Smart Links Tool - Requirements

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1.0 Motivation

Water quality (salinity) is being added to the groundwater object for the URGWOM team. The proposed functionality includes the addition of 8 links for each direction of the groundwater object. Thus, there could be more than 32 links to a single groundwater object. Currently, each of those links would need to be created by hand using the right-click context "Quick Links" menus or the Link Editor. This is very time consuming, error prone, and inefficient.

Also, in general, linking in RiverWare is too flexible. There are only a small subset of slots that should be linked between any two objects. The user should be provided with more guidance on which links should be created.

Because of these two motivations, a more user friendly and efficient way to link slots will be added to RiverWare. This document presents the desired user process, functional requirements, development areas and examples of commons slots that are linked.

2.0 User Process

Following are the steps the user takes to create links between two objects using the Smart Links tool:

1. The user adds groundwater and other objects to the workspace.
2. The user selects the necessary methods on each object.
3. The user chooses two objects on the workspace that are to be linked and uses a menu or tool bar button to initiate the Smart Links.
4. For certain objects with certain methods selected, the user must specify the directional relationship of the two objects, i.e. Upstream/Downstream or Left/Right.

   A general example is a Reservoir and a Reach. The user must say that the downstream side of the reservoir is to be linked to the upstream side of the reach. (The resulting link would be Reservoir.Outflow <---> Reach.Inflow). Alternatively, the user could specify that the downstream side of the reach should be linked to the upstream side of the reservoir. (The resulting proposed link would be Reach.Outflow <---> Reservoir.Inflow).
5. Based on the orientation and the two object's method selections, there is a set of slots that should be linked as enumerated in Section 5.0. Beside each proposed link, there is a toggle for the user to un-check links that are not desired; all are initially selected.
6. The user confirms the operation and the link tool creates the links and closes.

3.0 Additional Requirements

Following are additional requirements of the **Smart Links** tool:

- A linking operation is always started by first choosing objects on the workspace. Some special handling will be necessary for aggregate objects. The user must be able to link both the aggregate (E.g. Lumped Agg Diversion site to Agg Reach) and individual elements (No Structure Agg Diversion Site Water User Element link to Agg Reach Element)
- The Smart Links tool is accessed from the workspace by clicking on a menu, icon, or right click context menu. It is always available and there are three possible results of choosing it, depending on the objects selected:
  - If exactly 2 objects are selected and there are links that can be created or that already exist, the Smart Links tool opens.
  - If 0, 1, 3, or more objects are selected, a message is posted that “Smart Links not available for n objects. Please select exactly 2 objects”
  - If 2 objects are selected, but there are no available Smart Links, a confirmation dialog pops up and says: “Smart Links not available for the two selected objects. Use the Link Manager or right-click Quick Links to create desired links”
- The Smart Link dialog is modal.
- A new icon is needed for the Smart Links tool. This new icon/button should replace the existing tool bar link icon on the workspace toolbar.
- The existing **Edit Link** dialog (i.e. the Link Editor) will be left in place initially but may soon be deprecated.
- The user should also be able to delete multiple links in one operation. That is, the user can select two linked objects, open the **Smart Links** tool and click a button to delete all or some of the links.
- The underlying data structure of possible links should not reside on each Engineering Object bus should reside on the Link Manager. The structure should be easy for a Water Engineer to add desired links as methods are created. See section 5.5 for the proposed dictionary structure.
- Only Slots with the same Unit Type may be linked.
- If there is one or no directionality between the two objects, then the user will not have to specify a direction setting. It will be automatic.

4.0 Development Areas

There are three main tasks to implement the above requirements. Each requires additional design and discussion. The three areas are:

- **Data Structure**: Underlying software mechanism and data structure (SW Engineer)
- **User Interface**: Smart Links dialog, menu, etc (SW Engineer)

- **Slots to Link**: Determine which slots to link for each object, method, and orientation (Water Engineer). The next section describes example links and a proposed data structure.

