 as its header. The surcharge pool may be phase 3.0, etc. Knowing the pool elevation at a given time, the periodic slot can be used to determine the current phase. Interpolating across columns, this outward lookup may determine that the current phase is 2.5 for a given pool elevation and date, meaning pool is halfway from the bottom of flood pool to the bottom of the surcharge pool.

Referencing Periodic Slots in RPL

In RPL, periodic slots are referenced using the Slot[E, E] syntax. Like other tables, this is a row by column reference. But, because it is a periodic slot, the row is a DateTime: Slot[<DateTime>, E]. When referenced in RPL,

the configuration of the slot will be used when accessing dates that are “between rows”. That is, it will either interpolate or look up depending on the slot’s configuration.



For periodic slots with *text headers*, the column specification is a text string matching a column or the zero-based column index. For periodic slots with *numeric headers*, the column specification is a numeric value with units. You can specify any number that falls within the min and max column values. That is, you don’t have to specify an exact column’s value, but can use numeric values that are “between columns” and it will linearly interpolate for you. For example, the slot shown in Table 5.2 represents low flows that are based on reservoir levels. It is configured to lookup.

Table 5.2

	5000 ft	**5010 ft**
Jan. 1	10 cfs	20 cfs
Feb 1	40 cfs	60 cfs
March 1	60 cfs	80 cfs

In RPL, to reference this slot on January 15 for reservoir elevation 5002ft, the following would be used:

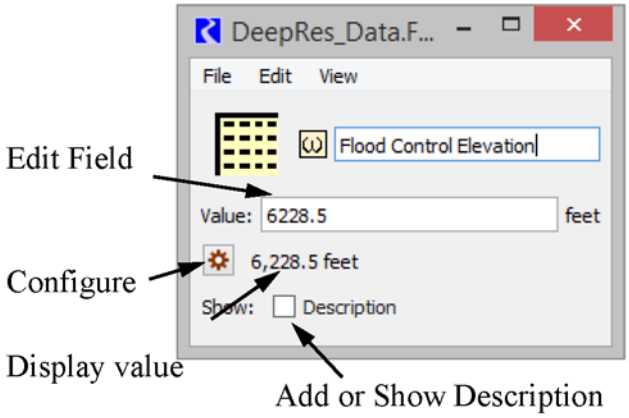
```
Slot[@“January 15,2011”, 5002 ft]
```

It would return the following:

```
12 cfs
```

Scalar Slots

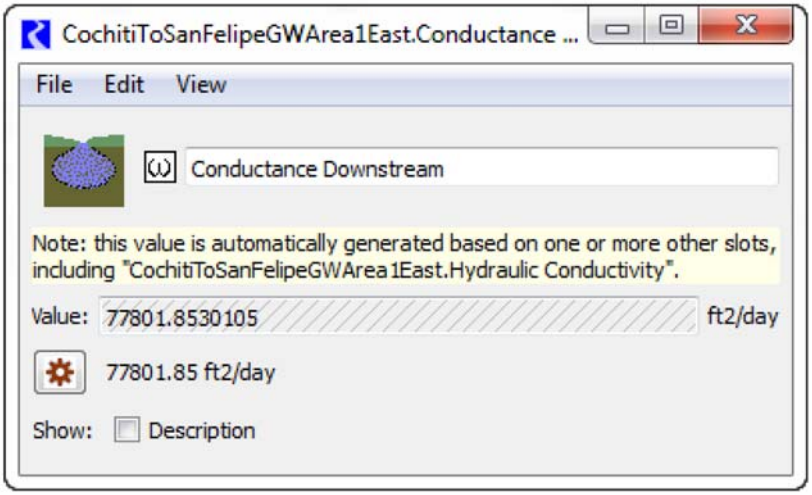
Scalar slots represent a single value. Configuration options include units and display format. Scalar slots are used only for input data parameters. See “View Menu” on page 161 for details on configuring slots, including Scalar Slots.



Some specific scalars and tables have a *Source* slot. When a slot has a source slot, the values are computed from other slot values. Thus, it becomes read-only and displays a cross hatch over the data (see Figure 5.24). It also

provides a note indicating the source slot used to compute the data. The source slot is typically set or not set at beginning of run, so the user must initialize the run to see the read-only status.

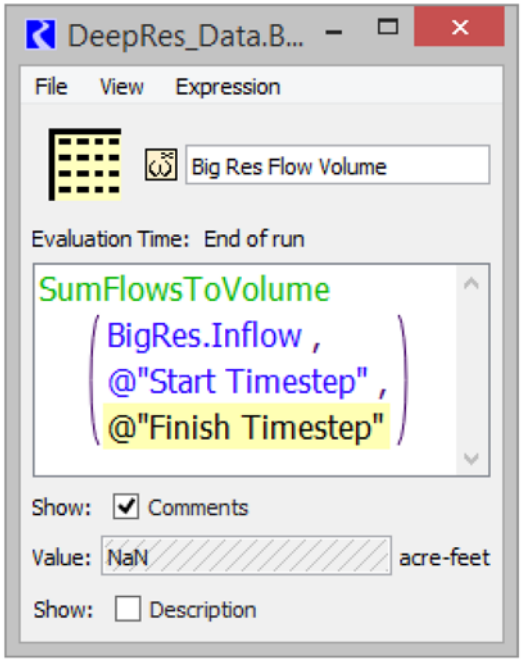
Figure 5.24



Scalar Slots With Expression

To add a Scalar slot with expression select **Slot**, then **Add Scalar Slot with Expression**. This slot, similar to the Series Slot with Expression, is used to evaluate an expression that evaluates to only one value, i.e. timestep independent. See “Series Slots With Expression” on page 193 for details on Series Slots with Expression, as that information is valid here too. The difference is that the scalar expression slot does not have an Evaluation Range, it

will evaluate for the single value only. Like the series expression slot, the user can configure when it evaluates. Use the **Expression**, then **Evaluation Time** menu to choose.



Mass Balance Summary Slots

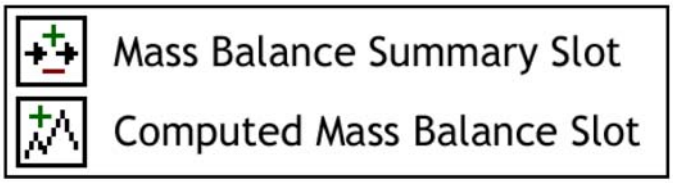
The Mass Balance Summary slot is a user-defined hierarchy of series slot collections used to check (i.e. sum) mass balance across many objects. The collections are themselves series slots representing the sum of the contained slots. These slots can be used within RPL expressions and any other place where series slots are used.

There are two levels of within a Mass Balance Summary slot:

- Water Balance. The sum of one or more Slot Sums. For example, a water balance might represent all water flowing in/out of the main channel or all flows in the groundwater.
- Slot Sum. The sum of one or more series slots. Slot sums are useful to summarize or classify different slots. For example, a Slot Sum might represent all the seepage, evaporation, diversions or return flow slots. The sum is represented as either the positive or negative sense. Negative Slot Sums are subtracted from their containing Water Balance. Positive Slot Sums are added in the containing Water Balance. Only flow/volume or mass (unit type) series slots having the model run timestep size can be used. References to RPL expression slots are supported for entities not represented by simulation slots.

Figure 5.25 shows the icons for the Mass Balance Summary Slot and the Computed Mass Balance Slots (i.e. Water Balances and Slot Sums).

Figure 5.25

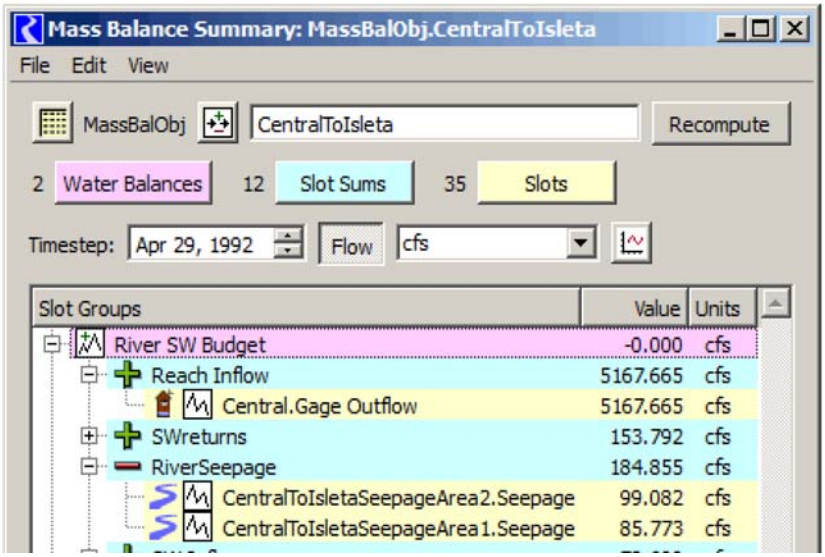


The Computed Mass Balance Slots are computed:

- On demand (by you) and/or
- At the end of a run, immediately after the evaluation of post-run RPL expression slots.

Also, a list of RPL expression slots to be evaluated after a Mass Balance Summary slot computation can be specified within the summary definition. For example, this can be used for annualization of mass balance summary results.

The screenshot shows the dialog for a Mass Balance Summary Slot. Colors are associated with the three collection levels:



The color buttons at the top of this dialog function as a legend for the three levels. Also, selecting those buttons open the tree items in the list to the corresponding level. Also individual collection items can be opened and closed in the usual way, by selecting the tree controls.

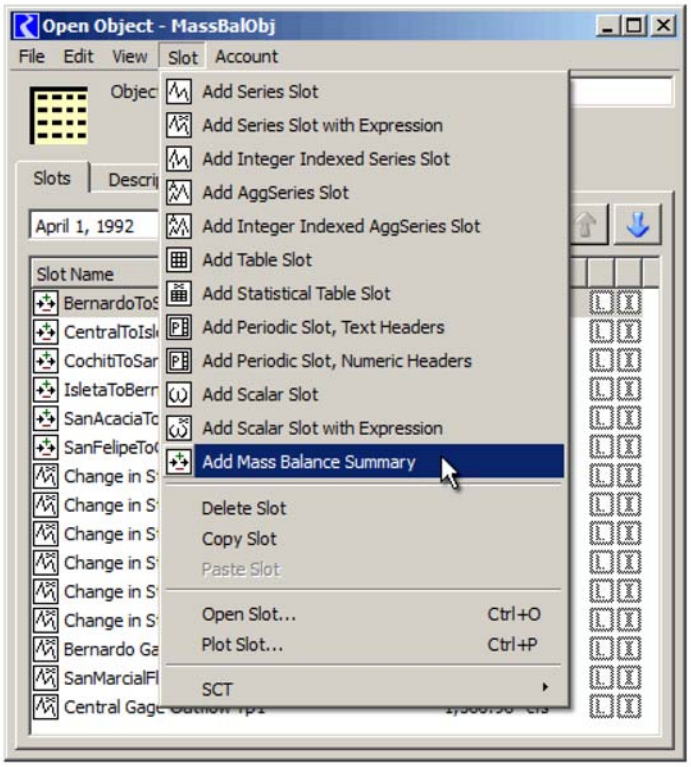
Finally, the slots can be shown in any user units and plotted as needed.

Collection Level		Backgrond Color
1	Water Balance	Pink
2	Slot Sum	Cyan
3	Slot Reference	Yellow

Creating a Mass Balance Summary Slot

A Mass Balance Summary Slot can be created by selecting the Add Mass Balance Summary operation.

The name of the new Mass Balance Slot can be edited in the dialog. When the entered name is not valid, the text in the name entry field is shown in red.

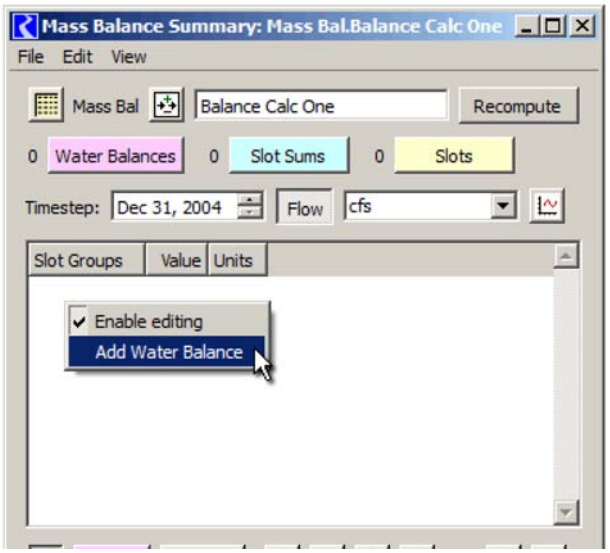


Configuring a Mass Balance Summary Slot

Editing the configuration of a Mass Balance Summary Slot can be enabled or disabled. It is initially enabled on a newly created slot. Editing can be enabled or disabled with the following controls:

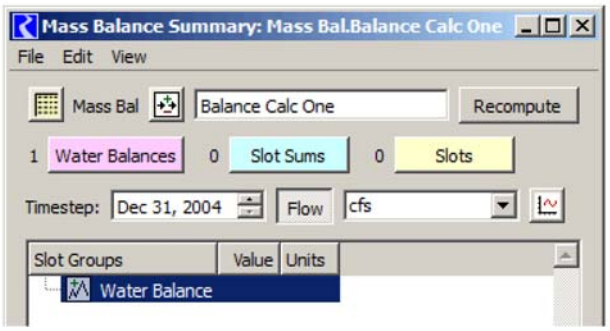
- The lock icon toggle button in the bottom left of the dialog. 
- The **Enable editing** item in the right-click context menu.
- The **Enable editing** item in the **Edit** menu.

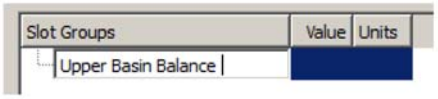
Right-clicking the list outside of any defined items (e.g. when the list is empty) shows a simple context menu including the Add Water Balance operation.

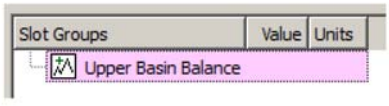


The buttons along the bottom of the dialog are also context sensitive; that is, their operation and enabledness depends on the selection within the slot list. When no items are selected, the **New** button also adds a water balance to the list.

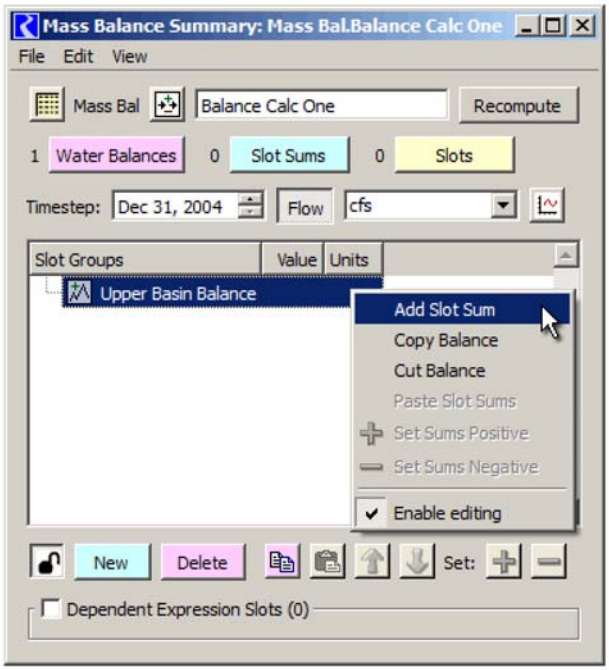
When new Water Balances or Slot Sums are created, they are given a unique default name. The name can be edited *inline* by double-clicking the name.

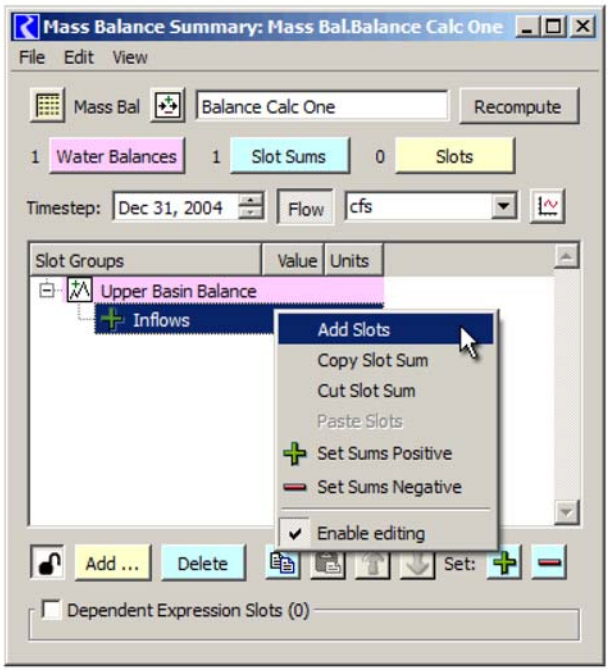






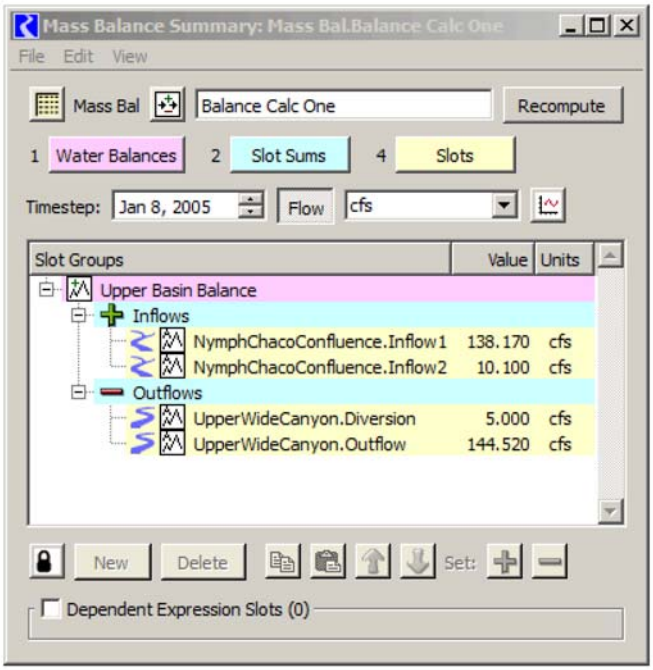
Slot Sums can be added to Water Balances, and Slot References can be added to Slot Sums using the **Add** context menu operation or the bottom context buttons.





When adding Slots, the slot selector dialog is shown. This will allow the selection of only series slots. The slot selector's unit type filter will be shown, initialized to "Flow". It is also valid to select "Volume" slots which represent a non-static volume entity; that is, those that can be converted to "Flow" by dividing its value by the

timestep interval (i.e. volume per time). (The computed results will be strange if a static volume slot, such as Reservoir Storage, is selected).



Alternatively, slots representing mass units (g, kg, tons, etc) can be chosen. This is particularly useful when looking at the salinity mass balance across many objects.

> **Note:** A Mass Balance Summary can either show Flow/Volume units or Mass units, but not both. If both types of slots are shown (or slots with any other unit type), an error will be issued when the mass balance is computed.

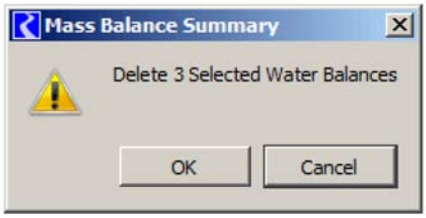
Figure 5.26 shows the operations provided by the first several buttons, as a function of the selected item or items. Tooltips on these buttons provide additional information.

Figure 5.26

	Selected Item	Operations
New Delete	None	Create new Water Balance
New Delete	Water Balance	Create New Slot Sum; Delete / Copy Water Balance
Add ... Delete	Slot Sum	Add Slot Reference; Delete / Copy Slot Sum
Add ... Remove	Slot Reference	Add Slot Reference; Remove / Copy Slot Reference

The New, Add, and Paste operations are enabled only for single-item selections. The Delete, Remove, and Copy operations are enabled on single or multiple selections when all selected items are at the same level. The

enabledness of the Paste operation depends also on the type of items (Water Balances, Slot Sums, or Slot References) in the clipboard. You must confirm Delete / Remove operations.



The **Up** and **Down** arrows move the selected items up or down within the set of "sibling" items. They are enabled only when the selected items are all at the same level.

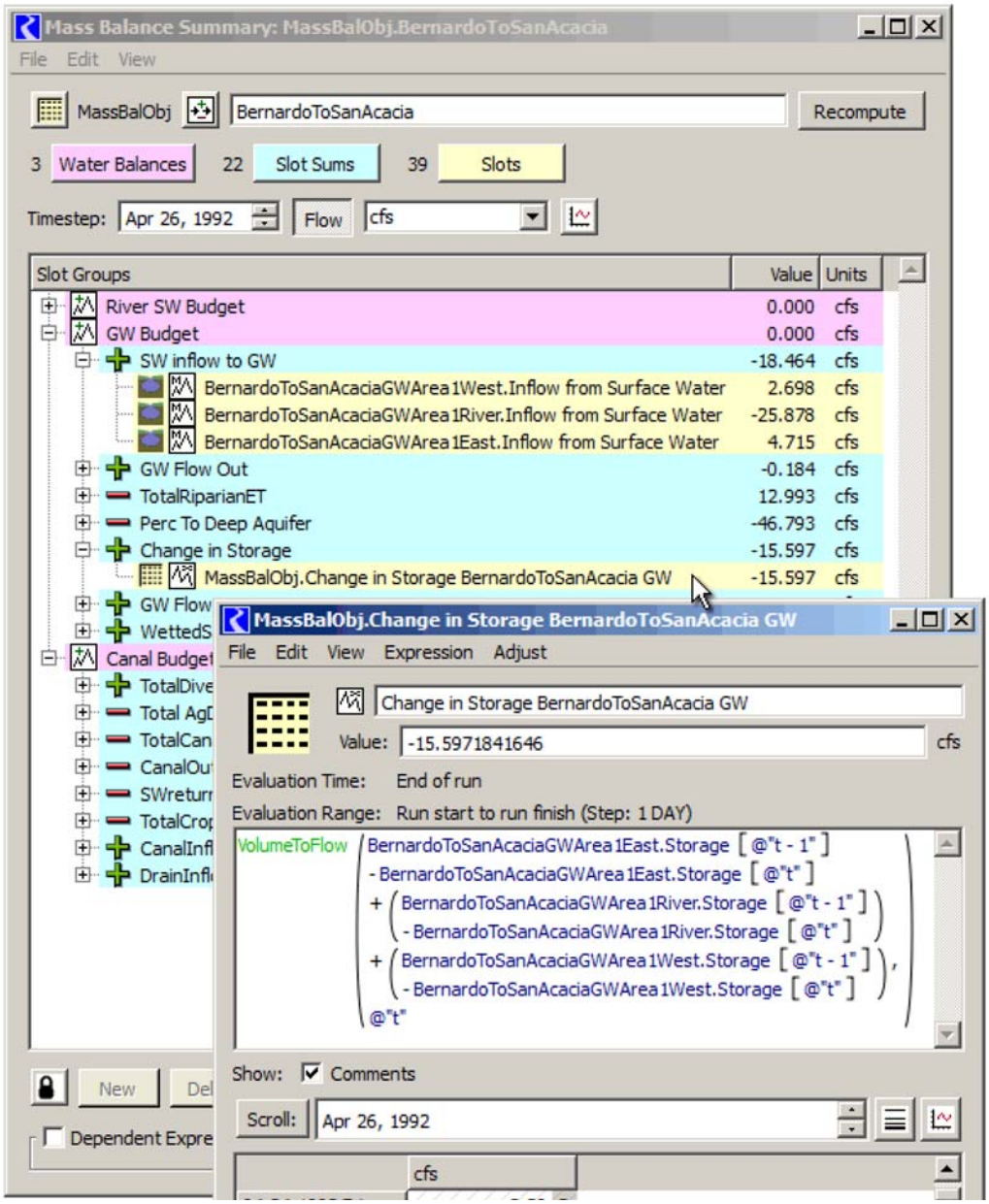
The  and  buttons affect the Slot Sums within the set of selected items.

Note: When the mass balance summary is computed, the values of positive Slot Sums are added to the containing Water Balance; the values of negative Slot Sums are subtracted.

RPL Expressions for Other Slots

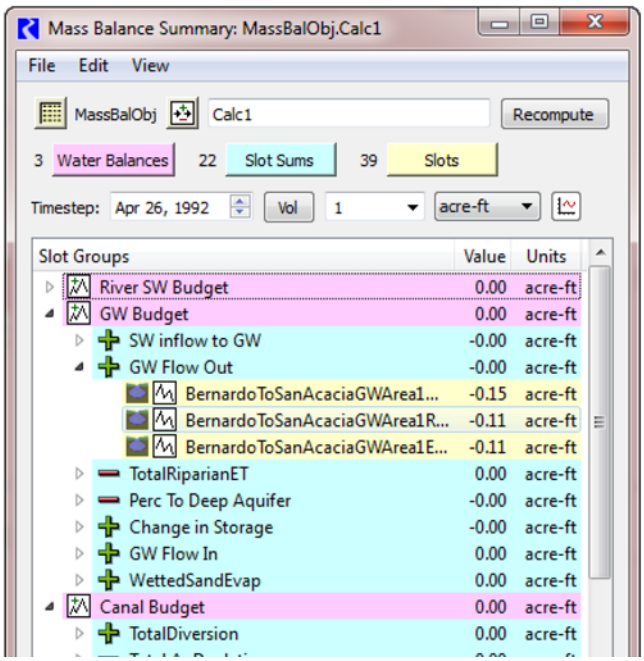
For any value not provided as a RiverWare slot, you will need to define and refer to a RPL expression slot. Figure 5.27 is an example of the inclusion of a *change in storage* expression slot from the previous to the current timestep.

Figure 5.27


Mass Balance Summary: MassBalObj.BernardoToSanAcacia
File Edit View
MassBalObj
BernardoToSanAcacia
Recompute
3 Water Balances
22 Slot Sums
39 Slots
Timestep: Apr 26, 1992
Flow
cfs
Slot Groups
Value
Units
River SW Budget 0.000 cfs
GW Budget 0.000 cfs
SW inflow to GW -18.464 cfs
BernardoToSanAcaciaGWArea1West.Inflow from Surface Water 2.698 cfs
BernardoToSanAcaciaGWArea1River.Inflow from Surface Water -25.878 cfs
BernardoToSanAcaciaGWArea1East.Inflow from Surface Water 4.715 cfs
GW Flow Out -0.184 cfs
TotalRiparianET 12.993 cfs
Perc To Deep Aquifer -46.793 cfs
Change in Storage -15.597 cfs
MassBalObj.Change in Storage BernardoToSanAcacia GW -15.597 cfs
MassBalObj.Change in Storage BernardoToSanAcacia GW
File Edit View Expression Adjust
Change in Storage BernardoToSanAcacia GW
Value: -15.5971841646
cfs
Evaluation Time: End of run
Evaluation Range: Run start to run finish (Step: 1 DAY)
VolumeToFlow
BernardoToSanAcaciaGWArea1East.Storage [@"t - 1"]
- BernardoToSanAcaciaGWArea1East.Storage [@"t"]
+ (BernardoToSanAcaciaGWArea1River.Storage [@"t - 1"] - BernardoToSanAcaciaGWArea1River.Storage [@"t"])
+ (BernardoToSanAcaciaGWArea1West.Storage [@"t - 1"] - BernardoToSanAcaciaGWArea1West.Storage [@"t"]),
@"t"
Show: Comments
Scroll: Apr 26, 1992
cfs
New
Dependent Expre

Display Operations

The Mass Balance Summary Slot dialog shows a single timestep value of all contained series slots.



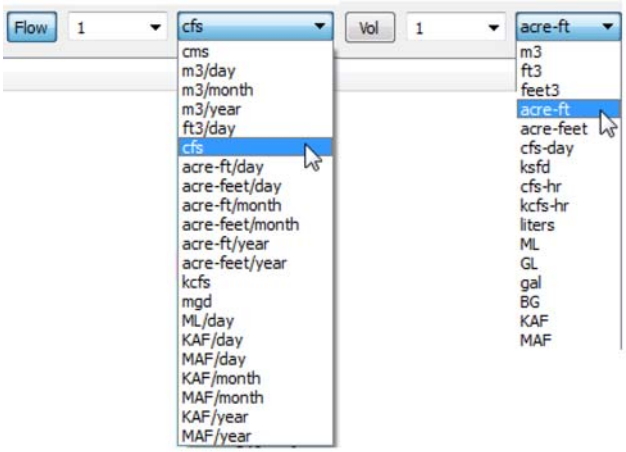
Note: All Water Balances, Slot Sums and series slot references must have the same timestep size as the model run. Water Balances and Slot Sums are computed for the model run interval (start to finish timesteps).

Units

In this dialog, series values have the following options:

- Flow or Volume units. Volume values are converted to flows by dividing by the timestep interval. The individual settings for Flow and for Volume units are separately retained. That is, selecting the **Flow and Volume** button switches between the last selected unit for those two unit types.
- Mass units. This is typically used for salinity.

Note: A Mass Balance Summary can either show Flow/Volume units or Mass units, but not both. If both types of slots are shown (or slots with any other unit type), an error will be issued when the mass balance is computed.



The selected unit type, scale and unit is both a display setting and a configuration setting; when the mass balance summary is computed, the computed slots are shown with these units. Precision can be set from the **View**, then **Set Precision** menu.

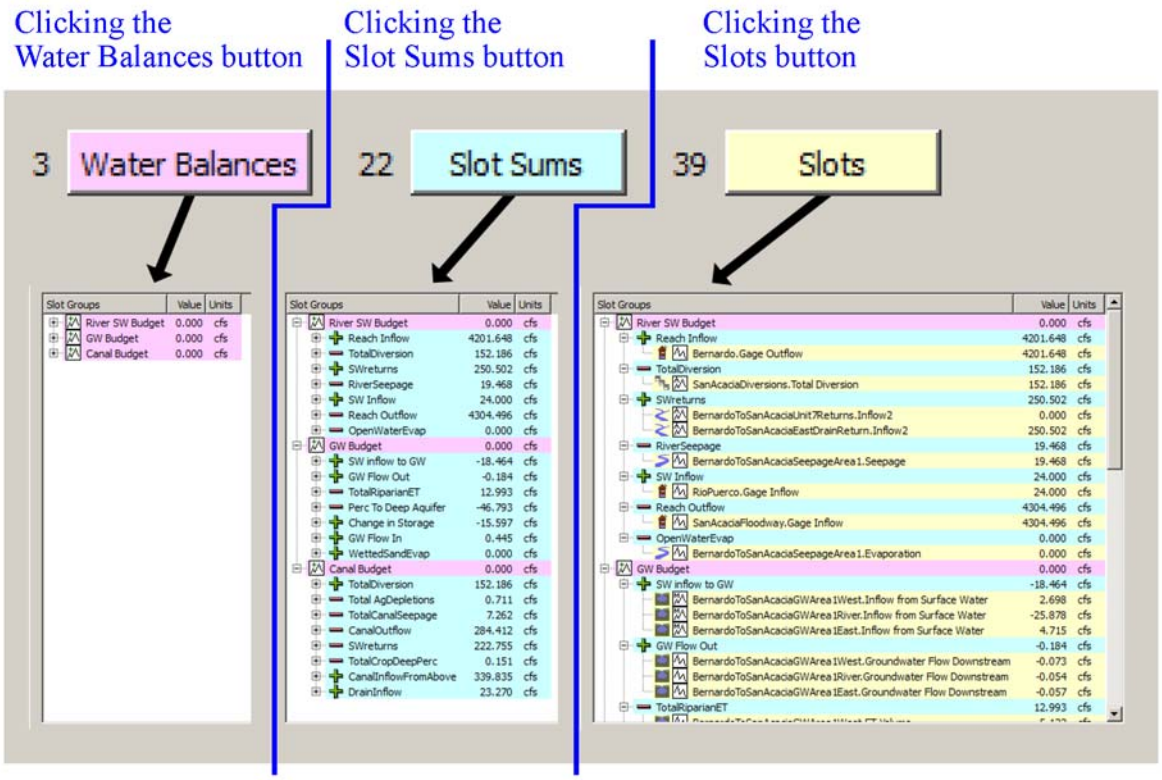
In fact, changing the unit, scale, or precision from this dialog actually changes the active Unit Scheme (by adding exceptions). You can also change the settings from the Unit Scheme Manager by changing attributes or activating a different scheme. See "Unit Schemes" on page 91 for details.

Note: When the computed results (Water Balances and Slot Sums) are referred to by RPL expressions, the units must work correctly or an error will be issued. Unit type incompatibilities will be reported by the RPL expression evaluation mechanism in the usual way.

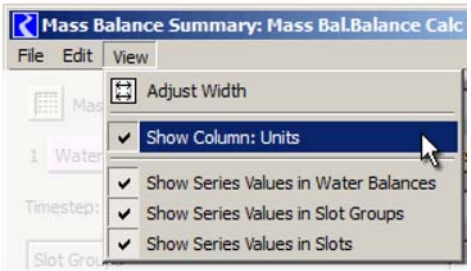
Tree Display

As previously mentioned, the level **Legend** buttons function to open the entire tree to the indicated level. Of course, individual tree items can be opened or closed by selecting the standard tree controls.

Figure 5.28



The **View** menu provides operations that affect data display within this dialog.



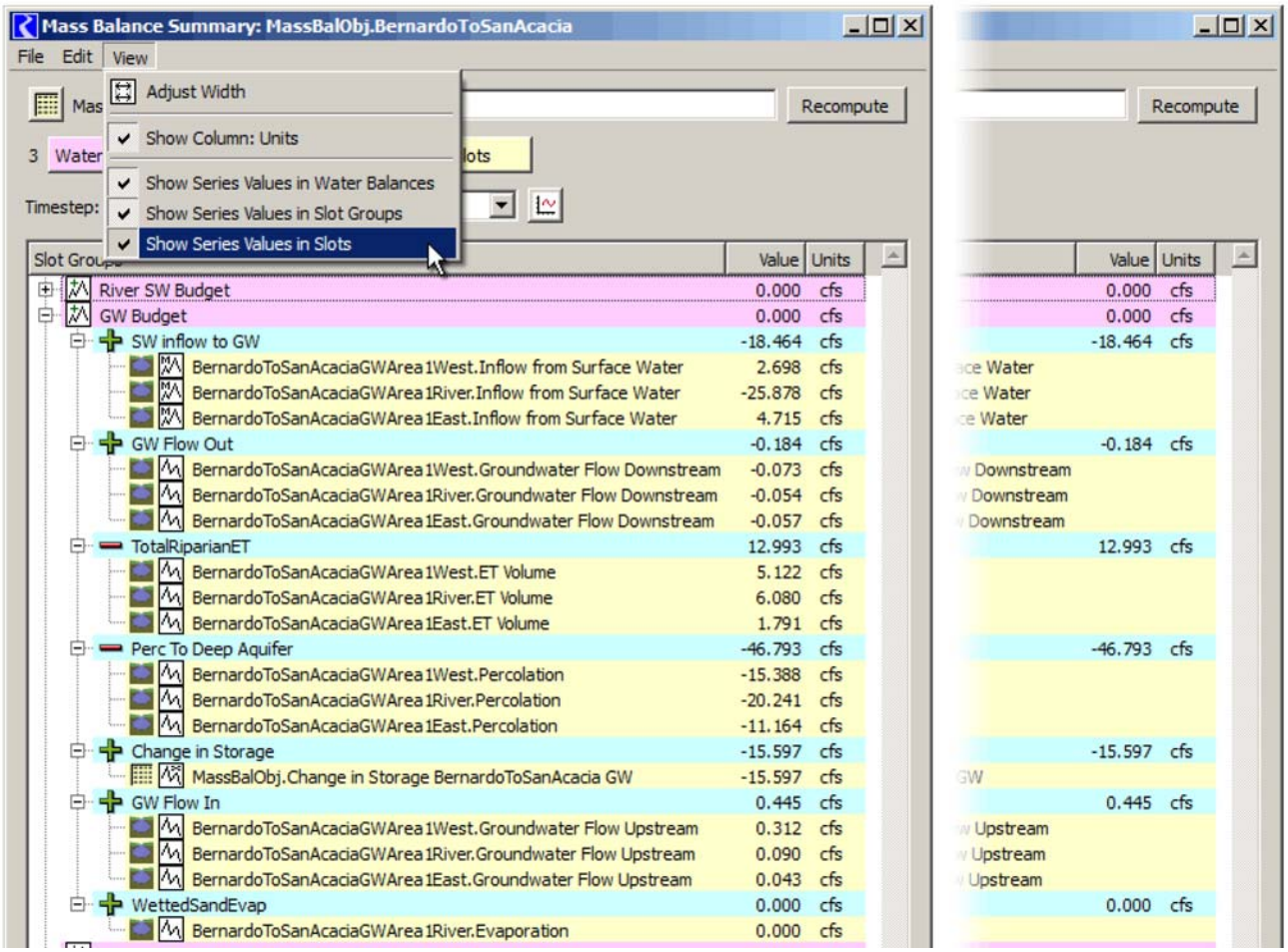
Show Column: Units

The units column in the slot list can be hidden. But, if slots having different unit types (other than flow/volume or mass) are added to the list, units are unconditionally shown and the option to hide the units column is disabled.

Show Values

You may want to hide values at any of the levels, so that only comparable values (at the same level) are displayed. The three **Show Series Values** toggles in the **View** menus are used to show or hide the numeric values; Figure 5.29 illustrates.

Figure 5.29



Other Display Operations

From the Open Mass Balance Summary Slot dialog, you can perform the following operations:

- Show selected slots in an open slot dialog.
- Show slots in a new SCT or in the single open SCT. You can show either the visible (in the tree), or only the selected slots.
- Plot the selected slots.
- Copy selected slots, e.g. to an Output Device or to the Snapshot Manager.

These options are described in the following sections.

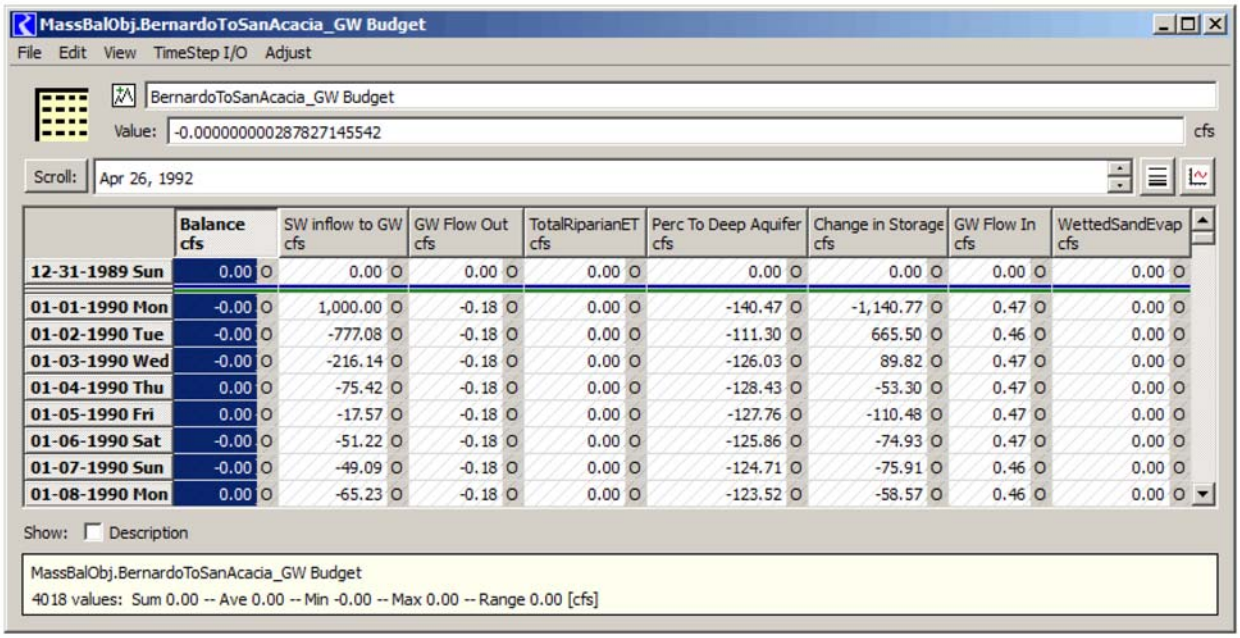
Show Computed Slots in an Open Slot Dialog

As currently implemented, Water Balances are generated as aggregate series slots and each of the Water Balance's Slot Sums are generated as series slot columns on that aggregate. Use the **Open Slots c**ontext menu to show the slot dialog for the selected component (editing disabled).

Note: There is currently no indication of the Slot Sums' "sense" being positive or negative.

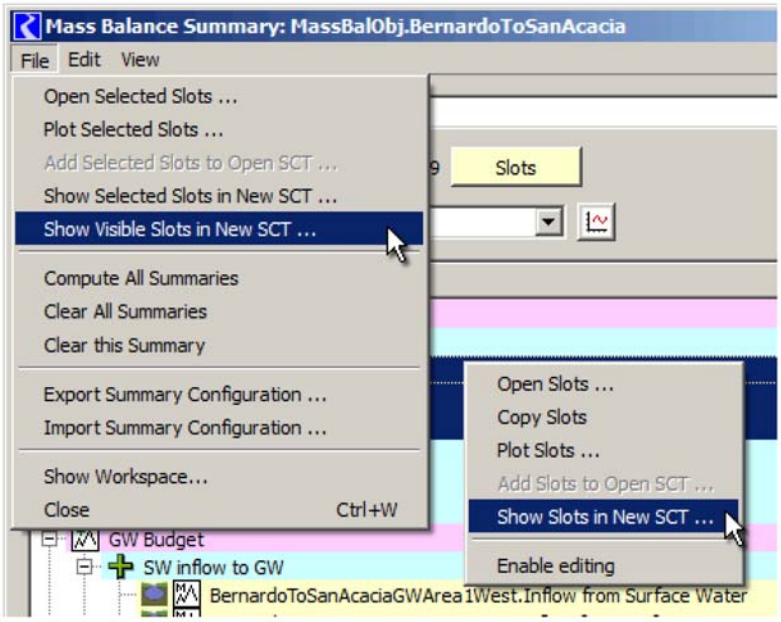
Values are displayed with a crosshatch indicating that they are "read-only" (non-editable). In Figure 5.30, the not-quite-zero value in the "Value" line edit field from the single selected cell (upper left cell); this sort of value will be typical of actual computed Water Balance values (due to convergence). Enabling the display of the selection statistics (from the View menu) and selecting the first column provides a convenient way to determine whether or not the whole Water Balance series is zero.

Figure 5.30

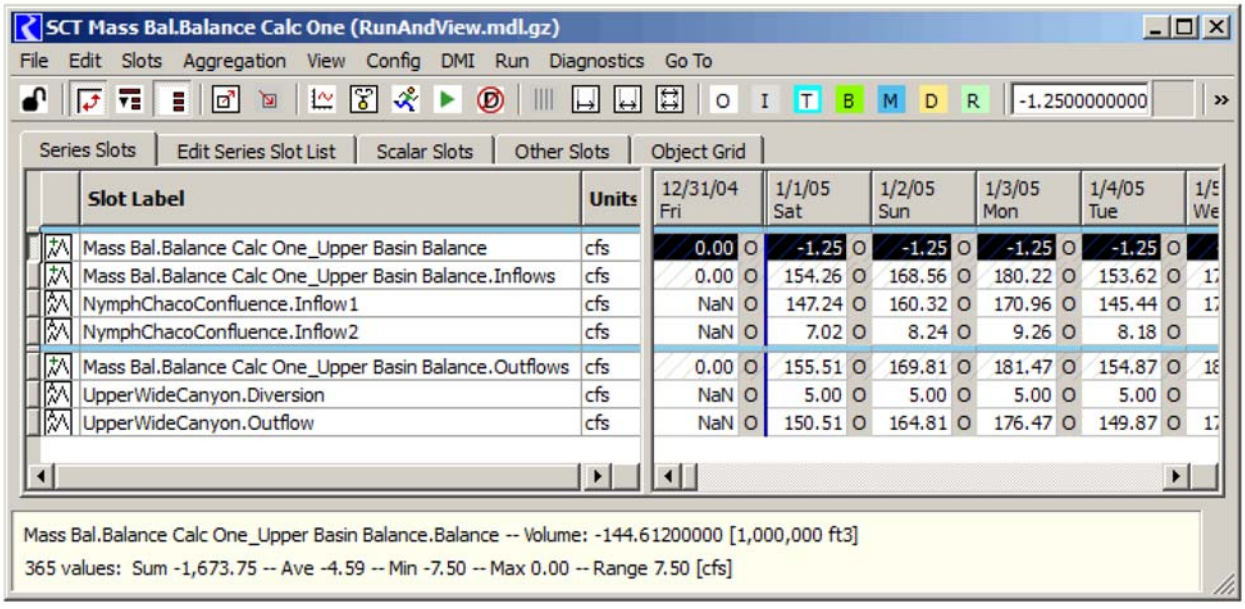


Show Slots in an SCT

Computed summary and referenced slots can be shown in an SCT. If a single SCT is open, slots from the Mass Balance Summary dialog can be *added to* that SCT (the SCT must have the same timestep size as the model run).



The **File** menu **Show Visible Slots in New SCT** option shows all slot items current visible in the slot list (i.e. excluding those hidden under a closed tree branch).

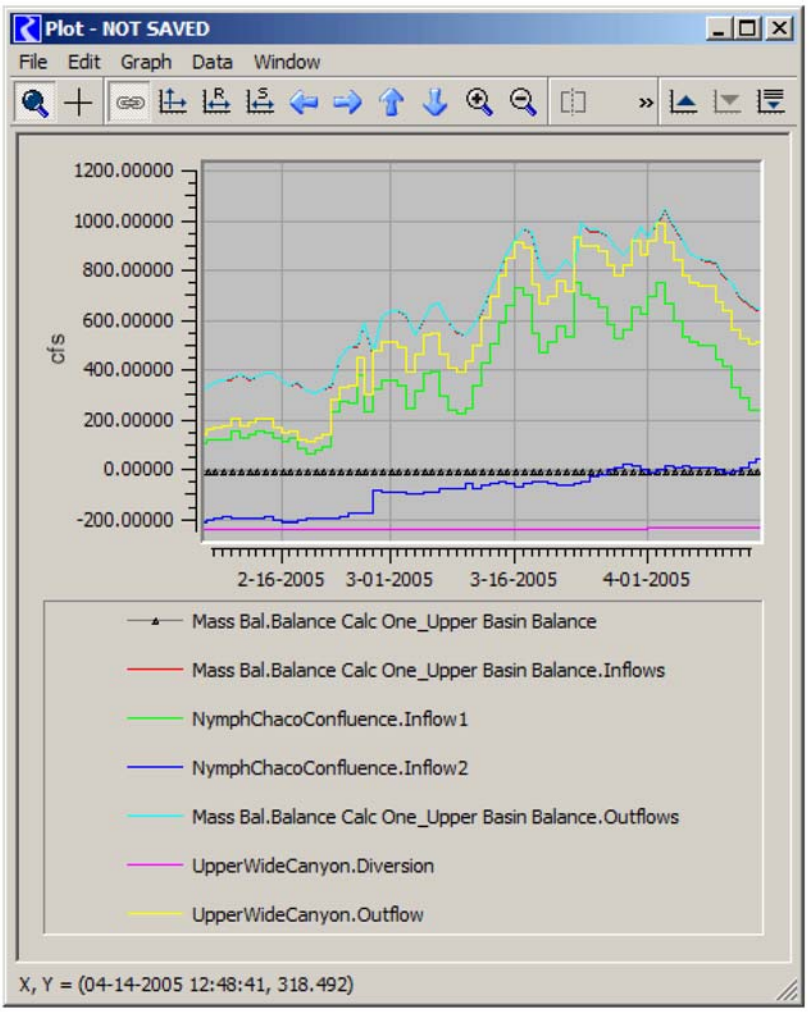


Note: Water Balance and Slot Sum slots are shown with the values and units set at the time of the most recent mass balance computation; that is, not necessarily the current unit setting in the Open Mass Balance Summary Slot dialog. If referenced slots are including in the “show in SCT” operation,

they will be shown with their currently configured (or “active”) units. And if they are editable slots, they will be editable in the SCT. (Rows that are not cross-hatched can be edited directly.

Plot Slots

Computed summary and referenced slots can be plotted in a single plot. Those operations are visible in the menus shown in the prior section. The note above regarding the active units of computed and referenced slots applies also to Plots; that is, the units used will not necessarily be those of the current settings in the Open Mass Balance Summary slot dialog.



Note: All values are plotted in their positive (actual) sense; that is, values in negated Slot Sums are not shown as negated values.

Copy Slots

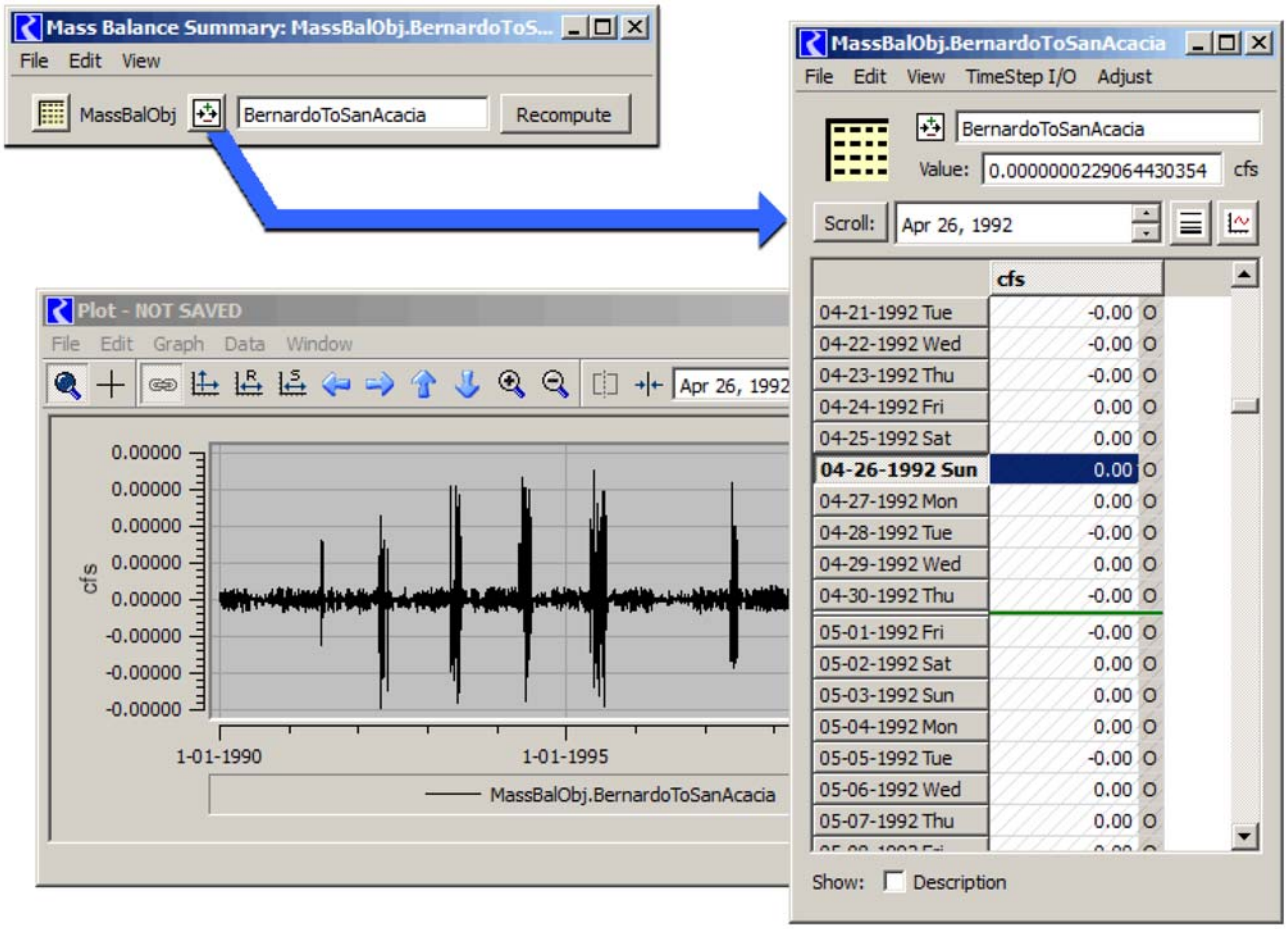
Computed summary and referenced slots can be copied to the RiverWare Slot Clipboard. From there, they can be pasted into various slot lists in RiverWare, including the general Output Device slot list and the Snapshot Manager slot list.

Examining the Mass Balance Summary Slot's Series

The Mass Balance Summary Slot is itself a series slot and can be examined by selecting the Mass Balance Summary Slot icon button at the top of the dialog. (In a sense, a Mass Balance Summary Slot has two different open slot dialogs).

In Figure 5.31, all the values represented on the vertical axis are zero (to a precision of five fractional decimal digits).

Figure 5.31

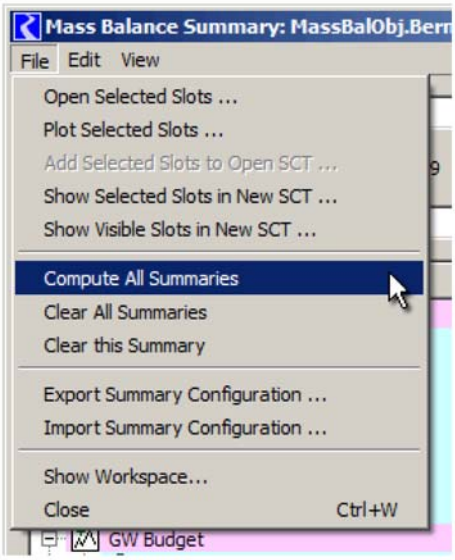


Dependent RPL Expression Slot Support

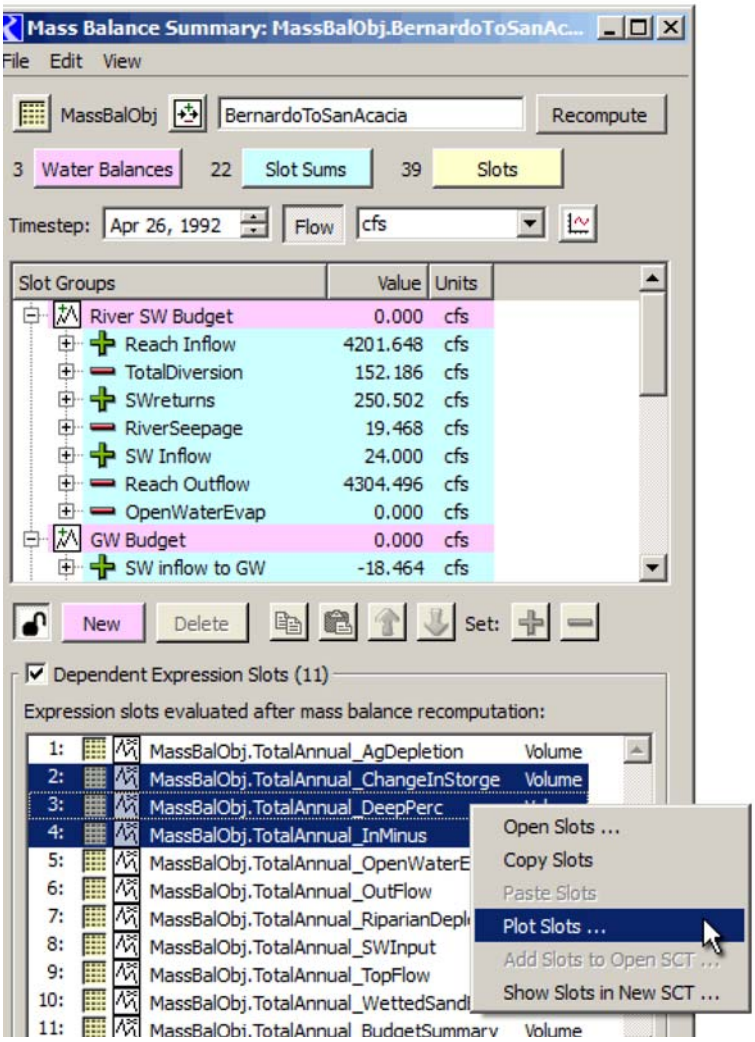
Mass Balance Summaries are designed in such a way that intermediate and final sum results (Slot Sums and Water Balances) are usable for custom user calculations implemented in RPL Expression Slots, such as annualization of values. In a run, the mass balance summary is computed after RPL Expression slots. To allow RPL expression slots to reference mass balance summary data, the Dependent Expression Slot List in a Mass Balance Summary is evaluated, in order, once, after each Mass Balance Summary is computed.

Dependent Expression Slot results will generally be incomplete when computing a Mass Balance Summary if the RPL Expression Slots in the list depends on sums from *multiple* mass balance summaries. The following provisions address this problem:

- The automatic end-of-run mass balance computations are performed in this order:
  1. The RPL Expression slots in the Dependent Expression Slot Lists in ALL Mass Balance Summaries are cleared.
  2. All Mass Balance Summaries are computed.
  3. The RPL Expression slots in the Dependent Expression Slot Lists in ALL Mass Balance Summaries are evaluated.
- In addition, in the **File** menu, there is a **Compute All Summaries** option that perform this model-wide computation (the three steps in the prior item)



The Dependent Expression Slot panel at the bottom of the Open Mass Balance Summary Slot dialog implements editing and display operations similar to those of the main slot list.



Note: If the dependent Expression Slots use a different from the model's run timestep, they can't be displayed in the same SCT as the computed summary slots and slot references.

Selecting the **Add** button opens the slot selector, initialized with Has RPL Expression and Unit Type ("Flow") filters on by default.

Computation

When computed, the timestep size and timestep range of each of the Mass Balance Summary and Slot Sums are set to the step size and range of the run controller. The unit type and configured display units are set to those specified. For each timestep in the run time range, any of the contained slots having a valid value at that timestep contributes that value to the Slot Sum or Water Balance's value at that timestep. NaNs are ignored (effectively zero). The computed slots are set to be "read-only".

Limitations of the current Mass Balance Summary Computation:

- No “routed terms”. A timestep offset cannot be applied to any slot reference within a Slot Sum, or to any Slot Sum within a Water Balance.
- No knowledge of static volumes. The mechanism unconditionally converts all volumes to flows by dividing the volume by the timestep size (for each timestep). See “RPL Expressions for Other Slots” on page 238 for a RPL implementation of the change in storage calculation.

Mass Balance Summary Computations are performed in these ways:

- By selecting **Recompute** in the Open Mass Balance Summary Slot dialog.
- By selecting **Compute All Summaries** in the **File** menu of that dialog.
- Automatically, at the end of a run, immediately after the *end-of-run* RPL Expression Slots evaluation. This is performed unconditionally.

As a tool for debugging and testing Mass Balance Summary implementations (including user definitions), operations to *clear* an individual Mass Balance Summary, and all Mass Balance Summaries (including Dependent Expression Slots) is provided in the **File** menu.

Persistence

All Mass Balance Summary configuration information is stored on the Mass Balance Summary Slot. This is applied both in the RiverWare model file and in Export files.

