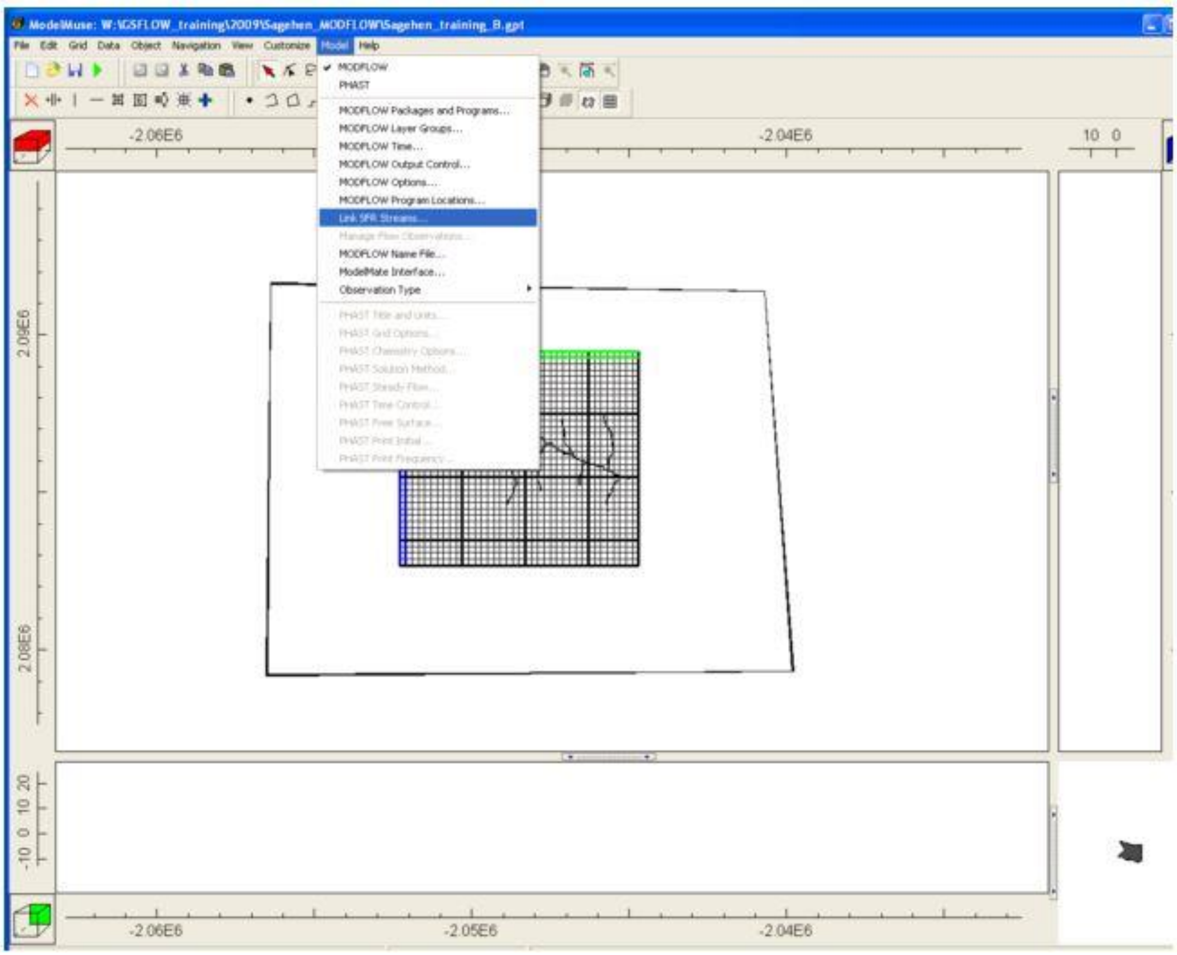
Contents



ModelMuse: W:\GSFLOW_training\2009\Sagehen_MODFLOW\Sagehen_training_B.gpt
File Edit Grid Data Object Navigation View Customize Model Help
MODFLOW
PHAST
MODFLOW Packages and Programs...
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-2.05E6
-2.04E6
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2.08E6

GSFlow Training Class Material: Instructions for GSFLOW Model Input Preparation

Overview

Purpose and Scope

This report describes the input preparation process for GSFLOW, version 1.1, specifically, the creation of the PRMS Data File, the GSFLOW maps, the PRMS Parameter File, and the MODFLOW Input Files.

These instructions are not the only way to prepare input for GSFLOW, but are intended to serve as a procedural guide. Clearly, any single step from the outline below, could involve (and may require) much more effort, study, and expertise from a GSFLOW modeler or modeling team. Anyone considering a GSFLOW modeling project is encouraged to work through this outline and complete the example problem to gain insight into what will be required to develop a full application.

The USGS has corporate policies about the hardware and software tools which are made available to its employees and cooperators. These instructions reflect these policies and are not intended to endorse any particular trade, product, or firm. These instructions can (and have been) successfully carried out with many alternative hardware and software configureations.

Software Requirements

The following software packages are required to prepare input for GSFLOW:

- USGS Downsizer (available only on USGS computers)
- ESRI ArcMap and Workstation (version 9.3), including a license for the Spatial Analyst extension
- CRWR ArcHydro extension to ArcMap
- XTools Pro extension to ArcMap
- Microsoft Excel
- USGS PRMS Paramtool
- USGS ModelMuse

Hardware Requirements

The following represents a minimum hardware configuration to prepare input for GSFLOW:

- PC with Windows XP Operating System
- 2.0 GHz PC (or higher) Processor
- 1 GB (or higher) RAM
- 100 GB (or higher) Hard Disk
- SVGA, 1024x768 resolution, 16 bit color (or better) Monitor
- 32 MB RAM (or higher), 24 bit true color Graphics Card

Download Example Problem Data Sets

The data for the following example is available here (ftp://brrftp.cr.usgs.gov/pub/mows/data/gsflowTrainingMaterial.zip).

These steps should be completed in order, as later steps may require maps or data produced in earlier steps.

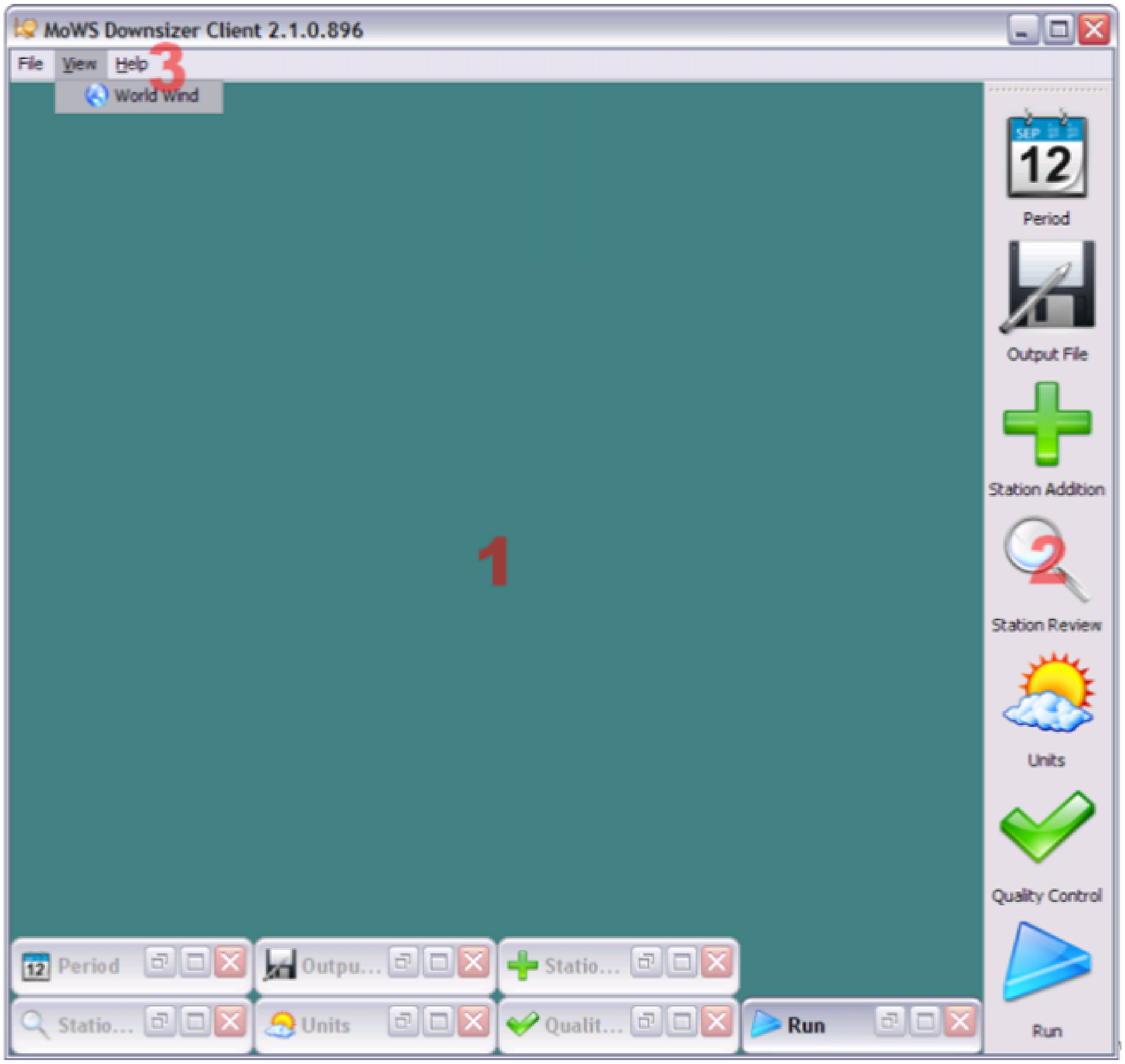
Making PRMS Data File

Create a PRMS Data File (for time series climate and stream flow data)

Creating a PRMS Data File with the USGS Downsizer

Start the Downsizer by navigating to the download directory and double click on client.bat.

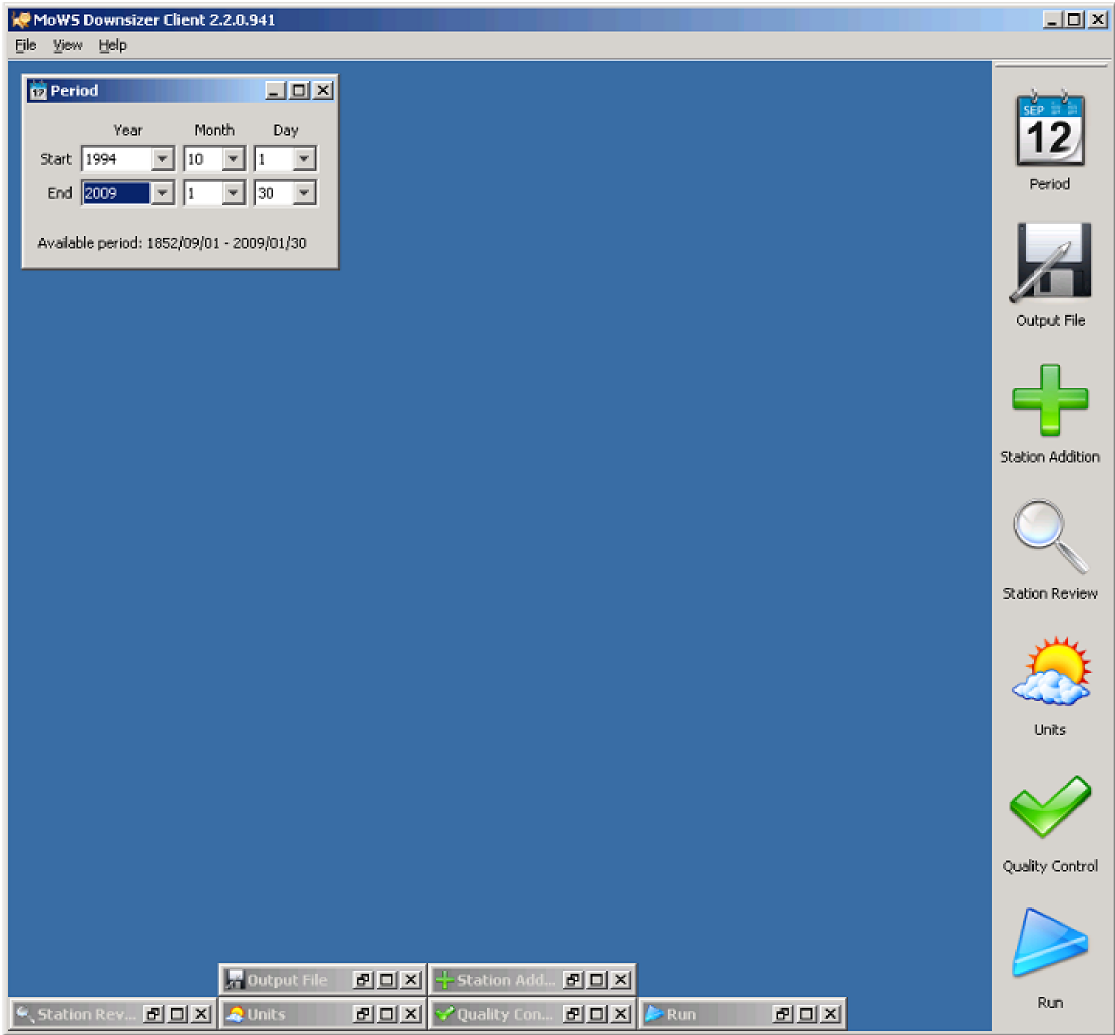
The Downsizer client window is the parent container from which all Downsizer functionality is accessible. This window contains (1) the desktop area, (2) the tool bar, and (3) the menu bar. These parts are described below.



Use the icons on the toolbar on the right side to go through the steps in order:

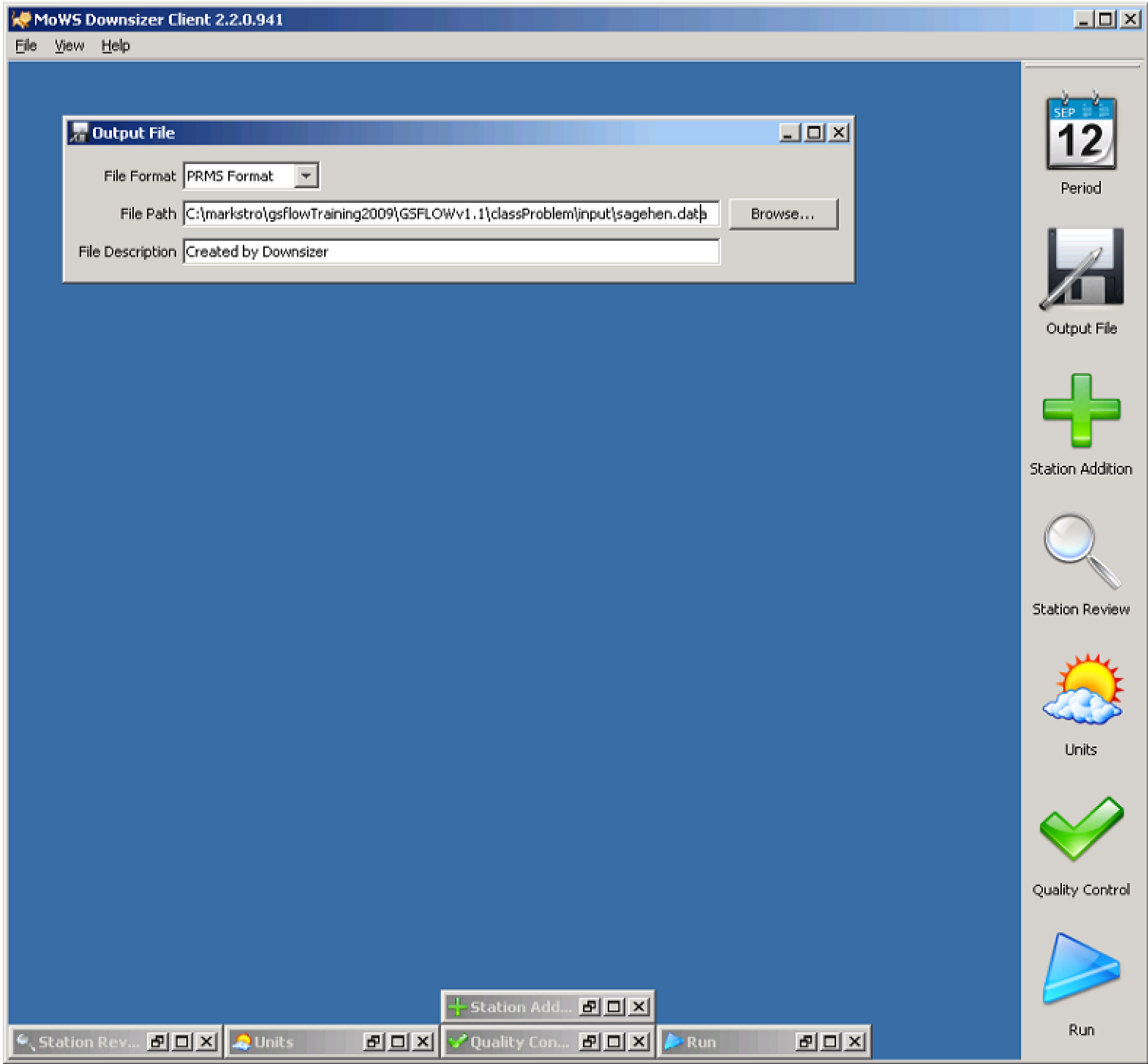
Set the time period for the data pull

Click on the Period icon in the toolbar. Set the start period to 1994-10-1. Set the end period to 2009-01-30



