



## Technical Documentation Version 7.3

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# Units

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Center for Advanced Decision Support for  
Water and Environmental Systems (CADSWES)

UNIVERSITY OF COLORADO **BOULDER**

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# Units

This document describes the use of units in RiverWare including:

- 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

## 1. Standard Units

In RiverWare, all calculations are performed in standard or internal units. The internal units are as follows for the standard unit types:

UNIT TYPE	RIVERWARE INTERNAL UNIT	DISPLAY VALUE
Flow	meter <sup>3</sup> / second	cms
Volume	meter <sup>3</sup>	m3
Length	meter	m
Area	meter <sup>2</sup>	m2
Time	hour	hour
Energy	megawatt hour	MWH
Power	megawatt	MW
Velocity	meter / second	m/s
Mass	gram	g
Heat	joule	J
Concentration	gram / meter <sup>3</sup>	g/m3
Temperature*	degrees Celsius	C
Temperature_F*	degrees Farenheit	F
DateTime	Fully Specified Date-Time	
*Note: As there is no multiplicative factor to convert Celsius to Farenheit, Celsius and Farenheit are maintained as separate unit types.		

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 [HERE \(Section 2.\)](#) or for an individual slot through the slot configuration menu described [HERE \(Slots.pdf, Section 2.1.5\)](#).

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.

All units available in RiverWare are specified in the "units" text file which resides in the same directory as the RiverWare executable. You may view the conversion factors for all units in this file or use the unit converter described [HERE \(Section 3.\)](#).

## 2. Unit Schemes

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

- Units
- Scale
- Precision
- Format

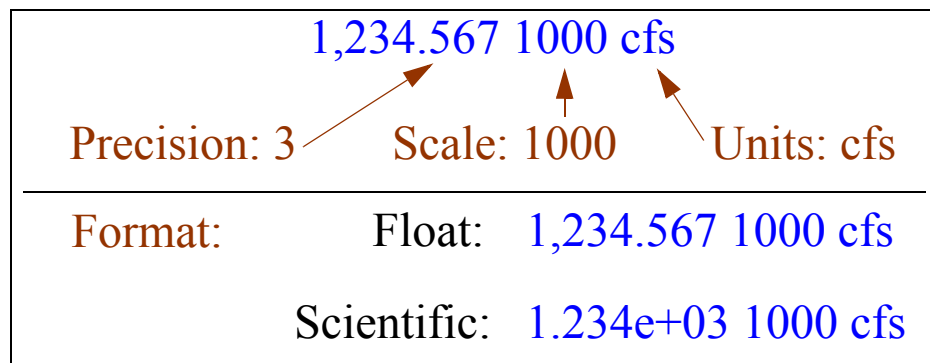
These four attributes are shown in the example to the right.

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 m<sup>3</sup>/year, 1000 m<sup>3</sup>, 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:
  - 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. The resource database file (riverwareDB) is now obsolete.



- 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.

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**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.

