

Scenario Manager Enhancements / Scenario Playbox

Design for RiverWare 6.3

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This document describes a set of enhancements to RiverWare “Scenarios” to better support stakeholders’ workflow of generating scenarios and examining results.

0.1 Document Status

- 02-02-2013 (b): Ready for review.
- 02-09-2013: Revision: The Scenario Output Snapshot Slot Template (slot list) is edited in the Scenario Manager, rather than as a special slot list within the Snapshot Manager. See section 2.1.

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1.0 Overview

1.1 Prior RiverWare Scenario Capabilities

The prior scenario capability (in RiverWare 6.2 and prior versions) allows a *stakeholder* (user) to edit the values of a subset of a RiverWare model's slots prescribed by a *scenario engineer*. These *scenario input slots* have values initially assigned from corresponding non-modifiable *baseline input slots*. Stakeholder operations on scenario series slots included:

- Reverting the scenario slot to the original baseline values.
- Multiplying the scenario slot values by a specified factor ("scaling").
- Editing the scenario series slot values in the Open Slot Dialog. This also provides certain high-level operations on an arbitrary selection of timesteps within the series, include scaling, "offsetting" (adding an absolute value), and interpolating selected timestep ranges.

Although the user can freely edit scenario input slot values, warnings are indicated when those values do not conform to minimum and maximum limits for those slots. Those limits are constants set by the scenario engineer and associated with each baseline slot in the baseline model.

The stakeholder's workflow generally consisted of these steps:

1. Load a baseline model (which had been prepared by a scenario engineer).
2. In the Scenario Manager, create a new scenario. This contains new *scenario input slot* copies of a predetermined set of *baseline input slots*.
3. Modify the values of the scenario input slots.
4. Run the model.
5. In the Snapshot Manager, "take" a new snapshot to capture the values of the output slots of interest which were generated from the scenario run. The first time this is done, the Snapshot Manager's "Slot List Template" needs to be set up to identify which slots from the model will be *copied off* to each new snapshot object.
6. Compare the output slots (series) of various scenarios and the baseline using RiverWare Plots or other analysis tools.

This poses several challenges for stakeholders who, in general, are not experienced RiverWare users. For example:

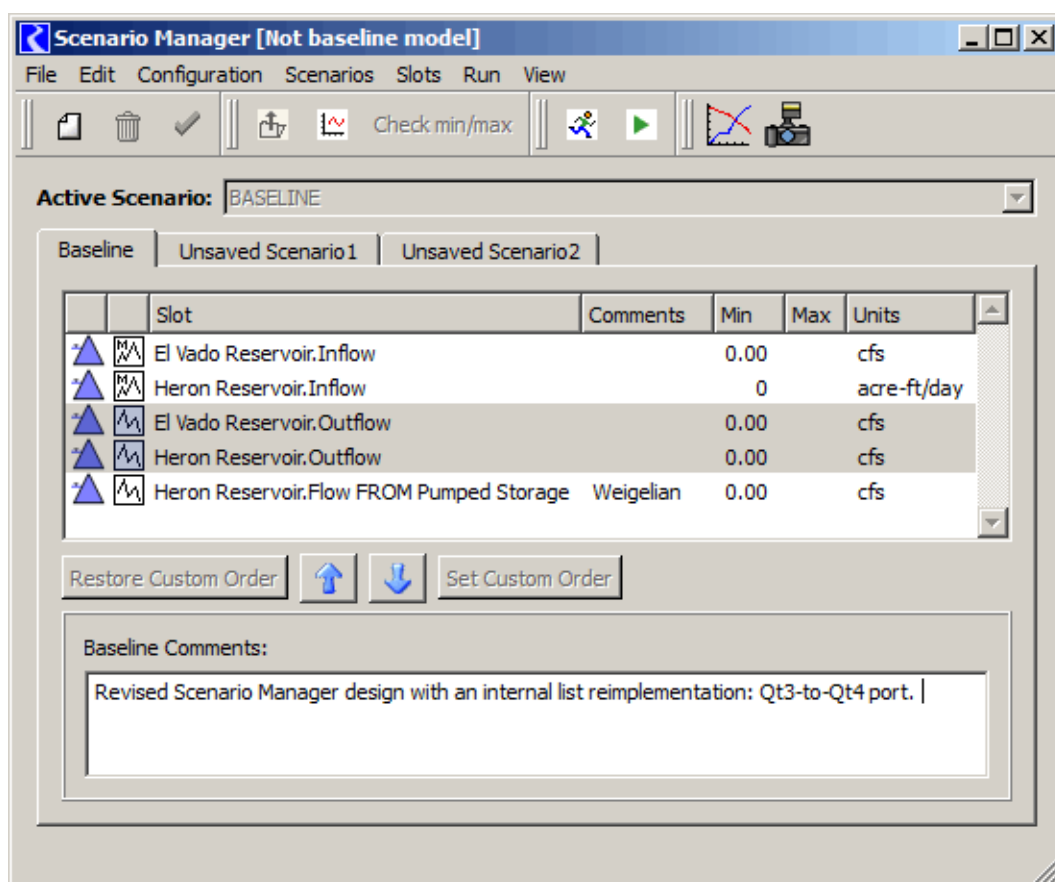
- The supported edit operations on scenario input slots are more complicated than they need to be. In general, editing the values of individual timesteps within an input series is not required. The characterization of simple transformations stakeholders would want to use -- for example, "increase a particular outflow, with respect to its baseline values, by 20%" -- is not directly supported.
- The Snapshot Manager must be operated manually by the stakeholder to capture the results of a scenario run. And it's up to the stakeholder to give the generated snapshot object a name which semantically associates it with the scenario.
- The outputs generated from a scenario run cannot be saved with the scenario. They can be preserved only by exporting a snapshot object as a distinct RiverWare object file.

1.2 Recent Enhancements to the Scenario Manager Dialog

In the course of RiverWare 6.3 development, the Scenario Manager dialog's *input slot list display* implementation was ported from Qt3 to Qt4. As part of this work, the following enhancements were implemented. (This work was completed in July 2012):

- Multiple slot item selection (in place of single-item selection of the Qt3 implementation), and enhancement of many slot operations to apply to the *multiple* slot selection. [See Gnats 3789].
- Additional optional column display, and redesigned custom order and sorting controls. Standard column sorting is now supported by clicking on a column header; clicking again on the current sort column header reverses the order.
- The scenario input slot custom order (one sort option) is now global for the whole model -- it applies to all loaded Scenarios.
- The *object type* icon for the slots' containing object is now shown.
- Addition of a "paste slot" context-menu operation for pasting slot references from the RiverWare Slot Clipboard, e.g. for slot references copied from the "Find Slots with Inputs" dialog. (This is relevant for the creation of a baseline model by the scenario engineer).

The following screenshot precedes the RiverWare 6.3 release:



1.3 RiverWare Scenarios Enhancements Overview

Enhancements to RiverWare Scenarios (beyond those done as part of the Qt4 port, see above) are of these types:

- General enhancements to the RiverWare Scenario feature.
- Support for a new “Scenario Playbox” for stakeholders.

1.3.1 General enhancements to RiverWare Scenarios

1. Addition of a new distinct snapshot slot list template used specifically for generated scenario outputs. This slot list template is defined within the baseline model and is not editable by the stakeholder.
2. Automatic generation of a special scenario output snapshot object at the completion of a scenario run. The snapshot object has the same name as the scenario from which it was generated. A “BASELINE” snapshot is also generated for the baseline (non-scenario) run. These actions occur only if the snapshot slot list template for scenarios (see prior item) is non-empty.
3. Included with a scenario’s automatically generated output snapshot object are automatically generated comment lines indicating the list of scenario input slots which have been modified by the stakeholder. For input slots included in the scenario playbox configuration (*see next section*), the adjustment parameters are also indicated.
4. Addition of a button on each scenario tab in the Scenario Manager Dialog to show the Open Object Dialog for the baseline’s or scenario’s output snapshot object.
5. Persistence of a scenario’s output snapshot object within the scenario file.