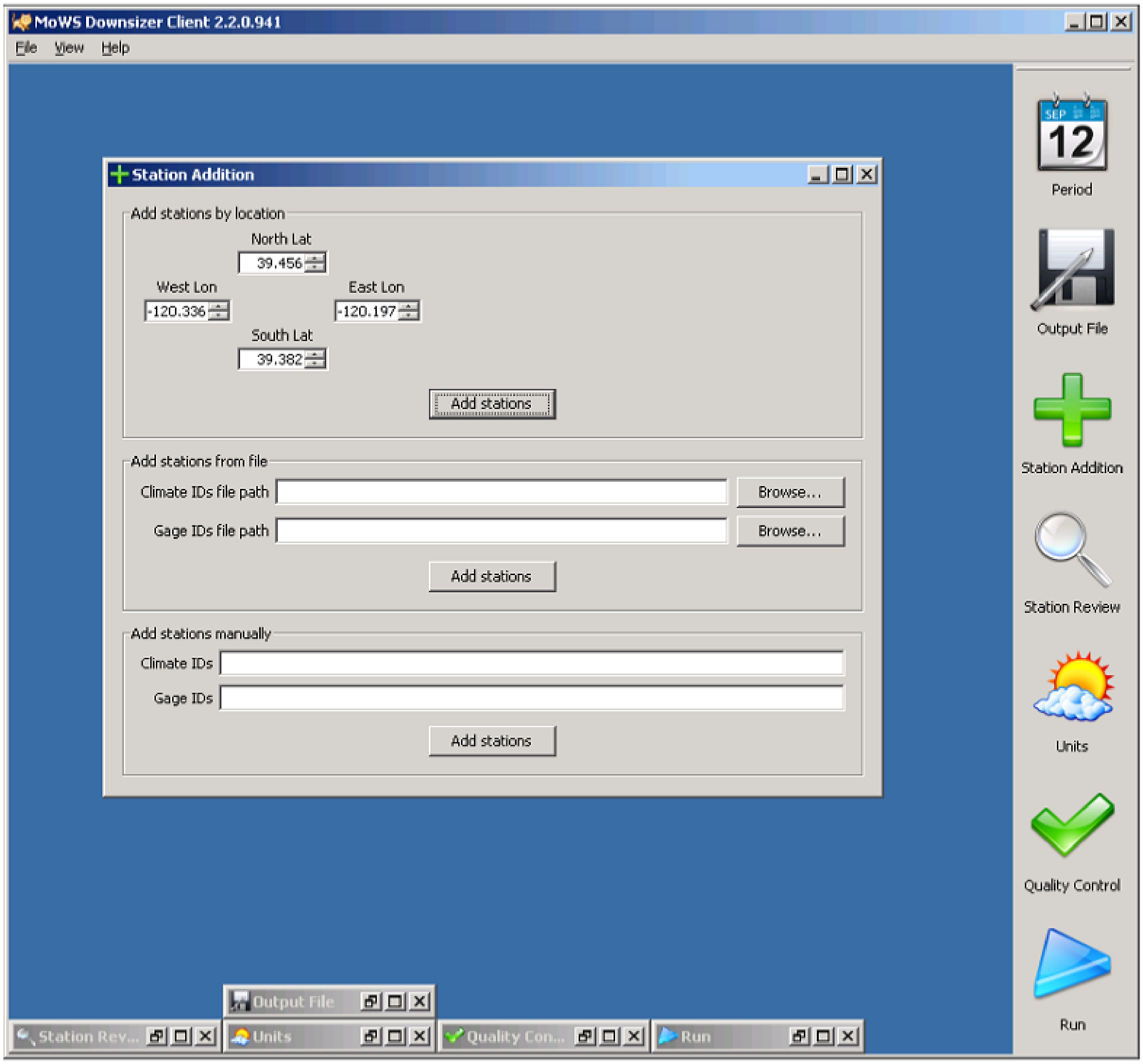
Set the PRMS Data File name and format

Click on the Output File icon in the toolbar. Set the File Format to PRMS Format. Set the File Path by browsing to the classProblem\input folder. Name the file sagehen.data

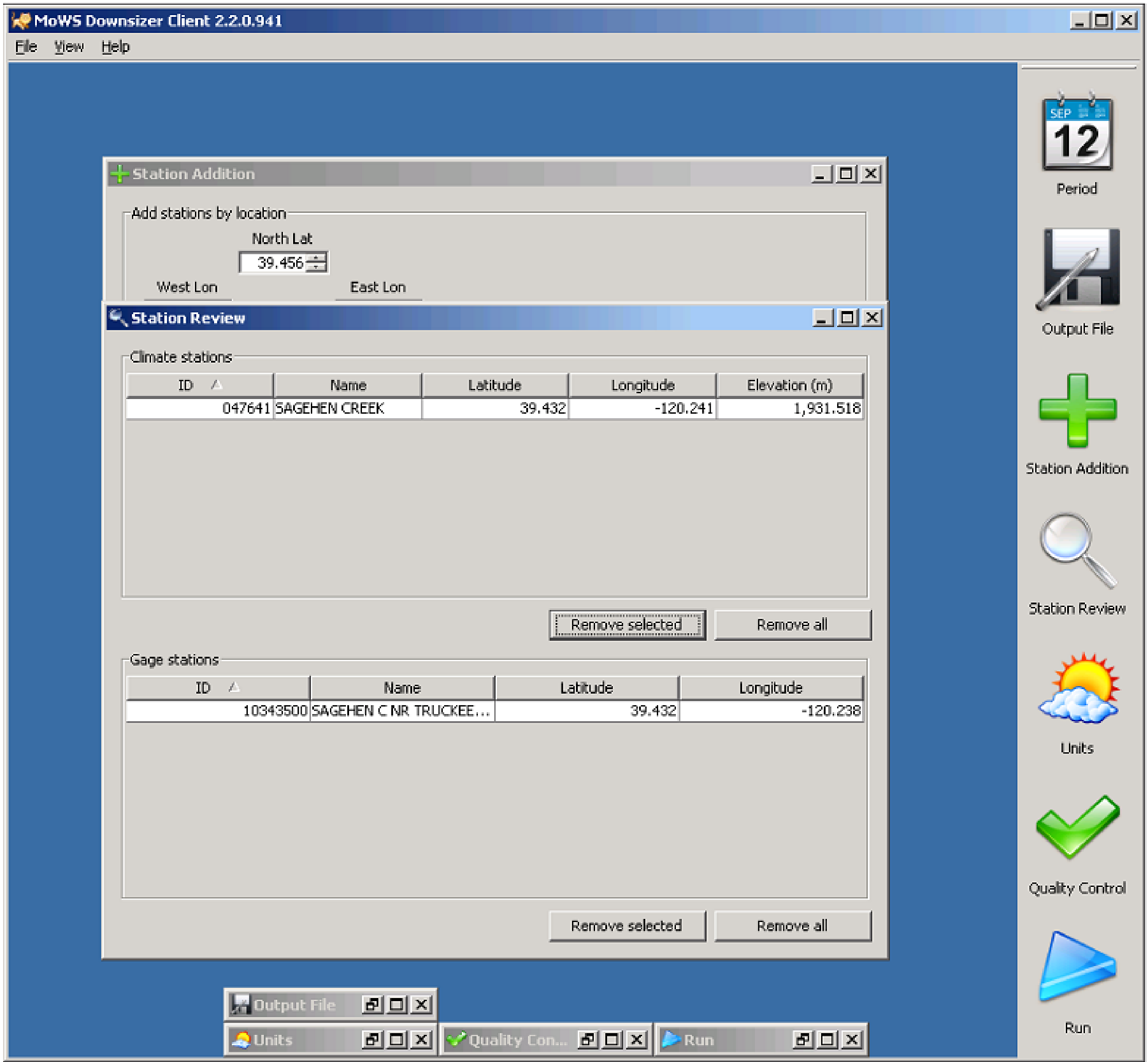


Selecting the stations for the PRMS Data File

Click on the Station Addition icon in the toolbar. Set the North Lat to 39.456; West Lon to -120.336; East Lon to -120.197; and South Lat to 39.382

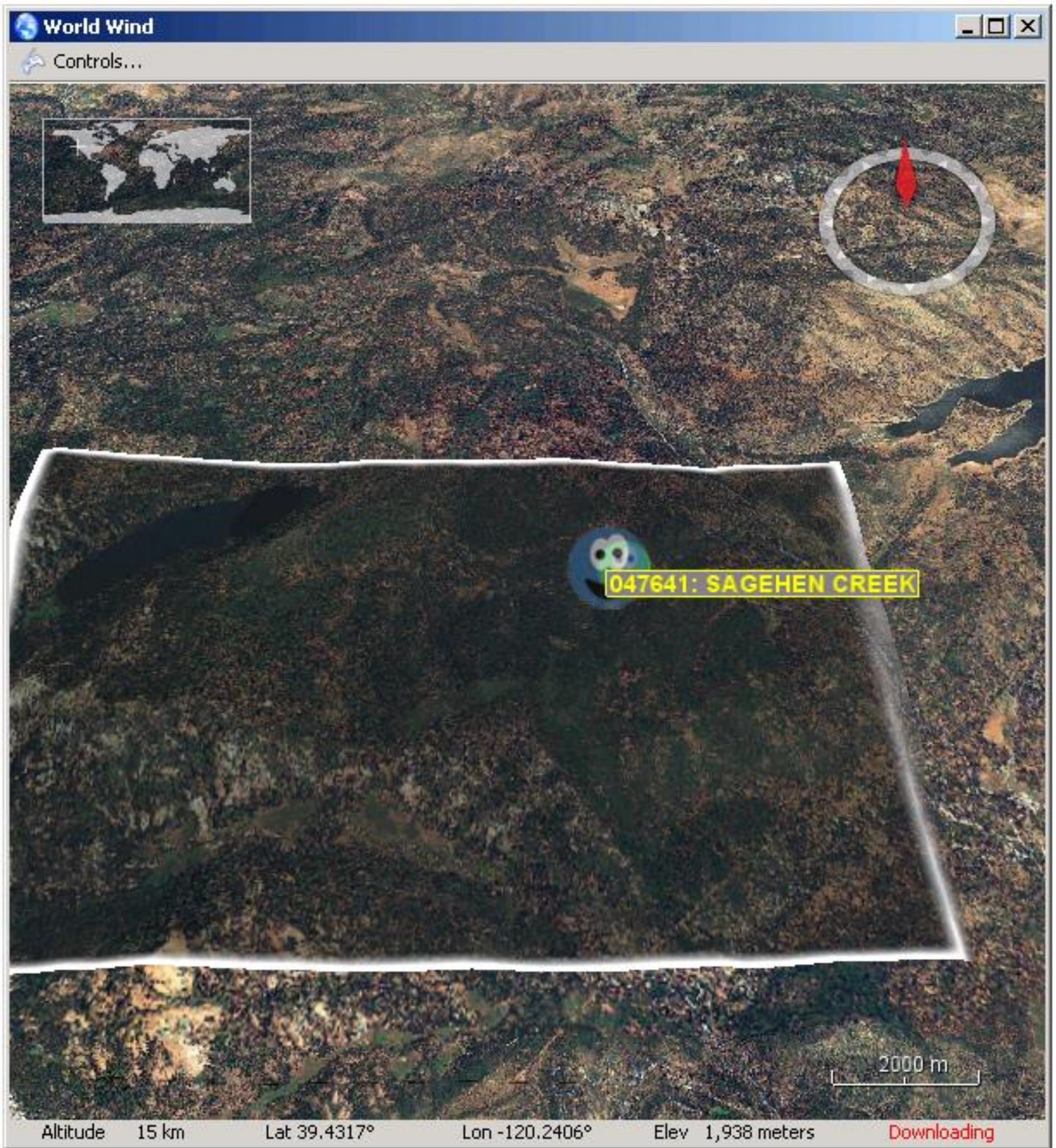


Click the Add stations button to bring up the Station Review window.



Also notice that the locations of the stations are shown in the World Wind window.

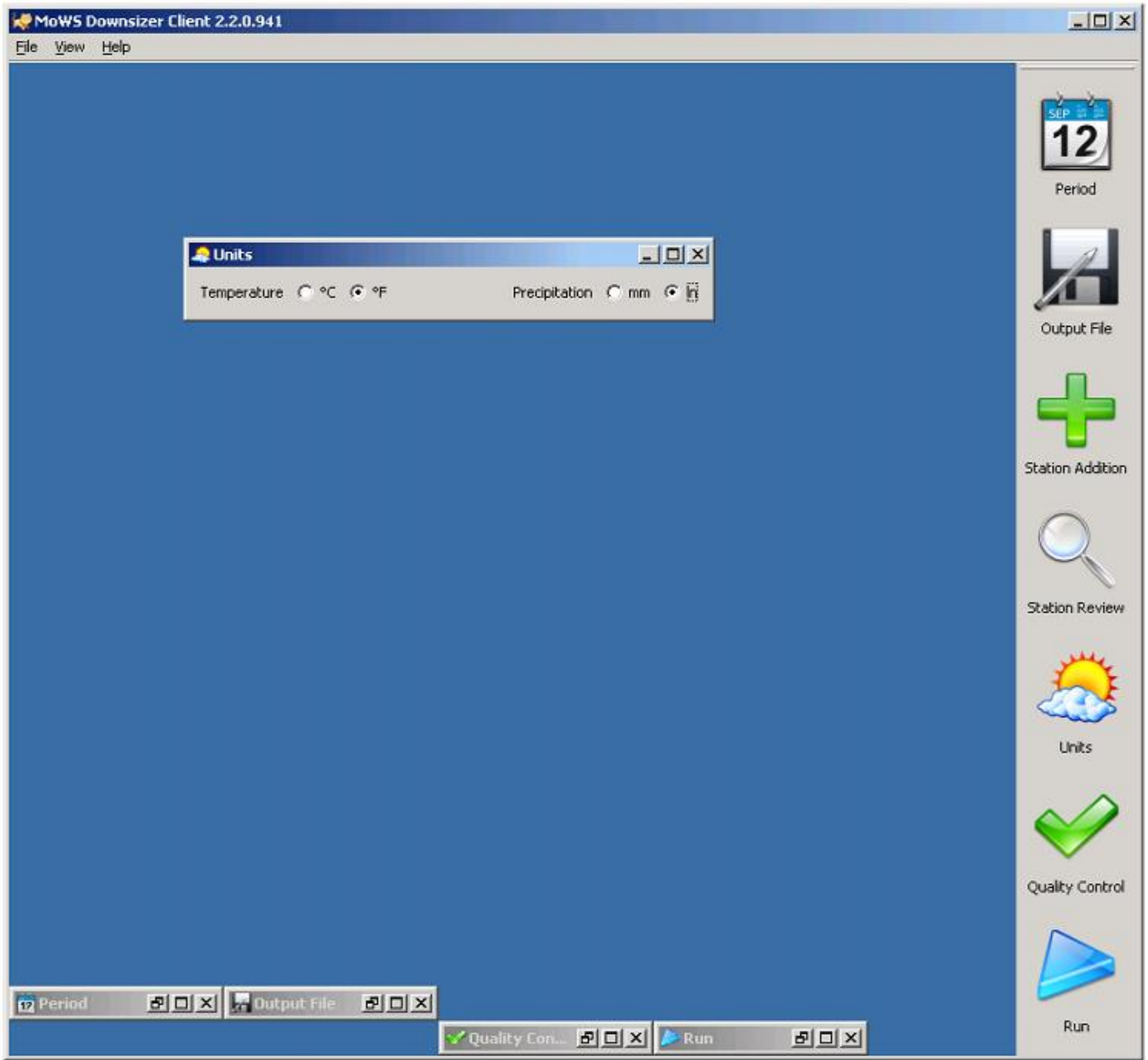
Zoom in, with the mouse wheel, to better see the selection.



The World Wind window can be used to set the extent of the lat/lon selection box in the Station Addition window. It can also be used to select/deselect individual station in the tables in the Station Review window.

Set the Units for the PRMS Data File

Click on the Units icon in the toolbar. Set the Temperature to F and Precipitation to in (inches).

