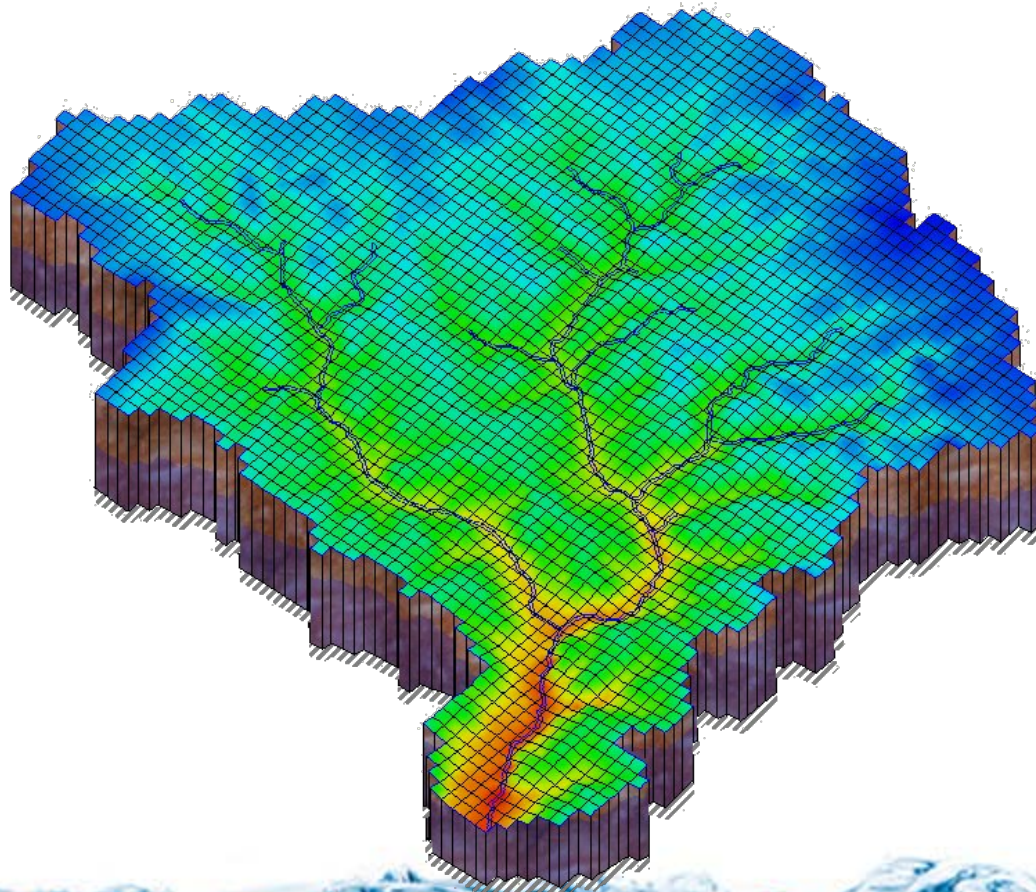




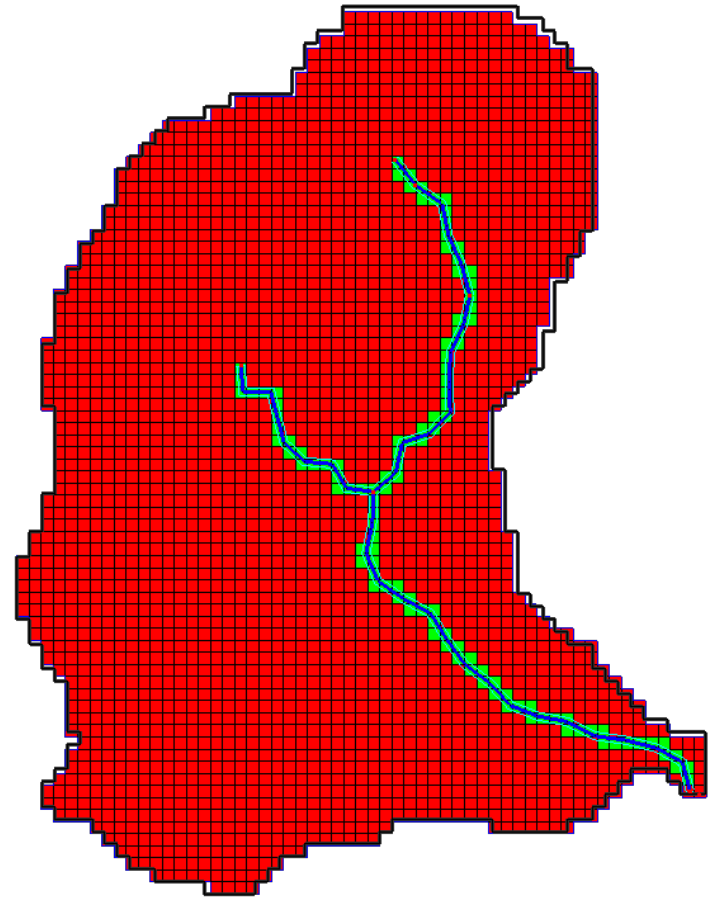
Groundwater Modeling





Base Model

- We will continue working with the Eight Mile Creek Watershed
- The base model that you will open has the following processes defined:
 - Long Term Simulation
 - Distributed Infiltration
 - Distributed overland flow roughness
- You will add Groundwater parameters and run the model
- You will add other advanced groundwater features such as groundwater boundary condition, wells etc on the same model and re-run