1.3.2 Support for a new “Scenario Playbox” for stakeholders

The typical workflow for a stakeholder is now supported in a new “Scenario Playbox” dialog. The configuration of the playbox is defined by the scenario engineer using a Scenario Playbox Configuration dialog. The initial implementation of this feature supports a single playbox configuration within a baseline model. A Scenario Playbox supports:

1. Up to three input scenario slots to be adjusted by the stakeholder.
2. Slider controls to adjust the values of each input scenario slot. Supported transformations from the baseline series values are: (a) scaling (multiplying by a factor) and (b) offsetting (adding a positive or negative term, specified in the display units for the slot).
3. A change in the application of minimum and maximum limits set on the baseline slots: the adjusted (scaled or offset) scenario values are automatically “clipped” at these limits, if they are defined.
4. “Easy” plotting of scenario output slots shown in a plot panel within the playbox. For a single selected slot among a prescribed set of scenario output slots, the plot panel shows the baseline series plus the generated scenario outputs for one or more selected scenarios. The plot is redrawn with each dynamic selection change within “generated scenario” and “output slot” lists.

2.0 General Scenario Enhancements

2.1 Formalization of a Scenario Output Snapshot Slot List

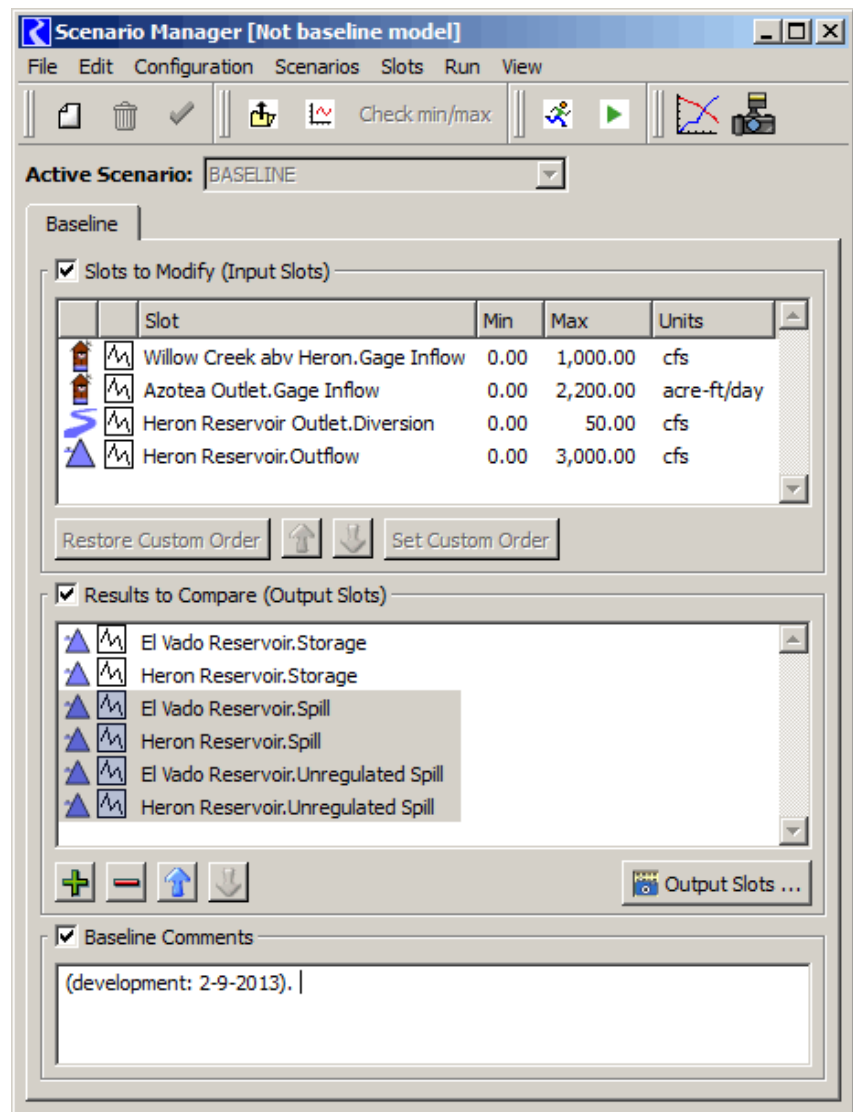
With the prior version of the Scenario mechanism, the stakeholder was responsible for manually creating a snapshot object to capture the results of a scenario run. This made use of the Snapshot Manager's single Snapshot Slot Template (slot list), which is editable by the stakeholder.

The new design introduces a special slot list template used specifically for the automatic generation of scenario output snapshot objects -- *see the next section*.

The “**Results to Compare (Output Slots)**” slot list is edited by the scenario engineer in the Scenario Manager's Baseline tab. This list is saved in the baseline model and is not modifiable by the stakeholder; this is important because the new “playbox” configuration is dependent on this list.

Internally, this slot list is referred to as the **Scenario Output Snapshot Slot Template**. Although it is a component of RiverWare's “snapshot” capability, this slot list is not visible within the Snapshot Manager dialog. However, scenario snapshot objects generated from this list are visible in that dialog's *snapshot object* list.

The three panels on the Baseline tab of the Scenario Manager (*see image above*) can be resized by dragging up or down (invisible) “splitter controls” between the panels. Also, any of these panels can be collapsed by turning off the panel's checkbox.

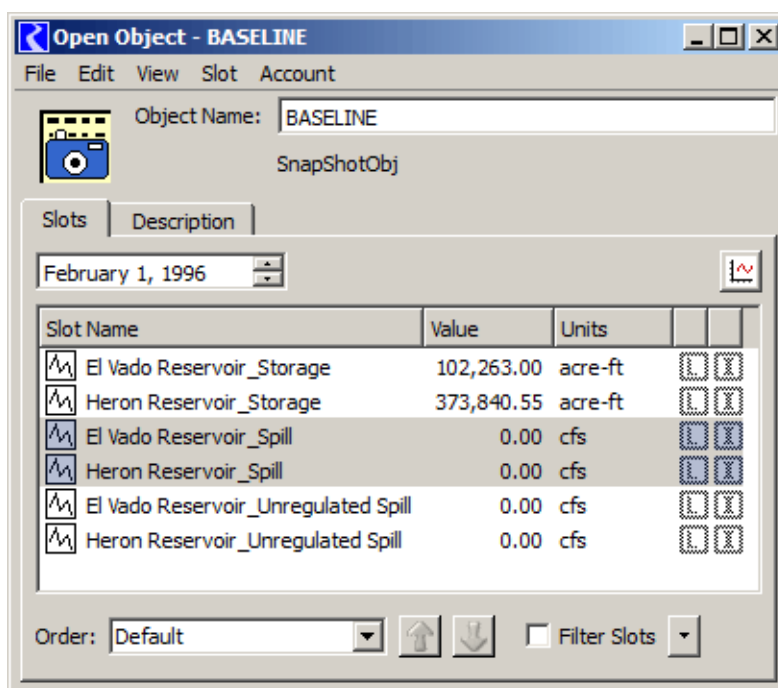
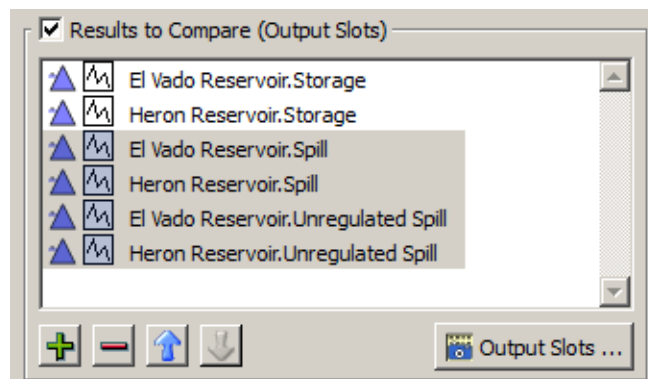


The **green “+” button** shows the general slot selector to pick more slots for this list.

