My Project

version 4.0

Author Name

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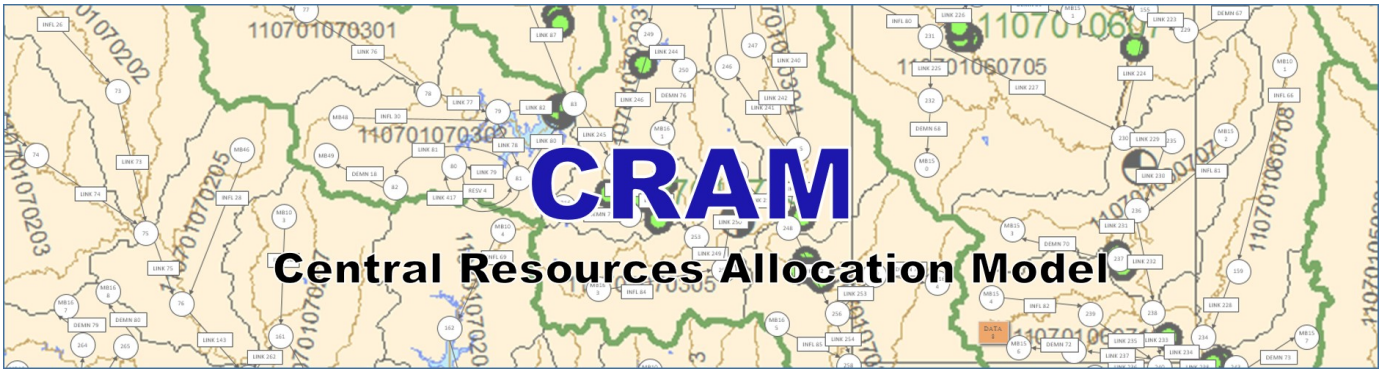
Contents

CRAM Documentation



CRAM is a water resources model used to support decisions for short, medium and long-range planning of a system's raw water supply. CRAM simulates all components of a system including reservoirs, water rights, wells, diversions, exchanges and more, through an intuitive drag and drop user interface. Whether your role is decision-maker, water resources manager, planner, engineer or accountant, CRAM will provide you with a more complete understanding of your water supply and demand, as well as how to optimize the use of this limited resource. CRAM is currently used by many cities, states and agencies throughout the United States for their water resources modeling and decision-making.

Guide

What Is CRAM

CRAM is a network flow model used to simulate water resources systems. It provides system optimization and simulation in the easy-to-use, familiar environment of Excel.

CRAM uses priority-based assignments applied to the physical constraints of a system to properly allocate water according to past, present or future operations. CRAM's interface allows users to build networks that represent real systems. The network is then forced by hydrologic time series (flow) at a consistent time step.

CRAM networks are constructed from several types of active elements, connected by nodes. There are 8 types of active elements: Nodes, Links, Inflows, Demands, Decrees, Reservoirs, Instream Flows, and Return Flows.

Water enters the network through inflows. Like a real system, all the water that enters the system plus any change in storage at reservoirs in the system must be equal to outflows (such as through demands or links that represent river reaches that leave the study area) and losses (such as evaporation or losses to groundwater.) CRAM automatically enforces mass balance.

When CRAM solves the network, it supplies water first to those elements with the highest numerical priority, subject to any constraints, such as physical availability and capacity constraints. This makes CRAM highly suitable for analyzing systems where water rights must be administered in priority, or operations involve prioritized targets.

Applications

CRAM is used by many cities, states and agencies throughout the United States for their water resources modeling and decision-making. Some typical applications include:

- Simulate municipal water supply
- Evaluate changes in water demand
- Evaluate the effects of capital improvement projects
- Water allocation by water rights (prior appropriation)
- Evaluate climate change scenarios
- Manage water use within a watershed
- Evaluate water rights
- Simulate water resources facilities and their operations

Features

- Interactive user interface
- Reservoir operations
- Trans-basin diversions
- Minimum flow requirements
- Return flows
- Groundwater
- Advanced “What-If” scenario analysis capabilities

Under the Hood

CRAM optimizes systems while preserving mass balance using what is known as a circulating network. It solves the minimum-cost flow problem using the Out-of-Kilter algorithm, where flows (or some quantity) are solved for while minimizing costs.

CRAM runs within Excel, utilizing its graphics, spreadsheets and VBA code to create a familiar user interface.

Model Basics

Network Elements

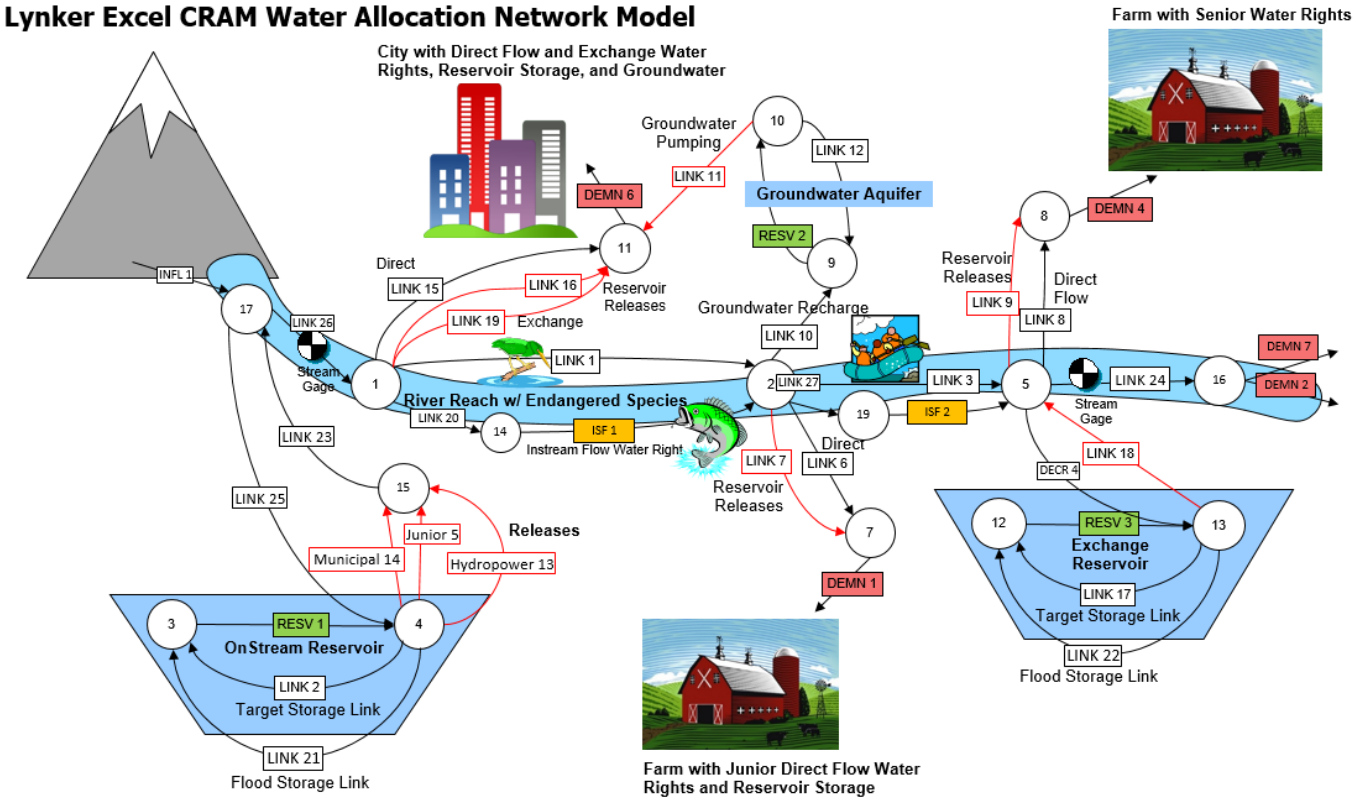
CRAM uses 8 types of objects to represent real-world systems.

- **Nodes:** Nodes are general-purpose elements within the model network. They are used along with links to build a model network that represents a real-world system. Mass balance nodes are a special type of node added automatically by CRAM. They are connected to inflows and demands and are used to maintain mass balance.
- **Links:** Links are general-purpose elements most often used to simulate rivers or canal reaches. They are also used as arbitrary connectors between two nodes.
- **Inflows:** Inflows represent flow into a network. They are frequently used to represent a raw water supply such as a river.
- **Demands:** Demands represent flow out of a network. They are frequently used to represent withdrawals from a system such as a diversion ditch or water right.
- **Reservoirs:** Reservoirs represent storage within a system. They are more complex than other network elements, requiring nodes and links for proper configuration.
- **Decrees:** Decrees are used to model water rights. They can be used to represent the limits on total annual diversion to canals, to set annual filling limits on water rights into reservoirs, or to limit supplemental water to an annual limit without having to determine in which months it might be needed.
- **Return Flows:** Return flows represent water that leaves the surface water system at one location but then returns at another location and possibly another time.
- **Instream Flows:** Instream flows represent the minimum water that must be available in a river, for example to support fish health.