Turn groundwater on

- Turn on Groundwater process from Job Control

GSSHA Job Control Parameters

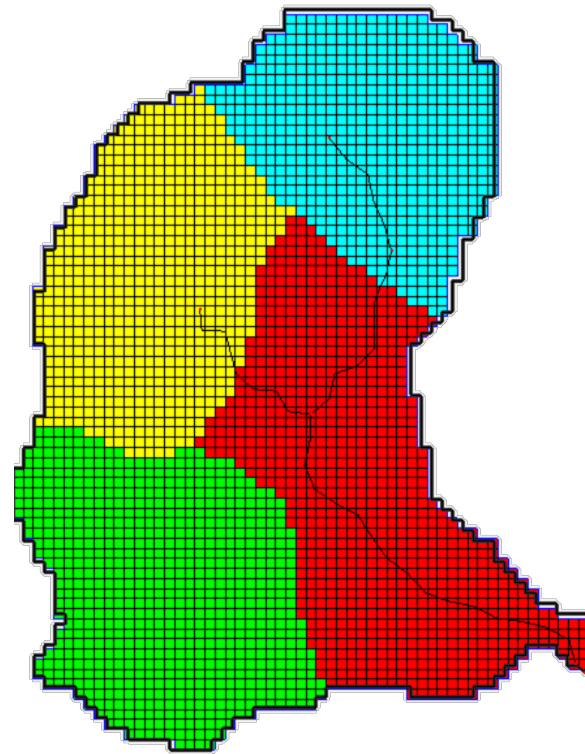
Computation parameters Total time (min): 2000 Time step (sec): 60	Outlet information Column: 56 Row: 66 Slope: 0.01000	Infiltration <input type="radio"/> No infiltration <input checked="" type="radio"/> Green + Ampt with soil moisture redistribution Help Sacramento Model...	Channel routing computation scheme <input type="radio"/> No routing <input checked="" type="radio"/> Diffusive wave Edit Parameters... <input type="radio"/> MESH
Overland flow Computation method ADE <input checked="" type="checkbox"/> Interception <input type="checkbox"/> Initial depth <input checked="" type="checkbox"/> Retention depth <input type="checkbox"/> Area reduction	Evapotranspiration <input type="radio"/> No evaporation <input type="radio"/> Deardorff method <input checked="" type="radio"/> Penman method <input checked="" type="checkbox"/> Seasonal resist.	<input type="radio"/> Richard's infiltration Edit Parameters... <input checked="" type="checkbox"/> Soil depth (m) 0.25 <input checked="" type="checkbox"/> Top layer depth (m) 0.25	<input checked="" type="checkbox"/> Groundwater Edit parameter... <input type="checkbox"/> Soil erosion Edit parameter... <input checked="" type="checkbox"/> Long term simul... Edit parameter... <input type="checkbox"/> Contaminant tra... Edit parameter... <input type="checkbox"/> Nutrients Edit parameter... <input type="checkbox"/> Storm/tile drain Edit parameter... <input type="checkbox"/> Stochastic Edit parameter... <input type="checkbox"/> Calibrate Edit parameter... <input type="checkbox"/> Link CE-QUAL...

Help Output Control... OK Cancel



Preliminary data

- You will need the following data to add create groundwater using the base model described in the previous slide
 - Aquifer bottom elevations
 - Initial Phreatic surface (Water table)
 - Porosity
 - Hydraulic Conductivity





Aquifer Bottom Elevations

- Aquifer bottom - from scatter data sets

File Import Wizard - Step 1 of 2

File import options

Set the column delimiters:

☒ Delimited ☐ Fixed Width

☒ Space ☒ Tab ☐ Semicolon
☒ Comma ☐ Other: Text qualifier:

☒ Treat consecutive delimiters as one ☒ Skip leading delimiters

Start import at row: 2 ☐ Heading row

File preview

	Aquifer	Bottom	Elevation
1			
2	559115.6839	4977909.238	335.1456
3	559085.6839	4977969.238	335.9481
4	559025.6839	4977939.238	335.5527
5	558965.6839	4978089.238	336.3036

Help < Back

File Import Wizard - Step 2 of 2

WMS data type:
2D scatter points

☐ No data flag -999.0

Name: aquifer_bot_elevs

Mapping options
☐ Transient data set
Data set name:

10C invis 0.000 invis invis inv

File preview

Type	X	Y	Data set
Header			
	559115.6839	4977909.238	335.1456
	559085.6839	4977969.238	335.9481
	559025.6839	4977939.238	335.5527
	558965.6839	4978089.238	336.3036
	558935.6839	4977939.238	336.2613