The **red “-” button** removes the selected slots from this list.

The **blue up and down arrow buttons** move the selected slot items up or down within the list.

As described in the next section, the **“Output Slots ...” button** accompanying this slot list (*on the baseline tab*) shows the “BASELINE” snapshot object which is automatically generated at the completion of a non-scenario run (if this list is non-empty). This button is enabled only when that snapshot object exists within the workspace.

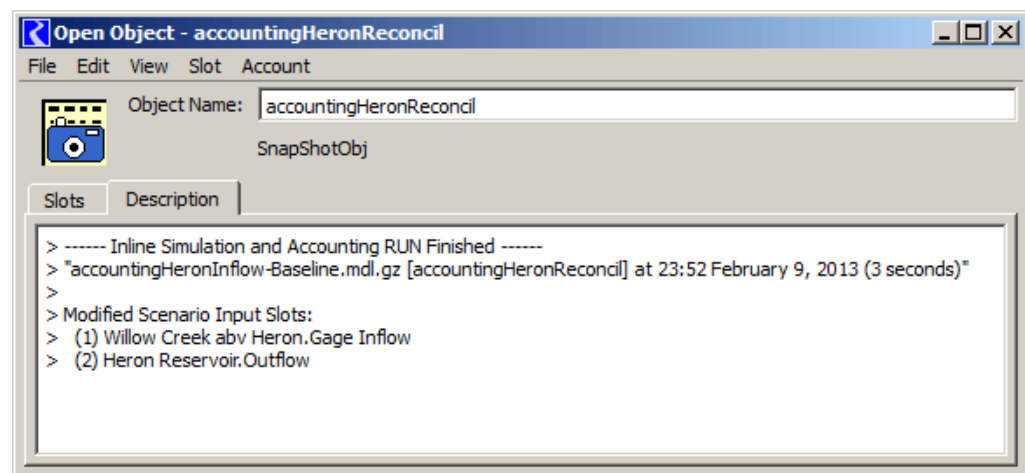


2.2 Automatic generation of scenario output snapshot objects

If the “**Results to Compare (Output Slots)**” slot list described above is non-empty, then, at the end of a run, a special snapshot object having the same name as the active scenario (or else, “BASELINE” in a non-scenario run) is created with the following data:

- Non-editable copies of the slots enumerated in the Scenario Output Snapshot Slot Template,
- Automatically generated comments in the snapshot object’s description indicating:
 - (a) A timestamp of the run completion.
 - (b) A list of scenario input slots which have modifications with respect to the baseline values. For scenario playbox adjusted slots, also the scale or offset value with which the scenario input slot’s values were computed.

The automatically generated text lines within the snapshot object’s description begin with a special character (“>”) to distinguish them from user-entered comments. All such lines are deleted from the description before generating new comment lines.



The association between a scenario and its output snapshot object is based only on the scenario and the object having the same name. As described in the following section, this snapshot object will be saved with the scenario when the scenario is saved as a scenario file.

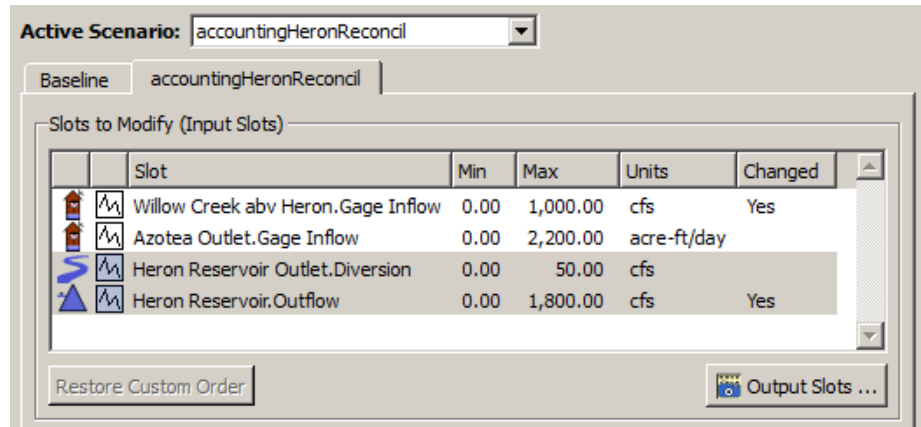
In the initial implementation, a scenario’s *existing* output snapshot object and slots (*from a prior run*) are *deleted and regenerated*. The following properties are preserved:

- The snapshot object’s locations on the three RiverWare workspaces.
- Comments entered by the user in the snapshot object’s description.

Because these objects and slots are deleted instead of just having their slots’ values updated, the following somewhat undesirable effects occur when a run completes:

- The “open” Open Object Dialog for the baseline’s or scenario’s snapshot object is closed.
- Any “open” slot dialogs for these slots will be closed. And traces for these slots in any existing plots will be erased. (An exception to this sort of behavior is the SCT, which maintains *symbolic* references to slots).

The Open Object Dialog for the scenario's output snapshot object can be shown by clicking a new “**Output Slots ...**” button on the scenario's tab in the Scenario Manager dialog. This button is disabled if that snapshot object has not yet been generated.



Possible Future Enhancement: Some indication of whether scenario input slots have been changed since the scenario's output snapshot was generated. (Changes to scenario inputs should technically “invalidate” the generated outputs).

2.3 Persistence of a scenario's output snapshot object in the scenario file.

As with the prior implementation, scenarios are saved in their own files, apart from the baseline model. Now, the scenario's output snapshot object is also saved in that file. When loading a scenario file, the snapshot object is loaded. This will replace any existing snapshot object on the workspace having the same name.

A scenario acquires its non-default name when it is saved to a scenario file. If the scenario has a corresponding scenario output slot snapshot (automatically generated, having the same name as the scenario), that object will also be renamed -- to the scenario's new name.

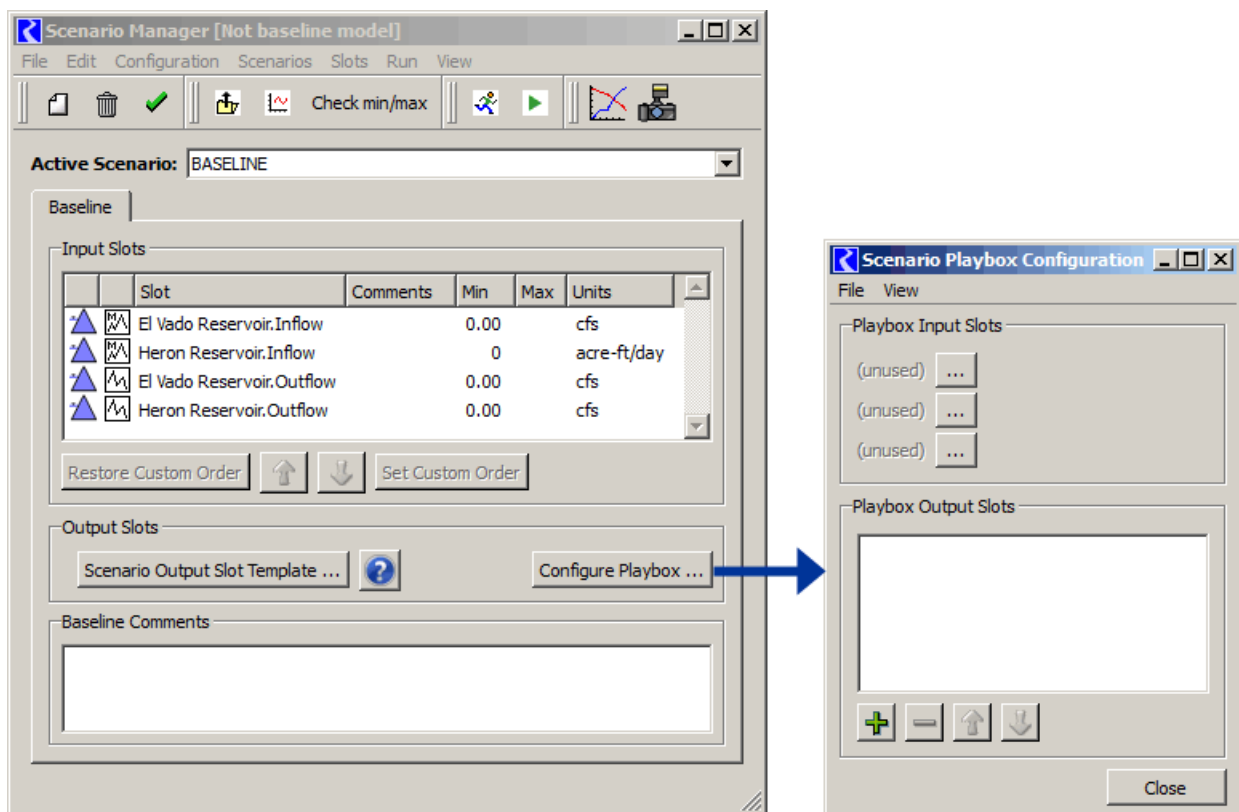
3.0 Scenario Playbox (New Dialog)