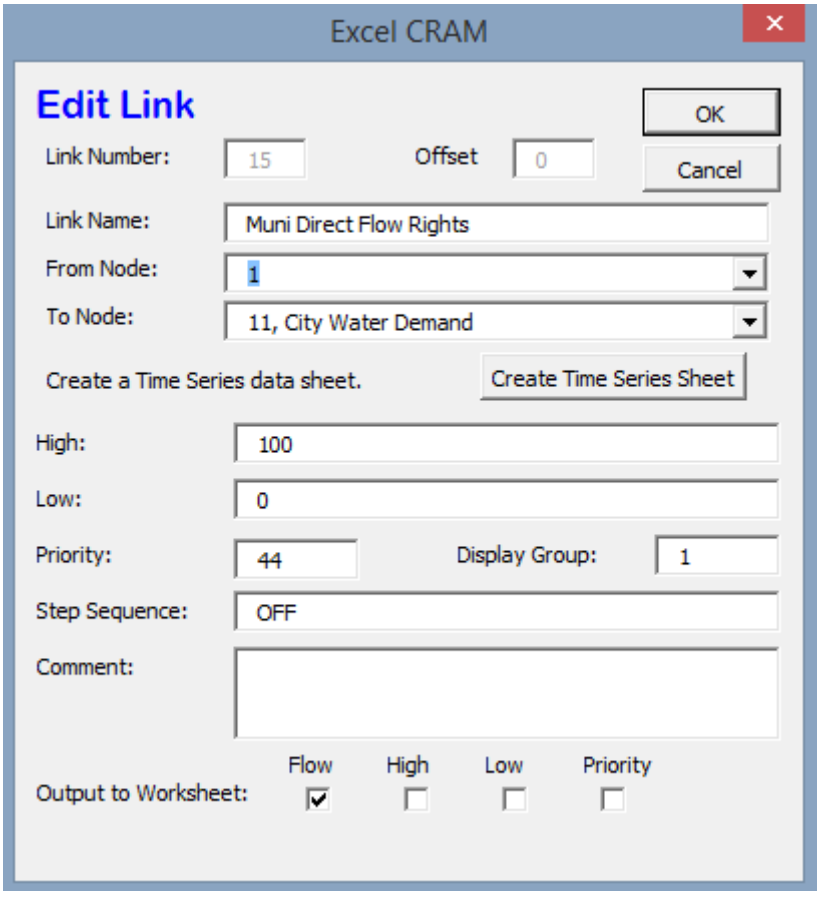
Data Objects are an additional type of model object that can be added to the network. They are used to track model output and do not affect the configuration or solution of the model. That is to say, Data Objects don’t connect with a To Node and From Node within the network.

The Network Schematic

The network schematic shows the physical connections in the model network. It is the user interface for CRAM, displaying a graphical representation of the links and nodes that represent the system. This includes inflows, reservoirs, demands, return flows, and groundwater use. **Click the image below for a full resolution network schematic.**



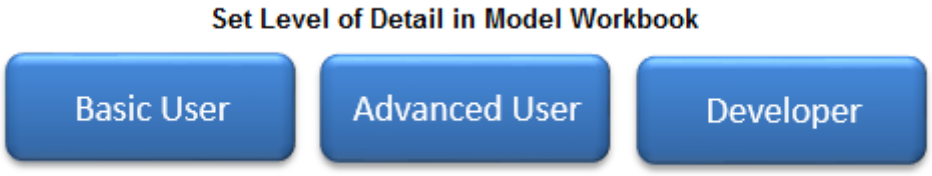
The network schematic is an interactive interface for building the model and editing model parameters. It allows the user to access most locations in the model. For instance, clicking on Link 15 opens a pop-up that lists the link name, how it's connected in the model (From Node, To Node), and the types of output it should have. **This is shown in the image provided below.**



The User Input Sheet

The user input sheet contains the settings for a model. This allows the user to run the model, set model parameters, and show additional model details to name a few. The complexity of this sheet is dependent on the complexity of the model.

The user sheet can set the level of detail in the model, with the “Basic User” hiding most model sheets as discussed in the CRAM Worksheet Names section. The “Advanced User” reveals the timeseries data sheets within the model and “Developer” mode unhides all of the sheets in a model workbook.



Time Steps

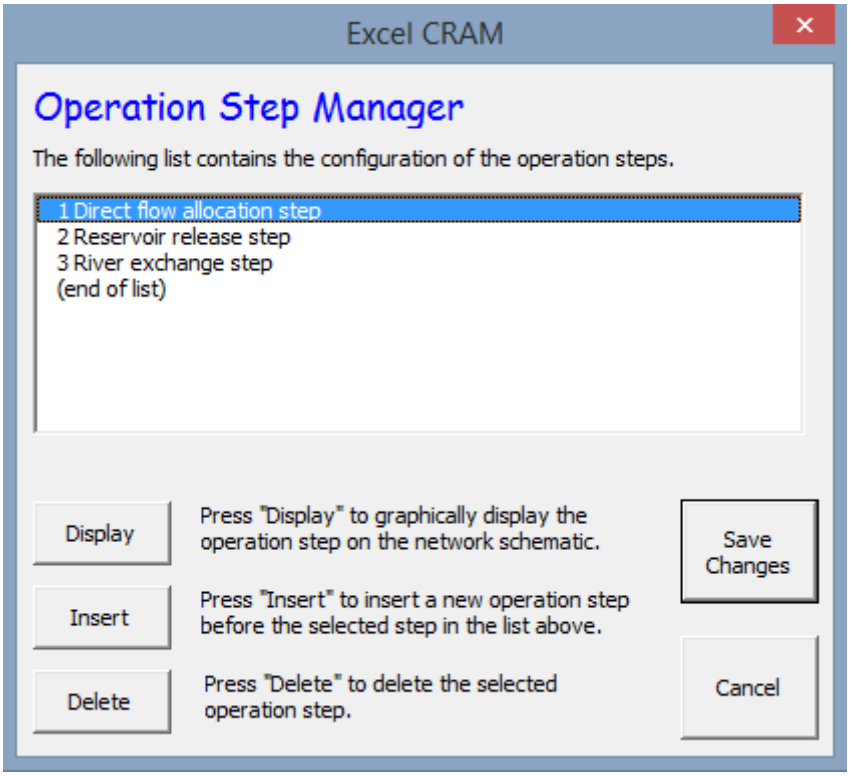
CRAM can be operated at any time step; however, daily, weekly, and monthly are the most common.

CRAM operates using a two time step hierarchy: the major time step and the minor time step. These two modeling concepts are used to represent real-world time periods. For example, a common model representation would be that the major time step represents years and the minor time step represents months.

The minor time step is where most of the work gets done - CRAM solves the network once or more at each minor time step. The major time step is a concept used to organize data for the minor time steps.

Operation Steps

Operations steps are used to build complex system operations that are often involved with water rights, reservoirs and exchanges. More information on the use of operation steps can be found in the Model Details documentation.



User Code

Since CRAM runs within Excel, VBA code can be used to check and changes values in the model while it is running. These functions allow the user to intercept the execution of the model at various points to allow the use of macros. This is useful for creating customized conditions based on complex system operations. More information on the user code can be found in the Model Details documentation.

CRAM Worksheet Names

Most of the CRAM model data (time series data, model parameters, network connections) are stored within Excel worksheets. The worksheets have been listed in the tables below based on their functionality within in the model. By default many of these sheets are hidden to users. This functionality can be changed via the Worksheet Dictionary.

Standard CRAM Sheets: This is the core functionality within CRAM. Do not rename or delete these sheets.

Sheet Name	User Level	Description
User Controls	Basic	Contains settings for the model, most recent run.
Network Schematic	Basic	Contains the Network diagram
Worksheet Output Template	Basic	Contains list of elements to export to output file.
Worksheet Dictionary	Basic	Controls sheet visibility.
Model Workbook Version History	Basic	Worksheet to track changes to model workbook. Manually updated by users.
Output Sheet	Basic	Worksheet to store model results for model run. CRAM raw output.

Internal CRAM Sheets: These sheets are hidden in the default “Basic User” settings. Do not rename or delete these sheets.

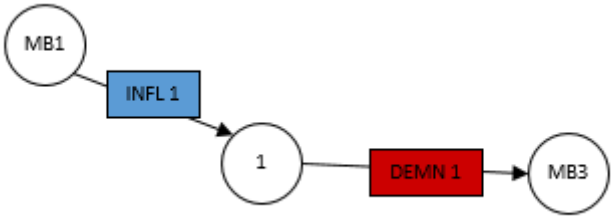
Sheet Name	User Level	Description
Global Data Sheet	Developer	Contains settings for CRAM model, global variables for model execution, most recent run and dialog box settings.
Node Sheet	Developer	Contains text data used in node dialog box.
Link Sheet	Developer	Contains text data used in link dialog box.
Inflow Sheet	Developer	Contains text data used in inflow dialog box.
Demand Sheet	Developer	Contains text data used in demand dialog box.
Reservoir Sheet	Developer	Contains text data used in reservoir dialog box.

Time Series Data Sheets: These sheets are automatically created by CRAM as the user builds the model. They are sequentially numbered by CRAM.