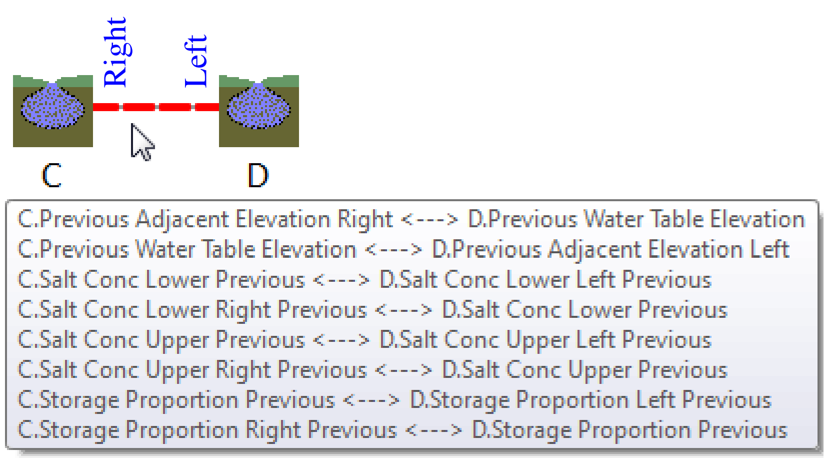
5.0 Slots to Link

The slots to link are based on the selected objects, their method selections, and the specified orientation of the two objects. Following are some common examples of sets of objects where more than one link is created and this tool would be especially useful.

5.1 Groundwater

Groundwater objects can be set up in a grid and the solution is based on the head differential between adjacent (i.e. linked) objects. To use this approach, the user chooses the **Head Based Groundwater Grid** method in the **Solution Type** category (these category and method names have been newly changed for 6.3). They then choose the directions in which they wish to link using method selections. The **Lateral Link Direction** category contains methods that are the permutations of Upstream, Downstream, Left and Right. That is, there are 16 methods representing each possible combination of directions, E.g:

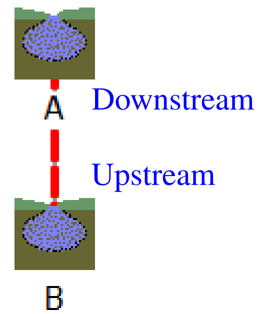
- Upstream
- Upstream and Downstream,
- Upstream and Left,
- Upstream and Right,
- Upstream, Downstream, and Right
- Upstream, Downstream, and Left
- ...



In the figure, C has **Right** selected and D has **Left** selected. If there were other objects in the system that were intended to be linked to C, then C would have to have one of the other methods selected: Upstream and Right, Right and Left, etc... Basically any of the "Right" methods would have to be selected. It is the same with D, any of the left method could be selected for these links to be made.

When these methods are selected, there are two elevation links to create. If Layered / Discretized Salinity is selected, there are 6 additional links to create as shown above.

The relationships are either upstream/downstream OR left/right but not both. The direction is relative to that object, not the relative position of two objects; this is often confusing. For example, the downstream side of A is to be linked to the upstream side of B. Or the right side of C to be linked to the left side of D.



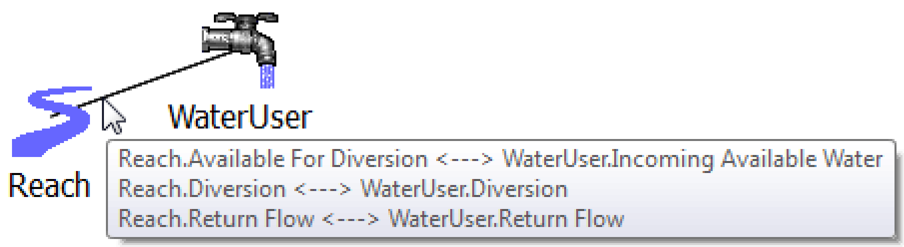
The Groundwater object's **Inflow From Surface Water** is also be linked to a Reach or Distribution Canal to model seepage from the surface. Return flows can be linked to the groundwater object's **Inflow From Surface Water** from various objects. The table presented in section 5.6 shows many (but not necessarily all) links to create between the groundwater and other objects.