The Scenario Playbox is a new dialog intended for stakeholders (scenario users). It facilitates a stakeholder's workflow of creating a new scenario, adjusting the values of up to three (3) predetermined scenario input slots with sliders, running the scenario, and comparing scenario output results.

In the initial implementation, only a single Scenario Playbox instance is provided. This can be used with any of the scenarios created by the stakeholder. In the future, we may choose to support multiple *named* Scenario Playboxes (having distinct configurations).

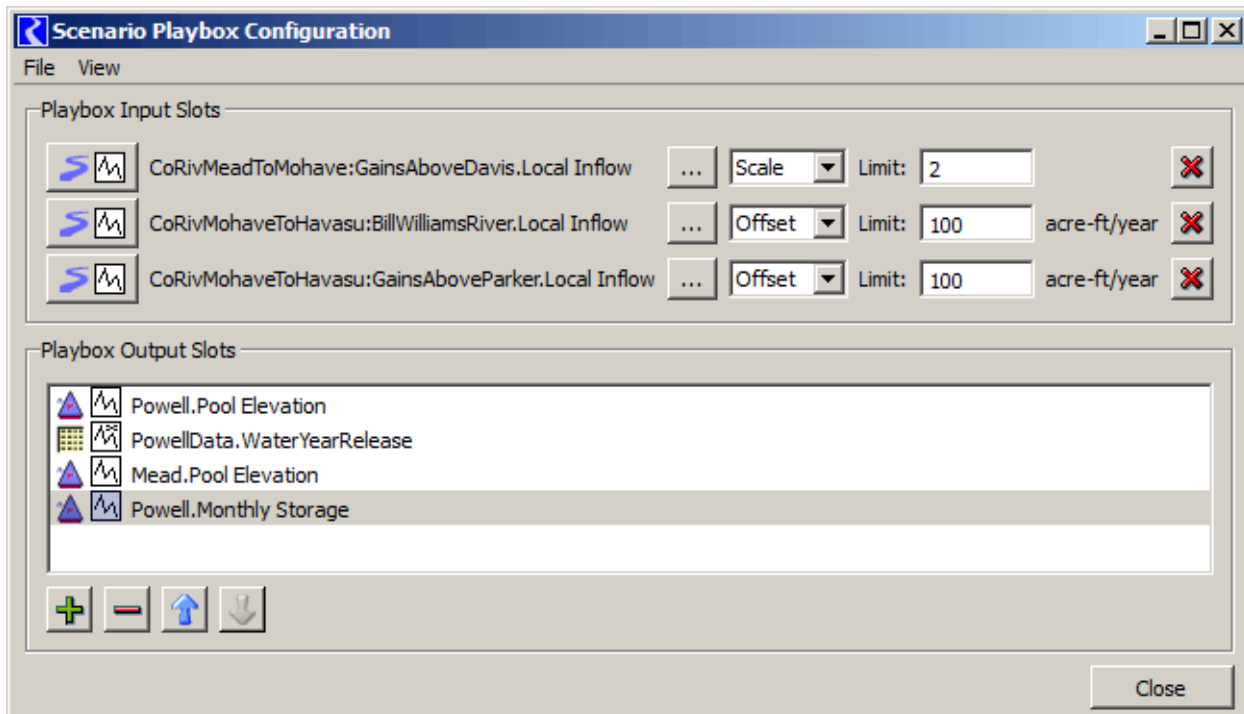
3.1 Scenario Playbox Configuration

The Scenario Playbox configuration is created by the scenario engineer and is saved in the baseline model. This configuration is not editable by the stakeholder. The Scenario Playbox Configuration dialog is shown by clicking the "Configure Playbox..." button on the *Baseline* tab of the Scenario Manager ...



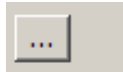
The Scenario Playbox configuration consists of the following properties:

1. A selection of up to three (3) scenario input slots to be adjusted by the stakeholder in the playbox. The configuration for each of these three slots consists of:
 - Whether the slot values are adjustable by *scaling* (multiplying by a factor) or by *offsetting* (increasing by a negative or positive amount).
 - *Limits* for the adjustment parameters, corresponding to extreme ends of a slider control. The manner in which these limits are defined is devised such that the slider's mid-point represent "no change".
 - For scaling factor values, an upper limit (greater than 1.0) is specified; the lower limit will be the reciprocal of the upper limit. (*Read more about the non-linear implementation of the scaling slider, below*).
 - For offset term values, a positive upper limit is specified; the lower limit will be the negative of the upper limit.
2. A selection of up to five (5) scenario output slots from the new Scenario Output Slot Template (slot list).





Shows the Open Slot dialog for the configured input slot.



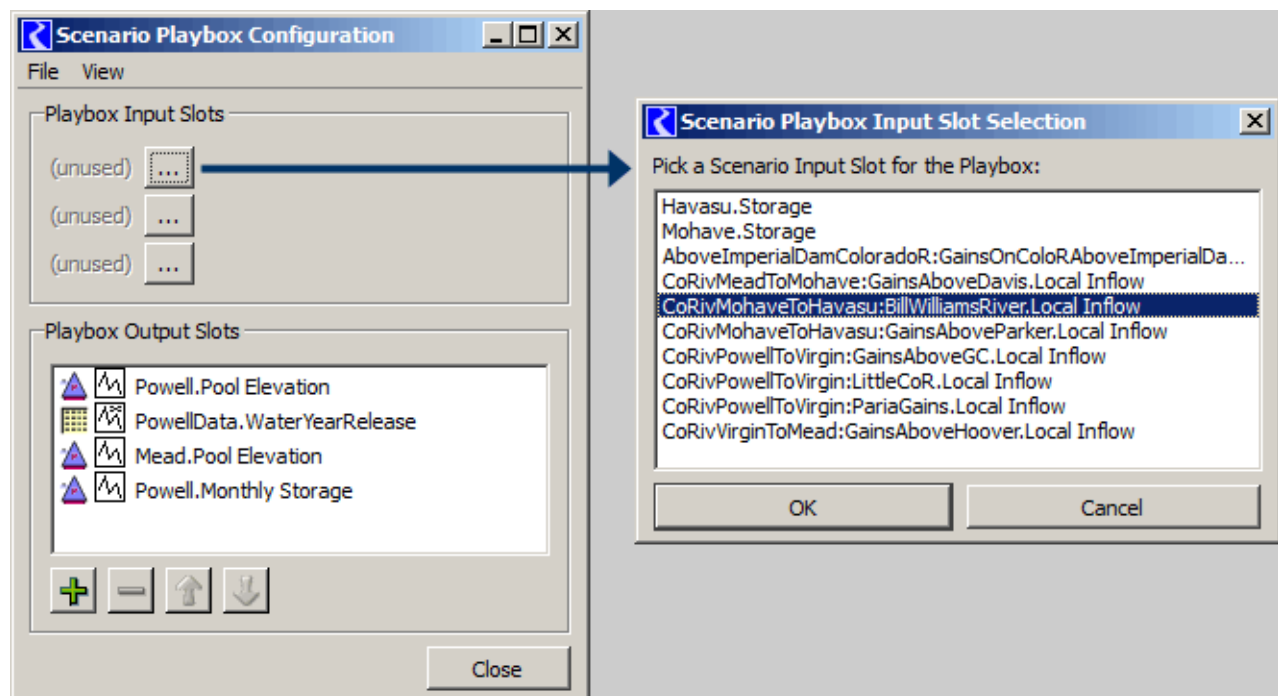
Shows a popup dialog to select a playbox input slot from among the baseline's input slots. (*See below*).