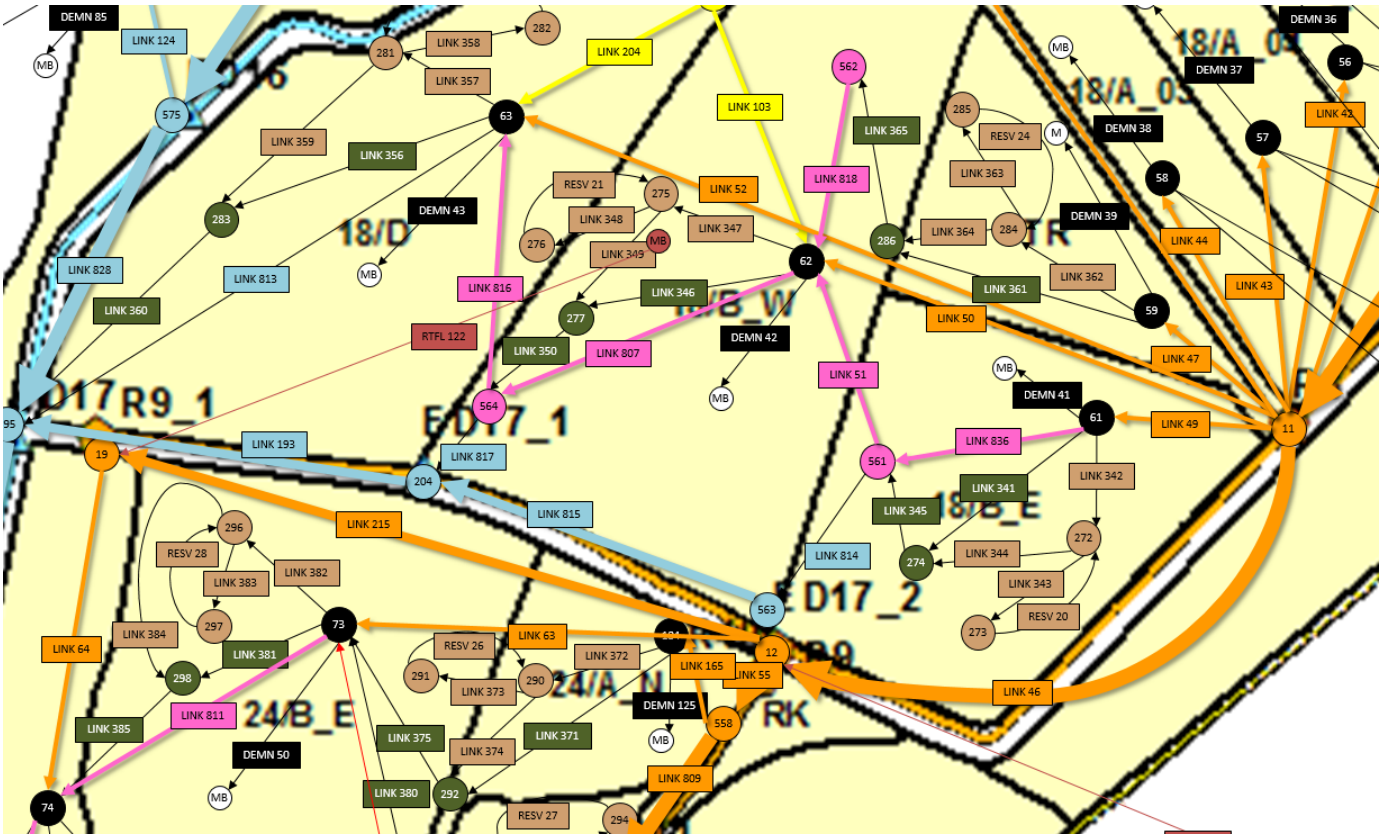
Sheet Name	User Level	Description
Link n	Advanced	Contains time series data for user defined link sheets.
Inflow n	Advanced	Contains time series data for user defined inflow sheets.
Demand n	Advanced	Contains time series data for user defined demand sheets.
Instream flow n	Advanced	Contains time series data for user defined instream flow sheets.

Creating a Network

In its simplest form, a CRAM network consists of a single node with one inflow and one demand. The inflow specifies the amount of water entering the system and the demand specifies the amount of water leaving the system. Because CRAM enforces mass-balance, all of the flow entering through the Inflow must exit through the Demand. If the demand has been constrained to a capacity less than the Inflow flow found in one of the minor time steps the model will determine that an infeasible solution has occured.



Most CRAM models will consist of a few hundred nodes connected by a larger number of links allowing water (flow) to be delivered to many different competing demands from a variety of sources. CRAM optimizes the system to determine the most efficient use of the water given the delivery constraints (both physical and administrative). After a solution has been attained, the user may want to experiment with additional stresses, constraints, or options on the simulation network. This is a core component of CRAM's scenario analysis.



The modeling tool supports reservoirs, instream flows, decrees, and return flows which can greatly increase the complexity of models. CRAM's operation steps allow modeling of the most complex exchanges and water rights. Please read the additional information about these features to be aware of "gotchas" that you may encounter when using the CRAM modeling tool. The blue note boxes provide tips that may be helful in avoiding modeling errors such as creating infeasible solutions.

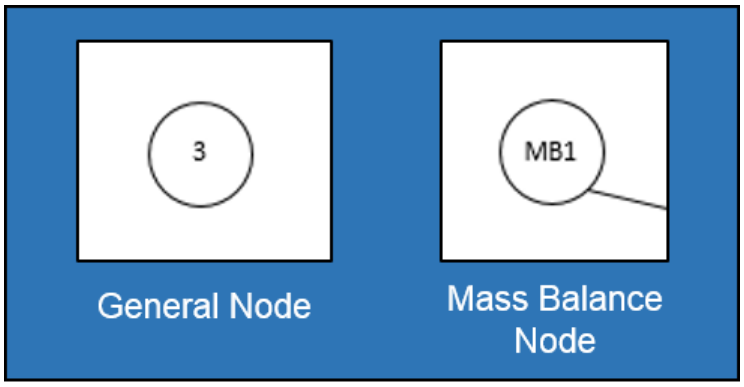
Adding a Node

Nodes are the basic building block of a CRAM network. Nodes are used to connect other network arc types (e.g., links, inflows, demands) and help determine the potential paths for flow in the model. There are two kinds of nodes in a model.

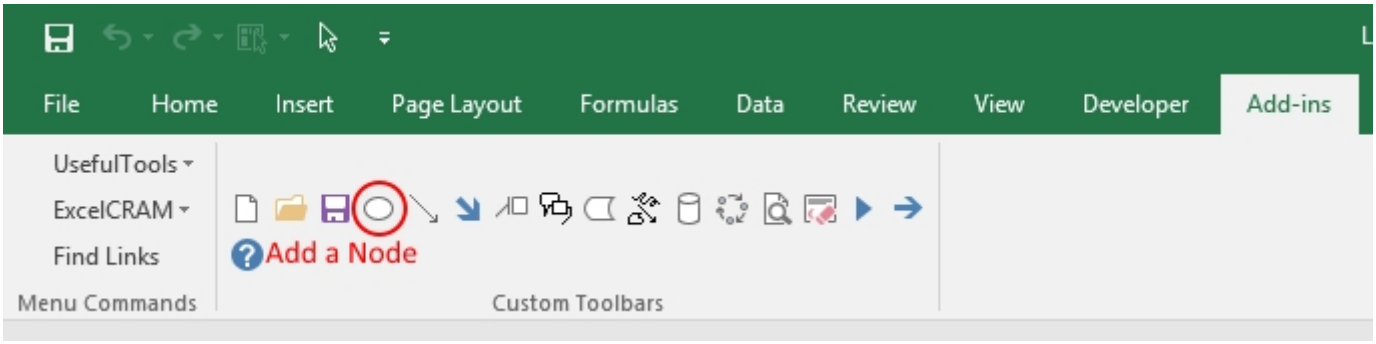
1. General nodes are nodes that have a single instance and physical location in the model. These are the types of nodes added to the model by the user. General nodes can be idetified by a circle with a number inside of it.
2. Special case nodes are related to mass balance. In each CRAM model there is one mass-balance node, but in the network diagrams (see The Network Schematic) it is represented in multiple locations. However, they all represent the same node in the model. For instance an inflow arc is attached from a mass balance node, while a demand arc is attached going-to a mass balance node. Mass balance nodes in the network schematic an be

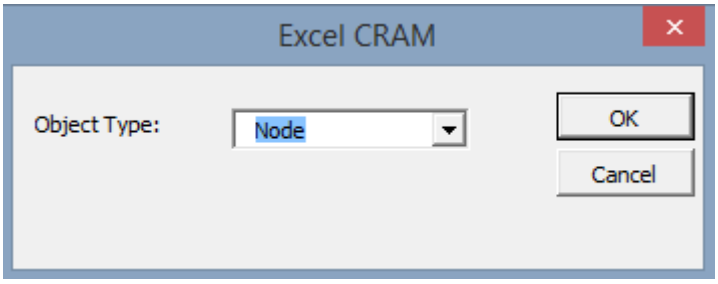
identified by the MB prefix before the node number. The MB node number is irrelevant, and simply used for book keeping. These are automatically added to a model network as needed by CRAM.

All nodes in the network maintain mass balance during every step of the solution.



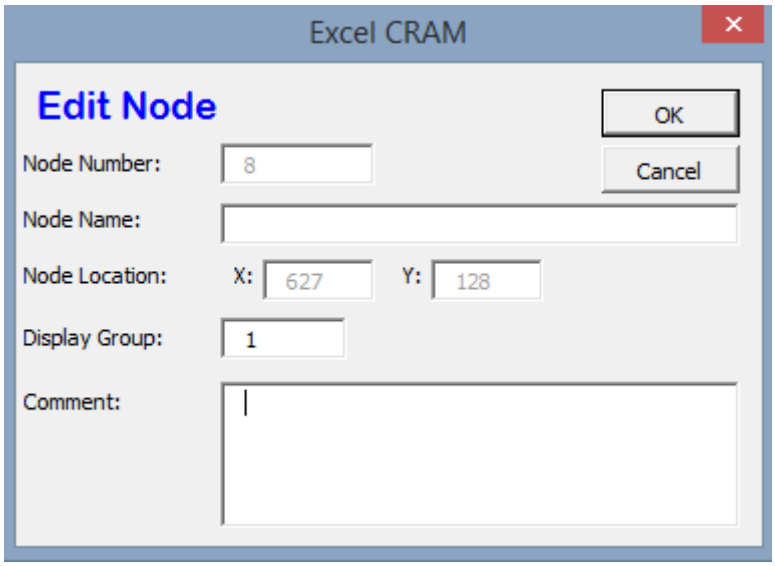
To add a node to the network click on the Create Node button on the toolbar (shown below) or click on the menu ExcelCRAM->Network->Add Object… menu item and select Node from the object type dropdown box.