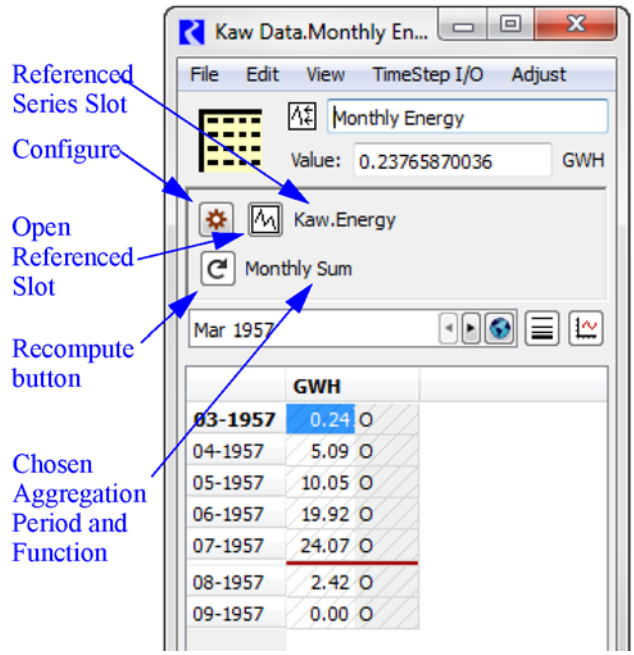
A Mass Balance Summary Slot’s computed slots are created as (effectively) invisible slots on the same object. They do show up in the slot selector!

A Mass Balance Summary Slot’s configuration can also be saved to, and read from a file using Export and Import operations in **File** menu.

Time Aggregation Series Slots

Time Aggregation Series Slots temporally aggregate another series slot. For example, you might aggregate a daily flow to an annual average. They can be recomputed manually or automatically at the end of a run. The configuration of a Time Aggregation Series Slot includes the following properties. Figure 5.32 illustrates.

Figure 5.32



- The series slot to be aggregated, chosen using the slot selector.
- The aggregation function, one of:
  - **Sum**. Add the values during the aggregation period.

$$\text{Sum} = \sum_{i=\text{first timestep}}^{i=\text{last timestep}} \text{Value}_i$$

Note: For slots with a rate unit type (flow or velocity), a true sum does not make sense and is therefore not an option in the menu. Instead, use the average which represents a time weighted average. Change the display units as needed to see the values desired.

  - **Average**. Report the mean during the aggregation period.

$$Average = \frac{\sum_{i=\text{first timestep}}^{i=\text{last timestep}} Value_i \times \Delta t_i}{\sum_{i=\text{first timestep}}^{i=\text{last timestep}} \Delta t_i}$$

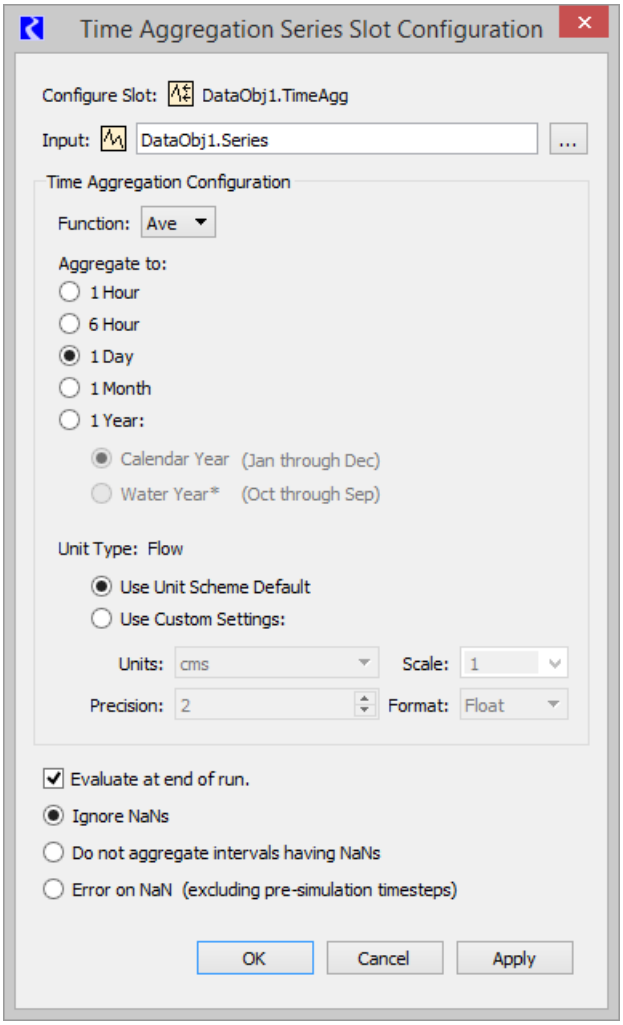
  - **Minimum**. The smallest value (in units displayed) in the aggregation period is reported.
  - **Maximum.** The largest value (in units displayed) in the aggregation period is reported.
  - **First value**. The first value in the aggregation period is reported.

  - **Last value**. The last value in the aggregation period is reported.
- Choice of aggregation period, as follows:
  - 1 Hour
  - 6 Hour
  - 1 Day
  - 1 Month
  - 1 Year, Calendar Year
  - 1 Year, Water Year*
- The **Units** you wish to show, including display unit, scale, precision, and format.
- If you wish to evaluate them at end of run.
- What to do when encountering NaN.

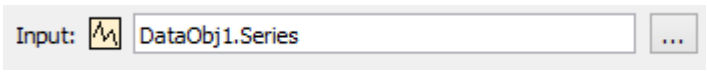
Functionality is provided to duplicate a Time Aggregation Series Slot for the same named slot on multiple other "similar" objects.

Configuration Settings

Once created (from the Object's **Slot**, then **Add Time Aggregation Series Slot** menu), open the slot dialog to configure the slot. Configuration controls are available in a separate dialog which is shown by selecting the **Configure** icon  .



1. Select the slot to aggregate using the **Input** field.

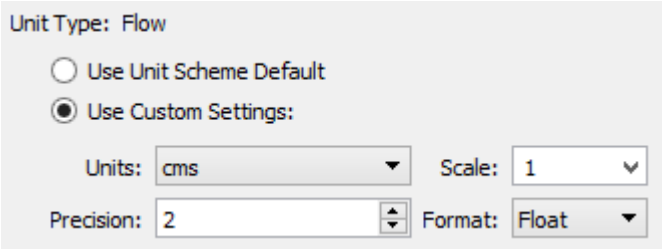


2. Select the aggregation function; use the **Function** menu to select the aggregation function to be used. See "Time Aggregation Series Slots" on page 250 for details on the functions.
3. Select one of the following the aggregation periods (only aggregation periods larger than the source slot's timestep are available):
   - **1 Hour**
   - **1 Day**

- **6 Hour**
- **1 Month**
- **1 Year - Calendar Year**
- **1 Year - Water Year***

4. Hover over the Water Year text to display a tooltip. See "Annual Aggregation Support for Non-calendar Water Years" on page 255 for details on Water Year.
5. Then choose the **Units** to show for the aggregated data. The Unit Type is fixed to the Unit Type of the referenced series slot. But you can specify any display units to use. For example, you can show daily flows in cfs averaged as monthly values, displayed in acre-feet/month. The options are as follows:
   - **Use Unit Scheme Default**. When this is selected, the unit scheme specification, including any slot name exceptions will be used. See "Standard Units" on page 89 for details on Unit Schemes.
   - **Use Custom Settings.** When selected, specify the units directly in this dialog.

     Note: This will actually make a Slot Exception in the Unit Scheme with the specified units.

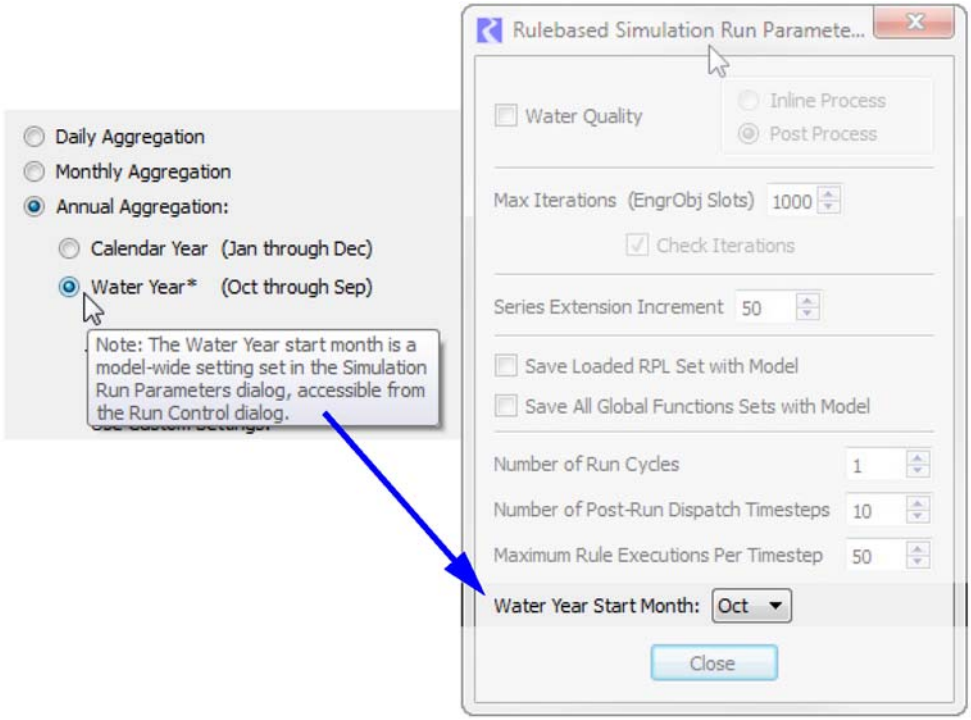


6. Optionally, enable automatic end of run evaluations. The **Evaluate at end of run** checkbox controls whether this slot is automatically evaluated (recalculated) at the end of the run. The end of run evaluations are performed after all end of run RPL Expression Slot evaluations. (So, it would be reasonable for a Time Series Aggregation Slot to aggregate an "end of run" RPL Expression Series Slot).
7. Select one of the following NaN value options:
   - **Ignore NaNs.** NaNs do not contribute to the aggregated values. Intervals with some values and some NaNs will become values at the larger timestep.
   - **Do not aggregate intervals having NaNs.** Any interval with NaNs are not aggregated. Intervals with some values and some NaNs will be NaN at the larger timestep.

     Note: For the **First** and **Last** aggregation function, only the **First** and **Last** timestep is considered. Other timesteps do not matter in their NaN status.
   - **Error on NaN (excluding pre-simulation timesteps).** An error is issued to diagnostics.

Annual Aggregation Support for Non-calendar Water Years

One of the supported aggregation modes is aggregation to Water Years, starting in a user-specified month.



The **Water Year Start Month** is a model-wide setting, configured in the Simulation Run Parameters dialog, accessible from the Run Control Dialog; see "Simulation Run Parameters" on page 296 for details.

> **Note:** The resulting series with a 1 Year timestep is still nominally identified as a calendar year (ending on December 31). Water years are named by the year in which the water year ends, i.e. a water year from October 2000 through September 2001 is the "2001" water year.

Creating Similar Time Aggregation Series Slots for Different Objects

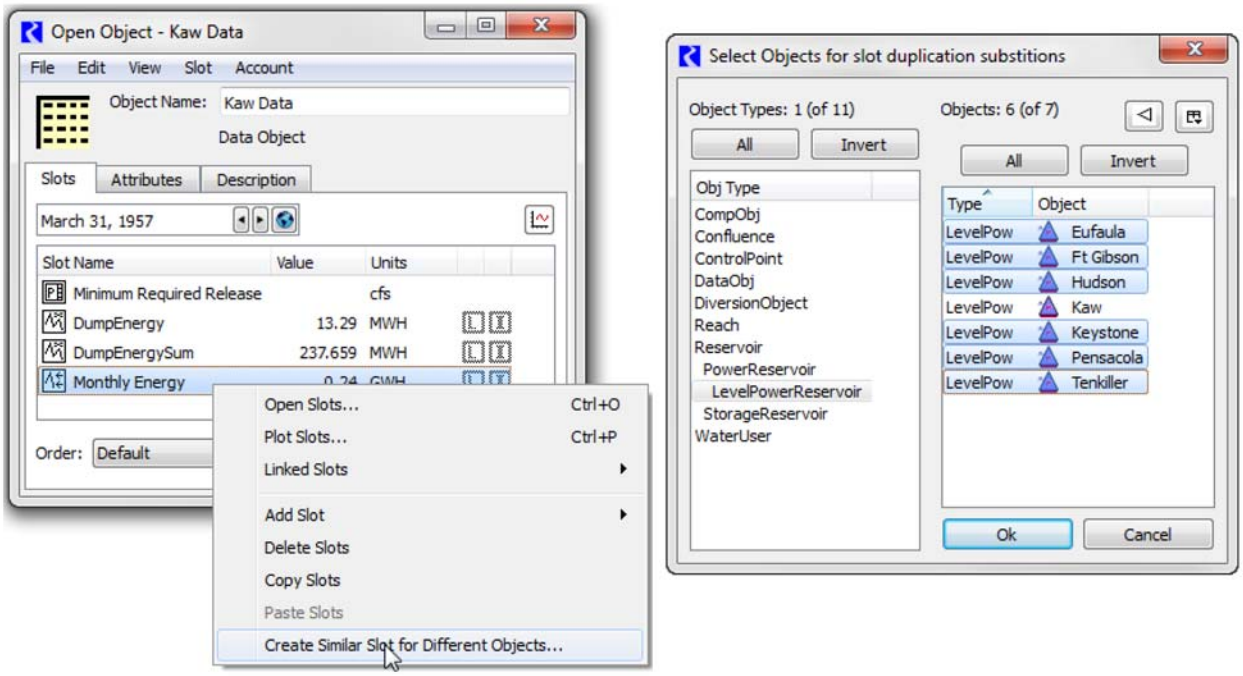
In a single operation, you can create a Time Aggregation Series Slot for the aggregation of the same series slot on multiple other selected simulation objects. For example, if a given time aggregation slot is annually summing the Energy slot on a power reservoir, similar aggregation slots can be created for all other power reservoirs, in a single operation. Figure 5.33 shows an example.

When a properly configured Time Aggregation Series Slot item is selected within an Object's slot list, the **Create Similar Slot for Different Objects** operation under the **Slot** menu is enabled. Activating that menu item brings up the simulation object selector dialog where multiple objects can be selected. The selector is initialized to show objects of the same type as the object containing the reference slot (e.g. in this example, Power Reservoirs). Ultimately though, you can select a broader range of simulation objects.

The names of the new slots are devised as follows: If the originally selected time aggregation slot's name contains the name of the referenced slot's containing object, then the new names are that name, with the original containing object name replaced by the new selected objects. In the example, the original time aggregation slot named "Monthly Energy" is aggregating the "Kaw.Energy" slot. However, the originally selected time aggregation slot's

name does not contain the name of the referenced slot's containing object, no direct name substitution is possible. Instead, the names of the new selected objects are appended to the slot name for the new slots: Monthly Energy_Eufaula, Monthly Energy_Hudson, and so forth.

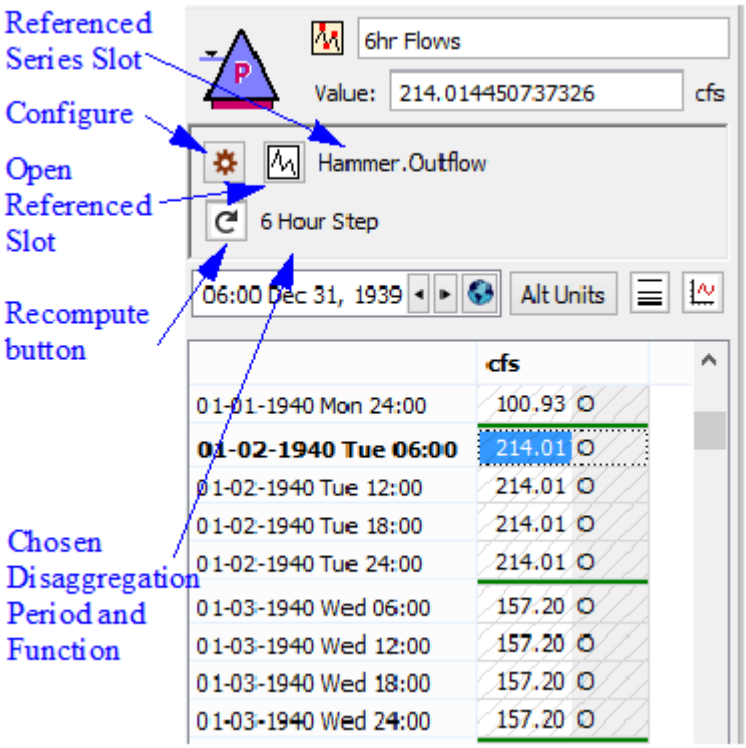
Figure 5.33



Time Disaggregation Series Slots

Time Disaggregation Series Slots temporally disaggregate another series slot into a smaller timestep. For example, you might disaggregate a daily flow to an hourly flow using the same value for each hour in the day. They can be recomputed manually or automatically at the end of a run. The configuration of a Time Disaggregation Series Slot includes the following properties. Figure 5.34 illustrates.

Figure 5.34 Screenshot of Time Disaggregation Series Slot

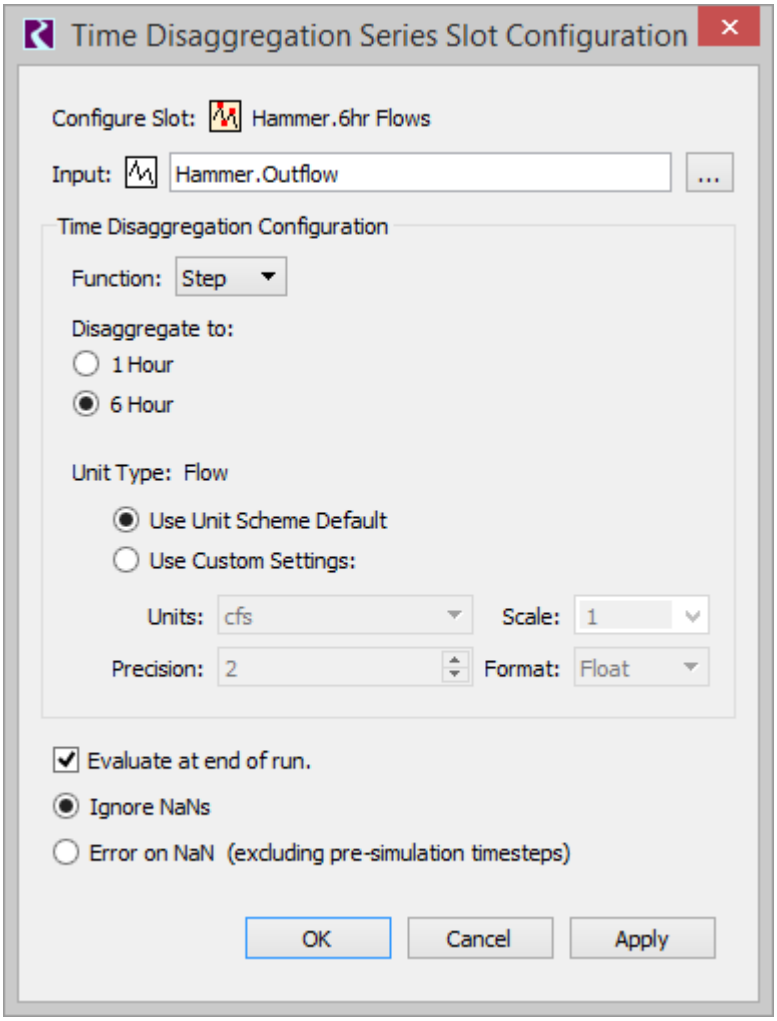


- The series slot to be disaggregated, chosen using the slot selector.
- The aggregation function, one of:
  - **Step**. Use the value at the end of the larger timestep for each value in the smaller disaggregated timestep. This is useful when you need the average over the period to remain the same, for example for FLOW values.
  - **Interp**. Linearly interpolate between the values on the larger timestep. This is useful when the values change linearly over the disaggregation period. For example, Pool Elevations can be assumed to change linearly from one larger timestep to another.
- Choice of disaggregation period, as follows:
  - 1 Hour
  - 1 Day
- The **Units** you wish to show, including display unit, scale, precision, and format.
- If you wish to evaluate this slot at end of run.
- What to do when encountering NaNs.

Functionality is provided to duplicate a Time Disaggregation Series Slot for the same named slot on multiple other "similar" objects as described in "Creating Similar Time Disaggregation Series Slots for Different Objects" on page 259.

Configuration Settings

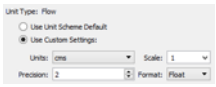
Once created (from the Object's **Slot**, then **Add Time Disaggregation Series Slot** menu), open the slot dialog to configure the slot. Configuration controls are available in a separate dialog which is shown by selecting the **Configure** icon .



1. Select the slot to disaggregate using the **Input** field.
2. Select the disaggregation function; use the **Function** control to select the aggregation function to be used. See "Time Disaggregation Series Slots" on page 256 for details on the functions.
3. Select one of the following the disaggregation periods (only disaggregation periods smaller than the source slot's timestep are available):
   - **1 Hour**
   - **1 Day**

4. Then choose the **Units** to show for the disaggregated data. The Unit Type is fixed to the Unit Type of the referenced series slot. But you can specify any display units to use. The options are as follows:
   - **Use Unit Scheme Default**. When this is selected, the unit scheme specification, including any slot name exceptions will be used. See "Standard Units" on page 89 for details on Unit Schemes.
   - **Use Custom Settings.** When selected, specify the units directly in this dialog.

     Note: This will actually make a Slot Exception in the Unit Scheme with the specified units.



5. Optionally, enable automatic end of run evaluations. The **Evaluate at end of run** checkbox controls whether this slot is automatically evaluated (recalculated) at the end of the run. The end of run evaluations are performed after all end of run RPL Expression Slot evaluations. (So, it would be reasonable for a Time Series Disaggregation Slot to disaggregate an "end of run" RPL Expression Series Slot).
6. Select one of the following NaN value options:
   - **Ignore NaNs.** NaNs do not contribute to the disaggregated values. Timesteps with NaN values will remain NaNs at the smaller timestep.
   - **Error on NaN (excluding pre-simulation timesteps).** An error is issued to diagnostics if a NaN is found.

Creating Similar Time Disaggregation Series Slots for Different Objects

In a single operation, you can create a Time Disaggregation Series Slot for the disaggregation of the same series slot on multiple other selected simulation objects. For example, if a given time disaggregation slot is disaggregating the Pool Elevation slot on a power reservoir, similar disaggregation slots can be created for all other power reservoirs, in a single operation. This operation is identical to creating similar time aggregation slots for different objects. See "Creating Similar Time Aggregation Series Slots for Different Objects" on page 255 for more information.

List Slots

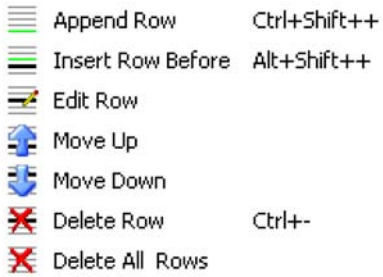
A List Slot is used to store a collection of non-numeric data, typically a group of objects. Figure 5.35 shows a sample Upstream Reservoirs List Slot.

Figure 5.35



This slot contains the Reservoirs that are upstream of the given control point. It is used in the Regulation Discharge and Flood Control algorithm to specify the reservoir which contribute to the flow at this control point. Figure 5.36 shows the options available from the **Edit** menu, from the toolbar icons, and from the right-click context menu:

Figure 5.36



On a List Slot that contains either Objects, Slots, Accounts, or Supplies, when the user selects either **Append Row**, **Insert Row Before**, or **Edit Row**, a selector will open allowing the user to choose the appropriate items.

Global Slot Configuration

The Configure Existing Slots utility enables you to configure the following parameters on multiple slots at once:

- Convergence
- Unit Type for Custom Slots
- Upper and Lower Bounds on Series Slots
- Upper and Lower Limits for Table Verification

  Note: Configuration settings such as units, scale, format and precision are set through Unit Schemes; see "Unit Schemes" on page 91.

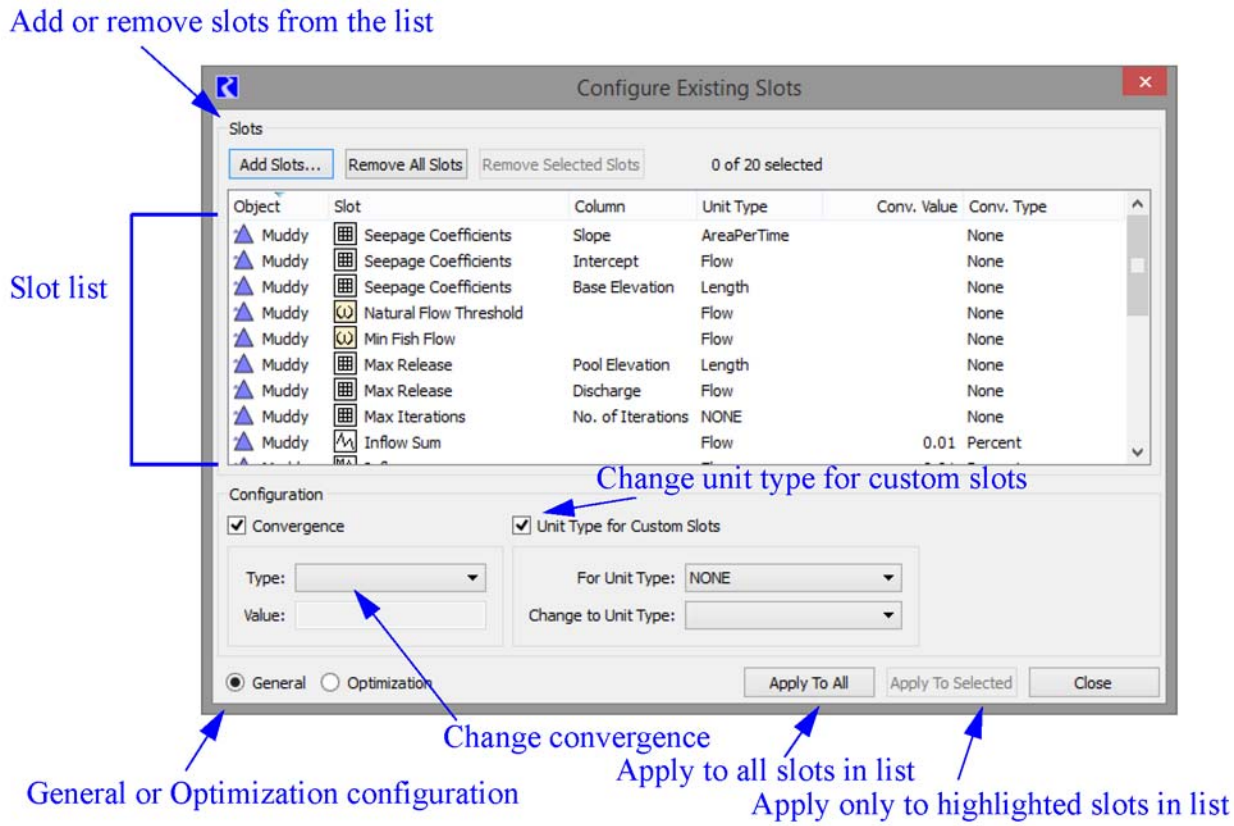
Note: The slots available do not include accounting slots as accounting slots are configured from the Open Account dialog.

To access the Configure Existing Slots dialog, select the **Workspace**, then **Slots**, then **Configure Slots** menu item from the main workspace dialog in RiverWare. The dialog is used in the following general sequence:

1. Add slots to the list.
2. Select one or more of the slots from the list.
3. Select new bounds or convergence, or change the unit type for custom slots.
4. Apply the changes to all or selected slots.

These steps are described in the following sections. Changes are immediate and are reflected in the dialog. Changes only apply to relevant slots, e.g. changes to convergence only apply to slots that have convergence (i.e. Series Slots). Figure 5.37 highlights the main areas of the dialog.

Figure 5.37



Selecting Slots to Configure

Add the slots you wish to change to the slot list by selecting the **Add Slots** button. This opens RiverWare's slot selector. See "Selecting Slots" on page 311 for details on using the selector. The selector can be used to add all or a subset of the existing non-accounting slots in the current model.

After making a selection of one or more slots, those slots are added to the list. These slots, or a subset, are the slots you wish to modify.

> **Note:** If a slot has multiple columns that can be configured independently, an entry is created in the list for each column. For tables where data in any column must have the same units, only one list item is shown. If some configuration item, like convergence, is not applicable to an item, that column is left blank in the list display.

To remove specific slots from the dialog, first select them. Then select the **Remove Selected Slots** button or use the corresponding context menu item available with a right-click in the slot list view. All slots can be removed using the **Remove All Slots** button or its corresponding context menu item. Double-clicking an item in the slot's list view will bring up the Open Slot dialog for that slot.

> **Note:** The label above the list view indicates the number of items selected and the total number in the list.

Global Slot Configuration Options

The configuration depend on whether the **General** or **Optimization** option is selected. The resulting options are described in the following sections.



General

The configuration panel at the bottom of the dialog has checkboxes for two types of configuration items: **Convergence** and **Unit Type for Custom Slots**. By checking or unchecking these, any combination of the configuration options can be used. For example, if only convergence values are to be altered, only use its checkbox; unit types will not be modified by any applied changes.

Specifying Convergence

To change convergence, select the **Convergence** checkbox and enter a **Type** and/or **Value**.

Specifying a new Unit Type for Custom Slots

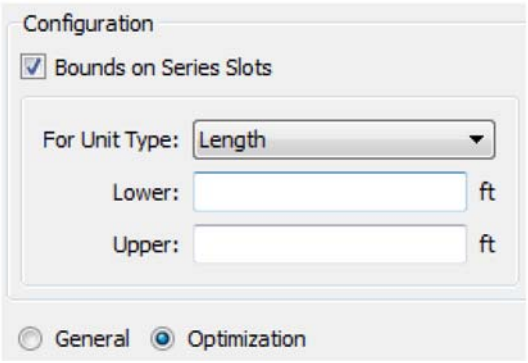
To change the unit type of a custom slot, select the **Unit Type for Custom Slots** checkbox and specify the old unit type and the new unit type. These changes only apply to custom slots; you are not allowed to change the unit type of a simulation slot. Display units can be set from the slot itself or from the Unit Scheme.

Optimization

When the **Optimization** option is selected, the bottom of the dialog switches to show the Optimization Bounds and Limits regions.

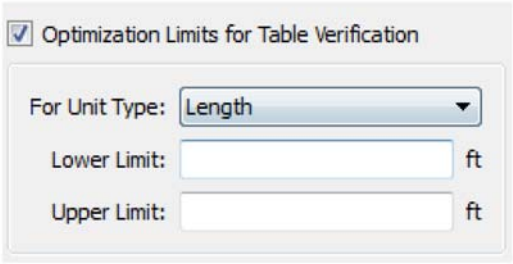
Specifying Bounds on Series Slots

To set the Lower and Upper bounds, check the box, then choose a unit type from the **For Unit Type** menu. Specify a new **Lower** or **Upper Bound**.



Optimization Limits for Data Verification

Configure the Lower and Upper Limits for Table slots that are verified in optimization. To find these slots, use the Supports Opt Limits filter in the Selector; see "Selecting Slots" on page 311 for details.



Applying Global Slot Changes

When all desired configuration changes have been made, they can be applied in two ways, **Apply to Selected** or **Apply to All**. To apply changes only to selected items in the slot's list view, select the **Apply To Selected** button at the center bottom of the dialog. This will change only those slots highlighted in the list view.

> **Note:** The desired items should be selected before entering the configuration information because changing selections clears the configurations.

Configuration changes can be applied to all slots in the slot list, whether selected or not, by selecting the **Apply To All** button at the left bottom of the dialog.

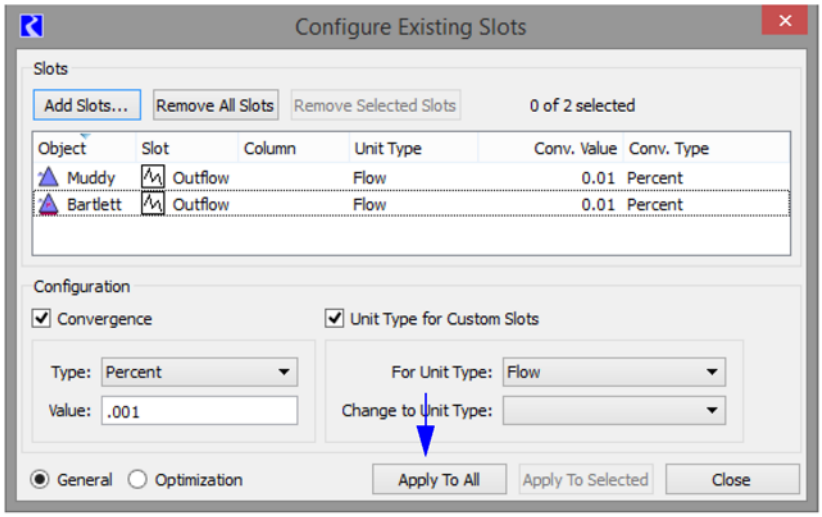
If changes are applied to a slot where they are not applicable, the changes will be ignored for that slot. For example, if convergence is configured to be changed and is applied to a slot that does not have convergence, it will be ignored.

Global Slot Configuration Example

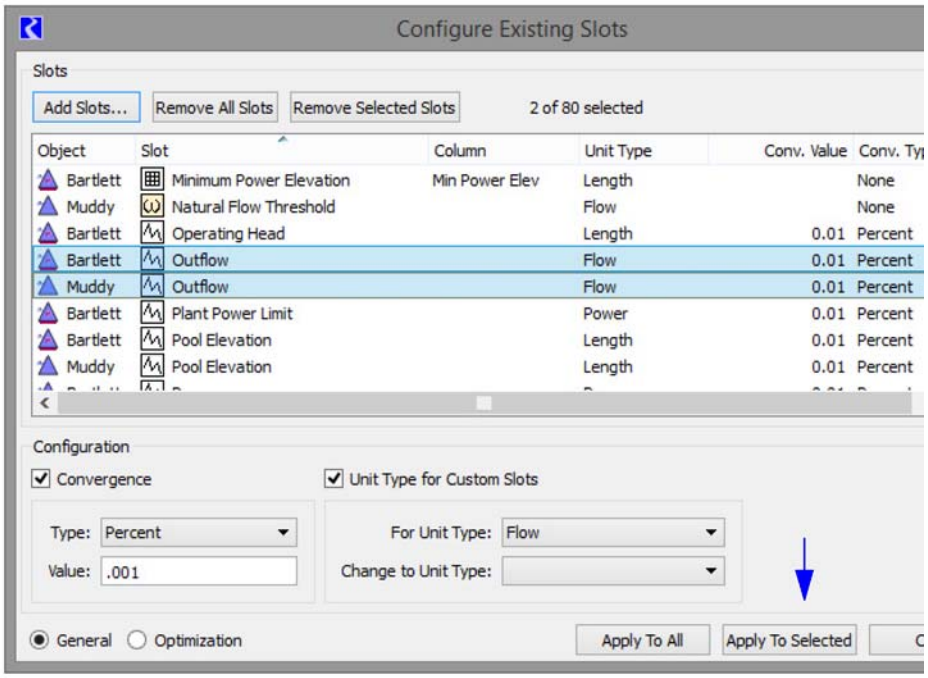
Example 5.1 Changing convergence on specific slots

In this example, you decide that for debugging purposes, you need to decrease convergence on all reservoir outflows. There are two approaches for using the Configure Existing Slots dialog to make these changes:

- Add only the Reservoir Outflow slots to the list using the slot selector. A **Name Filter** can be applied in the selector to filter only the desired slots. In the Configure Existing Slots dialog, check the **Convergence** box, select **Percent** for the **Type**, then enter a new value (like 0.001) in the **Value** box. Then select **Apply to All** to commit the changes.



- Add all of the reservoir slots to the list. Highlight only the desired Outflow slots, check the **Convergence** box, select **Percent** for the **Type**, then enter a new value (like 0.001) in the **Value** box. Select **Apply To Selected** button to commit the changes.



Using the selector to choose the appropriate slots is more powerful and more elegant but you don't see the slots' configuration values before you make the selection. Selecting all slots, then choosing the desired slots in the list view allows you to see all these slot configurations before you modify them.

DateTime Values in Slots

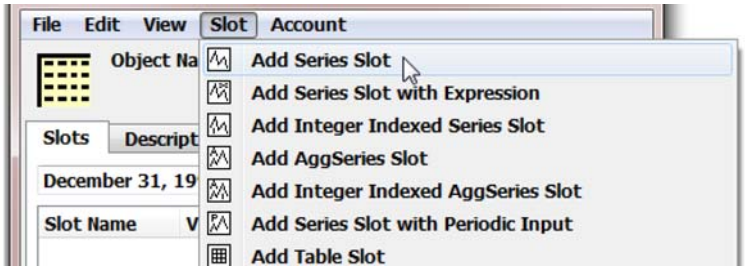
In addition to the standard unit types (Flow, Length, Volume, and so on) that can be configured on custom slots. It is possible to add slots that have values in the slot that represents a DateTime. This is possible by configuring the slot to have a DateTime unit type. Following is a walk through describing how to add a slot with a DateTime value. Following that is a description of each of the date times and a description of how to use the values in RPL.

Adding a Slot with DateTime Values

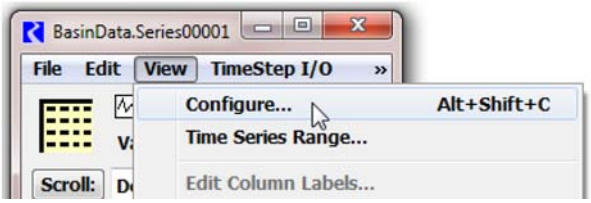
To introduce how DateTime values exist on RiverWare Slots, this section walks the user through the process of creating a series slot with DateTime values on a data object.

1. Create a Data Object and Add a Series Slot, or any of the following types of Slots. All of the following support DateTime values:
   - Series Slot
   - AggSeries Slot
   - Table Slot

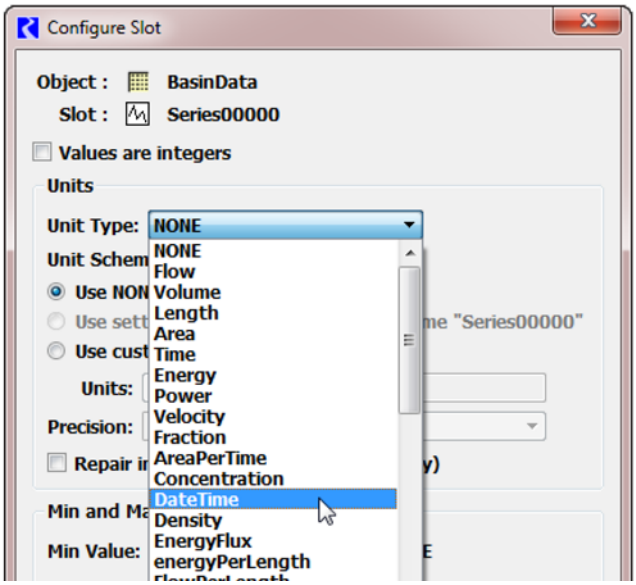
– Scalar Slot



2. From the object dialog, double-click your new Series Slot to show the Open Series Slot dialog.
3. From the Open Series Slot's **View** menu, select **Configure** to open the Series Slot Configuration dialog box.

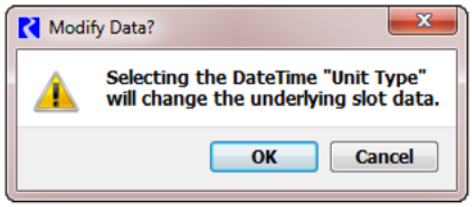


4. From the Series Slot Configuration dialog box, select the last item from the **Unit Type** option menu: **DateTime**.



Note: The "DateTime" Unit Type, and the eight supported DateTime User Units are special in RiverWare. These selections cause the Slot's values to be displayed and edited as DateTime values rather than as numeric values.

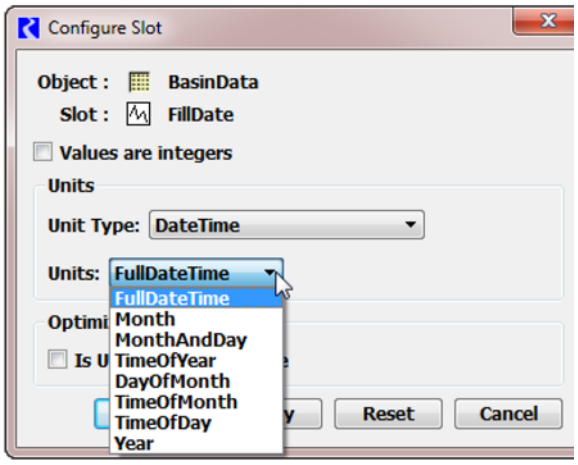
Unlike switching between ordinary Unit Types, switching to the “Date Time” Unit Type, and between the various DateTime “User Units” causes a change in the underlying Slot values. The user must confirm these changes with this dialog.



5. As a result of switching to the DateTime Unit Type and selecting **Apply**, configuration properties associated with only numeric values are hidden (e.g. Min/Max values, Display Format, Convergence).

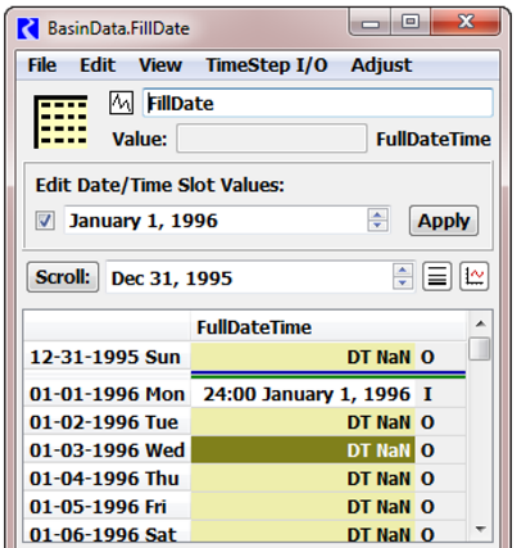
   Notice the eight different “User Units” associated with the DateTime Unit Type. You can keep the default selection, **FullDateTime**. Select **OK**.

   Note: AggSeries Slots and Table Slots support independent Numeric / DateTime configuration on each column.



6. As a result of selecting a DateTime unit, the Edit Date/Time Slot Values area is added to the Open Slot dialog.

Figure 5.38



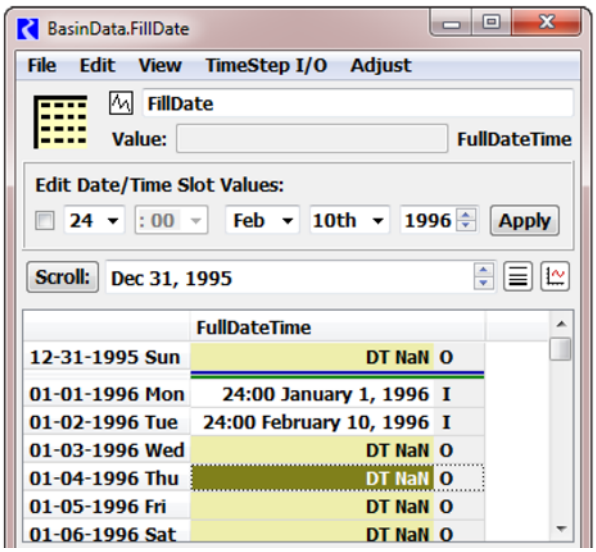
The entry and selection fields shown within the Edit Date/Time Slot Values area depend on which DateTime User Unit selection was made. For the **FullDateTime** selection, two alternative entry modes are available, selectable with the checkbox on the left.

- Timestep selector. For DateTimes on Timestep Boundaries; see Figure 5.38.
- Unconstrained Date/Times. For selection of any DateTime within the supported RiverWare date range; see Figure 5.39.

7. Try making different cell selections, selecting the **Apply** button and repeating these steps with different DateTime entry values.

   Notice that the **Value** field at the top of the Open Slot dialog is disabled (not editable, and shown with a gray background). This field shows the actual internal numeric value associated with the selected cell's DateTime value.

Figure 5.39



Double-clicking a cell assigns the cell's value to the Edit Date/Time Slot Values area.

When a range of cells is selected with the first and last cell having valid values, interpolated DateTimes can be assigned to the intervening cells. Try **Edit**, then **Interpolate** (not illustrated here).

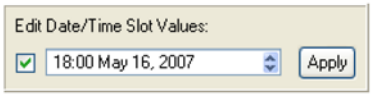
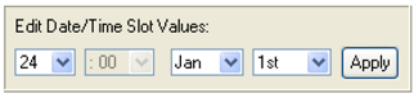
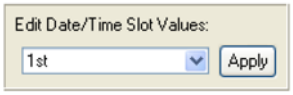
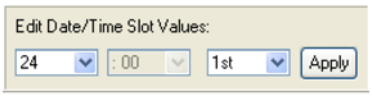
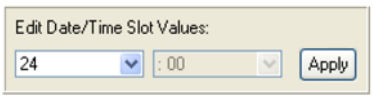
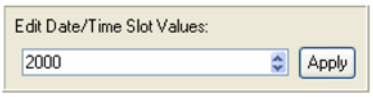
Plotting of DateTime value series is also supported. (Select the **Plot** icon on the right side of the dialog). DateTime coordinates are not shown on the axes, but relative DateTime "magnitudes" can be discerned.

DateTime values that do not conform to the Slot's (or Slot column's) configured DateTime "units" (Partial DateTime configuration) are shown with a yellow cell background. In addition, a value that is Not a Number (NaN) is shown with the syntax DT NaN.

Partial DateTime Editor

The Partial DateTime Editor in the Open Slot dialog also shows the applied DateTime. Table 5.3 shows this dialog in standard numeric configuration and in the various Full and Partial DateTime configurations. The screenshots shown are for a Scalar slot but they are applicable to the other supported slots as well.

Table 5.3

DateTime User Unit	Example	Selection Mechanism
Full DateTime	18:00 May 16, 2007	Timestep selector  Unconstrained Date/Times 
Month	January	Month menu 
Month and Day	January 1st	Month and Day menu 
Time of Year	24:00 Jan. 1	Hour, Month, Day menu 
Day of Month	1st	Day of Month menu 
Time of Month	24:00 1st	Hour and Day of Month menu 
Time of Day	24:00	Hour menu 
Year	2000	Year selector 

Access to DateTime Values Using RPL

RPL doesn't directly support DateTime Slot values as DATETIMES. All Slot values are handled as numeric values. Two Predefined RPL Functions are used to convert the Slot DateTime values to and from RPL DATETIME values. Figure 5.40 and Figure 5.41 demonstrate the use of the DateToNumber and NumberToDate Predefined functions. The following sections provide more information about these predefined functions.

Figure 5.40

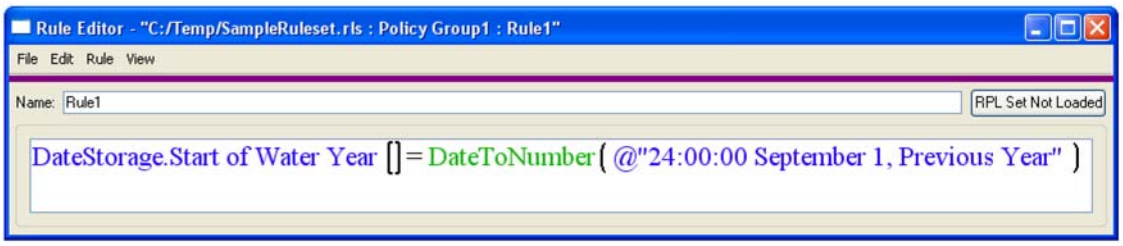
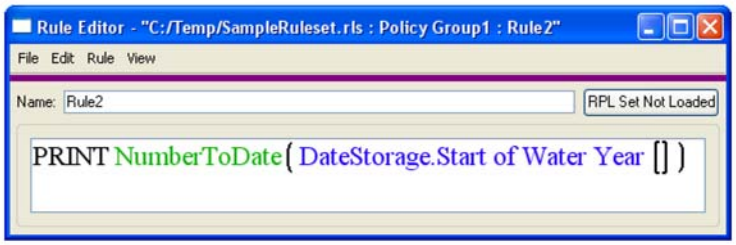


Figure 5.41



See the following documents for details:

- DateToNumber. Converts a DATETIME to the corresponding number. See "DateToNumber" in *RiverWare Policy Language (RPL)* for details.
- NumberToDate. Converts a number to a corresponding DateTime. See "NumberToDate" in *RiverWare Policy Language (RPL)* for details

  Note: Only DATETIMES with the FullDateTime unit should be set on slots with rules. Due to the numeric values underlying DATETIME values, trying to set partial DATETIME value with rules can have unintended behavior.

Conversion of DateTimes to Numeric Values

Although rare, you may need to see the value that is stored on the slot. Use the Unit Converter and the DateTime unit type for this purpose. See "Converting DateTime Values to Numeric Values" on page 102 for details.

Notes on Series Slots

Annotation of series slots using *Notes* allows you to comment on data in a RiverWare model. For example, you may use notes for any of the following actions:

- Document certain characteristics of input data such as filled values, storm events, etc.
- Provide metadata on the source of the input data.
- Call attention to specific operations, decisions, or outcomes for a model run.

Notes are for documentation purposes; they do not affect the solution and they cannot be accessed (read or assigned) via rules or other RPL sets. In general, notes are available for all types of series (Series, Multi, Agg, Series with Expression) and can be edited via the Open Slot dialogs, the SCT, and the Edit Account dialogs.

Notes Overview

Notes are short text strings that are associated with one or more timesteps. Each note belongs to a *Note Group*. Each Note Group contains a list of associated slots and the timesteps to which they apply. The Note Group Manager utility dialog facilitates creation and management of Note Groups. The display icon for each group can be assigned a color.

Notes can be imported and exported as follows:

- From/to text files using the Control File-Executable (non-direct-to-database) DMI functionality; see “Exporting Notes Using DMIs” on page 284.
- From/to an external XML file using the Note Group Manager; see “Importing and Exporting Notes Using Text Files” on page 284.

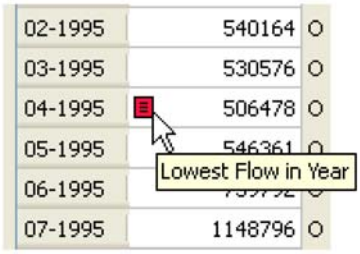
Note: Support for text Notes on series slot timesteps (“Annotations” or just “Notes”) was redesigned in RiverWare 5.2. Notes are still organized within Note Groups, but notes are now directly applied to individual series slot timesteps rather than by associating their containing Note Groups with whole series slots. Additionally, multiple notes can be associated with a timestep on an individual series slot.

Notes

A Note is a text string that is associated with a series slot at a timestep and each note belongs to a Note Group. A Note has the following properties:

- Note text. The text string that makes up the Note.
- Note group membership. A note belongs to exactly one Note Group.

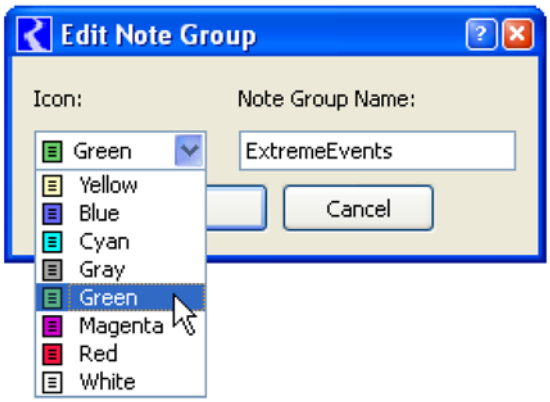
- Slots and timesteps. A note is applied to one or more series slots at specified timesteps



Note Groups

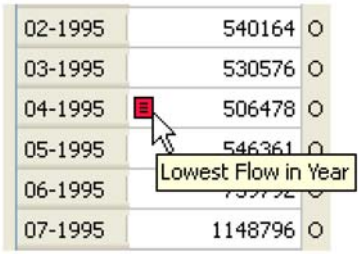
A Note Group is composed of the following properties:

- Name. a name is generally provided by the user.
- Icon Color. A note group has one of eight basic colors.
- Set of Notes. A Note Group has a set of one or more text Notes.

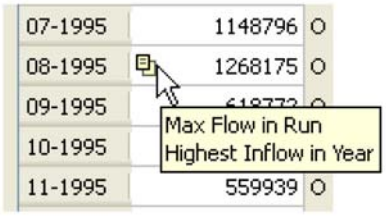


Displaying and Editing Notes

Note text can be seen and reviewed in the series slot dialogs. In the series slot dialogs (for Series Slots, Agg Series Slots, Multi Slots, Table Series Slots and Edit Account dialogs), the presence of a note is shown by a small icon to the left of the value. The color of the icon is defined for the Note Group. Hovering over the icon displays a tooltip with the Note text.



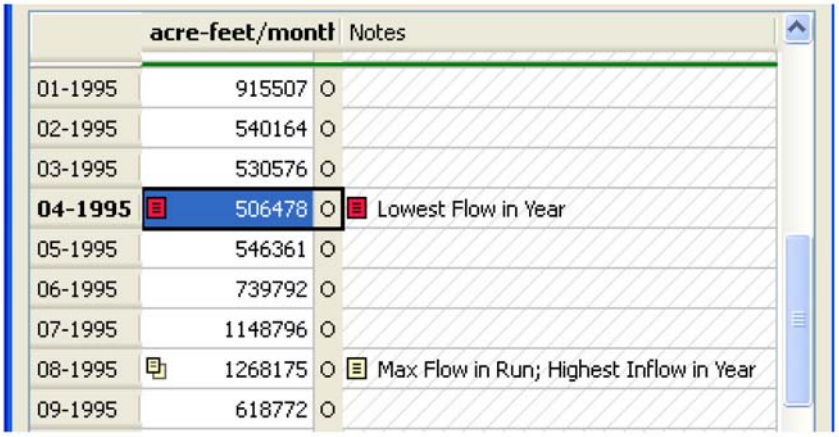
Cells having more than one note have a special icon suggesting one note stacked on the other. The tooltip lists each note, one per line. That icon is always yellow and does not reflect the color of any of the corresponding Note Groups.



The note text can be shown in a separate column using the **View**, then **Show Notes Column** toggle menu item.

> **Note:** You can configure your preferences on whether or not to show the Notes column using Slot Dialog Display Preferences; see "Slot Dialog Display Preferences" on page 161.

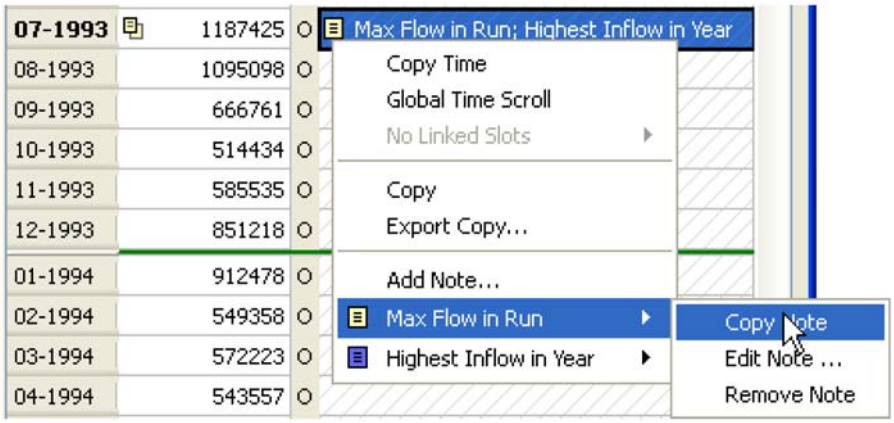
If the Notes Column is visible and the open slot belongs to one and only one Note Group, a new note can be created by simply typing in the Notes Column. The Note will be created as a member of the slot's Note Group.



When one or more notes exist on a particular Slot/Timestep, the context menu (right-click) on the cell includes a menu for each note; see Figure 5.42. The title of the menu shows the Note Group icon and the Note Text. The menu contains the following operations:

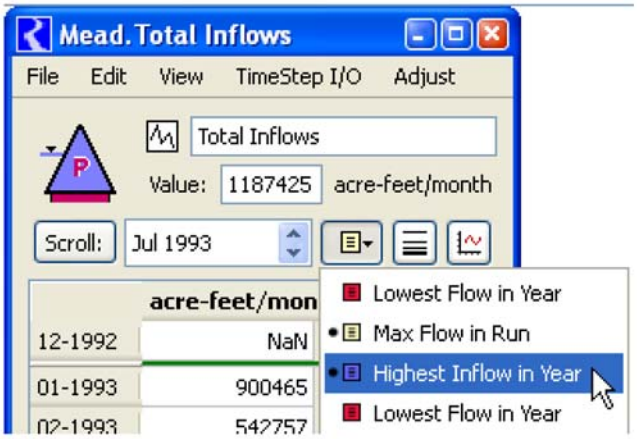
- **Copy Note.** The **Copy Note** menu item copies a Note reference to the Note Copy Buffer. In Figure 5.42, the "Max Flow in Run" note would be copied to the buffer. The note can then be pasted in one or more cells using the **Paste Note** operations.
- **Edit Note.** The **Edit Note** menu item shows the Note Group Manager Dialog, with the indicated Note preselected. You may change the note text, or move the note to a different Note Group (potentially having a different Note Group icon).
- **Remove Note.** The **Remove Note** menu item removes the indicated note from the selected Slot/Timestep (only). This does not effect the appearance of the same note at other timesteps on the same Slot, or on any other Slot.

Figure 5.42



The dialog can be scrolled to the timestep of a note on the Slot using the **Note Navigation** menu button; see Figure 5.43. Items in the **Note Navigation** menu having a bullet indicate that the timestep of the note matches that of the timestep selector.

Figure 5.43



Pressing the **Shift** key while selecting an item causes a Global Time Scroll (scrolling all open series-related dialogs to the corresponding timestep).

Creating Notes

Following are three ways to create a note:

- In an open series slot dialog, edit account dialog or SCT:
  - Right-click a cell.
  - Select **Add Note** from the context-sensitive pop-up menu. This will open the Note Group Manager; see "Note Group Manager Dialog" on page 276 for details.
  - Choose or create a **Note Group**.

  - Choose or create the **Note** text.
  - Choose the slots and timesteps to which the note should apply by selecting the **Add Entry Using Context** button. This opens the Apply Notes to Slots dialog; see "Apply Note to Slots Dialog" on page 279 for details. The slot and timestep from which this right-click operation began are selected.
  - Change/add slots or timesteps (if necessary) and select **Ok** to associate the Note with the slot/timestep.

- From the main workspace:
  - Choose the **Utilities**, then **Note Group Management** menu. This opens the Note Group Manager dialog; see "Note Group Manager Dialog" on page 276.
  - Choose or create a **Note Group**.
  - Choose or create the **Note** text.
  - Select the **Add Slot Entries** button to open the Apply Notes to Slots dialog; see "Apply Note to Slots Dialog" on page 279.
  - Select the **Add Slots** button and choose the slots to which the note applies.
  - Specify the timestep or range of timesteps to which the note applies.
- To create a note based upon an existing note (copy/paste of note). In an open series slot dialog, edit account dialog or SCT:
  - Right-click in a cell that has the desired noted.
  - Select the note from the context-sensitive menu and choose **Copy Note**.
  - Go to the destination slot and timestep and right-click in the cell.
  - Choose **Paste Note: Name**.