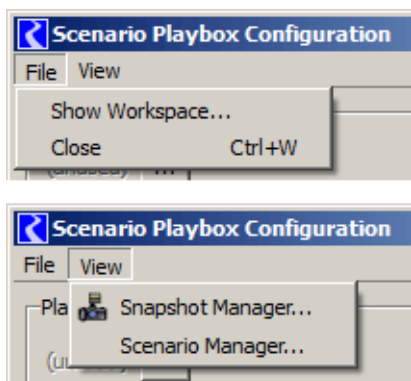
Clears the slot selection and configuration for the particular playbox input slot, i.e. the particular Playbox Input Slot *row*.

As mentioned above, each of the three playbox input slots can be configured for either of two different adjustment (transformation) functions of the baseline slot: *scaling* (multiplying by a factor) or *offsetting* (adding a negative or positive term, expressed in display units of the slot). The upper limit of the adjustment factor or term is also configured. The lower limit is either the reciprocal or the negative of the specified limit value, respectively for these two functions. (*See the description of the Playbox slider controls, below*).

Note that when a scenario input slot has been included in a playbox configuration, its values are no longer directly editable, e.g. in its Open Slot Dialog or an SCT. (Such slots' values will be "read-only" in those dialogs). This is necessary because the values of such a scenario input slot are *computed* using a linear function on its corresponding baseline slot.

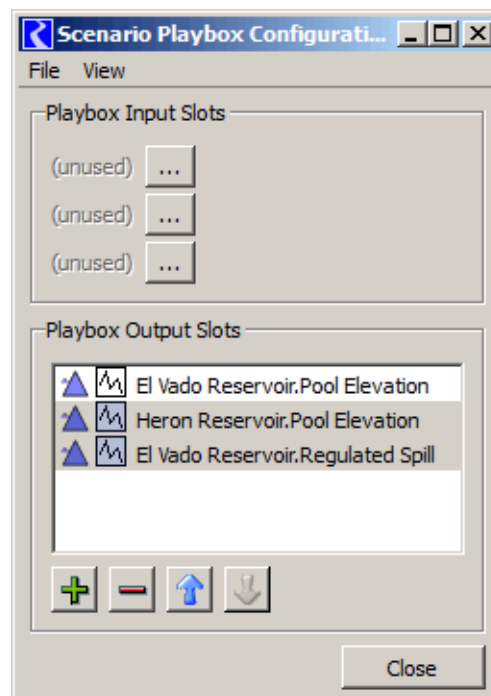


The Playbox Output Slot List is composed, by the scenario engineer, of slots picked from the Scenario Output Slot Template (slot list). As described above, that slot list is defined in the Snapshot Manager dialog. That dialog is accessible from this configuration dialog's "View" menu ...



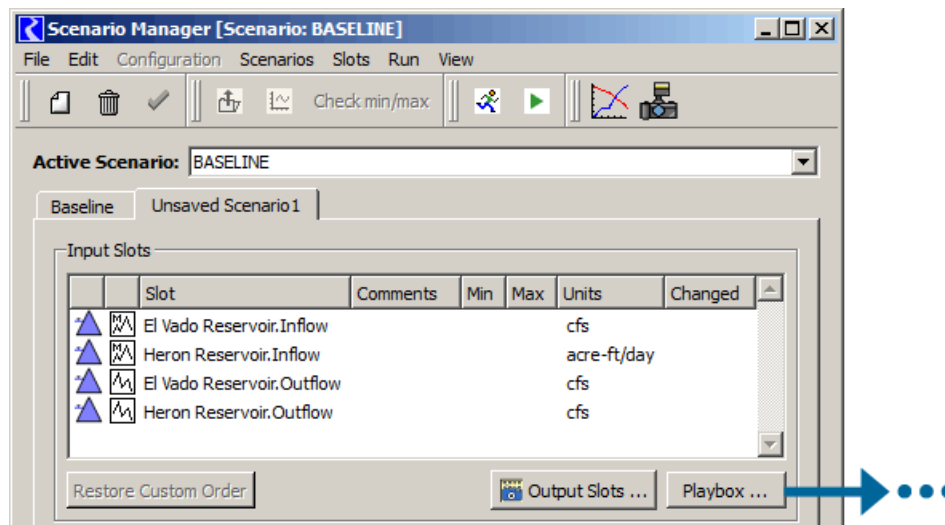
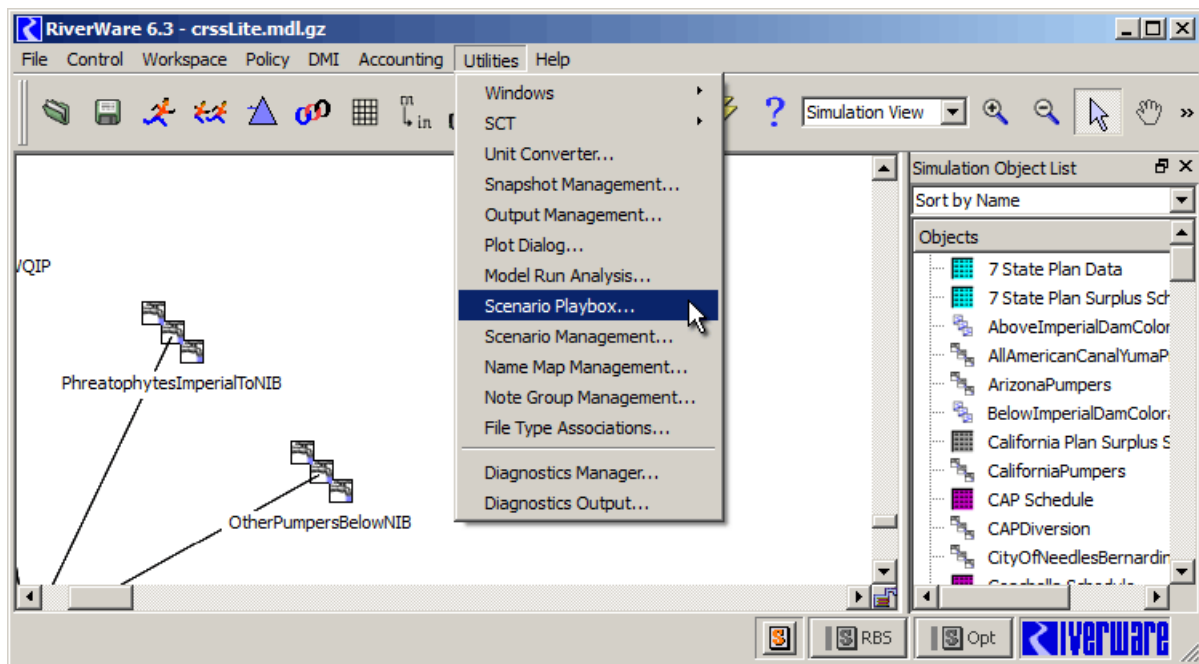
The **"plus" icon button** shows a selector for slots in the Scenario Output Slot Template (slot list). Up to five output slots can be configured, so this button is enabled only if the list contains four or fewer slots.