Node Basics

The basic features necessary to add a model node are discussed in this section. Here we step through the fields on the **Edit Node** dialog box.



The **Node Number** is automatically assigned by CRAM. Nodes can not be reused in the network.

The Node Name is user-defined, and is typically left blank. If the Node Name is used, it must be an ASCII string (alphanumeric and/or special characters). A good example for a node name would be a stream gage name, location, or other geographic reference.

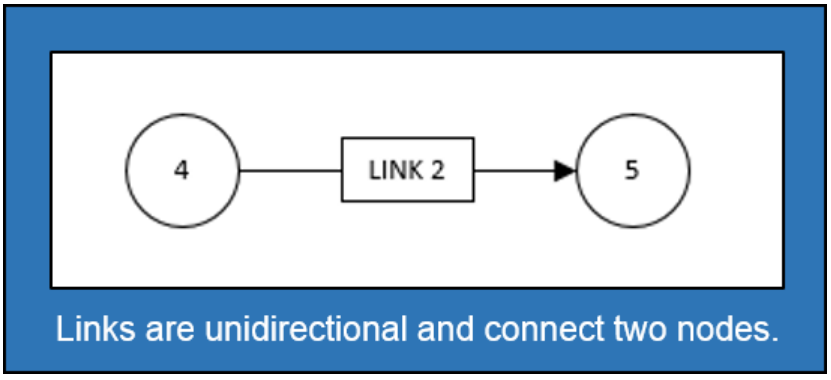
The **Comment** box allows the user to add any notes about the node that might be important to the design.

Advanced Node Setup

- The Display Group is set to “1” by default. The display group is an advanced feature that allows the user to hide network objects (nodes, links, etc.) in the network schematic. For more on display groups, see Model Details documentation.

Adding a Link

A link connects two nodes. It has four user configurable parameters which help determine the amount of flow passing from the “From Node” to the “To Node” in the model. The four parameters are:



1. **High:** The High parameter is the maximum amount of flow that can pass through the link in a single solution time step. Typically the default value of “Infinite” is used. However, integer values are commonly used to represent pipeline capacities.

Note

Advanced Note: *If the total amount of water at the From Node is greater than the sum of all High parameters on all arcs leaving that node, an infeasible solution will occur. Using the default value of “infinite” avoids this problem.*

2. **Low:** The Low parameter is the minimum amount of flow that MUST pass through the link in a single solution time step. Typically the default value of “0” is used.

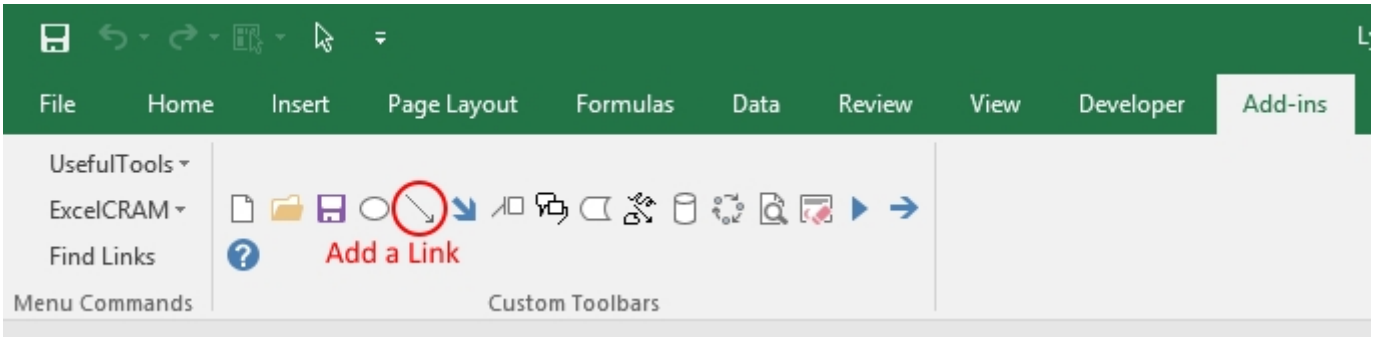
> ## Note
>
> *If the Low is set higher than the High parameter, an infeasible solution will occur. If the From Node for this link does not have as much flow into it as the sum of all of the Low parameters leaving that node, an infeasible solution will occur.*

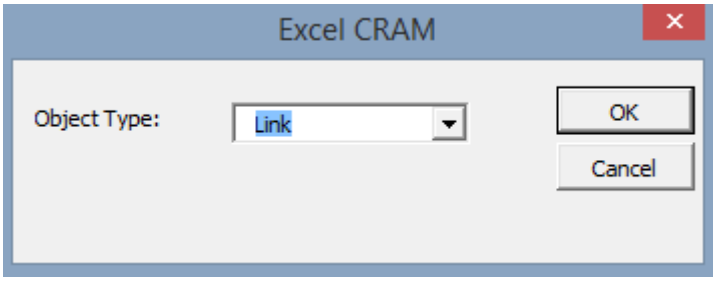
3. **Priority:** The Priority parameter helps the network to determine the relative priority of sending water through a link. Priorities (or ranks) in the network model are additive.

> ## Note
>
> *As a model becomes more complex, the additive values of different flow paths can become more complicated.*

4. **Flow:** The flow parameter is the optimized result of a model solution. The user is unable to change this value - it is model output only.

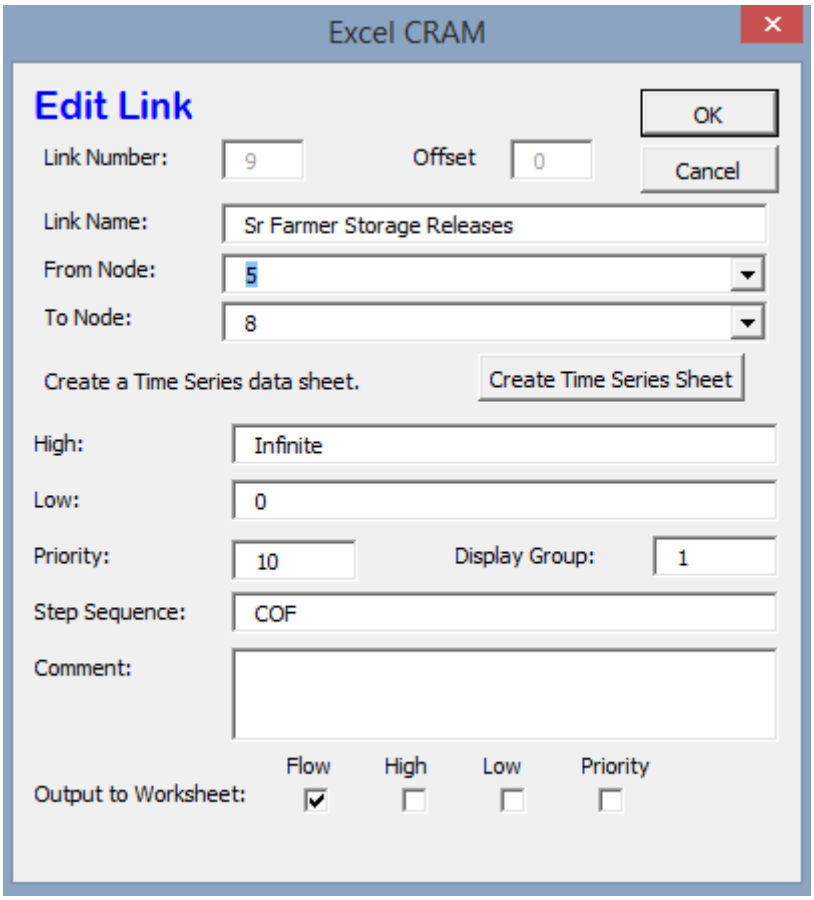
To add a link to the network click on the Create Link button on the toolbar (shown below) or click on the menu ExcelCRAM->Network->Add Object… menu item and select Link from the dropdown box.





Link Basics

The basic features necessary to build a model link are discussed in this section. Here we step through the fields on the **Edit Link** dialog box.



The **Link Number** is automatically assigned by CRAM. Link numbers can not be reused in the network.

The **Link Name** is a user-defined ASCII string that povide a common name to describe the reach. It is recommended that the name be unique within the first 32 characters but this not required. The name should normally be less than 256 characters in length.

The **From Node** identifies the node at the upstream end of the link.

The **To Node** identifies the node at the downstream end of the link. The To Node is where the flow from this link enters and mixes with all other sources (links).

Create Time Series Sheet/Go to Time Series Data button. This button has one of two labels on it. If the link being edited does not currently have any time series data associated with it, the button will read Create Time Series Sheet. Clicking on the button will create a formatted worksheet in the current scenario to hold timeseries data for the link. The user will need to populate the sheet with the appropriate data.

Note

Most links DO NOT have time series data associated with them. Links used to build advanced reservoirs are an exception to this.

The **High** field provides a space to specify a constant maximum capacity for the link. A value provided here will last for all minor time steps in a model run unless there is a Link Time Series Data sheet to override the value. A value of “Infinite” here indicates that the link does not have a capacity limit.