Note Group Manager Dialog

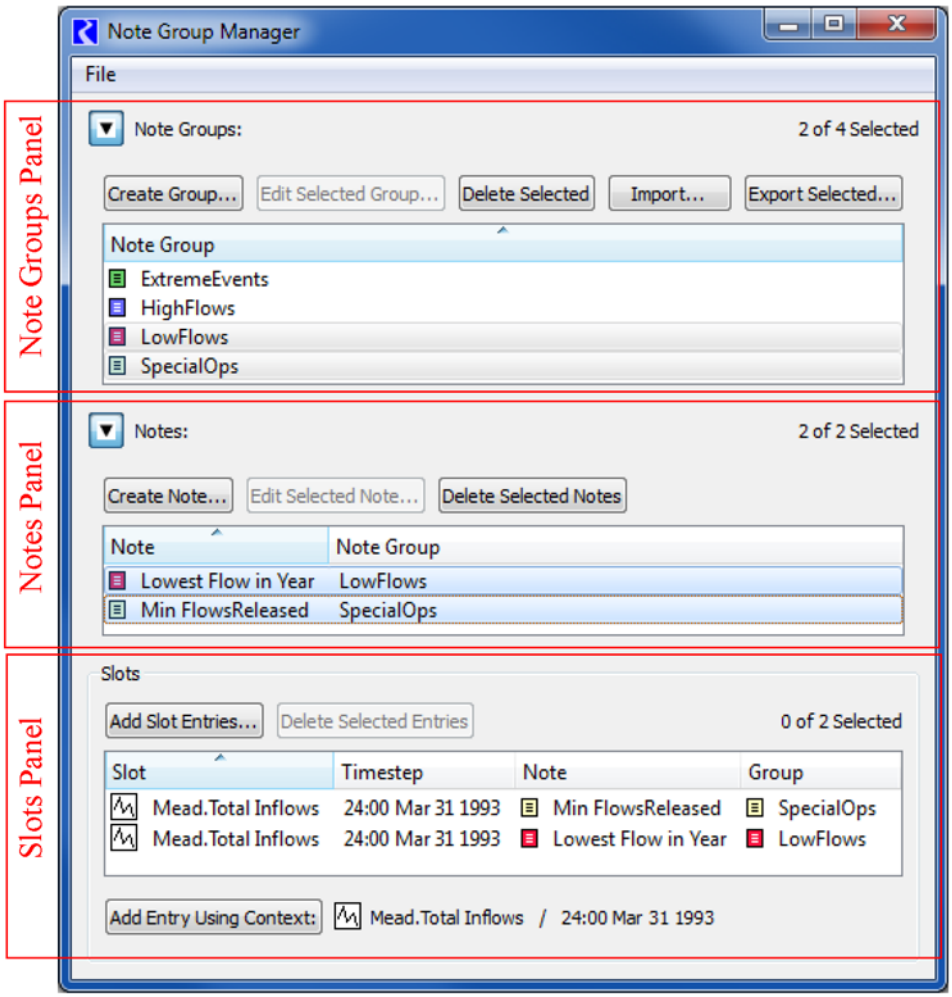
The Note Group Manager and supporting dialogs are used to maintain the set of notes on series slots.

This dialog is arranged vertically in three hierarchically defined panels as shown in the following figure: Note Groups, Notes, and Slots. The first two panels can show either a list or a menu, controlled by the triangle arrow button in each panel. The combo boxes allow for the selection of a single item (Note Group or Note), or "All" items.

The panels are used in a top to bottom order. First you select (highlight) one or more Note Groups. Then the member Notes are displayed in the Notes panel. Then you select one or more Notes in the Notes panel and the member slots and timesteps are displayed in the Slots panel.

Following is a description of these three panels.

Figure 5.44

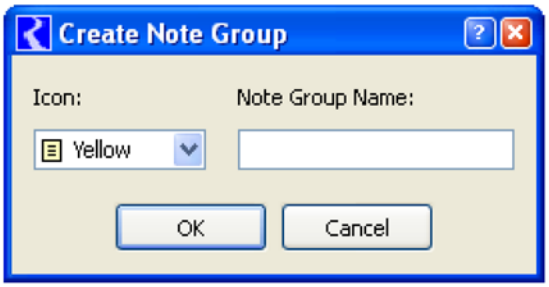


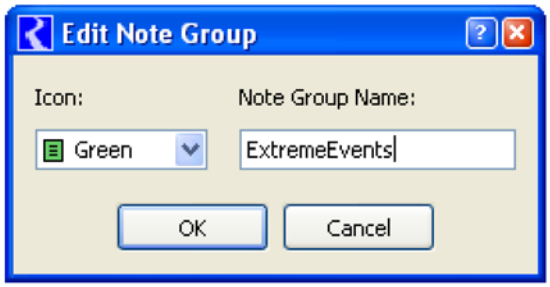
Note Groups Panel

The Note Groups panel shows all the defined Note Groups and supports the following operations (buttons):

- **Create Group**
- **Edit Selected Group**
- **Delete Selected**
- **Import.** See “Importing and Exporting Notes Using Text Files” on page 284.
- **Export Selected.** See “Importing and Exporting Notes Using Text Files” on page 284.

The first three buttons bring up dialogs for creating (define the name and icon color) or editing (changing the name and icon color), or confirming deletion of Note Groups.

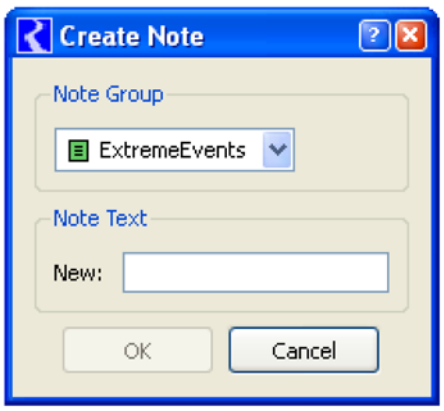


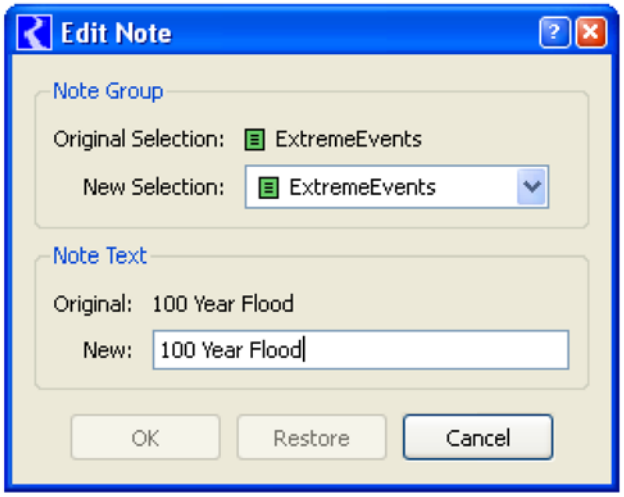


Notes Panel

For the selected Note Group in the above panel, the Notes panel shows the notes that are a member of that group. It supports three operations (buttons):

- **Create Note.** Enter a new **Note** text and choose the **Note Group** to which it belongs.
- **Edit Selected Note.** Edit existing **Note** text or change the **Note Group** to which it belongs.
- **Delete Selected Notes.** Delete the selected **Note** after confirmation.



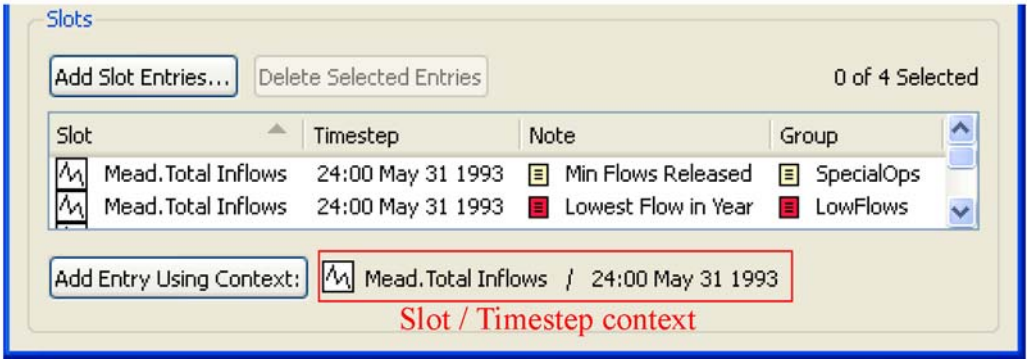


Slots Panel

For the selected Notes in the middle panel, the Slots panel shows the slots and timesteps to which the note has been applied.

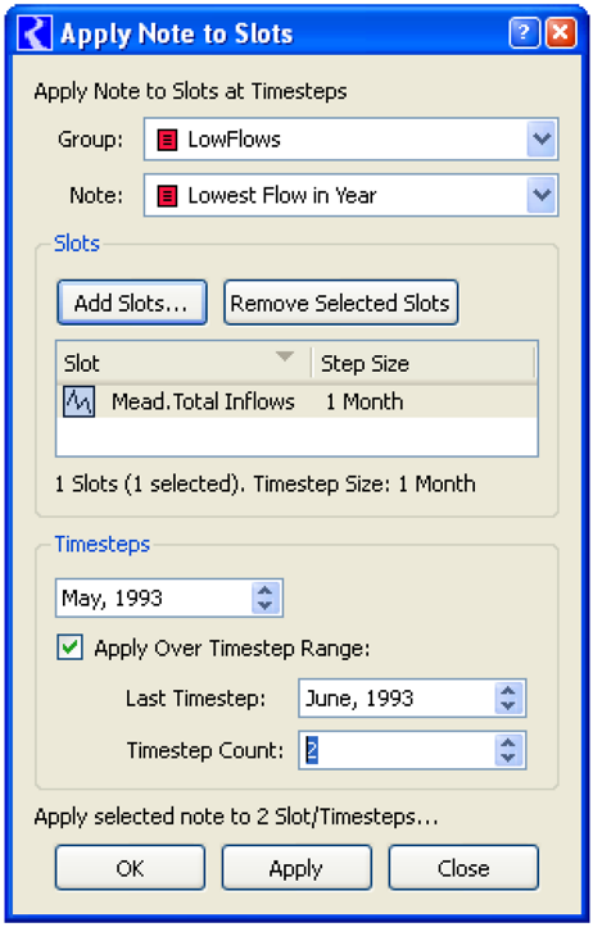
Both the **Add Slot Entries** and **Add Entry Using Context** buttons bring up the Apply Notes to Slots dialog described in the next section. These differ only in the initial selections used in that dialog. The **Add Entry Using Context** button is available when the manager dialog is shown from the context of a particular slot and timestep,

i.e. right-clicking a cell in a slot or SCT then choosing **Add** (or **Edit**) Note. The current context (Object.Slot and Timestep) is listed on the same line as the button.



Apply Note to Slots Dialog

The Apply Note to Slots dialog allows the user to associate a particular note with one or more Slots at one or more contiguous timesteps.



The list of slots and the timestep selections are sometimes preselected, depending on how the Apply Note to Slots dialog is shown. These selections can be modified before creating the new Note/Slot/Timestep associations.

The Group and Note combo boxes can be modified to select a different note. Only one note can be selected at any one time.

Additional Slots can be added to the Slot List by selecting the **Add Slots** button. This brings up the RiverWare Slot Selector.

Slots can be removed from the Slot List by selecting items in the list and selecting the **"Remove Selected Slots"** button. Doing so has no effect on any existing Note/Slot/Timestep associations.

In the Timesteps section, the user can choose one timestep or range of timesteps (continuous only) to which the note will apply.

The **OK** or **Apply** buttons are enabled only if the inputs specify a valid state representing Note/Slot/Timestep associations that are not yet existing. For one thing, all of the Slots in the Slot list must have the same timestep size. If enabled, the **OK** and **Apply** buttons create a Note/Slot/Timestep association for all of the Slots in the list (i.e. not just the selected Slot items).

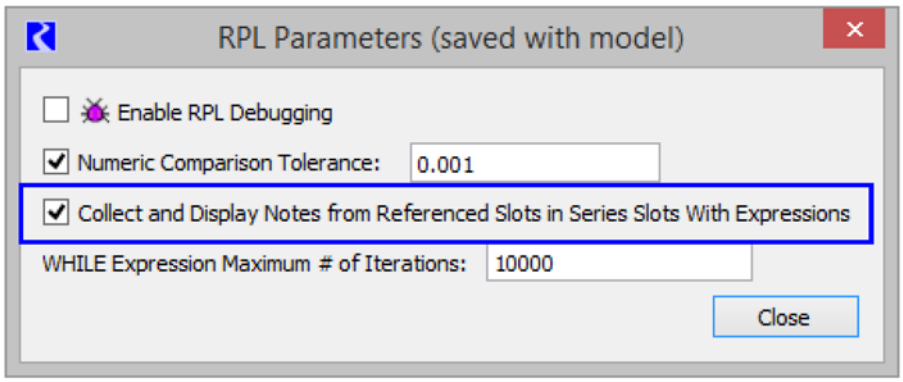
Status lines under the Slot List and above the bottom buttons indicate the state of the inputs. Examples of the various messages shown in the bottom status line are as follows. (The OK and Apply buttons are enabled only in the 4th example):

- No defined Note is selected.
- The Slot list is empty.
- The Slot list includes Slots having different timestep sizes.
- Apply selected note to 6 Slot/Timesteps [enabled state]
- The selected note has been applied to 6 Slot/Timesteps.

Collected Notes on Expression Slots

Collected notes are a special type of note associated with series expression slots (i.e. Series Slot with Expression). When the expression slot is evaluated, notes from the series slots referenced in its expression ("source" slots) are copied to corresponding timesteps in the expression slot. The source slots for providing notes are an accumulated list of the source slots referenced across the expression slot's evaluations at all timesteps. The notes from the source slots are collected and copied once at the end of the expression slot's evaluation. The collected notes are removed and re-collected each time the expression slot evaluates. In the context of a run, they are removed at the beginning of the run and collected at the end of the run, so if the run is paused or aborts in the middle, the collected notes will be absent.

The collection of notes for series with expressions is optional and is controlled on a model-wide basis by a parameter selection in the RPL Parameters dialog. This dialog is available from the RiverWare workspace under the **Policy** menu.

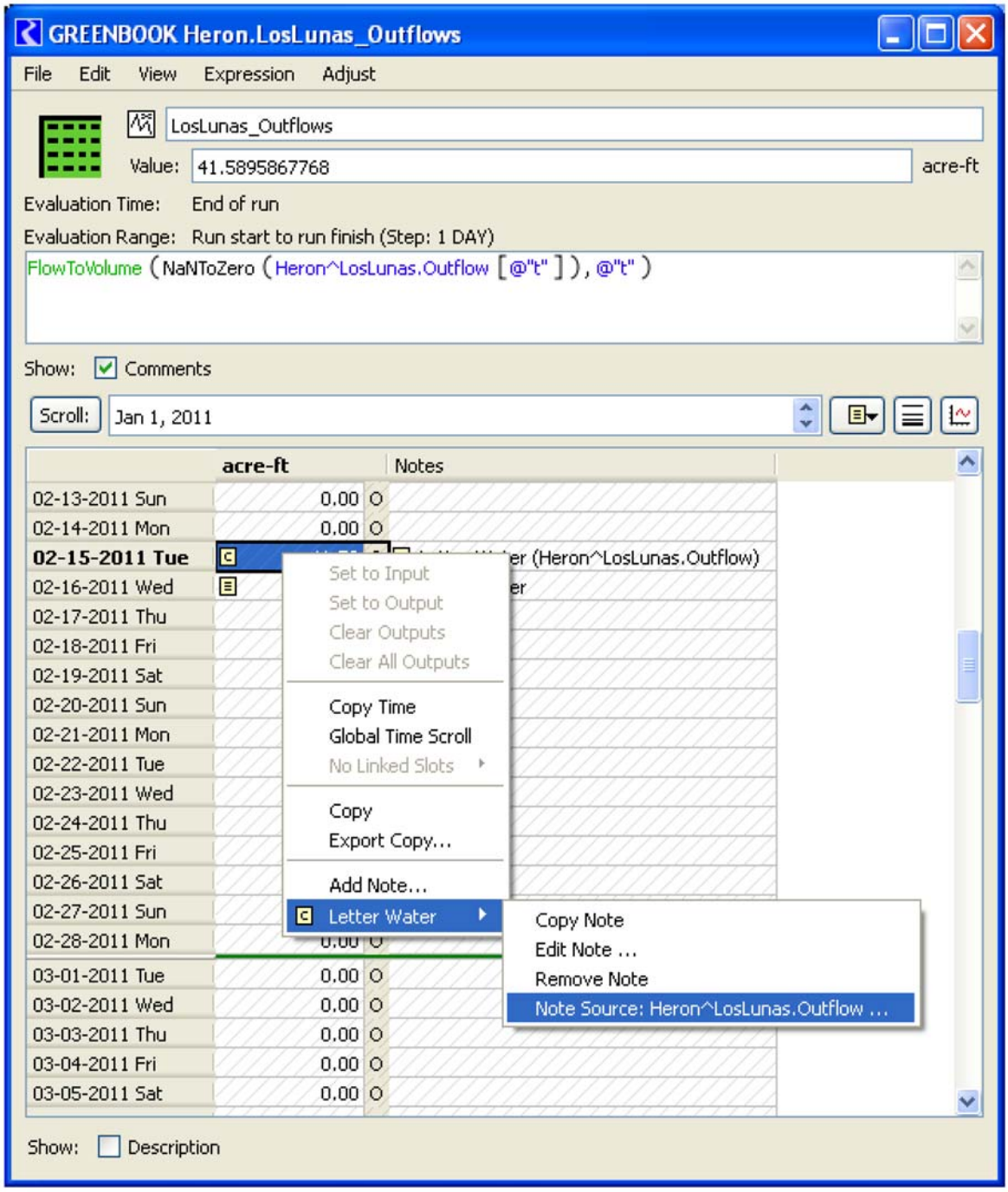


In the places where notes for series can be displayed (Series Slot, SCT and Notes Group Manager dialogs), collected notes are differentiated by having a C in their icon; see Figure 5.45. The text of a collected note, where displayed in the notes column or in a tool tip when mousing over a note icon, will show the text of the note followed by the source slot name in parentheses.

> **Note:** If a note is propagated through a number of expression slots, the slot where the note originated is maintained as the source slot for the note, even though one expression slot may be picking it up from another expression slot that referred to the source slot.

The context menu (right-click) on a cell for a collected note in the series slot and SCT dialogs will have an additional menu entry showing the source slot of the collected note. Select the item to open the source slot's dialog. If a source slot is deleted from the model, the collected notes that refer to that source slot will also be deleted.

Figure 5.45



Accounting Multi Slot Notes

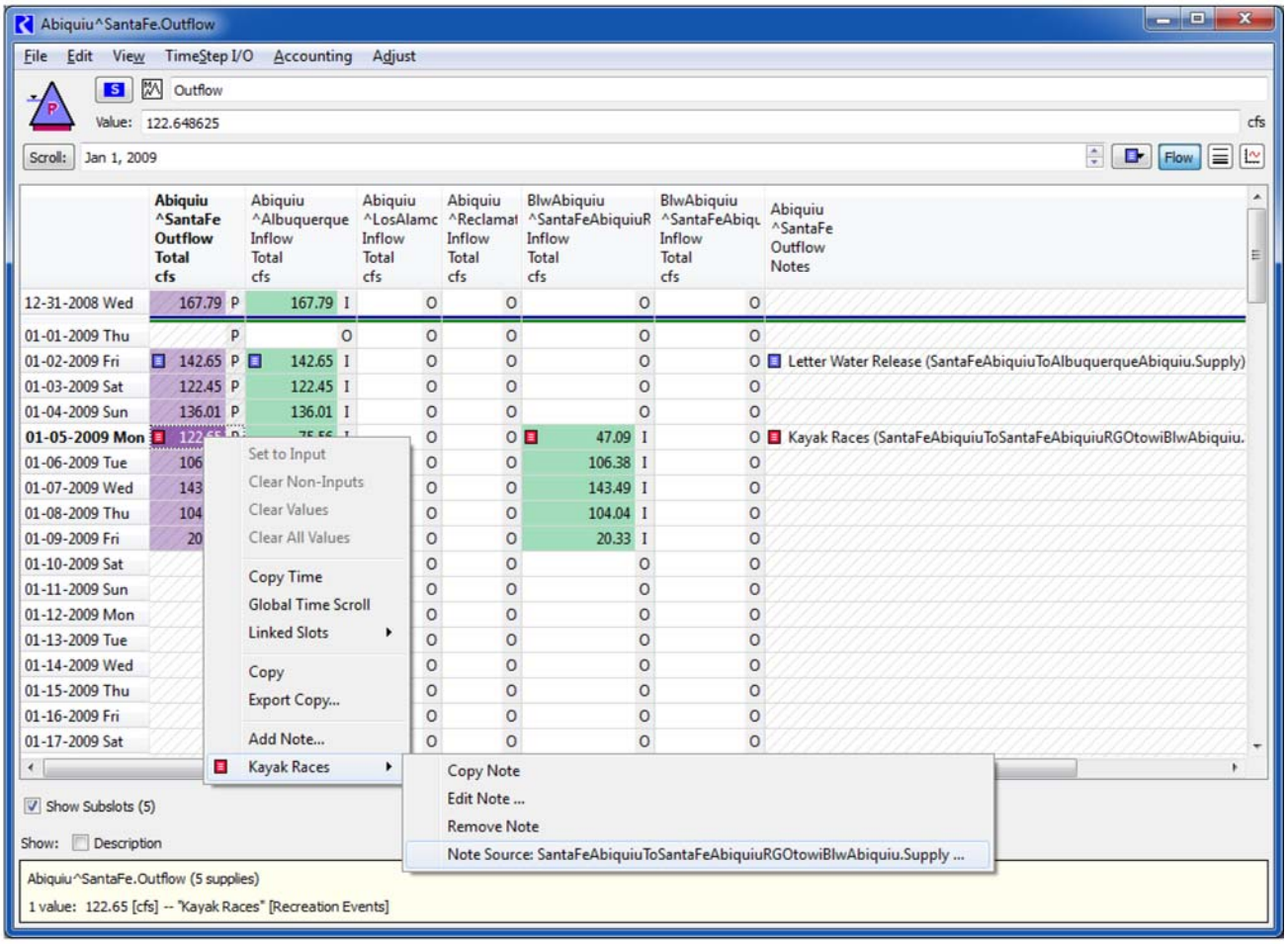
Accounting multi slots, such as storage account inflow or outflow, have a subslot for each supply linked to the multi slot. You can add a note to the multi slot or the supply/subslot.

Note: It is good practice to add the note to one of the linked supplies.

When you add a note to a multi slot that has one or more subslots or supplies, a confirmation asks you which you would like to use.



When a note is added to a linked supply, the note is automatically propagated to the multi slots on either end of the supply. Notes propagated in this way are assigned a source slot corresponding to the supply. The display of the propagated note is similar to collected notes (see "Collected Notes on Expression Slots" on page 280), where the source slot name is displayed in parentheses after the note text in the notes column, and the right-click context menu contains an item for the source slot that, when selected, will open the source supply's slot dialog. When a note on the supply is deleted, or the supply itself is deleted, propagated notes will be removed from the corresponding accounting multi slots.



Importing and Exporting Notes Using Text Files

Notes can be imported or exported to a text (xml) file. The export/import functionality allows notes made in a copy of a model to be transferred back into the original.

Selecting the **Import** or **Export Selected** buttons brings up a file selector to specify an import or export file for Note Groups. These operation are also available from menu items in the **File** menu at the top of the dialog. Exporting one or more selected Note Groups will write information to the file for the group, its notes, and the slot associations for those notes. On import from a file, a Note Group is created if it does not already exist, notes in the group are created if they do not already exist, and slot associations for the notes are created if they do not already exist. A feedback dialog will indicate if note associations with slots cannot be made (i.e. if the slot is not in the new model).

Exporting Notes Using DMIs

Notes can be output from RiverWare slots to data files using control file-executable DMIs. The control file keyword used to specify notes is as follows:

```
slot_anno = true
```

The default value for slot_anno (i.e. slot annotations) is false, meaning no Notes will be written.

A line in RiverWare time series format (for DMI import or from DMI export) containing a note will be formatted as:

```
<value> anno {Storm Events} {4.3 Inches}
```

where <value> will be a numeric value, “anno” is a keyword, Storm Events defines the Note Group to which the note belongs and 4.3 Inches is the note itself. The “<“a “>” will not exist in actual output. The “{” and “}” do exist, delimiting the Note Group name from the note text itself.

Note: In the external RiverWare time series format, only one Note will be supported at one given timestep on any one SeriesSlot. That is, if a given SeriesSlot is a member of more than one (say, two) Note Groups, and if both of those Note Groups have a Note at the same timestep (say, 2-13-2007), then only ONE of those Notes will be preserved in the DMI operation.

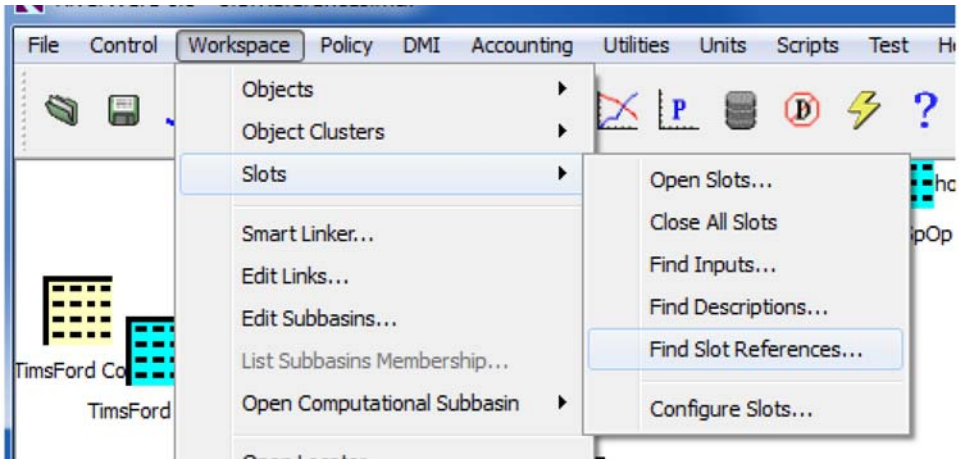
Finding Slot References

RiverWare models are often built by multiple modelers over many years. Sometimes, slots are created for a particular task. When the task is over, the slot is set aside and may never be used again, but no one wants to delete the slot for fear that it is accessed somewhere else. In addition, you may want to know where a slot on a simulation object is used. Are there any plots or output devices for Reservoir.Outflow? Is it imported or exported by any DMIs? There are many places in RiverWare where a slot can be referenced. Finding these references for a particular slot would be a very tedious and time-consuming task. For this reason, a utility was created to centralize and streamline this search process. This section describes this utility which searches through a model to find references to specified slots.

The utility then lists where the slot is referenced and you can investigate the matches. If you determine that the slots are obsolete or no longer necessary, you can delete the slots (custom slots) directly from this utility.

Find Slot References Dialog

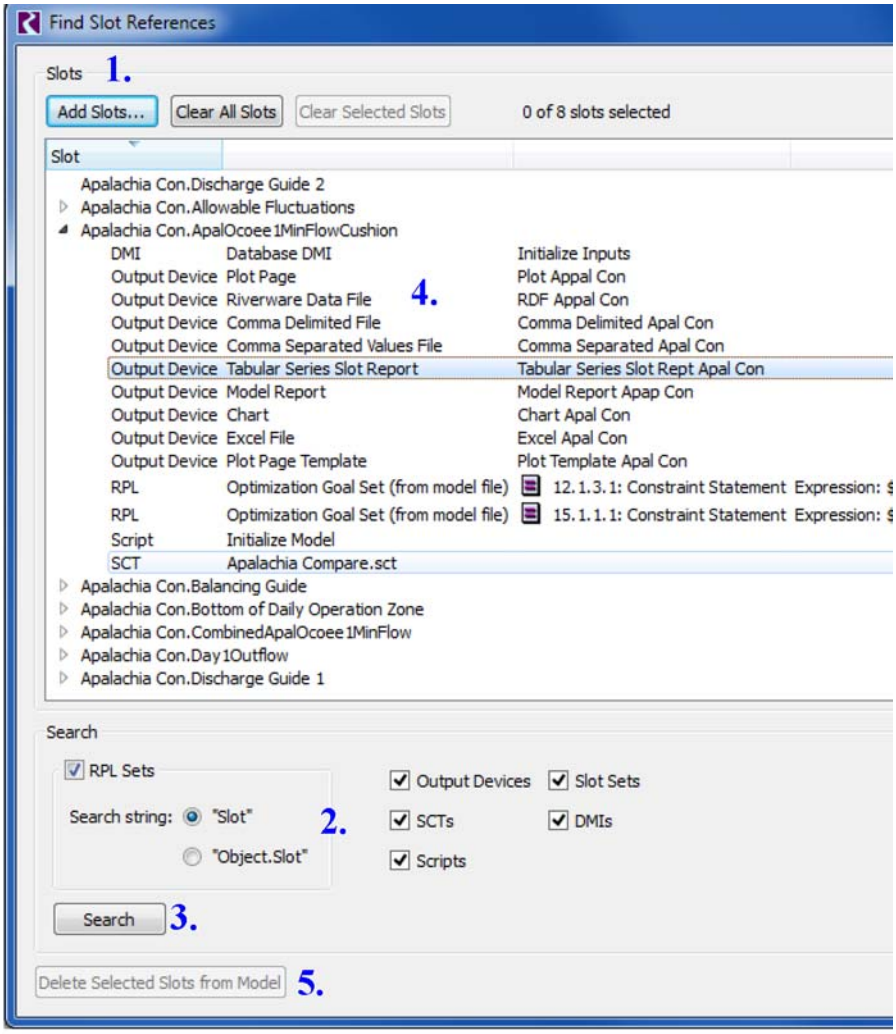
The Find Slot References dialog is available from the **Workspace**, then **Slots** menu.



The general work flow of the dialog is as follows:

1. Add slots to the list.
2. Select the areas to search.
3. Initiate the search for references to the chosen slots.
4. Found references are listed as items under the slot. Double-click an item to open that reference.

5. Slots no longer needed can be selected and deleted from the model using the **Delete Selected Slots from Model** button.



The following sections describe these steps and configuration options in more detail.

Selecting Slots to Search

The Slots frame is where you select the slots for which to look for references.

- **Add Slots. O**pens the slot selector to choose slots to add to the list.
- **Clear All Slots**. Removes all slots from the slot list.
- **Clear Selected Slots**. Removes only the selected slots from the list.

Selecting Areas to Search

Check the areas where you would like to search for references to your slots and select the **Search** button to initiate the search. Search results are listed as items under each slot. Sorting the search results by selecting the row header will group together slots with results versus slots without results. Following is a description of the areas to search:

- RPL Sets. Search through the following RPL expressions/sets open in the RiverWare session:
  - Expression Slots (i.e. the RPL expressions shown on the open slot dialog)
  - Expression Slot Functions Set
  - Global Functions Sets
  - Initialization Rules Set
  - Iterative MRM Rules Set
  - Object Level Accounting Method Set
  - Optimization Goal Sets
  - Rulebased Simulation Rulesets

  The two options allow for the search string to be the "Slot" name or the complete "Object.Slot" name. Any occurrences of the specified string in RPL will be located, so may identify places that are not actually references to the slot. For example, if you have BigRes.Inflow in the slot list, the following will occur:
  - "Slot" Any occurrence of the string "Inflow" will be found including references to the Inflow on each reservoir, reach, control point, etc in the model. But, this setting is useful to search RPL logic where the slot names are created during RPL evaluation. For example a FOR loop that is looping over reservoirs and creating the slot using the expression: Res."Inflow".
  - "Object.Slot" Only occurrences of the slot/string "BigRes.Inflow" will be found. The search is a basic text search, so the utility will find references to BigRes.Inflow and BigRes.Inflow Sum.

  Double-clicking a RPL result item will open the associated RPL set dialog so you can examine the reference.
- Output Devices. Search through output devices to see if the specified slots are referenced in the configuration of the device. An output device result line gives the type of the device and the device's name. Double-clicking the line will open the configuration dialog for the device.
- SCTs. Search open SCTs to find specified slots in the configuration of the SCT. An SCT result line gives the name of the SCT and double-clicking the line brings up the associated SCT dialog.

  Note: A slot may be used in the configuration of a custom summary row for the SCT that might not be visible under the current SCT view orientation.
- Scripts. Search scripts in the model to find references to the specified slots in script actions. A script result line gives the name of the script and double-clicking the line opens the script editor dialog.
- Slot Sets. Search for references to the specified slots in Slot Sets. A result line gives the name of the Slot Set. Double-click the line to open the Slot Set Manager.
- DMIs. Search DMIs in the model to find if the specified slots are imported or exported with the DMI. A DMI result line gives the type of the DMI and its name. Searching control file-executable and trace directory type DMIs requires parsing the associated control file. If there is a problem during this DMI validation, error

messages will be posted in the diagnostic window. Double-clicking a DMI result line will open the DMI's edit dialog.

Deleting Slots

If you search for references to one or more slots and find that they are no longer needed, you can use the **Delete Selected Slots From Model** button at the bottom of the dialog to permanently delete them from the model. This is only allowed for custom slots. If the slot is a simulation slot, these are not deleted; a warning message is issued indicating the number of slots not deleted.

Slot Sets

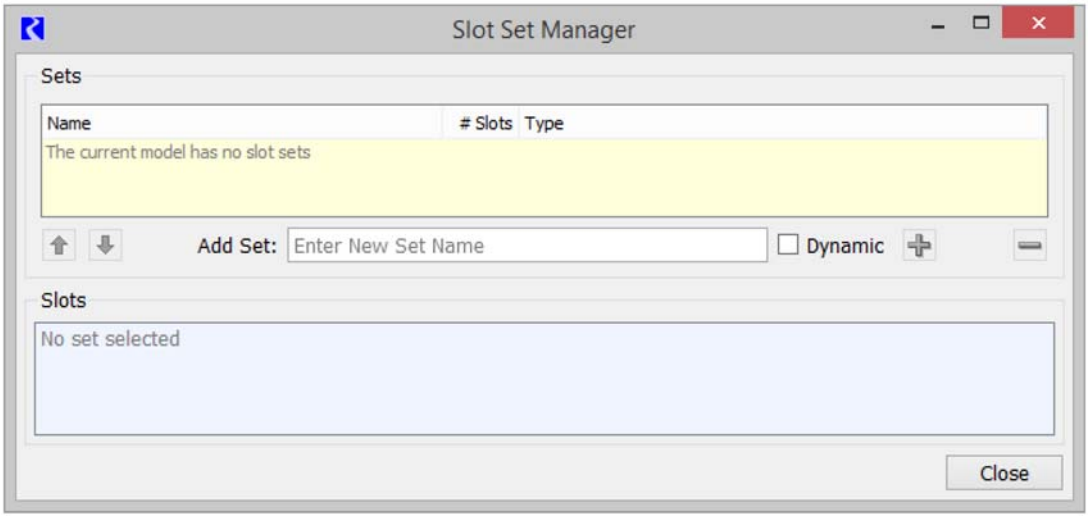
Many utilities in RiverWare require you to specify a set of slots, e.g., as part of the configuration of DSS datasets, scripts, and output devices. You can either specify the slots in the configuration of each utility or you can create and name a collection of slots in the Slot Set Manager and refer to that set in one or more utilities.

A *Slot Set* is a named collection of slots. Slot sets support wild card entries and can be referenced in contexts that require a user-specified set of slots, such as Script actions, DMI datasets, and Output Devices. Where the same set of slots is used in multiple contexts within the same model, the use of named slot sets eliminate duplication of input effort and ensures consistency across the multiple uses. Within RPL, Slot Sets provide a reusable collection of slots that can be referenced by a RPL predefined function.

Slot Set Manager

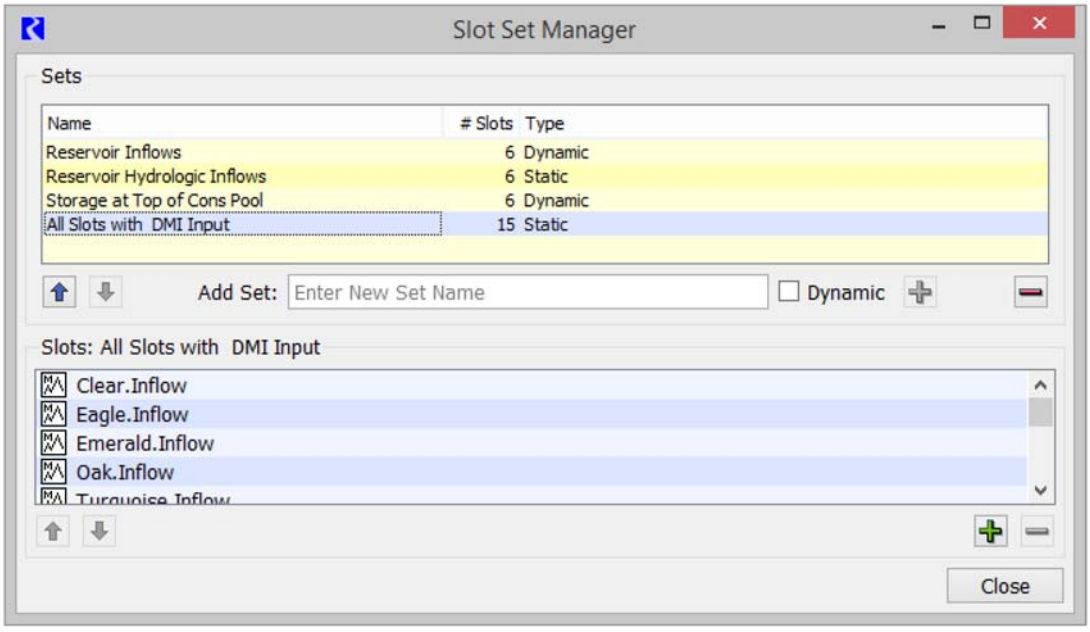
Slot sets are created, deleted and organized in the Slot Set Manager.

To open the Slot Set Manager, use the **Workspace**, then **Slots**, then **Slot Set Management** menu. The Slot Set Manager dialog appears.



The upper portion (the Sets panel) shows the sets defined in the model; if one of these slots is selected, the lower portion (the Slots panel) lists the slots in the selected set. Figure 5.46 shows the Slot Set Manager dialog for a model with multiple sets.

Figure 5.46



The selected set in the Sets panel is highlighted in blue, and its slots are shown in the Slots panel. In addition to the slot set name, the Sets panel shows the number of slots in each set and whether the set is Dynamic or Static.

To rearrange the order of the sets, use the arrow buttons to move the selected row up or down. To create a new Set, enter a name in the Add Set field, choose whether it is Dynamic (or conversely Static) and then select the green **Plus** button. A slot selector will open allowing you to define the slots in the set.

> **Note:** Choosing whether a set is dynamic or static must be done at the time the set is created. It influences how the slot selection is made. The type of set cannot be changed later; although you can delete and re-create it.

The two types of sets are as follows:

- **Static Slot Sets** contain an ordered list of slots that will not change automatically. You can add and remove slots from the set manually, as well as rearrange their order, but the set will not be updated if slots are added to the model. See "Static Slot Sets" on page 290 for details.
- **Dynamic Slot Sets** contain a symbolically specified slot selection. With this type of set, if you add an object or slot to the model that meets the set definition, it will automatically be added to the set. See "Dynamic Slot Sets" on page 291 for details.

Static Slot Sets

Static Slot Sets contain a list of slots that will not change automatically. The contents and order of slots in a static set are specified when the set is created and only change when the slot set is edited.

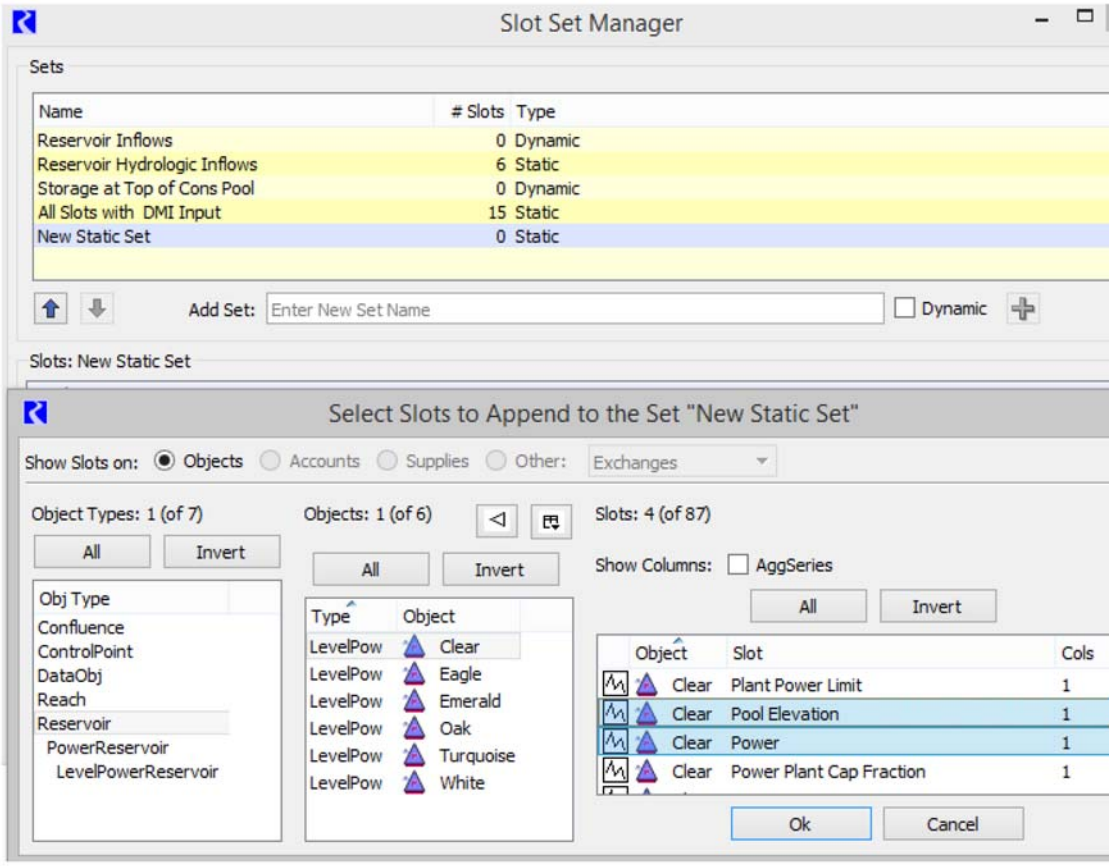
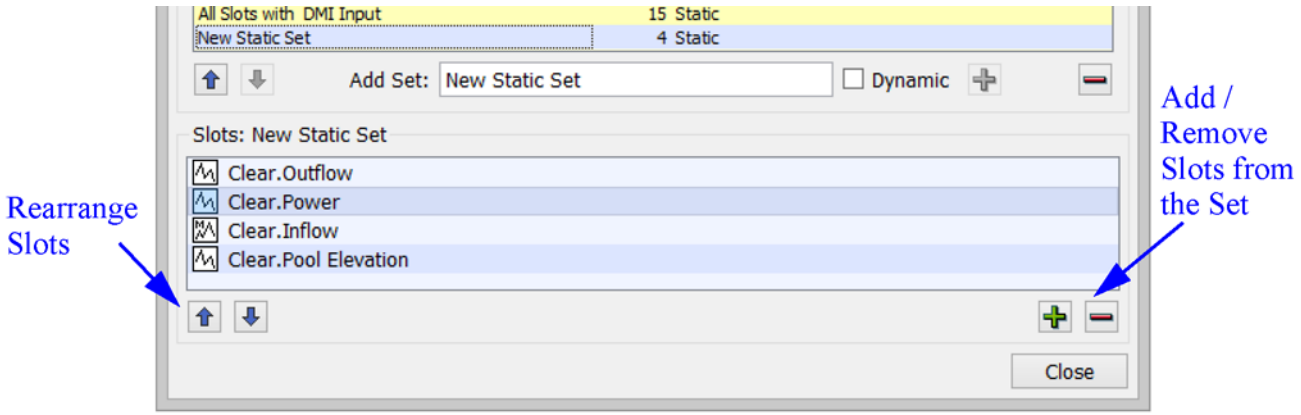


Figure 5.47 shows the resulting Static set.

Figure 5.47



Notice the buttons to rearrange the slots and add or remove slots from the set.

Dynamic Slot Sets

Dynamic Slot Sets contain a symbolically specified slot selection. The contents and order of the slots in a dynamic slot set are determined when the set is used, by evaluating the set specification. The set specification may include wild cards and filters, which could lead to different results for different evaluations.

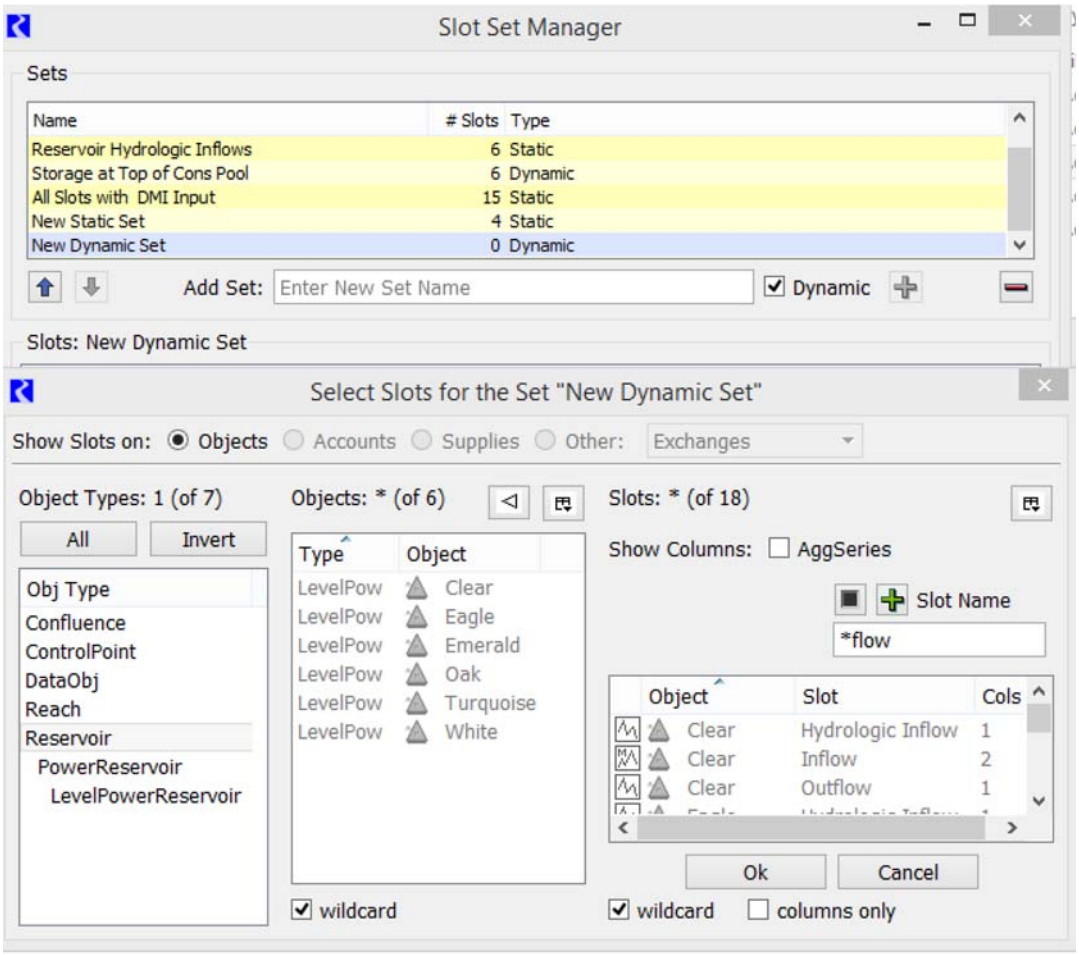
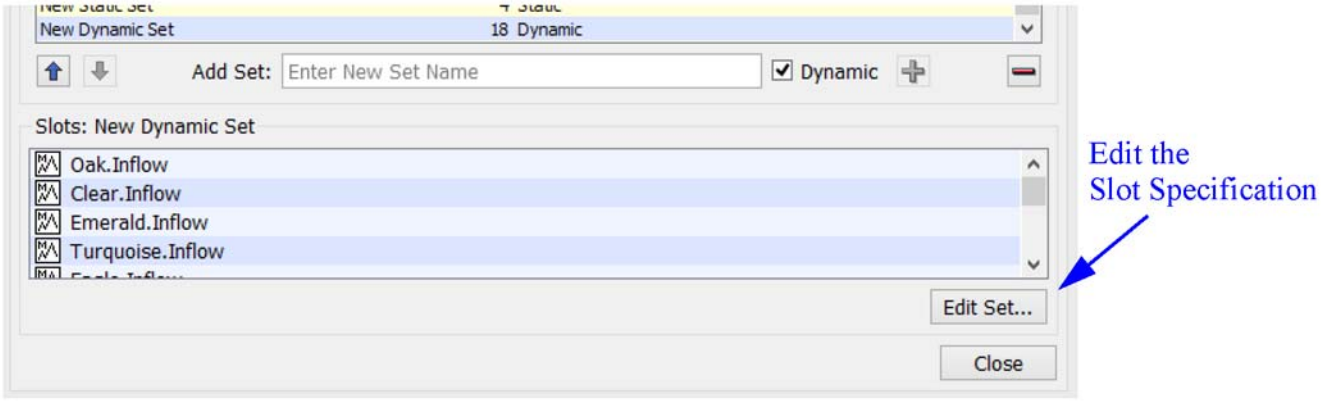


Figure 5.48 shows the resulting set.

Figure 5.48



Note: There are no buttons to rearrange the slots, as the order in a dynamic set is indeterminate. Also, you cannot add or remove slots, but instead you can **Edit Set** to modify the selection.

Referencing Slot Sets

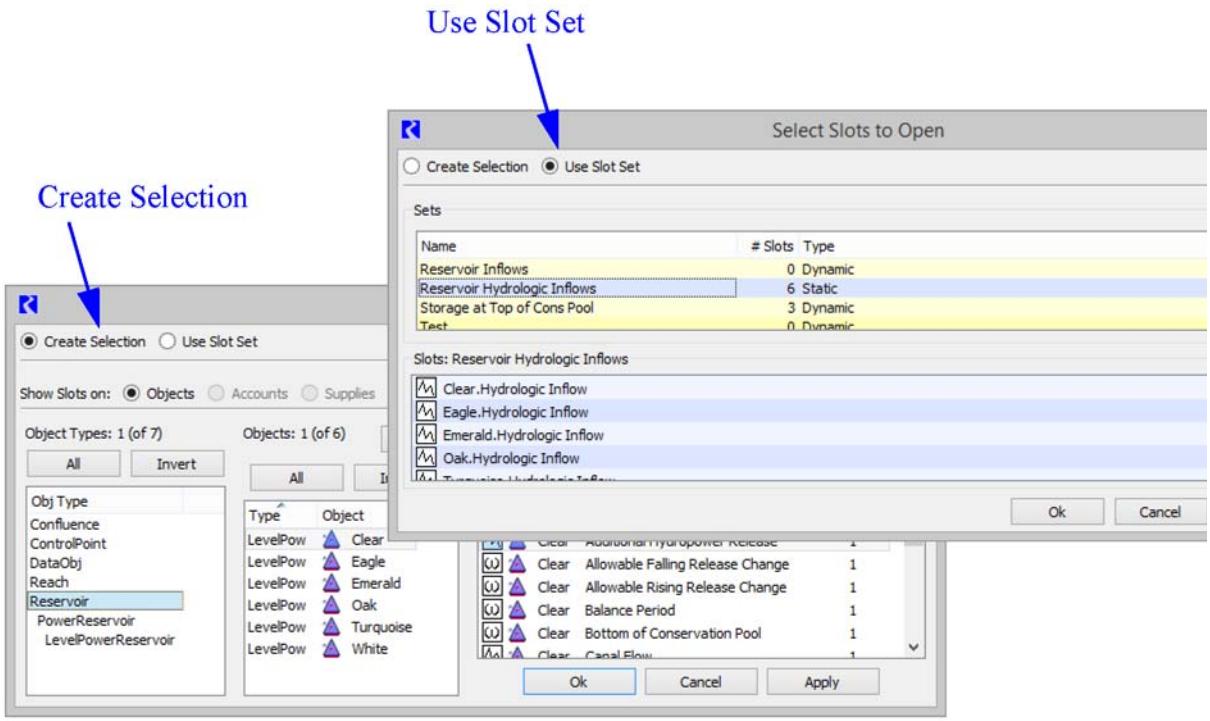
The power of Slot Sets is realized when you refer to a Slot Set from various applications. Examples include Scripts setting one or more slots, DMI slot selections, and RPL accessing lists.

This section describes how to reference sets in the Selector and from RPL and DMIs.

Using Slot Sets When Selecting Slots

Slot sets can be referenced in most places that a Slot Selection is made. To refer to a Slot Set, in the Selector, choose **Use Slot Set** instead of **Create Selection**. Figure 5.49 shows both views.

Figure 5.49



Within the Use Slot Set view, select the desired Slot Set. The slots in that set are shown in the lower, non-editable panel. Select **Ok** to confirm.

See "Use Slot Set" on page 316 for details.

> **Note:** When the application only needs one slot (like adding a curve to a plot), the first slot in the Slot Set is used.

Using Slot Sets in RPL and DMIs

Slot Sets can be referenced from RPL logic using the `ListSlotSet` predefined function; see "ListSlotSet" in *RiverWare Policy Language (RPL)*. This function returns a list where each item is a slot in the set.

Within Database DMIs, Slot Sets can be referenced within the Slot Selection as described above. Within Control-File Executable and Trace Directory DMIs, Slot sets can be referenced using the key word SlotSet and the set name. Thus, the slot specification of a control file entry is:

```
SlotSet.<slot set name>
```

For example, `SlotSet.Reservoir Hydrologic Inflow: file=~/%o.%s` would expand to all of the slots in the Reservoir Hydrologic Inflow set.

See "Object.Slot Specifications" in *Data Management Interface (DMI)* for details.

Chapter 6
Run Control

The Run Control dialog controls the execution of a run, as well as providing the interface for selecting the solution type, timestep, and run times.

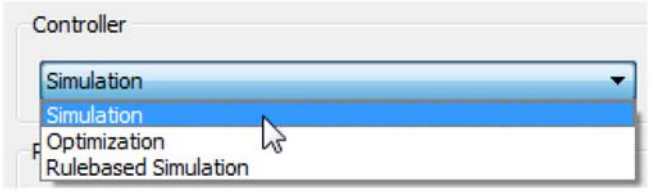
Topics

- Controllers, page 295
- Controller-specific Parameters, page 296
- Timestep, page 299
- Run Times, page 300
- Making a Run, page 301
- Aborted Run, page 303
- Synchronization, page 303

Controllers

There are three basic solution techniques, or controllers: Simulation, Optimization, and Rulebased Simulation, Rulebased Simulation and Optimization both require the construction of a Simulation model; therefore, all models need a basic simulation component. For this reason, the Simulation controller is the default selection when the Run Control dialog is first opened. To select a different controller, click on the **Controller Option** menu to view the other controller choices.

A large number of slots are associated with each controller. When an object is created, it is initialized with the slots belonging to the selected controller. When a new controller is selected after the objects have been constructed, the original slots remain in memory and new slots are allocated for the new controller. This situation may leave many unnecessary slots which affect memory and model size. When building the initial simulation model, the Simulation controller must be selected.



Controller-specific Parameters

Each controller has specific parameters which are set through an extension of the Run Control dialog. The additional dialog is invoked using the **View**, then **<Controller> Run Parameters** menu, depending on the selected controller.

Simulation Run Parameters

Max Iterations(EngrObj Slots)

This value represents the maximum number of times a slot can be reset or recalculated on a given timestep.

Series Extension Increment

RiverWare allocates space for the entire run length of each series. If, during the run, timesteps beyond the run are given values, RiverWare has to extend the series and copy over all the existing values, because RiverWare requires that the series values be stored in contiguous memory. This is a time consuming operation, so it is in the users' interest to avoid this operation. Thus, this parameter allows the users to allocate a little extra space if they know that their models will be solving for timesteps beyond the end of the run. This is particularly important where reach routing causes timesteps beyond then end of the run to acquire values. For example, if a reach has a routing coefficient vector of 40 elements, the series extension increment should be at least 40. A second example is if the model solves into the future throughout a defined forecast period. Set the Series Extension Increment equal to the forecast period as that many timestep will be required at the end of the run.

Warn when Values are out of Bounds

Series slots have upper and lower bounds that are used as part of an optimization solution. Using this parameter, you can show a warning message when values set in Simulation or Rulebased Simulation are outside these bounds. See "Configure Slot Dialog Functionality" on page 175 for details.

Water Quality

Also in this dialog, Water Quality calculations may be enabled and configured. See "Water Quality Overview" in *Water Quality* for details.

Number of Post-Run Dispatch Timesteps

Sometimes, computations are required past the end of the run. This is particularly true for models with lags and forecasting algorithms. For example, if you are trying to determine how much water to release on the run's finish timestep and you have a two timestep lag to the controlling location, you need the downstream reaches to dispatch two timesteps past the end of the run.

The Number of Post-Run Dispatch Timesteps parameter represents the number of timesteps past the run finish timestep for which object dispatching will be allowed. Whether an object dispatches or not still depends on the knowns and unknowns, i.e. the dispatch conditions. Also, additional data may be required for the objects to correctly dispatch and solve. Data defaults (like reservoir diversion) will be set past the end of the run, too. Note, the Number of Post-Run Dispatch Timesteps is controller specific, that is, it can be different for the Simulation and Rulebased Simulation controllers.

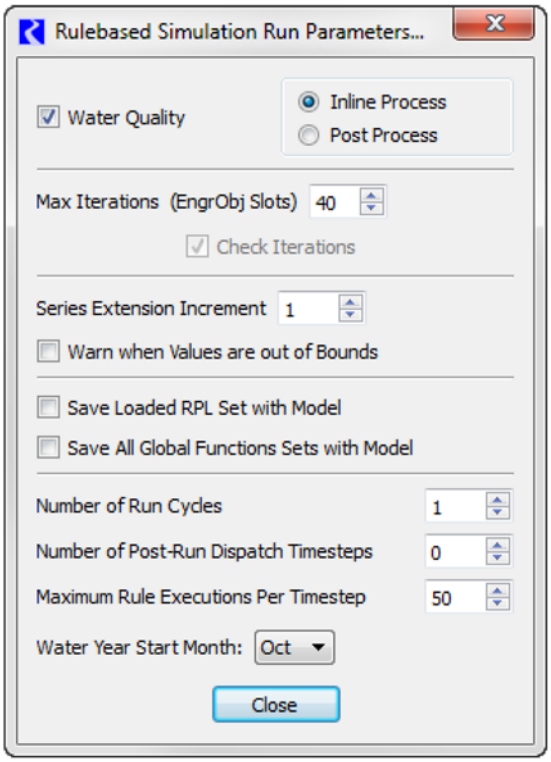
Water Year Start Month

This is the start month of the water year. This is currently only used by the Time Aggregation Series Slot computation. See "Annual Aggregation Support for Non-calendar Water Years" on page 255 for details.

Save All Global Functions Sets with Model

This checkmark specifies that any open Global Functions RPL sets should be saved with the model file. See "Save Location" in *RiverWare Policy Language (RPL)* for details.

Rulebased Simulation Run Parameters



Water Quality

Water Quality calculations may be enabled and configured. See "Water Quality Overview" in *Water Quality* for details.

Max Iterations(EngrObj Slots)

Represents the maximum number of times a slot can be reset or recalculated on a given timestep.

Series Extension Increment

RiverWare allocates space for the entire run length of each series. If, during the run, timesteps beyond the run are given values, RiverWare has to extend the series and copy over all the existing values, because RiverWare requires that the series values be stored in contiguous memory. This is a time consuming operation, so it is in the users' interest to avoid this operation. Thus, this parameter allows the users to allocate a little extra space if they

know that their models will be solving for timesteps beyond the end of the run. This is particularly important where reach routing causes timesteps beyond then end of the run to acquire values. For example, if a reach has a routing coefficient vector of 40 elements, the series extension increment should be at least 40. A second example is if the model solves into the future throughout a defined forecast period. Set the Series Extension Increment equal to the forecast period as that many timestep will be required at the end of the run.