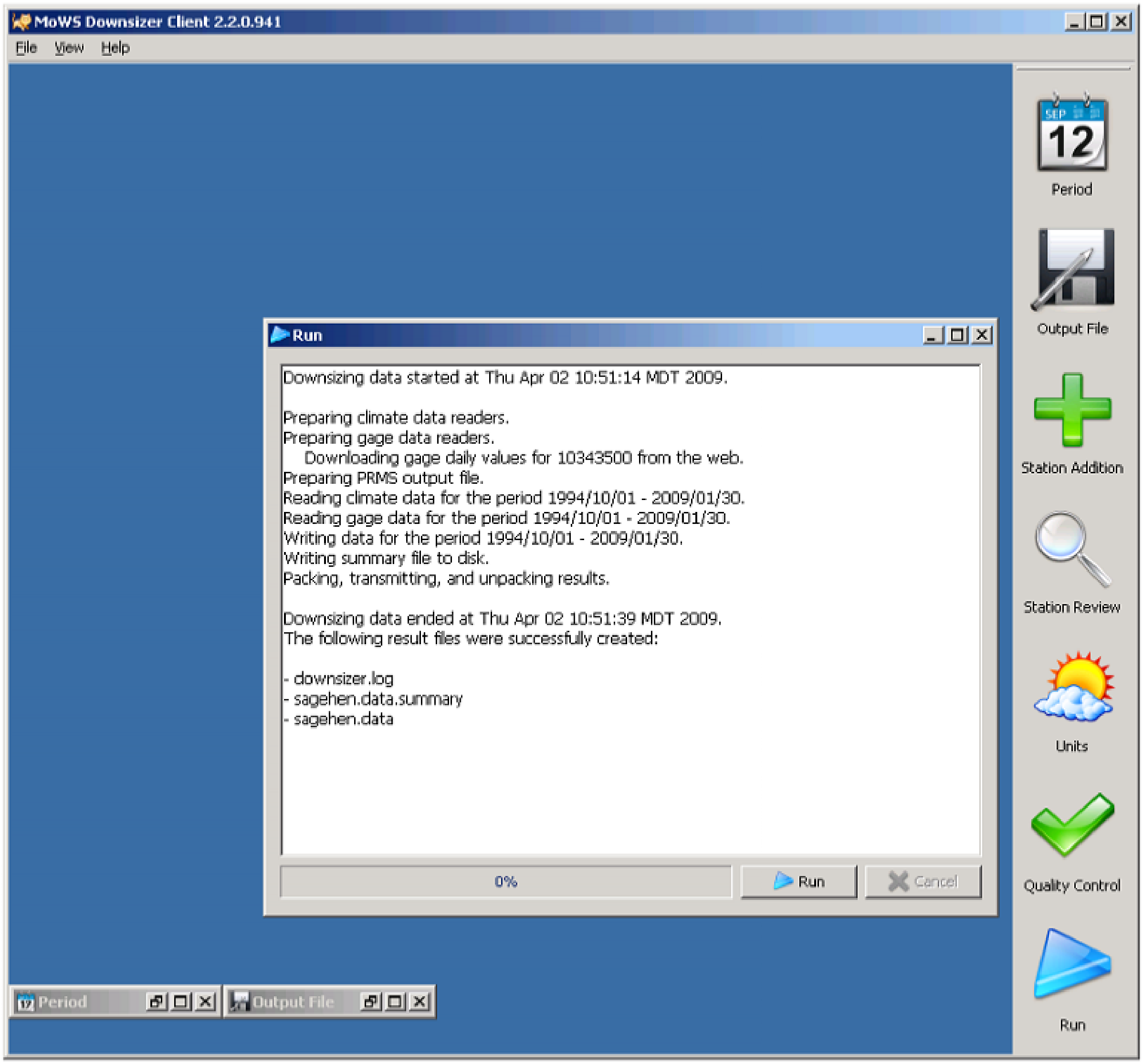


Look at the Flags for Quality Control Checks

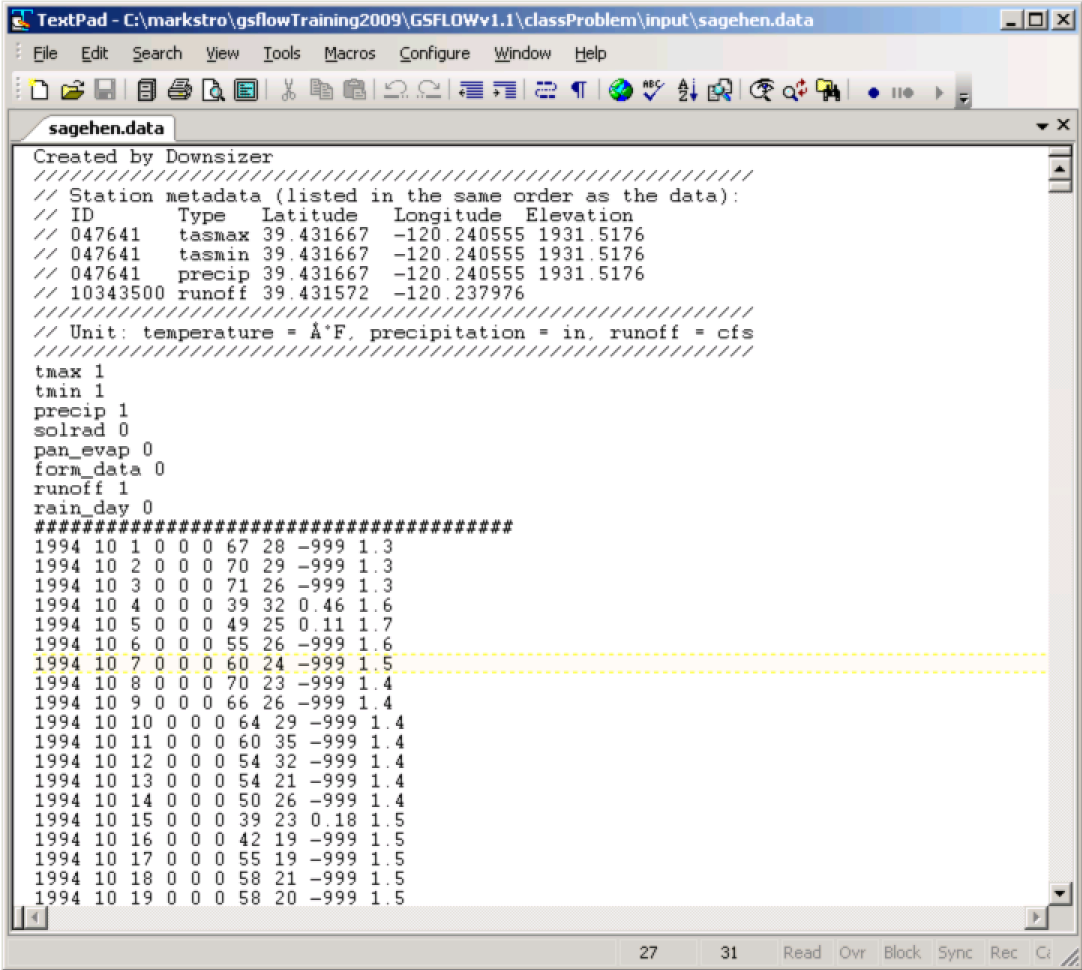
Click on the Quality Control icon in the toolbar. This is where different flags can be set to look for "bad data." This tool will set bad data values to the missing data value

Run the Downsizer

Click on the Run icon in the toolbar. Click on the Run button.

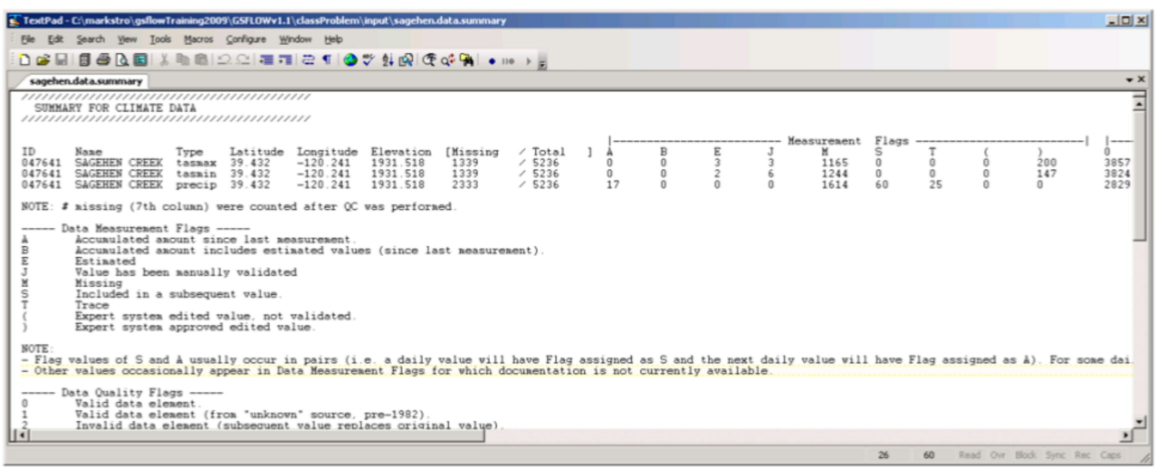


Look at the sagehen.data file that was made by the Downsizer.




```
Created by Downsizer
////////////////////////////////////////////////////////////
// Station metadata (listed in the same order as the data):
// ID        Type    Latitude   Longitude   Elevation
// 047641    tasmax 39.431667  -120.240555 1931.5176
// 047641    tasmin 39.431667  -120.240555 1931.5176
// 047641    precip 39.431667  -120.240555 1931.5176
// 10343500 runoff 39.431572  -120.237976
////////////////////////////////////////////////////////////
// Unit: temperature = Å°F, precipitation = in, runoff = cfs
////////////////////////////////////////////////////////////
tmax 1
tmin 1
precip 1
solrad 0
pan_evap 0
form_data 0
runoff 1
rain_day 0
########################################
1994 10 1 0 0 0 67 28 -999 1.3
1994 10 2 0 0 0 70 29 -999 1.3
1994 10 3 0 0 0 71 26 -999 1.3
1994 10 4 0 0 0 39 32 0.46 1.6
1994 10 5 0 0 0 49 25 0.11 1.7
1994 10 6 0 0 0 55 26 -999 1.6
1994 10 7 0 0 0 60 24 -999 1.5
1994 10 8 0 0 0 70 23 -999 1.4
1994 10 9 0 0 0 66 26 -999 1.4
1994 10 10 0 0 0 64 29 -999 1.4
1994 10 11 0 0 0 60 35 -999 1.4
1994 10 12 0 0 0 54 32 -999 1.4
1994 10 13 0 0 0 54 21 -999 1.4
1994 10 14 0 0 0 50 26 -999 1.4
1994 10 15 0 0 0 39 23 0.18 1.5
1994 10 16 0 0 0 42 19 -999 1.5
1994 10 17 0 0 0 55 19 -999 1.5
1994 10 18 0 0 0 58 21 -999 1.5
1994 10 19 0 0 0 58 20 -999 1.5
```

Look at the sagehen.data.summary file that was made by the Downsizer.




```
///////////////////////////////////////////////
  SUMMARY FOR CLIMATE DATA
///////////////////////////////////////////////

                                                                                   |------------------------ Measurement  Flags -------------------------|  |----
ID       Name           Type    Latitude  Longitude  Elevation  [Missing   / Total   ]  A       B       E       J       M      S      T       (       )       0
047641   SAGEHEN CREEK  tasmax  39.432    -120.241   1931.518    1339      / 5236       0       0       3       3       1165   0      0       0       200     3857
047641   SAGEHEN CREEK  tasmin  39.432    -120.241   1931.518    1339      / 5236       0       0       2       6       1244   0      0       0       147     3824
047641   SAGEHEN CREEK  precip  39.432    -120.241   1931.518    2333      / 5236       17      0       0       0       1614   60     25      0       0       2829

NOTE: # missing (7th column) were counted after QC was performed.

------ Data Measurement Flags ------
A        Accumulated amount since last measurement.
B        Accumulated amount includes estimated values (since last measurement).
E        Estimated
J        Value has been manually validated
M        Missing
S        Included in a subsequent value.
T        Trace
(        Expert system edited value, not validated.
)        Expert system approved edited value.

NOTE:
- Flag values of S and A usually occur in pairs (i.e. a daily value will have Flag assigned as S and the next daily value will have Flag assigned as A). For some dai
- Other values occasionally appear in Data Measurement Flags for which documentation is not currently available.

------ Data Quality Flags ------
0        Valid data element.
1        Valid data element (from "unknown" source, pre-1982).
2        Invalid data element (subsequent value replaces original value).
```

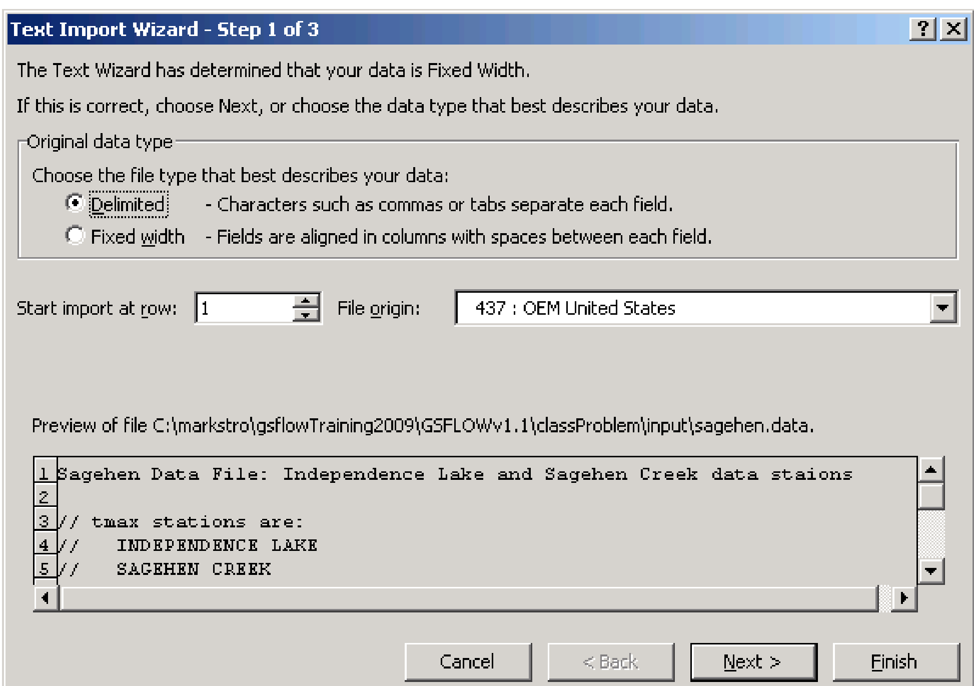
Creating a PRMS Data File with a text editor

Create the PRMS Data File according to the description on pages 139 - 142 of *GSFLOW - Coupled Ground-Water and Surface-Water Flow Model Based on the Integration of the Precipitation-Runoff Modeling System (PRMS) and the Modular Ground-Water Flow Model (MODFLOW-2005)* (http://pubs.er.usgs.gov/publication/tm6D1).

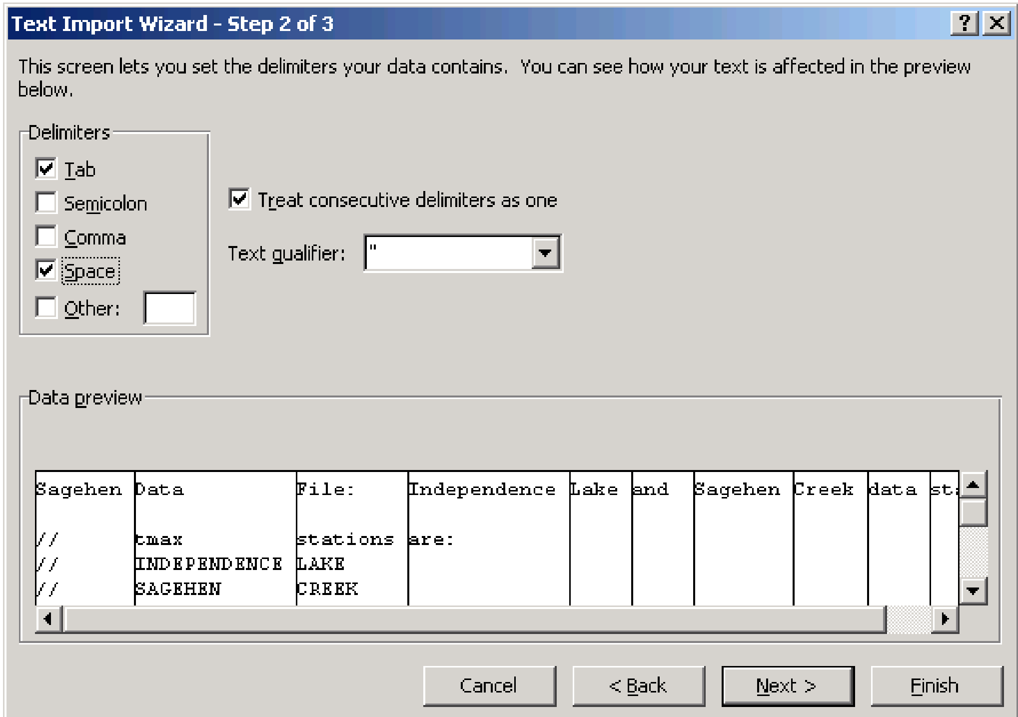
People have successfully created this file on Linux based systems using the cut, paste, and awk utilities. Also, people have successfully created this file on PC based systems using text editors and/or spreadsheet programs.

Computation of Lapse Rates/Monthly Means using Excel

Start MS Excel. Select Data->From Text and browse to the PRMS Data File (sagehen.data). Choose "Delimited" in Step 1 of the Text Import Wizard.

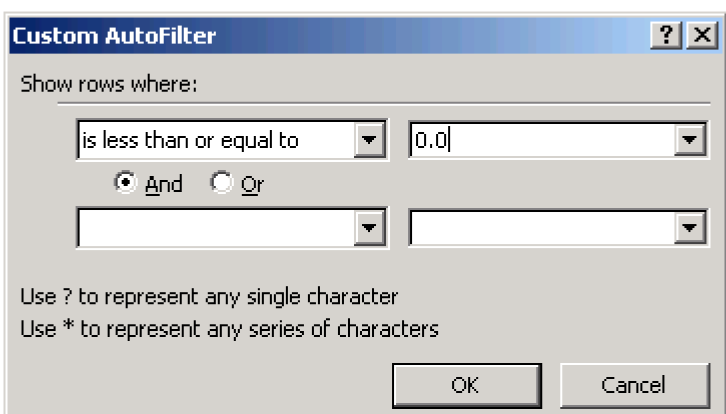


Check on "Space" in Step 2 of the Text Import Wizard.