The **Low** field provides a space to specify a constant minimum flow for the link. A value provided here will last for all minor time steps in a model run unless there is a Link Time Series Data Sheet in the current scenario with the Low parameter specified there.

> **Note**
>
> *If a negative value is used in this field, water will flow "backwards" through the link generating a negative priority for each unit of flow transferred. This should be used with caution, and it is recommended the priority value is set to zero.*

The **Priority** field provides a space to enter the priority to be assigned to that link.

The **Comment** box allows the user to add any notes about the node that might be important to the design.

Advanced Link Setup

- The Display Group is set to "1" by default. The display group is an advanced feature that allows the user to hide network objects (nodes, links, etc.) in the network schematic. For more on display groups, see Model Details documentation.
- The Step Sequence allows you to enter the state of the element (Open, Closed, Frozen) for each operation step. More information can be found in Model Details documentation.

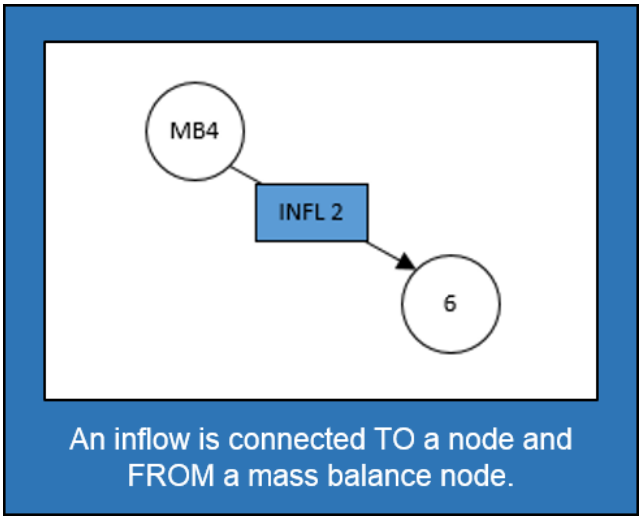
> **Note**
>
> *The default value is "O" for open. Other values should only be used by advanced CRAM users.*

- Output To Worksheet provides a list of check boxes for Link parameters that can be written to the output worksheet when the model is run.

Adding an Inflow

Inflows provide the source of water for an CRAM network. Once in the model the water (flow) is divided up among the demands based on the total priority of routing, from the inflow to the bottom of the network. Behind the scense, the model "circulates" the water using the mass balance nodes.

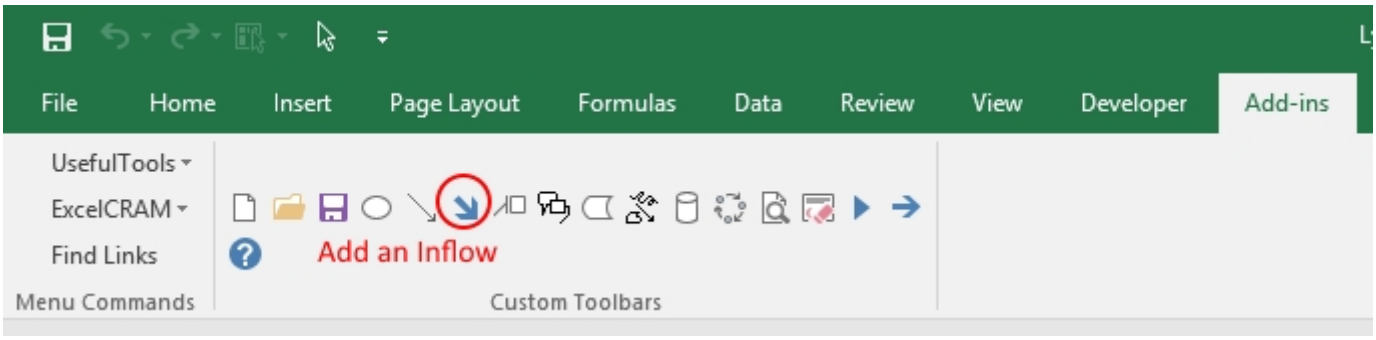
- An inflow can be connected TO any node (except a mass balance node)
- An inflow will always be connected FROM the mass balance node

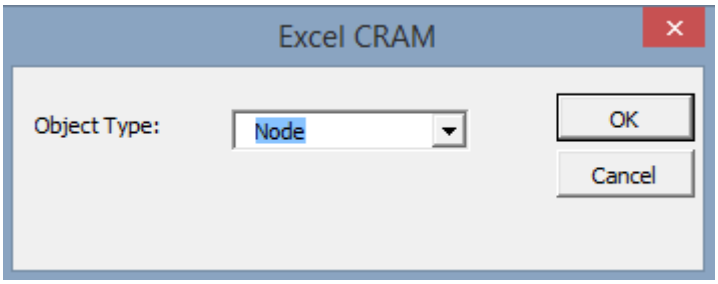


An inflow is connected TO a node and FROM a mass balance node.

Inflows only have one parameter, Flow. For Inflows, the Flow defines both the High and the Low on the arc. If the Flow from an inflow is not able to find a route through the network and back to the mass balance node an infeasible solution will occur.

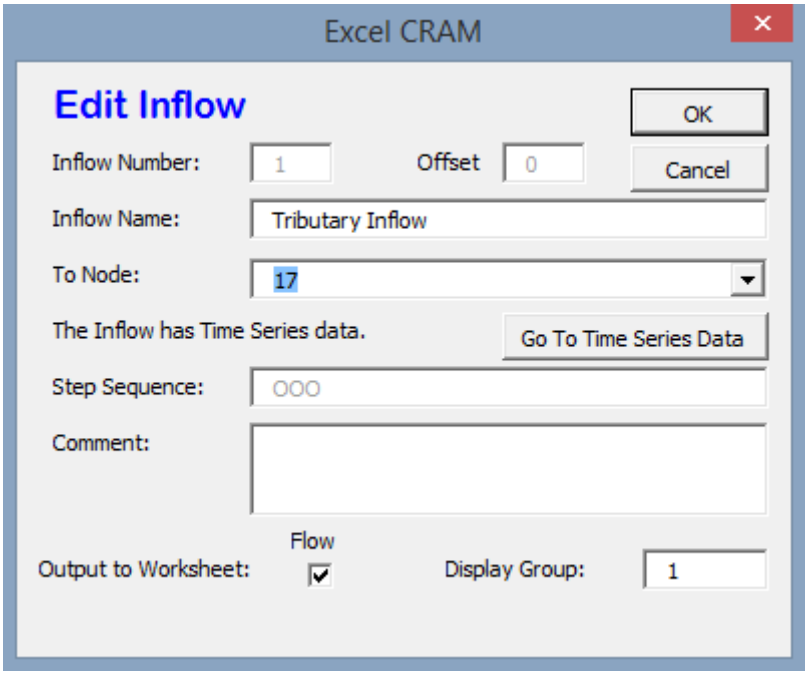
To add an inflow to the network click on the Create Inflow button on the toolbar (shown below) or click on the menu ExcelCRAM->Network->Add Object… menu item and select Inflow from the dialog box that appears.





Inflow Basics

The basic features necessary to add model inflows are discussed in this section. Here we step through the fields on the **Edit Inflow** dialog box.



The **Inflow Number** is automatically assigned by CRAM. Inflow numbers can not be reused in the network.

The **Inflow Name** is a user-defined ASCII string that povide a familiar name to describe the inflow. *Inflows are ALWAYS named by users within the model.* We recommend that the name be unique within the first 32 characters but this not required. The name should normally be less than 256 characters in length.

The **To Node** identifies the node at the receiving end of the inflow. The To Node is where the flow from the inflow enters and mixes with all other sources (links or inflows).

Create Time Series Sheet/Go to Time Series Data button. This button has one of two labels on it. If the inflow being edited does not currently have any time series data associated with it the button will read Create Time Series Sheet. Clicking on the button will create a formatted worksheet in the current scenario to hold timeseries data for the link. The user will need to populate the sheet with the appropriate data.

> **Note**
>
> *Inflows should always have time series data associated with them. Failure to create a Time Series Sheet will result in a zero inflow.*

The Comment box allows the user to add any notes about the node that might be important to the design.

Advanced Inflow Setup

- The Step Sequence specifies the operation steps to be used for this Inflow. More information can be found in Model Details documentation.

> **Note**
>
> *The default value is "O" for open. Other values should only be used by advanced CRAM users.*

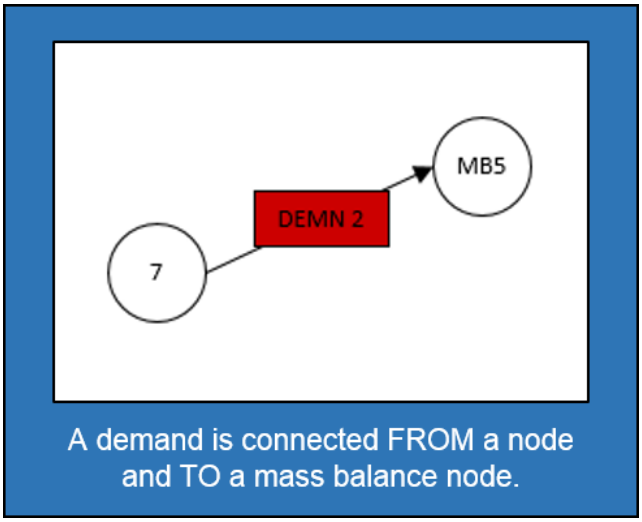
- The Display Group is set to "1" by default. The display group is an advanced feature that allows the user to hide network objects (nodes, links, etc.) in the network schematic. For more on display groups, see Model Details documentation.
- Output To Worksheet provides a list of check boxes for the Inflow parameter that can be written to the output worksheet when the model is run.