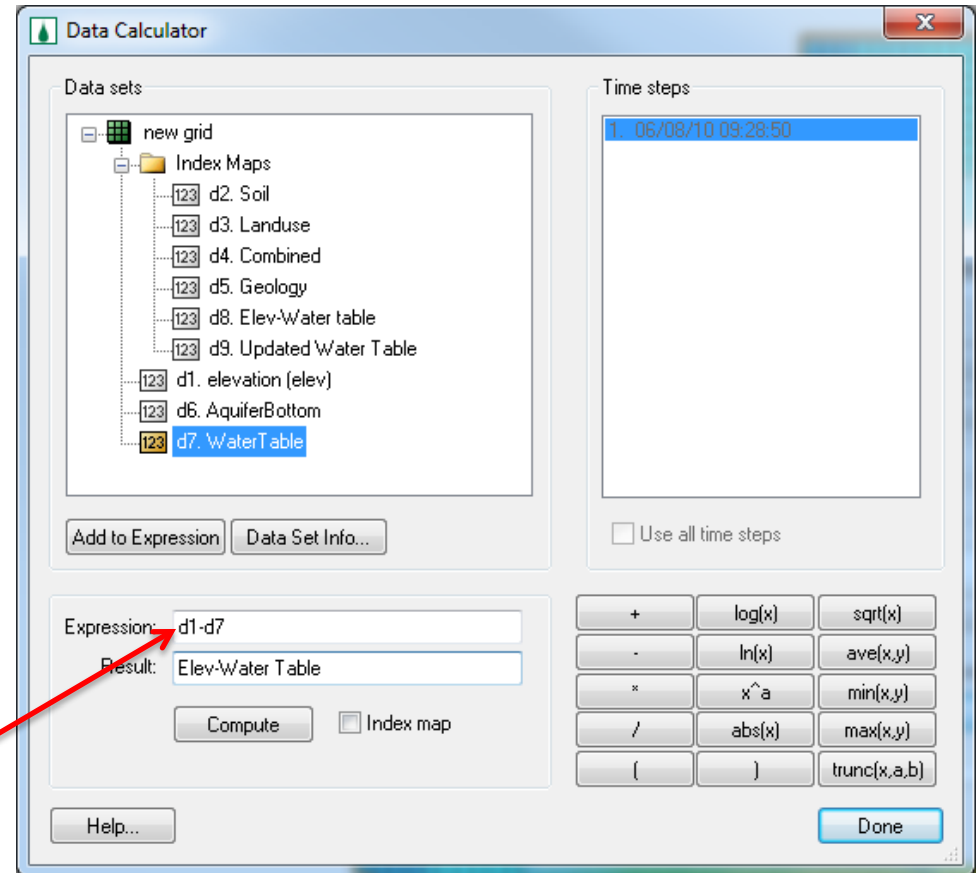
First 20 lines displayed.

Help < Back Finish Cancel



Initial Water Table Elevations

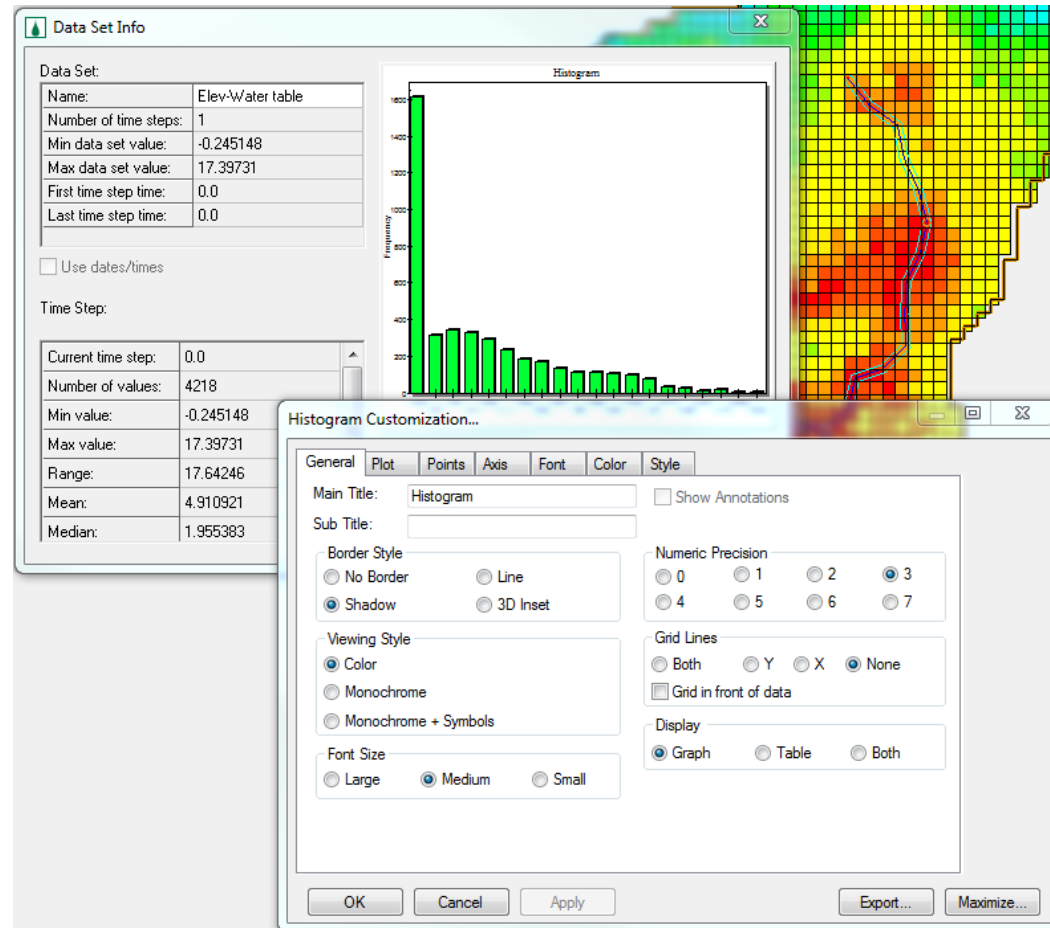
- Initial Water Table Elevation – From scatter data sets
- Need to see if during interpolation the water table elevation assigned to be higher than ground surface elevation
- Use Data calculator
- New data = water table elev – ground elev