The **"minus" icon button** removes the selected items, and the **arrow buttons** move them up and down in the list.



3.2 Accessing the Scenario Playbox

The Scenario Playbox is accessible from the RiverWare Workspace and from the Scenario Manager. If a Scenario Playbox has been configured, a "Scenario Playbox..." menu item appears in the Utilities menu, above the "Scenario Management..." item. In the Scenario Manager, each Scenario Tab has a "Playbox..." button which brings up the playbox with the corresponding scenario initially selected; (*see below*).

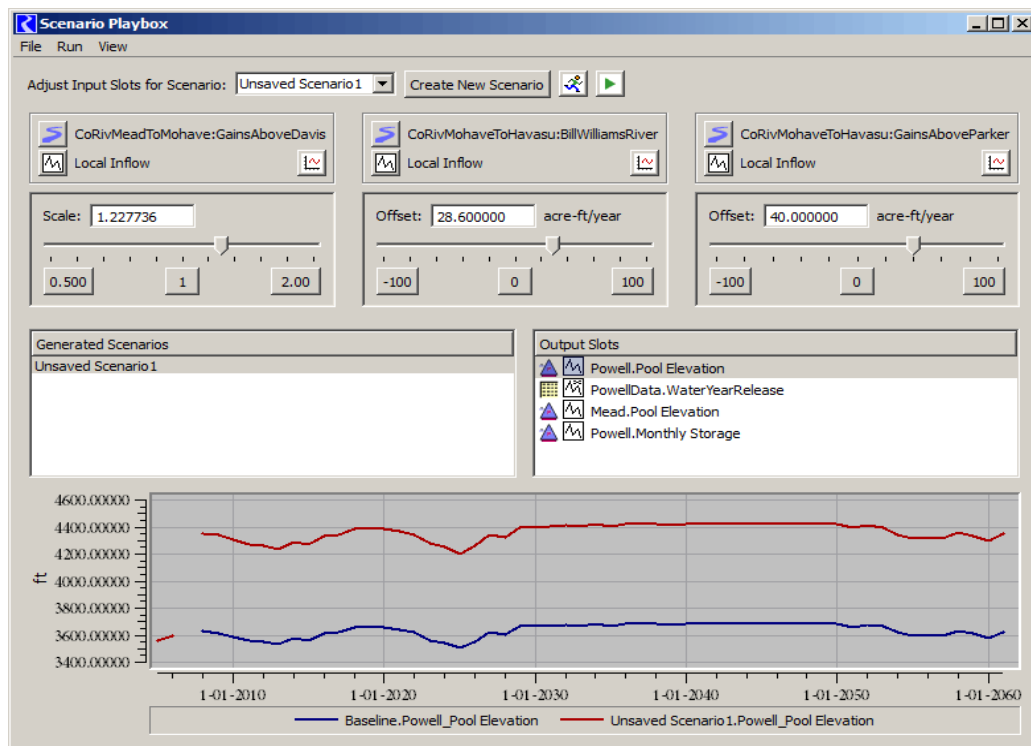
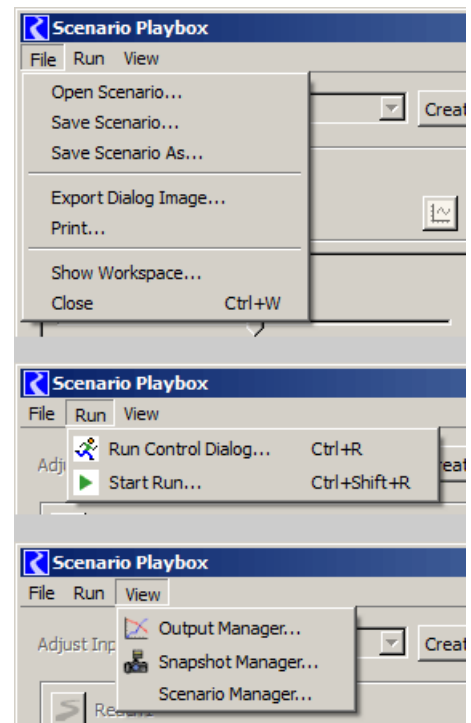


3.3 Scenario Playbox: Controls Overview

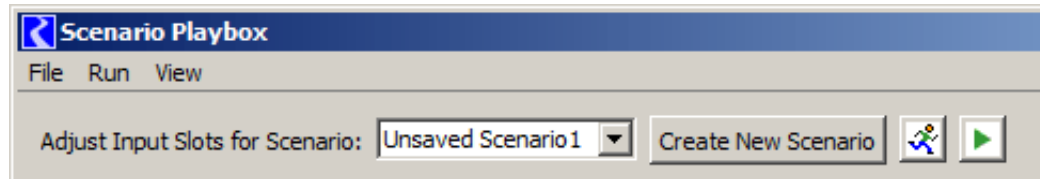
The Scenario Playbox presents to a stakeholder all the functions necessary to support a basic scenario generation and analysis workflow within a loaded baseline model.

The following general functions are made available in the dialog's menubar and top-row of controls.

- Create a New Scenario (see below).
- Open an existing Scenario File.
- Save a Scenario to a Scenario File.
- Show the Run Control Dialog.
- Start a Run.
- Show the Scenario Manager Dialog.
- Show the Workspace.
- Show the Snapshot Manager.
- Show the Output Manager.
- Print or export an image of the playbox dialog.



Until at least one scenario has been created, only the "Create a New Scenario" button is enabled. That function creates a new scenario with a new unique name in the form of "Unsaved Scenario#" (e.g. "Unsaved Scenario1") and sets the "Adjust Input Slots for Scenario" combo box to that new scenario.



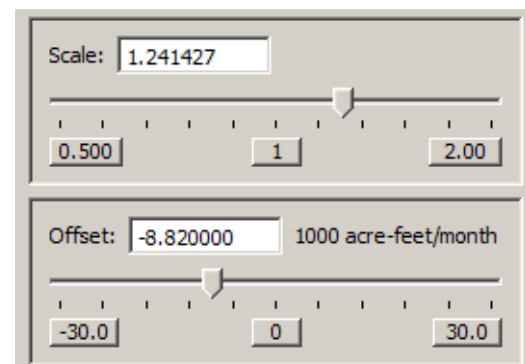
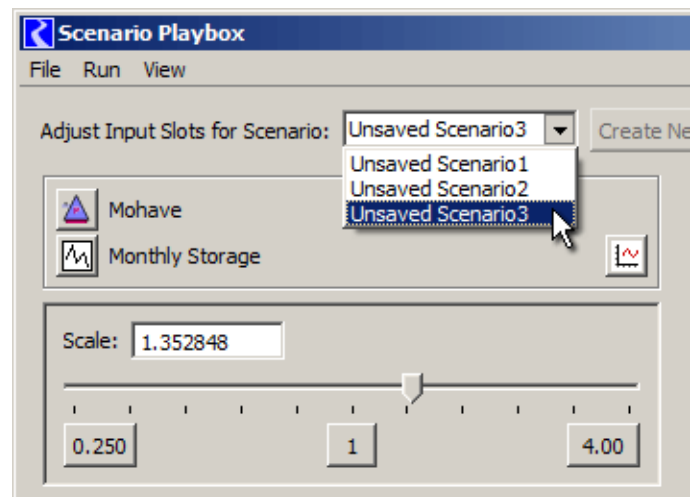
While the playbox is shown, the playbox indicated in the "Adjust Input Slots for Scenario" combo box is implicitly made to be the "Active" Scenario (which is otherwise established in the Scenario Manager dialog).