Adding a Demand

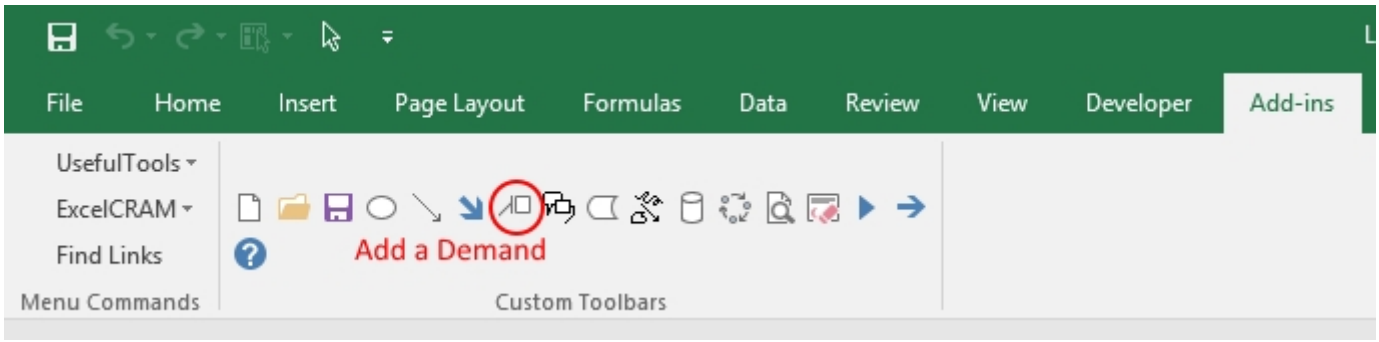
Demands are used to route water to specific users in the CRAM network (e.g., cities, farmers, ditches). The water that passes through a demand arc is not available for use anywhere else in the network during the same time step. Demands can be thought of as the final destination of water within the network.

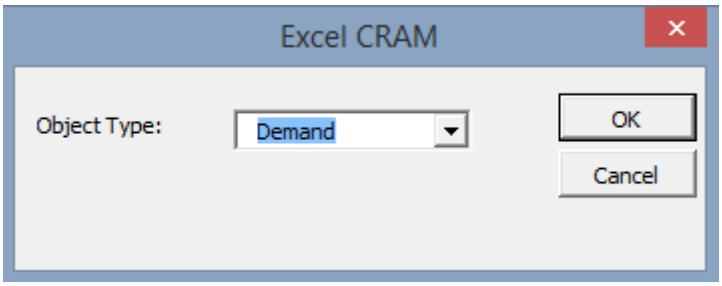
The capacity of a demand is determined by the High parameter while the minimum flow that must pass through a demand arc is set by the Low parameter.

- A demand can be connected FROM any node (except a Mass-Balance node)
- A demand is always connected TO a mass balance node



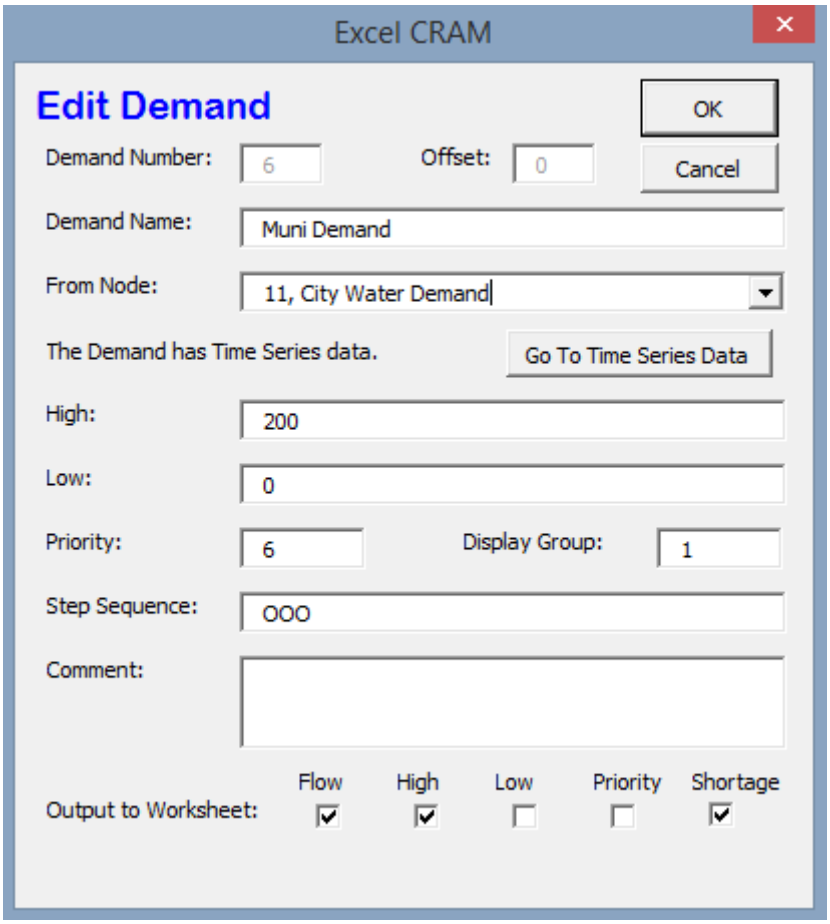
To add a demand to the network click on the Create Demand button on the toolbar (shown below) or click on the menu ExcelCRAM->Network->Add Object… menu item and select Demand from the dialog box that appears.





Demand Basics

The basic features necessary to add model demands are discussed in this section. Here we step through the fields on the **Edit Demand** dialog box.



The **Demand Number** is automatically assigned by CRAM. Demand numbers can not be reused in the network.

The **Demand Name** is a user-defined ASCII string that povide a familiar name to describe the demand. *Demands are ALWAYS named by users within the model.* We recommend that the name be unique within the first 32 characters but this not required. The name should normally be less than 256 characters in length.

The **From Node** identifies the node at the upstream or distributing side of the demand.

Create Time Series Sheet/Go to Time Series Data button. This button has one of two labels on it. If the demand being edited does not currently have any Time Series data associated with it the button will read Create Time Series Sheet. Clicking on the button will create a formatted worksheet in the current scenario to hold timeseries data for the link. The user will need to populate the sheet with the appropriate data.

> ### Note
>
> *Demands should always have time series data associated with them. Failure to create a Time Series Sheet will result in the demand having a default value of infinite.*

The **High** field provides a space to specify a constant maximum capacity for the demand. A value provided here will last for all minor time steps in a model run unless there is Demand Time Series Data Sheet to override the value. A value of “Infinite” here indicates that the demand does not have a capacity limit. This can be useful for creating a demand that will take all available flow in a network.

The **Low** field provides a space to specify a constant minimum flow for the demand. A value provided here will last for all minor time steps in a model run unless there is a Demand Time Series Data Sheet in the current scenario with the Low parameter specified there.

> ### Note
>
> *If the user sets the Low value higher than the available water in a time step an infeasible solution will occur. Non-zero low values should be used sparingly*

The **Priority** field provides a space to enter the priority assigned to that demand.

Advanced Demand Setup

- The **Display Group** is set to “1” by default. The display group is an advanced feature that allows the user to hide network objects (demands, links, etc.) in the network schematic. For more on display groups, see Model Details documentation.
- The **Step Sequence** allows the user to enter the state of the element (Open, Closed, Frozen) for each operation step.

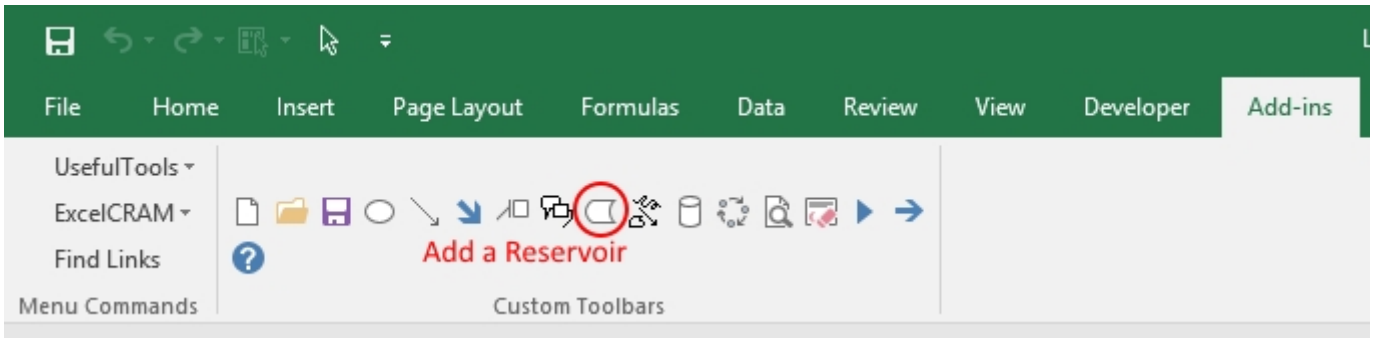
> ### Note
>
> *The default value is “O” for open. Other values should only be used by advanced CRAM users.*

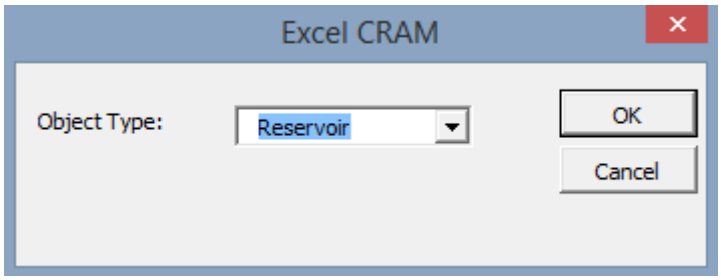
- The **Comment** box allows the user to add any notes about the node that might be important to the design.
- **Output To Worksheet** provides a list of check boxes for Demand parameters that can be written to the output worksheet when the model is run.