Creating GW datasets

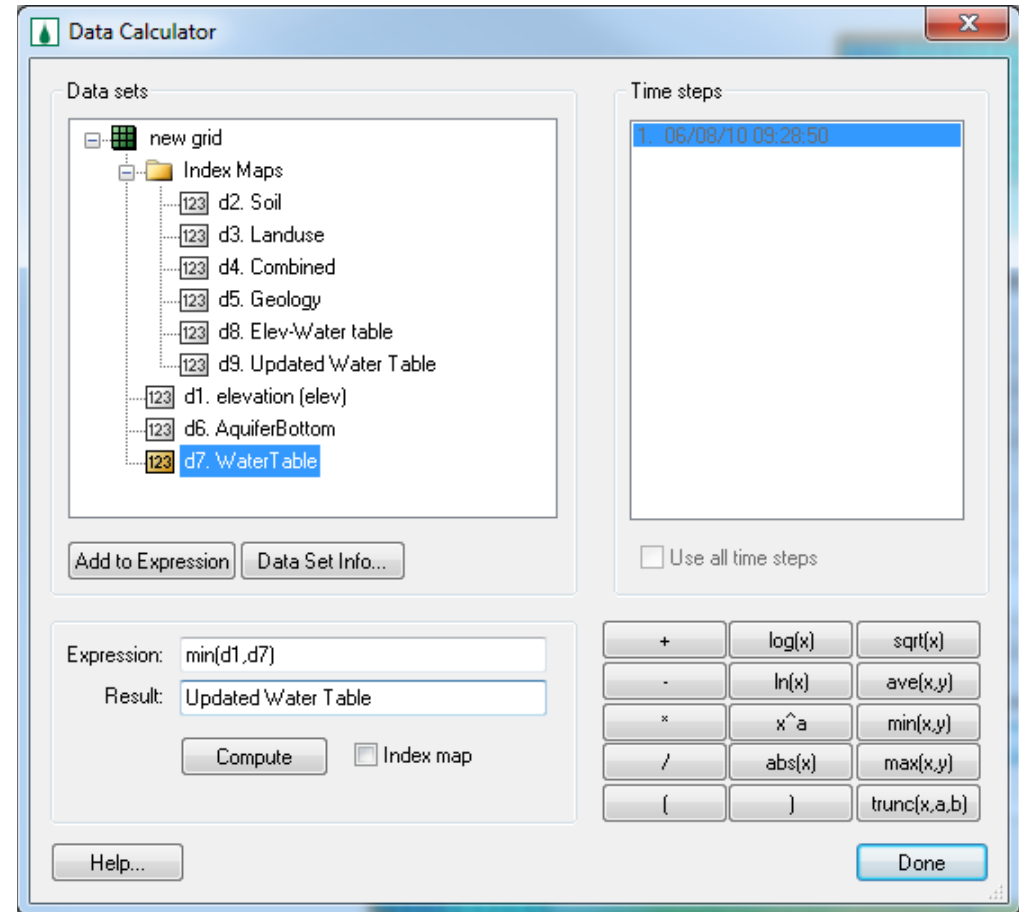
- Check the values in the new data set
- Negative values indicate that the water table elevation > Ground elevation





Creating GW datasets

- Use $\min(x,y)$ function in the data calculator to create a new data which is minimum of water table elevation and ground elevation
- Assign the maps to GSSHA model