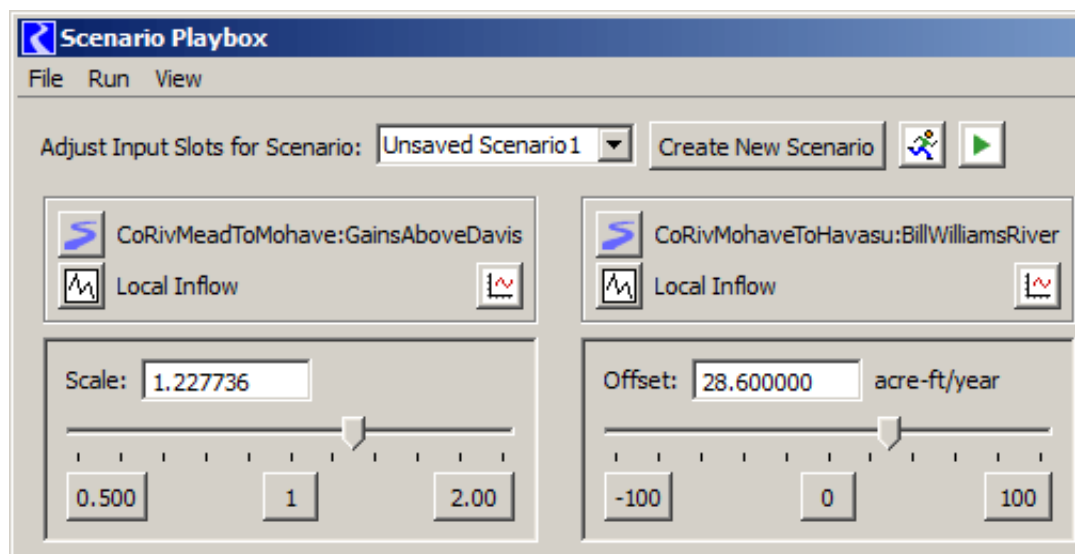
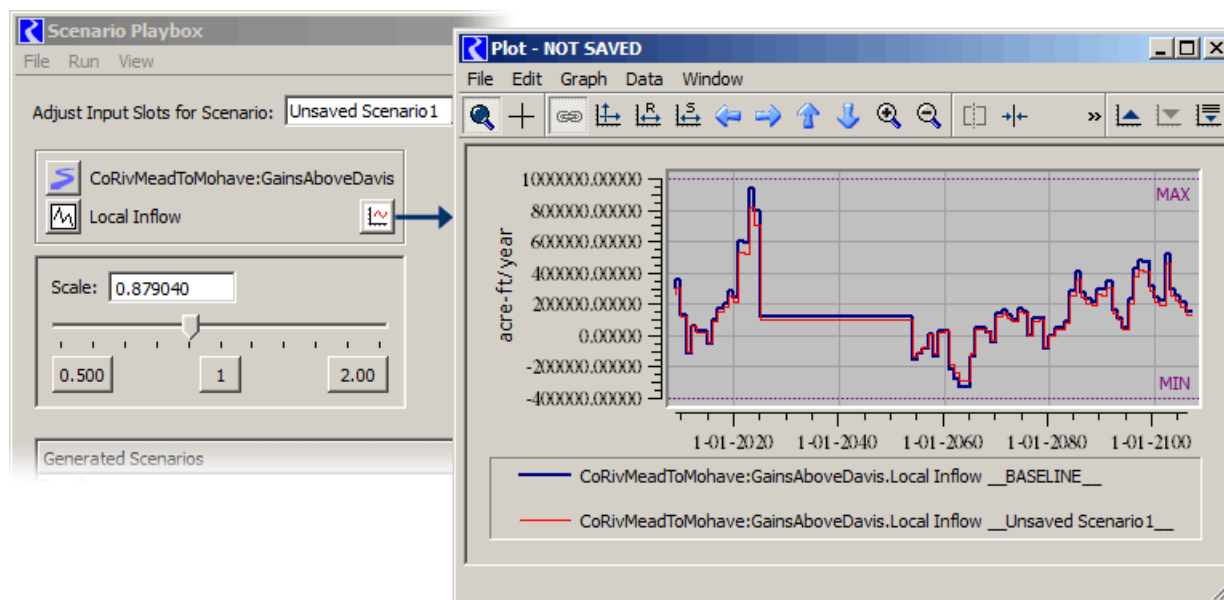
3.4 Scenario Playbox: Input Adjustment Controls

Value adjustment sliders are presented for up to three (3) scenario input slots. Such slots from one particular scenario are effected.

Up to three panels -- for each of the adjustable input slots -- are arranged horizontally. Each panel contains the following controls:

- Slot ID panel, including type icons and names of the containing object and the slot.
- A plot button to show a plot dialog with both the adjusted scenario slot values and its baseline slot values. If minimum and/or maximum limits are configured for the scenario slot, those limits are shown as horizontal markers in the plot. (*See the screenshot on the following page*).
- A slider panel -- of either the "scale" or "offset" type. Each includes:
 - A numeric field showing the value of the current slider position. The field is directly *editable*; editing the value sets the position of the slider.
 - A horizontal slider control.
 - Three numerically labeled buttons -- *see description below*.
 - *For the "offset" type only*: a unit indication.





The Scale sliders are exponential. The range is based on the upper value set by the scenario engineer. The lower limit of the range is the *reciprocal* of the specified upper value. The mid-point is always "1", which results in no difference from the baseline slot values. Note: although the scale slider bar's positions are interpreted exponentially, the slider's tick marks are evenly spaced; this is a limitation of the Qt4 slider widget.

The Offset sliders are linear, and range from the negative value to the positive value of the adjustment limit value set by the scenario engineer. The mid-point is always "0", which results in no difference from the baseline slot values. The Offset values are in the slot's display units. Note that offsets are applied in user-units -- so, in the case of

irregular time units such as "*acre-feet per month*", the adjustment to the underlying standard values (e.g. "cms") is different depending on the month or year in which the timestep occurs.

When a slider bar has "focus" (e.g. after it has been clicked), the slider "thumb" can be stepped by a small amount by pressing the right or left arrow keys. Holding down those arrow keys for about one second causes them to repeat, effectively animating the motion of the slider thumb and resulting value.

The three numerically labeled buttons below the slider function both as a slider "value key" and controls to set the slider to the corresponding positions. The middle position represents the "null transform" for each of these functions, 1.0 and 0.0 respectively for "scale" and "offset".

The actual computation of the scenario input slots from the baseline slots -- as a linear function using the scale or offset values -- occurs generally after the slider has stopped moving for about half a second. Any plots, Open Slot Dialog or SCT showing the scenario input slot's values are dynamically updated to show the new computed values.

The computed scenario slot values are "clipped" at the configured minimum and maximum values for the baseline slot -- if those have been configured. *This is not considered an error condition.*