Adding a Reservoir

A CRAM Reservoir is used to simulate the storage of water in a reservoir. This network object may be used to represent either surface or groundwater storage systems. Reservoirs can be built to include complex operations such as hydropower, water rights exchanges, flood storage and dead storage.

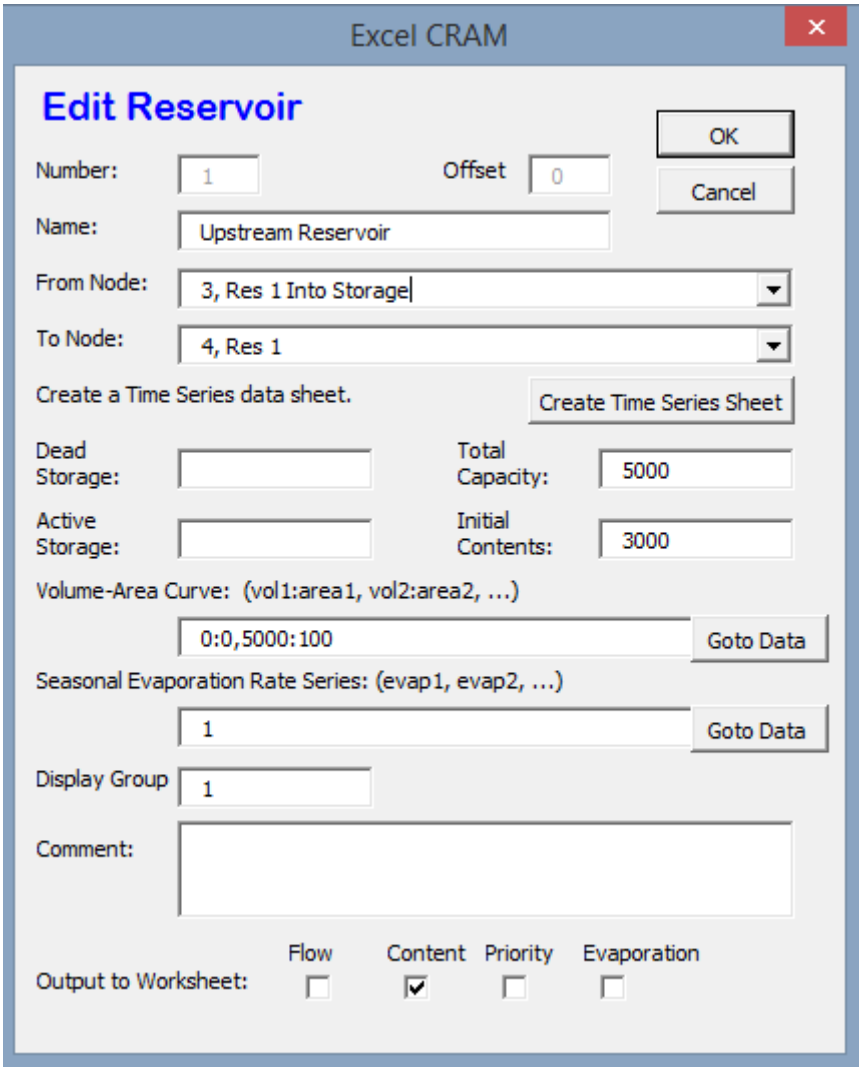
To add a demand to the network click on the Create Demand button on the toolbar (shown below) or click on the menu ExcelCRAM->Network->Add Object… menu item and select Demand from the dialog box that appears.





Reservoir Basics

The basic features necessary to add reservoirs are discussed in this section. Here we step through the fields on the **Edit Reservoir** dialog box.



The **Reservoir Number** is automatically assigned by CRAM. Reservoir numbers can not be reused in the network.

The **Reservoir Name** is a user-defined ASCII string that povide a familiar name to describe the reservoir. *Reservoirs are ALWAYS named by users within the model.* We recommend that the name be unique within the first 32 characters but this not required. The name should normally be less than 256 characters in length.

The **From Node** identifies the node at the upstream or distributing side of the reservoir.

The **To Node** identifies the node at the downstream end of the inflow. This node is where the flow stored by the reservoir in the previous time step (Minor Time Step) is released back to the network. A link from this node to the From Node will allow the reservoir to retain storage from one time step (Minor Time Step) to another.

Create Time Series Sheet/Go to Time Series Data button. This button has one of two labels on it. If the reservoir being edited does not currently have any Time Series data associated with it the button will read Create Time Series Sheet. Clicking on the button will create a formatted worksheet in the current scenario to hold timeseries data for the link. The user will need to populate the sheet with the appropriate data.

Note

Reservoirs usually do not have time series data associated with them. However, links that are a part of the reservoir, such as those used to represent target storage, usually do have time series data.

The **Dead Storage** is currently inactive.

The **Active Storage** is currently inactive.

The **Total Capacity** provides a place to record the total storage capacity of the reservoir. This can be either active storage or total storage depending on how you have decided to model the reservoir.

Note

The Total Capacity must be less than or equal to the maximum value added to the reservoir elevation-area-volume curve (data).

The **Initial Contents** provides a place to record the initial storage contents of the reservoir. This can be a variety of values (including zero), depending on how the reservoir is modeled.

The **Volume-Area Curve** contains pairs of numbers that describe the volume-area relationship for the reservoir. This table of numbers is used to calculate average surface area over a time step (minor time step) to calculate evaporation. The numbers for this field are entered in increasing order from the lowest volume to the reservoir's total capacity with the corresponding area following the colon. (i.e. 0:0, 100:40, 200:60 would represent a reservoir that had covered 40 acres when it contained 100 acre-feet (AF) and covered 60 acres when it contained 200 AF). Values between the points are linearly interpolated to determine volume and surface area. Using the previous example, 150 AF of water would correspond to 50 acres in surface area.

The **Seasonal Evaporation Rate Series** stores the evaporation rates as a series of comma delimited numbers. There should be one value for each minor time step in your model.

Note

There are 2 options for evaporation data. 1. Time series of reservoir evaporation (by Minor Time Step). 2. Annual reapeating evaporation values (by Minor Time Step).

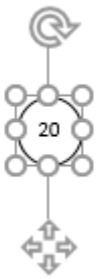
Advanced Reservoir Setup

- The **Display Group** is set to "1" by default. The display group is an advanced feature that allows the user to hide network objects (demands, links, reservoirs, etc.) in the network schematic. For more on display groups, see Model Details documentation.
- The **Comment** box allows the user to add any notes about the node that might be important to the design.

- **Output To Worksheet** provides a list of check boxes for Reservoir parameters that can be written to the output worksheet when the model is run.

Moving Objects in CRAM

When a new node is added to the model, it is positioned as close as possible to the last cell selected on the network schematic. The node can be repositioned by bringing up the Drawing Toolbar and clicking on the arrow to move the drawing of the node. Alternatively, right-click the node, the left click to remove the pop-up menu, then place the cursor at the edge of the node to grab it and move it.