Warn when Values are out of Bounds

Series slots have upper and lower bounds that are used as part of an optimization solution. Using this setting, you can show a warning message when values set in Simulation or Rulebased Simulation are outside these bounds. See "Configure Slot Dialog Functionality" on page 175 for details.

Save Loaded RPL Set with Model

This checkmark specifies that the loaded RBS ruleset should be saved with the model file. See "Save Location" in *RiverWare Policy Language (RPL)* for details.

Save All Global Functions Sets with Model

This checkmark specifies that any open Global Functions RPL sets should be saved with the model file. See "Save Location" in *RiverWare Policy Language (RPL)* for details.

Number of Run Cycles

This integer value controls how many times the rulebased simulation controller will cycle through the timesteps. See "Run Cycles" in *Solution Approaches* for details.

Number of Post-Run Dispatch Timesteps

Sometimes, computations are required past the end of the run. This is particularly true for models with lags and forecasting algorithms. For example, if you are trying to determine how much water to release on the run's finish timestep and you have a two timestep lag to the controlling location, you need the downstream reaches to dispatch two timesteps past the end of the run.

The Number of Post-Run Dispatch Timesteps parameter represents the number of timesteps past the run finish timestep for which object dispatching will be allowed. Whether an object dispatches or not still depends on the knowns and unknowns, i.e. the dispatch conditions. Also, additional data may be required for the objects to correctly dispatch and solve. Data defaults (like reservoir diversion) will be set past the end of the run, too. Note, the Number of Post-Run Dispatch Timesteps is controller specific, that is, it can be different for the Simulation and Rulebased Simulation controllers.

In RPL, you can access the timestep represented by the function using the DispatchEndDate function; see "DispatchCount" in *RiverWare Policy Language (RPL)* for details.

Maximum Rule Executions Per Timestep

This value indicates how many times a single rule can execute on each timestep.

Water Year Start Month

This is the start month of the water year. This is currently only used by the Time Aggregation Series Slot computation. See "Annual Aggregation Support for Non-calendar Water Years" on page 255 for details.

Accounting

If Accounting is enabled, the following parameters are added to either the Simulation or Rulebased Simulation parameters described above:

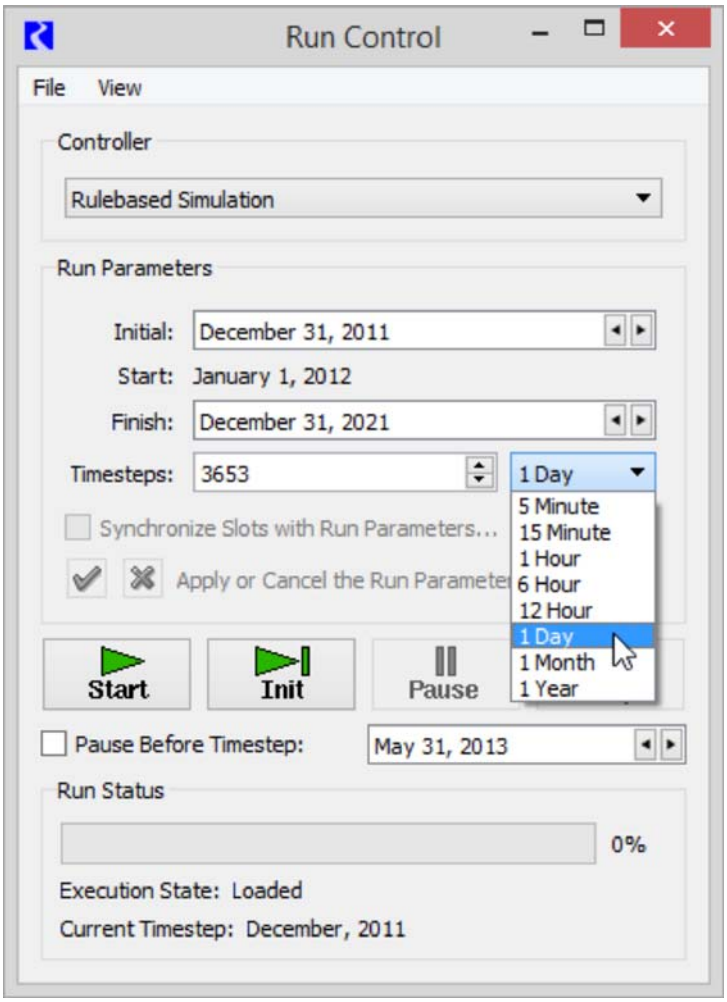
Max Iterations (Account Slots)

This parameters represents the maximum number of times an account slots can be reset or recalculated.

Timestep

Many different timesteps are available for simulation. The currently selected timestep is shown on the **Timestep** menu (see Figure 6.1). When the Run Control dialog is invoked on an empty workspace, it has the default timestep value of 6 Hour. You must select the desired timestep before building a model. This facilitates data entry by initializing new objects to the desired run times.

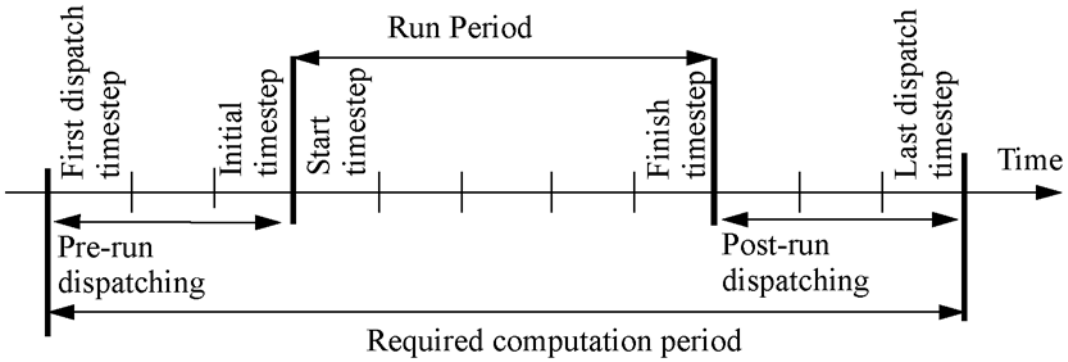
Figure 6.1 Run Control showing Timestep menu



Run Times

The initial time, end time, and duration of the run are set through text fields on the Run Control panel. RiverWare's time management system requires that times for data and for the run be given in actual time (hour, day, month and year), rather than relative time, as is seen in many other modeling systems. Figure 6.2 illustrates runtime term definitions.

Figure 6.2



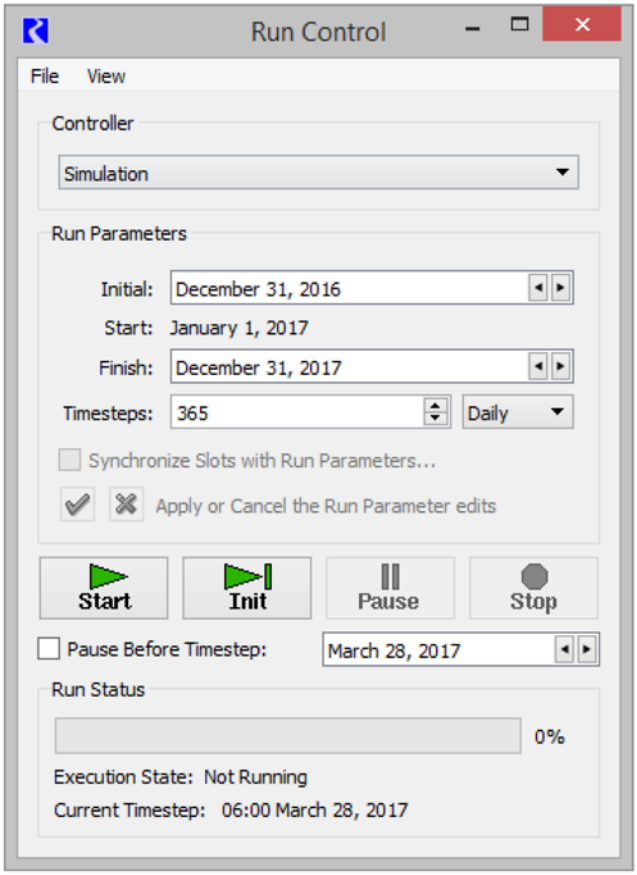
The Initial time is the time at which the simulation begins and the beginning of the first timestep. Initial condition data are required at this timestep. Solutions are reported at the end of each timestep. The Start time is the end of the first timestep and is the first time at which output is given. The Finish time is the end of the last timestep of the run. The Timesteps field contains the number of timesteps in the run. For 1, 6, or 12 hour timesteps, the time of day is displayed. RiverWare denotes midnight as 24:00 hours instead of 0:00 in the next day. For all other timesteps, the time of day is not displayed.

Changing the Initial time changes the Finish time accordingly; run Timesteps remain the same.

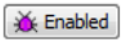
Valid dates in RiverWare are from 24:00 December 31, 1799 to 23:00 December 31, 3799.

Making a Run

The dialog is invoked by selecting **Control**, then **Run Control Panel** from the workspace menu bar or by clicking on the **Run Control** toolbar button. 



The buttons are used to control the execution of a model. They are as follows.

-  **Confirm**. Confirm run control changes (i.e., changes to number of timesteps, run parameters, or simulation type).
- . **Reject**. Reject run control changes.
-  **Enabled** or **Disabled**. Optionally shown, RPL Debugging is enabled or disabled. See "Enabling RPL Debugging" in *Debugging and Analysis* for details.
- **Start**. Execute a run.
- **Init**. Execute initialization or the next timestep only. (If no run is in progress, execute initialization. The second click of the Step button executes the first timestep)

- **Pause**. Interrupt execution after the current timestep.
- **Continue**. Continue execution from the current timestep. (When the run is started the start button becomes the continue button)
- **Stop**. Abort execution after the current timestep.
- **Pause Before Timestep**. Pause the run before the specified timestep. This is particularly useful when debugging a model run.

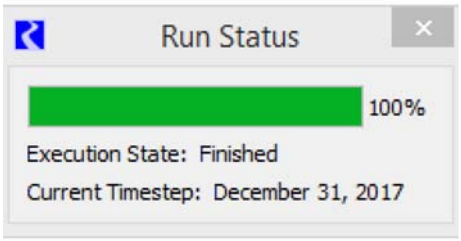


- **Execute Initialization Rules**. Specify whether to execute Initialization Rules. The checkbox is only available when Initialization Rules are defined. See "About RPL Sets" in *RiverWare Policy Language (RPL)* for details.

When a run is not in progress, only the **Start** and **Step** buttons are available. If changes are made to the run dates, the timesteps, or other Run Control parameters, the **Check** button must be clicked to enable all the other Run Control buttons. The **Continue**, **Step** and **Pause** buttons are then enabled after the Initializing period has ended.

When a run is started, the Run Status area is updated. You can see a separate version of this dialog using the **View**, then **Run Status** menu.

The indicator bar moves from left (start) to right (finish), indicating the progress of the run. The Execution State: also indicates the state of the run with a status description. The possible Execution States are: Initializing, Running, Finished, Stopped, Waiting, Paused, and Aborted.



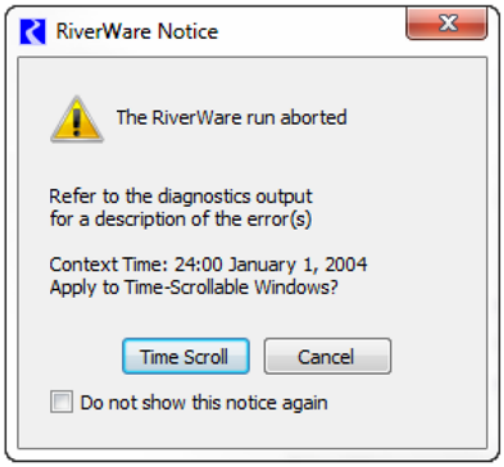
The Controller Clock (date and time of the currently executing timestep expressed in units of the selected timestep size) is displayed under the Execution State. Due to time horizon dispatching, the Controller Clock may not represent the timesteps of all objects being solved. See "Time Horizon Simulation" in *Solution Approaches* for details.

> **Note:** When there is more than one Run Cycle, the Run Cycle is listed in the Timestep and there are controls for the Run Cycle in the Pause Before Timestep line. See "Run Cycles" in *Solution Approaches* for details.

Aborted Run

If a run cannot continue because of errors, a RiverWare Notice window will be shown and error messages will be posted to the diagnostic output window; see "Diagnostic Output Window" in *Debugging and Analysis* for details. The user has the following options from the confirmation window:

- **Time Scroll**. Scroll all time-scrollable windows to the context time. The user can select to scroll all time windows, like the Open Slot dialog, SCTs and the Plot window to this date. This saves the user time when debugging the model.
- **Cancel**. Close the dialog, but do not Time Scroll.
- **Do not show this notice again**. Request that the dialog not be shown again. If this box is selected, then subsequent aborts will use the same selection (Time Scroll or Cancel) and the dialog will not be shown. This applies only to the current RiverWare session.



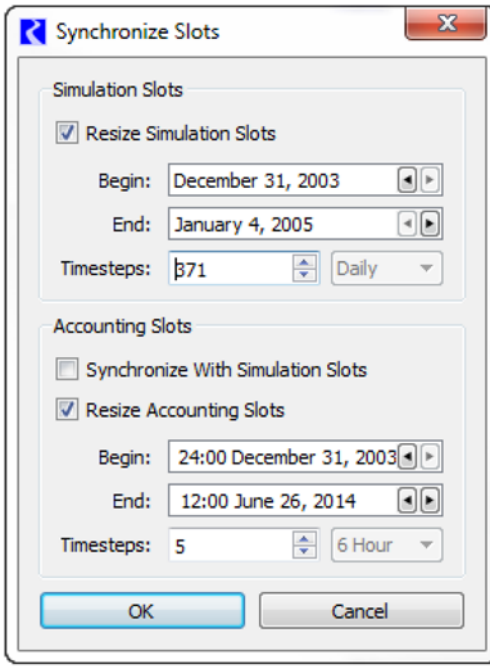
Synchronization

There are two ways to synchronize all or selected objects to the either the run control or a specified period: by changing the run control and applying the changes through its child dialogs, or by using the Synchronization Control dialog. These two methods are described below

Synchronize From Run Control

On the Run Control, after making changes to the run range, the user is presented with the green check and red X to either apply the changes or cancel the changes. Also, the **Synchronize Slots with Run Parameters** checkbox is enabled. If checked, when the green check is clicked, the Synchronize Slots dialog is opened. This dialog allows the user to configure how the slots should be resized. The default Begin, End and number of Timesteps is taken

from the Run Control. The user can optionally synchronize accounting slots with the simulations slots or enter a different time range.



If changes are made to the timestep size, the **Synchronize Slots with Run Parameters** checkbox is not available, rather the Synchronize Timestep Change dialog is opened when the green check is clicked to apply run parameter changes. This dialog allows the user to optionally synchronize objects with the new timestep. An option allows for exclusion of slots with timesteps different than the original timestep. If the timestep change represents a valid aggregation, options are presented to aggregate input data in slots to the new timestep. Valid aggregations are as follows:

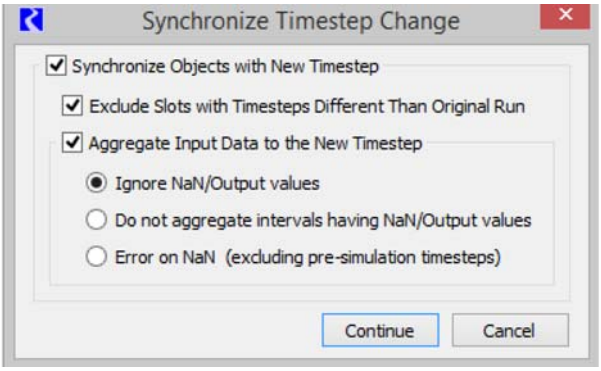
- 1 Hour, 6 Hour, 12 Hour, or 1 Day aggregating to 1 Month
- 1 Hour, 6 Hour, 12 Hour, 1 Day, or 1 Month aggregating to 1 Year

The following options are available for how to treat NaNs when aggregating input data:

- **Ignore NaN/Output values**. NaNs or Output values do not contribute to the aggregated values. Intervals with some inputs and some outputs or NaNs will become inputs at the larger timestep.
- **Do not aggregate intervals having NaN/Output values**. Any interval with NaNs or an output value is not aggregated. Intervals with some inputs and some outputs or NaNs will be NaN at the larger timestep.

  Note: For the Last aggregation function, only the Last timestep is considered. Other timesteps do not matter in their NaN/Output status.

- **Error on NaN (excluding pre-simulation timesteps)**. An error is issued.



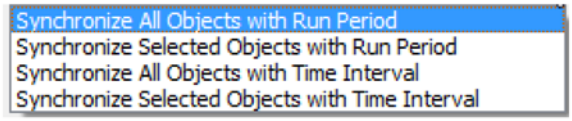
The method by which input data is aggregated is controlled by a slot's unit type. Table 6.1 provides detail. Inputs in slots with unit types *not* listed are not aggregated. An information dialog will indicate slots that were not aggregated.

Table 6.1

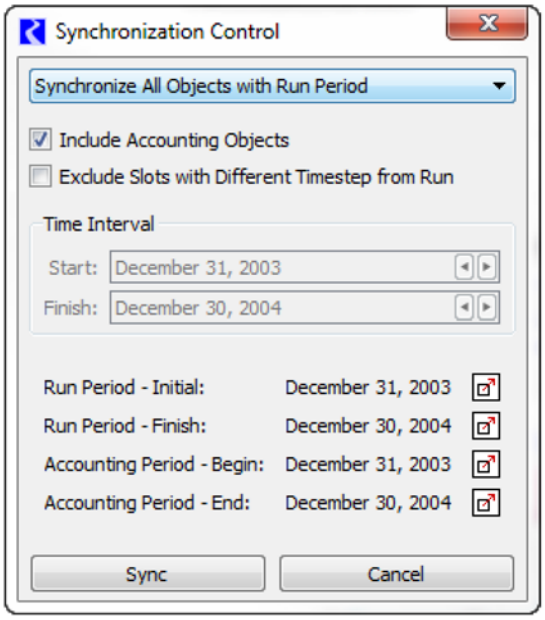
Unit Types	Aggregation Method
Area	Last
Concentration	Average
Energy	Sum
Flow	Average
Fraction	Average
Length	Last
LengthPerTemperature	Average
Mass	Sum
No Units	Last
Power	Average
PowerCost	Average
PowerPerFlow	Average
Temperature	Average
TemperatureInF	Average
ValuePerFlow	Average
ValuePerVolume	Average
Velocity	Average
VelocityPerTemperature_F	Average
Volume	Last

Synchronization Control Dialog

The Synchronization Control dialog allows the user to synchronize slots without changing the run control. To access this dialog, use the **Workspace**, then **Objects**, then **Synchronize Objects.** The user is able to synchronize all or selected objects to be synchronized to the Run Control or a separate specified time interval.



The new time interval must encompass the run control time interval. A checkbox allows users to **Include Accounting Object** in the synchronization action. A second checkbox allows the user to **Exclude Slots with Different Timestep** from the synchronization. This option may be useful, in particular, to retain data stored in data objects.



Chapter 7
Selector Dialogs

In RiverWare, a common selector dialog is used to select objects, slots, accounts and supplies. The selector can be used for the following activities:

- Simple selections, like selecting a slot to plot.
- Complicated selections like dynamically creating lists of slots in which to import or export using database DMI's.
- Choosing a previously created Slot Set.

Topics

- Selector Features, page 307
- Selecting Objects, page 309
- Selecting Slots, page 311
- Selecting Accounts, page 317
- Selecting Slots on Accounts, page 318
- Selecting Supplies, page 319
- Wildcards, page 321
- Examples, page 321

Selector Features

The appearance of the dialog depends on the required selection and the application from which the selector is invoked. For example, in any one invocation of the selector dialog, the user will be selecting only objects, only slots, or only supplies, etc. The following document describes how to use the dialog in each of the selection modes.

When creating a selection, the user starts with a general set of items and narrows it down until they can select the item they wish. In general, this is done from left to right and top to bottom. There are two main actions the user must take when making a selection: displaying the items and selecting them as described in the following section.

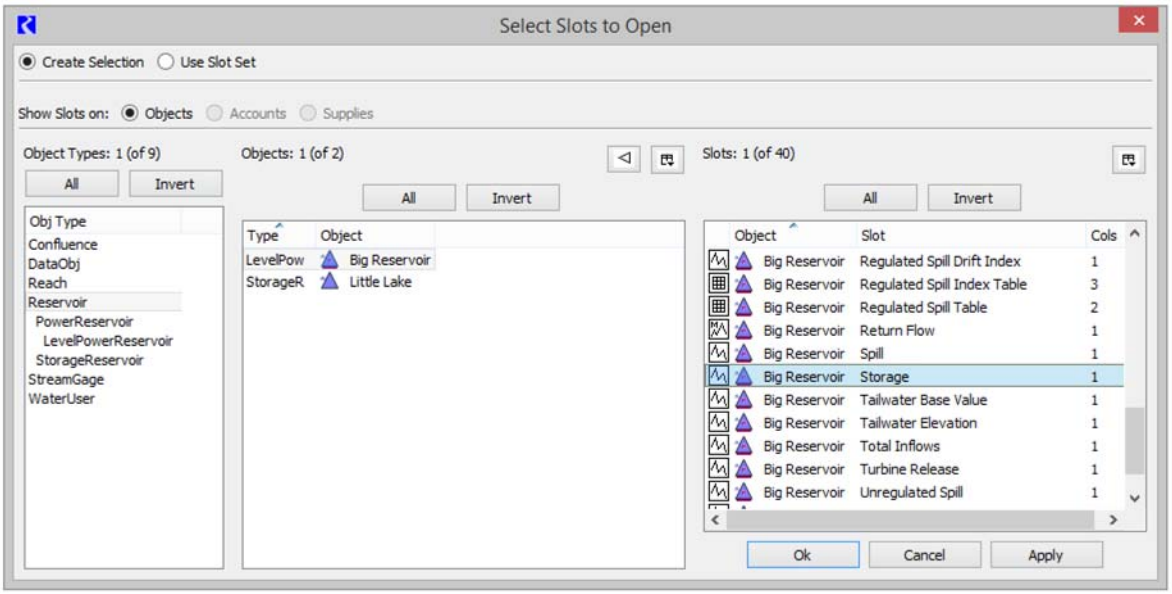
> **Note:** Selecting slots in a Slot Set is performed from the **Use Slot Set** checkbox; see "Use Slot Set" on page 316 for details.

Displaying Items and Filtering

Displaying items is accomplished from general to specific. If the user is selecting a slot, they first start on the left by highlighting one or more Object Types, and then they are able to highlight a specific object or set of objects, and then they are able to highlight the specific slot or set of slots on those objects. These items are displayed by selecting the appropriate Object Types, Objects, and Slots or using the **All** buttons to select all. In Figure 7.1, we have highlighted all Reservoirs (including Level Power and Storage) in the left most pane. Then we have highlighted the Big Reservoir object in the center pane. Shown in the right pane are all of the slots on this object.

Note: Multiple items can be highlighted in each pane.

Figure 7.1



In addition to highlighting items one at a time, there are filters which can be used to constrain the set of items displayed based on different criteria. The filters are turned on by selecting the **Filter** button , then selecting the appropriate filter. Each filter field makes use of the following two buttons: . Selecting the gray square disables that filter option. Selecting the green **Plus** symbol (thereby changing it to a red minus symbol) will result in an inverse filter. This is the equivalent of displaying those objects that do *not* match the filter: .

The filters for each type of selection (Objects, Slots, Accounts, and Supplies) is described in the each selection's section.

Making a Selection

After displaying a set of items, the user must then select the desired ones. Selecting the items consists of highlighting the desired items and selecting **OK** or **Apply**. The **All** and **Invert** buttons help the user select all items

or invert the selection items. Depending on the application, the user can also select one item, select **Apply**, then make additional selections finally selecting **OK** or **Cancel**.

Also, in certain situations, wildcards are allowed to select all of the displayed items; see "Wildcards" on page 321 for details.

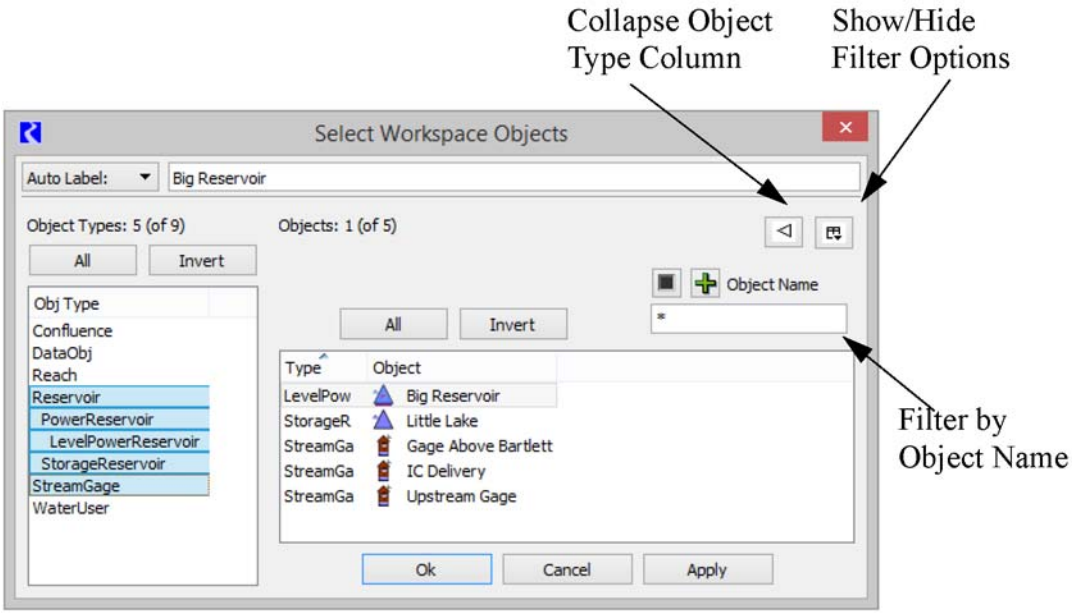
In the above example, to select the Storage slot, we highlight the line Big Reservoir Storage and select **OK** or **Apply**.

Selecting Objects

Many actions in RiverWare require the user to select an Object. For example, on the **Workspace**, then **Objects**, then **Select Objects** menu, the user can highlight a set of objects which can then be deleted, added to a subbasin, etc.

Filters can be enabled through the **Show/Hide Filter Options** button. These features exist for each of the various configurations of the selector dialog (object selector, slot selector, account selector, and supply selector).

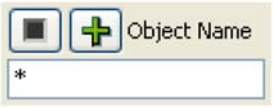
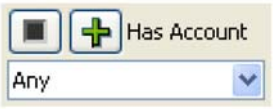
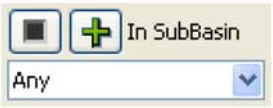
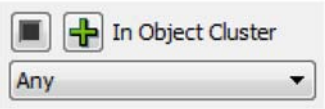
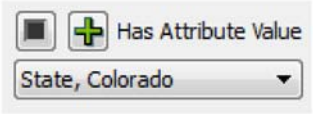
Figure 7.2



The **Object Name** filter field allows the user to type a part of the object name and use wildcard symbols (i.e. *) for name completion. For example, typing Lake* in the **Object Name** field will display only those objects that begin with "Lake". By default, a * exists in the **Object Name** field and all objects will be displayed.

Table 7.1 summarizes the Object selector filters.

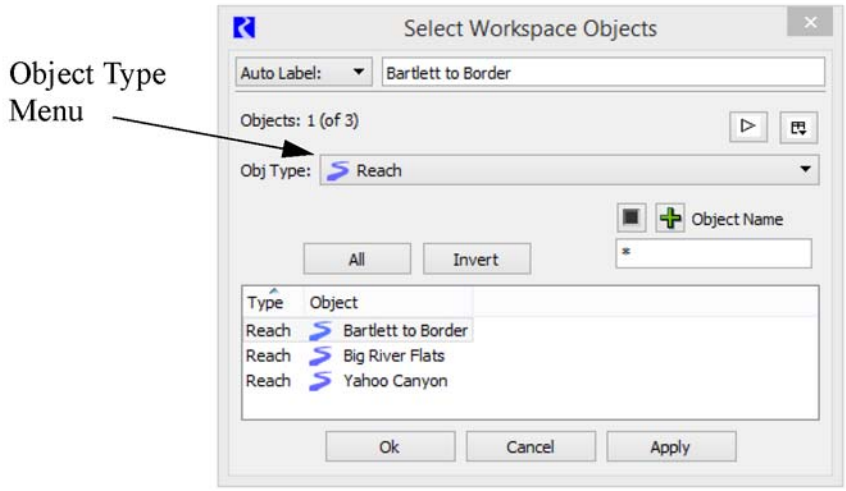
Table 7.1

Object Filter	Description	Screenshot
Object Name	Filters to only the Object which matches the text entered in the text-field. If the text is entered within asterisks (like so: *text*), then will filter only to Objects which contain that fragment of text.	
Has Account	If the model is an accounting model, the **Has Account** field can be used to show only those objects that contain a specified account. The drop down list allows the user to choose the account used for filtering. By default, the Any option is enabled and those objects that contain any account will be displayed **Note**: Objects that do not contain an account will not be displayed). The **Any: Agg & Elements** option is more inclusive than the Any option. This option will display aggregate objects that do not contain accounts if their elements do contain accounts. In the Any option, aggregate objects that do not contain accounts will not be displayed even if their elements contain accounts.	
In SubBasin	The **In Subbasin** field allows the user to select a user-defined subbasin and only show objects in that subbasin.	
In Object Cluster	The **In Object Cluster** field allows the user to select a user defined Object Cluster and only show objects in that cluster. See "Object Clusters" on page 44 for details on clusters.	
Has Attribute Value	The Has Attribute Value filter allows the user to select an Attribute/ Value pair and only show objects that have that pair. See "Object Attributes" on page 128 for details on object attributes.	

Show Object Types in an Option Menu

The user can choose to collapse the object type column into an option menu by selecting the  button. Figure 7.3 shows the object selector when this option is enabled.

Figure 7.3



All modes of the selector dialog (object selector, account selector, slot selector, supply selector) have the option of collapsing the object type column into an option menu. While each of the dialogs may have a slightly different appearance, the function of the  button remains the same.

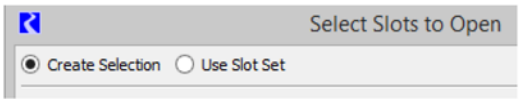
All Objects and No Objects

If appropriate, for example when selecting objects in the Diagnostics Settings dialog for filtering diagnostics by object, the **All Objects** and **No Objects** buttons will be available. If either of these options are selected, either all of the objects (regardless of filtering or selections) or none of the objects are automatically selected and the dialog is closed.

Selecting Slots

Selecting slots is one of the most common operations in RiverWare, whether for plotting, snapshots, or DMI's. To select a slot, you must also select an Object, so the Selecting Objects section is relevant here too.

When using the selector, you generally work from top to bottom and left to right. The first choice is whether to **Create Selection** or to **Use Slot Set** as shown in the image:



Create a selection if you want to choose slots on objects. Use a Slot Set if you want to use a previously defined set of slots. See "Use Slot Set" on page 316 for details on this approach.

Creating a Selection

When creating a selection, you choose the object type and objects on which the slots reside. Then you choose the slots from a panel that lists the slots. Similar to the object selector, the slot selector has fields for selecting and filtering by object and object type. These sections work the same in both the object selector and the slot selector. In addition, there are toggle buttons at the top of the dialog to specify whether or not the slots are on objects, accounts, supplies, or exchanges. Depending on the invocation of the slot selector dialog (the dialog from where the selector dialog is being invoked), these options may not be present. For example, sometimes the slot selector applies only to slots on objects or slots on accounts. In these cases, the toggle options will not be present and the dialog will appear in the appropriate configuration.

Table 7.2 summarizes the slot selector filters. Any text can be entered with the wildcard asterisks (like so: *text*), then the filter will only show Slots which contain that fragment of text.

Table 7.2

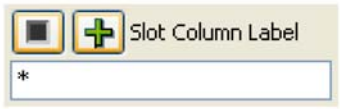
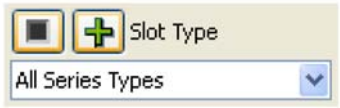
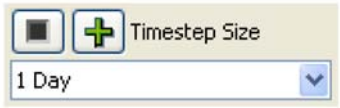
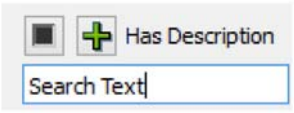
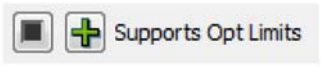
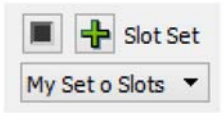
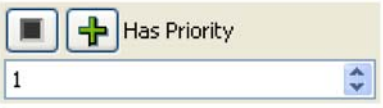
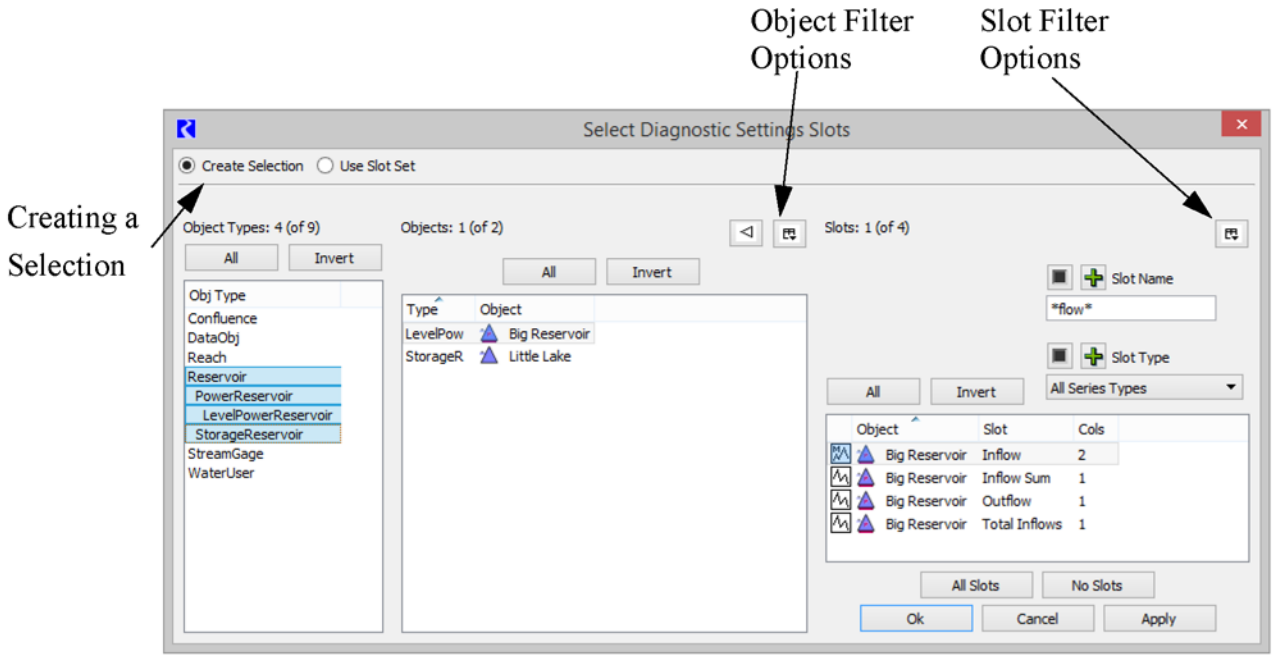
Slot Filter	Description	Screenshot
Slot Name	Filters to only the Slots whose Name matches the text entered in the text-field.	
Slot Column Label	Filters to only Slots which have a column label that matches the text entered in the text field.	
Slot Unit Type	Filters to only the Slots which have the specific Unit type selected from the drop down menu. (i.e. Flow, Length, Time, etc.)	
Slot Type	Filters to only the Slots which are of the specific Slot type selected from the drop down menu (i.e. Series, All Table Types, Series with RPL Expression, etc.)	
Has RPL Expr	Filters to only the Slots which have a RPL expression (such as a SeriesSlot with Expression or Scalar Slot with Expression).	
Timestep Size	Filters to only the Slots which have the timestep length selected in the drop-down menu.	

Table 7.2

Slot Filter	Description	Screenshot
Allows Flag	Filters to only the Slots which allow a specific flag selected from the drop-down menu (such as the Target flag on Storage or Pool Elevation Slots, or the Max Capacity flag on Outflow or Energy slots).	
Slot Attrib	The **Slot Attrib** option will filter to show only slots that are Dispatch slots or RBS Governing slots. Dispatch slots are linkable slots that trigger object dispatching when they receive a value. RBS Governing slots are the slots that dictate the solution direction (on a particular object) during rulebased simulation. They are the dispatch conditions (knowns and unknows) associated with the dispatch methods. If these options are hidden or disabled, no filtering takes place.	
Has Description	This filter finds slots which have the specified search text. Leave the field blank to locate all slots which have a non-blank description	
Supports Opt Limits	This filter is used to find table slots that are verified in optimization based on specified min and max limits.	
Is Custom	Filters to show only Custom slots; i.e. those created by the user that are not Simulation Slots.	
Slot Set	Filters to show slots that are part of the selected Slot Set.	
Has Flag	Filters to only the Slots which have a specific flag. Except for the User Input (Init Period) and User Input (Run Period), the slot will be shown if it has the specified flag at any timestep in its range.	
Has Priority	In a rulebased simulation model, filter to only show slots that have a priority equal to the specified priority. The slot will be shown if it has the priority at any timestep in the range.	
Name Uniqueness	When selecting slots on multiple objects, this filter will only show the first instance of a slot name. For example, on two reservoirs, it will only show the first reservoir's Storage slot.	

If appropriate, for example when selecting slots in the Diagnostics Settings dialog for filtering diagnostics by slot, the **All Slots** and **No Slots** buttons will be available. If either of these options are selected, either all of the slots (regardless of filtering or selections) or none of the slots are automatically selected and the dialog is closed.

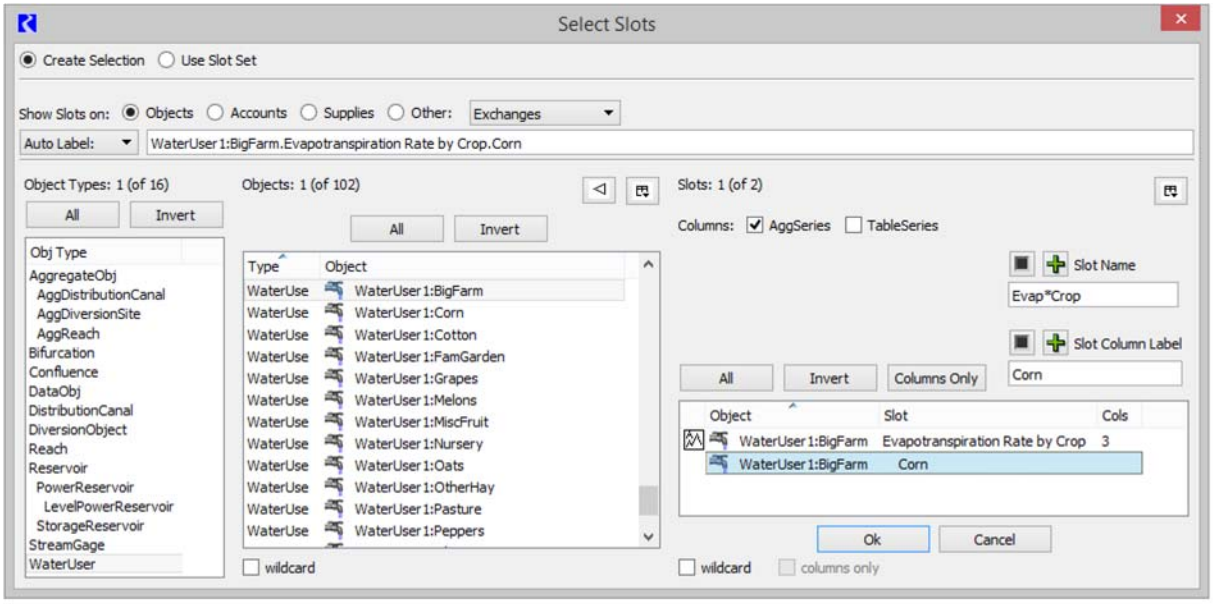
Figure 7.4



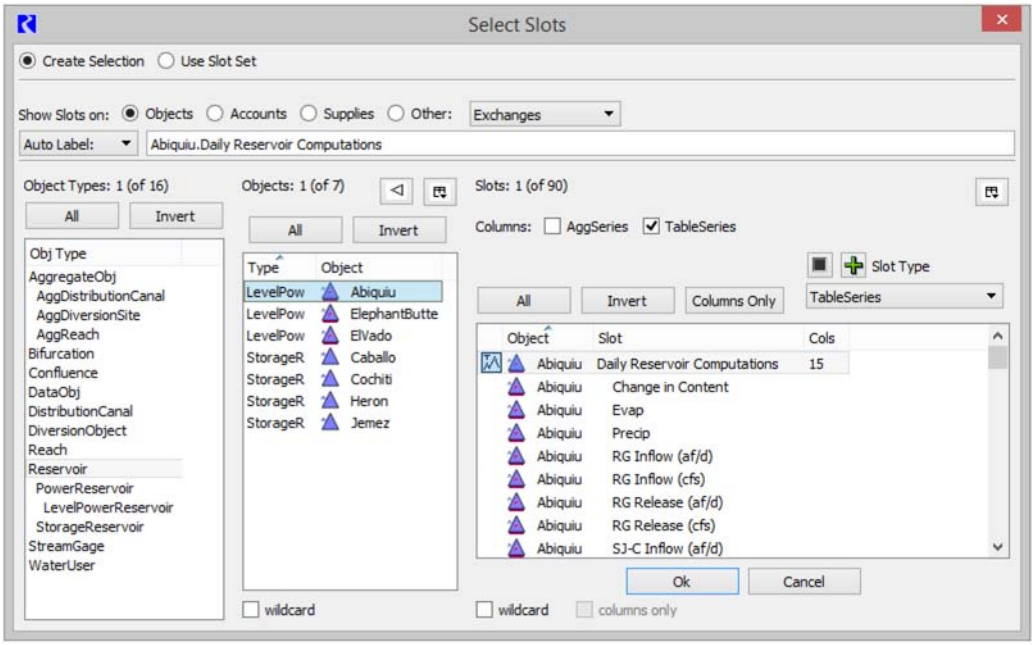
When selecting columns of an Agg Series Slots, Table Slots or Table Series Slots, the Slot Column Label Filter can be used. This is available in, for example, Database DMI Name Maps where the user can select to import column 2 of an Agg Series Slot. In addition, a push button was added to highlight Columns Only on the selection. The **Wildcard** checkbox also works for this type of selection. A **Columns Only** checkbox next to the **Wildcard** checkbox allows the user to specify that in the wildcard selection, only the columns should be selected and not the overall slot.

Following is an example of how this could be used: A user configures 5 agg series slots to contain crop water requirements for 10 different crops. (5 slots * 10 columns = 50 timeseries) When creating a name map for use in importing via the database DMI, the user sets the filter to select each of the columns that are labeled “Crop 1” across the multiple slots. The user can then specify that “Crop 1” maps to “corn” in the database Name Map. This enables the user to set up only 10 Name Maps, one for each crop, instead of the 50 that were previously required. Figure 7.5 shows the selector with the Slot Column Label Filter, and **Columns Only** button and wildcard options.

Figure 7.5



In addition to the **Columns: AggSeries** checkbox shown in the previous example, the selector has a **TableSeries** checkbox. If checked, TableSeries slot columns are displayed in the selector dialog.



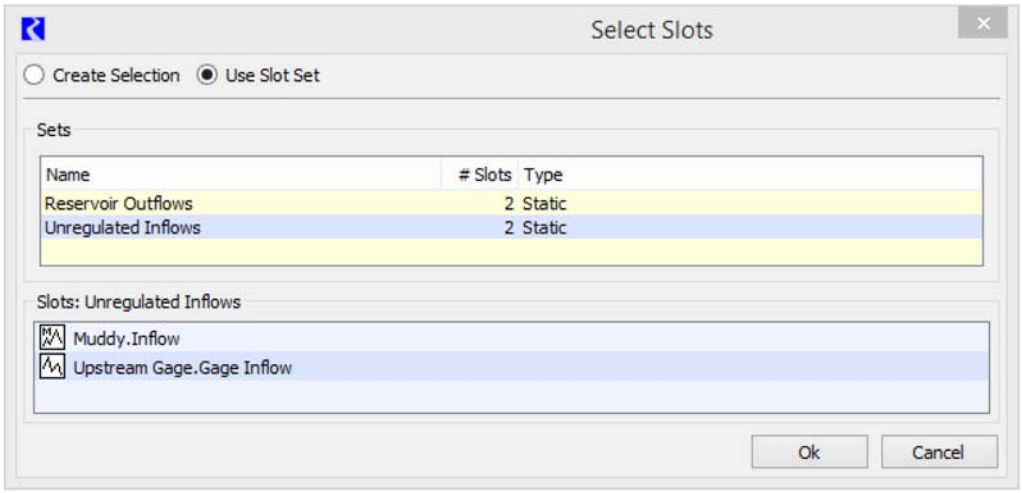
The **Columns Only** button and the **Columns only** checkbox behave for TableSeries slot columns as they do for AggSeries slot columns, as described above.

Note: When you select objects or slots for the database DMI (in the Name Map, Dataset or Database DMI dialogs) you have the option of providing a descriptive name for the selection in the **Custom**

Label menu and text box. If you don't provide a custom label then RiverWare will provide an Auto Label, which frequently is not as readable (or user-friendly) as a custom label.

Use Slot Set

Slot Sets are named collections of slots. See "Slot Sets" on page 288 for details. To use the slots that are in a Slot Set, select the **Use Slot Set** option.



With this option selected, the selector dialog shows a list of the defined Slot Sets in the upper panel.

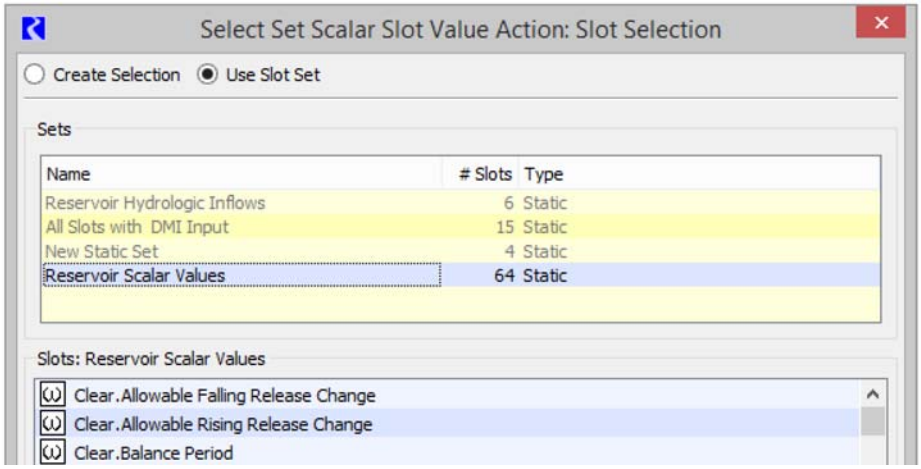
When one of these rows is selected, the lower panel displays the slots that are contained in that set. The lower panel is for informational purposes only. There is no way to manipulate slots in the set from the selector. All edits to slot sets must be made from the Slot Set Manager.

Choose the desired slot set from the upper panel and select **OK**.

Note: When the application only needs one slot (like adding a curve to a plot), the first slot in the Slot Set is used.

With Slot Sets, you can create sets that are not applicable for a particular selection. For example, in Figure 7.6, the Script action Set Scalar Slot Values requires Scalar Slots. Rows in the upper panel are disabled (dimmed and not selectable) because those slot sets contain one or more slots that are inconsistent with the selection criteria. Only the Slot Set named Reservoir Scalar Values is applicable and valid.

Figure 7.6



Selecting Accounts

When selecting accounts, the selection operation is as follows: **Object Type**, then **Objects**, then **Accounts**. There are additional fields for filtering by account. The checkbox options allow the user to show Storage Accounts, Diversion Accounts, and/or Pass Through Accounts. Also, the **Show/Hide Filter Options** button enables filtering by Account Name, Water Type, Water Owner, Junior To, and Senior To.

Figure 7.7

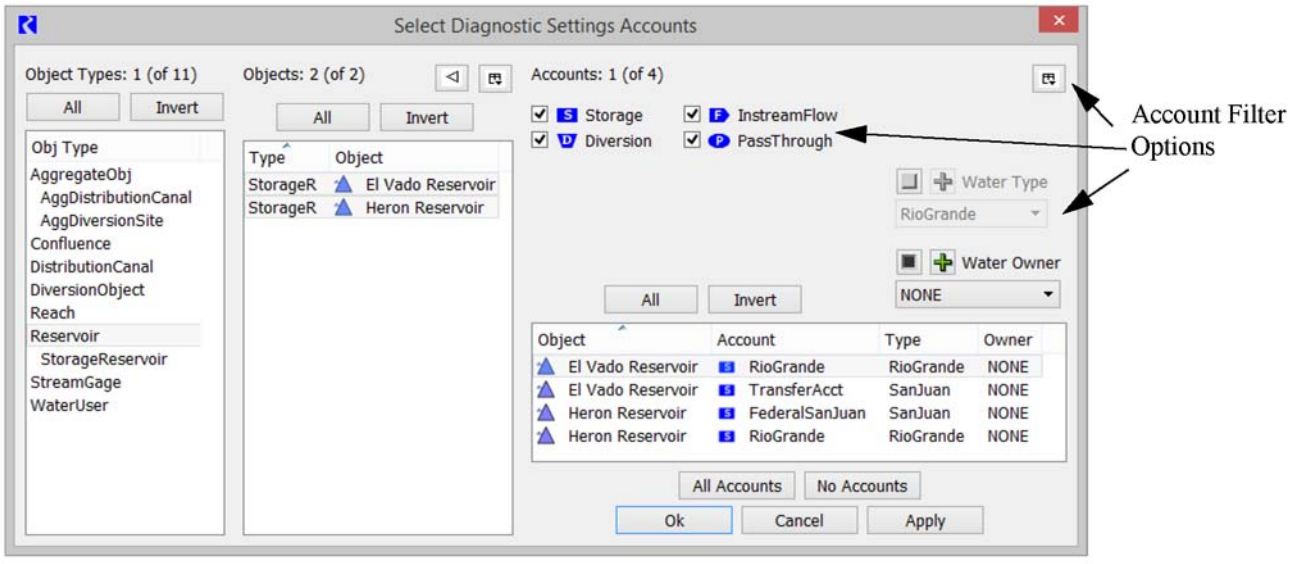
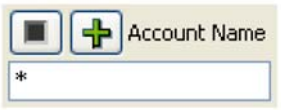
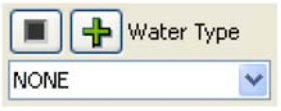
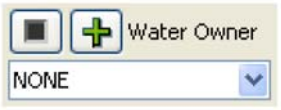


Table 7.3 summarizes the Account selector filters.

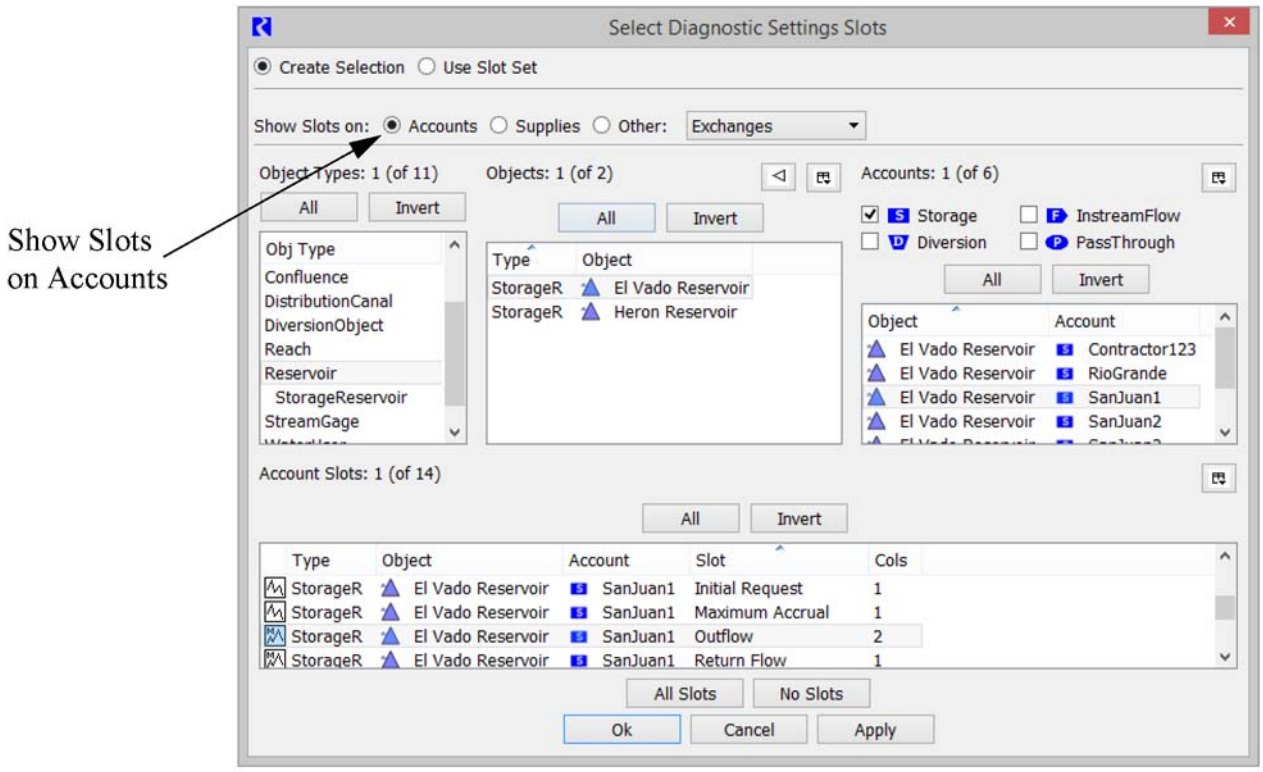
Table 7.3

Account Filter	Description	Screenshot
Account Name	Filters to only the Account which matches the text entered in the text-field. If the text is entered with the wildcard asterisks (like so: *text*), then the filter will show any Accounts which contain that fragment of text.	
Water Type	Filters to only the Accounts which contain the specific Water type selected from the drop down menu.	
Water Owner	Filters to only the Accounts which contain water owned by the specific Water owner selected from the drop down menu.	
Junior To	Filters to only Accounts which have a priority date Junior (at a later date) than the date specified.	
Senior To	Filters to only Accounts which have a priority date Senior (at an earlier date) than the date specified.	

Selecting Slots on Accounts

The dialog for selecting slots on accounts is similar to the dialog for selecting slots on objects, but these slots are on accounts, so there is an additional level of selection. The selection operation is as follows: **Object Type**, then **Objects**, then **Accounts**, then **Account Slots**. Filtering options are the same as for Objects, Accounts, and Slot. Figure 7.8 shows the selector.

Figure 7.8



Selecting Supplies

When selecting supplies (accounting links), the selection operation is as follows: **Object Type**, then **Objects**, then **Accounts**, then **Supplies**. The dialog for selecting supplies is similar to the dialog for selecting slots on accounts. The same filtering options exist for object type, objects, and accounts (see the previous sections for these details). However, the section of the dialog for selecting supplies is a bit different. The user has the option to either show supplies from the specified accounts or to the specified accounts. Then supplies can be filtered based on Supply Types, Supply Name, Release Type, Destination, and Supply Role.

Figure 7.9

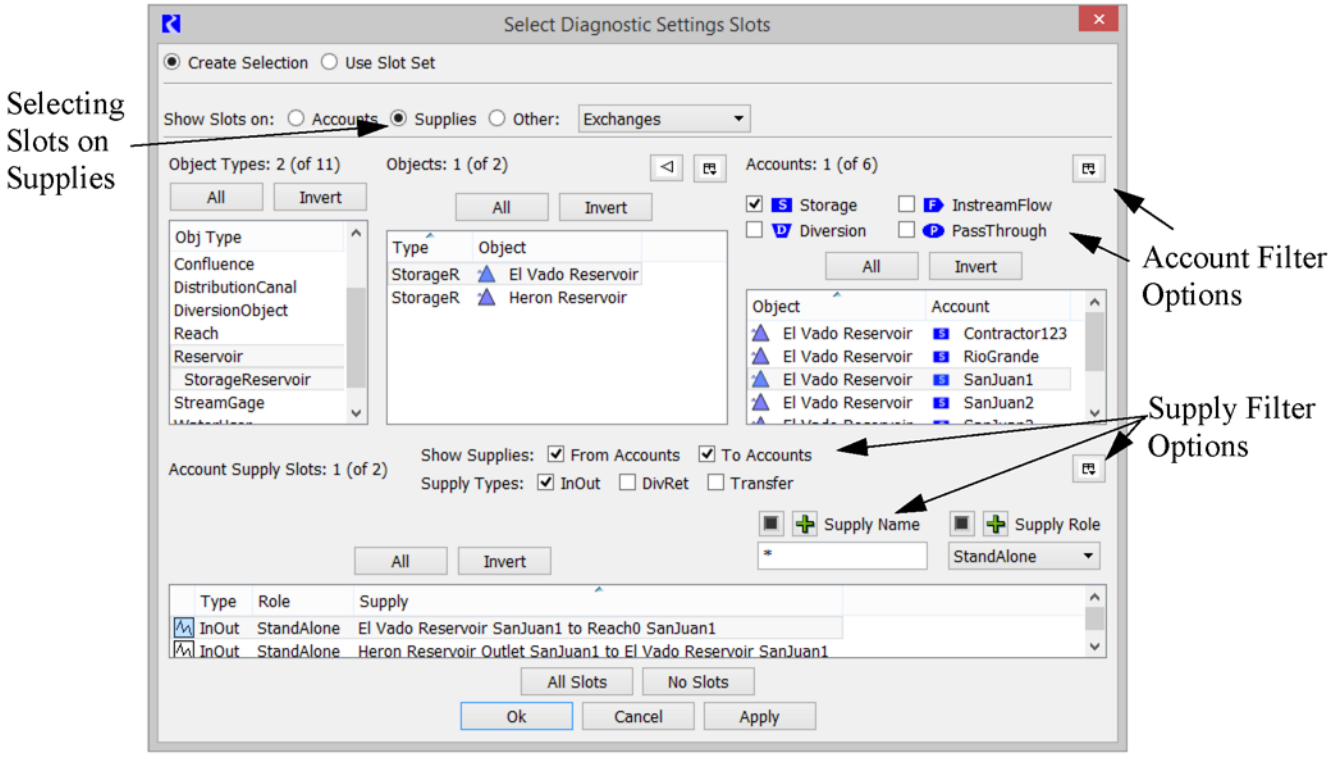


Table 7.4 summarizes the Supply selector filter.