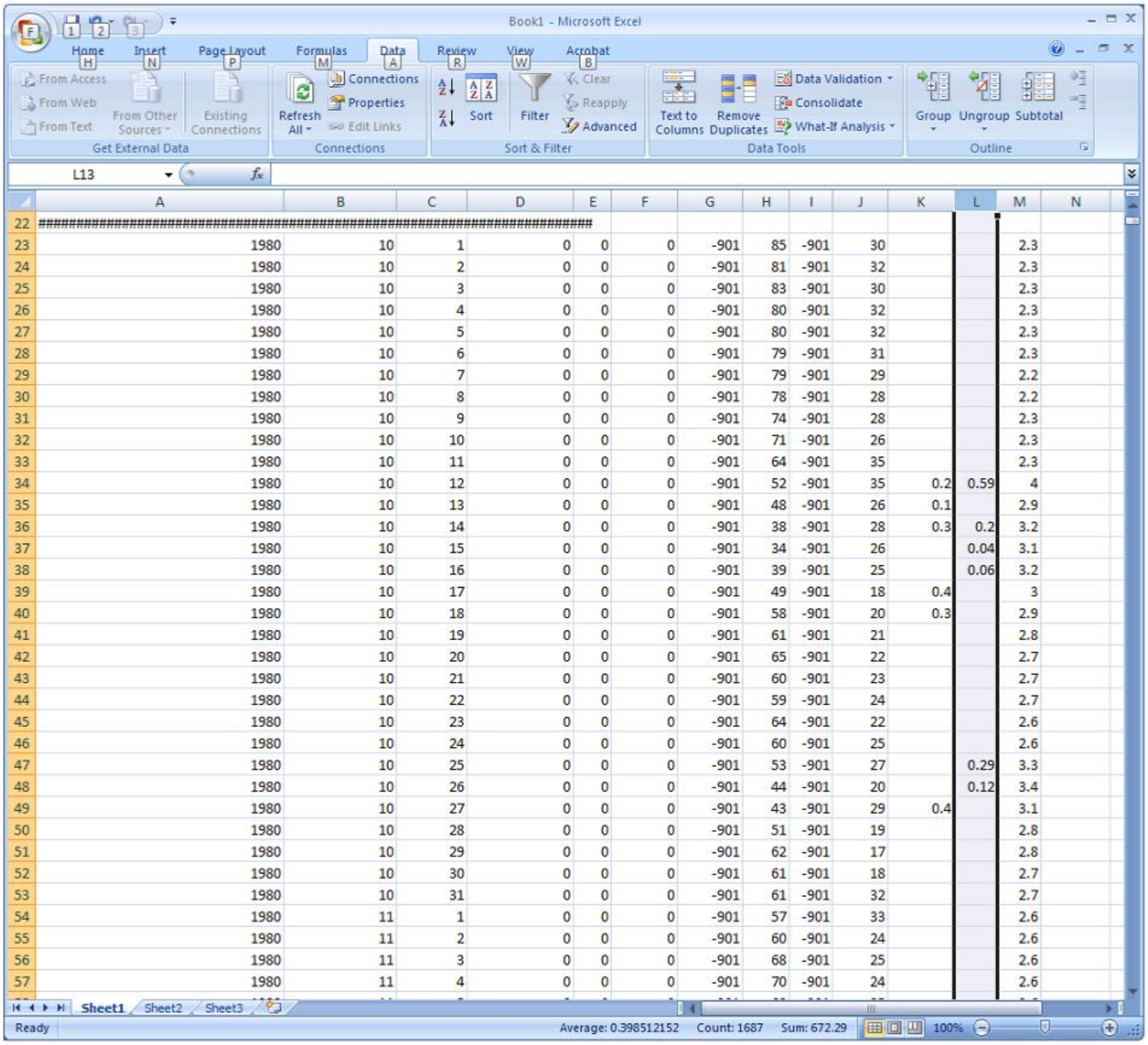


Click on Finish in Step 3 of the Text Import Wizard.

Column K is the precipitation values for Independence Lake SNOTEL and column L is the precipitation values for Sagehen Creek COOP. Click on the column K label heading and then click on Data-> Filter. Choose Number Filter->Less Than or Equal To for column K. Enter 0.0 into the box next to is less than or equal to.



Right click on column K header and select Clear Contents. This blanks out all cells which are less than or equal to zero. Repeat this process for column L too.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
22	##													
23	1980	10	1	0	0	0	-901	85	-901	30			2.3	
24	1980	10	2	0	0	0	-901	81	-901	32			2.3	
25	1980	10	3	0	0	0	-901	83	-901	30			2.3	
26	1980	10	4	0	0	0	-901	80	-901	32			2.3	
27	1980	10	5	0	0	0	-901	80	-901	32			2.3	
28	1980	10	6	0	0	0	-901	79	-901	31			2.3	
29	1980	10	7	0	0	0	-901	79	-901	29			2.2	
30	1980	10	8	0	0	0	-901	78	-901	28			2.2	
31	1980	10	9	0	0	0	-901	74	-901	28			2.3	
32	1980	10	10	0	0	0	-901	71	-901	26			2.3	
33	1980	10	11	0	0	0	-901	64	-901	35			2.3	
34	1980	10	12	0	0	0	-901	52	-901	35	0.2	0.59	4	
35	1980	10	13	0	0	0	-901	48	-901	26	0.1		2.9	
36	1980	10	14	0	0	0	-901	38	-901	28	0.3	0.2	3.2	
37	1980	10	15	0	0	0	-901	34	-901	26		0.04	3.1	
38	1980	10	16	0	0	0	-901	39	-901	25		0.06	3.2	
39	1980	10	17	0	0	0	-901	49	-901	18	0.4		3	
40	1980	10	18	0	0	0	-901	58	-901	20	0.3		2.9	
41	1980	10	19	0	0	0	-901	61	-901	21			2.8	
42	1980	10	20	0	0	0	-901	65	-901	22			2.7	
43	1980	10	21	0	0	0	-901	60	-901	23			2.7	
44	1980	10	22	0	0	0	-901	59	-901	24			2.7	
45	1980	10	23	0	0	0	-901	64	-901	22			2.6	
46	1980	10	24	0	0	0	-901	60	-901	25			2.6	
47	1980	10	25	0	0	0	-901	53	-901	27		0.29	3.3	
48	1980	10	26	0	0	0	-901	44	-901	20		0.12	3.4	
49	1980	10	27	0	0	0	-901	43	-901	29	0.4		3.1	
50	1980	10	28	0	0	0	-901	51	-901	19			2.8	
51	1980	10	29	0	0	0	-901	62	-901	17			2.8	
52	1980	10	30	0	0	0	-901	61	-901	18			2.7	
53	1980	10	31	0	0	0	-901	61	-901	32			2.7	
54	1980	11	1	0	0	0	-901	57	-901	33			2.6	
55	1980	11	2	0	0	0	-901	60	-901	24			2.6	
56	1980	11	3	0	0	0	-901	68	-901	25			2.6	
57	1980	11	4	0	0	0	-901	70	-901	24			2.6	

Mean precipitation amount can be computed from these two columns for days with precipitation. For example, to compute mean monthly precipitation for January, filter column B to show the values for month 1 only. The average value for a station will be the average precipitation (on days with precipitation) for the selected month. These averages can vary greatly depending on which years are included in the analysis, so be sure and choose years that are representative of the simulation time period.

The results of this for both stations, for all months have already been computed and are located in the Excel worksheet sagehenLapseRates.xls.

Making GSFLOW maps

Before Starting

GOAL: Make sure that the GIS software and the basic spatial data sets are ready to go.

Arcmap with Archydro and XTool Pro installed

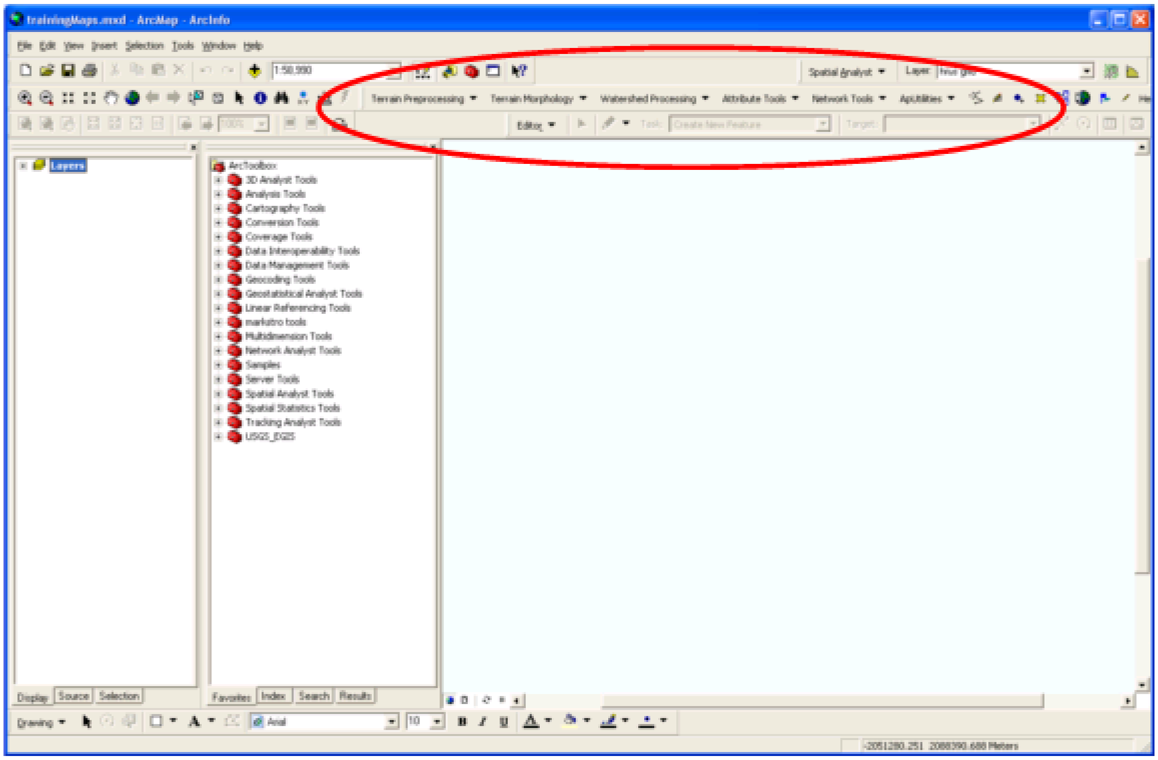
General notes about ArcMap:

- If tools/windows give an unexpected error, shorten the path names
- If tools/windows give an unexpected error, exit and restart ArcMap.
- In general, anything produced by ArcMap should be moved, copied, deleted, etc. with ArcCatalog.

Start the ArcMap application by double clicking on the gis\sagehenGIS.mxd. This will start the Sagehen GIS project with the necessary starting data preloaded. Check to make sure that the ArcHydro extension is installed (requires admin rights) and ArcHydro toolbox is added to the ArcToolbox (does not requires admin rights).

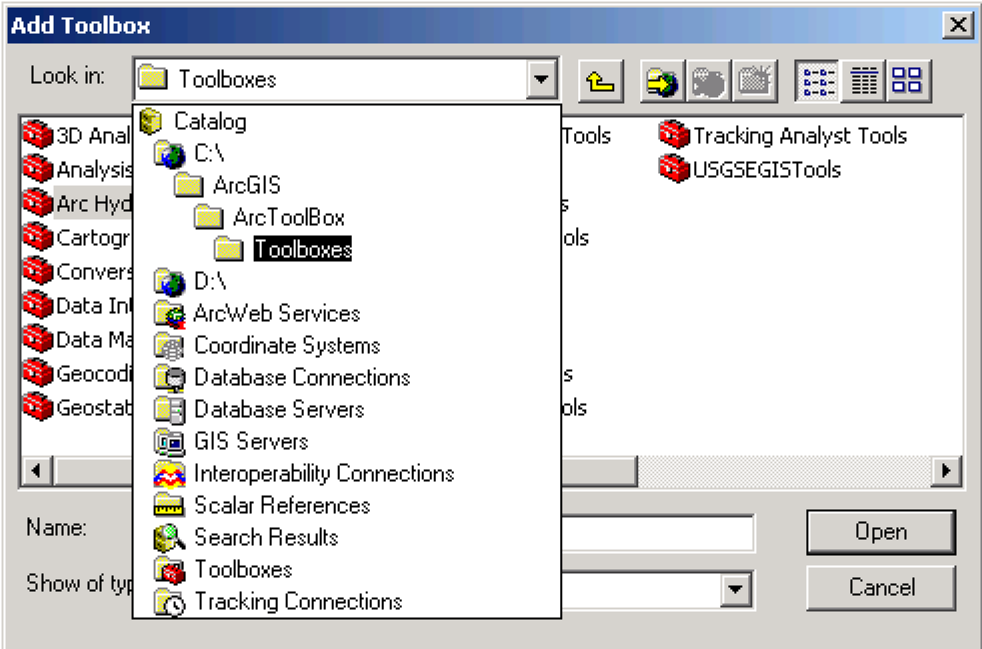
http://www.crwr.utexas.edu/giswr/hydro/ArcHOSS/index.cfm

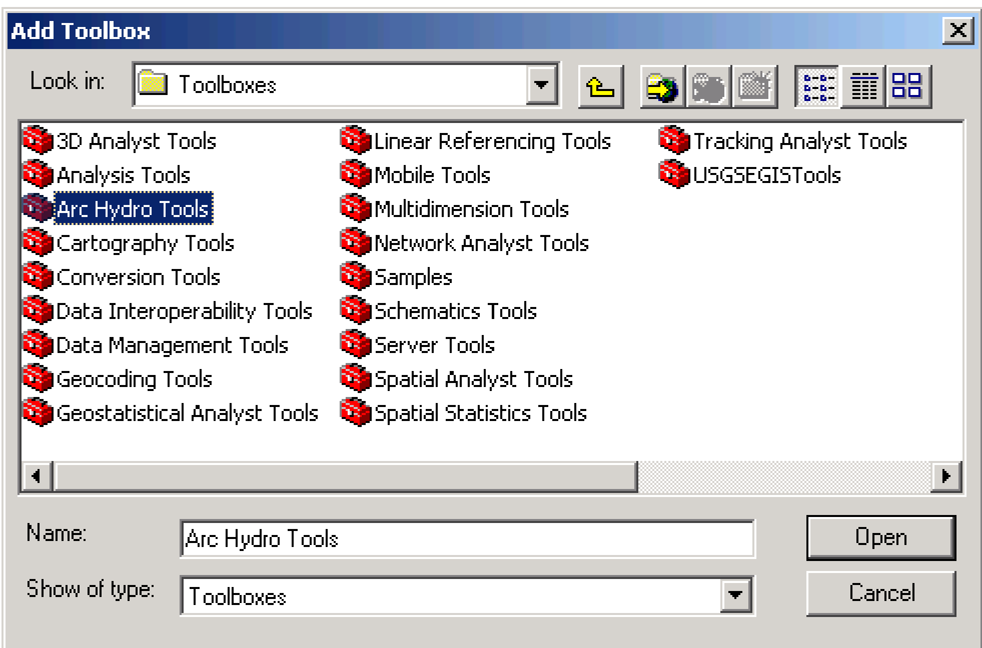
http://support.esri.com/index.cfm?fa=downloads.dataModels.filteredGateway&dmid=15



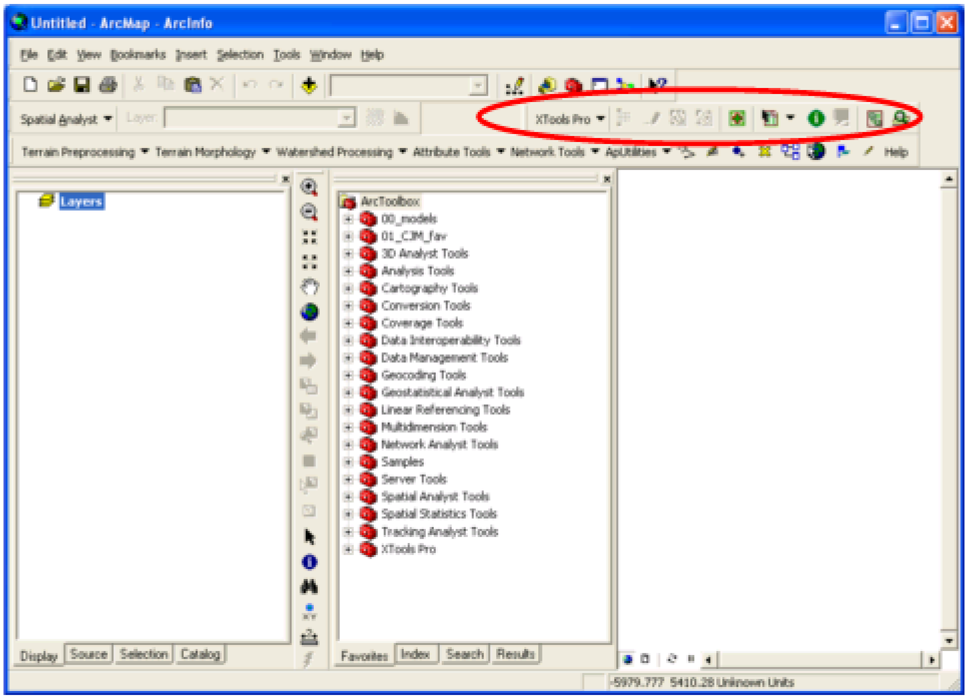
If the ArcHydro toolbar is not visible Click: View->Toolbars->Arc Hydro Tools 9

If ArcHydro toolbox is not present in the ArcToolbox, add the Archydro Tool box, right click on the ArcToolbox root node and choose Add Toolbox.