Groundwater Properties

GSSHA Groundwater

Groundwater

Time step: 600.0000

LSOR direction: Vertical

LSOR convergence: 0.000010

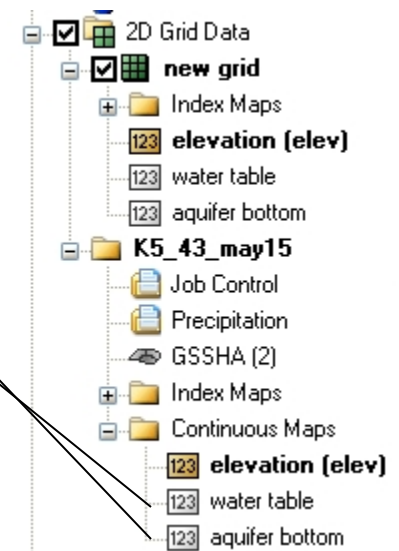
Relaxation coefficient: 1.2000

Leakage rate: 0.0000

Aquifer cell size: 0.0000

Name	Data Set
Aquife...	aquifer bottom
Water ...	water table
Hydra...	
Porosity	

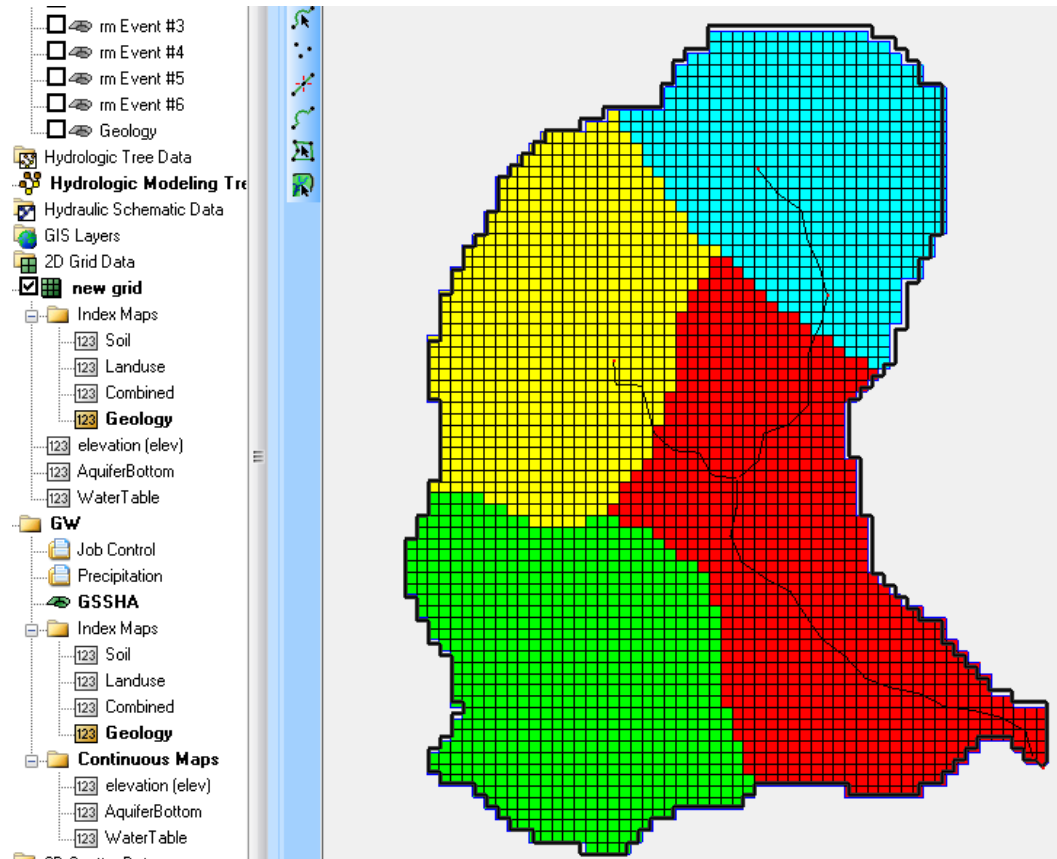
Help OK Cancel





GW Index Map

- Create groundwater index map using geology shapefile
- Define hydraulics conductivity and porosity based on groundwater index map





Groundwater Map Table Parameters

GSSHA Map Table Editor

Roughness	Interception	Retention	Evapotranspiration	Infiltration	Initial Moisture	Soil Erosion
Contaminants	Nutrients	Continuous Maps	Groundwater			

Using index map: Geology

Generate IDs Add ID Delete ID

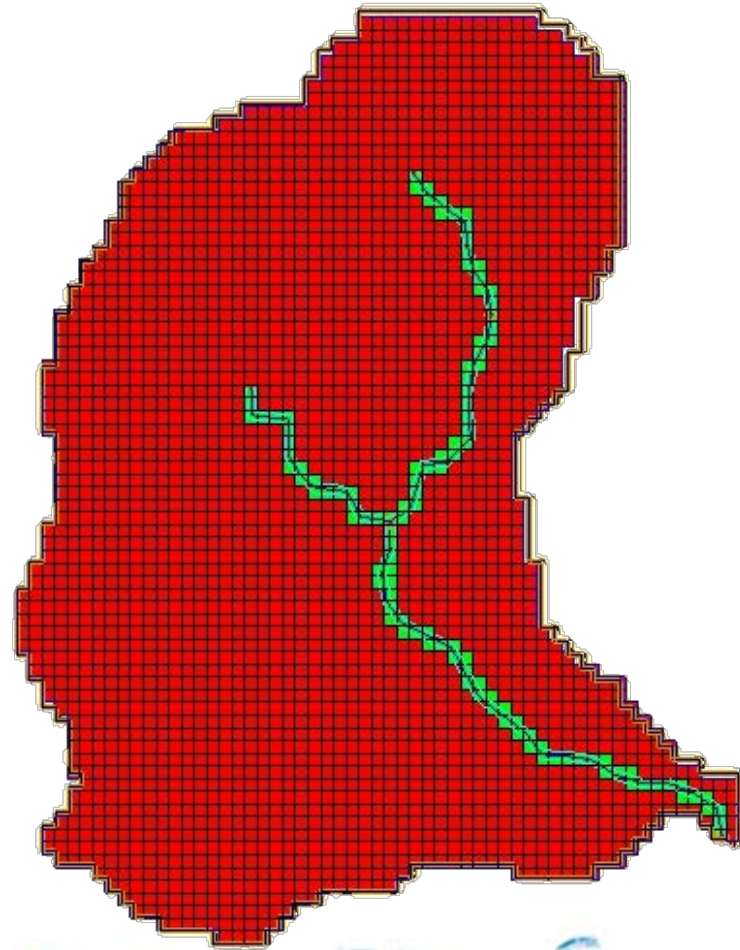
Groundwater				
ID	6	10	13	17
Description1	Groundwat...	Groundwater...	Groundwater...	Groundwater...
Description2
Hydraulic Conductivity (cm/hr)	5.980000	2.180000	1.320000	0.680000
Porosity (m^3/m^3)	0.437000	0.453000	0.463000	0.501000

Help Import Table... Export Table... Job Control Done



Groundwater Boundary Conditions

- Generic
- No flow
- Constant head
- Flux river
- Head river
- Static well (index map)
- Dynamic well (index map)





Groundwater Boundary Conditions

- BC defined in an Arc, eg river flux, constant head etc

Properties

Feature type: Arcs

Show: Selected

Filter using: Column: None

Value:

ID	Type	Groundwater BC	Flow BC Type	Variable Stage BC	Constant BC	Solution Results
All			
2	Generic	Generic	None	...	0.0	...
9	Generic	No flow	None	...	0.0	...
12	Generic	Constant head	None	...	0.0	...
226	Generic	Flux river	None	...	0.0	...
		Head river				
		Generic	None	...	0.0	...

Help...