Table 7.4

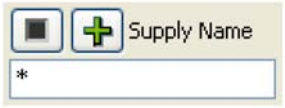
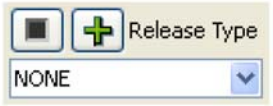
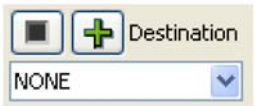
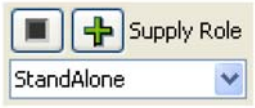
Supply Filter	Description	Screenshot
Supply Name	Filters to only the Supply which matches the text entered in the text-field. If the text is entered within asterisks (like so: *text*), then will filter only to Supplies which contain that fragment of text.	
Release Type	Filters to only the Supplies which have the Release Type specified in the drop-down menu.	
Destination	Filters to only the Supplies which have the Destination Type specified in the drop-down menu.	

Table 7.4

Supply Filter	Description	Screenshot
Supply Role	Filters to only the Supplies which have the Role specified in the drop-down menu.	
Allows Flag	Filters to only the Slots which allow a specific flag selected from the drop-down menu.	

Wildcards

There are two types of wildcards that can be used in the selector dialogs: wildcards in filters and using wildcards on whole selections. In each of the filters, the user can type in "*" to replace a portion of the text. For example, in an object name filter, typing Lake* in the **Object Name** field will display only those objects that begin with "Lake" thereby displaying Lake Mead and Lake Powell. By default, a * exists in the **Object Name** field and all objects will be displayed.

The second type of filter occurs in certain types of slot selections including DMI Name Maps and Database DMI's slot selections. A **Wildcard** checkbox exists at the bottom of the slot selector. The wildcard indicate that every item matching the filters (i.e. the items shown) should be selected. When the **Wildcard** checkbox is checked, the selection buttons (All, Invert, etc) are removed and each of the displayed items are selected. This operation is useful in Name Maps/Database DMI's as the selection becomes dynamic. For example, if you use a filter to show all slots named Pool Elevation, then specify that you want to wildcard the whole selection. you can then import/export all slots named Pool Elevation. If you then add a reservoir to the model, the new reservoir's Pool Elevation slot will then be part of the selection because of the wildcard and imported/exported as defined.

Examples

The best way to learn how to use the selector dialogs is to experiment with the various filters, checkboxes, and options. Shown in the following sections are examples of common selections.

Finding Slots in a Model

A modeler might wish to find all of the slots in a model that have a certain attribute. The modeler might need to change all of these slots or might just wish to show them all in one SCT. Example 7.1 illustrates this type of action.

Example 7.1

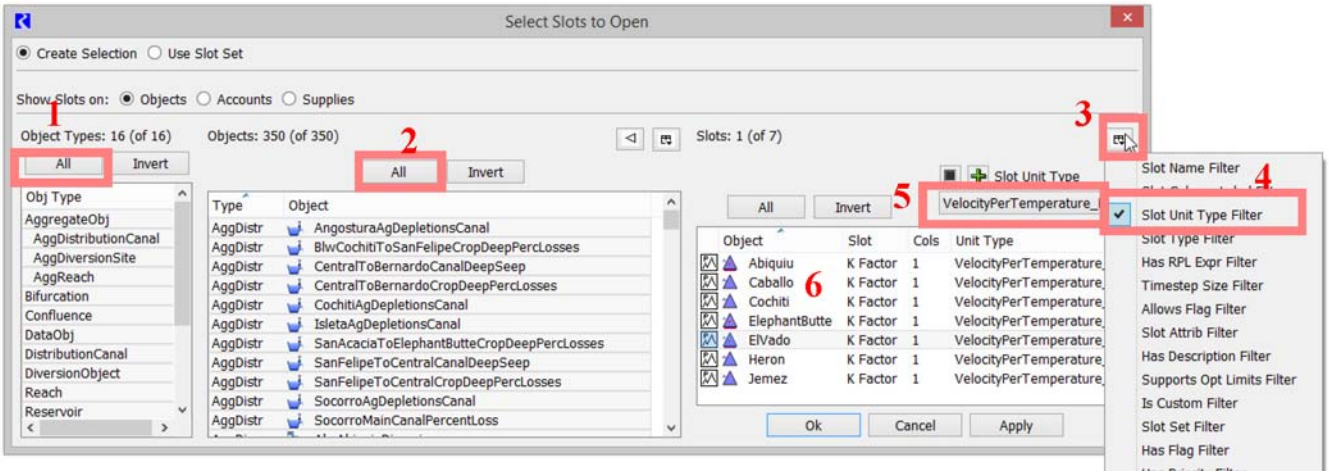
In this case we are trying to find all of the slots that have the VelocityPerTemperature_F unit type.

From the main workspace, select **Workspace**, then **Slots**, then **Open Slot** to bring up the slot selector.

Figure 7.10 shows the slot selector configured to select slots with this unit type.

1. In the Slot Selector, select the **All** button in the Object Types column (1) and the **All** button in the Objects column(2).
2. Then select the **Slot Filter** button  (3) and select Slot Unit Type Filter (4).
3. In the **Slot Unit Type** menu, select VelocityPerTemperature_F (5).
4. Any slots that appear in the slot area (6) have this unit type. Select one of them, and select **OK** to bring up the Open Slot for that slot. If you were making this selection from the SCT, you would have been able to select all and then show them in the SCT. To find slots that have a different attribute (or multiple attributes) use any of the other filters. For example, you could enable the Slot Name Filter and find only slots that have a certain name.

Figure 7.10



Adding Objects to a Subbasin

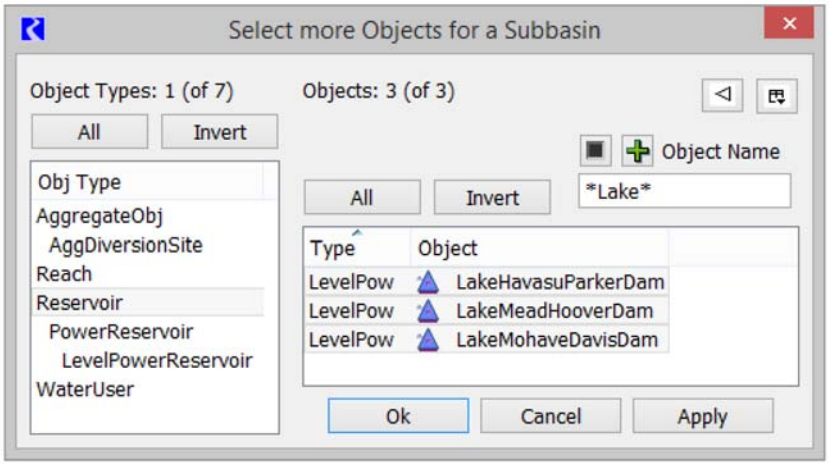
Example 7.2

In this example, we will use the selector to create a subbasin of all of the reservoir objects with the word "Lake" in their name.

1. First, create a new subbasin from the subbasin manager (**Workspace**, then **Edit Subbasins**, **Subbasin,** then **Append New Subbasin**).
2. Then, from the subbasin manager, select **Subbasin,** then **Invoke Member Selector** to bring up the object selector.
3. In the left column select the Reservoir object type.
4. Next select the **Filter** button and select Object Name Filter.
5. In the text box, type "*Lake*" to specify that the word Lake can occur anywhere in the name.
6. Select the **All** button to select all of those reservoir and select **OK**.

   You have just added those reservoirs to the subbasin. Figure 7.11 shows this selection.

Figure 7.11



Creating a Name Map of All Reservoir.Inflow Slots

Example 7.3

In the Database DMI interface, we want to create a name map that says that all of the Reservoir.Inflows are called RES-INFLOW in our database. See "Name Mapping" in *Data Management Interface (DMI)* for details.

1. First add a name map; see "Configuring Name Mapping" in *Data Management Interface (DMI)* for instructions.

   When you select the **Select Slot** option, it brings up the slot selector.

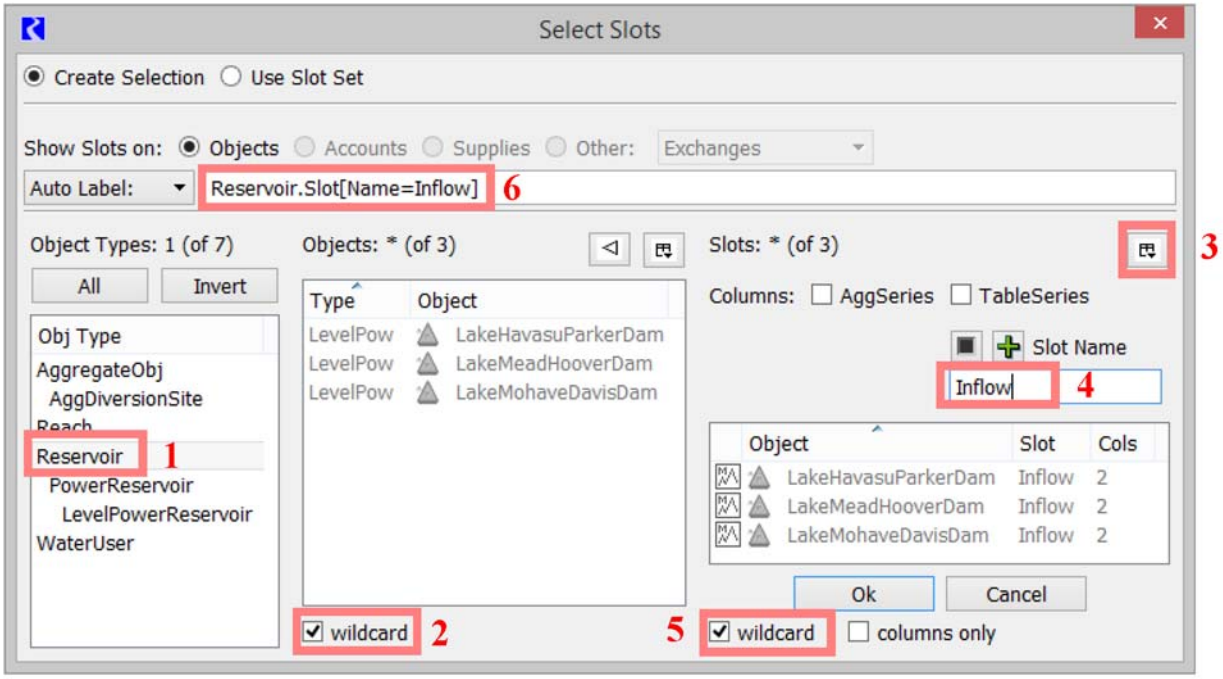
2. To select all Reservoir Inflows do the following; Figure 7.12 illustrates the steps.

   1. In the left pane, Obj Type, select Reservoir (1).
   2. In the center pane, Objects, select the **Wildcard** button on the bottom center (2). This specifies that we will do this for any reservoir.
   3. In the right pane, select the **Filter** icon (3) and select Slot Name Filter. Type "Inflow" into the filter box (4).
   4. Instead of selecting each slot or selecting **All**, select the **Wildcard** checkbox at the base of the dialog (5).

      Note: Once you do this, the Name Map Auto Label becomes Reservoir.Slot(Name=Inflow) (6).

      This indicates that this name map will apply to all Reservoir.Inflow slots. Figure 7.12 shows the selector for this application.

Figure 7.12


Select Slots
Create Selection
Use Slot Set
Show Slots on:
Objects
Accounts
Supplies
Other:
Exchanges
Auto Label:
Reservoir.Slot[Name=Inflow]
6
Object Types: 1 (of 7)
All
Invert
Obj Type
AggregateObj
AggDiversionSite
Reach
Reservoir
1
PowerReservoir
LevelPowerReservoir
WaterUser
Objects: * (of 3)
Type
Object
LevelPow
LakeHavasuParkerDam
LevelPow
LakeMeadHooverDam
LevelPow
LakeMohaveDavisDam
wildcard
2
Slots: * (of 3)
3
Columns:
AggSeries
TableSeries
Slot Name
Inflow
4
Object
Slot
Cols
LakeHavasuParkerDam
Inflow
2
LakeMeadHooverDam
Inflow
2
LakeMohaveDavisDam
Inflow
2
Ok
Cancel
5
wildcard
columns only

Chapter 8
System Control Table (SCT)

The RiverWare System Control Table (SCT) is a customizable, editable view of slots and data in a RiverWare model.

Topics

- SCT Tabs, page 325
- SCT Overview, page 327
- SCT Configuration Settings, page 337
- Series Slots Tab, page 346
- Edit Series Slot List Tab, page 363
- Scalar and Other Slots Tabs: Slot Lists, page 373
- Object Grid Tab, page 379
- How To Configure the SCT, page 386
- How To Manipulate Data to Model Operations, page 399
- How To Print, Plot, and Export Data, page 409

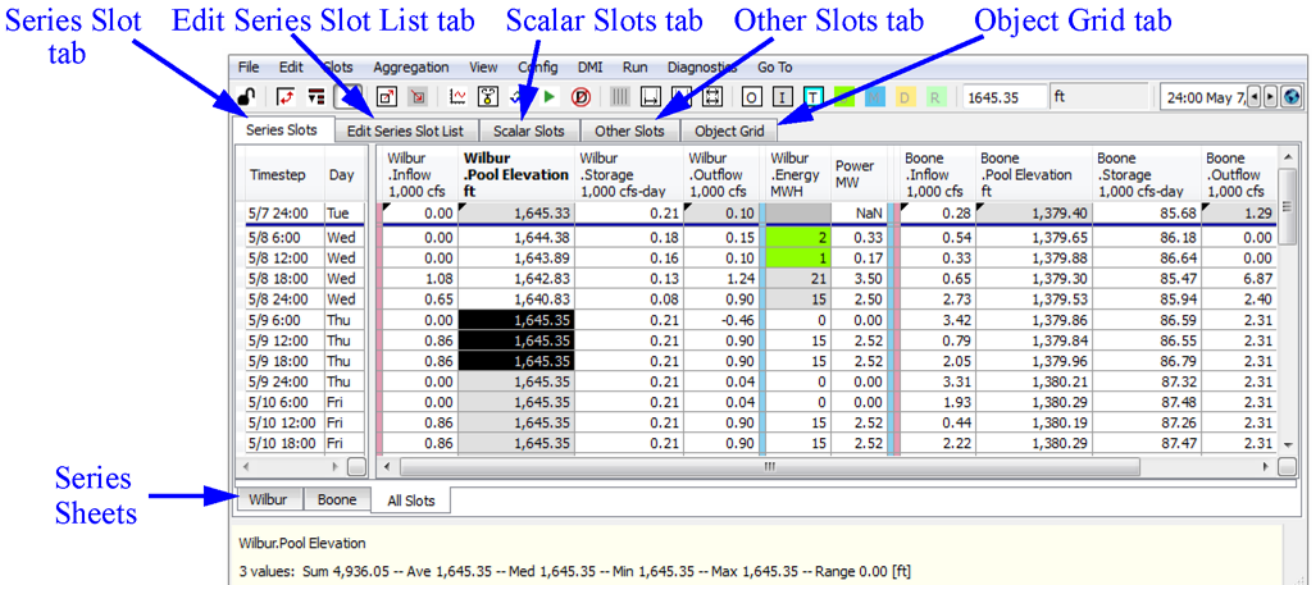
SCT Tabs

It provides five top-level tabs, or views of different types of data. Figure 8.1 illustrates.

- **Series Slots**. Series data (series slots, including Agg Series Slot columns, and Table Series Slot columns) on physical simulation objects and accounting slots can be displayed. The SCT presents series data in a scrollable grid of numeric values. Background colors are used to indicate each slot timestep's flag value—generally an indication of how the numeric value was created. Custom text and background colors can be configured to alert you when values are within a specified interval. The series data can be further organized into user defined **Series Sheets** that provide tabs on the bottom of the SCT.
- **Edit Series Slot List.** A list of series slots can be shown for configuration purposes. Slots can be added/deleted, or re-arranged. Similar sections or groups can be duplicated for other objects. When applied, the organization in this table is used for the **Series Slots** tab.
- **Scalar Slots**. A list of scalar and 1x1 table slots can be shown and edited from the **Scalar Slots** tab.
- **Other Slots**. A list of the other types of slots can be displayed including table, periodic, list, and statistical tables. These are not editable but allow you to keep track of different slots without opening each individually.

- **Object Grid**. A grid of objects and their contained scalar and table slots can be shown. This view is particularly useful when specifying parameters on objects that interact with one another, like groundwater objects.

Figure 8.1 Annotated illustration of the System Control Table tabs



Data in the SCT

The data displayed in an SCT is contained in the RiverWare model, rather than in the SCT. Therefore, editing data displayed in an SCT does not affect the SCT—it affects only the RiverWare model. The SCT is just a configurable window into the model.

The SCT configuration—i.e., the settings which can be saved and reloaded as an SCT—consists of the following sections:

- Lists of RiverWare slots
- Configurable display properties for each of those slots
- A set of general configurable display properties for the overall SCT
- An aggregation definition for aggregating multiple timesteps within each slot
- Object and slot ordering on the Object Grid tab

The time range displayed by the SCT matches the RiverWare model's Run Control configuration, plus a configurable number of pre- and post-simulation timesteps. See "Run Menu" on page 334 for details.

Many SCTs may be used simultaneously within a single RiverWare session (i.e., showing distinct views into the same RiverWare model). An SCT may be used with different RiverWare models as long as the Object and Slot names are the same.

SCT Overview

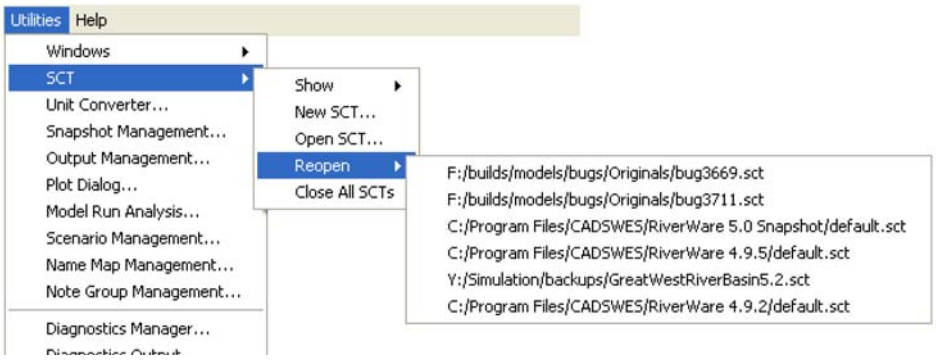
Following is an overview of the SCT and its organization. First the general areas of the SCT are discussed, then each of the tabs—Series Slots, Scalar Slots, and Other Slots—are discussed.

Menus in the RiverWare Workspace (select **Utilities**, then **SCT**) and the SCT **File** menu provide the following functions:

- **New SCT**. Create an empty SCT in a new SCT window.
- **Open SCT** file using the file chooser.
- **Show** and raise an open named SCT.
- **Reopen** a recently-accessed SCT File. Up to six SCT files are remembered from one RiverWare session to the next. SCTs which are already open are excluded from the **Reopen** menu. (Those appear instead in the **Show** menu).

Figure 8.2 shows the SCT menus in the RiverWare Workspace and in the SCT file menu.

Figure 8.2



Create a new SCT from the **RiverWare Workspace** menu. Select **Utilities**, then **SCT**, then **New SCT.** The SCT initially will have the user-defined default configuration.

After creating a new SCT, the **Edit Series Slot List** tab is shown (see "Edit Series Slot List Tab" on page 363). If you are adding slots to the Series Slots tab, you will want to add Slots and Slot Dividers. Otherwise, you can cancel and go to the desired tab to begin configuration. See "Add Slots, Sheet Tabs, and Slot Dividers" on page 387 for details.

SCT Menu Bar

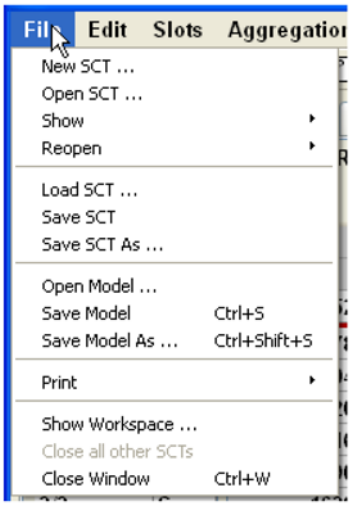


The SCT menu bar is described in the following sections.

- File Menu, page 328
- Edit Menu, page 329
- Slots Menu, page 330

- Aggregation Menu, page 331
- View Menu, page 332
- Config Menu, page 333
- DMI Menu, page 334
- Run Menu, page 334
- Scripts Menu, page 334
- Diagnostic Menu, page 335
- Go To Menu, page 337

File Menu

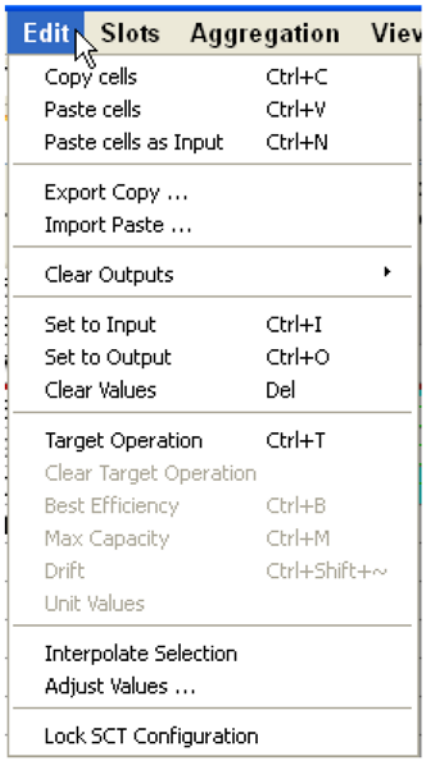


The SCT **File** menu supports the following operations:

- **New SCT** lets you create a new SCT.
- **Open SCT** lets you open an additional SCT so there is more than one SCT open for the model.
- **Show** lets you select an opened SCT and brings it to the front.
- **Reopen** lets you select a previously opened SCT and then loads it.
- **Load SCT** lets you open a different SCT file in place of the particular SCT. The current SCT is replaced with the loaded one.
- **Save SCT** and **Save SCT As** saves the current SCT configuration as an SCT file.
- **Open Model, Save Model** and **Save Model As** perform the same operations as the **Save** and **Save As** operations in the RiverWare workspace. They neither affect the SCT nor cause the SCT configuration to be saved.
- **Print.** See “Printing” on page 409 for details.
- **Show Workspace** brings the workspace to the front.

- **Close all other SCTs** closes any other SCTs except the given one.
- **Close Window** closes the SCT; however, this does not automatically save the SCT configuration.

Edit Menu



The SCT **Edit** menu supports the following operations.

The behavior of the Copy and Paste operations depends on the nature of the current selection within the SCT. See the following topics:

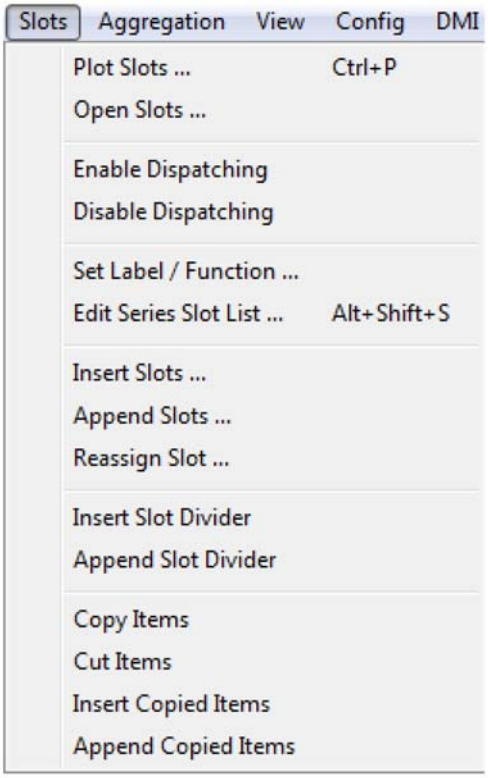
- Copy a Single Value to One or Many Timesteps, page 404
- Copy Multiple Values, page 405
- Copy a Timeslice Across All Slots, page 406
- Copy a Whole Slot, page 407

  Note: These Copy and Paste operations use the internal clipboard to store data. The **Export Copy** and **Import Paste** operations use the system clipboard.

  See "Copy and Paste" on page 360 for the difference between the default paste operation and paste as input.
- **Export Copy**; see "Copy/Paste Data to/from the Clipboard (e.g., to Excel)." on page 408.
- **Import Paste**; see "Copy/Paste Data to/from the Clipboard (e.g., to Excel)." on page 408.
- **Clear Outputs** and **Clear Values**; see "Clear Values" on page 402

- Flag-setting operations; see “Set a Flag” on page 403 and “Set a Target Operation” on page 404.
- **Interpolate Selection**. See “Set Multiple Values” on page 400 for details.
- **Adjust Values**. See “Set Multiple Values” on page 400 for details.
- **Lock SCT Configuration**. See “Lock or Unlock the SCT Configuration” on page 386 for details.

Slots Menu

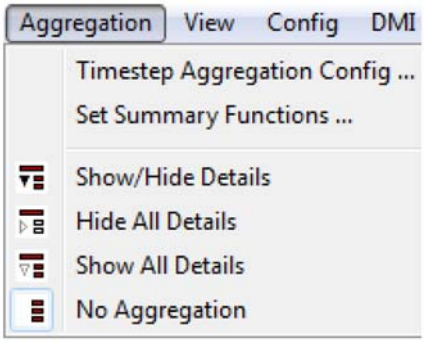


The SCT **Slots** menu supports the following operations:

- **Plot Slots**. See “Plotting” on page 410 for details.
- **Open Slots.** Opens selected slot(s).
- **Enable Dispatching** and **Disable Dispatching**. Set the dispatching state of the simulation objects containing the current SCT slot selections. Slots on a simulation object with dispatching disabled are indicated with a crosshatch of a configurable color (see “Color Tab” on page 346) on slot labels in the row header table (in **Horizontal Timestep Axis Orientation** only).
- **Set Label/Function**. See “Slot Names and Slot Labels” on page 349 for details.
- **Edit Series Slot List**. Takes you to that tab.
- **Insert**, **Append**, **Reassign**. See “Add Slots, Sheet Tabs, and Slot Dividers” on page 387 for details.
- Other copy, cut, insert, and append operations. See “Move Slots and Slot Dividers” on page 389 for details.

- **Cut Items**. See “Remove Slots and Slot Dividers” on page 389 for details.

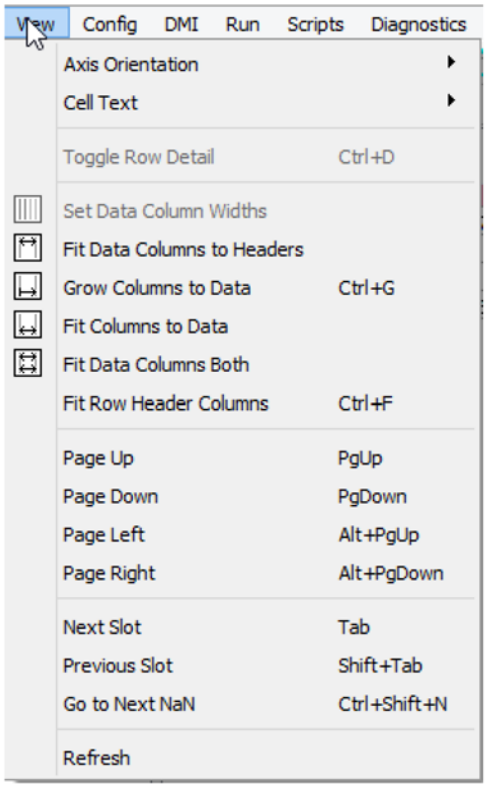
Aggregation Menu



The SCT **Aggregation** menu allows you to aggregate the data up to a larger timestep. For example, for an 1 Hour timestep model, aggregate and show values at a 1 Day timestep. The following operations are available in the Aggregation Menu:

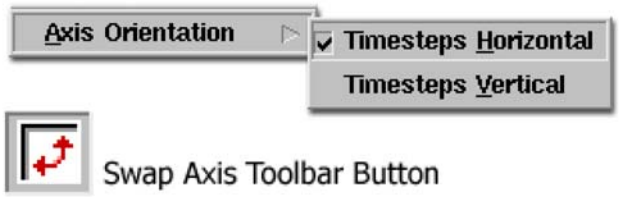
- **Timestep Aggregation Config.** Shows the SCT Timestep Aggregation Dialog.
- **Set Summary Functions.** Shows the Set SCT Aggregation Summary Functions dialog
- The **Show/Hide Details**, **Hide All Details**, **Show All Details**, and **No Aggregation** exclusive checkboxes select the SCT detail mode. The first three choose the aggregated view of the currently selected **Axis Orientation** (see “View Menu” on page 332), and **No Aggregation** shows the corresponding non-aggregated view. See “Show or Hide (Aggregation) Summaries” on page 392 and “Show or Hide Details” on page 393 for details.

View Menu



The SCT **View** menu supports the following operations.

- **Axis Orientation**. The **Axis Orientation** selections switch between horizontal timestep axis orientation and vertical timestep axis orientation. See "Axis Orientation" on page 358 for details.



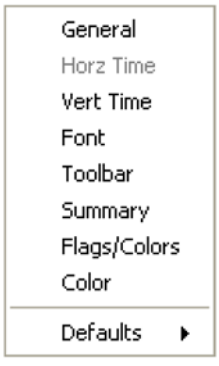
- **Cell Text**. The **Cell Text** menu allows you to show numeric **Values Only**, values and flag letters (**also Flag Letters**), or values, flag letters and priority numbers (**also Priority Numbers**). Priority numbers are only relevant when using rulebased simulation. This is a temporary setting—it is not saved in the SCT file.



  The SCT also shows tooltips indicating which rule or DMI was responsible for the value, where applicable. Hover over a value to see this information. See "Tooltips" on page 174 for details.

- Alternate Row Detail. See "Show or Hide Details" on page 393 for details.
- Column Width. See "Adjust Column Widths" on page 394 for details on **Set Data Column Widths** and the various *fit column* operations.
- **Page Up/Down/Left/Right**. The various page operations scroll the SCT window in the indicated direction. Although you generally will access these via the indicated keyboard accelerators, these operations are included in this menu to document their implementation.
- **Next Slot/Previous Slot**. The **Next Slot** and **Previous Slot** operations move the active cell to the next or previous Slot.
- **Go To Next NaN**. The **Go To Next NaN** operation navigates to the next NaN (Not A Number) in the slot. The search always go first through timesteps, then through the subsequent slots. An accelerator key combination **Ctrl+Shift+N** also executes the search.

Config Menu



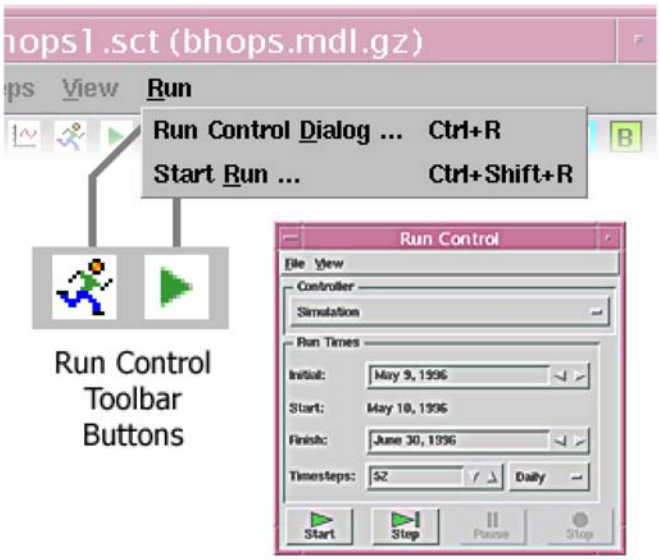
The SCT Config Menu allows you to access the configuration settings. The menu choices open the configuration dialog to the specified tab. See "SCT Configuration Settings" on page 337 for details.

See "Use the Default Configuration" on page 399 for details on the **Defaults** operations.

DMI Menu

The DMI menu includes all defined Input and Output DMIs and DMI Groups, along with **I**, **O**, or **G** icons. The menu has a checkbox to switch between the presentation of all items in the single top-level menu (if there aren't too many items), or cascaded into three menus. ***Choosing a DMI or Group will invoke that DMI!*** You can also show the DMI Manager from this menu.

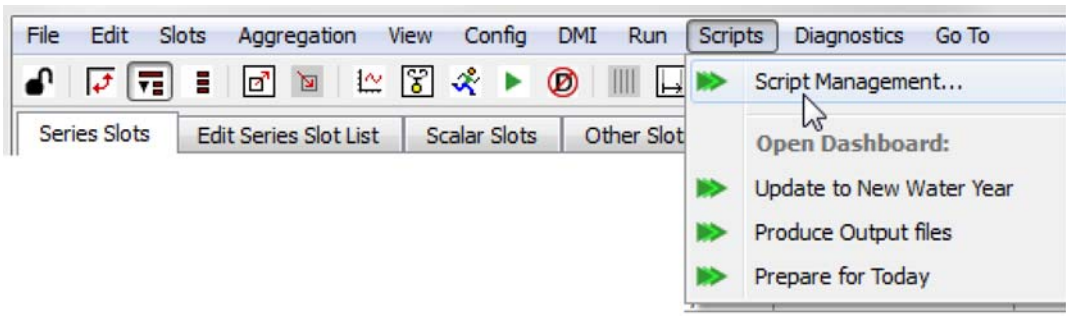
Run Menu



The SCT **Run** menu and toolbar buttons allow you to make a run directly from the SCT.

- **Run Control Dialog** shows the Run Control dialog (also pictured here).
- **Start Run** initiates a run using the selected controller and run times indicated in the Run Control dialog.
- **Run Analysis** opens the Model Run Analysis tool.

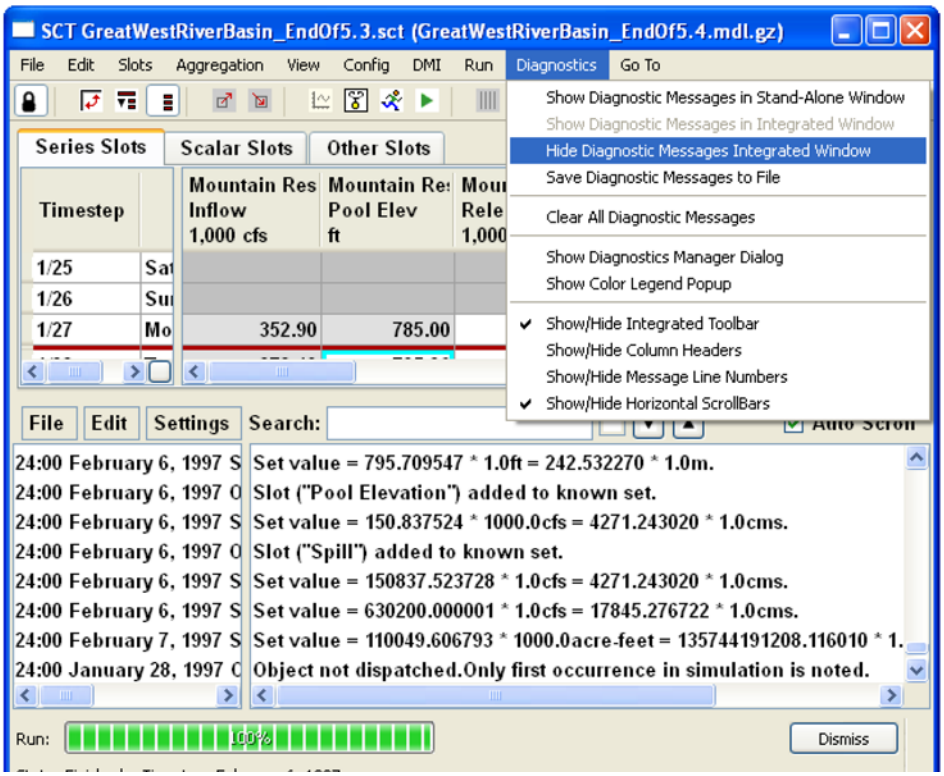
Scripts Menu



The SCT **Scripts** menu allows you to access scripts directly from the SCT.

Use the **Script Management** menu to open the Script Manager. Or use the menu options for each named script to open that script's dashboard dialog.

Diagnostic Menu



The Diagnostic Output window can be shown as a panel at the bottom of a single SCT or as a stand-alone window. It will appear in only one place at any given time. Diagnostics can be enabled in or out of the SCT using the stethoscope icon in the SCT toolbar or the SCT Diagnostics menu.

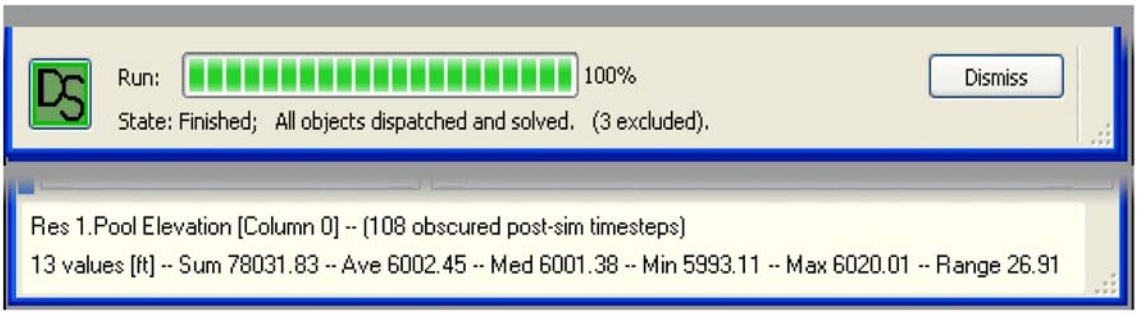


To reduce the amount of vertical space taken up by the Diagnostic Output panel, you can hide the Diagnostic Window's integrated menu/toolbar. The menu operations in integrated menu-/toolbar are also available in the SCT **Diagnostics** menu.



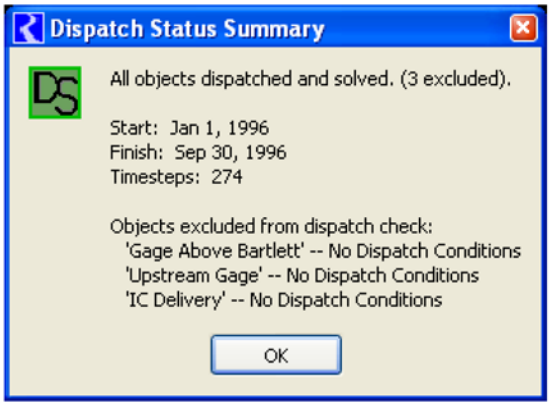
Status Area

When a run is started, the selection status area of the SCT is replaced with the a display of the run status (if that is enabled in the SCT configuration). This is displayed until you select somewhere in the SCT table or select **Dismiss**. Unlike the Diagnostic Output, the Run Status will simultaneously be displayed in multiple SCTs and as a stand-alone dialog. However the stand-alone popup is not automatically raised if the Status can be displayed in an open SCT (i.e. by showing and raising any SCT which is already open).

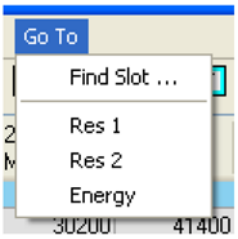


Also shown in the Run Status area is information on the dispatching of objects within the run. An icon is shown that displays the most limiting dispatching of objects within the run. Also displayed are the number of objects that meet the most limiting condition.

Selecting the icon takes you to the Model Run Analysis tool (see "Simulation" in *Debugging and Analysis* for details), with the first relevant object at the earliest timestep highlighted. When you **Shift-Click** on the icon, a dialog is shown with a summary of the run analysis. Listed are the objects and numbers of objects that have dispatched, dispatched but not solved, and those that have not dispatched.



Go To Menu



The SCT **Go To** menu allows you to scroll to named locations in the SCT. This can be useful when an SCT has a large number of slots that do not fit on a single screen.

- **Find Slots**. The **Find Slot** option allows you to enter a slot name (including wildcards) and the SCT will search for that name.
- Dividers. The other options in the **Go To** menu will scroll to any of the Sheet Dividers or Slot Dividers in the SCT, as referenced by name. The divider names are either a unique label (set by selecting **Slots**, then **Set Label / Function** when the divider is selected; see "Slots Menu" on page 330) or using the default name, which is the slot just to the right of or below the divider as follows:
  - If the SCT contains Sheets, **Go To** menus are presented for each Sheet.
  - For Sheets that contain Slot Dividers, a menu is presented with an initial **Start of Sheet** item, and items for each contained Slot Divider.
  - If the SCT doesn't contain sheets, then Slot Dividers are presented as top-level items.

SCT Configuration Settings

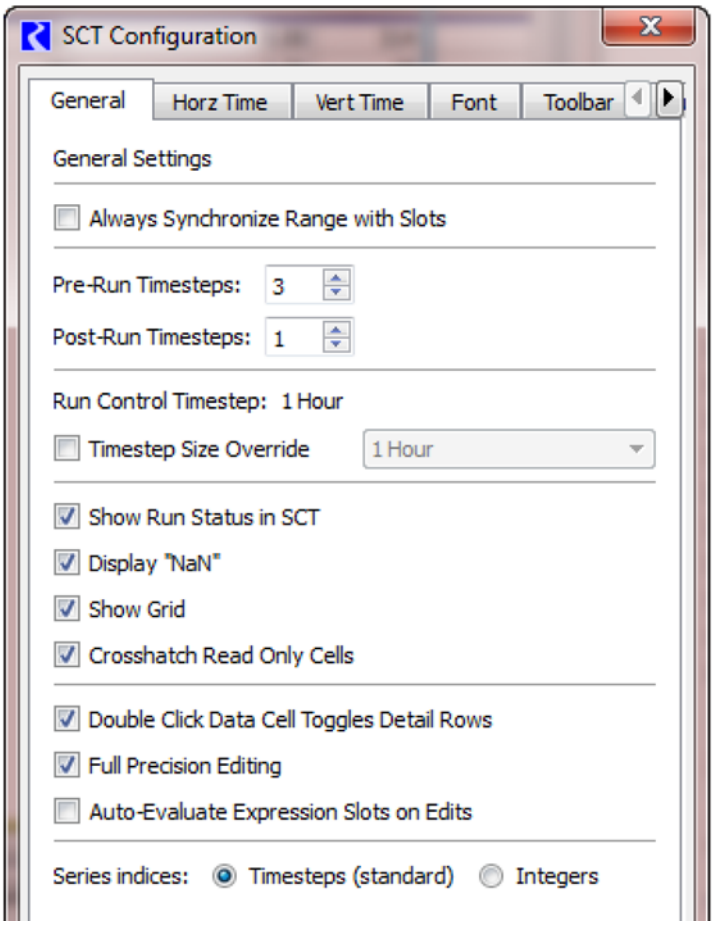
Most of the settings for an SCT are controlled through the **SCT Configuration** dialog, which you can access from the **Config** menu. All options will open the configuration dialog but depending on the menu selected, the appropriate tab will be enabled.

The properties this dialog supports are described in the following sections:

- General Tab, page 338
- Horizontal Time Tab, page 339
- Vertical Time Tab, page 340
- User-configurable Fonts, page 341
- Toolbar Tab, page 342
- Summary Tab, page 343
- Flags Tab, page 344
- Color Tab, page 346

General Tab

To display the SCT Configuration dialog, select **SCT Config**, then **General**.



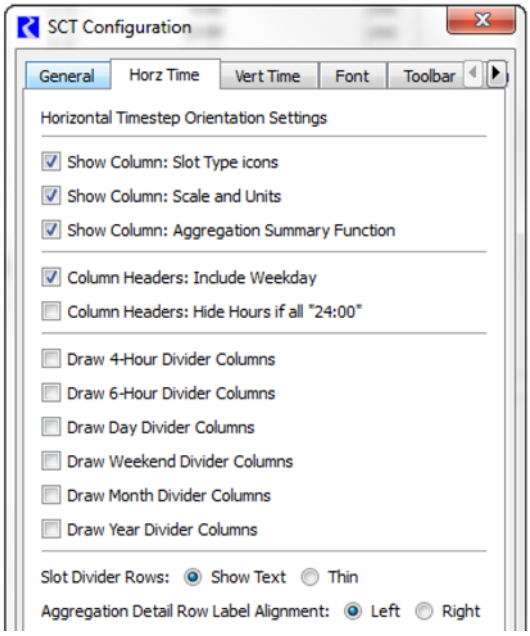
- The **Always Synchronize Range with Slots** option disables the time range settings in the SCT. The SCT timesteps will be the same as the timesteps of the slots shown in the SCT. Checking this box disables the next three settings.
- The **Pre-Run Timesteps** and **Post-Run Timesteps** integer selector values are used to extend the SCT beyond the run range. The indicated timesteps number is added to the RiverWare model's Run Control time range. See "Run Menu" on page 334 and "Timesteps" on page 353 for details.
- The **Timestep Size Override** lets you configure the timestep to use a timestep different than the run.
- See "Change Ornamentations" on page 397 for details on the various display options in the middle area of the SCT Configuration dialog.
- The **Double-click Data Cell Toggles Detail Rows** setting allows you to change the behavior of double selecting the SCT data table. Turning this option on replaces the default behavior of double-clicking (i.e., initiating an edit) with an open/close details operation. Although the latter functionality is relevant only for the aggregated views, for consistency, it still prevents an edit when not aggregated. See "Set a Single Value" on page 400 and "Show or Hide Details" on page 393 for details.

- The **Full Precision Editing** checkbox allows you to specify whether you edit values using full precision or with the display precision.
- The **Auto-Evaluate Expression Slots on Edits** checkbox allows you to specify that expression slots shown on the SCT should fully evaluate (all timesteps) any time a value on that SCT is edited. Checking this box allows the SCT to behave like a spreadsheet where expression slot calculations are performed immediately after editing a value. For example, you might have an expression slot that sums the Outflows from multiple reservoirs. This checkbox allows you to see this sum each time you edit an Outflow.

  Note: This checkbox could cause refresh delays if there are many expression slots or their evaluation is not quick.

Horizontal Time Tab

To display the SCT Configuration dialog, select **SCT Config**, then **Horz Time**.



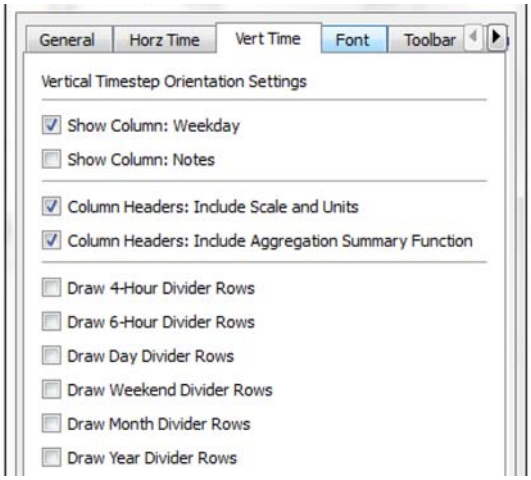
These settings affect the appearance of the horizontal timestep axis orientation views (time on top).

- In the top part of the tab, choose the columns that you wish to show. Options include showing a column for Slot Types, Scale and Units, and the Aggregation Summary function (i.e. Min, Max, Avg).
- In the column headings, do you want to see the weekdays or 24:00 for timesteps greater than 12hrs? The middle of this tab has checkboxes for these options.
- The bottom section allows you to configure automatic divider columns for standard time intervals. Each of these six types of time dividers can be independently enabled or disabled, and can be shown with independently configurable colors.
- The next setting is used to specify if you want to see text labels in divider rows. If so, you can add custom text to the divider row labels. If not, the divider rows are shrunk to conserve height.

- The final setting allows you to specify the alignment of the aggregation detail row labels. See the following topics for explanations of these settings:
  - Configure Row and Column Headers, page 394
  - Change Ornamentations, page 397

Vertical Time Tab

To display the SCT Configuration dialog, select **SCT Config**, then **Vert Time**.

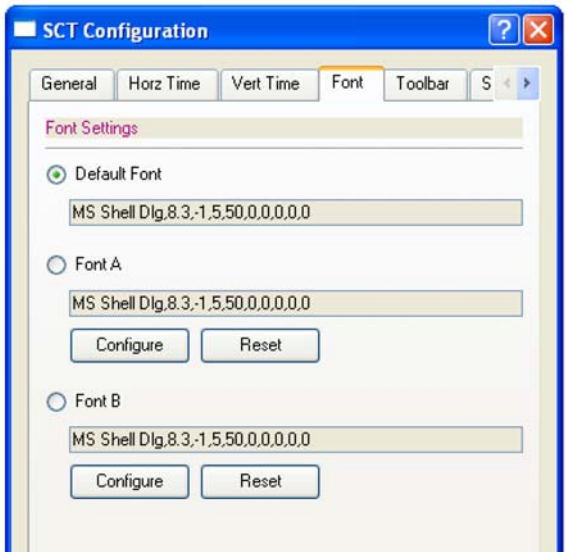


These settings affect the appearance of only the vertical timestep axis orientation views (time down the side).

- On this tab, you can specify whether to see a column containing the Weekday (i.e. Sunday, Monday, etc) and/or a column containing Notes. See "Notes on Series" on page 352 for details on Showing Notes on the SCT.
- You can also specify if you want to include scale and units and the aggregation function in the column heading.
- The bottom section allows you to configure automatic divider rows for standard time intervals. Each of these six types of time dividers can be independently enabled or disabled, and can be shown with independently configurable colors. See the following topics for explanations of these settings:
  - Configure Row and Column Headers, page 394
  - Change Ornamentations, page 397

User-configurable Fonts

To display the SCT Configuration dialog, select **SCT Config**, then **Font**.

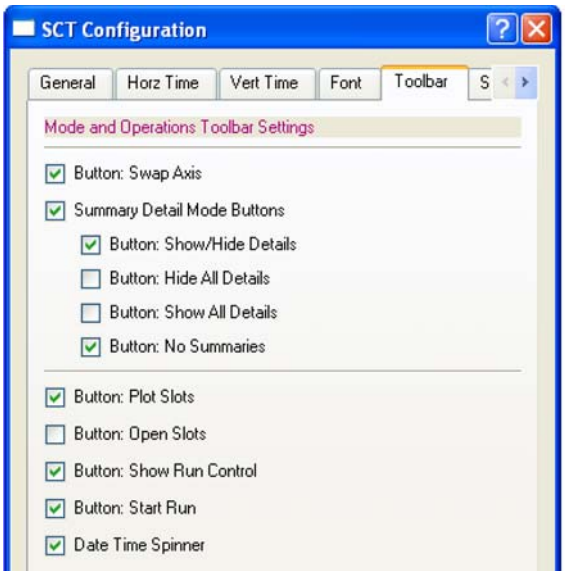


In this tab, you can choose the SCT font. Only one font can be displayed at any given time, and that font is used for both screen display and printing.

- Two custom font specifications can be saved with each SCT, and with the default SCT configuration. You can choose to use either of those two custom font specification, or the default font.
- Select either of the **Configure** buttons to change the corresponding custom font specification. This brings up a font selector which allows you to select a different font face (font family), font size, font weight (e.g. normal or bold), and other font properties.
- Select either of the **Reset** buttons associated with either the Font A or Font B item to restore that font specification to the default font.Applying a font specification to the SCT (with either the **OK** or **Apply** button) may take a moment to complete since the SCT geometry needs to be readjusted.

Toolbar Tab

To display the SCT Configuration dialog select **SCT Config**, then **Toolbar**.



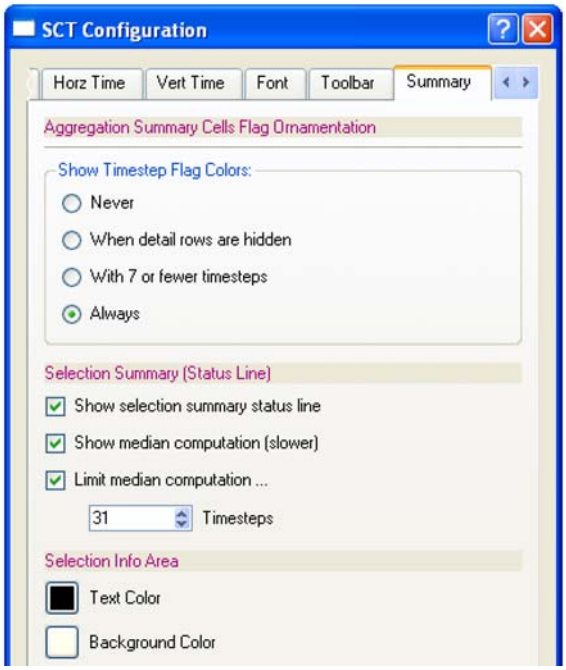
These settings control which toolbar buttons are displayed in the SCT Toolbar. See "SCT Overview" on page 327 for details.

The operations associated with each of the configurable toolbar buttons are also represented in the SCT menus.

> **Note:** The flag setting buttons are configured through the **Flags** tab rather than through the **Toolbar** tab. See "Flags Tab" on page 344 for details.

Summary Tab

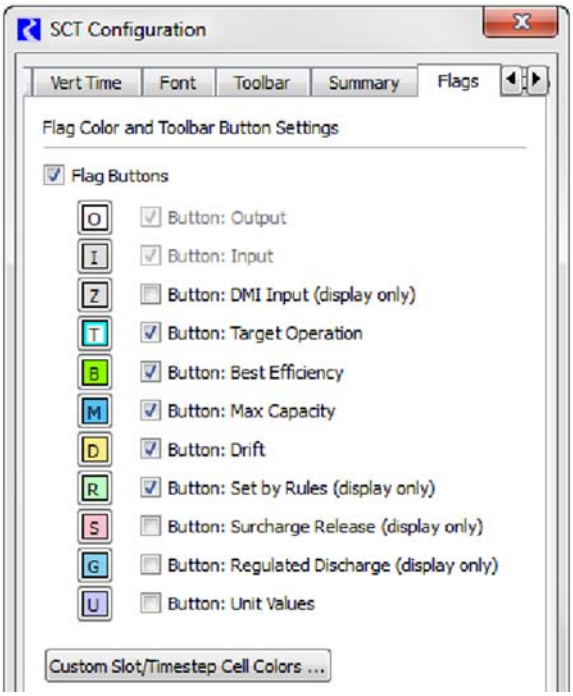
To display the SCT Configuration dialog, select **SCT Config**, then **Summary**.



The settings on this tab allow you to change the colors shown when timesteps are aggregated. See "Change Ornamentations" on page 397 for details on the **Show Timestep Flag Colors** options.

- The **Selection Summary (Status Line)** options disable or limit the second status line displayed at the bottom of the SCT. The three components are used for limiting the median computation, which is the only statistic that requires a set of values to be sorted.
- You can configure the colors for the background and the text displayed in the area at the bottom of the SCT. Pressing either of these buttons brings up a Color Chooser:

Flags Tab



The **Flags** tab is used for three types of settings related to the support of slot timestep flags in the SCT.

- The checkbox controls are used to determine the presence of the flag toolbar buttons in the SCT Toolbar (see "SCT Overview" on page 327 for details). If the **Flag Buttons** checkbox is selected, the **Input** and **Output** flag toolbar buttons are displayed unconditionally. The other flags can be enabled or disabled as desired.
- The colored buttons on the **Flags** tab illustrate the appearance of the flag toolbar buttons. Selecting the colored buttons brings up a color chooser, allowing you to select a different color for that flag. See "Flags Tab" on page 344 for details.
- Custom foreground (text) color and background colors can be configured by selecting the **Custom Slot/ Timestep Cell Colors** button. This is described in the next section.

Custom Cell Colors

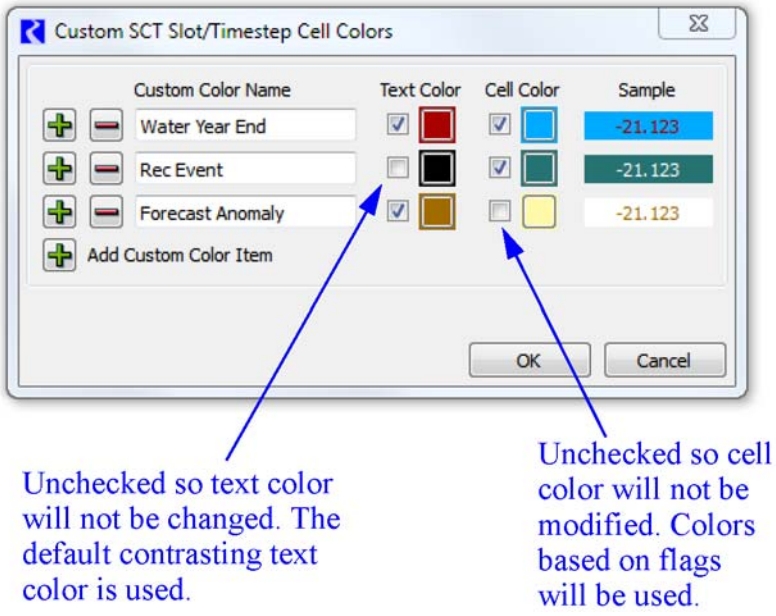
Use the following steps to edit the definition of custom colors.

1. Select the **Custom Slot/Timestep Cell Colors** button on the **Flags** tab.

   Each row represents a named custom cell color including the name, **Text Color**, **Cell Color** and a sample.

2. Select the green **Plus** button to insert/append a row of controls for a new custom color item. Select a red **Minus** button to remove the row/color.

3. Specify the name of a custom color item directly in the **Custom Color Name** field. The name must be non-blank and unique.



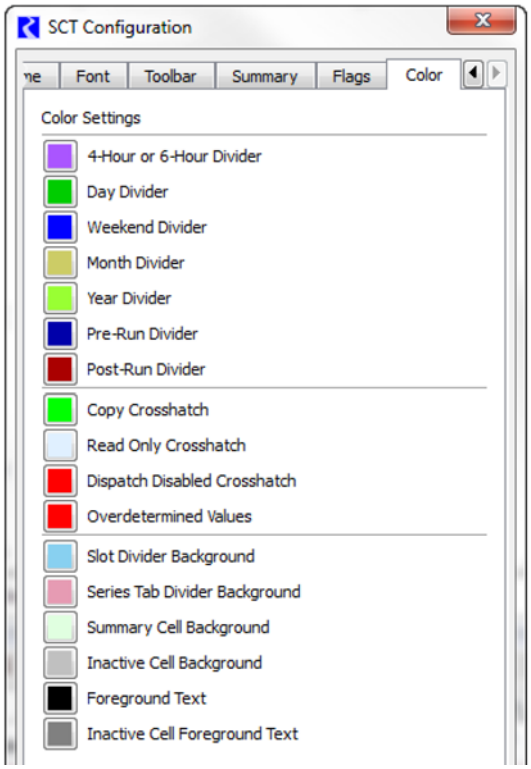
4. Use the checkboxes to specify whether the Text color or Cell Color will change.

   Note: One or both must be selected. If cleared, the color will remain the default color.

5. Select the color buttons and specify the desired color. The Sample field shows the result.
6. Select **OK** to confirm the changes.
7. To have these definitions applied to the SCT, you must then select the **OK** or **Apply** buttons in the SCT Configuration dialog.

See "Apply Custom Colors to Slot/Timestep Cells" on page 395 for details on applying the custom colors to specific cells in the SCT. See "Configure Color Alerts" on page 371 for details on using the custom colors for Alerts (i.e. conditional formatting).

Color Tab



The **Color** settings tab lets you configure colors, other than flag colors that are set on the **Flags** tab (see "Flags Tab" on page 344 for details).