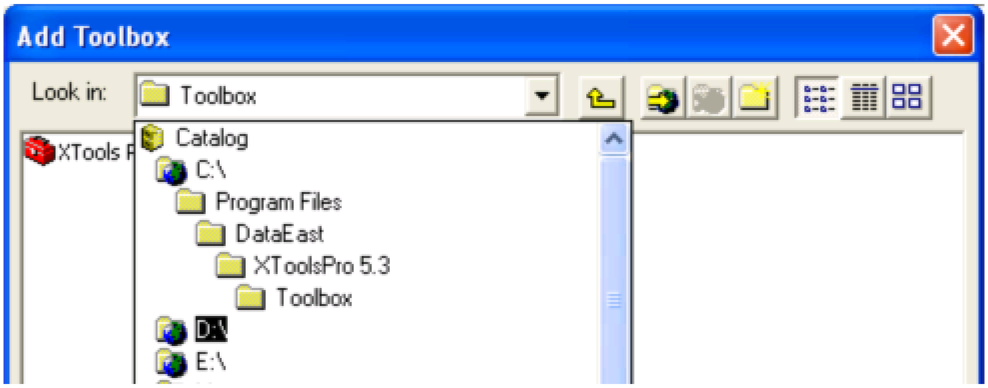
Check to make sure that the XTools Pro extension is installed (requires admin rights) and XToolsPro toolbox is added to the ArcToolbox (does not requires admin rights). The USGS has an enterprise license for this extension. If you are a USGS employee, have your system administrator install and configure XToolsPro for you.

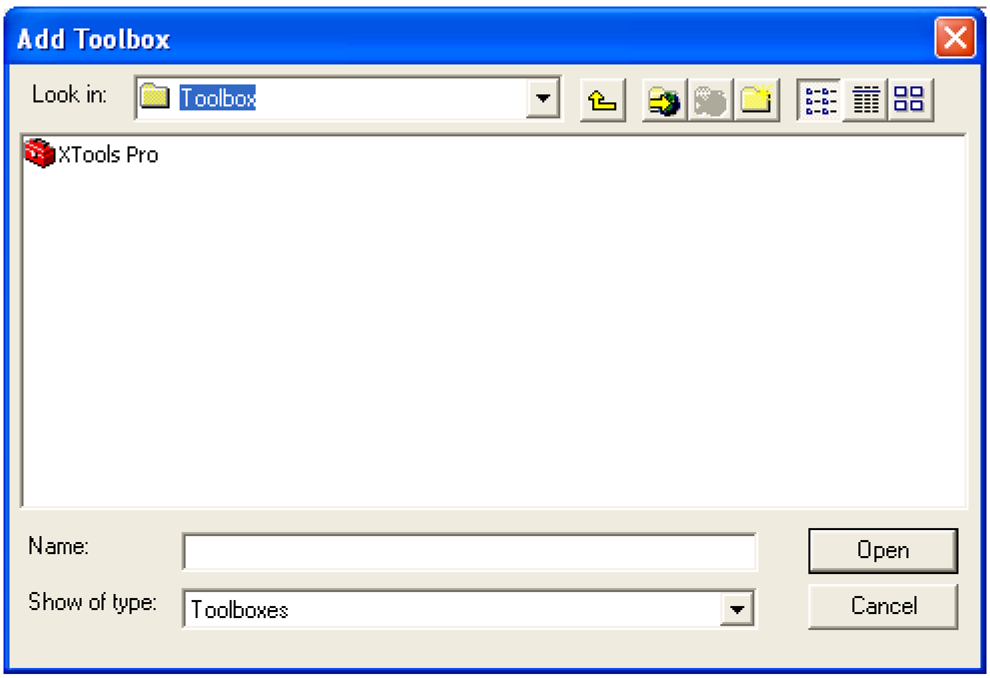


Confirm that the XTools Pro extension is turned on. Tool->Extensions->XTools Pro

If the XTools Pro toolbar is not visible Click: View->Toolbars-> XTools Pro

If XTools Pro toolbox is not present in the ArcToolbox, add the XTools Pro Toolbox, right click on the ArcToolbox root node and choose Add Toolbox.





This example problem uses an ESRI "Personal Geodatabase." There are many reasons for this, but ease of set up, distribution, and use are primary ones. Also, it is possible to query the spatial data directly with the Microsoft Access application.

Set the "Environments" for the ArcMap Project

Here's ESRI's webpage describing environment settings:

http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=An_overview_of_geoprocessing_environments

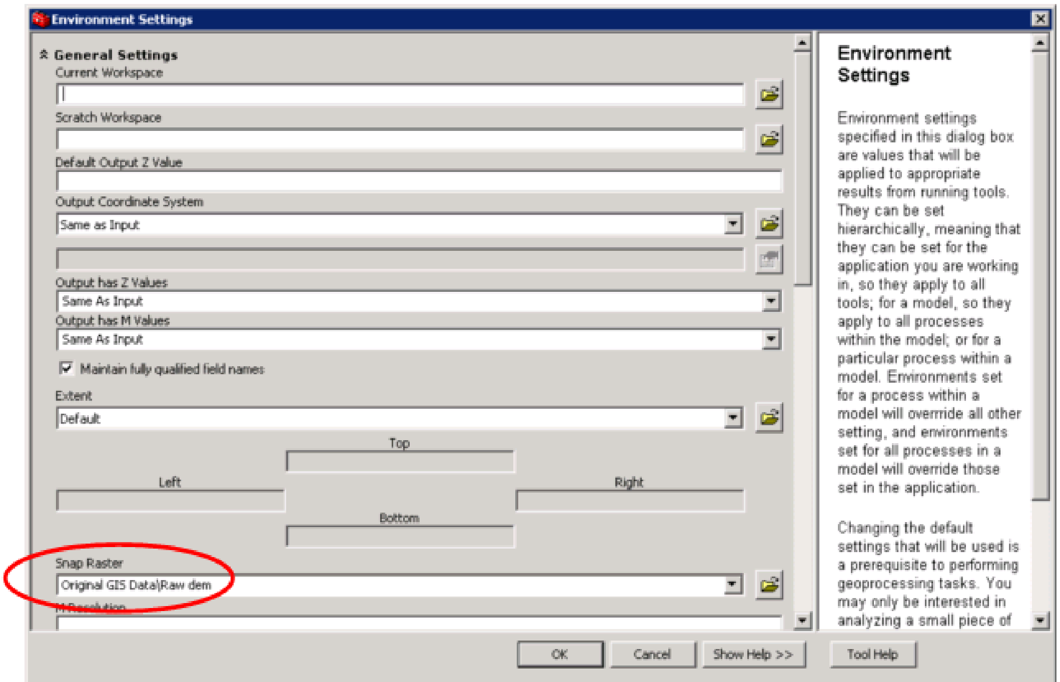
If the Environment is set for the ArcMap project, it will retain those settings during any geoprocessing within the project, i.e. Toolbox, toolbars (such as Spatial Analyst), ModelBuilder, etc. If the Environment is set only with the Toolbox, the settings will be retained during any geoprocessing within the toolbox. Also, environments can be set for individual tools as well. For this example, make sure that the environments are set for the entire project.

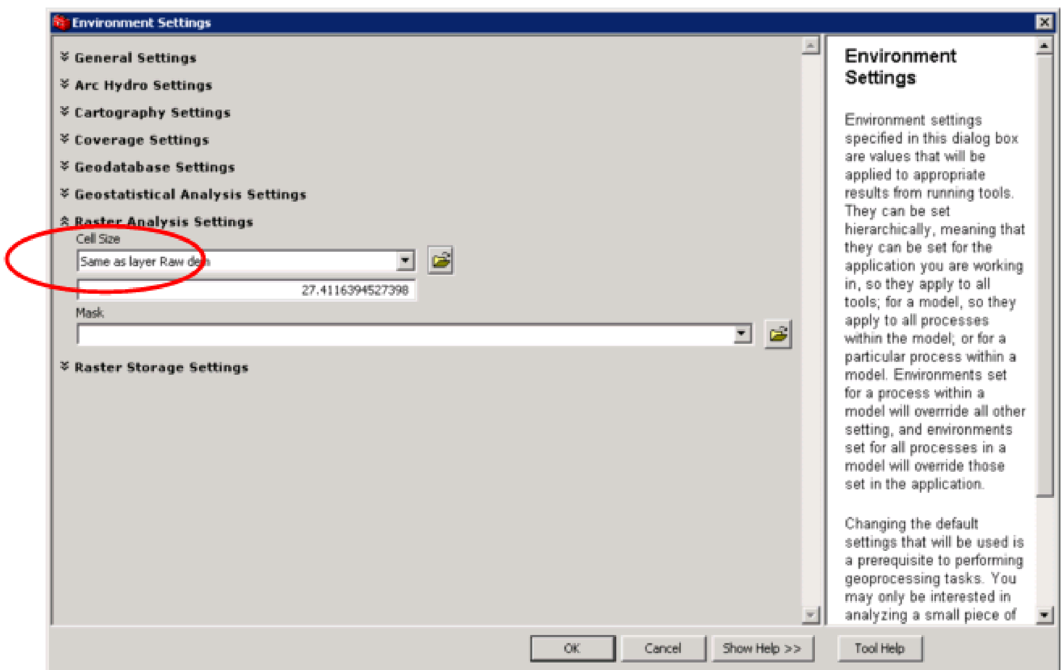
Within the environments, it is possible to set the current and scratch workspace (workspaces for inputs and outputs), the extent, and output coordinate system. More importantly, the cell size (especially for MODFLOW models) and the snap raster can be set. The snap raster setting is what lines everything up, so subsequent maps don't have slivers. Usually, it is a good idea to set the snap raster to the original DEM:

http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=How_Snap_Raster_works

However, the MODFLOW cells the DEM are rarely the same size. So, the cell size can be fixed as a ratio of the original DEM or the cell size can be set to the desired model cell size and interpolation will be used to adjust the cells to that specified size as it is being snapped to the raster.

Now, on how to physically set the environments. To set the environments within the ArcMap project, Tools>Options>Geoprocessing>Environments. Once in the Environment Settings dialog box, the Snap Raster can be set under General Settings.



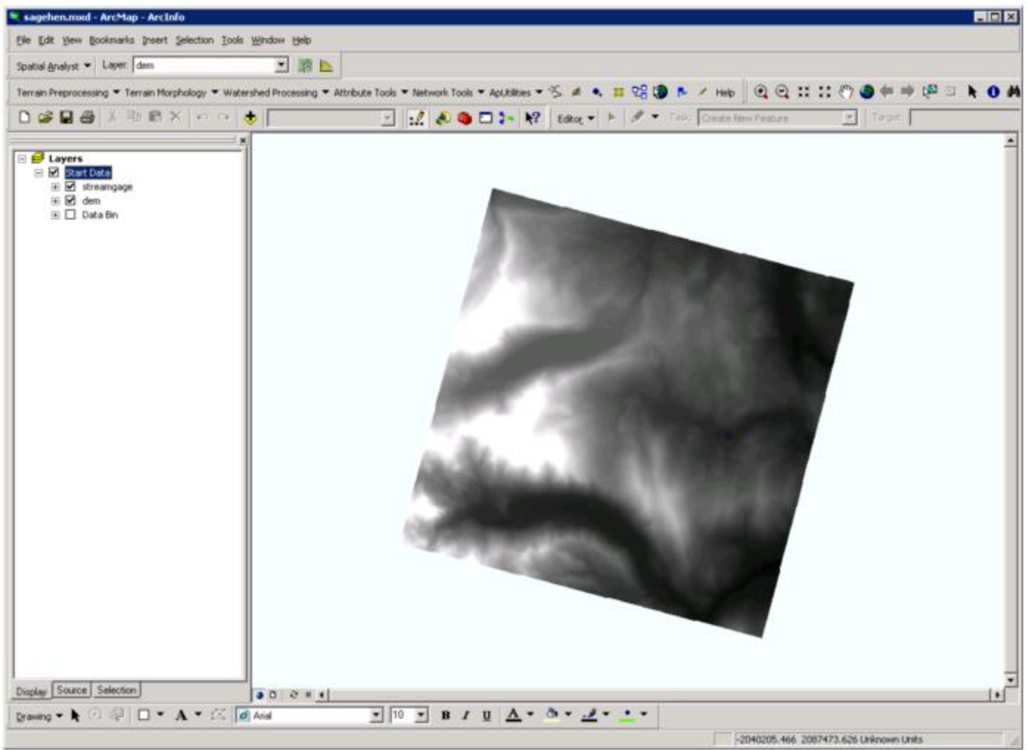


Check the Digital Elevation Model (DEM) raster map

A DEM which covers the model domain is required. The DEM for the Sagehen example problem is located in Start Data->dem. DEMs for other basins can be obtained from the USGS "Seamless" server (http://ned.usgs.gov/downloads.asp).

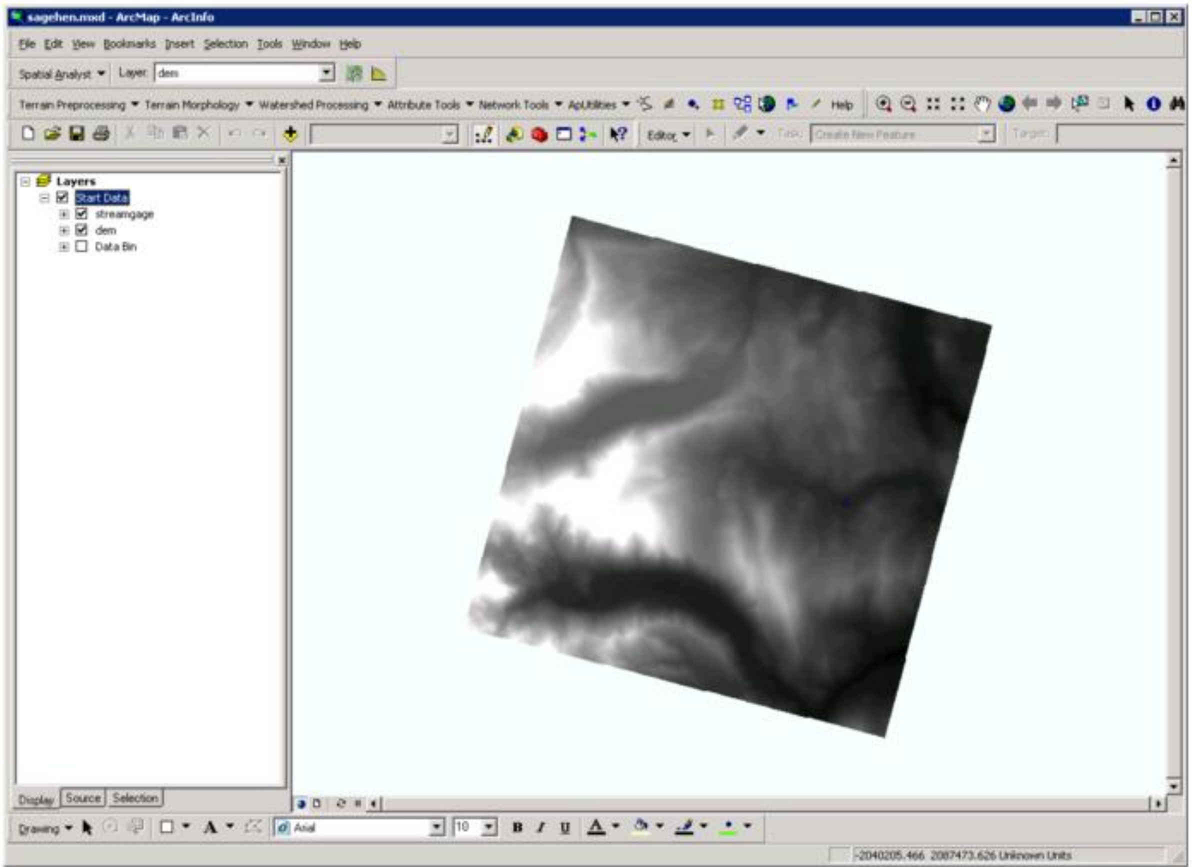
Check the streamgage map

In this exercise, a point corresponding to a streamgage location will be used to help define the model domain. Load this point with is located in Start Data->streamgage.



Data Bin raster maps

The Data Bin folder contains raster maps of information that will be needed to estimate spatially distributed parameters for GSFLOW. This includes: (1) available water holding capacity of the soil (awc1k), (2) clay content of the soil (clayav1k), (3) vegetation density (density1k), (4) land use/land cover (lulc1k), (5) soil depth to bed rock (rockdep1k), and (6) sand content of the soil (sandave1k).