5.2 Reach - Water User

A typical linking structure for a reach and a water user object is shown below. This occurs when the reach has the following method selections

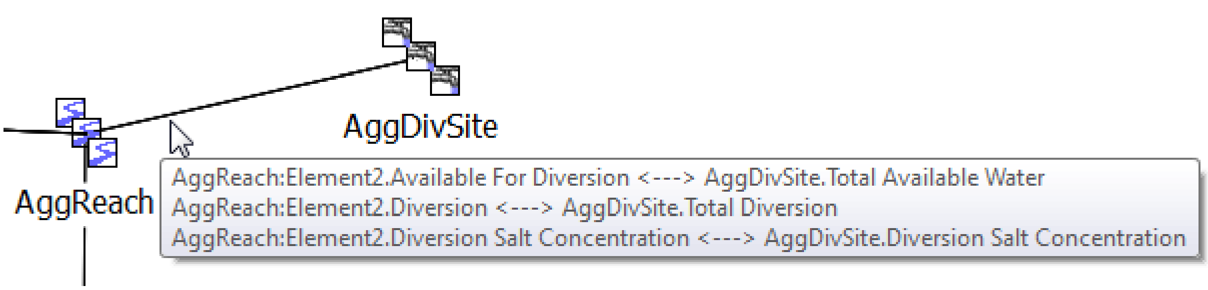
- **routingMethodCategory** category, **noRouting** method
- **Diversion from Reach** category, **Available Flow Based Diversion** method

The water user can have any **returnFlow-Calculation** method selected except the default **None** method.

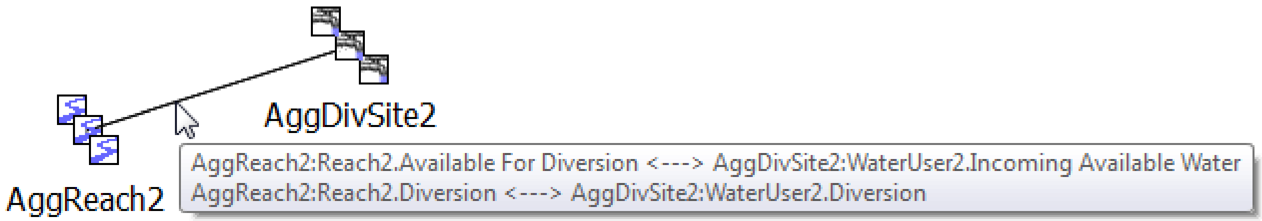


5.3 Agg Reach - Agg Diversion Site

The linking tool must be able to link slots on the elements as well as link slots on the aggregate. The first screenshot below shows the elements of the agg reach linked to slots on the AggDivSite (the aggregate, not the element). AggDivSite uses the **lumpedStructure**. The structure is chosen from a menu (**LinkStructure**) on the aggregate diversion site; in the code it is treated like a method selection.



The next screenshot shows slots linked on the individual elements, not the aggregate. In this case, AggDivSite2 is set up to use the **noStructure** linking structure.

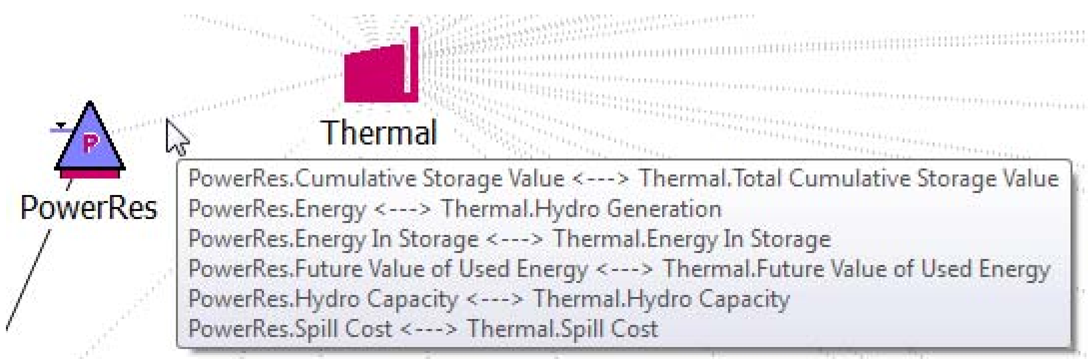


5.4 Power Reservoir - Thermal Object

In optimization models, the Thermal object is used to aggregate information from reservoirs and other power productions objects (all 4 types of reservoirs and Inline Power Plants) via multi-slots. Following is a sample of the links that are created between a power reservoir and the thermal object. In this case, the power reservoir has the following methods selected that require these links:

- **powerCalculationCategory**, **plantPowerCalc** method
- **Energy in Storage** category, **EIS Table Lookup** method
- **FutureValueCalcCategory**, **CalculateFutureValue** method

The Thermal object does not have any methods selected that affect the links; all the linked slots are general slots.



5.5 Preliminary Data Structure

Based on these samples links, the data structure for the slots to link should contain a dictionary (in the Link Manager Library) with the following components:

	Component	Description	Sample
1	Object 1 Type	The SimObj Type of Object 1	Groundwater Storage
2	Object 1 Method Set	The category/method to which the slots listed in component 7 depend	Head Based Groundwater; Layered Salt
3	Object 2 Type	The SimObj Type of Object 2	Groundwater Storage; Reach
4	Object 2 Method Set	The category/method to which the slots listed in component 7 depend	Head Based Groundwater, Layered Salt

	Component	Description	Sample
5	Object 1 Side to Link	The side of Object 1 to link. This is an optional field; if there is no direction filter it will not be shown to the user. The chosen side of Object 1 determines the side of Object 2, see samples.	Left (to Right); Right (to Left); Upstream (to Downstrean), Downstream (to Upstream); None
6	Link Set Name	The name that will be presented to the user for this group of links. Perhaps if there is only one link, then there is no name.	Elevations; Salinity
7	Sets of {SlotName, SlotName} to link	The set of slot pairs representing the proposed links to create.	{{Elevation Right Previous, Elevation Previous}, {Elevation Previous, Elevation Left Previous}}

The dictionary would be used as follows by the tool:

Given Object 1 and Object 2, the tool will search through the dictionary and find the entries that match the Object types and selected methods for both 1 and 2. Of those entries, the tool will present to the user the possible "Object 1 Side to Link" in a pulldown menu or otherwise. The side to object 2 is presented also but it is based on Object 1's side. The user chooses the desired side and the tool presents the user the sets of slot pairs to link, organized into groups labelled by "Link Set Name".

The user can then choose to create all/some/none of the links.

A sample of this type of dictionary is shown in the following table. The numbers in the first two rows correspond to the fields described above. These two rows would both be returned and the user would be presented with two groups of links: Elevations - 2 links and Salinity - 6 links.

5.6 Slots to Link Table

Following are the slots that should be linked based on object type, method selection, and directional relationship.

Object / Cat;Method / Direction / WQ	Links to Create	Object / Method / Direction / WQ
1.Groundwater / 2. Lateral Link Direction; Right and Left/ 5. Right	6.Elevations 7. Elevation Right Previous <---> Elevation Previous Elevation Previous <---> Elevation Left Previous	3. Groundwater / 4. Lateral Link Direction; Right and Left/ Left
1.Groundwater / 2. WQ Salt Connection; Right and Left 5. Right /	6. Salinity 7. Storage Proportion Previous <---> Storage Proportion Left Previous Storage Proportion Right Previous <---> Storage Proportion Previous Salt Conc Upper Previous <---> Salt Conc Upper Left Previous Salt Conc Upper Right Previous <---> Salt Conc Upper Previous Salt Conc Lower Previous <---> Salt Conc Lower Left Previous Salt Conc Lower Right Previous <---> Salt Conc Lower Previous	3.Groundwater / 2. WQ Salt Connection; Right and Left any Left