For an explanation of these settings, see the following topics:

- Change Ornamentations, page 397
- Change SCT Flag and Other Colors, page 395

Series Slots Tab

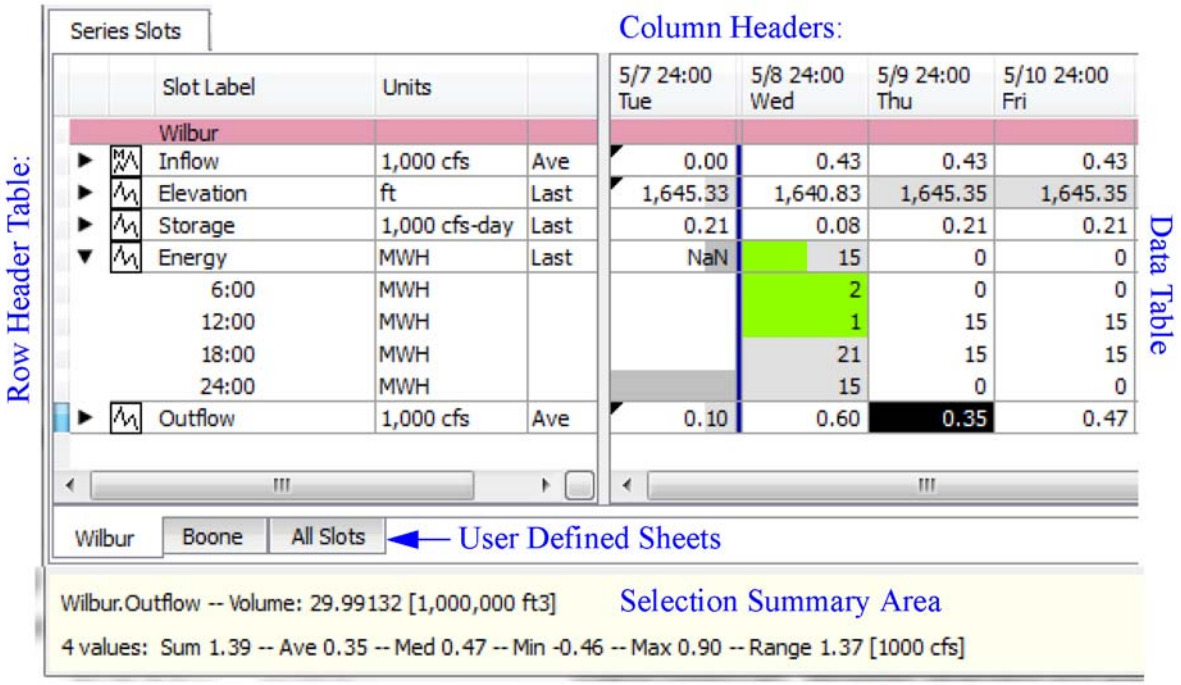
Series data is represented in a spreadsheet view on the Series Slots tab of the SCT. This table supports swapable axis (slots vs. timesteps) and optional timestep aggregation. The following screenshot shows the areas of the **Series Slots** tab. Row Headers and Column Headers provide the slot label, units, aggregation information, and timestep information. Columns and rows are swapable so this information is displayed differently depending on the orientation.

Further, you can organize your series slots into user configurable sheets where there is a tab at the bottom of the SCT. When there are multiple sheets, there will always be an **All Slots** tab that shows all of the slots on one tab. You can *tear off* or show any sheet as a new SCT. See"Create a new SCT from a Series Sheet tab" on page 390 for details.

At the bottom of the SCT is the Selection Info Area also called the Summary area. This displays information on the selected cells in the SCT including the name or number of slots and then statistics on the selection. Statistics

include Sum, Average, Median, Min, Max, Range, and Difference. All, some or none of these may be shown depending on the number of cells selected and the units of those cells. Figure 8.3 shows the areas of the Series Slots tab of the SCT.

Figure 8.3



Slots and Slot Dividers

Either rows or columns (depending on the current axis orientation) correspond to slots and slot dividers. See "Axis Orientation" on page 358 for details.

Slots

RiverWare slots are identified with a fully qualified name (including the name of the simulation object, account, or other entity the slot is on). SCT slots for which a match cannot be found on the workspace are indicated as disabled—no data is shown, and you cannot provide data for such slots. See "Slot Names and Slot Labels" on page 349 for details.

Properties associated with slot items (within the SCT configuration) include the following:

- Single-line Slot Text Label (used when slots are shown as rows).
- Multiple-line Slot Text Label (used when slots are shown as columns).
- Slot Column Width (in pixels) (used when slots are shown as columns).
- Summary Function for computing the value shown for aggregates of timesteps within the particular slot. See "Summary Functions" on page 355 for details.

Dividers

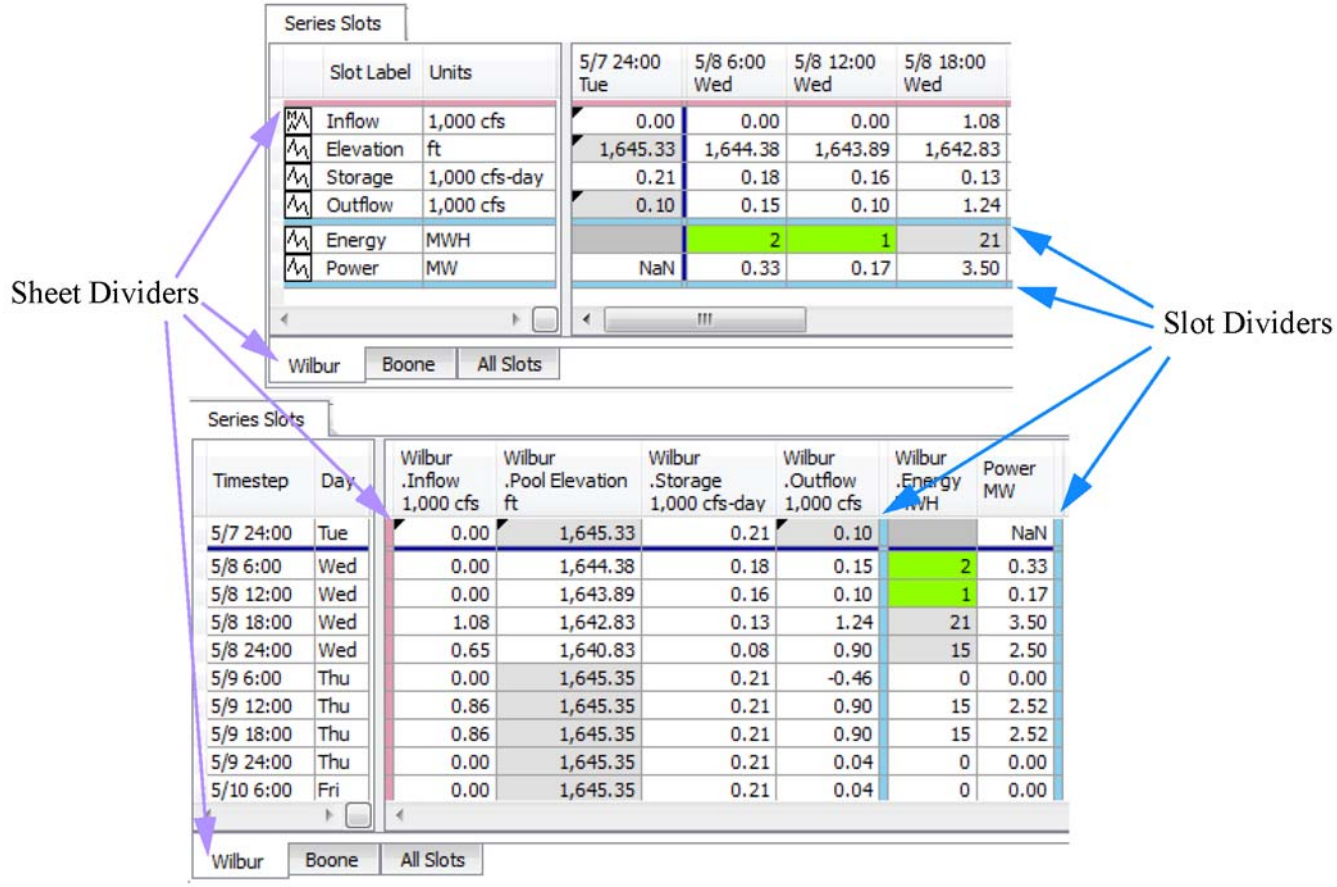
There are two kinds of dividers you can add to organize your SCT, as follows:

- **Slot dividers**. Rows or columns (depending on the current axis orientation) that you can place between slot rows or columns. You can choose one particular background fill color for all slot dividers. When slot dividers display as rows, they are tall enough for a line of text. In this orientation, you can enter text in the **Slot Label** field of the slot divider (row). When the SCT is unlocked, you can edit slot divider row text by double-selecting that field. When slot dividers display as columns, they are drawn as thick lines. In this orientation, you cannot place text within the slot divider (columns). See "Axis Orientation" on page 358 for details.
- **Sheet Dividers**. Delineate on which sheet a series slot it shown. You can choose one particular background fill color for all sheet dividers. The sheet dividers is shown at the top/left of each tab.

See "Change Ornamentations" on page 397 for details on changing background colors.

In Figure 8.4, thin slot dividers display as blue, while sheet dividers are pink. Each graphic shows multiple tabs and two slot dividers.

Figure 8.4



See the following topics for more information:

- Add Slots, Sheet Tabs, and Slot Dividers, page 387

- Move Slots and Slot Dividers, page 389
- Remove Slots and Slot Dividers, page 389
- Create a new SCT from a Series Sheet tab, page 390

Slot Names and Slot Labels

RiverWare uses Slot Names to refer to a particular slot. Generally, the slot name includes the simulation object or account that the slot is on. You cannot change a slot's name within the SCT. (Simulation slots cannot be renamed; custom slots can be renamed from the open object dialog.) See "Ornamentation of Hidden Pre- and Post-Run Timesteps" on page 399 for details.

Slot Labels are text strings that you can use to label a slot within a particular SCT. Two slot labels text strings are associated with a slot item, as follows:

- A single-line text string for use when slots are shown as rows
- A (potentially) multiple-line text string for use when slots are shown as columns

In the horizontal timestep axis orientation (where slots are rows), if the SCT is unlocked, you can edit a slot label in-line. In either orientation, you can edit a slot label by selecting the slot (e.g., select a data cell within the slot) and then selecting **Slots**, then **Set Label / Function**; see "Slots Menu" on page 330.

Note: The SCT must be unlocked.

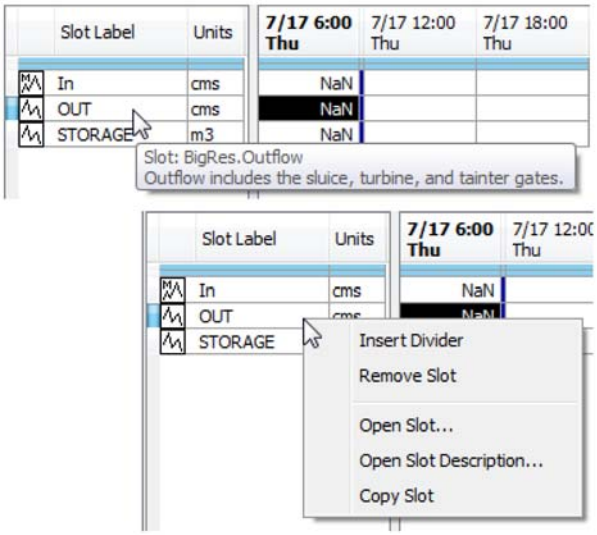
You can set the label for multiple slots to standard values; see "Edit Multiple Slot Labels" on page 370 for details.

Slot Labels are always visible within the SCT as either row or column headers. If the current SCT selection includes only a single slot, the name for a slot displays in the Selection Info area (at the bottom of the SCT).

In the following examples, one slot is selected (by virtue of one of its timesteps being selected). See "Vertical Timestep Axis Orientation" on page 359 for details.

1. Its Slot Label is Hoover Energy.
2. Its Slot Name is LakeMeadHooverDam.Energy (see bottom of SCT).

Note: Hover over a slot name or label to see a tooltip with the full slot name and any description defined on that slot. Use the right-click menu to choose **Open Slot** or **Open Slot Description** to see that slot's dialog without or with the description panel shown, respectively.



Numeric Values

Although numeric slot (time series) values are stored internally as double-precision floating point numbers, values are presented in the SCT (and elsewhere in the RiverWare interface) with a display precision. Display precision is a non-negative integer that specifies the number of fractional decimal digits (to which the internal value is rounded). The SCT uses a slot's display precision for all data cells.

The values displayed in a slot are in the units displayed elsewhere for the slot as defined by the Unit Scheme. The SCT does not provide the ability to change display units of slots.

If you select a single value, it is redundantly displayed with model precision in the **Toolbar Value Edit** field, where it can also be edited. Model precision is not necessarily the full precision of the internal value.

Slot values can be in an undefined state. Depending on an SCT Configuration, undefined values can be displayed as NaN (which stands for *Not a Number*) or as blanks. See "General Tab" on page 338 for details.

Note: **Show Commas in Numbers** setting. In the SCT, commas are shown by default as a thousands separator. This is a global setting that is specified from the **Workspace**, then **Show Commas in Numbers** menu on the workspace. See "Show Commas in Numbers" on page 9 for details.

The SCT also shows tooltips indicating which rule or DMI was responsible for the value, where applicable. See "Series Slots" on page 166 for details.

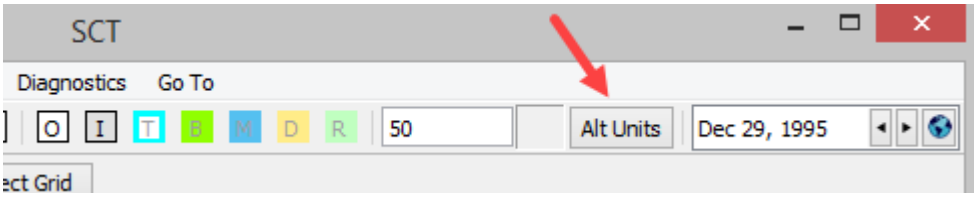
Alt Units Toggle

The SCT always provides an alternative units (Alt Units) toggle button on the toolbar as shown in Figure 8.5. The button provides the following display options:

- Standard - Display flows and volumes without conversion
- Flow - Display flow slots as flows and display volumes as flows (as appropriate)
- Volume - Display flow slots as Volumes and display volume slots as volumes.

All flow series slots on the SCT can be displayed as volume over the timestep using the default unit scheme definition for volume. Certain volume slots can be shown as flows. See "Alt Units button" on page 172 for more information.

Figure 8.5 SCT toolbar with Alt Units button highlighted



Note: Slots shown in their alternate units are shown with an asterisk next to their unit, if shown.

Custom Cell Colors

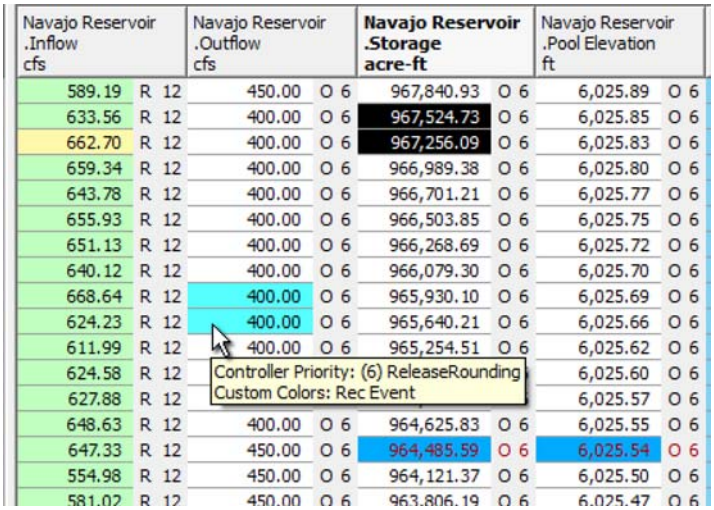
You can define and apply custom cell colors for series slots. Use one of the following approaches:

- Specify the named color for particular slot/timestep values.
- Specify intervals and colors for the entire slot such that the colors change based on the values. These Alerts will display on the SCT cells when values warrant.

When applied, the configured text and background colors are shown on the SCT instead of the standard flag colors. Tooltips provide the flag information and the custom color label or interval name, as shown in Figure 8.6.

- Configure the set of named color items in the **Flags** tab of the SCT configuration; see "Custom Cell Colors" on page 344 for details.
- Apply the named colors using the right-click **Apply Custom Colors**; see "Apply Custom Colors to Slot/Timestep Cells" on page 395 for details.
- Configure intervals for a particular slot and choose the colors to show for each interval; see "Configure Color Alerts" on page 371 for details.

Figure 8.6



Navajo Reservoir .Inflow cfs		Navajo Reservoir .Outflow cfs		**Navajo Reservoir .Storage acre-ft**		Navajo Reservoir .Pool Elevation ft	
589.19	R 12	450.00	O 6	967,840.93	O 6	6,025.89	O 6
633.56	R 12	400.00	O 6	967,524.73	O 6	6,025.85	O 6
662.70	R 12	400.00	O 6	967,256.09	O 6	6,025.83	O 6
659.34	R 12	400.00	O 6	966,989.38	O 6	6,025.80	O 6
643.78	R 12	400.00	O 6	966,701.21	O 6	6,025.77	O 6
655.93	R 12	400.00	O 6	966,503.85	O 6	6,025.75	O 6
651.13	R 12	400.00	O 6	966,268.69	O 6	6,025.72	O 6
640.12	R 12	400.00	O 6	966,079.30	O 6	6,025.70	O 6
668.64	R 12	400.00	O 6	965,930.10	O 6	6,025.69	O 6
624.23	R 12	400.00	O 6	965,640.21	O 6	6,025.66	O 6
611.99	R 12	400.00	O 6	965,254.51	O 6	6,025.62	O 6
624.58	R 12					6,025.60	O 6
627.88	R 12					6,025.57	O 6
648.63	R 12	400.00	O 6	964,625.83	O 6	6,025.55	O 6
647.33	R 12	450.00	O 6	964,485.59	O 6	6,025.54	O 6
554.98	R 12	450.00	O 6	964,121.37	O 6	6,025.50	O 6
581.02	R 12	450.00	O 6	963,806.19	O 6	6,025.47	O 6

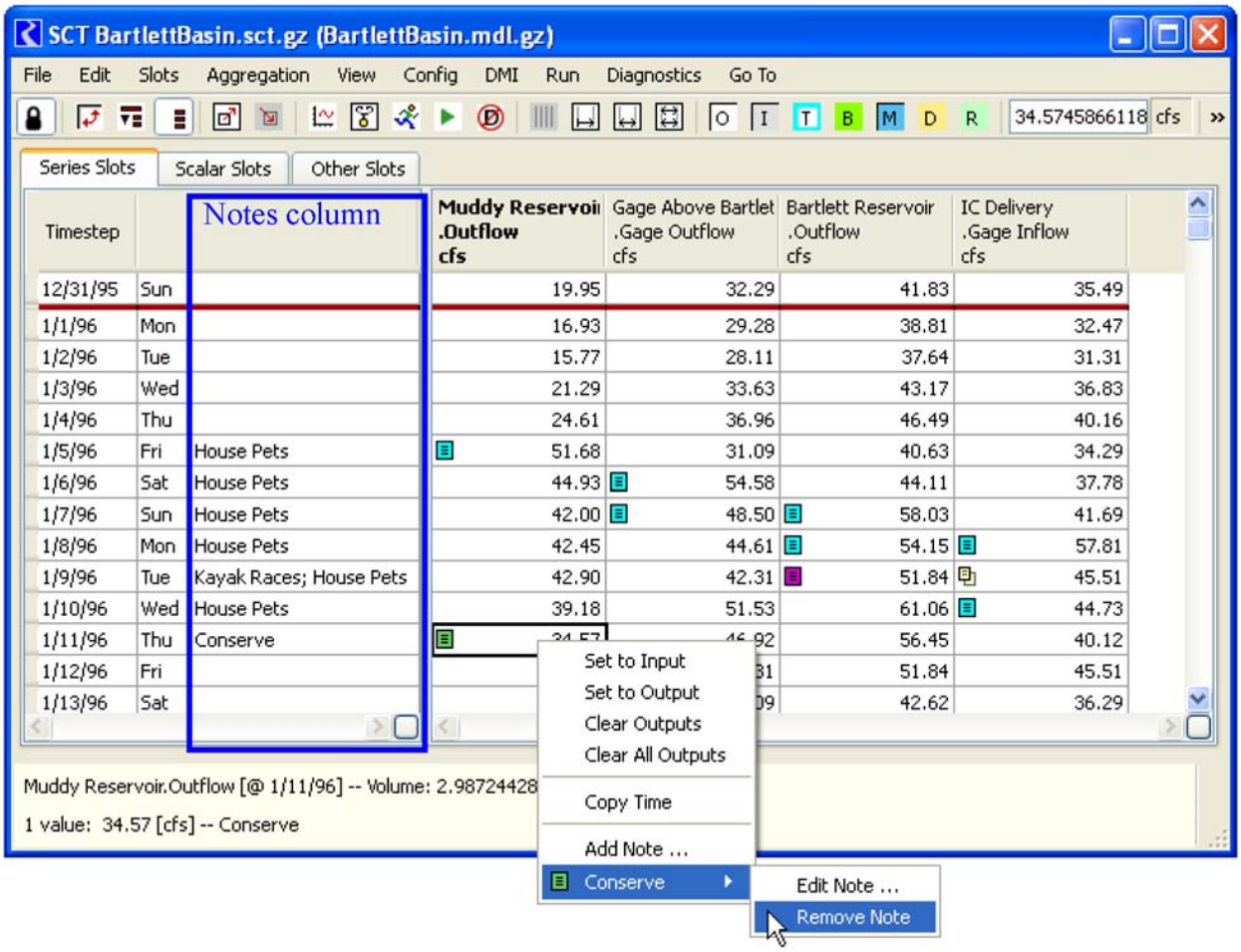
Controller Priority: (6) ReleaseRounding
Custom Colors: Rec Event

Notes on Series

The SCT supports timestep annotations on the Series Slots tab. Operations on Notes are performed with the right-click context menu, with the same operations as those available in the Open Slot dialog. See “Notes on Series Slots” on page 272 for details.

If a single SCT cell is selected, the note text associated with that cell are displayed in the SCT selection status bar, at the bottom of the SCT. As with the series data shown in an SCT, the notes are associated with the SeriesSlots shown in the SCT, and not with the SCT itself.

Figure 8.7



When the SCT is in the Non-Aggregated Vertical Timestep view (see Figure 8.7), the text for all of the notes in each timestep row can be shown in a row header column, depending on the setting on the **Vert Time** tab of the SCT configuration; see "Vertical Time Tab" on page 340 for details.

Timesteps

An SCT can be configured to show a timestep interval matching the RiverWare model's Run Control or any other timestep supported in RiverWare. This feature is configured using a SCT Timestep Size Override property which is configured on the General tab of the SCT configuration dialog. See "Run Menu" on page 334 for details.

> **Note:** An SCT can only show one timestep size for all series slot sheet tabs. But you can have multiple SCTs open showing different timestep sizes.

In addition, the timestep range of slots in an SCT do not have to match **Run Control**; SCT cells corresponding to a timestep on a slot that is out of that slot's defined range display merely as blank.

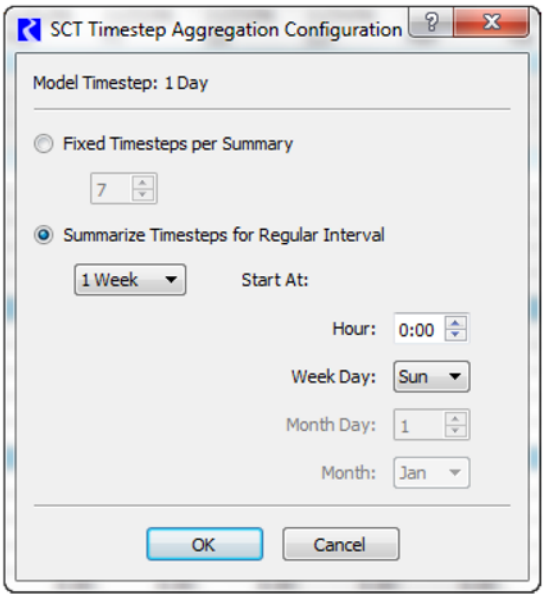
Conversely, the displayed timestep range of the SCT—the model's current run control timestep range plus the indicated number of pre-simulation and post-simulation timesteps—may not cover the complete timestep range of

slots displayed in the SCT. When this occurs, a special ornamentation (an upper-left or lower-right corner triangle) on the slot's first and/or last cells indicate the presence of obscured (hidden) timestep values for that slot. See "Ornamentation of Hidden Pre- and Post-Run Timesteps" on page 399 for details.

Timestep Aggregation

For display (and certain data export) purposes only, groups of timesteps within each Slot can be aggregated and summarized as single numeric values within an SCT. Aggregation is done by choosing an aggregation interval size larger than the timestep interval size—for example, aggregate 1 Hour timestep data up to a 1 Day timestep. It is also possible to select a constant number of timesteps for aggregation. See "Timesteps" on page 353 for details.

When in an Aggregated View, each slot displays only the summary cells.



To configure the aggregation, access the SCT Timestep Aggregation Configuration dialog by selecting **Aggregation**, then **Timestep Aggregation Config**. See "Aggregation Menu" on page 331 for details.

Within the dialog choose one of the following:

- **Fixed Timesteps Per Summary.** A specified constant number of timesteps is used for each aggregation. Aggregations start with the first timestep displayed in the SCT.
- **Summarize Timesteps for Regular Interval.** A specified interval of time with a start offset is used. You select the aggregation interval size—which must be larger than the timestep —and **Start At** (offset) settings. The accompanying graphic shows a weekly aggregation starting on Sunday at 0:00. This indicates it will summarize the following 7 days (1 Day timestep model) Monday to Sunday.

With interval aggregation, the number of timesteps per aggregation can vary for the following reasons:

- Monthly aggregations will have various numbers of timesteps. Other irregular relationships between aggregation and timestep intervals are also possible.
- The first aggregation will have fewer timesteps if the first timestep displayed in the SCT isn't at the beginning of a regular interval aggregation (with respect to the selected offset).

- The last aggregation will have fewer timesteps if the last timestep displayed in the SCT does not fall at the end of a regular interval aggregation (with respect to the selected offset).

The SCT supports both non-aggregated and aggregated views. In non-aggregated views, every data cell displays the value of exactly one timestep. Aggregated views have both detail and summary cells. These are described in the next section.

Detail Cells and (Aggregation) Summary Cells

Aggregated SCT views display the following types of data cells (see "Timestep Aggregation" on page 354 for details).

- Detail cells display the value of exactly one timestep (of one slot), as do all cells in non-aggregated views.
- Summary cells display the aggregated values. These are the result of a particular Summary Function on the timesteps that make up the aggregation. See "Summary Functions" on page 355 for details.

In both axis orientations, summary cells and detail cells have the same relative arrangement. An aggregation's detail cells (showing each of the individual timesteps within the aggregation) are laid out immediately below the aggregation's single summary cell. Also, the two types of cells are laid out in rows—i.e., Summary Rows and Detail Rows—though the correspondence of those rows to the same slots versus the same timesteps differs in the two axis orientations. See "Axis Orientation" on page 358 for details.

In the aggregated views, summaries are always displayed while detail cells can be displayed or hidden. The non-aggregated views display only details without summaries.

Summary Functions

You can select a Summary Function for slots in the model based on the unit type, slot name or individually for each slot in an SCT. The function is applied to the set of timesteps within each timestep aggregation and displayed in a Summary cell. See "Timestep Aggregation" on page 354 and "Detail Cells and (Aggregation) Summary Cells" on page 355 for details.

The following Summary Functions are supported:

- **1st**
- **Last**
- **Sum**
- **Ave**. Mean
- **Med**. Median, Since Median requires a sorting of values, this can slow down the speed of SCT refreshes. If there is an even number of non-NaN values, the Median is defined as the mean of the middle two values.
- **Min**. Minimum
- **Max**. Maximum
- **Nth (**particular *n*—e.g., 5th)

For the arithmetic functions, undefined values (NaNs) are ignored.

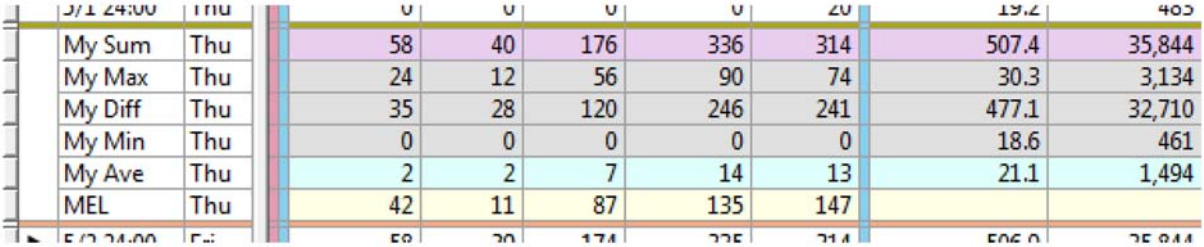
How To:

• Change a Slot's Summary Function, page 390

Custom Aggregation Rows

For time-aggregated, vertical timestep view (where slots are columns), you can specify one or more custom **Summary Rows** at the end of each time aggregation.Figure 8.8 shows eight custom rows (including dividers as the first and last custom summary rows).

Figure 8.8

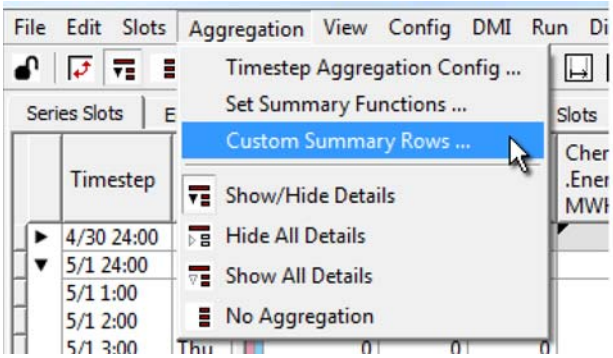


My Sum	Thu	58	40	176	336	314	507.4	35,844
My Max	Thu	24	12	56	90	74	30.3	3,134
My Diff	Thu	35	28	120	246	241	477.1	32,710
My Min	Thu	0	0	0	0	0	18.6	461
My Ave	Thu	2	2	7	14	13	21.1	1,494
MEL	Thu	42	11	87	135	147		

The following custom summary row types are supported.

- Divider. A thin row, without text, having a configurable color.
- Sum of all timesteps in the time aggregation.
- Average of all timesteps in the time aggregation
- Maximum of all timesteps in the time aggregation
- Minimum of all timesteps in the time aggregation
- Difference of the prior two data rows.
- Slot Reference. This resolves to either a scalar slot or a series slot having a timestep size of the timestep aggregation.

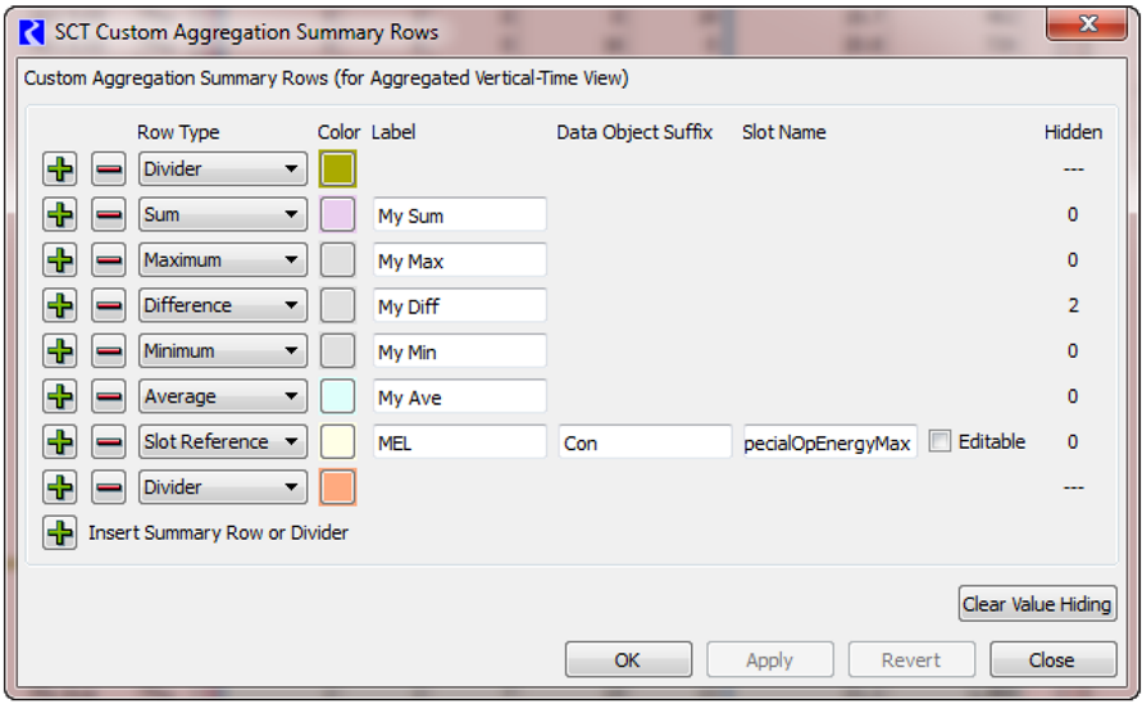
Each custom summary row can be configured with a unique background color. To display the Custom Aggregation Summary Rows configuration dialog box, select **Aggregation**, then **Custom Summary Rows**.



Each row is configured through these controls.

-  button. insert a new row, above.

-  button. delete the row.
- **Row Type**. an option menu for selecting among these different types of aggregation
- **Color**. background color. Select the button to choose a color.
- **Label**. A text field used to label the row.



Slot Reference Rows

These contain the following additional controls to identify a particular series slot (of the aggregation size) or scalar slot for each simulation object column. The primary reference simulation object will be the object containing the SCT column's associated series slot. The reference slot must have the same unit type as the slot. If they have different unit types, no data will be shown in the reference row. The additional controls are:

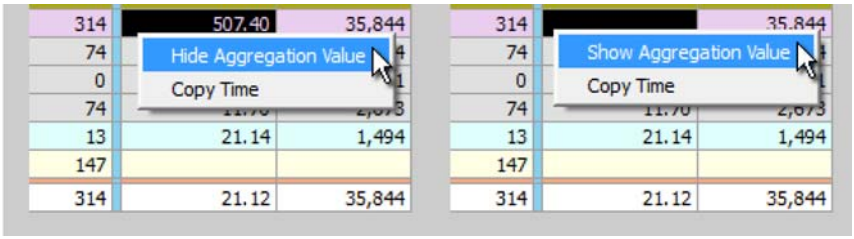
- **Data Obj Suffix**. optional object name suffix to specify a Data Object associated with the reference object.
- **Slot Name**. the name of a slot on the reference object or associated data object.
- **Editable**. checkbox to indicate if the data should be editable in the SCT.

Custom Summary Row Behavior

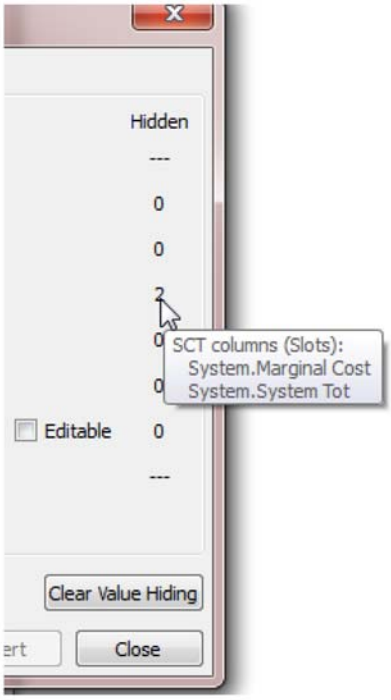
The Custom Summary Rows support only single-cell selection, and such a selection is active only if no other SCT cells are selected. The Custom Summary Row cells are primarily read-only, but the read-only cross-hatch is ***not*** shown. Custom Summary Row cells are automatically updated whenever changes to any of the other SCT cell values change. In the case of Slot Reference rows, changes to the referenced slot are also automatically reflected.

Hiding Row Values

The content of a custom summary cell can be hidden by right-clicking the cell and selecting **Hide Aggregation Value**. This can be useful to hide the aggregation if it does not make sense for a particular slot. A cell value hidden in this way can be reshown by selecting the **Show Aggregation Value** context menu operation.



All such hidden cell values can be reshown with an operation in the configuration dialog accessed from the **Aggregation**, then **Custom Summary Rows** The Hidden column lists the number of hidden slot values. Hover over a number to see the slots hidden. Select the **Clear Value Hiding** button to show all values.

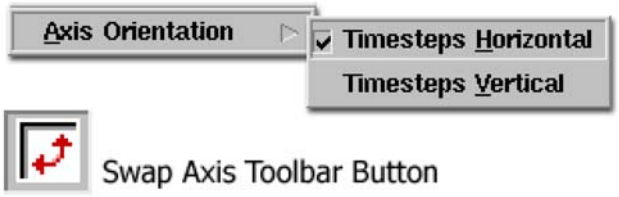


Axis Orientation

Use one of the following methods to swap the two SCT axes:

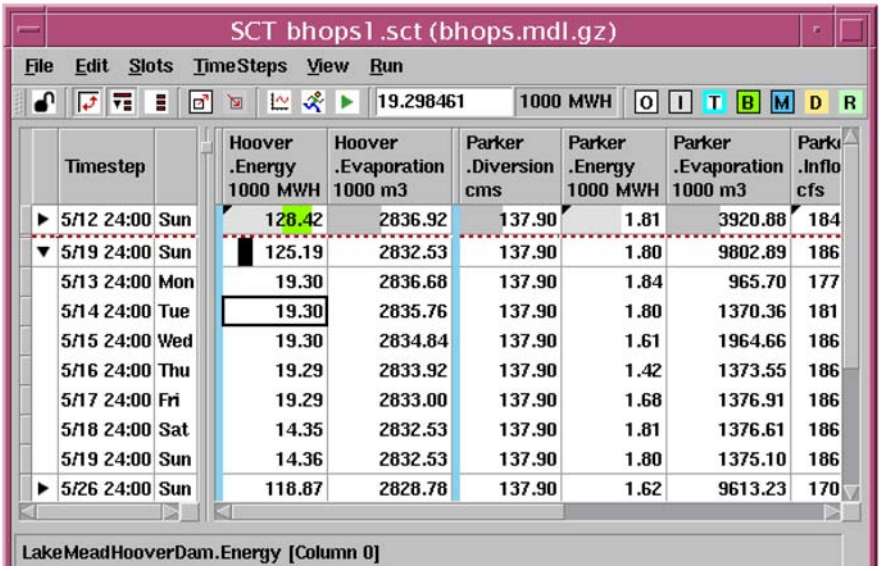
- Select the **Swap Axis Toolbar Button**.

- Select **View**, then **Axis Orientation**.



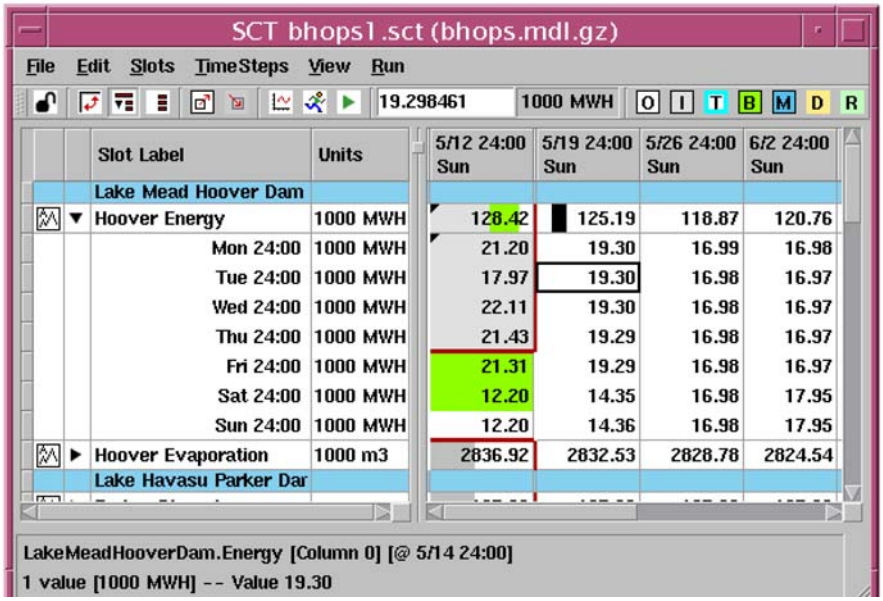
You can display either axis orientations as Aggregated or Non-Aggregated views (see"Timestep Aggregation" on page 354 for details).The axis orientations are referred to in the interface and in SCT documentation as *vertical* or *horizontal* timestep axis orientation.

Vertical Timestep Axis Orientation



- Columns are Slots
- Rows are
  - Timesteps or
  - Timestep aggregate summaries
  - Custom aggregation summary rows

Horizontal Timestep Axis Orientation



- Rows are Slots
- Columns are Timesteps or Timestep Aggregates

Copy and Paste

See the following topics for descriptions of the types of Copy and Paste that can be done in an SCT:

- Copy a Single Value to One or Many Timesteps, page 404
- Copy Multiple Values, page 405
- Copy a Timeslice Across All Slots, page 406
- Copy a Whole Slot, page 407

Copy and Paste

The default Copy operation (**Ctrl+C**) copies the selected cell's values to the ***INTERNAL*** RiverWare SCT clipboard (i.e. it is available only to the SCT not elsewhere in RiverWare or other applications). The copy action is only available for selection within a single slot or across one or more entire timesteps. The default paste operation (**Ctrl+V**) (and the **Paste** toolbar button) pastes only Input values into the current selection. Values computed as a result of a model run are not pasted. Specifically:

- Input flagged values are pasted to the destination timesteps with the **Input** Flag.
- The final timestep value of a **Target Operation** is copied to the destination with the **Target Flag**, and the **Begin Target** is pasted if an explicit **Begin Target** timestep was defined (but only if the entire **Target Operation** was included in the copied selection).

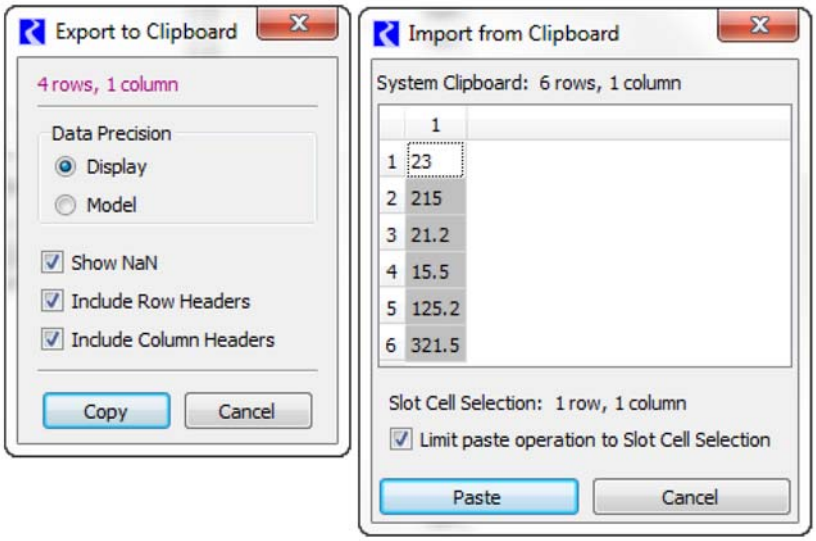
- **Best Efficiency** (B), **Max Capacity** (M), **Drift** (D) and **Unit Values** (U) flagged timesteps in the copied (source) selection are pasted as undefined (NaN) values in the destination timesteps but with the source flag.
- Other timesteps are cleared—that is, set to NaN with an **Output Flag**.

Copy and Paste as Input

The default Copy operation (**Ctrl+C**) copies the selected cell's values to the ***INTERNAL*** RiverWare SCT clipboard (i.e. it is available only to the SCT not elsewhere in RiverWare or other applications). The copy action is only available for selection within a single slot or across one or more entire timesteps. Selecting **Edit**, then **Paste as Input** (also, **Ctrl+N**) pastes all defined (non-NaN) values from the copied (source) selection to the destination timesteps, assigning the **Input Flag** to those values. Undefined (NaN) values from the copied (source) selection are pasted as **NaN / Output Flagged** values in the destination timesteps.

Export Copy and Import Paste

The **Export Copy** operation copies the selected cell's values to the ***SYSTEM*** clipboard (i.e. it is available for any other application and within RiverWare where an Import Paste is supported). Select **Edit**, then **Import Paste** to paste all defined (non-NaN) values. Both operations provide a dialog that gives options on what to export/import.



See "Copy/Paste Data to/from the Clipboard (e.g., to Excel)." on page 408 for additional information on using Export Copy and Import Paste.

Integer Indexed SCTs

Up to this point, we have presented the SCT and assumed that the you are always displaying timeseries data. It is also possible to display integer indexed slots. See "Integer-indexed Series and Agg Series Slots" on page 203 for more information on Integer Indexed Series Slots. An SCT can show integer indexed slots, but because a SCT must have the same timestep size for all slots displayed, it cannot also show time indexed slot. As a result, you are prohibited from adding integer indexed slots to a SCT that already has time indexed slots and vice versa. When an SCT is created, if you add an integer indexed slot, that SCT becomes fixed using integer indices. An Integer

Indexed SCT is slightly different than a normal SCT because certain operations are not allowed. The following describes the differences when an SCT is displaying integer indexed series

- SCT dialog. The following controls are disabled as they are not valid:
  - **Aggregation**, then **Aggregation Config**
  - **Aggregation**, then **Show/Hide Details**
  - **Aggregation**, then **Hide All Details**
  - **Aggregation**, then **Show All Details**
  - **Aggregation**, then **No Aggregation**
  - **Config**, then **Save Current Settings as Default**
- SCT dialog. The following controls are relabeled to better indicate the operations
  - **View**, then **Axis Orientation**, then **Timesteps Vertical** becomes **Indices Vertical**
  - **View**, then **Axis Orientation**, then **Timesteps Horizontal** becomes **Indices Horizontal**
- SCT Configuration dialog, **General** tab. Options have been disabled
  - **Always Synchronize Range to Slots** checked and disabled

    Note: Selecting this item indirectly disables alternative range controls.
  - **Double-click Data Cell Toggles Detail Rows** unchecked and disabled
- SCT Configuration dialog, **Horz Time** tab. Options have been renamed or disabled
  - Tab renamed to **Horz Index**
  - Description becomes **Horizontal Index Orientation Settings**
  - **Column Headers: Include Weekday** unchecked and disabled
  - **Column Headers: Hide Hours if all "24:00"** unchecked and disabled
  - **Show Column: Agg. Summary Function** unchecked and disabled
  - **Draw Day Divider Columns** unchecked and disabled
  - **Draw Weekend Divider Columns** unchecked and disabled
  - **Draw Month Divider Columns** unchecked and disabled
  - **Draw Year Divider Columns** unchecked and disabled
- SCT Configuration dialog, **Vert Time** tab. Options have been renamed or disabled
  - Tab renamed to **Vert Index**
  - Description becomes **Vertical Index Orientation Settings**
  - **Column Headers: Include Agg. Summary Function** unchecked and disabled
  - **Show Column: Weekday** unchecked and disabled
  - **Draw Day Divider Rows** unchecked and disabled
  - **Draw Weekend Divider Rows** unchecked and disabled

  - **Draw Month Divider Rows** unchecked and disabled
  - **Draw Year Divider Rows** unchecked and disabled
- SCT Configuration dialog, **Toolbar** tab: Options have been renamed or disabled
  - **Summary Detail Mode Buttons** unchecked and disabled
  - **Button: Show/Hide Details** unchecked and disabled
  - **Button: Hide All Details** unchecked and disabled
  - **Button: Show All Details** unchecked and disabled
  - **Button: No Summaries** checked and disabled
  - **Date Time Spinner** unchecked and disabled
- SCT Configuration dialog, **Summary** tab: Options have been renamed or disabled
  - **Show Timestep Flag Colors: Never** cleared and disabled
  - **Show Timestep Flag Colors: When detail rows are hidden** cleared and disabled
  - **Show Timestep Flag Colors: With 7 or fewer timesteps** cleared and disabled
  - **Show Timestep Flag Colors: Always** selected and disabled
- SCT Configuration dialog, **Color** tab: Options have been renamed or disabled
  - **Day Divider** button disabled
  - **Weekend Divider** button disabled
  - **Month Divider** button disabled
  - **YearDivider** button disabled
  - **Simulation Boundary Divide**r button disabled

Edit Series Slot List Tab

The **Edit Series Slot List** tab contains a list of series slot columns shown in the **Series Slots** tab and consists of two modes:

- **Add / Delete Move Series Slots**. This is used to configure which slots are shown and their ordering and grouping on the SCT.



- **Configure Color Alerts.** Configure thresholds for color alert interval ranges. Essentially, this mode allows you to create conditional coloring on the Series Slots tab.

These two operations are described in the following sections. For both modes, the dialog shows a two-level tree-view with dividers as top-level items and subsequent slot items as children of the divider.

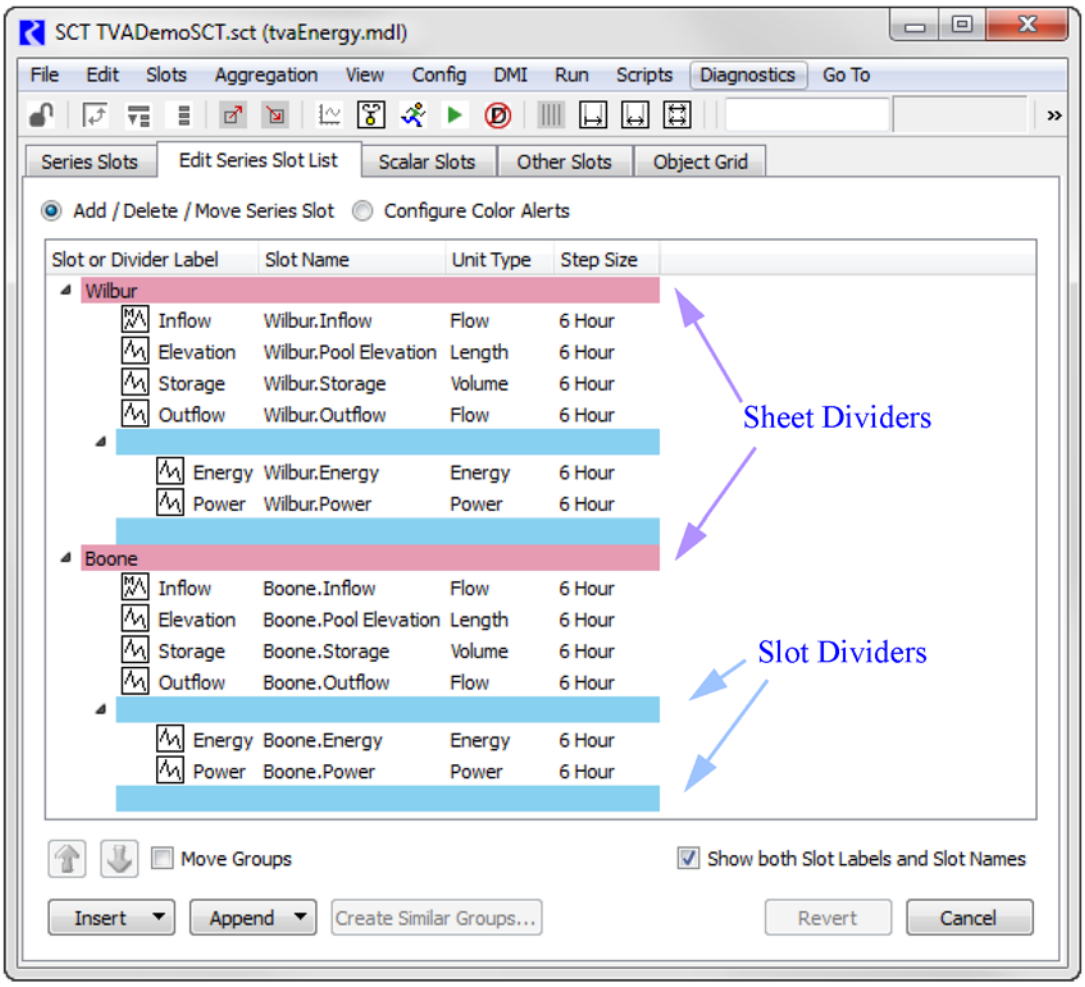
> **Note:** Dividers without text are shown with the text of the following slot item when the divider's tree is closed.

Adding, Deleting, and Moving Slots

When in Add / Delete Move Series Slots mode, this dialog is used to organize your series slots. You can re-arrange the order, create groups, and even create separate sheet tabs from this dialog. There are two kinds of dividers:

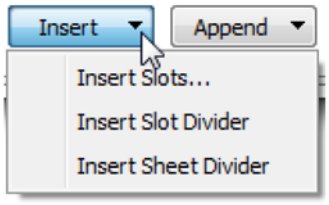
- Sheet Dividers are used to create separate sheets with a tab for each sheet located at the bottom of the SCT.
- Slot Dividers are graphical elements that are used to separate slots on each sheet

Both types of dividers behave the same in this dialog in terms of moving and creating similar groups. The slot list has an initial divider item so there is always at least one group.



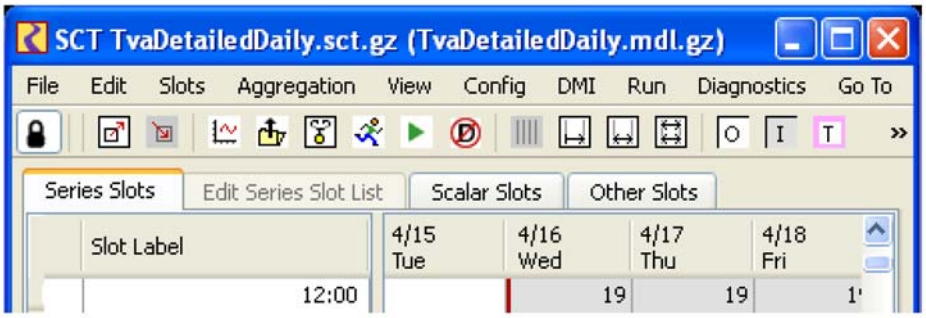
Following is a description of the buttons available on this tab:

- **Insert.** Use the menu to **Insert Slots**, **Insert Slot Divider**, or **Inset Sheet Divider.** You must select a row before this option is enabled. The Insert Slots option opens the slot selector to insert new slots onto the SCT.

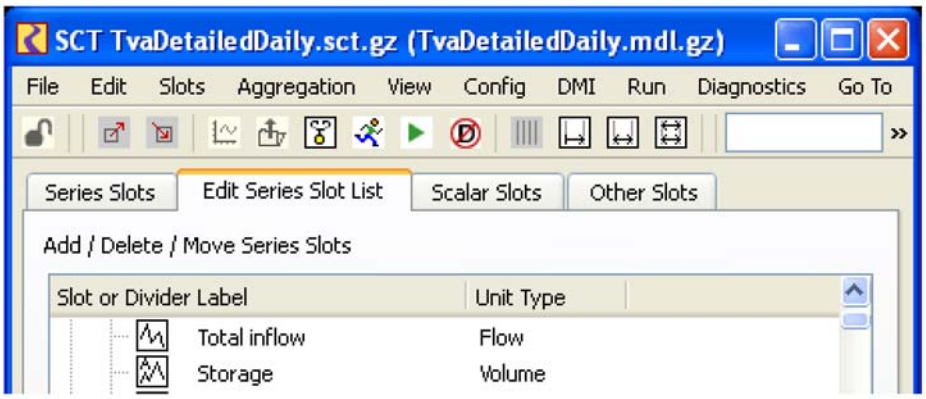


- **Append**. Use the menu to **Append Slots**, **Append Slot Divider** or **Append Sheet Divider**. You must select a row before this option is enabled. The Append Slots option opens the slot selector to append new slots onto the SCT.
- **Create Similar Groups**. special operation for groups containing slots on a single simulation object or account.
- **Revert**. discards changes made to the series slot list since the series slot list edit mode was started. This button is enabled only if changes have been made.
- **Accept / Cancel**. takes you to the Series Slot tab. If any changes to the slot list had been made, the button label will be **Accept**, and selecting the button applies those changes to the series slot data table. If no changes had been made (or if changes had been reverted), the button label is **Cancel** and selecting the button has no effect on the series slot data table.

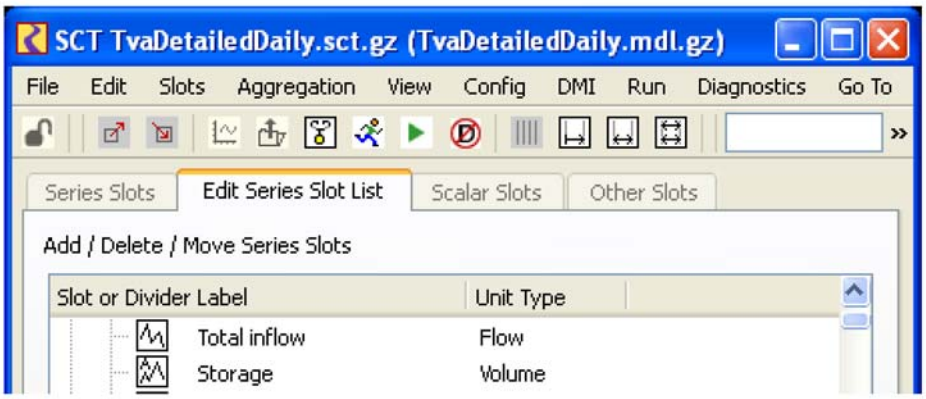
The SCT must be unlocked for any operation to be enabled. If the SCT is locked, the Edit Series Slot List tab is disabled.



When showing the **Edit Series Slot List** tab, the SCT Lock controls (toolbar button and menu item) become disabled. The other SCT tabs remain enabled until a change is made to the Series Slot list.

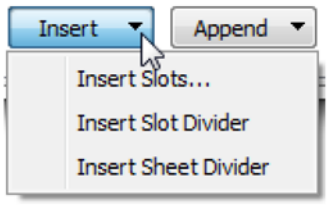


Once a change is made to the Series Slot list, the other tabs become disabled. You can **Revert** or **Accept** the changes.

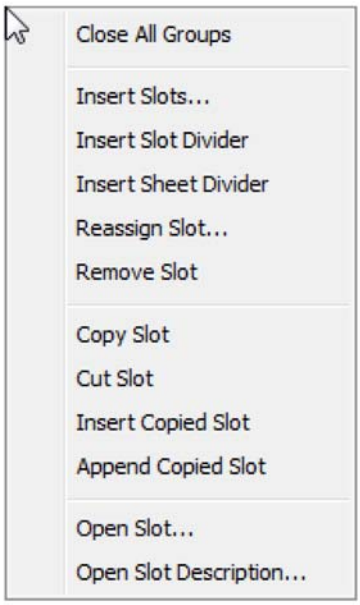


Adding Slots and Dividers

In general, use the **Insert** or **Append** buttons at the bottom.



Alternatively, use the right-click context menu to access a list of possible actions.



Slot Dividers can be added at either the top or secondary level. Sheet Dividers are always added at the outermost level.

Organize Slots

Two different move modes are supported. You can switch between these two modes by toggling the **Move Groups** checkbox. Selected items or groups are moved up or down one logical position (defined by the mode) by selecting the **Up** or **Down** arrow buttons.

- **Move Groups ON**. The **Up** and **Down** arrow buttons are enabled only when at least one divider is selected (and only when the divider selection doesn't include an item already at the top or bottom, for the two respective move directions). In this mode, the order of the slots within each group is preserved.

  Note: When all groups are closed, the **Move Groups** checkbox is forced on, and is disabled.