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## 2.1 FAQ

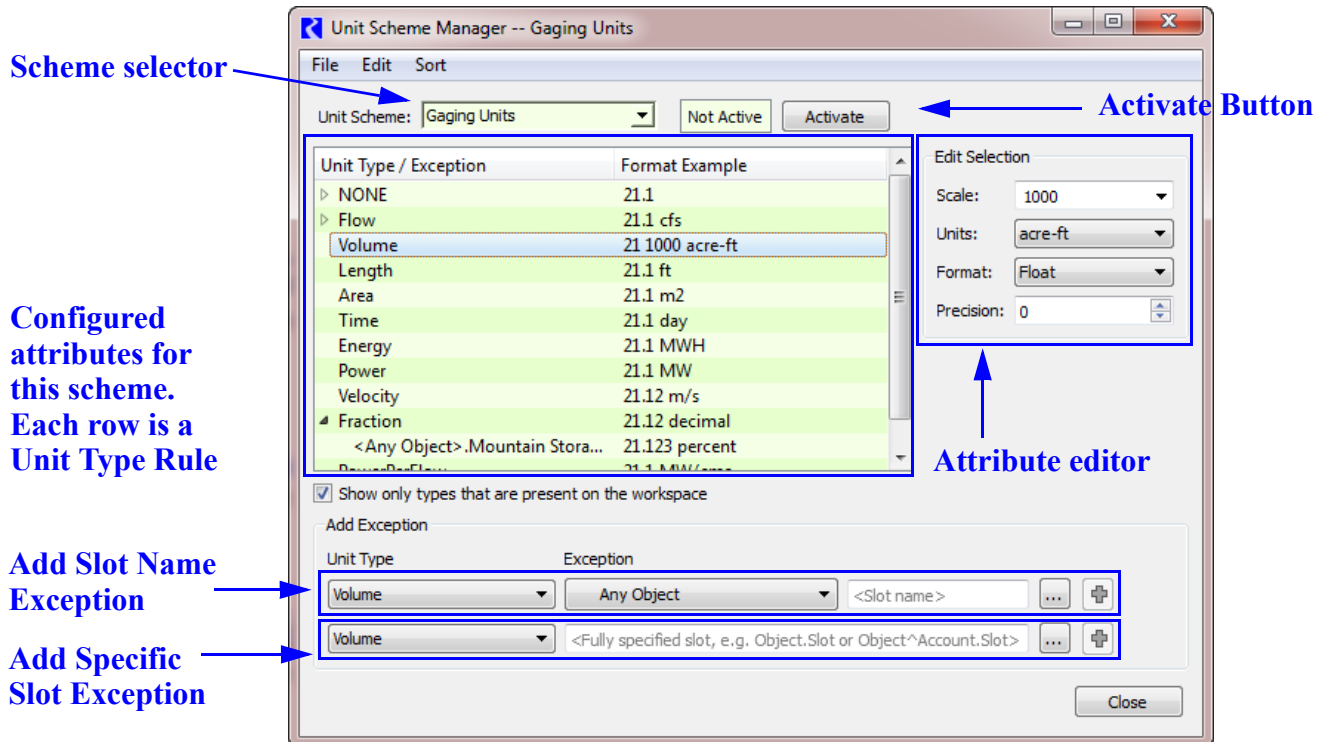
Following is a table of frequently asked questions, with short answers, followed by links to more information:

QUESTION	ANSWER	LINK
What are Unit Schemes?	A <b>Unit Scheme</b> describes how you want to display numeric slot values in terms of four display attributes: units, scale, precision, and format.	See overview above, <a href="#">HERE</a>
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	See first bullet above, <a href="#">HERE</a>
How do I switch between schemes?	From the workspace, open the Unit Scheme Manager using the <b>Units</b> ➔ <b>Unit Scheme Manager</b> . From the Unit Scheme pulldown menu, choose a new scheme and click Activate	<a href="#">HERE (2.2.2)</a>
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.	<a href="#">HERE (2.3.2)</a>
Can I still change the display units from the slot dialog itself?	Yes, when you change the units from a slot, you automatically create a Slot Exception.	<a href="#">HERE (2.5)</a>
How do I fix a slot's units, without changing the displayed values?	Change the units from the Open Slot and choose to <b>Repair incorrect Units</b> .	<a href="#">HERE (2.6)</a>
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.	<a href="#">HERE (2.2.1)</a> and <a href="#">HERE (2.3.1)</a>
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.	<a href="#">HERE (2.4)</a>

QUESTION	ANSWER	LINK
If I change the units or activate a different scheme, will I get the same results?	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.	<a href="#">HERE (2.7)</a>
Do some computations or methods depend on specific units?		
Can I share schemes between two models?	Yes, <b>Export</b> the scheme from one model and <b>Import</b> it into another model.	<a href="#">HERE (2.2.3)</a>

## 2.2 Working with Unit Schemes

Following is an annotated screenshot of the Unit Scheme Manager showing the main areas.

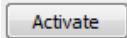


### 2.2.1 Creating and Deleting

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, a dialog (shown to the right) will open where you can specify the new name.

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

### 2.2.2 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. If you want to fix values because you imported them into a slot with the incorrect display units, use the approach described [HERE \(Section 2.6\)](#).

### 2.2.3 Sharing Schemes using Import / Export

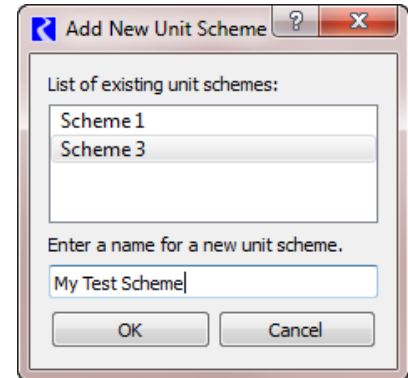
Schemes from one model can be exported to a file, and then imported into another model. Choose the desired scheme and then:

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

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

## 2.3 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.



### 2.3.1 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 unchecking the box.

Show only types that are present on the workspace

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 shown 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.