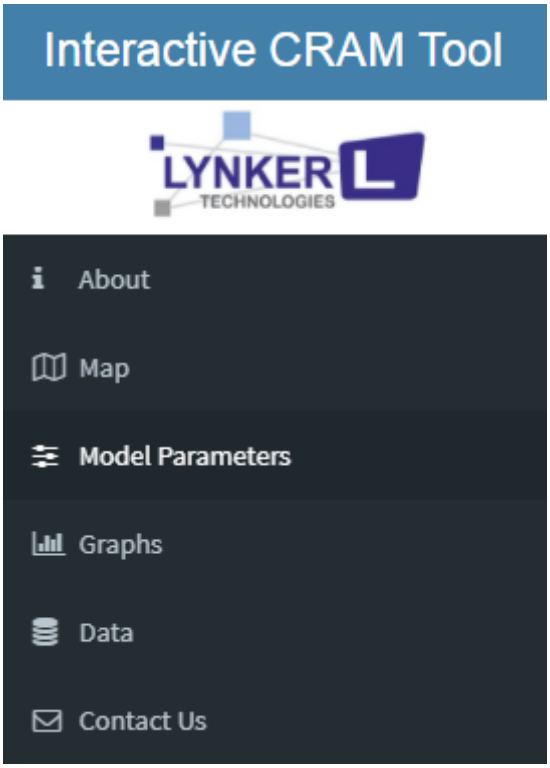


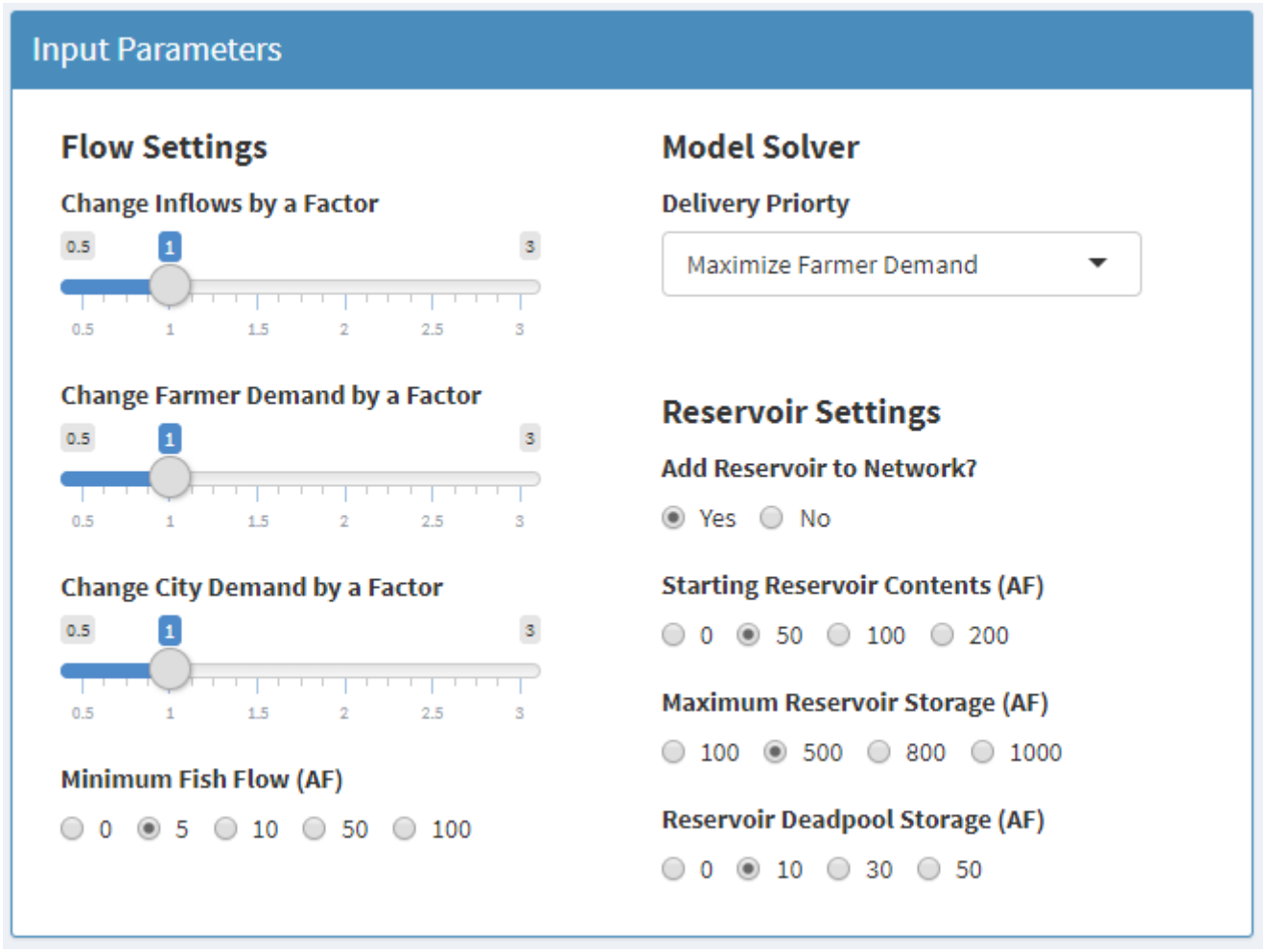
Model Details

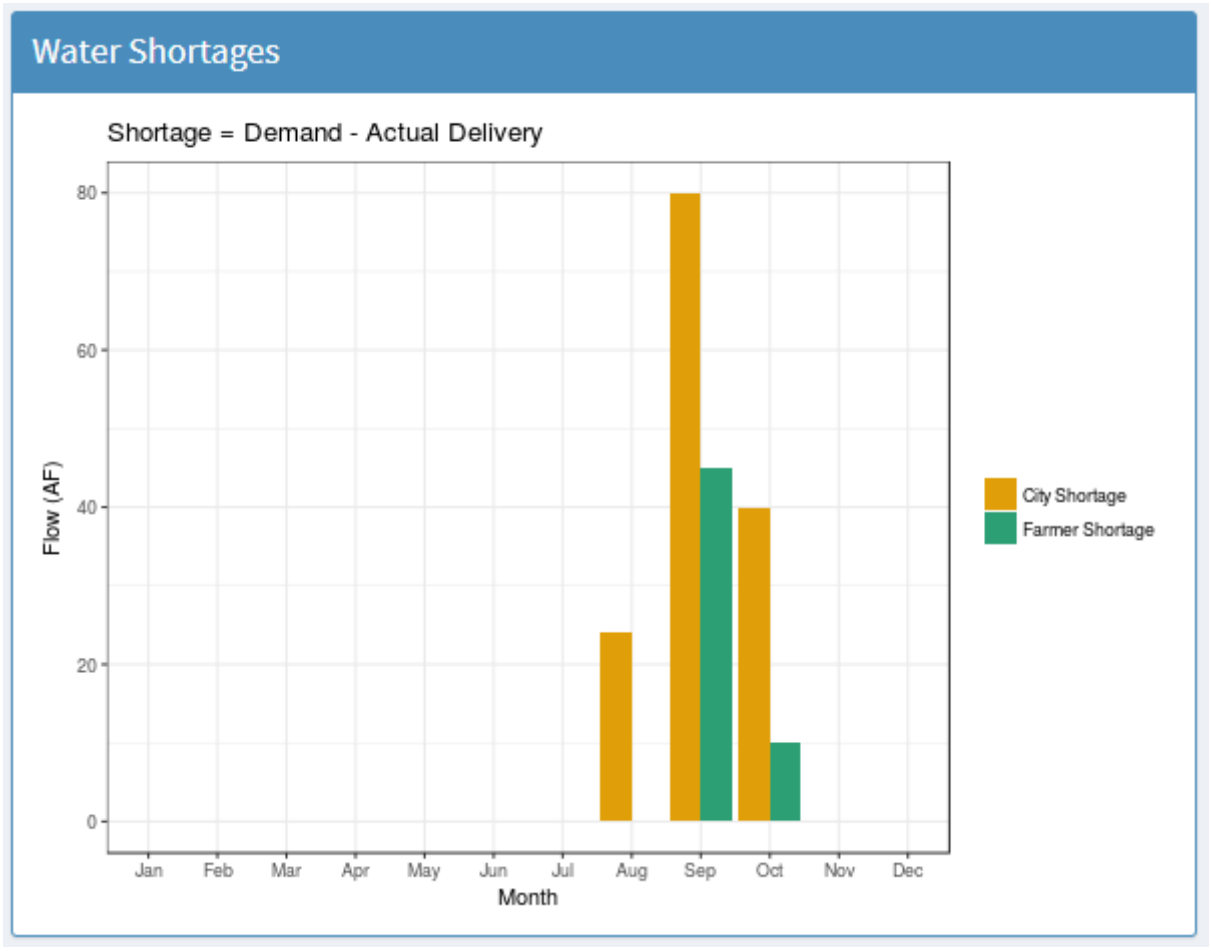
This section is under construction.

Interactive CRAM Tool

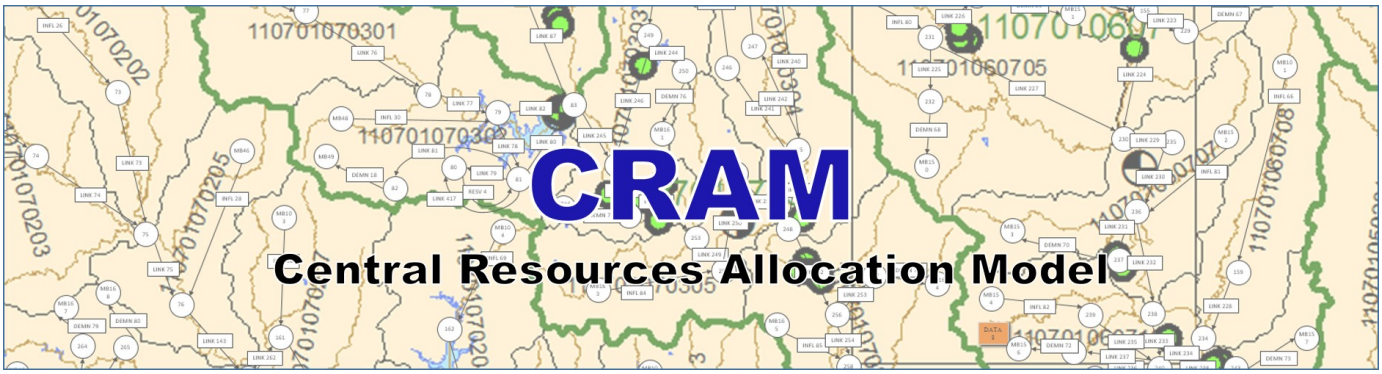
A simple interactive CRAM tool is available online to demonstrate how the model works. It can be found at Lynker's Shiny page.




Input Parameters
Flow Settings
Change Inflows by a Factor
0.5
1
3
0.5
1
1.5
2
2.5
3
Change Farmer Demand by a Factor
0.5
1
3
0.5
1
1.5
2
2.5
3
Change City Demand by a Factor
0.5
1
3
0.5
1
1.5
2
2.5
3
Minimum Fish Flow (AF)
0
5
10
50
100
Model Solver
Delivery Priorty
Maximize Farmer Demand
Reservoir Settings
Add Reservoir to Network?
Yes
No
Starting Reservoir Contents (AF)
0
50
100
200
Maximum Reservoir Storage (AF)
100
500
800
1000
Reservoir Deadpool Storage (AF)
0
10
30
50


Water Shortages
Shortage = Demand - Actual Delivery
Flow (AF)
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
City Shortage
Farmer Shortage

Help



Have more questions about CRAM?

Interested in making CRAM work for you?

Contact Us:

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