- **Move Groups OFF**. Selected slot and divider items are moved up or down without respect to the grouping defined by the dividers. This is useful for placing dividers at a different position, and for moving slot items within a group, or between different groups.

Since the text label for a slot item does not have to be the name of the slot, you have the option of showing a Slot Name column. This is done by turning on the **Show both Slot Labels and Slot Names** checkbox.

Create Similar Groups Operation

The **Create Similar Groups** button is used to create a group of slots similar to the selected group. The button is enabled when the selection applies to slots on one simulation object or account. Selecting the **Create Similar Groups** button displays a selector that you use to select new objects or accounts.



In the case of simulation objects, the object selector is limited to the type of the object of the originally selected group.

After picking one or more simulation objects or accounts, a new group is created for each of those objects (immediately below the originally selected group in the Edit Series Slot List) with the same slots as in the original group. The order of the slots in the original group is used for the new groups.

In Figure 8.9, the original group has slots from one particular power reservoir (Abiquiu Reservoir). This includes slots not present in the two storage reservoirs subsequently picked with the simulation object selector. The slots from the original group that are not present in the picked reservoirs are not included in the new groups.

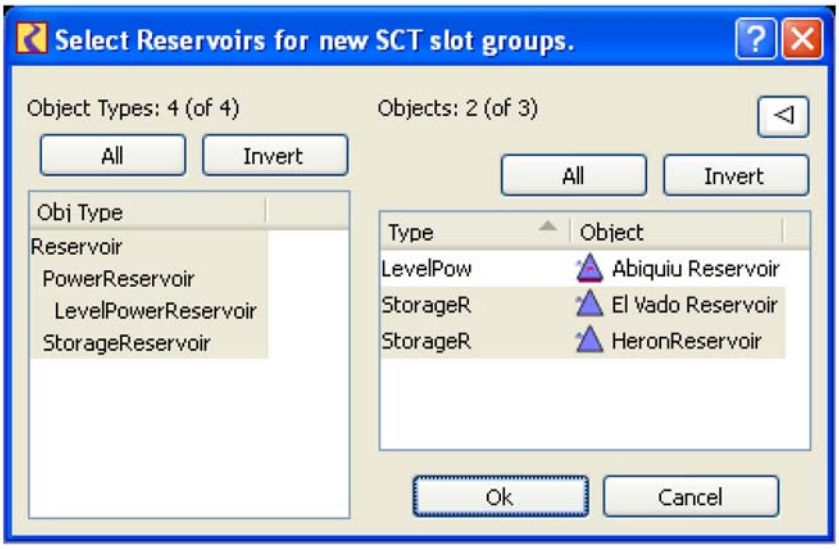
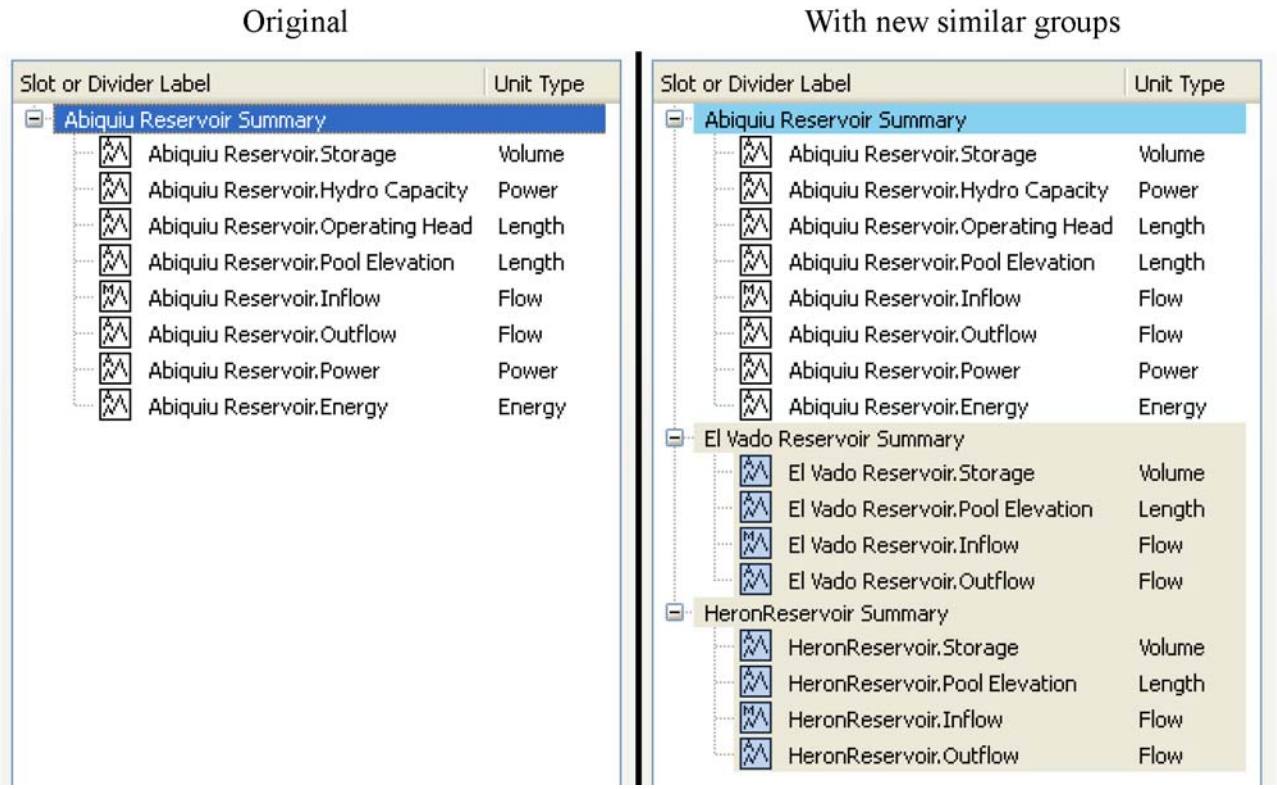


Figure 8.9

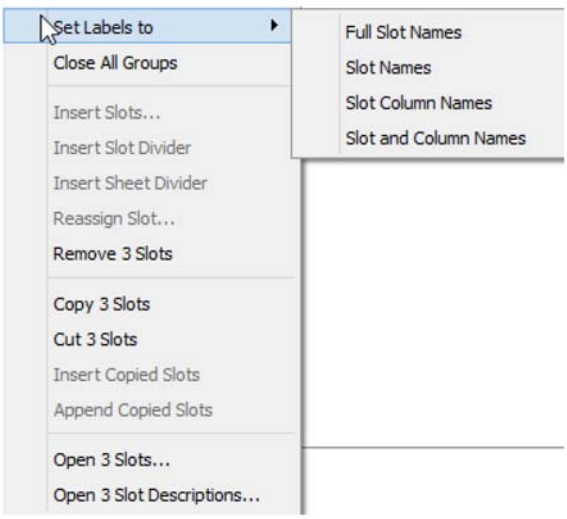


If the original group's divider's text label contains the name of the group's simulation object or account, that name will also be substituted in the divider labels for the new groups.

The **Create Similar Groups** operation is available only when all the slots within the selected group are from one simulation object or one account.

Edit Multiple Slot Labels

As noted in "Slot Names and Slot Labels" on page 349, a slot's label does not need to match the Slot name. Select **Slots**, then **Set Label / Function** and enter any text you like for either the row or column label. See "Slots Menu" on page 330.



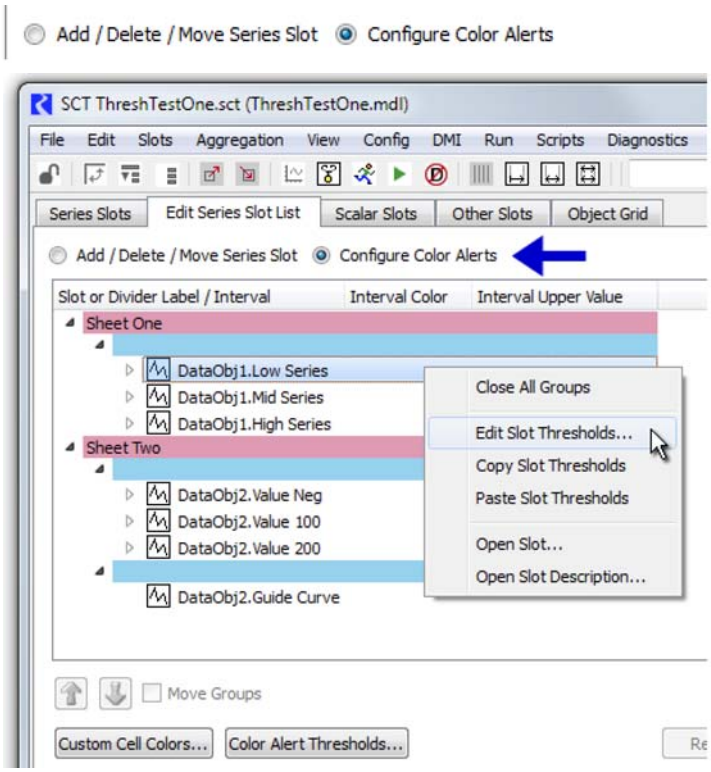
When on the Edit Series Slot List tab, you can set the labels for many slots in one action. Highlight the desired slots, and right-click, then select **Set Labels to**. Select one of the following options:

- **Full Slot Names**. Change the label to the Object.Slot name. E.g. "Mead.Inflow"
- **Slot Names**. Change the label to just the slot name. E.g. "Inflow"
- **Slot Column Names**. For Agg Series and other multi-column slots, use the column label. E.g. "Rice"
- **Slot and Column Names**. For Agg Series and other multi-column slots, use the slot and column label. E.g. "Evapotranspiration Rate by Crop.Rice"

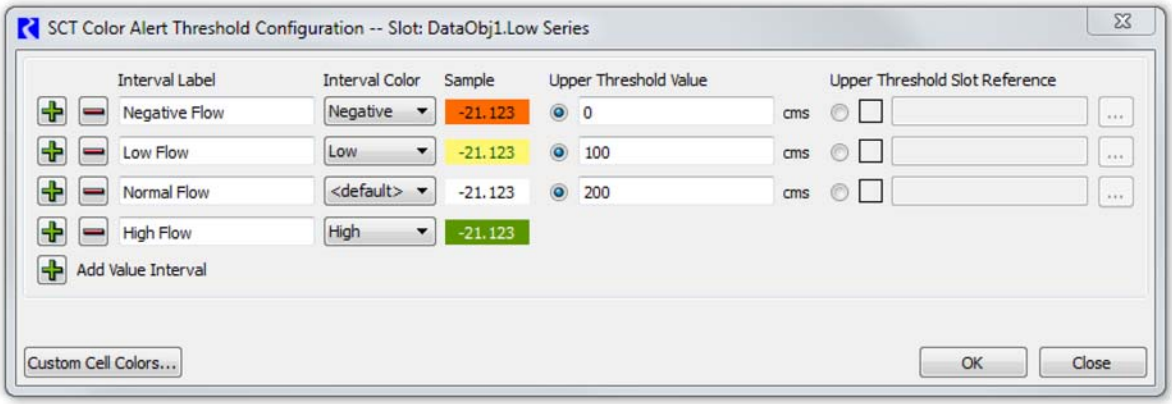
  Note: This operation will change both the row and column labels.

Configure Color Alerts

When **Configure Color Alerts** is enabled, the slot list is used to configure the interval/thresholds and colors to use for those values. The intervals and their associated colors are defined for individual series slots.



Right-click a slot and select **Edit Slot Thresholds** context menu to open the SCT Color Alert Threshold Configuration dialog box. This is also accessible from the **Color Alert Thresholds** button, enabled when a single slot item is selected.

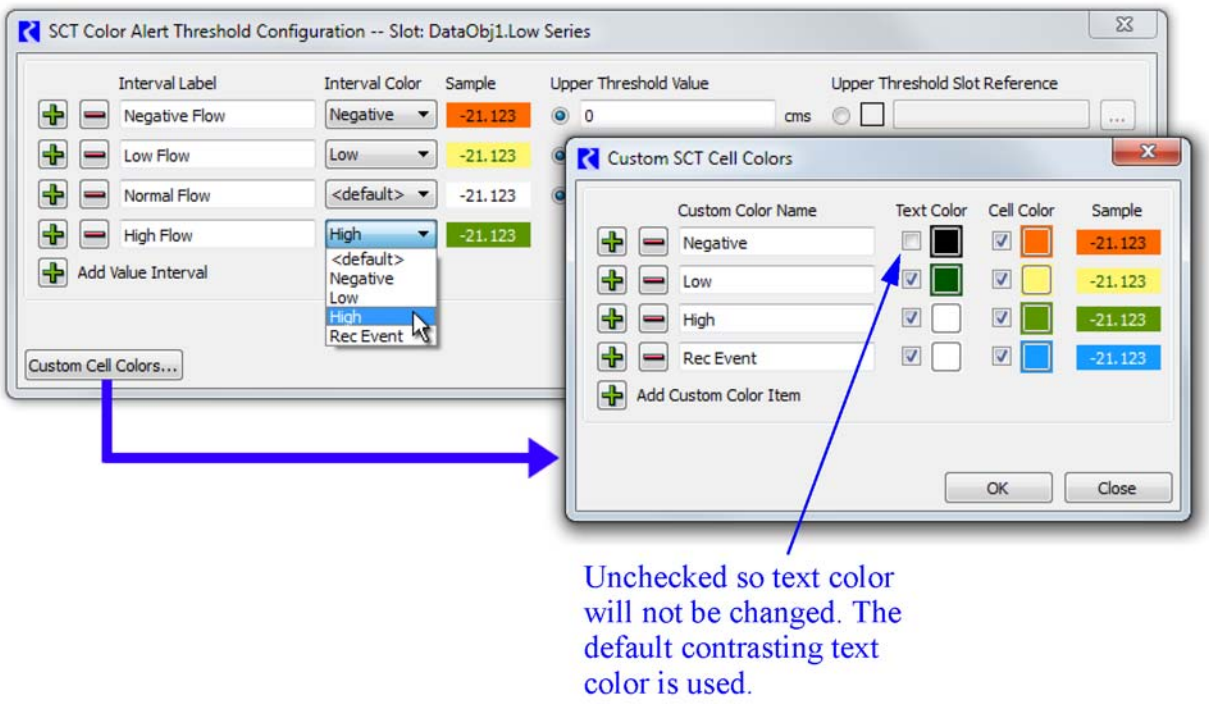


Add intervals using the **Plus** button. Remove an interval using the **Minus** button.

For each value interval, you choose among the available Custom SCT Cell Colors defined in the SCT **Flags** tab or the **<default>** option, which uses the color associated with the slot timestep cell's series flag. The custom colors

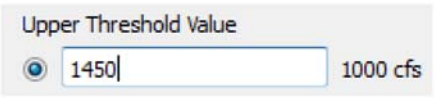
can be edited by selecting the **Custom Cell Colors** button. See "Flags Tab" on page 344 and "Custom Cell Colors" on page 344 for details.

Figure 8.10

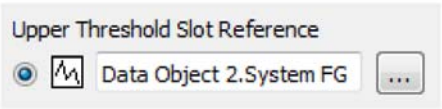


The upper threshold for each interval can be specified as either a static numeric value or you can reference a slot. Select one of the following options:

- Specify a static numeric **Upper Threshold Value** by entering it into the box. The numeric **Upper Threshold Value** is shown in the slot's current display units, as determined by the currently active unit scheme.



- Specify the **Upper Threshold Slot Reference**. The name of the referenced slot can be directly edited, or selected using the slot selector (by selecting the **More** button). The slot selector is shown with the appropriate unit type filter shown, and is limited to the supported types of slots (series, periodic, and scalar).



After accepting the SCT Color Alert Threshold Configuration, the slot's sequence of value intervals is shown as tree view items under the slot.

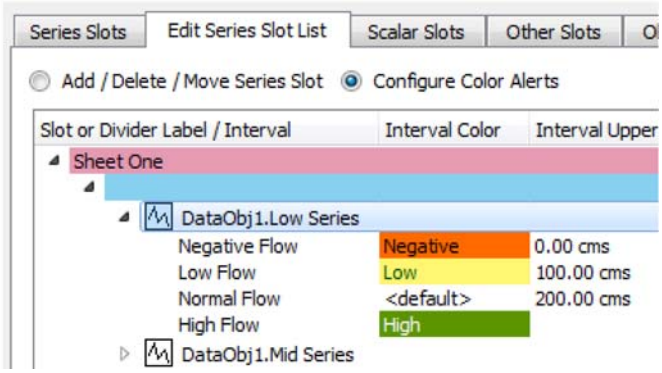


Table 8.1 describes the color values used in the previous examples.

Table 8.1

SCT cells with these values	Are shown with these custom colors
Below 0cms	Negative (orange background).
Between 0 and 100cms	Low (yellow background)
Between 100 and 200cms	<default> colors, based on individual cell's slot timestep series flag (e.g. Input, Output, or Rules).
Above 200 cms	High (green background)

Note: Custom SCT colors can be applied manually to any set of selected cells, but value alerts have precedence over manually assigned colors. See "Apply Custom Colors to Slot/Timestep Cells" on page 395 for details.

Note: Several indications are provided for undefined threshold values. This applies both to a missing slot or NaN values within such a slot. A missing slot is indicated in the SCT Color Alert Threshold Configuration dialog with an empty slot type icon. In the SCT series data table, cells for which a missing slot or NaN value is encountered are drawn with a dotted pattern and have a tooltip indicating the threshold value error.

Copying thresholds to other slots

A slot's set of value intervals can be copied to multiple other slots with the use of the **Copy Slot Threshold** and **Paste Slot Thresholds** right-click context menu operations.

Note: Slot references are copied as is, no attempt is made to substitute a new object's name.

Scalar and Other Slots Tabs: Slot Lists

The **Scalar Slots** and **Other Slots** tabs display lists of slots. They are used to organize non-series data allowing you to collect these slots together in a convenient location. For example, instead of opening each reservoir and looking for the Elevation Volume table, these can be grouped together on the **Other Slots** tab.

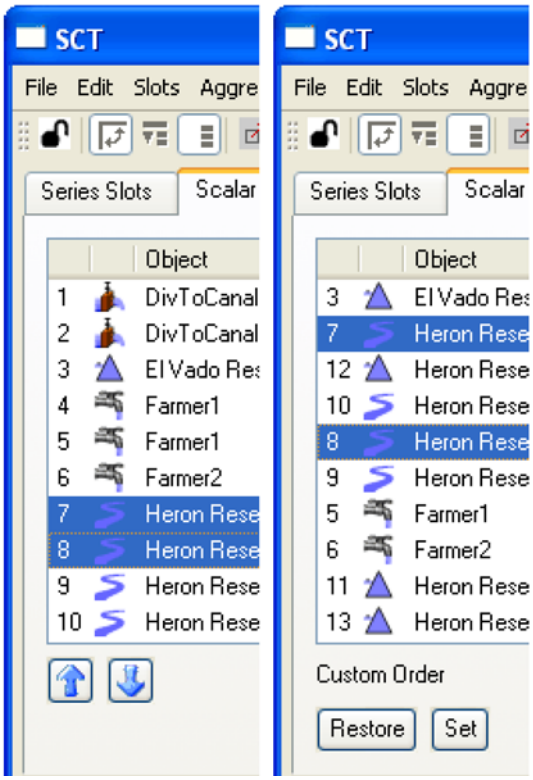
All slots on the list can be opened and edited from their individual slot dialogs. Also, one or more scalar values can be edited directly from the SCT. The slots are sorted using the same approach used in "Scalar and Other Slots Tabs: Slot Lists" on page 373.

Non-series slots are added to the SCT in the same way that series are added. See "Add Slots, Sheet Tabs, and Slot Dividers" on page 387 for details.

This section describes the two Slot List tabs and their functionality.

Sorting and Reordering Slots

Slots in the Slot List Tabs maintain a custom order. You can change this order or temporarily override it by selecting a column header, which re-sorts, or reverses the sort using data in the selected column.



If the list is currently sorted by the custom order, then **Up** and **Down** arrow buttons are shown to move the selected items up or down. These buttons immediately modify the custom order.

If the list is not currently sorted by the custom order, the following two Custom Order operations are available ***(see image)***

- **Restore**. Resort to the custom order.

- **Set**. Reset the custom order from the currently displayed sort order. Before this operation is performed, you must select **Yes** in the confirmation dialog.

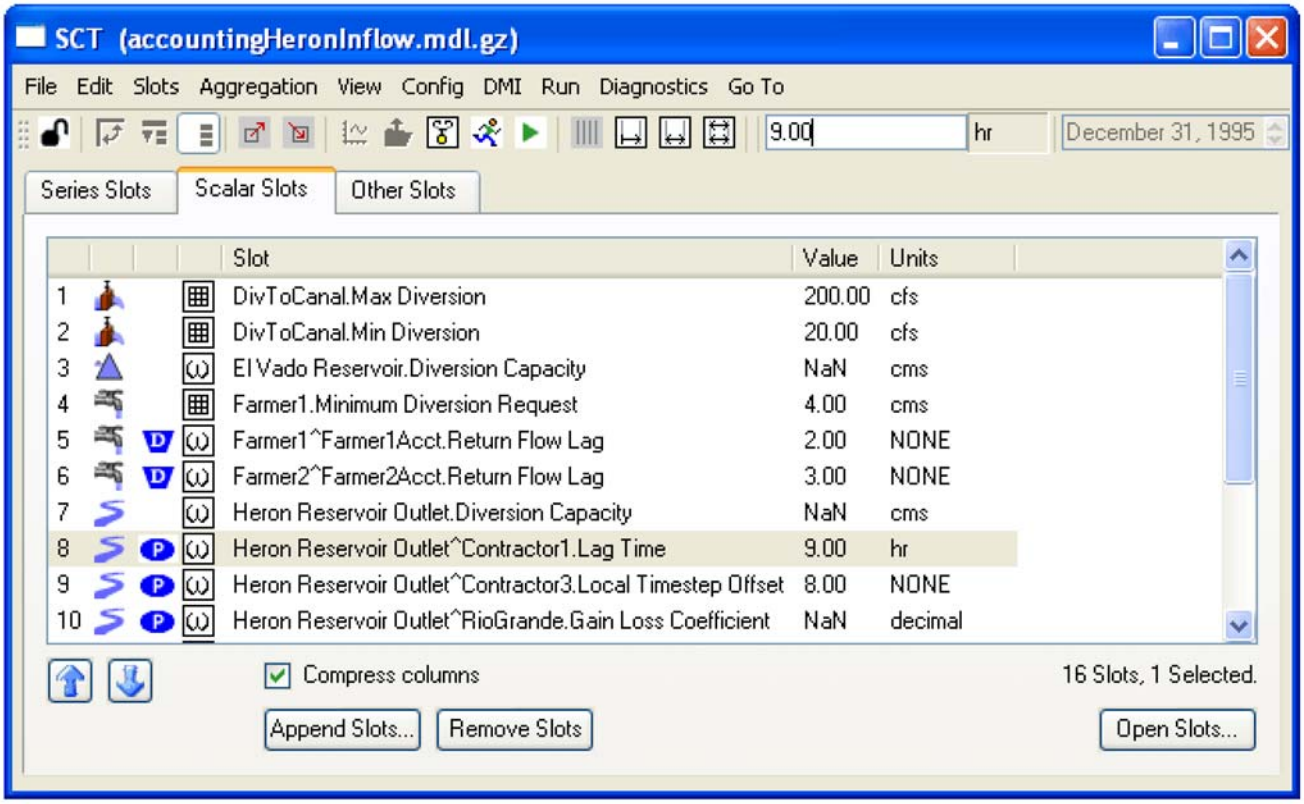


Compress Columns Checkbox

Instead of showing a column for the object and one for the slot, you can instead Compress the names into one column. This is controlled by a **Compress Columns** box at the bottom of each Slot List Panel.When checked, slots are identified with a single complete name.

Compare Figure 8.11 with Figure 8.12.

Figure 8.11 Compress Columns image

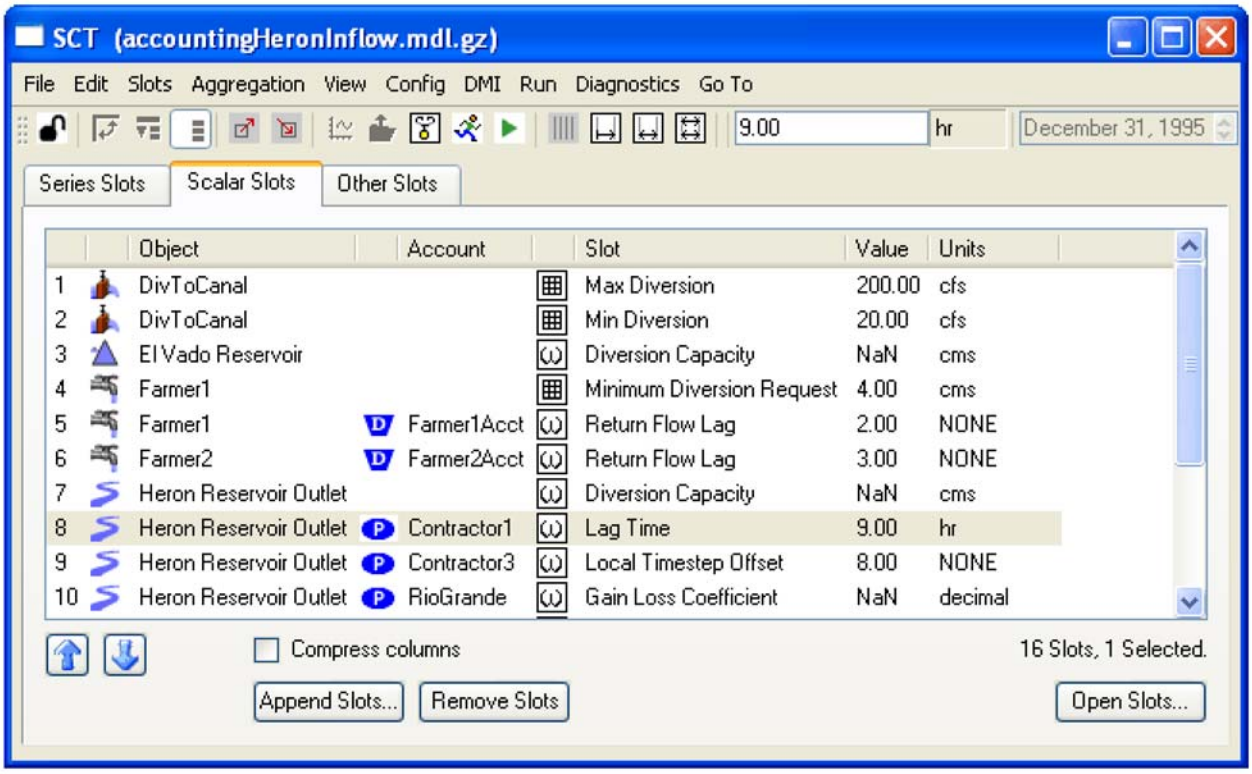


Scalar Slots tab

The **Scalar Slots** tab is used to show a list of Scalar and 1x1 Table Slots.

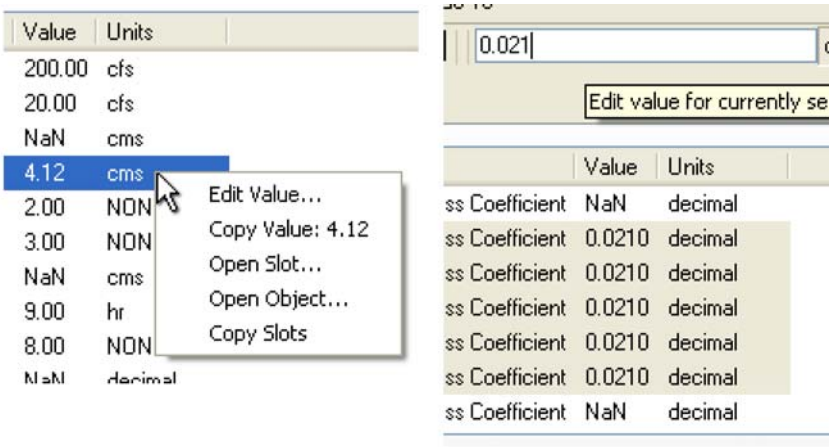
> **Note:** 1x1 table slots were used for scalar values before Scalar Slots were implemented. Following is a screenshot of the **Scalar Slots** tab of an SCT. See "Scalar and Other Slots Tabs: Slot Lists" on page 373 for additional information on the slot list panel.

Figure 8.12



The values of Scalar Slots and 1x1 Table Slots can be edited from the SCT Scalar Slot List tab in the following ways.

- Double-click on the value.
- Use the right-click context menu.

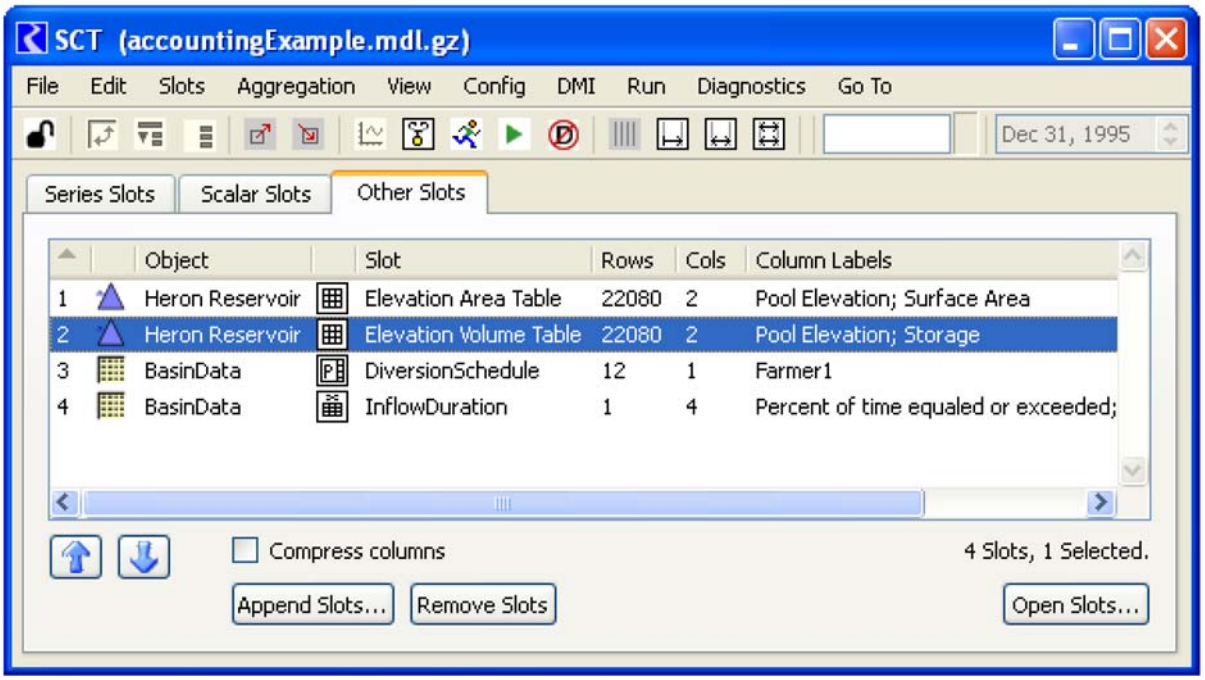


- Select multiple scalars and then enter a number in the SCT main edit field (at the top of the SCT). ***See image.***
- Double-click the slot and edit the value from the Open slot dialogs.

Note: Modifying the number of rows or columns in a 1X1 table slot can lead to unexpected results when editing that slot from the SCT. Also, upon loading the SCT, a previously displayed 1X1 table slot that now has more rows or columns will not be shown.

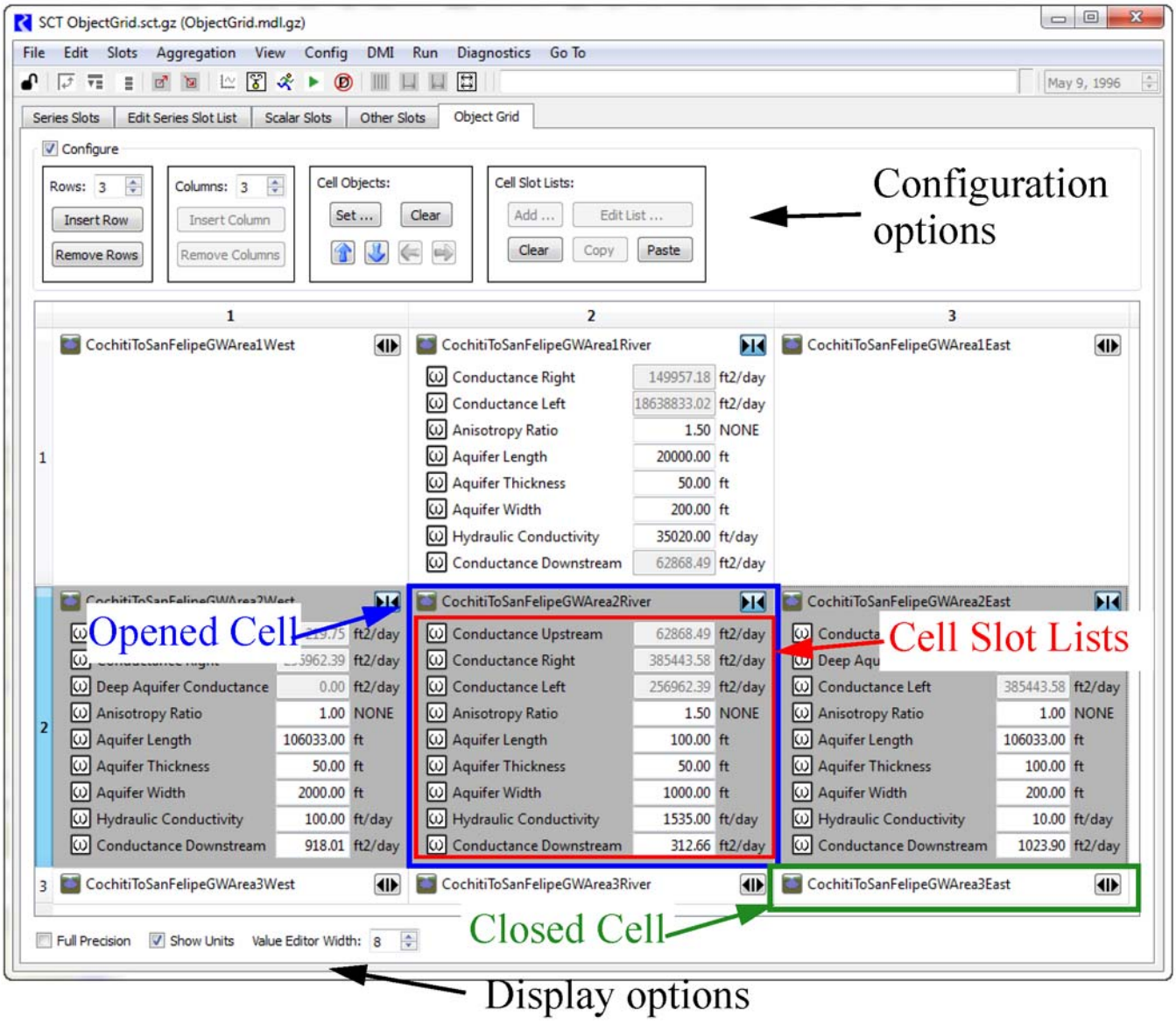
Other Slots Tab

The **Other Slots** tab can be used to display a list of other types of slots including Table Slots, Periodic Slots, Statistical Table Slots, and List Slots. These slots are not editable directly from the SCT, but can be easily opened using the **Open Slot** button.



Object Grid Tab

The SCT **Object Grid** tab presents a user-configured grid of simulation objects. Each Cell represents one object. Scalar slots and single-cell table slots are displayed (and are directly editable) as a list of slots within the cell. These are referred to as Cell Slot Lists.



In the Object Grid, you can:

- Configure the number of rows and columns in the grid; insert rows and columns before a cell selection; and delete selected rows and columns.
- Assign existing simulation objects to individual grid cells.
- Move an arbitrary selection of defined cells up, down, left or right within the grid.

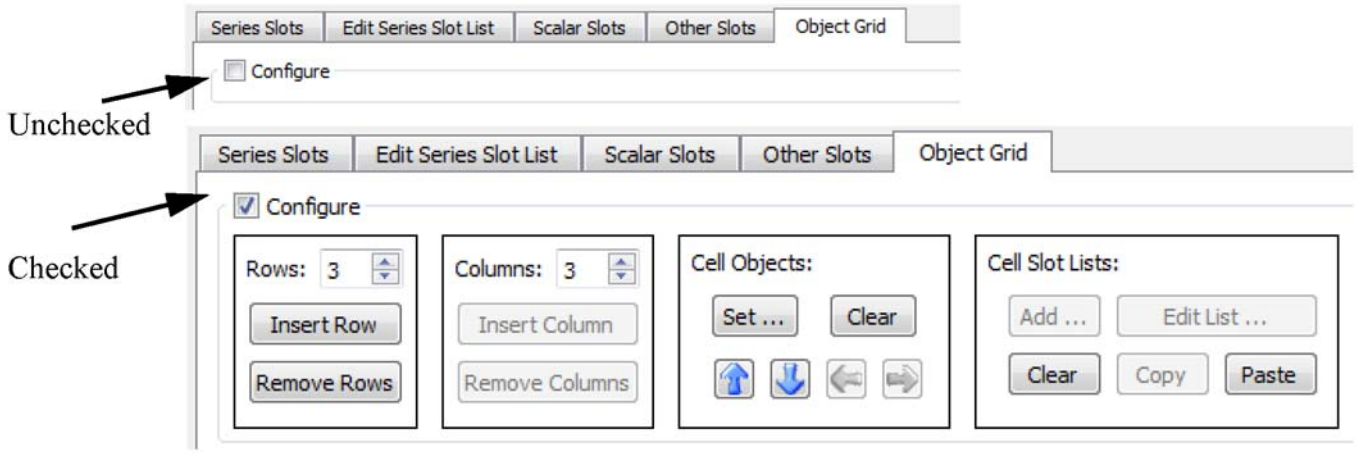
- Pick scalar and table slots from a cell's simulation object to display in that cell.
- Show the open object dialog or open slot dialog for included objects or slots.
- Modify the composition and order of a cell's slot list.
- Apply a cell's slot list to an arbitrary selection of other defined cells. The target cells are configured with similarly-named slots on the cells' simulation objects. Slots which don't exist on the target cells' objects are shown as inactive (grey).
- Show or hide the slot lists within an arbitrarily large cell selection.
- Directly modify the values of scalar slots and single-cell table slots.
- Display slot values with either configured precision or *full precision*; optionally show slot value ***units***; and adjust the width of value editors.
- Export and import the whole object grid configuration to and from external files.

Very few of the SCT menu bar and toolbar controls operate on the object grid. Currently, the only SCT controls outside of the **Object Grid** tab that operate on the object grid are accessed by selecting **View**, then **Fit Data Columns**, to auto-adjust grid row and column sizes.

Object Grid Configuration

The configuration controls are enabled only if the SCT is unlocked, using the **Lock Toggle** button on the left side of the SCT toolbar). The primary configuration controls are optionally shown at the top of the object grid, based on the **Configure** group box checkbox.

Figure 8.13



Row and Column Configuration

Enter a value or use the selector controls to specify the number of rows and columns in the grid.

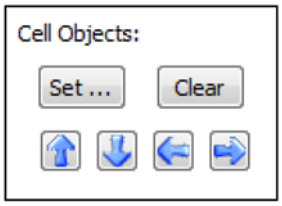
The **Insert Row** and **Insert Column** buttons are enabled when the cell selection is limited to a single row or a single column (including the case of just a single cell being selected). Use those operations to insert an empty row above, or an empty column to the left of the selected row or column.

The **Remove Rows** and **Remove Columns** buttons are enabled when whole rows or whole columns are selected (e.g. by selecting, or dragging along the row or column headers).

> **Note:** When the number of rows or columns is reduced using the integer spinners, the cells are ***not*** deleted but are just visually excluded. Those cells can become visible again when the number of rows or columns is sufficiently increased. When the SCT configuration is saved, those out of range cells are dropped.

Cell Object Configuration

When one or more cells are selected, use the Cell Object **Set** button to open the Object selector. Each time the selector's **Apply** button is selected, the chosen object is assigned to the *first* selected cell, and that cell is deselected. This allows the assignment of objects to multiple cells with a single invocation of the selector. The first selected cell is the topmost selected cell in the left-most column containing selected cells. (The assignment sequence proceeds downward in the left-most column until all selected cells in that column have been assigned objects).



It is valid to assign a particular simulation object to multiple distinct cells. Each of those cells could potentially show different slots from that object.

The Cell Object **Clear** button is enabled when one or more defined cells (having simulation objects) are selected. This operation removes the selected cells' simulation object (and slots).

The four arrow buttons shift the set of selected cells one position in the indicated direction.



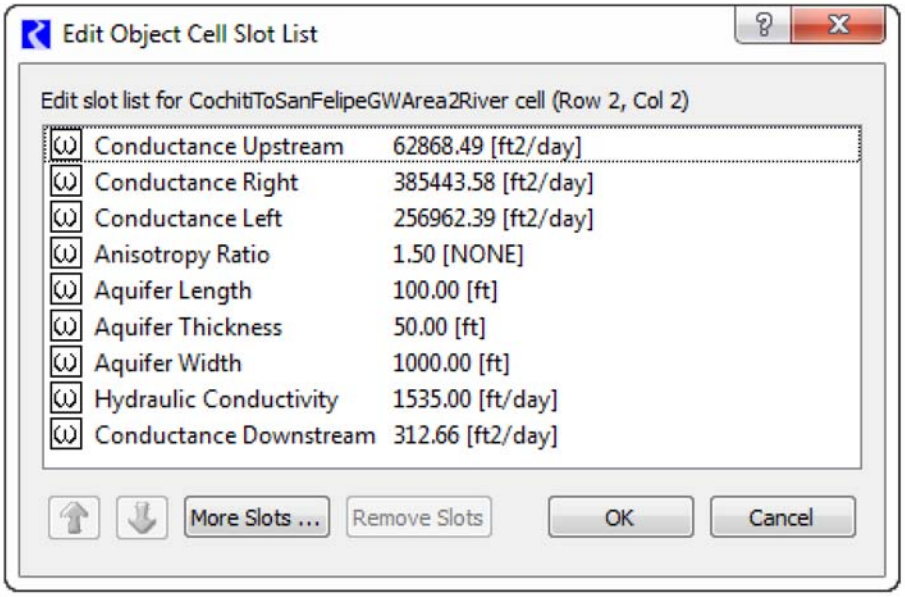
Cell Slot List Configuration

When the current cell selection contains at least one defined cell (having an associated simulation object), use the Cell Slot Lists controls to modify the slots shown for the cell(s). The **Add**, **Edit List** and **Copy** buttons are enabled

only if ***exactly one*** defined cell is selected. The **Clear** and **Paste** buttons can be applied to multiple selected cells in a single operation.



The **Add** (slots) button is actually a shortcut. Selecting it shows the Edit Object Cell Slot List dialog, as does the **Edit List** button, and automatically presses the **More Slots** button in that dialog to bring up the Slot Selector dialog.



The Edit Object Cell Slot List dialog edits the list of slots for a single cell. As mentioned above, this dialog's **More Slots** button brings up the Slot Selector to pick physical scalar and table slots (including periodic slots) on the cell's simulation object.

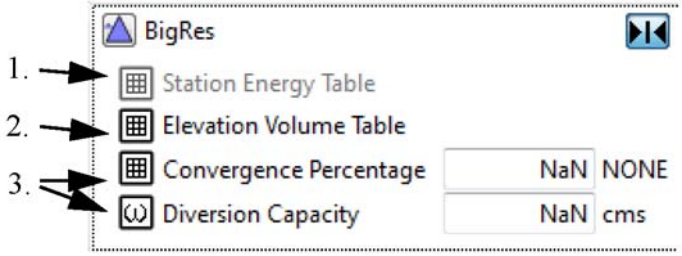
The **Remove Slots** button and the **Up** and **Down** arrow buttons operate on the slots selected within the list.

Returning to the SCT object grid configuration controls, the **Clear**, **Copy** and **Paste** buttons operate on the set of selected defined cells.

- **Clear** removes the list of slots from that cell.
- The **Copy** button (enabled when a single defined cell is selected) copies the slot list to the Slot Clipboard.
- The **Paste** button opens a dialog showing the number of selected cells and the list of slots in the Slot Clipboard (see above). Selecting **OK** replaces the selected cells' slot lists with the slot list from the Slot Clipboard.

Slots will appear in a cell in basically three different ways.

- Slots that don't exist on the cell's simulation object will be shown as disabled (dimmed).

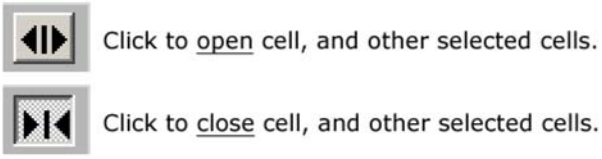


- Table slots having more than one cell will be shown with an active **Slot** icon button, but will not be shown with any numeric values.
- Scalar slots and single-cell table slots will be shown with an active **Slot** icon button and with an editable numeric value (and unit specification, if those are turned on in the dialog).

Cell Operations

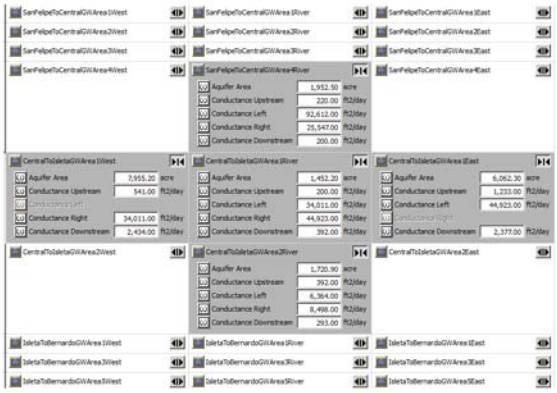
Each cell has three different types of buttons:

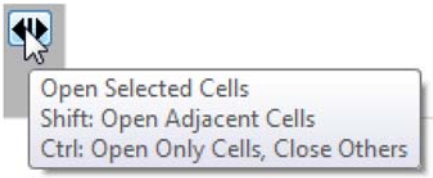
- **Object** Icon buttons:  shows the Open Object dialog.
- **Slot** Icon button:  shows the Open Slot dialog. This button will not be enabled if such a slot doesn't actually exist on the object.
- **Open / Close** checkbox button. shows or hides the cell's slots. This action is applied to all selected cells, not just the cell containing the button being selected.



To open and close multiple cells, you can drag the whole row or whole column to select it. Also all cells in the grid can be selected by selecting the square between the row and column headers in the upper-left corner of the grid.

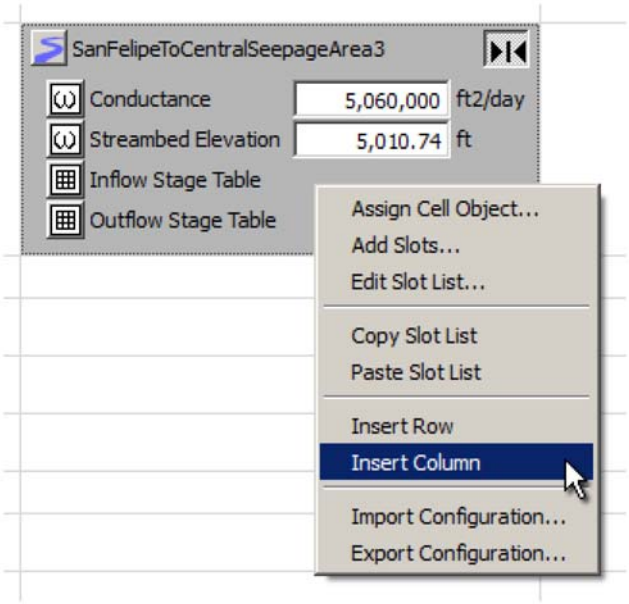
Shift-Click and **Ctrl-Click** operation of the **Open** / **Close** button have special behaviors. **Shift-Click** opens up the selected cell and its four immediate neighbors. The **Ctrl-Click** operation also closes all other cells. A tooltip on the button reminds you of this feature.





Cell Context Menu

Right-clicking in a cell shows the context menu. All of the operations, except the last two, are redundant with buttons in the Configure panel above the grid.



The **Import Configuration** and **Export Configuration** operations read or write the whole object grid's configuration from, or to, an external file. (The file is an XML text file). This can be used for moving Object Grid configurations between different SCTs.

Selecting these two context menu items brings up a file selector for reading or writing, from which the you may cancel the operation. When importing, the current object grid configuration is entirely replaced with the imported configuration.

Display Settings

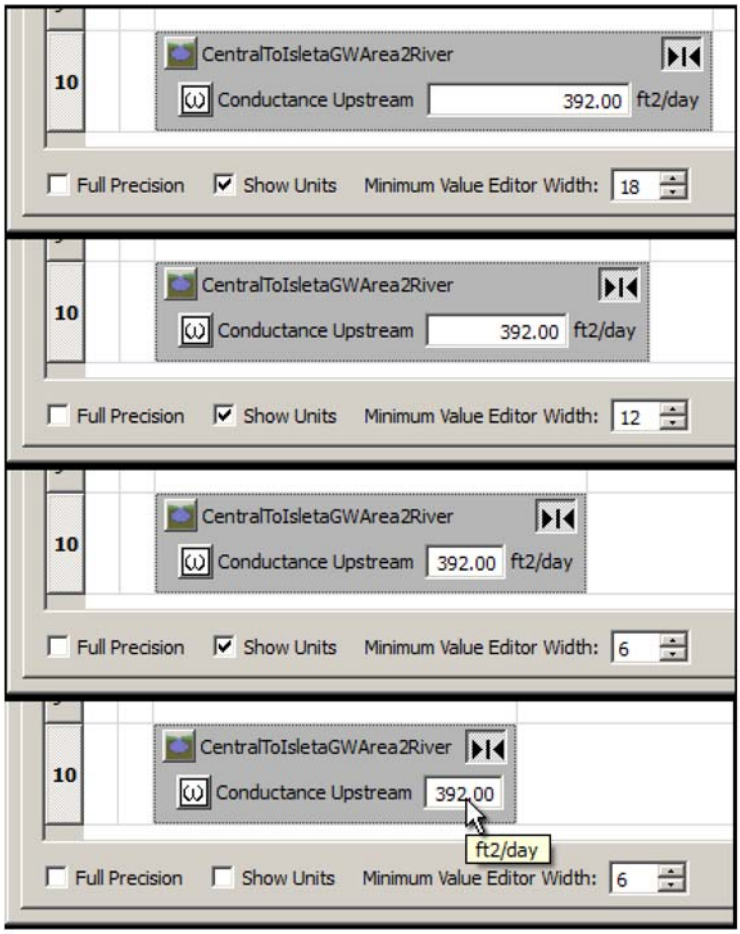
Use the controls along the bottom of the Object Grid to modify the data display.



The **Full Precision** checkbox switches between configured display attributes (e.g. a particular number of fractional decimal digits) and *full precision*, showing the number of fractional digits necessary to precisely represent the internal floating-point numeric value. (Full Precision is also shown automatically when a cell value is edited).



Use the **Show Units** checkbox to show or hide the units. When units are hidden, they are available as a tooltip on the value editor.



The **Value Editor Width** sets the width of slot value editors to ensure visibility of the specified number of characters. The supported range is 3 to 22. The default is 12.

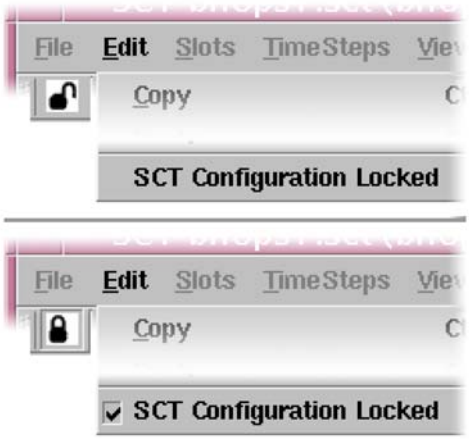
How To Configure the SCT

Lock or Unlock the SCT Configuration

When the SCT is locked, the following components of the SCT configuration cannot be changed:

- Slots and slot dividers cannot be added, removed, or moved.
- Slot Labels and Horizontal Slot Divider Labels.
- Slots' Summary Functions (for the aggregated views).

The SCT can be locked or unlocked by selecting the **Toolbar Locked** checkbox button or **Edit**, then **SCT Configuration Locked**. See "Edit Menu" on page 329 for details.



Add Slots, Sheet Tabs, and Slot Dividers

To add slots or slot dividers, the SCT must be unlocked. See "Lock or Unlock the SCT Configuration" on page 386 for details.

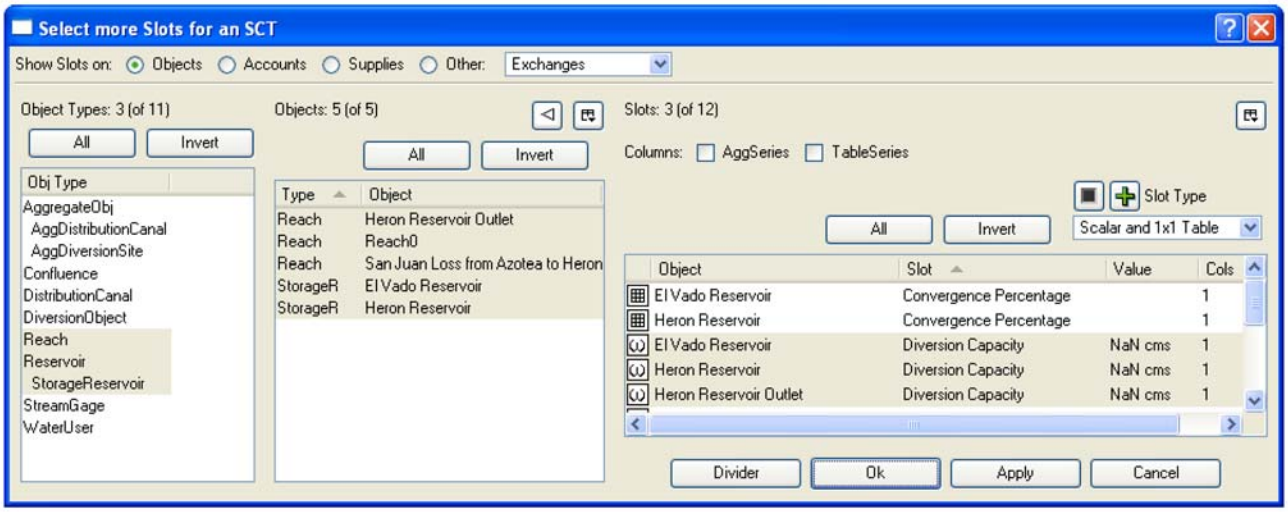
To add slots to an SCT, use one of the following actions:

- **Slots**, then **Append Slots** menu operation,
- **Slots**, then **Insert Slots** menu operation,
- **Append Slots** button on the two Slot List Tabs
- **Append** or **Insert** buttons on the **Edit Series Slot List** tab
- Right-click on the **Edit Series Slot List** tab and choose an option.

Only actual slots that exist in the currently loaded RiverWare model can be added to an SCT.

Through the RiverWare slot selector, you then select slots they want to add. Slots are added to all of the three panels using the slot Selector. See "Selector Features" on page 307 for more information on the Selector. Slots of

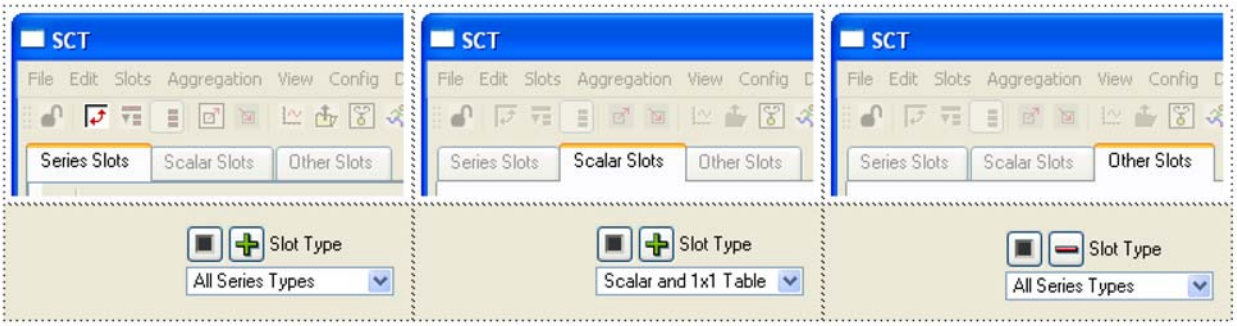
any type can be selected into an SCT. The selected slots (picked using the selector) are added to one of the three SCT Tabs, according to slot's properties.



The SCT / Slot Selector Slot Type Filter is automatically configured for the current **SCT** tab. But, you can modify or dismiss the Slot Type Filter, and select any Slots. See the following image. The Slot Types filter can be used to filter by the desired type of the slot including

- The **All Series Types** filter value includes Table Series Slots. (Those are technically not Series Slots, but functionally, they pretty much are).
- A **Scalar and 1x1 Table** filter includes Scalar Slots and Table Slots which have exactly one row and one column. (Scalar Slots were added to RiverWare after some Simulation Objects had already implemented scalar values as 1x1 Table Slots).

SCT Tab / GUS Slot Selector Slot Type Filter Initialization:



Once a slot(s) is selected and either the **Apply** or **Ok** button is selected, the slot(s) will be added to the appropriate tab of the SCT, and that data tab will become active.

Slot Dividers can be added directly (not using the selector) using the menus.

- **Slots**, then **Insert Slot Divider**
- **Slots**, then **Append Slot Divider**

Add Sheet Dividers from the **Edit Series Slot List** tab; see "Edit Series Slot List Tab" on page 363 for details.

Remove Slots and Slot Dividers

To remove slots or slot dividers, the SCT must be unlocked. See "Lock or Unlock the SCT Configuration" on page 386 for details.

Select **Slots**, then **Remove Slots / Dividers** to remove the selected slots from the SCT. See "Slots Menu" on page 330.

> **Note:** Removing a slot from the SCT neither removes it from the RiverWare model nor affects the slot's data.

Slots can be removed from the SCT **Slot List** tab by selecting one or more slot items in the list and selecting the **Remove** button or using the right-click context menu.

Move Slots and Slot Dividers

To move slots or slot dividers, the SCT must be unlocked. See "Lock or Unlock the SCT Configuration" on page 386 for details.

Series slots can easily be moved from the **Edit Series Slot List** tab; see "Edit Series Slot List Tab" on page 363 for details.

Also, slots and slot dividers can be copied, cut, and pasted (inserted or appended) within an SCT or between SCTs (within the same model). The data copy and paste operations (under the SCT Edit menu) are not related to the slot and slot divider moving operations. Instead, the following operations on the SCT **Slots** menu are used. See "Slots Menu" on page 330 for details.

- **Slots**, then **Copy Slots / Dividers**. At least one slot item must be selected.
- **Slots**, then **Cut Slots / Dividers**. At least one slot item must be selected.
- **Slots**, then **Insert Copied Slots / Divs**. Exactly one slot item must be selected.
- **Slots**, then **Append Copied Slots / Divs**. No particular selection is required.

> **Note:** **Copy Slots / Dividers** and **Cut Slots / Dividers** also add the selected slots to the RiverWare Slot Clipboard. Slots in the Slot Clipboard can be copied to other locations in RiverWare such as any Output Device's slot list.

The **Insert Copied Slots / Divs** operation inserts the previously copied or cut slot items immediately ***before*** the single selected slot item.