Unit Type / Exception	Format Example
Time	21.1 day
Energy	21.1 MWH
Power	21.1 MW
Velocity	21.12 m/s
▸ Fraction	21.12 decimal
AreaPerTime	21.12 m2/s
Concentration	21.12 g/m3
Density	21.12 kg/m3_dens
EnergyFlux	21.12 J/m2sec
energyPerLength	21.12 MWH/m
FlowPerLength	21.12 cms/m
FlowPerSqrLength	21.12 cms/m1/2

To set an attribute, (1) select a row in the tree view and then (2) edit one of the four attributes on the right. Changes are applied immediately.

**1. Select Row**

Unit Type / Exception	Format Example
▸ NONE	21.1
▸ Flow	21.1 cfs
▾ Volume	21 1000 acre-ft
< Any Object>.Evaporation	21.12 m3
Length	21.1 ft

**2. Change attribute(s)**

Edit Selection

Scale: 1000


Units: acre-ft

Format: Float


Precision: 0

### 2.3.2 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 may 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. Type in 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 .

Unit Type	Exception
Volume	Reservoir

Evaporation ... 

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.

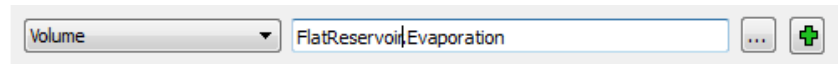
Choose that first from the pulldown

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





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**Note:** When you configure an individual slot, as described [HERE \(Slots.pdf, Section 2.1.5\)](#), you are actually creating a Slot Exception for that slot within the currently active Unit Scheme. After making the change in the slot, you can go to the unit scheme and see that exception.

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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 as described [HERE \(Section 2.3.1\)](#). The result is shown in the screen shot

Volume	21.12 1000 acre-ft
<Reservoir>.Evaporation	21.12 acre-ft
 FlatReservoir.Evaporation	21.12 100 acre-ft

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

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## 2.4 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:

- Is complete, i.e., covers all unit types.

- Describes the existing slot configurations, that is, this scheme displays all slots as configured in the model file.
- 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 1.122cfs. 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**.

## 2.5 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 ➔ Configure...** menu, you will get a dialog similar to the following. It lists the unit type and the active scheme. You can then choose one of the 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.

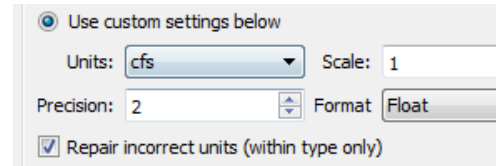
As you change the selection, the unit settings for that toggle are shown in the Unit/Scale/Precision Format areas.

Slot configuration is described in detail [HERE \(Slots.pdf, Section 2.1.5\)](#)

## 2.6 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** ➔ **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  $100\text{cms} = 3531.5\text{cfs}$  to  $100\text{cfs} = 2.83\text{cms}$ . But, it appears that the displayed value stays the same.

## 2.7 Unit Specific Calculations

In general, RiverWare does calculation in internal units. Changing the scheme will not affect underlying results. But, there are a few methods that depend on one or more slots' units. Following are these methods, organized by the category of calculation:

**Exponentiation:** For the following methods, a change in the units can produce different results due to calculations which use user-units in combination with a user-input exponent with units of NONE:

OBJECT	CATEGORY	USER METHOD	LINK (Objects.pdf)
Groundwater Storage	Groundwater Outflow	Exponential Flow	<a href="#">HERE (Section 14.1.2.6)</a>
	Deep Percolation	Exponential Percolation	<a href="#">HERE (Section 14.1.4.4)</a>
Reach	Reach Evaporation	Inflow Exponent Pan Evaporation	<a href="#">HERE (Section 22.1.19.2)</a>
	Reach Seepage	Seepage and Riparian CU Loss	<a href="#">HERE (Section 22.1.12.7)</a>
Reservoir	Sediment	CRSS Sediment	<a href="#">HERE (Section 24.1.28.2)</a>

**Time Units:** If the model timestep is monthly, the following method's lag time slots must have TIME units of "**month**" or an error will occur:

OBJECT	CATEGORY	USER METHOD	LINK (Objects.pdf)
Reach	Routing	Time Lag	<a href="#">HERE (Section 22.1.1.2)</a>
Reach	Routing	Variable Time Lag	<a href="#">HERE (Section 22.1.1.3)</a>
Reach	Drain Elevation	Stage Elevation Interpolation	<a href="#">HERE (Section 22.1.15.5)</a>

Similarly, in one or more of the following method's table slots, the TIME unit must be “**day**” in the first column or an error will occur:

OBJECT	CATEGORY	USER METHOD	LINK (Objects.pdf)
Reach	Gain Loss	Interpolated Flow Gain Loss	<a href="#">HERE (Section 22.1.10.5)</a>
Reach	Routing	Variable Time Lag	<a href="#">HERE (Section 22.1.1.3)</a>

**Unit Dependent Calculations:** The following methods 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.

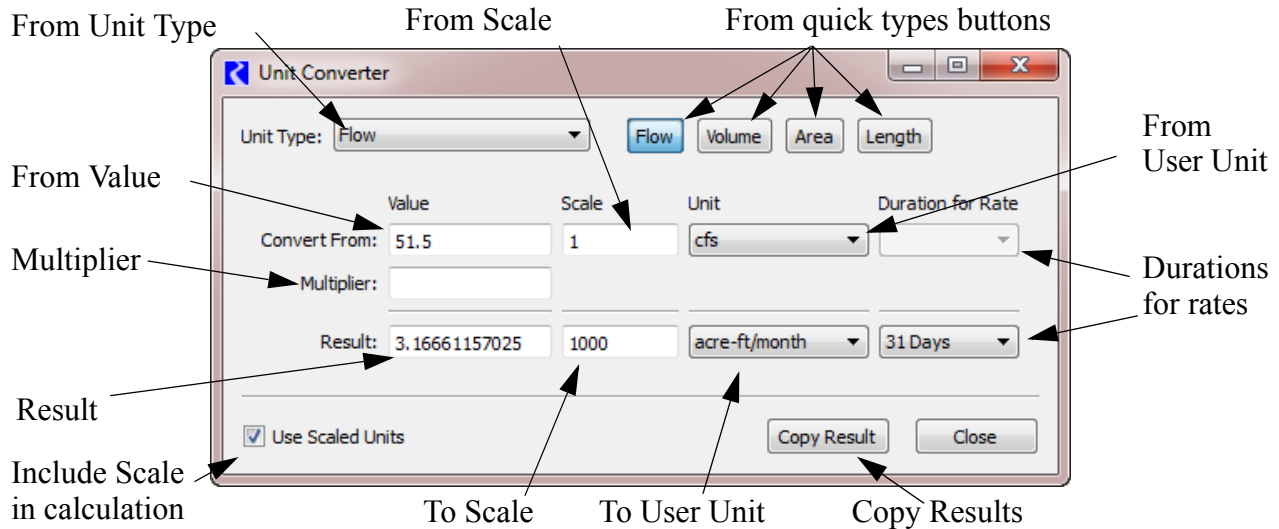
OBJECT	CATEGORY	USER METHOD	LINK (Objects.pdf)
Reach	Routing	Storage Routing	<a href="#">HERE (Section 22.1.1.14)</a>
		Variable Storage Routing	<a href="#">HERE (Section 22.1.1.15)</a>
	Depth to Flow	Power Function	<a href="#">HERE (Section 22.1.5.4)</a>
Distribution Canal	Flow Routing	Storage Time	<a href="#">HERE (Section 11.1.5.3)</a>
		Variable Storage Time	<a href="#">HERE (Section 11.1.5.4)</a>
Reservoir	Sediment Transport	Perm Pool Sed (Pre2000)	
		Total Vol Sed (Post2000)	

### 3. 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** ➤ **Unit Converter**.

### 3.1 Converting Numeric Values

The screenshot shows the dialog with all of the features displayed for numeric values. Following is the basic order in which the dialog is used and the options available:



- **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.
- **Value:** Input a value to **Convert From** in the text box
- **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.
- **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.
- **Duration for Rates:** For units that include a rate (e.g. acre-feet/month) where the time scale is not constant (i.e. monthly or yearly), specify the duration. For monthly rates, select 28, 29, 30, or 31 days. For yearly rates, the specify 365 or 366 days.
- **Multiplier:** Optionally enter a multiplier. The from value is converted to the units of the result and then multiplied by the **Multiplier**.
- **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.
- **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.