OK

Cancel





Groundwater Boundary Conditions

- BC defined in a node/point, eg Wells

Properties

Feature type: Points/nodes Show: Selected Filter using: Column: None Value:

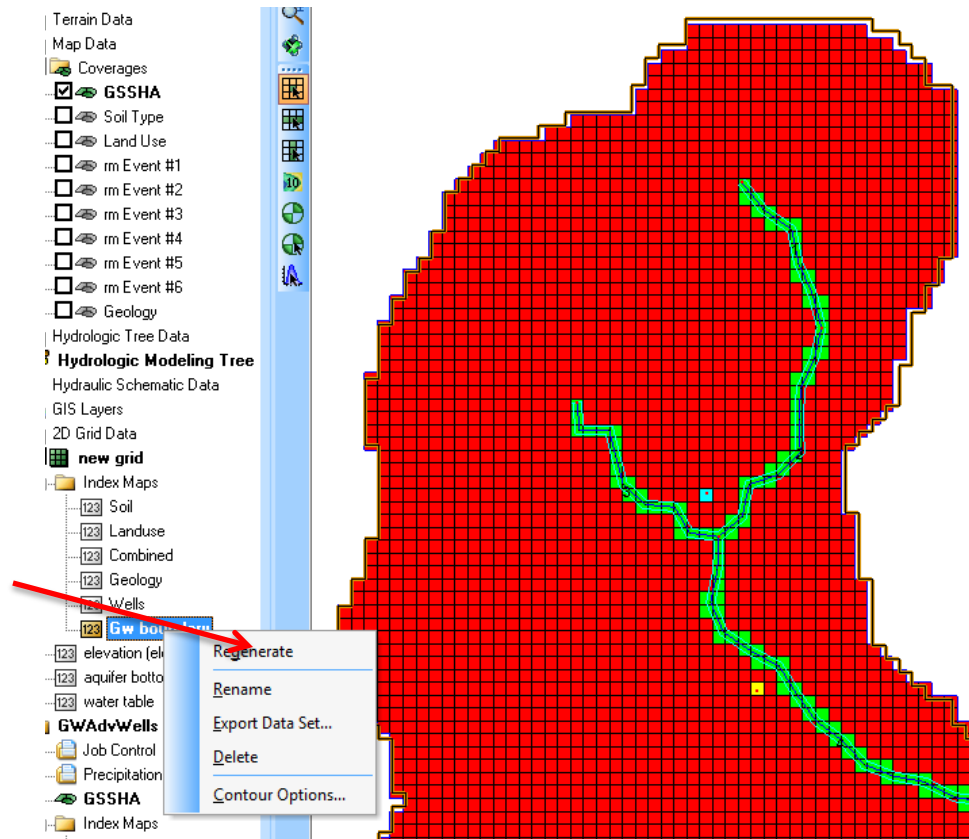
ID	Groundwater BC	Flow BC Type	Variable Stage BC	Constant BC	Solution Results	Observations	Use Input
All			<input type="checkbox"/>
386807	Generic Constant head Static well Dynamic well	None	...	0.0	<input type="checkbox"/>