Object / Cat;Method / Direction / WQ	**Links to Create**	**Object / Method / Direction / WQ**
Groundwater / Head Based Groundwater / any **Left**	Elevation Left Previous <---> Elevation Previous Elevation Previous <---> Elevation Right Previous	**Groundwater** / Head Based Groundwater / any **Right**
Groundwater / Head Based Groundwater / any **Left** / **Layered Discretized Salinity**	All in previous row plus: Storage Proportion Previous <---> Storage Proportion Right Previous Storage Proportion Left Previous <---> Storage Proportion Previous Salt Conc Upper Previous <---> Salt Conc Upper Right Previous Salt Conc Upper Left Previous <---> Salt Conc Upper Previous Salt Conc Lower Previous <---> Salt Conc Lower Right Previous Salt Conc Lower Left Previous <---> Salt Conc Lower Previous	**Groundwater** / Head Based Groundwater / any **Right**/ **Layered Discretized Salinity**
Groundwater / Head Based Groundwater / any **Upstream**	Elevation Upstream Previous <---> Elevation Previous Elevation Previous <---> Elevation Downstream Previous	**Groundwater** / Head Based Groundwater / any **Downstream**
Groundwater / Head Based Groundwater / any **Upstream** / **Layered Discretized Salinity**	All in previous row plus: Storage Proportion Previous <---> Storage Proportion Downstream Previous Storage Proportion Upstream Previous <---> Storage Proportion Previous Salt Conc Upper Previous <---> Salt Conc Upper Downstream Previous Salt Conc Upper Upstream Previous <---> Salt Conc Upper Previous Salt Conc Lower Previous <---> Salt Conc Lower Downstream Previous Salt Conc Lower Upstream Previous <---> Salt Conc Lower Previous	**Groundwater** / Head Based Groundwater / any **Downstream**/ **Layered Discretized Salinity**
Groundwater / Head Based Groundwater / any **Downstream**	Elevation Downstream Previous <---> Elevation Previous Elevation Previous <---> Elevation Upstream Previous	**Groundwater** / Head Based Groundwater / any **Upstream**
Groundwater / Head Based Groundwater / any **Downstream** / **Layered Discretized Salinity**	All in previous row plus: Storage Proportion Previous <---> Storage Proportion Upstream Previous Storage Proportion Downstream Previous <---> Storage Proportion Previous Salt Conc Upper Previous <---> Salt Conc Upper Upstream Previous Salt Conc Upper Downstream Previous <---> Salt Conc Upper Previous Salt Conc Lower Previous <---> Salt Conc Lower Upstream Previous Salt Conc Lower Downstream Previous <---> Salt Conc Lower Previous	**Groundwater** / Head Based Groundwater / any **Upstream**/ **Layered Discretized Salinity**
Groundwater / Head Based Groundwater	Elevation Previous <---> Previous Water Table Elevation Inflow From Surface Water <---> Seepage	**Reach** / Head Based Seepage
Groundwater / Head Based Groundwater / Wetted Sand Evaporation	All in previous row plus: Wetted Sand Area Excluded <---> Surface Area	**Reach** / Pan Evaporation
Groundwater / Head Based Groundwater	Inflow From Surface Water <---> Seepage	**Reach** / Any non-head based seepage

Object / Cat;Method / Direction / WQ	Links to Create	Object / Method / Direction / WQ
Groundwater / Layered Discretized Salinity	Inflow From Surface Water Salt Conc <---> Seepage Salt Concentration	Reach / Any Seepage / Layered Discretized Salinity
Groundwater / Head Based Groundwater / Input Pumped Flow	Available For Pumping <---> Incoming Available Water Pumped Flow <---> Diversion	Water User
Groundwater / Layered Discretized Salinity	Pumped Flow Salt Concentration <---> Diversion Salt Concentration	Water User / Layered Discretized Salinity
Groundwater / Single Computed Outflow / Downstream/	Outflow <---> Inflow	Any Object / Upstream
Groundwater / Head Based Groundwater	Elevation Previous <---> Previous Water Table Elevation Inflow From Surface Water <---> Canal Seepage	Distribution Canal / Head Based Seepage
Groundwater / Layered Discretized Salinity	Inflow From Surface Water Salt Conc <---> Seepage Salt Concentration	Distribution Canal / Layered Discretized Salinity
Any Object / Downstream	Outflow <---> Inflow	Any Object / Upstream
Any Object / Downstream / Layered Discretized Salinity	Outflow <---> Inflow Outflow Salt Concentration <---> Inflow Salt Concentration	Any Object / Upstream / Layered Discretized Salinity