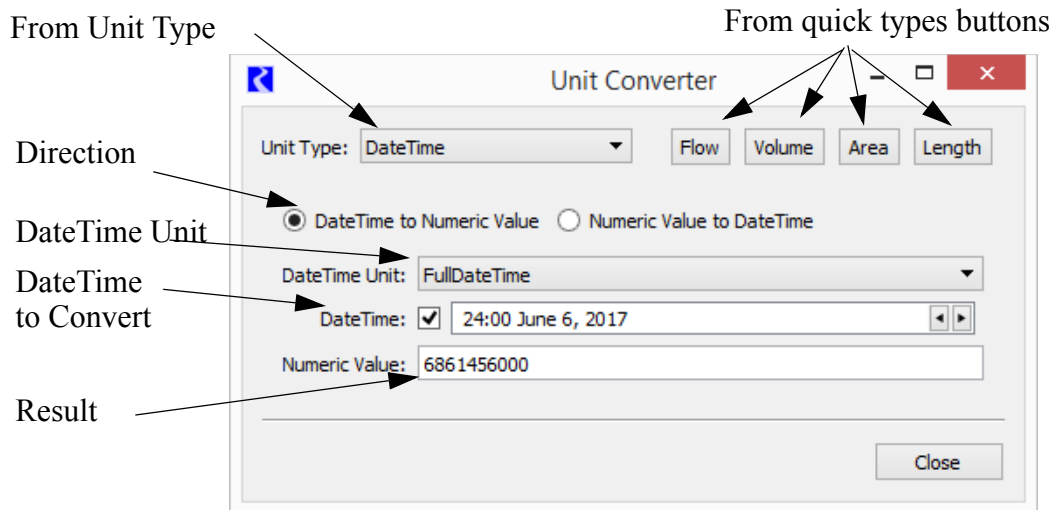
The Unit Converter uses the conversion values specified in the “units” text file which resides in the same directory as the RiverWare executable. This file is viewable by you and can even be modified if necessary.

### 3.2 Converting DateTime values to Numeric Values

As described [HERE \(Slots.pdf, Section 5.\)](#), slots can store DateTime value. 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. The screenshot shows the dialog with all of the features displayed for DateTime values. When DateTime is the selected unit type, a different set of controls as shown. First, chooses which direction to do the conversion by selecting one of these two radio buttons:

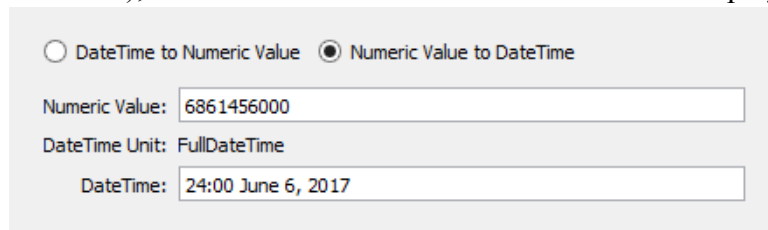
- **DateTime to Numeric Value**
- **Numeric Value to DateTime**

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



In the **DateTime to Numeric Value** direction (shown above), select the DateTime Unit (one of which is FullDateTime -- fully specified absolute date/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.

When the **Numeric Value to DateTime** option is selected (see below), enter a numeric value (often you would copy/paste this as needed), and both the DateTime unit and value are displayed for that value. .



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

Various units and controls are shown to the right.

**Technical Note:** DateTime values are stored in slots as floating point number. 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.

The image displays four screenshots of the Unit Converter Dialog, illustrating different units and conversion directions:

- Top Screenshot:** Conversion from DateTime to Numeric Value. DateTime Unit: FullDateTime. DateTime: 24:00 June 6, 2017. Numeric Value: 6861456000.
- Second Screenshot:** Conversion from DateTime to Numeric Value. DateTime Unit: FullDateTime. DateTime: 24 :00 6th Jun 2017. Numeric Value: 6861456000.
- Third Screenshot:** Conversion from DateTime to Numeric Value. DateTime Unit: MonthAndDay. DateTime: 1st January. Numeric Value: 126230400.609375.
- Bottom Screenshot:** Conversion from Numeric Value to DateTime. Numeric Value: 6861456000. DateTime Unit: FullDateTime. DateTime: 24:00 June 6, 2017.