Help... OK Cancel



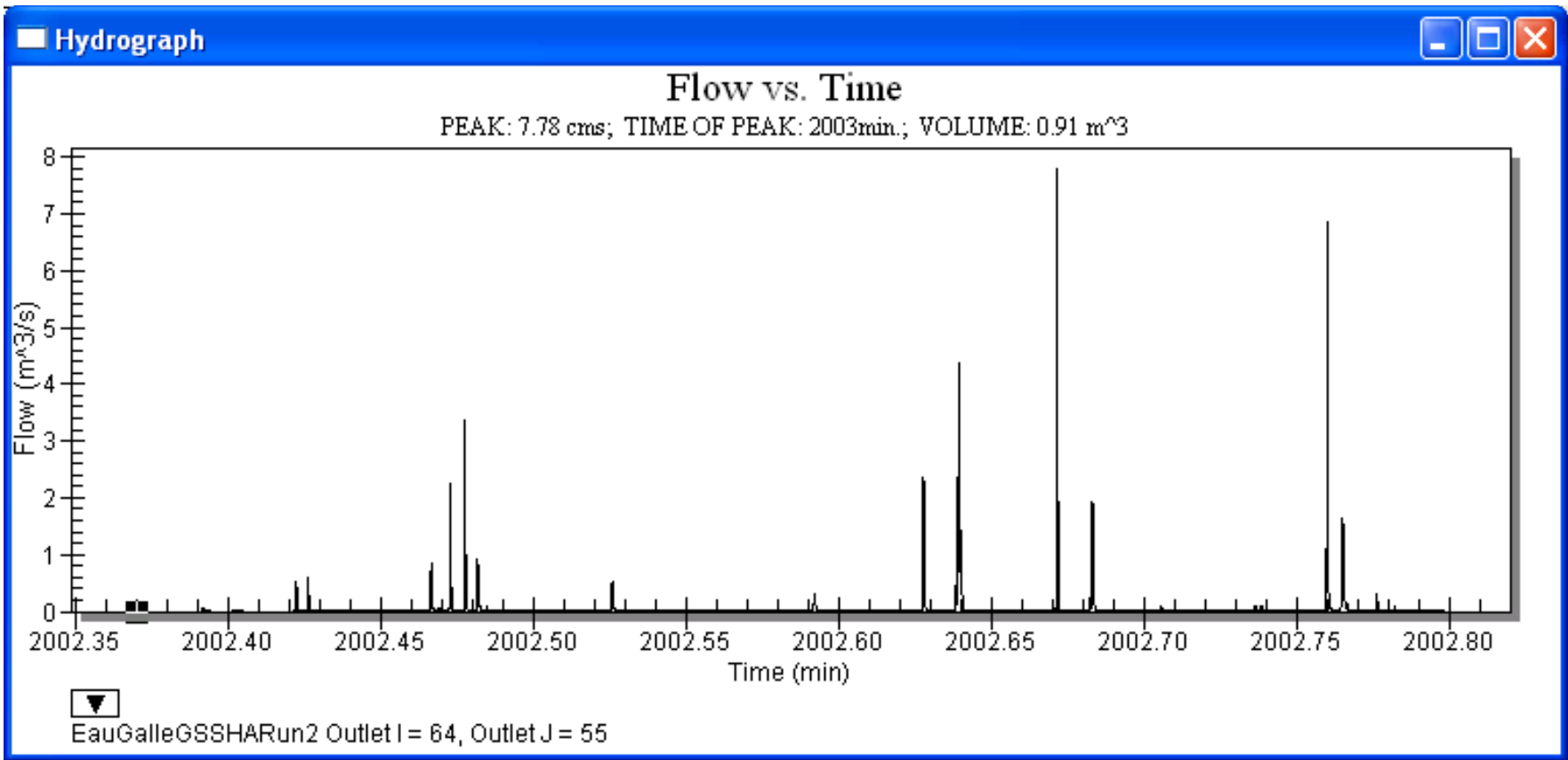
Regenerating Gw Index Map

- Once the groundwater option is turned on from Job Control, WMS generates a Gw Index map displaying all the boundary conditions defined in the model
- Every time a new boundary condition is added, you will have to regenerate the Gw Index map to reflect the changes





Save and Run





Add streams

Properties

Feature type: Arcs Show: Selected Filter using: Column: None Value:

ID	Type	L...	Manni...	Depth...	Bottom...	Side slop...	[2] ...	Sub-surfa...	Sediment thic...	Sediment hy...	Groundwater BC
All	Trapezoidal channel		0.119	0.5	1.0	4.2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	55.0	25.0	Flux river
2	Trapezoidal channel	0	0.119	0.5	1.0	4.2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	55.0	25.0	Flux river
9	Trapezoidal channel	0	0.119	0.5	1.0	4.2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	55.0	25.0	Flux river
12	Trapezoidal channel	0	0.119	0.5	1.0	4.2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	55.0	25.0	Flux river
226	Trapezoidal channel	0	0.119	0.5	1.0	4.2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	55.0	25.0	Flux river

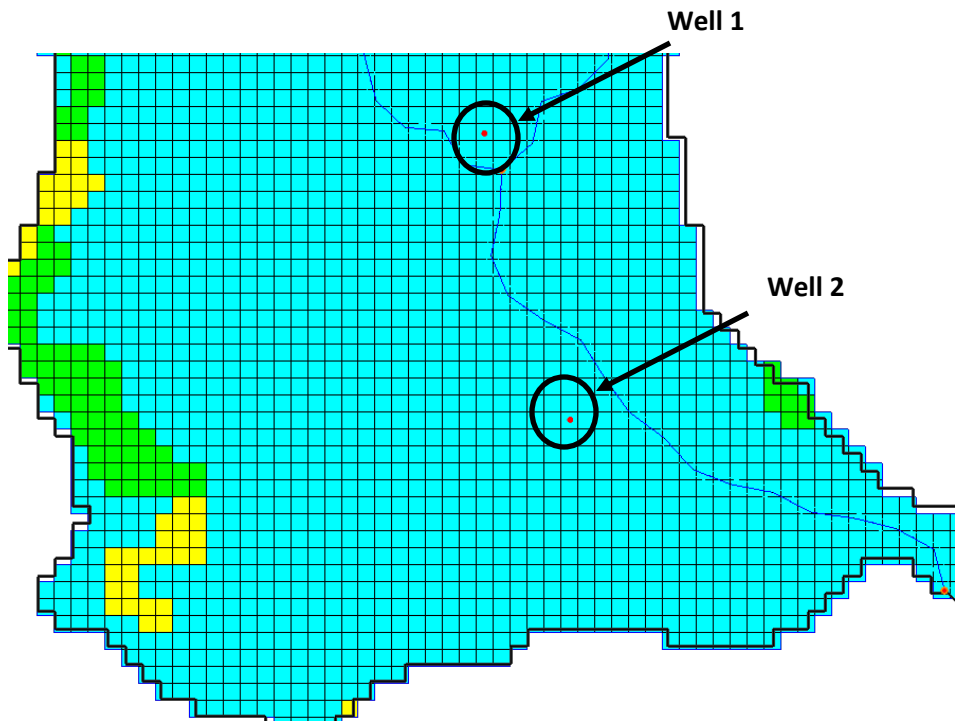
Help... OK Cancel





Add wells

- Wells can be
 - Static
 - Dynamic



Properties

Feature type: Points/nodes Show: Selected Filter using: Color

ID	Hydrograph output	Groundwater BC	Pump rate (m ³ /s)
All	<input type="checkbox"/>	Static well	
387374	<input type="checkbox"/>	Static well	2.55

Static pumping rate

Properties

Feature type: Points/nodes Show: Selected Filter using: Color

ID	Groundwater BC	Pump rate
All		...
387090	Dynamic well	...