The **Append Copied Slots / Divs** operation appends the previously copied or cut slot items to the end of the SCT slot item list, after the last slot row or after the last slot column, depending on the axis orientation. See "Axis Orientation" on page 358 for details.

The cell ornamentation (crosshatch) displayed on the copy data cell set also applies to the **Copy Slots / Dividers** operation.

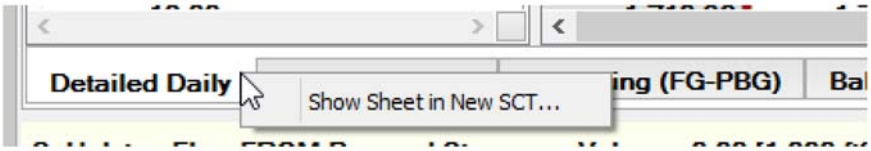
There is no problem with having a slot represented redundantly within an SCT (e.g., as a result of inserting or appending a slot reference into the same SCT from which it was copied). You may want to do this is to see two or

more distinct Summary Functions (e.g., Sum and Average) for aggregates of a particular slot. See "Summary Functions" on page 355 for details.

Create a new SCT from a Series Sheet tab

When you have multiple Series Sheets, you may want to look at more than one sheet at a time. This functionality is supported by *tearing off* a Series Sheet to create a new SCT. You can then see both SCTs at once. This operation is performed as follows:

On the Series Slots tab, right-click on the sheet tab and choose **Show Sheet in New SCT** The sheet is now shown in its own SCT.



Note: This operation does not remove the sheet from the original SCT. It just creates a copy of the sheet in a new SCT. You can decide to close or save that new SCT when finished.

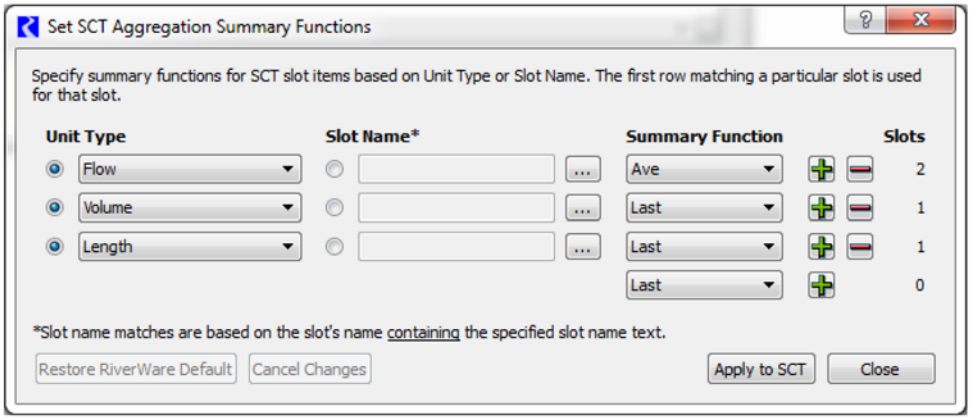
Change a Slot's Summary Function

See "Timestep Aggregation" on page 354 and "Summary Functions" on page 355 for details about Summary Functions.

To change a slot's Summary Function, the SCT must be unlocked. See "Lock or Unlock the SCT Configuration" on page 386 for details.

There are three ways to change Summary Functions. The first changes the summary functions of all slots in the SCT, the second two ways are for individual slots. If you wish to set most of the slots to use one summary functions, use the Set SCT Aggregation Summary Functions first, then change other specific slots as needed.

1. From the SCT, select the **Aggregation**, then **Set Summary Functions** menu to open the Set SCT Aggregation Summary Functions dialog.



This dialog allows you to specify the Summary Function for all slots in the SCT based on the unit type or the slot name. You create rows that match one or more slots and then select the Summary Function for that row.

2. Select the **Unit Type** checkbox or the **Slot Name** checkbox to specify which component you wish to use:

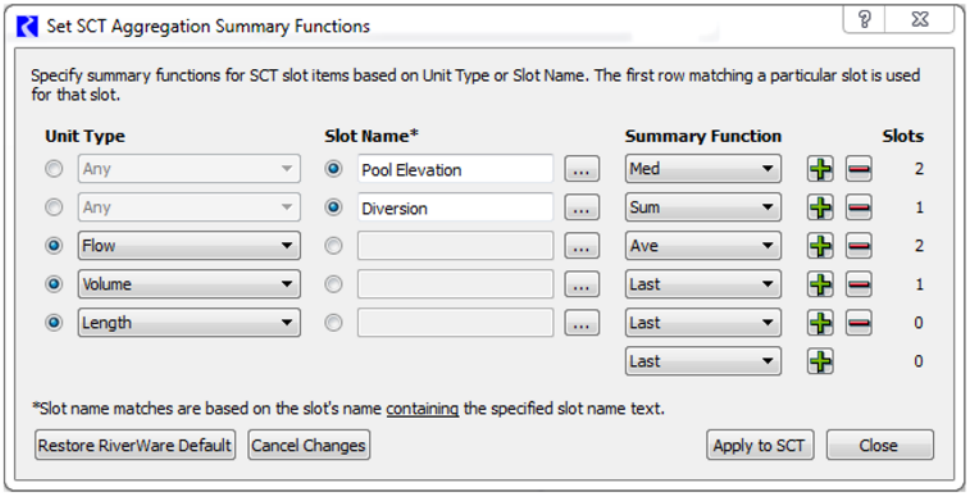
- **Unit Type**. Select the desired type from the pull down menu.
- **Slot Name**. Enter all or part of a slot name in the text box or use the ... button to select a slot name using the selector. As indicated in the note, the entered text must be contained in the Slot's name for a match to occur.

3. Use the Summary Function to choose one of the items, First, Last; see "Summary Functions" on page 355 for details. Add or remove rows from the dialog using the + and − buttons.

The number of slots matched for each row is displayed in the last column.

The first matching row is used for the slot, so the order of the rows may matter. For example, in Figure 8.14, Pool Elevation is the first row using **Med**, and Length is the last row using **Last**. Thus, all Pool Elevations in the SCT will use the **Med** function for aggregation.

Figure 8.14

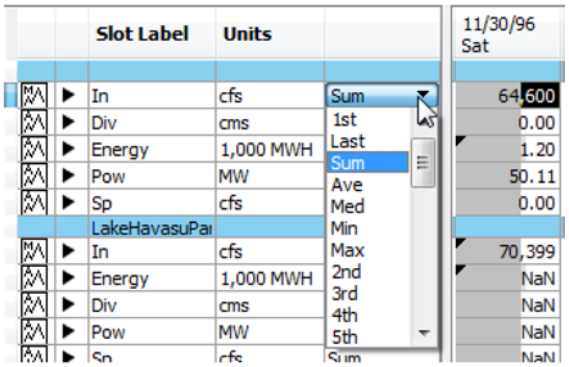


When you choose the **Apply to SCT** button, the matched slots are given the appropriate summary function.

4. Use the **Restore RiverWare Default** to return the dialog to its original state, that is, one row for Flow using the Ave function, one row for Volume using the Last function, and one row for Length using the Last function. There is a final *catch-all* row that uses the Last function as the default.

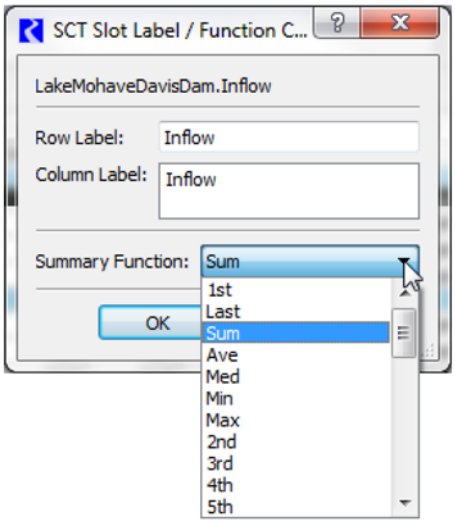
5. In the Aggregated Horizontal Timestep Axis View, if the Summary Function column in the Row Header Table is shown, you can double-click in the slot's **Summary Function** field to show an option menu with the

available Summary Function choices. See "Horizontal Timestep Axis Orientation" on page 360 and "Horizontal Time Tab" on page 339 for details.



See "Configure Row and Column Headers" on page 394 for details on showing the Summary Function column in the Aggregated Horizontal Timestep Axis View.

A slot's Summary Function can also be changed by selecting a single slot and then selecting **Slots**, then **Set Label/ Function**. See "Slots Menu" on page 330. In the dialog, you can select a different option from the **Summary Function** menu.



Show or Hide (Aggregation) Summaries

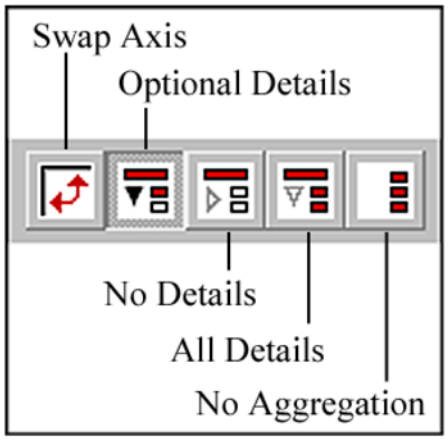
See "Show or Hide (Aggregation) Summaries" on page 392 and "Timestep Aggregation" on page 354 for details.

Summary cells always display the aggregated data. To display or hide summaries, you can switch to the appropriate view in either of these ways:

Select one of the detail modes from the SCT **Aggregation** menu, or use the following toolbar buttons:

- **Show/Hide Details**
- **Hide All Details**

- **Show All Details**
- **No Aggregation**



Show or Hide Details

See "Show or Hide (Aggregation) Summaries" on page 392 and "Timestep Aggregation" on page 354 for details.

You can display all details by selecting the **No Aggregation** detail mode either from the **Aggregation** menu, or by accessing the detail mode toolbar buttons (see "Show or Hide (Aggregation) Summaries" on page 392 for details).

In the **Aggregated Horizontal Timestep Axis Orientation View**, each summary row corresponds to one slot. Therefore, showing or hiding the details for a single summary row displays or hides the details for one slot.

In the **Aggregated Vertical Timestep Axis Orientation View**, each summary row corresponds to one timestep aggregation. The detail rows under a summary row represent the individual timesteps within each timestep aggregation. Details for a single summary row that corresponds to one timestep aggregation across all slots (where each slot is in a separate column).

In the aggregated views in **Show/Hide Details (Optional Details)** detail mode, you can display or hide details (detail cells) independently for each summary row in the following three ways:

- by using a treeview control (rightward or downward pointing triangle) on the left side of a summary row.
- by entering **Ctrl+D** when one or more cells are selected. This sets the detail open/closed state to the opposite of the first slot or timestep aggregation represented in the cell selection.

  Note: In this detail mode, you can display or hide all details by selecting a whole column and entering **Ctrl+D**.

- If the following checkbox on the **General** tab of the Configuration Dialog is on, then double-clicking in a cell alternates the detail open/closed state corresponding to the cell. (If this checkbox is deselected, then double-clicking in a data cell starts an in-cell modify-edit operation for the value in that data cell). See "General Tab" on page 338 for details.

  `[x] Double Click Data Cell Toggles Detail Rows`

You can display or hide all details (detail cells) by selecting the **Show All Details** or **Hide All Details** detail modes from the SCT **Aggregation** menu, or by accessing the corresponding toolbar buttons. Selecting these modes does not affect the individual summary row detail open/closed states in the **Show/Hide Details** detail mode.

Configure Row and Column Headers

Since the correspondence between slots and times with rows and columns depends on the axis orientation, the types of information that can be shown in row and column headers depends primarily on the selected axis orientation. See "Axis Orientation" on page 358 for details.

The visibility of certain row header columns and types of information in data column headers is controlled separately for the two axis orientations through the use of two corresponding tabbed panes in the Configuration Dialog.

- Horizontal Time Tab, page 339
- Vertical Time Tab, page 340

In the **Horizontal Timestep Axis Orientation** only, where rows correspond to slots, the following two in-cell edit operations are supported when the SCT is unlocked (see "Lock or Unlock the SCT Configuration" on page 386 for details):

- Editing a slot row label (by double-clicking).
- Changing a slot's summary function by double-clicking on the slot's summary function—if the Summary Function column is displayed (see "Change a Slot's Summary Function" on page 390 for details). Since summary functions are relevant only for the aggregated views, this application is available only in the **Aggregated** (**Horizontal**) view.

Adjust Column Widths

You can manually resize columns by dragging the dividers between the column headers. The following operations are also available in the SCT View menu. See "View Menu" on page 332 for details.

- **View**, then **Set Data Column Widths** is used to set all data columns to the width of the single selected column. The best way to use this is to follow these steps:
  - Manually resize one of the data columns to the desired width by dragging the column header divider on the right side of the column.
  - Select the column by selecting the middle of its column header.
  - **Select View**, then **Set Data Column Widths**. This resizes all of the data columns to the width of the selected column.

  This function, which is active when a single column is selected, applies to columns on all Sheet tabs, This operation sets the width of all columns to that of the selected column.
- **View**, then **Fit Data Columns to Headers** resizes all of the data columns to fit the text in the corresponding column headers.
- **View**, then **Grow Columns to Data** resizes all of the data columns to fit the numeric values in the corresponding column.

- **View**, then **Fit Columns to Data** resizes all of the data columns to fit the widest numeric value displayed in the corresponding columns.
- **View**, then **Fit Data Columns Both** resizes all of the data columns to fit the widest heading or numeric value displayed in the corresponding columns.
- **View**, then **Fit Row Header Column** resizes the columns in the Row Header Table to fit the widest content in the corresponding columns. This operation also adjusts the splitter between the Row Header Table and the SCT Data Table to fit the Row Header Table exactly.

Many, though not all, of the column width adjustments are preserved when you save and reload an SCT.

Change SCT Flag and Other Colors

You can modify colors by selecting the **Flags** tab or the **Color** tab of the SCT Configuration Dialog. See "Flags Tab" on page 344 and "Color Tab" on page 346 for details.

1. From the SCT Menu, select **Config**, then **Flags** or **Colors**.
2. Specify the colors to modify, as follows:
   – Select the **Flags** tab to modify flag colors.
   – Select the **Color** tab to modify other colors.
3. Selecting one of the color buttons brings up a Color Chooser where you can change only one color at a time.

See "Use the Default Configuration" on page 399 for details on saving the new settings as default, or restoring the default color settings.

Apply Custom Colors to Slot/Timestep Cells

To apply custom colors to selected cells, named custom colors must be first defined and configured; see "Custom Cell Colors" on page 344. for details. Then perform the following steps to apply the colors:

1. Select the desired cells on the **Series Slots** tab.
2. Use the right-click context menu and choose **Apply Custom Colors**, then select the desired named color item.

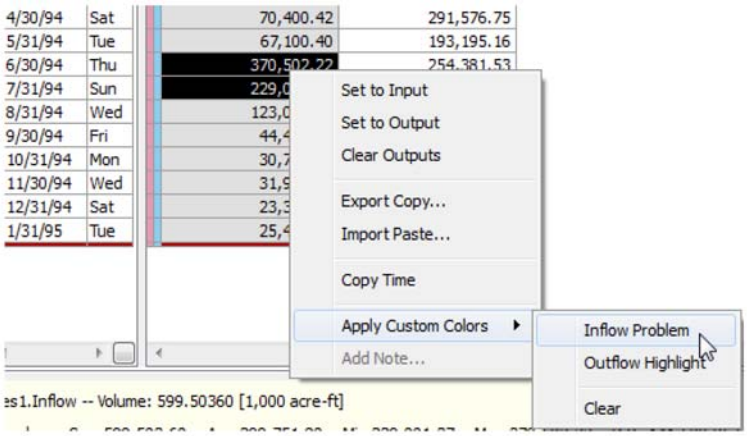
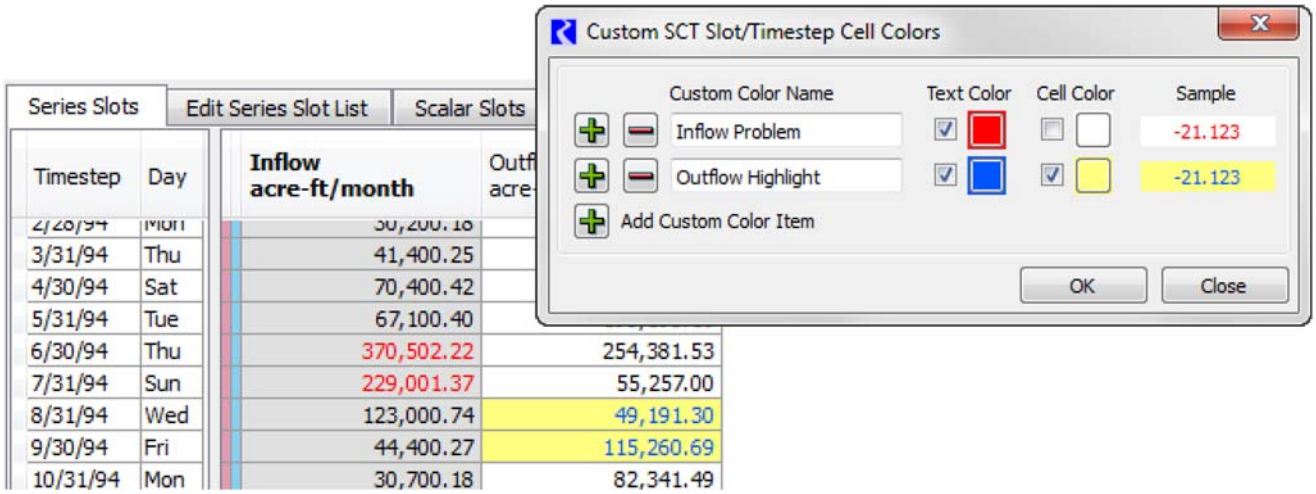


Figure 8.15 shows a color definition and the colors applied to cells in the SCT.

Figure 8.15



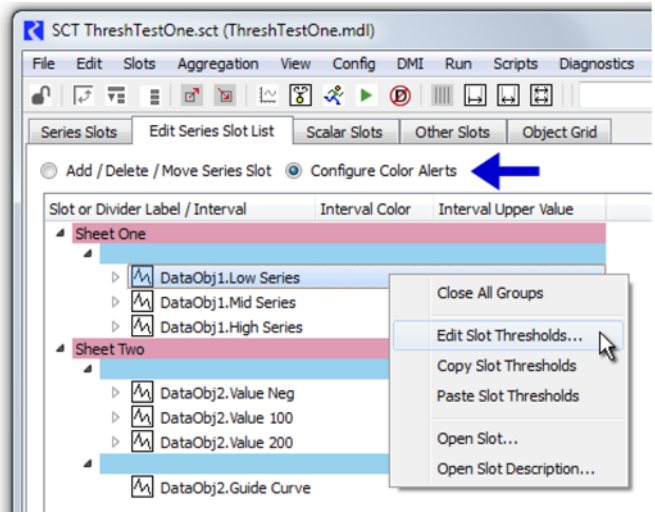
> **Note:** When SCT cells are selected, the foreground and background colors of the numeric portion of those cells are reversed (swapped). So initially, the colors appear reversed, but clicking away from the cells will show your configured colors.

Use the **Apply Custom Colors**, then **Clear** operation to remove those cell colors, restoring the selected cells' colors to those associated with the series flag. Custom cell colors can be cleared from the entire SCT by selecting all cells, e.g. by selecting the upper left area of the row header table and performing the **Clear** operation.

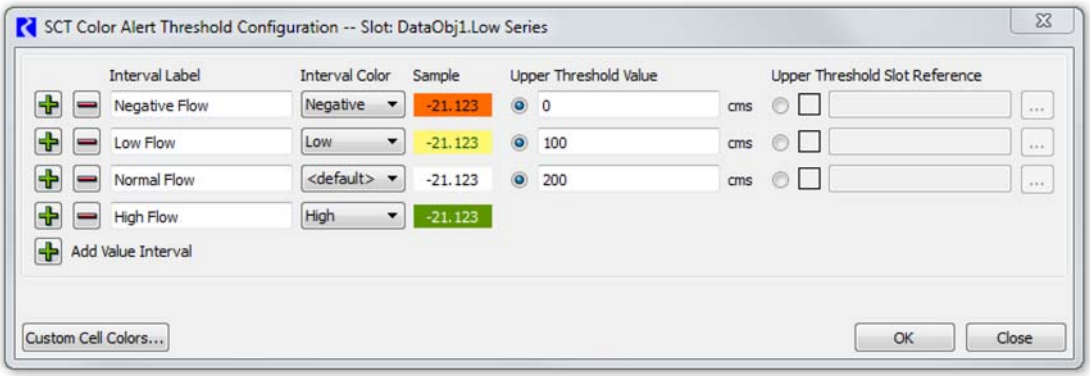
> **Note:** The cell / custom color associations are stored in the SCT, not in the RiverWare model. So the SCT must be saved to retain these color associations.

Apply Color Alerts Based on Slot Values

To apply custom colors alerts (a form of conditional formatting) for a particular slot, define the colors and thresholds for each interval. On the **Edit Series Slot List** tab, switch to the **Configure Color Alerts** mode.



Right-click the slot and choose the **Edit Slot Thresholds** context menu to open the SCT Color Alert Threshold Configuration dialog box. Then define the thresholds/intervals and colors. See "Configure Color Alerts" on page 371 for details.



Change Ornamentations

You can configure the graphical ornamentations through settings in the SCT Configuration Dialog. These settings are represented on various tabbed panes in that dialog. See "SCT Configuration Settings" on page 337 for details.

- **General** tab
  - **Display NaN**. If this is disabled, undefined numeric values are shown as blanks (empty cells).
- **Show Grid**
  - **Crosshatch Read Only Cells** (for example, expression slots and accounting system slots). Non-editable values are shaded with a crosshatch of a configurable color; see "Color Tab" on page 346 for details.

- **Horz Time** tab
  - **Draw Weekend Divider Columns**. This function lets you specify the drawing of thick lines between pairs of timesteps that straddle a Friday-to-Saturday or Sunday-to-Monday boundary in the Horizontal Timestep Axis Orientation Views. If enabled, Weekend Divider columns are drawn with the configurable Weekend Divider color; see "Color Tab" on page 346 for details.
  - **Draw Month Divider Columns**. This function lets you specify the drawing of thick lines between pairs of timesteps that straddle the first and last timesteps of calendar months in the Horizontal Timestep Axis Orientation Views. If enabled, Month Divider columns are drawn with the configurable Month Divider color; see "Color Tab" on page 346 for details.
- **Vert Time** tab
  - **Draw Weekend Divider Rows**. This function lets you specify the drawing of thick lines between pairs of rows that straddle a Friday-to-Saturday or Sunday-to-Monday boundary in the Vertical Timestep Axis Orientation Views. In the Aggregated Vertical Time View, if the weekend boundary falls between detail rows that are hidden, then the divider is drawn as a dotted line immediately below the corresponding summary row. If enabled, Weekend Divider rows are drawn with the configurable Weekend Divider color; see "Color Tab" on page 346 for details.
  - **Draw Month Divider Rows**. This function lets you specify the drawing of thick lines between pairs of timesteps that straddle the first and last timesteps of calendar months in the Vertical Timestep Axis Orientation Views. In the Aggregated Vertical Time View, if the month boundary falls between detail rows that are hidden, then the divider is drawn as a dotted line immediately below the corresponding summary row. If enabled, Month Divider rows are drawn with the configurable Month Divider color; see "Color Tab" on page 346 for details.
- **Summary** tab
  - **Show Timestep Flag Colors** exclusive toggle buttons. This function lets you select the conditions under which flag values are indicated with background shaded regions in summary cells. **Always** is a good choice in most circumstances. This was introduced for the following reasons:
    - To experiment with ways of distinguishing Summary Rows from Detail Rows,
    - To support quicker screen refreshing with large aggregations.
- **Flags** tab
  - Custom colors that indicate slot timestep flag values with background color shading. You should choose flag colors that contrast with the Foreground Text color.
- **Color** tab
  - Other custom ornamentation colors.

Change the Aggregation Interval

You can change the Aggregation Interval by using the SCT Timestep Aggregation Dialog. This dialog is shown by selecting **Aggregation**, then **Timestep Aggregation Config**. See "Timestep Aggregation" on page 354.

Ornamentation of Hidden Pre- and Post-Run Timesteps

The time range of the SCT depends on the following factors:

- The time range of the loaded model's Run Control.
- The number of pre- and post-run timesteps configured for the SCT.

It is quite possible that the time range of any particular slot starts before the first timestep shown in the SCT or ends after the last timestep shown in the SCT. When this occurs, a small corner triangle displays in the first or last Summary cell and the first or last Detail cell in that slot. If you select such a Detail cell, the number of obscured timesteps displays in the Selection Info Area at the bottom of the SCT.

The only way to display a slot's obscured timesteps is to extend the time range of the SCT to cover the slot's full time range. This is done by selecting the **General** tab of the SCT Configuration Dialog. Increase either the Pre-Run Timesteps count or Post-Run Timesteps count by the required amount. See "General Tab" on page 338 for details.

Use the Default Configuration

When a new SCT is created, RiverWare looks to see if there is a default.sct file defined. If so, the configuration settings from the default are used in the new SCT. Also, at any time, you can choose to either save the current settings as default or revert to default settings. The default configuration is supported with the menu operations from the SCT **Config** menu. See "Config Menu" on page 333 for details.



- **Apply Default Settings** applies the saved default settings to the current SCT. The SCT slots are not affected.
- **Save Current Settings as Default** saves the SCT configuration (without the Slot Item list) as the default configuration.
- **Clear Default Settings** restores the default settings to the *factory defaults*. This does not affect the current SCT.

The default configuration is used to do the following:

- Create a new SCT.
- Migrate an old SCT (Previous Version #.#) to the new SCT.
- Apply the default settings explicitly to the current SCT, by selecting **Config**, then **Defaults**, then **Apply Default Settings**.

How To Manipulate Data to Model Operations

The sections above describe how to configure the SCT to look the way you wish. This section describes how to use the SCT to set values in the model. Remember, the SCT is just a window into the model, all values are stored in the model. So, this section describes how to use the SCT to operate the model.

Set a Single Value

Generally, you can directly edit data. Or you can select the cell, and then select the **Entry** field (at the top of the SCT) and edit the number there.

> **Note:** Entering **n** or **NaN** in either upper or lower case causes the value and flag to be cleared (i.e., set to the Output flag).
>
> **Note:** To abort an edit, press the Escape (**Esc**) key.
>
> **Note:** The **SCT Lock** does not prevent modifications to slot data.

When you enter a valid (non-NaN) value, in addition to the numeric value being set on the slot timestep, generally the **Input Flag** is set. An exception, cells with the **Target** flag initially set will retain that flag.

> **Note:** In terms of navigation, when you press **Enter** after editing a value, the selected cell will typically move to the next cell in the timeseries. This is true even when in Horizontal Timestep Axis Orientation. When you press **Tab**, it will move to the next slot, at the same timestep. Use the arrow keys to move through the SCT as though it is a spreadsheet.

You cannot edit certain types of slots, including expression slots and certain accounting system slots. These slots have **Read-Only** ornamentation. Read-only cells are cross-hatched with a user configurable **Read-Only** color. See "General Tab" on page 338 for details.

If you want expression slots to evaluate after you edit a value, the SCT must be configured to use the **Auto-Evaluate Expression Slots on Edits** checkbox in the **General** tab of the **Config** menu (see "General Tab" on page 338 for details). With the checkbox selected, expression slots shown on the SCT will fully evaluate (all timesteps) any time a value on that SCT is edited.

Set Multiple Values

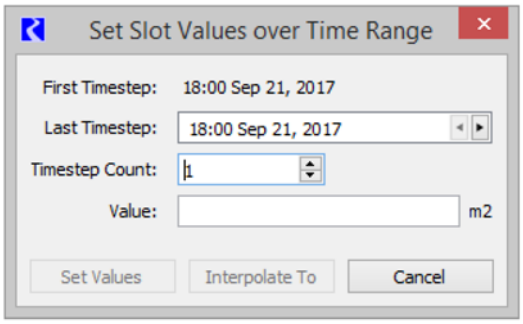
When you select multiple data cells, the value you enter is set on all cells on the selection. So, editing the active cell within a multiple-cell selection behaves similarly to setting a single value, but the value is set on all cells in the selection This can include slots having different unit types (e.g., Flow and Area). It is up to you to insure that the multiple-value setting operation makes sense. See "Set a Single Value" on page 400 for details.

Since selecting a Summary Cell is equivalent to selecting all of the corresponding Detail Cells, an edit of a Summary Cell is implicitly a multiple-value edit operation. See "Show or Hide (Aggregation) Summaries" on page 392 for details.

Set Slot Value over Time Range

If you want to set a particular slot to a particular value (or interpolate to a value) from a start timestep to some finish timestep (often a long way out), use the Set Slot Value over Time Range dialog.

On the SCT, select the first cell in the range and right-click. Choose the **Set Values over Time Range** menu item.



Specify either the **Last Timestep** or the **Timestep Count** to define the time range. As you change the range, the cells are selected on the SCT. Then specify the **Value** to set in the units of the slot, as shown.

The three buttons are as follows:

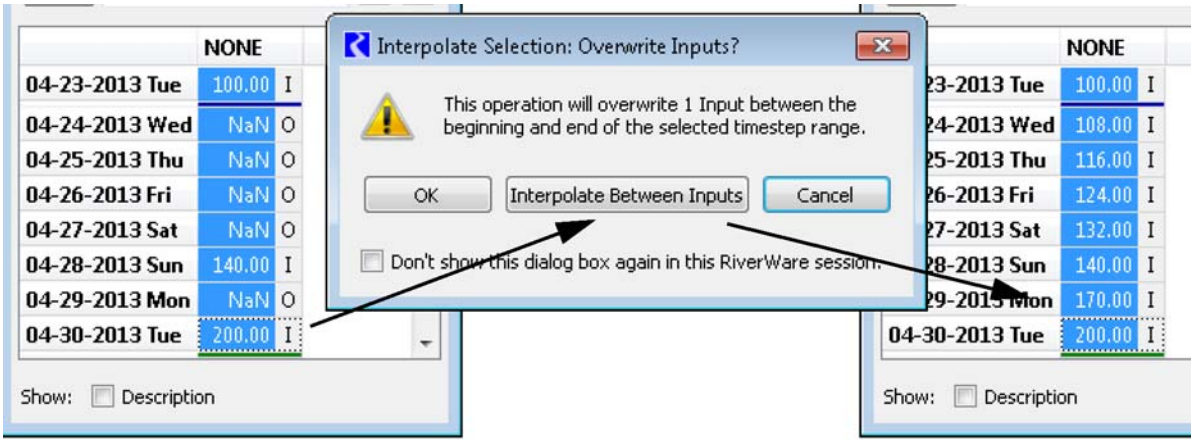
- **Set Values**. Sets the specified time range to the specified value.
- **Interpolate To**. Sets the final timestep to the specified value, and interpolates all of the values in between. (This is enabled only if the value of the first timestep is non-NaN). An alternative interpolation is described in the next section.
- **Cancel**. Dismiss the dialog, with just the original cell selected.

Interpolation

To linearly interpolate between input values, select **Edit**, then **Interpolate Selection** (also, **Ctrl+I**). See "Edit Menu" on page 329 for details.

This operation interpolates between the beginning and ending values in the selection. Because this will overwrite inputs, a confirmation is provided, as shown in Figure 8.16. Select **OK** to overwrite any inputs in between the two end values. Or if you want to preserve your sparse inputs, select **Interpolate Between Inputs**. One possible application of this is filling the gaps in series data. This functionality exists for both the slot and SCT dialogs.

Figure 8.16



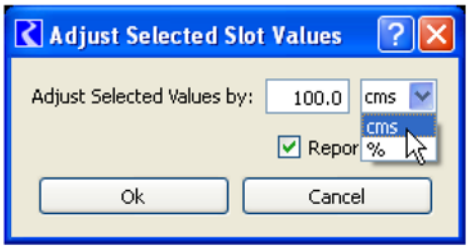
Interpolate is available (enabled) if the following are true:

- The slot/timestep cell selection is rectangular and contiguous in both slot and timestep dimensions.
- The rectangular selection contains at least three contiguous timesteps.
- All slot values at the first and last timesteps are defined (not NaN).

Note: All interpolation is done within the internal units and then converted to the display units. For 1 Month timesteps, this takes into account the lengths of different months. Since the standard internal units for per-time values are never per month (e.g., flow values are cms), the potentially undesirable effect on the interpolation function due to the different amounts of time represented by different months is avoided. by using internal units.

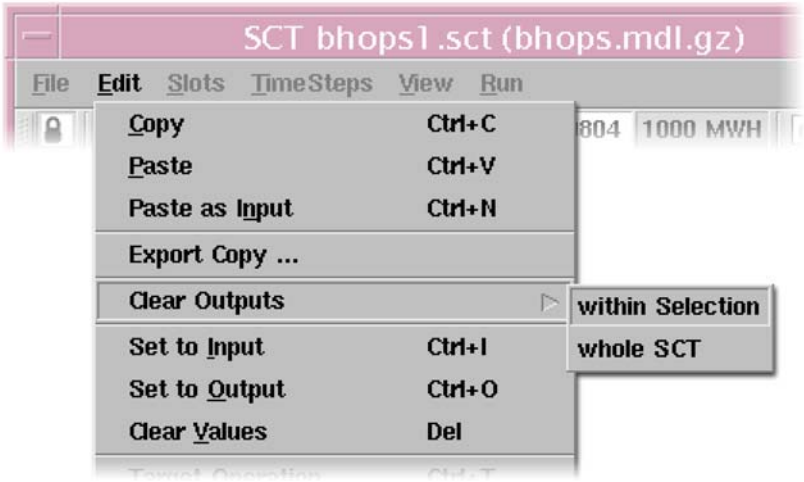
Adjust Values

The **Edit**, then **Adjust Values** operation allows you to either add (or subtract) a fixed value to the selection or scale the values by a percentage. This can be applied to any arbitrary slot / timestep cell selection in the SCT. Both absolute and relative (percentage) adjustments of values in series slots can be made. Absolute adjustments are available only when all cells in the selection have the same scale and unit. Neither NaN values nor Read-Only (cross-hatched) values are affected. Since slots can appear in an SCT more than once, the adjust value operation is careful to adjust each selected Slot/Timestep value only once. Select the **Report Results** checkbox to see a summary of the slots changed.



Clear Values

You can clear all editable values by selecting them and pressing the **Delete** key. Or select **Edit**, then **Clear Values**.



When a value is cleared:

- Its value is set to NaN.
- Its flag is set to the output flag.

Also, to clear values, select **Edit**, then **Clear Outputs**, then **within Selection**, then **whole SCT**.

Clear Outputs clears values that would generally be computed during a model run. This includes clearing values that have the following flags:

- Output (O)
- Best Efficiency (B)
- Max Capacity (M)
- Drift (D)
- Unit Values (U)

Note: The **SCT Lock** does not prevent the clearing of slot data.

Set a Flag

Flags are properties associated with individual slot timesteps that are generally depicted in the SCT using background color shading.

You can set the Input (I) and Output (O) flags on editable slot timesteps; input flag can be set only on timesteps with a defined (non-NaN) value. Other flags can be set only on certain slots. The Target Operation sometimes involves coordinating pairs of internal flags on different timesteps. See "Set a Target Operation" on page 404 for details.

Flag operations are available in the **Edit** menu and as toolbar buttons that can be optionally shown or hidden depending on settings in the Configuration Dialog **Flags** tab. See "Edit Menu" on page 329 and "Flags Tab" on page 344 for details.

These operations are also available as keyboard accelerators, as follows:

- (I) Input: **Ctrl+I**
- (O) Output: **Ctrl+O**
- (T) Target: **Ctrl+T**
- (B) Best Efficiency: **Ctrl+B**
- (M) Max Capacity: **Ctrl+M**
- (D) Drift: **Ctrl+Shift+~**
- (U) Unit Values: N/A



If the current cell selection includes any slot that doesn't support a particular flag, the **Flag Set** operation for that flag is disabled. The disabled menu operations are indicated as grayed-out. The active Flag Set toolbar buttons are indicated with a black border.

Note: The **SCT Lock** does not prevent the setting of flag values on slot timesteps.

Set a Target Operation

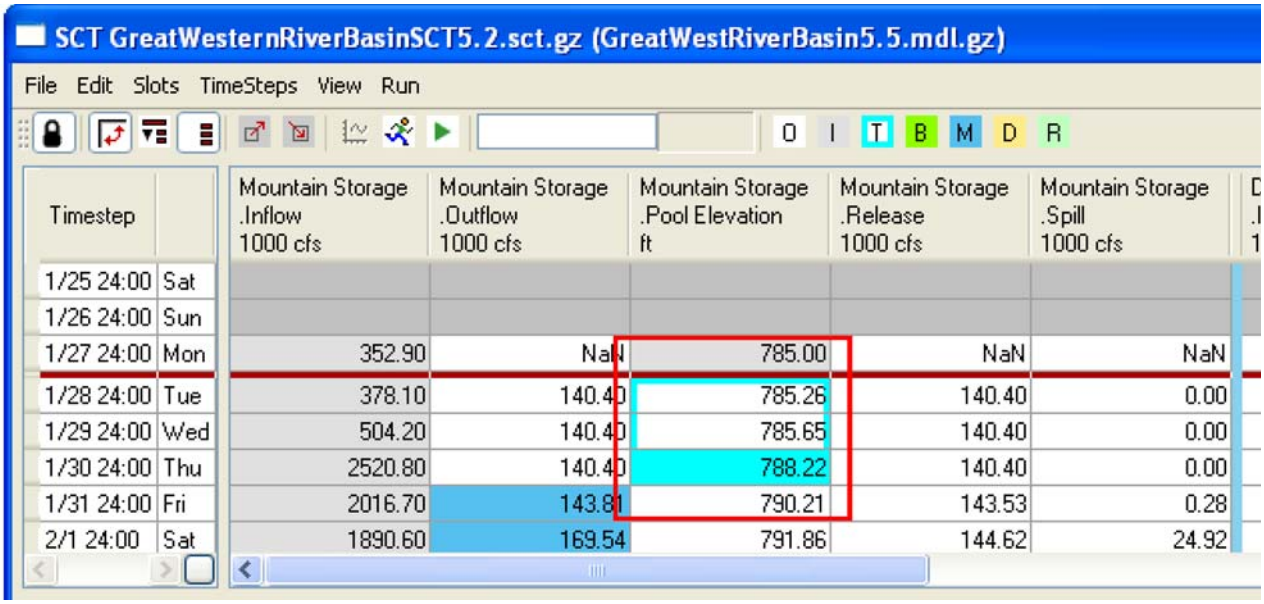
You can apply a **Target Operation** to a single timestep or to a contiguous range of timesteps on the following slots:

- Reservoir.Storage
- Reservoir.Pool Elevation

If the **Target Operation** is applied to a single timestep, by setting the Target Flag on a single selected timestep, then that timestep is regarded as the final timestep of the **Target Operation**. The first timestep is implied by the flag values in the preceding timesteps. This implicit **Target Begin** timestep is determined during the model run. See "Set a Flag" on page 403 for details.

If the **Target Operation** is applied to a range of timesteps within a slot then the earliest timestep is assigned the **Target Begin Flag** and the latest timestep is assigned the **Target Flag**. In this sort of **Target Operation**, the final target timestep is indicated with a solid background fill color of the user-configured Target color (see "Flags Tab" on page 344 for details), and the previous timesteps have only a thick border of that color.

Target Operations are indicated by a frame around all of the timestep cells within the target range.



Copy a Single Value to One or Many Timesteps

Through the following four steps, you can copy a single timestep value to one or more timestep values on a slot having the same unit type. This works both within a single SCT or between SCTs. You can repeat, any number of times, the third and fourth steps detailed below.

1. Select a cell (a detail cell, or a data cell in a non-aggregated view). See "Show or Hide (Aggregation) Summaries" on page 392 for details.
2. Perform the copy operation in one of three ways:
   - Press **Ctrl+C** or
   - Select the **Edit**, then **Copy** menu operation or
   - Select the **Copy** toolbar button.

   The source cell will be marked with the Copy Set Crosshatch of a user configured color; see "Color Tab" on page 346 for details.
3. Select (select or, optionally, drag) the destination cell(s).
4. Perform the paste operation in one of these ways:
   - Press **Ctrl+V** or **Ctrl+N** or
   - Select the **Edit**, then **Paste or Edit**, then **Paste as Input** menu operation or
   - Select the **Paste** toolbar button.
   - All but the **Paste as Input** and **Ctrl+N** operations perform the default paste operation, which pastes only input values and flags—and clears all the other destination timesteps. See "Copy and Paste" on page 360 for details.
   - The paste operations are enabled only if all of the destination cells are of the same unit type as is the source cell and if they are all editable (i.e., not read-only).
   - If the source cell is a summary cell (in an aggregated view), then generally this is equivalent to selecting multiple values (multiple timesteps), which would initiate the copy of multiple values. See "Copy Multiple Values" on page 405 and "Show or Hide (Aggregation) Summaries" on page 392 for details.

     Note: If the paste operation is enabled, then values that are pasted (depending on the type of paste operation) are assigned to the destination timesteps using standard units. This means that if the display units of the source and destination slots are different (e.g., cubic feet per second vs. cubic meters per second), then the pasted values will appear to be different than the source value. However, the quantities that those values represent will be the same. See "Copy and Paste" on page 360 for details.

Copy Multiple Values

You can copy a set of timesteps within a single slot to another time within the same slot or to a different slot having the same unit type. This works both within a single SCT or between SCTs.

1. Select the source cells. These can include all sorts of data cells, including summary cells. Timesteps indicated in the selection do not have to be contiguous.
2. Perform the copy operation in one of three ways:
   - Press **Ctrl+C** or
   - Select the **Edit**, then **Copy** menu operation or
   - Select the **Copy** toolbar button.

– The source cells are marked with the Copy Set Crosshatch with a user configured color; see "Color Tab" on page 346 for details.

3. Select a single cell as the first timestep at which to paste. This cell can be any sort of data cell, including a summary cell. If you select a summary cell, the implied earliest timestep is the first timestep within the timestep aggregation represented by that summary cell.

   Note: Alternate operation: Instead of selecting a single cell to identify the earliest destination timestep, if you select a single whole slot, the implied destination timestep is the earliest timestep from the source timestep selection. This is accomplished differently in the two axis orientations:

   – In Horizontal Timestep Axis Orientation (where rows correspond to slots), you select a slot as follows:

   • selecting a row tab at the extreme left side of a summary row or

   • if the SCT is locked, by selecting any row header field within a summary row or in any row in the non-aggregated view.

   – In Vertical Timestep Axis Orientation (where columns correspond to slots), you select a slot by selecting a column header.

4. Perform the paste operation in one of these ways:

   – Press **Ctrl+V** or **Ctrl+N** or

   – Select the **Edit**, then **Paste or Edit**, then **Paste as Input** menu operation or

   – Select the **Paste** toolbar button.

   – All but the **Paste as Input** and **Ctrl+N** operations perform the default paste operation that pastes only input semantics values and flags and clears all the other destination timesteps. See "Copy and Paste" on page 360 for details.

   – If there are timestep gaps in the source timestep selection, those gaps are honored by the paste operation. That is, the corresponding gaps in the destination will not be affected.

   – The paste operations are enabled only if the selection includes cells from just one slot. Pasting of defined values is performed using standard units. See "Copy a Single Value to One or Many Timesteps" on page 404 for details.

Copy a Timeslice Across All Slots

Within a single SCT, you can copy a set of contiguous timesteps across all slots to other timesteps. You can repeat, any number of times, the third and fourth steps (pasting) detailed below.

1. Select the source timesteps:

• In Horizontal Timestep Axis Orientation (where columns are timesteps or timestep aggregations), this is done by selecting and dragging in the column headers.

• In Vertical Timestep Axis Orientation (where rows correspond to timesteps or timestep aggregations), this is done by selecting or dragging in the row tabs at the far-left side of each row.

2. Perform the copy operation in one of three ways:

   – Press **Ctrl+C** or

– Select the **Edit**, then **Copy** menu operation or

– Select the **Copy** toolbar button.

The source timestep data cells will be marked with the Copy Set Crosshatch with a user configured color; see "Color Tab" on page 346 for details.

3. Specify the destination by selecting a timestep row or column as in the first step, above.
4. Perform the paste operation in one of these ways:

– Press **Ctrl+V** or **Ctrl+N** or

– Select the **Edit**, then **Paste** or **Edit**, then **Paste as Input** menu operation or

– Select the **Paste** toolbar button.

– All but the **Paste as Input** and **Ctrl+N** operations perform the default paste operation that pastes only input semantics values and flags—and clears all the other destination timesteps. See "Copy and Paste" on page 360 for details.

Copy a Whole Slot

You can copy the series data of a whole slot to another slot in the same SCT or to a different SCT. You can repeat, any number of times, the third and fourth steps (pasting) detailed below.

1. Select a source slot.

- In Horizontal Timestep Axis Orientation (where rows correspond to slots), select a row tab at the extreme left side of a summary row or any data row in the non-aggregated view. If the SCT is locked, select any row Header field within a summary row or in any row in the non-aggregated view.
- In Vertical Timestep Axis Orientation (where columns correspond to slots), select a column header.

2. Perform the copy operation in one of three ways:

– Press **Ctrl+C** or

– Select the **Edit**, then **Copy** menu operation or

– Press the **Copy** toolbar button.

The source timestep data cells will be marked with the copy set crosshatch with a user configured color; see "Color Tab" on page 346 for details.

3. Specify the destination by selecting a timestep row or column as in the first step, above.

Note: Alternate operation: Instead of selecting a single cell to identify the earliest destination timestep, if you select a single whole slot, the implied destination timestep is the earliest timestep defined in the source slot (regardless of the time range shown in the SCT). This is accomplished differently in the two axis orientations, as described in the first step, above.

4. Perform the paste operation in one of these ways:

– Press **Ctrl+V** or **Ctrl+N** or

– Select the **Edit**, then **Paste or Edit**, then **Paste as Input** menu operation or

– Press the **Paste** toolbar button.

All but the **Paste as Input** and **Ctrl+N** operations perform the default paste operation that pastes only input semantics values and flags—and clears all the other destination timesteps. See "Copy and Paste" on page 360 for details.

Copy/Paste Data to/from the Clipboard (e.g., to Excel).

It is possible to copy to the system clipboard the numeric values displayed in an SCT and, to then paste those values into another application like Microsoft Excel.

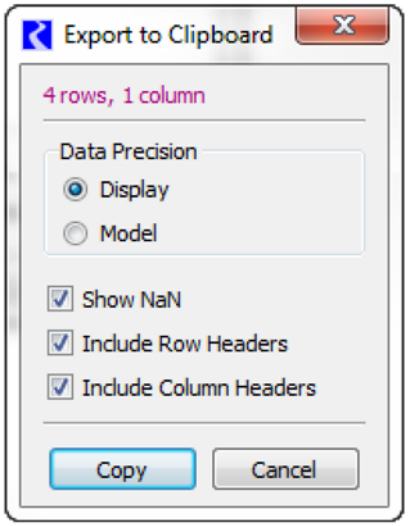
Data is copied with the displayed units and without reference to units (but, optionally, with greater precision).

Copy Data

Use the following steps to copy data to the system clipboard.

1. Select data cells in the SCT.
2. Select **Edit**, then **Export Copy**

   The Export to Clipboard dialog box appears.



3. Select **Display** or **Model** data precision, and whether undefined values should be pasted as NaN (or remain as a blank). Also specify if you wish to include row headers or column headers. Depending on the axis orientation, the headers include the following:
   – The complete label and the units (if enabled for display in the SCT) OR
   – The timestep (sufficient to identify the timestep) and the timestep weekday (if enabled for display in the SCT)
4. Select the **Copy** button.
5. The data is now in the system clipboard and can be pasted in the other application (e.g., Excel).

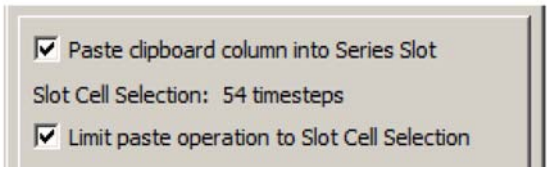
Paste Data

Use the following steps to paste data from the system clipboard.

1. Copy the data from the other application (Excel, for example)
2. Make a cell selection in the SCT.(Aggregated views are allowed.)
3. Select **Edit**, then **Import Paste**. Alternatively, right-click the SCT and select **Import Paste**.

   The Import from Clipboard dialog box displays.
4. Make any desired adjustments to the options.
5. Select **Paste**.

   Note: In Horizontal Timestep Axis Orientation (where rows correspond to slots), you can specify if you want to paste a column of data (or row) as time series data or just paste it directly into the SCT grid across slots. Use the **Paste clipboard column into Series Slot** to paste the data into a single series slot. Clear the checkbox to paste across slots, as though the aggregated cells are a spreadsheet. Use the **Limit paste operation to Slot Cell Selection** to limit the paste to only those cells selected in the SCT.



   Note: Clipboard data format is ASCII-encoded decimal numeric values (or NaN for undefined values—if selected) within a row are separated with tab characters. Rows are separated with New Line characters.

How To Print, Plot, and Export Data

Printing

You can print a depiction of all or part of an SCT. From the SCT, only the Row Header Table and SCT Data Table (with column headers) are included. The printed-page header and footer contains some information about the SCT and RiverWare model.

There are three **File**, then **Print** menu operations:

- **File**, then **Print**, then **Selection**
- **File**, then **Print**, then **Page**
- **File**, then **Print**, then **Full SCT**

The **Print**, then **Selection** operation prints the minimum enclosing rectangle around the selection. In the aggregated views, summary rows are included only if all of their subordinate detail rows are included. The selection ornamentation (reverse colors) prints only through the **Print**, then **Page** and **Print**, then **Full SCT** operations.

Plotting

When you select the plot operation, the full range of the selected slots is plotted in a Plot Page. Plotting is enabled only if no more than two unit types are represented within the selection.

You can display a plot of the selected slots either by one of the following:

- Selecting **Slots**, then **Plot Slots**.
- Selecting the **Plot** toolbar button.

Exporting Data

The SCT does not support directly exporting data to files. However, see "Copy/Paste Data to/from the Clipboard (e.g., to Excel)." on page 408 for instructions on copying selected information.

Data can also be exported to text files from the individual slots. Select **Slots**, then **Open Slots** to open the slot. Then use the **File**, then **Export** menu to export the data. See "Slots Menu" on page 330.

Chapter 9
Subbasins

Subbasins are user-defined sets of objects that can be referenced by name. Subbasins are typically defined to represent connected parts of the basin network, such as “Reservoirs above Powell” or “Holston System.” The objects in the Subbasin can be referenced as a group in RPL sets including Expression Slots, Optimization Constraints, and Rules. The subbasin manager is used to create and edit subbasins.

Topics

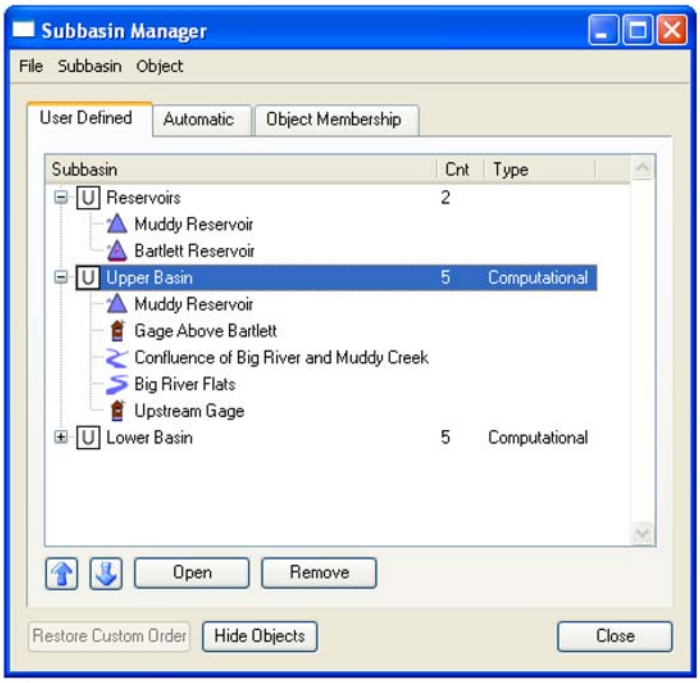
- Subbasin Manager, page 411
- Creating New Subbasins, page 412
- Adding and Removing Subbasin Members, page 413
- Viewing an Object’s Subbasin Memberships, page 413
- Selecting Objects Belonging to a Subbasin, page 414
- Computational Subbasin, page 415

Subbasin Manager

To open the Subbasin Manager dialog, select **Workspace**, then **Edit Subbasins**. The Subbasin Manager has the following tabs:

- **User Defined**. Allows the user to show/create/edit subbasins defined by the user. User Defined Subbasins are displayed with a “U” icon next to their name.
- **Automatic. A**llows users to show fundamental Subbasins which are automatically defined by RiverWare, and may be used in expressions and constraints in the same manner. These include groups such as “Entire Network”, “Reaches”, “Reservoir”, “DataObj”, etc. Automatic subbasins are displayed with an “A” icon next to their name.

- **Object Membership**. Allows the user to show all of the subbasins to which an object belongs.



Creating New Subbasins

To create a new user-defined subbasin, first select the desired objects on the workspace. In the subbasin manager, make sure you are in the **User Defined** tab. Next select **Subbasin,** then **Append New Subbasin**. A new subbasin is created that contains the selected objects on the workspace. The name of the subbasin can be modified by selecting the name and entering a new name (or using the right-click **Edit Subbasin Name** menu). Alternately, you do not need to select the objects before creating the subbasin. Instead, create an empty subbasin and then add objects to it using the selector; see "Adding and Removing Subbasin Members" on page 413 for details. Additional subbasins can be created or removed using the menu options in the **Subbasin** menu to append or insert a new subbasin.

An additional menu option, **Append Typed Subbasin** allows the user to add a subbasin that has a special classification. These include

- No-Optimization
- Smooth-Energy
- Preferred-Customer
- Allocated
- Computational

The first four types are used in optimization. A Computational Subbasin can also be added using the **Subbasin,** then **Append Computational Subbasin** menu. See "Computational Subbasin" on page 415 for details.

Adding and Removing Subbasin Members

Objects are added to the subbasin through either the **Subbasin** menu or the right-click context menu. There are two general methods to add objects to an existing subbasin. Highlight the desired subbasin on the **User Defined** tab, then taking one of the following actions:

- Select **Subbasin,** then **Append Objects** using the Object Selector or right-click **Append Objects** with Object Selector to open the Selector dialog. You can use filtering or other tools on the selector to choose the desired objects.
- Highlighting the object on the workspace, then select either **Subbasin,** then **Append Objects from Workspace Selection** or **Subbasin,** then **Replace Objects from Workspace Selection.**

  Note: These options are only available if the subbasin is selected on the subbasin manager, not the objects in the subbasin.

Objects and entire subbasins are removed from the Subbasin Manager by highlighting them and selecting the **Remove** button on the bottom of the subbasin manager dialog (or through the right-click context menu). Objects and subbasin can be moved up  or down  in the list using the appropriate buttons. In addition, subbasins can be sorted by selecting any of the column headings: Subbasin, Cnt or Type. To return to the previous custom order, user the **Restore Custom Order** button. Computational subbasins can be opened by highlighting the subbasin then selecting the **Open** button or double-clicking the subbasin name. On other subbasins, if you double-click a subbasin, it will toggle the tree-view displaying the objects. If at any time in the Subbasin Manager you wish to close all the tree-views of the objects, select the **Hide Objects** button.

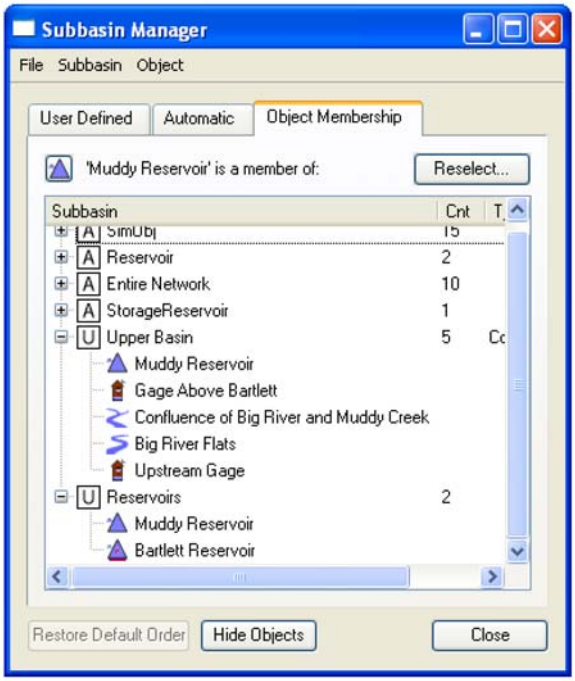
Aggregate objects (Aggregate Reach and Aggregate Diversion Site) have special behavior because their elements are objects themselves.

- When an aggregate object is added to a subbasin using a *workspace selection*, then all elements are also added to the subbasin. Any new elements will be automatically added to that subbasin. But if an element is removed from the subbasin, it is not automatically added back when the model is saved and loaded (as happened in previous versions of RiverWare). Also, once an element is removed, any new elements will not be automatically added to the subbasin.
- When the ***object selector*** is used to add objects to a subbasin, aggregate elements are only added to the subbasin if they are explicitly selected. Then, adding new elements to the aggregate will not automatically add them to the subbasin.

Viewing an Object's Subbasin Memberships

From the subbasin manager **User Defined** or **Automatic** tabs, the membership of an object can be viewed by highlighting a single object then selecting **Object,** then **List Subbasin Membership**. The subbasin manager automatically switches to the **Object Membership** tab. Displayed are the subbasin to which that object belongs,

both automatic (A) and user defined (U). You can also access this tab directly and use the **Select** or **Reselect** button to bring up the object selector.



Water Users have another way to display subbasin membership. Each Water User object contain a List Slot called Water User Groups that has a list of all of the subbasins to which the Water User is a member. See "Water User Groups" in *Objects and Methods* for details of this slot.

This slot was added to provide access to the subbasin membership from the object itself. Thus, the user can go into the object itself and see that a particular Water User belongs to subbasin A, B, and C, all from the object.

Selecting Objects Belonging to a Subbasin

From the **Object** menu, you can also choose to **Select Objects on Workspace**. This option will highlight and select the object on the workspace. Double-click an object in the subbasin manager to open the object directly. The right-click context menus have the following options:

- **Select Objects on Workspace**. Select the object on the workspace. No scrolling is performed.
- **Select Objects and Show Workspace**. Select the objects, then brings the workspace to the front of the screen. No scrolling is performed.
- Scroll to Object on the workspace. Scroll the workspace the selected objects.

Similarly, with a subbasin selected, use the **Subbasin,** then **Select Member Objects on Workspace** menu to select all of the objects on the workspace for the selected subbasin or selection. In addition, if you double-click a subbasin in the manager, it will select all the objects on the workspace.

Computational Subbasin

The Computational Subbasin supports computations that involve more than one object, so-called “global” solutions, though they need not encompass the entire network. A Computational Subbasin is created through the same dialogs as other typed subbasins, but it, like simulation objects, contains slots and other attributes that you can inspect and change, by “opening” the subbasin. To open a computational subbasin from the main workspace use the **Workspace,** then **Open Computational Subbasin** and select the desired basin from the list. To open a computational subbasin from the subbasin manager, select the subbasin, then select the **Open** button or double-click the subbasin name. Computational subbasins contain no general slots; all slots are dependent on user-selectable methods. See “User Methods” in *Objects and Methods* for details on the available methods and their slots.

Chapter 9
Subbasins