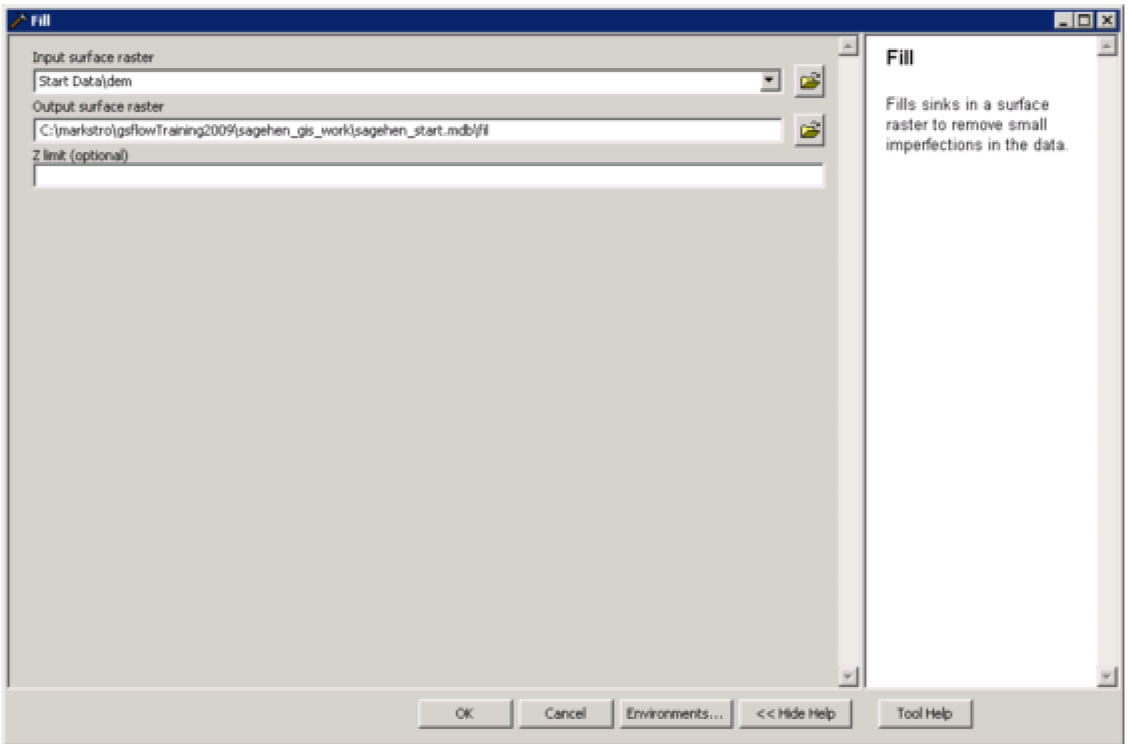


DEM Reconditioning

GOAL: Process the DEM so it is ready for GSFLOW modeling.

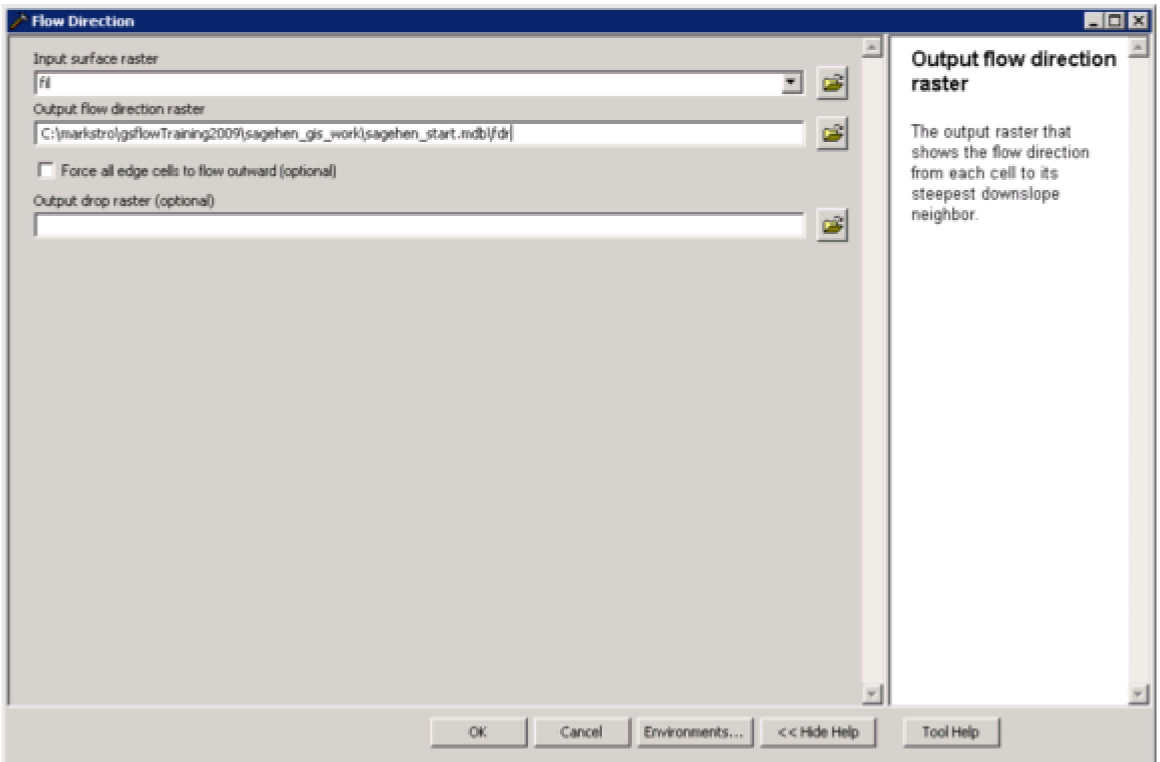
Fill the DEM

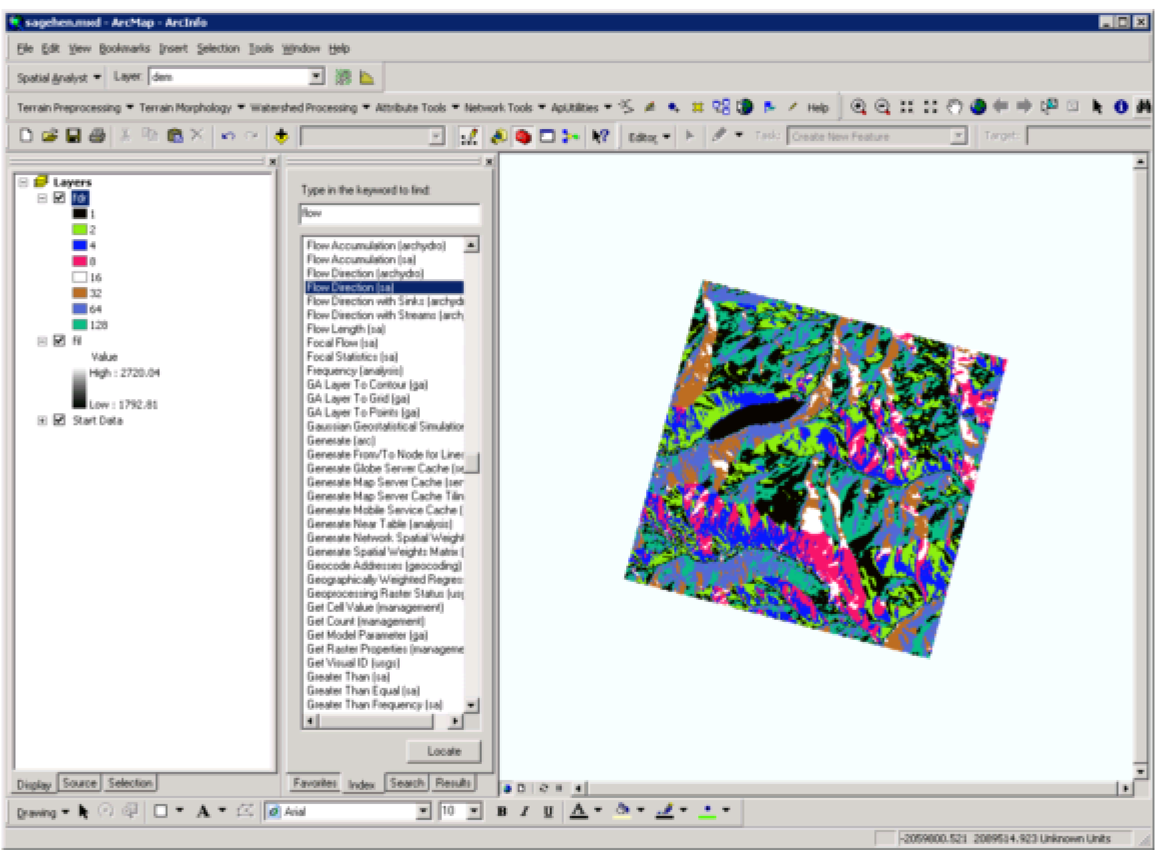
Sinks may exist in the DEM. These must be filled using Fill (Spatial Analyst) tool. Access all tools using the ArcMap Search window. Use Raw dem as the input. Browse to the raster\ folder and name the new raster map fil. Click OK.



Determine Flow Direction

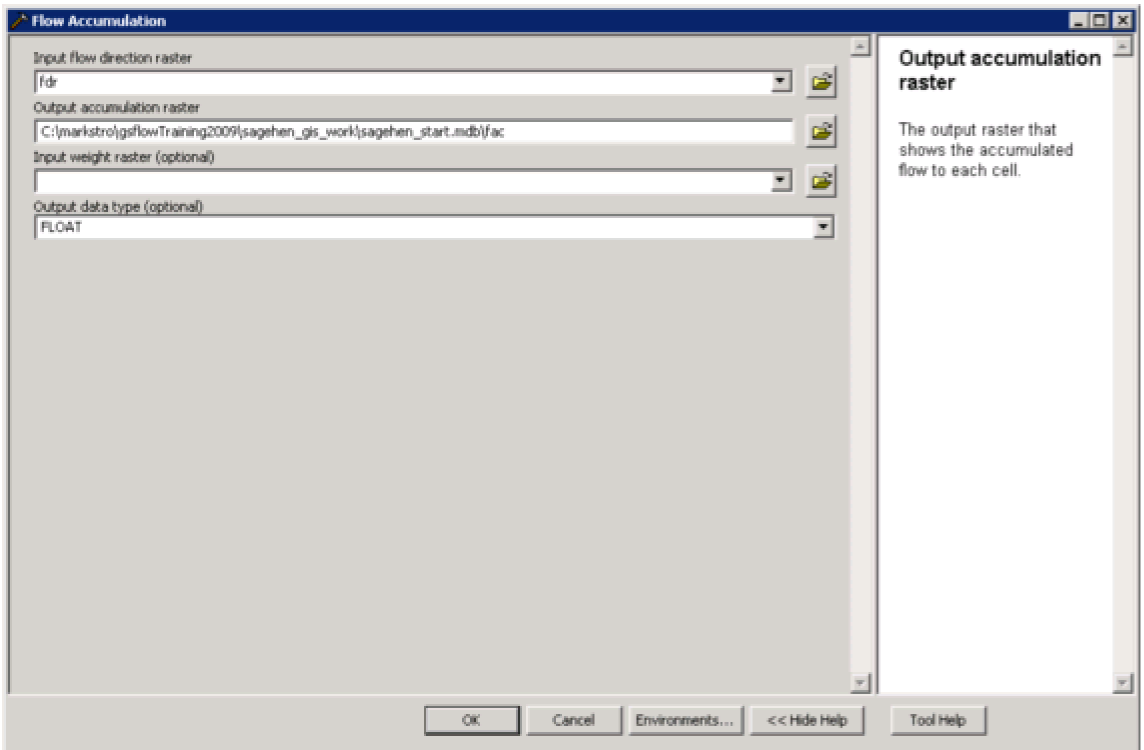
For each raster cell in fil the flow direction is calculated. These must be done using the Flow Direction (Spatial Analyst) tool. Name the map fdr.

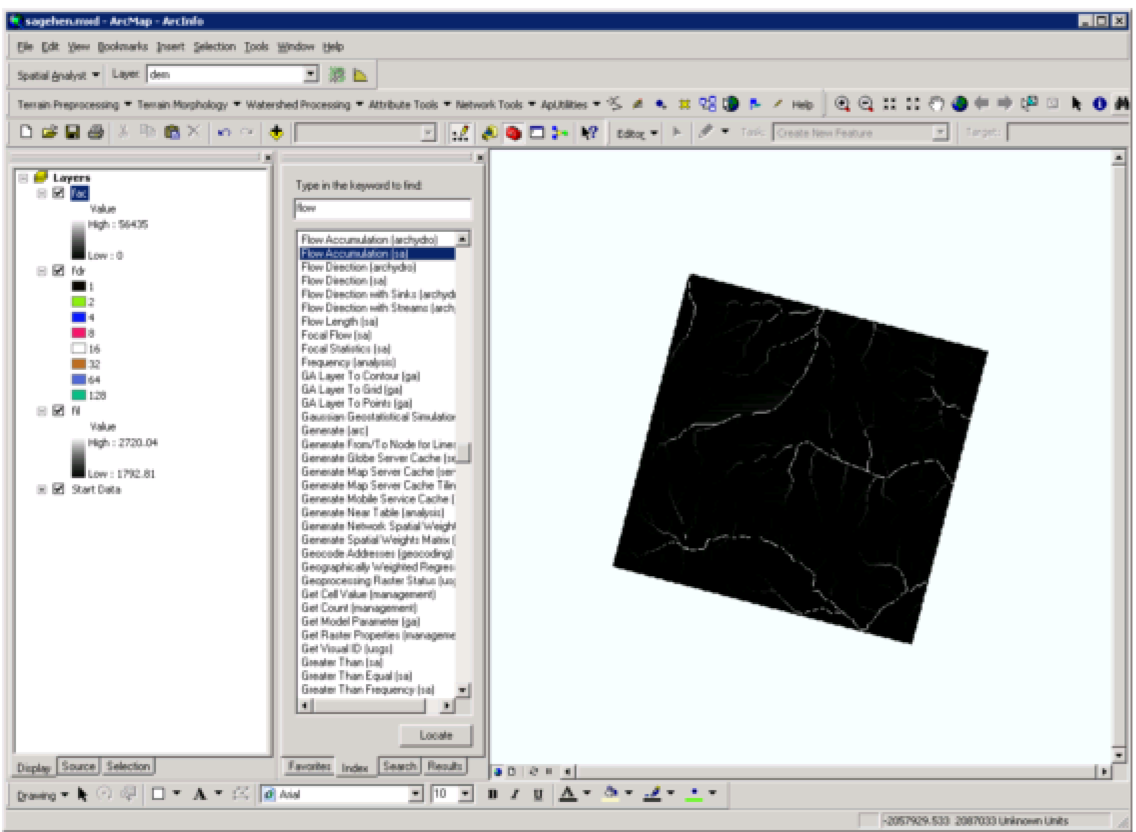

Flow Direction
Input surface raster
fil
Output flow direction raster
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\fdr
Force all edge cells to flow outward (optional)
Output drop raster (optional)
Output flow direction raster
The output raster that shows the flow direction from each cell to its steepest downslope neighbor.
OK
Cancel
Environments...
<< Hide Help
Tool Help


sagehen.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Layers
fdr
1
2
4
8
16
32
64
128
fil
Value
High : 2720.04
Low : 1792.81
Start Data
Type in the keyword to find:
flow
Flow Accumulation (archydro)
Flow Accumulation (sa)
Flow Direction (archydro)
Flow Direction (sa)
Flow Length (sa)
Focal Flow (sa)
Focal Statistics (sa)
Frequency (analysis)
Locate
Display Source Selection
Favorites Index Search Results

Determine Flow Accumulation

For each raster cell in fdr, the flow accumulation is calculated. This is done using the Flow Accumulation (Spatial Analyst) tool. Name the map fac.