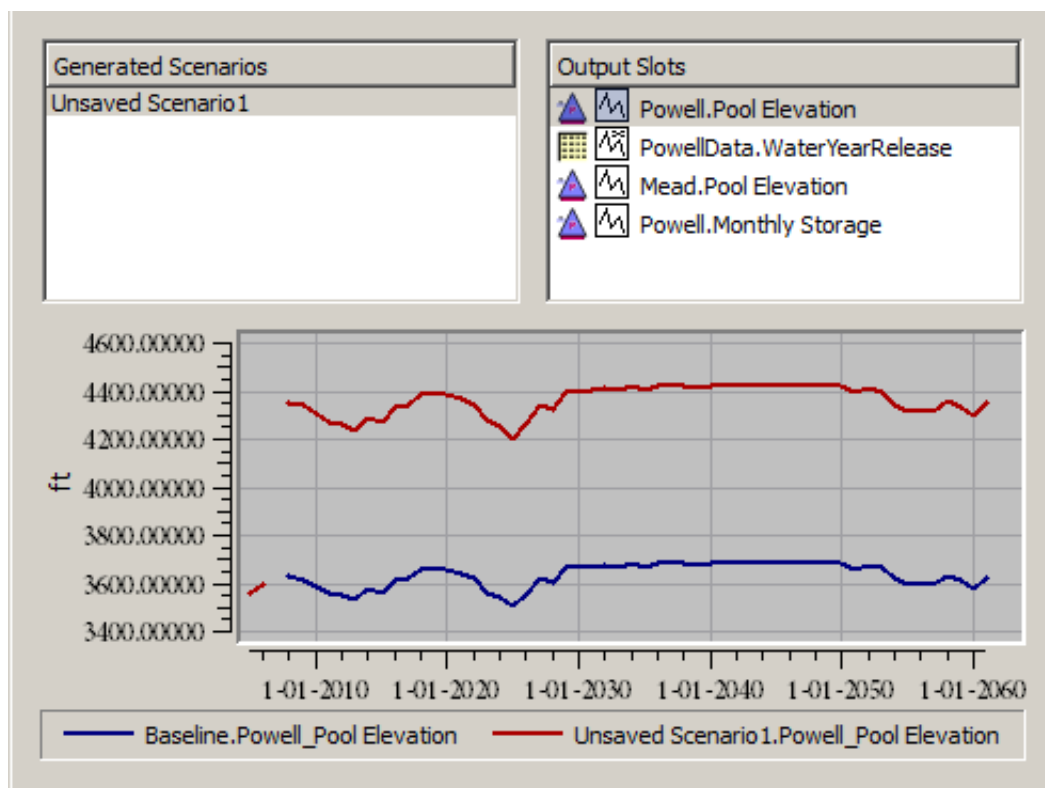
Note that these minimum and maximum values should not be confused with the adjustment limit values which apply to the *coefficients* of the linear adjustment transform function. These minimum and maximum values are applied to the *results* of that function.

3.5 Scenario Playbox: Output Plot Controls

The bottom section of the Scenario Playbox shows generated scenario results (outputs), in the form of a plot. It consists of three components:

- A list of the generated scenarios -- supporting *multiple* (technically, in Qt, "extended") item selection.
- A list of the playbox's scenario output slots -- supporting *single* item selection.
- A "slot plot" (similar to that shown in the Plot Dialog), including the curve legend below the plot.

The slot plot is dynamically updated as the selections in the two lists are changed. A curve is shown for each of the selected scenarios' copies of the single selected output scenario slot. A curve for the baseline slot is always shown.



Scenarios for which a scenario snapshot object has not yet been generated are shown as *disabled* in the Generated Slots list. Double clicking an item on the Generated Scenarios list shows the Open Object Dialog for that snapshot.

Context menu operations in the Output Slots list are provided to show the selected slot -- in the selected generated scenarios, plus the baseline -- in an SCT.

Using a context menu operation, the plot can be copied and pasted into any of the plot panels (of which there can be nine, arranged in 3 rows and 3 columns) within a plot page.

4.0 Development Tasks

Many aspects of the GUI have been developed in the process of preparing this design document. (Only a few of the screenshots presented in this document have been edited). The data model required to support playbox configurations and new required scenario data has not been implemented.

This iteration of Scenario Playbox development is intended to provide usable and sufficient capabilities for basic use. Refinement of these features may be considered in the future.

4.1 Snapshot Manager / Scenario Output Slot List / Snapshot Objects

- The Scenario Output Slot Template is a second, special instance of the Snapshot Manager's slot template. Both of these slot lists need to persist in the RiverWare model.
- A new persistent property of the Snapshot Object class is needed to indicate the template from which the snapshot was generated. This is needed because, in the Snapshot Manager, the enumerated snapshot objects (shown in the right-side panel) are those corresponding to the selected "Template" radio button.

4.2 Generation of Scenario Output Snapshot Objects

- When generating a snapshot object, the correct template (slot list) needs to be used.
- In the case of use of the Scenario Output Slot Template, parts of the process of creating and maintaining the snapshot object and its slots needs to be rewritten: already existing objects and slots need to be reused rather than generated anew. (The "classic" snapshot mechanism always creates a new, uniquely named snapshot).
- Also, in the case of use of the Scenario Output Slot Template, automatically generated comment lines characterizing the differences of scenario slots from their corresponding baseline values need to be generated.
- At the end of a successful standard run (in a non-baseline model), if there are any slots defined in the Scenario Output Slot Template, a "Baseline" scenario output snapshot object needs to be generated or updated.
- At the end of a successful scenario run (in a baseline model), a scenario output snapshot object having the same name as the active scenario needs to be generated or updated.

4.3 Persistence of a Scenario's Output Snapshot Object in the Scenario File

When saving and loading a Scenario to or from a Scenario File, a single simulation object record for the scenario's output slot snapshot needs to be written or read. When loading, if a snapshot object having the same name currently exists on the RiverWare workspace, that object is first deleted.

4.4 Scenario Playbox Configuration

The GUI for this configuration dialog, including supporting selector popup dialogs has been substantially completed.

Remaining tasks include:

- Definition and basic implementation of the Scenario Playbox Configuration class.
- Persistence of a single instance of this class in the RiverWare model.
- Integration of this data model with the existing "mockup" GUI implementation.

As with the configuration dialog, much of the actual *playbox* GUI has been implemented. Remaining tasks for completion of the playbox are described in subsequent sections

4.5 Scenario Playbox: Input Adjustments

Included in the substantial completion of the scenario input slot adjustment user interface, implementation of “adjustment slider” arithmetic is done -- in particular, the exponential behavior of the *scale* slider. [That arithmetic is characterized on this webpage: <http://cadswes2.colorado.edu/~philw/2012/Scenarios/Design/SliderScrollFormula.html>].

Remaining tasks include;

- Enhancement to the scenario slot data model to support persistent adjustment settings (scale and offset values). Persistence of these settings in the scenario file is required. (Although not initially used by any current functionality, copies of these values at the completion of a successful scenario run should also be maintained -- in parallel with the generated scenario output slot snapshot).
- Loading of adjustment controls from the playbox configuration and the current scenario input adjustment values. One, two, or three slot adjustment panels will be managed (depending on the set of input slots included in the playbox configuration).
- Recomputation of the scenario slots’ values as a parameterized adjustment function on the corresponding baseline shots. When irregular units are used (having an irregular per-time factor), this function must be applied to user-display values (not internal standard values).

4.6 Scenario Playbox: Output Functions

The dynamic generation of the plot panel’s traces based on “mocked up” representations of the Generated Scenarios and Output Slots *selections* has been provisionally implemented. Also, the necessary timer-based plot performance optimizations have been implemented to reasonably support rapid repeated plot generation.

Remaining tasks include:

- Updating the current mockup-up code to make use of the proper scenario output snapshot slots.
- Addition of context menus and their operations for items in the Generated Scenarios and Output Slots panels, e.g. to show open object dialogs, slot dialogs, and SCTs for the relevant snapshot and slot data.

4.7 Scenario Playbox: Model Run Issues and Workflow Testing

Various setup behaviors, and testing. For example, the currently selected “Adjust Input Slots for Scenario” combo box value (a scenario selection) needs to be made the “Active” scenario. However most of the required “Run” behavior is independent from the Scenario Playbox -- for example, the generation of scenario output slots at the completion of a scenario run is performed at a lower level -- see development task 4.2, above.

5.0 Development Estimates

Development estimates made on 2-1-2013 (Phil).

Sect	Estimate [Days]	Description
4.1	1.5	Snapshot Manager / Scenario Output Slot List / Snapshot Objects
4.2	3.0	Generation of Scenario Output Snapshot Objects
4.3	0.5	Persistence of a Scenario's Output Snapshot Object in the Scenario File
4.4	2.0	Scenario Playbox Configuration
4.5	3.0	Scenario Playbox: Input Adjustments
4.6	1.0	Scenario Playbox: Output Functions
4.7	2.0	Scenario Playbox: Model Run Issues ... and workflow testing.
	13.0	TOTAL [Days] (estimated 2-1-2013)

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