XY Series Editor

	Time (min)	Pump rate (m ³ /s)
1		
2		
3		

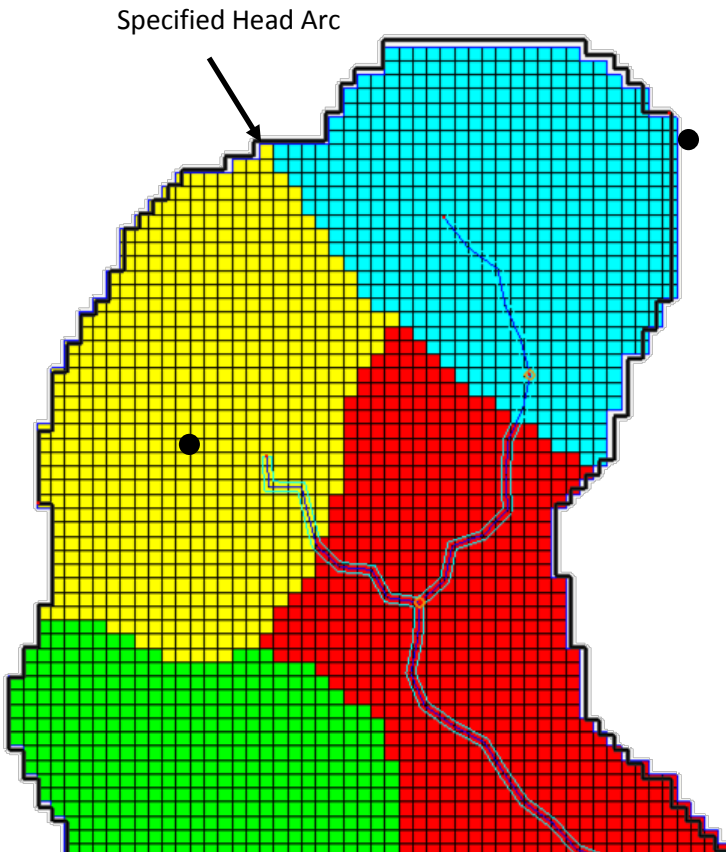
Pumping rate time series





Specified Head BC

Draw an arc over the boundary cells to represent the specified head boundary conditions and change the attributes



Properties

Feature type: Arcs Show: Selected Filter using: Column: None Value:

ID	Type	Groundwater BC	Flow BC Type	Variable Stage BC	Constant BC	Solution Results
All			
225	Generic	Generic	None	...	0.0	...

Generic
No flow
Constant head
Flux river
Head river

Help... OK Cancel



Using Richard's Equation

- This is an alternate infiltration equation that we will use instead of Green and Ampt Equation
- Select Richard Equation in Job Control

GSSHA Job Control Parameters

Computation parameters
Total time (min): 2000
Time step (sec): 10

Outlet information
Column: 56
Row: 66
Slope: 0.01000

Overland flow
Computation method
ADE

Evapotranspiration
☐ No evaporation
☐ Deardorff method
☒ Penman method
☒ Seasonal resist.

Infiltration
☐ No infiltration
☐ Green + Ampt with soil moisture redistribution
☒ Richard's infiltration

Channel routing computation scheme
☐ No routing
☒ Diffusive wave
☐ MESH

Groundwater
☒ Groundwater
☐ Soil erosion
☒ Long term simul...
☐ Contaminant tra...
☐ Nutrients
☐ Storm/tile drain
☐ Stochastic
☐ Calibrate
☐ Link CE-QUAL...

Soil moisture depth (m) 0.25
Top layer depth (m) 0.25

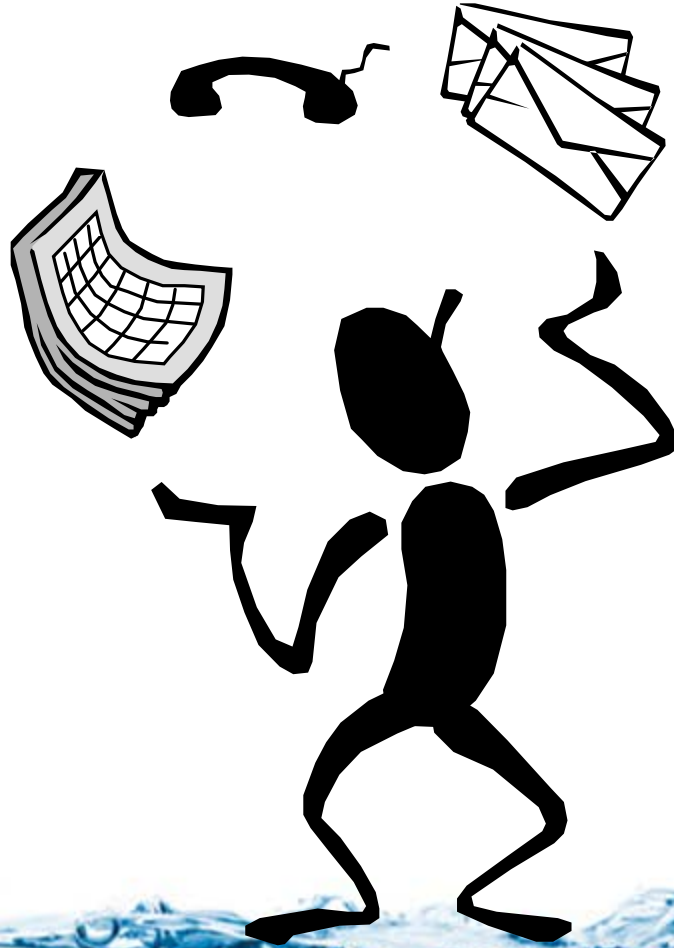
Help
Output Control...
OK
Cancel

- You will need to edit Richard's Equation parameters in the job control
- Also update the parameters in the Mapping table





Demonstration





Workshop