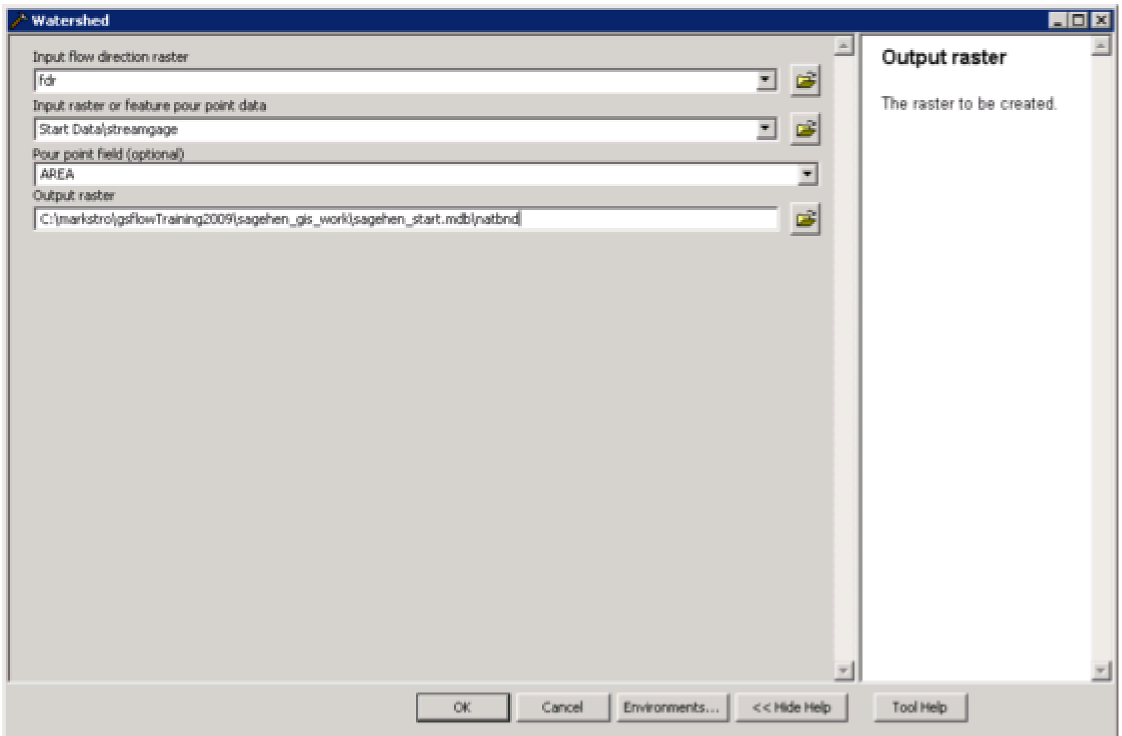


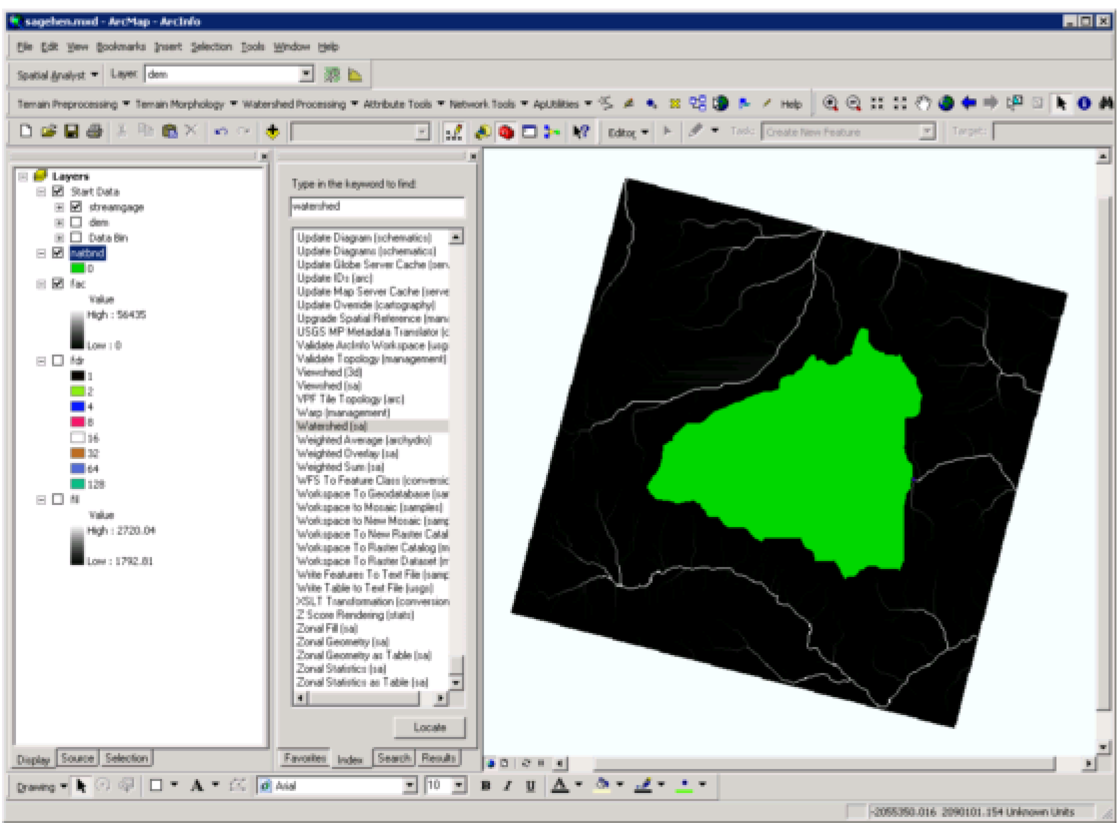
After all of these map have been created, save the Sagehen ArcMap project by clicking File->Save.

Delineation of Spatial Modeling Features for GSFLOW

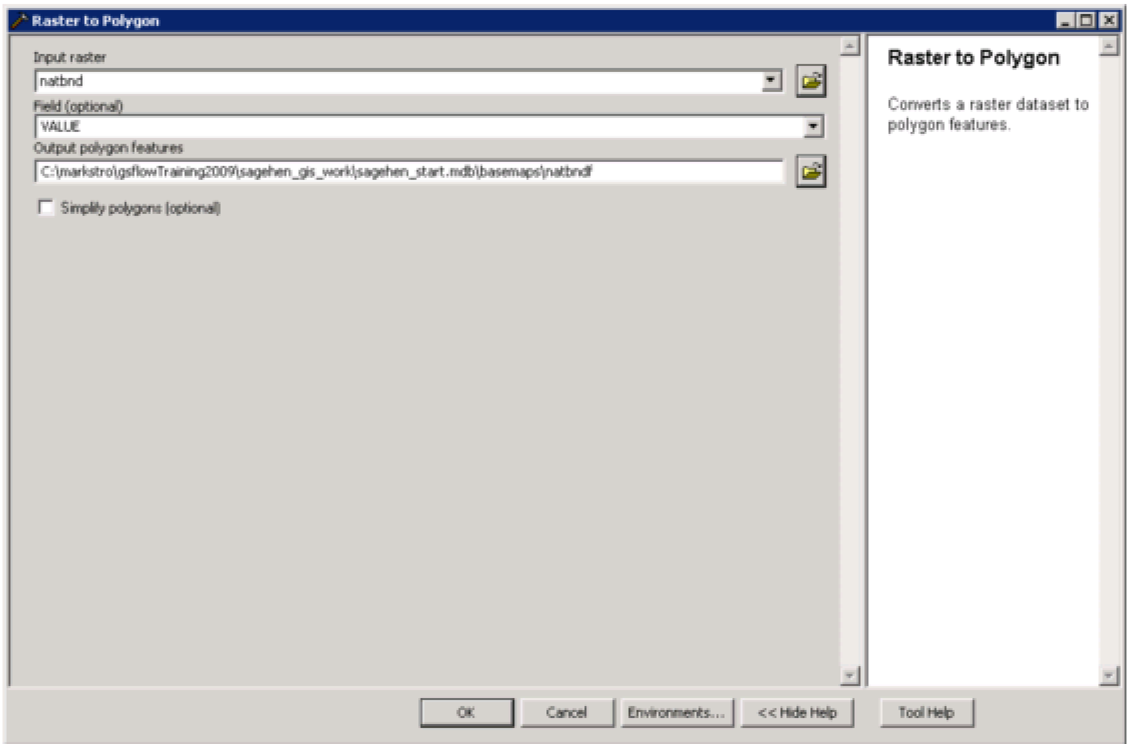
Natural Watershed Boundary

Use the Watershed (sa) tool to determine the natural watershed boundary. Use the fdr and streamgage maps as input.


Watershed
Input flow direction raster
fdr
Input raster or feature pour point data
Start Data\streamgage
Pour point field (optional)
AREA
Output raster
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\natbnd
Output raster
The raster to be created.
OK
Cancel
Environments...
<< Hide Help
Tool Help


sagehen.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Spatial Analyst
Layer: dem
Terrain Preprocessing
Terrain Morphology
Watershed Processing
Attribute Tools
Network Tools
ApUtilities
Help
Layers
Start Data
streamgage
dem
Data Bin
natbnd
fac
fdr
fil
Type in the keyword to find:
watershed
Locate
Display
Source
Selection
Favorites
Index
Search
Results
Drawing
Arial

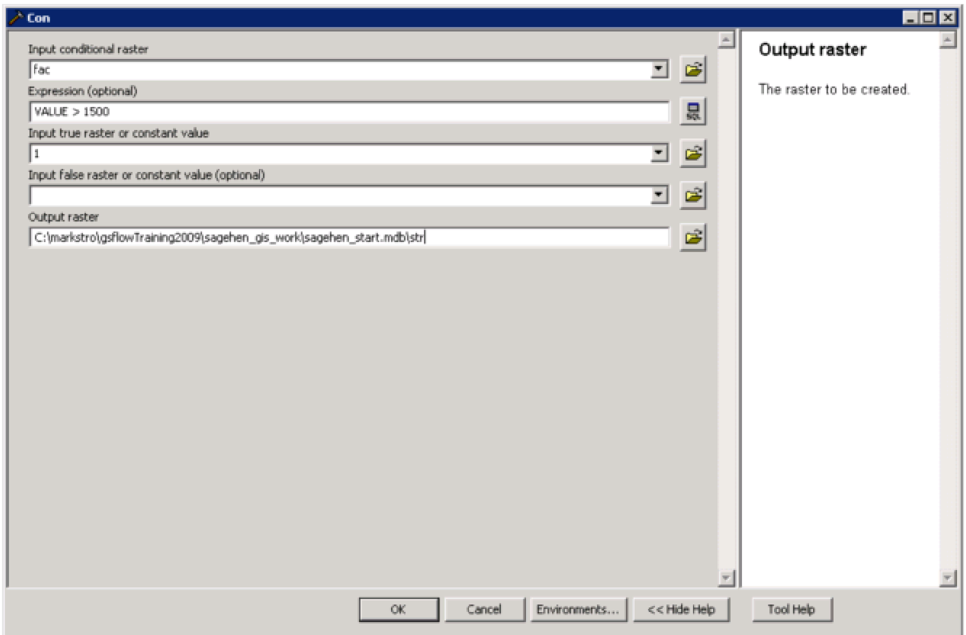
Name the output natbnd. Use the Raster to Polygon (conversion) tool to make a feature map. Name the output natbndf. Make sure the Simplify polygons box is unchecked.

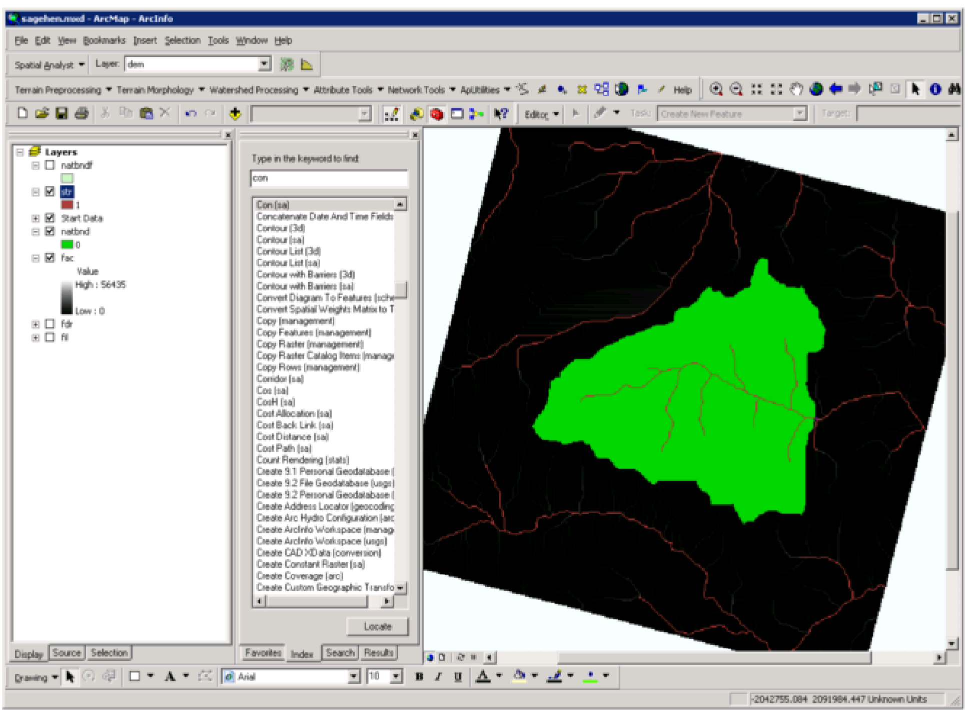


After this map has been created, save the Sagehen ArcMap project by clicking File->Save.

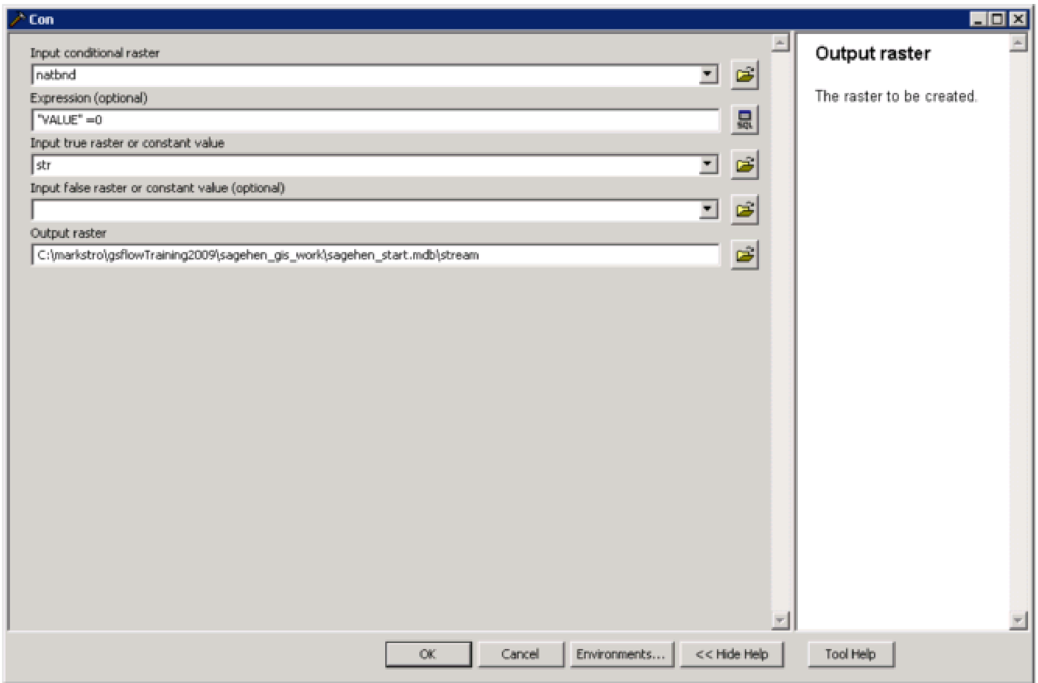
Generation of the Stream Segment map

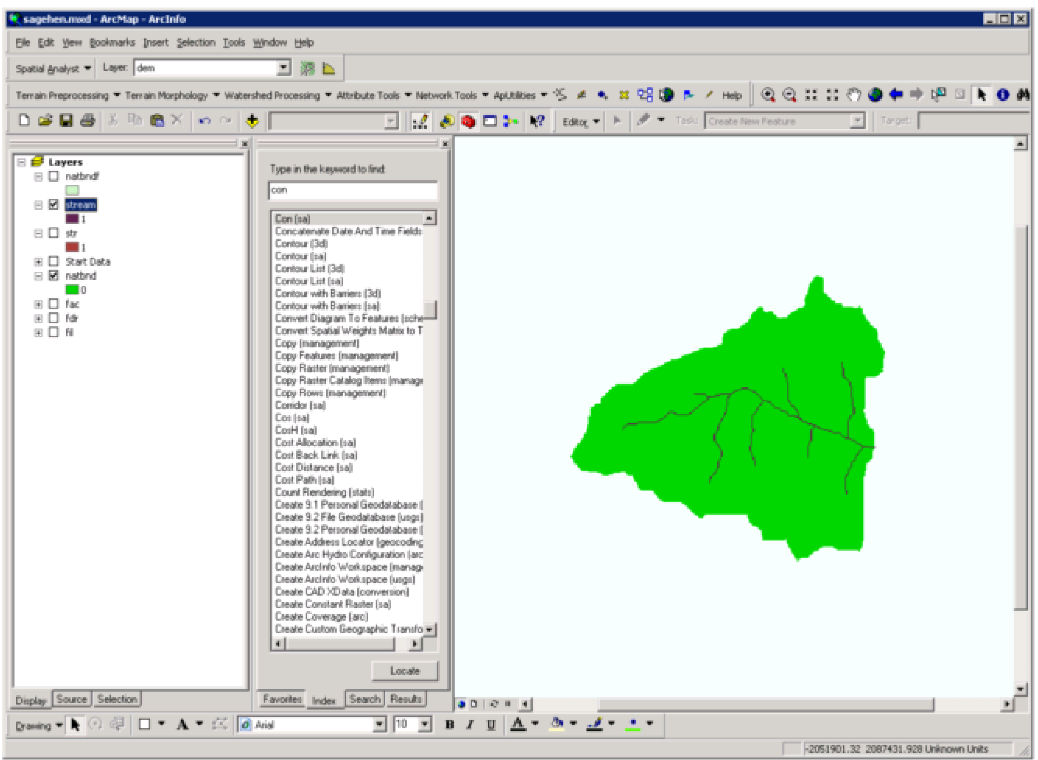
Find the location of the streams using the flow accumulation (fac) surface. Use the Con (sa) tool to create a new raster map that has a value of 1 in every cell that has a flow accumulation over 1500 cells, and NO DATA in all other cells. Name the output raster str.



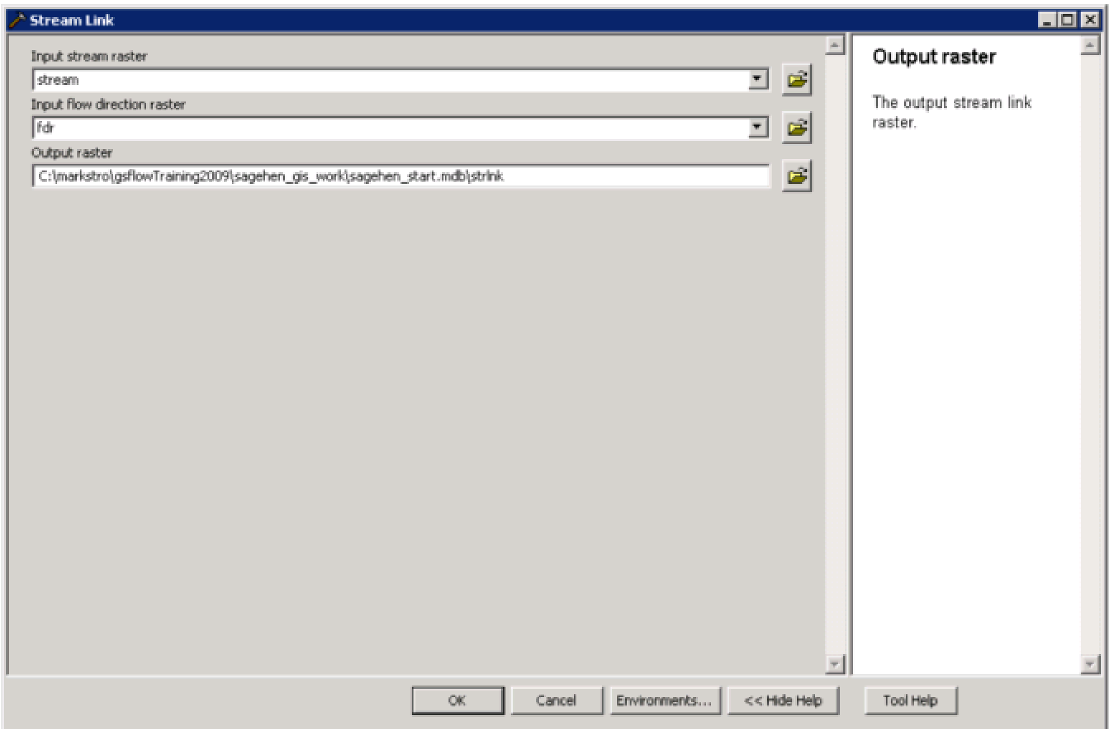


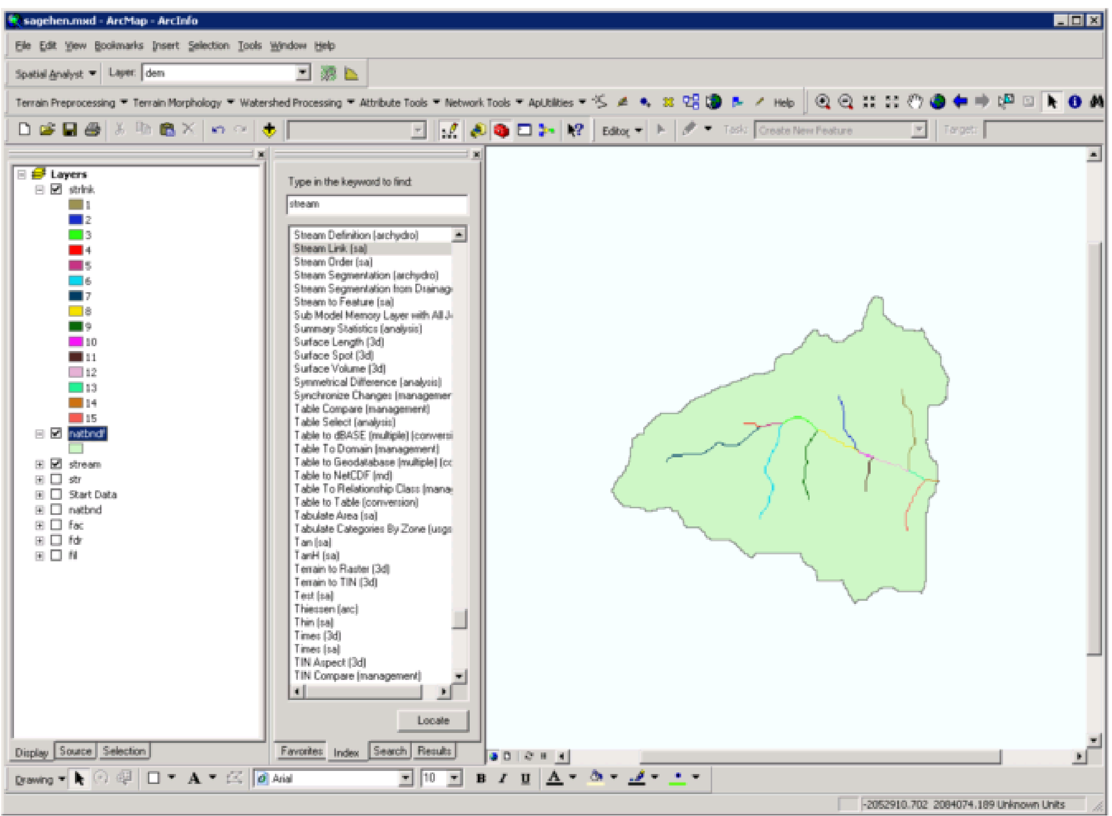
Use the Con (sa) tool to get rid of streams outside of Natural Boundary. Use the settings as shown below. This makes the raster map Stream.



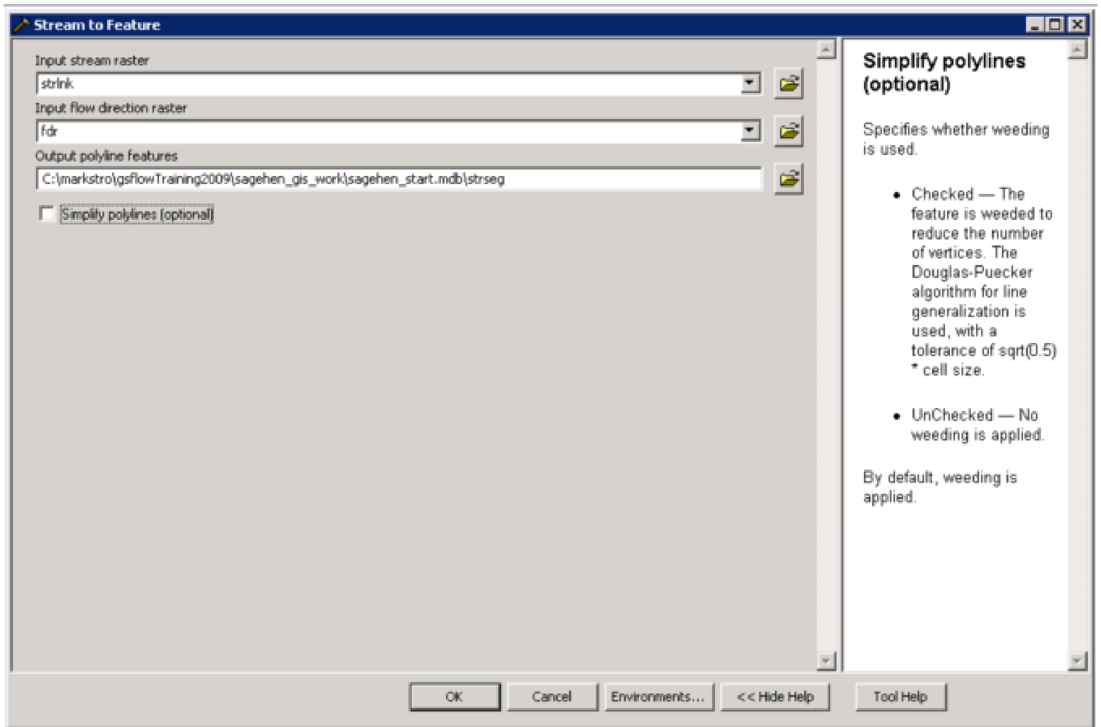


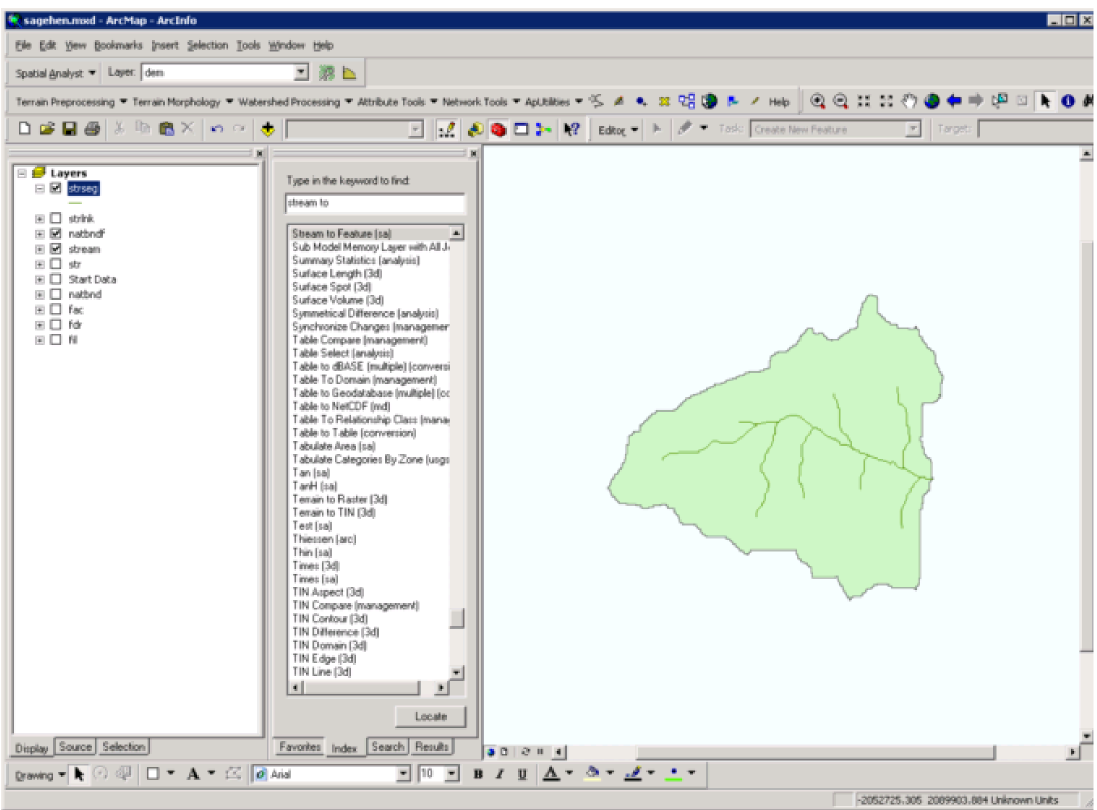
Use the Stream Link (sa) tool to break the stream raster map into stream segments. This makes the raster map StrLnk.


Stream Link
Input stream raster
stream
Input flow direction raster
fdr
Output raster
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\strlnk
Output raster
The output stream link raster.
OK
Cancel
Environments...
<< Hide Help
Tool Help

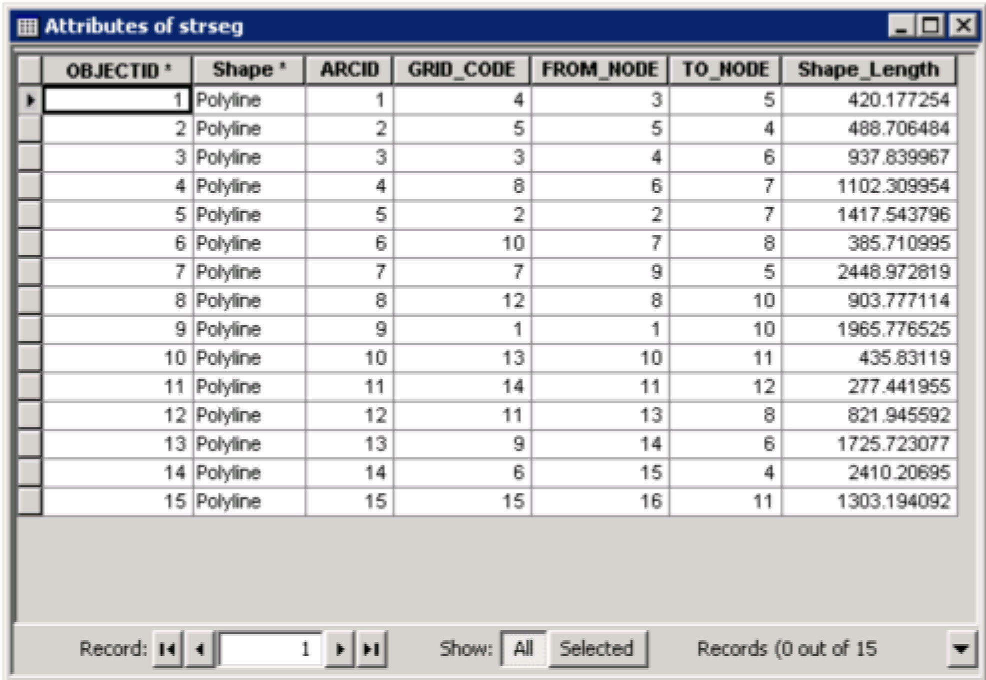

sagehen.mxd - ArcMap - ArcInfo
Layers
strlnk
natbndf
stream
str
Start Data
natbnd
fac
fdr
fil
Type in the keyword to find:
stream
Stream Definition (archydro)
Stream Link (sa)
Stream Order (sa)
Stream Segmentation (archydro)
Stream to Feature (sa)
Locate
-2052910.702 2084074.189 Unknown Units

Use the ArcMap tool Stream to Feature (sa) tool to make features and add connectivity and flow direction. Click off the check box to Simplify polygons. Name the output strseg.





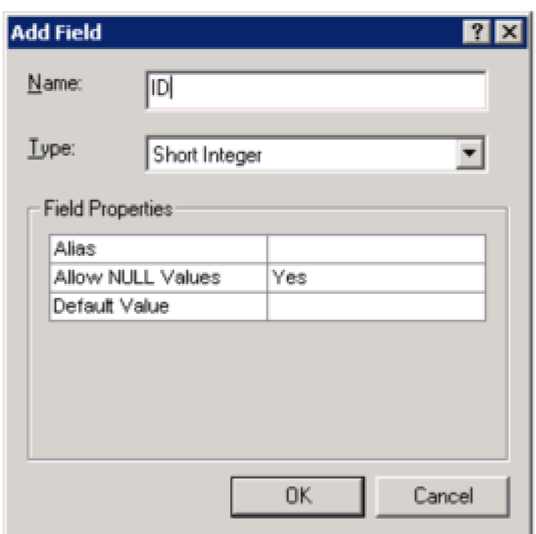
Right click on strseg in the ArcMap tree and select Open Attribute Table.


Attributes of strseg

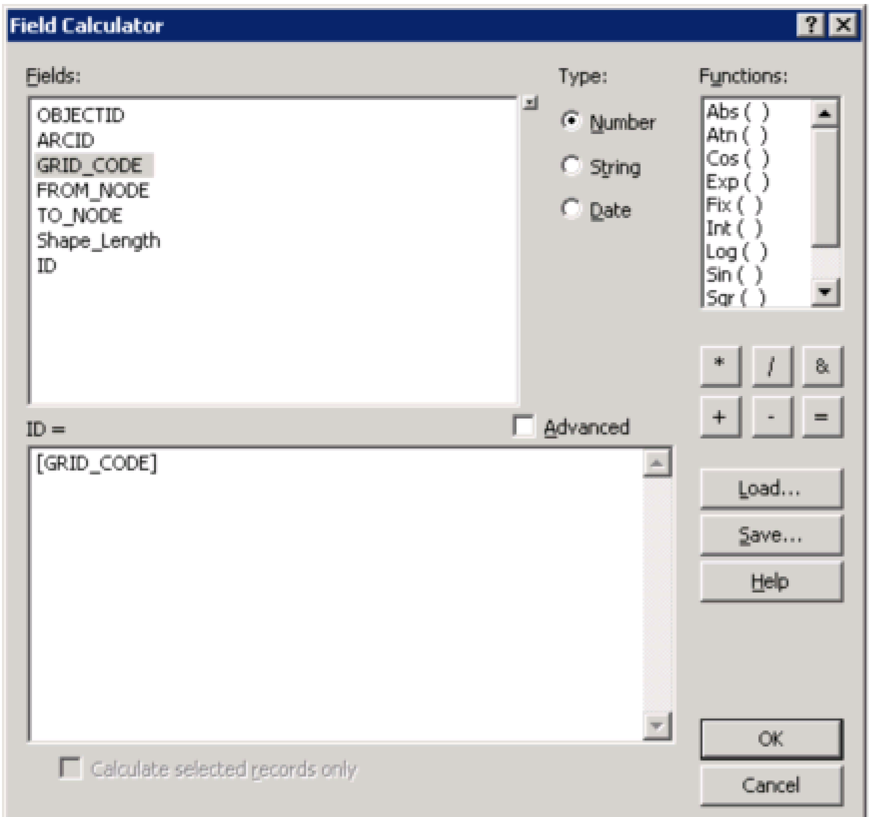
OBJECTID *	Shape *	ARCID	GRID_CODE	FROM_NODE	TO_NODE	Shape_Length
1	Polyline	1	4	3	5	420.177254
2	Polyline	2	5	5	4	488.706484
3	Polyline	3	3	4	6	937.839967
4	Polyline	4	8	6	7	1102.309954
5	Polyline	5	2	2	7	1417.543796
6	Polyline	6	10	7	8	385.710995
7	Polyline	7	7	9	5	2448.972819
8	Polyline	8	12	8	10	903.777114
9	Polyline	9	1	1	10	1965.776525
10	Polyline	10	13	10	11	435.83119
11	Polyline	11	14	11	12	277.441955
12	Polyline	12	11	13	8	821.945592
13	Polyline	13	9	14	6	1725.723077
14	Polyline	14	6	15	4	2410.20695
15	Polyline	15	15	16	11	1303.194092

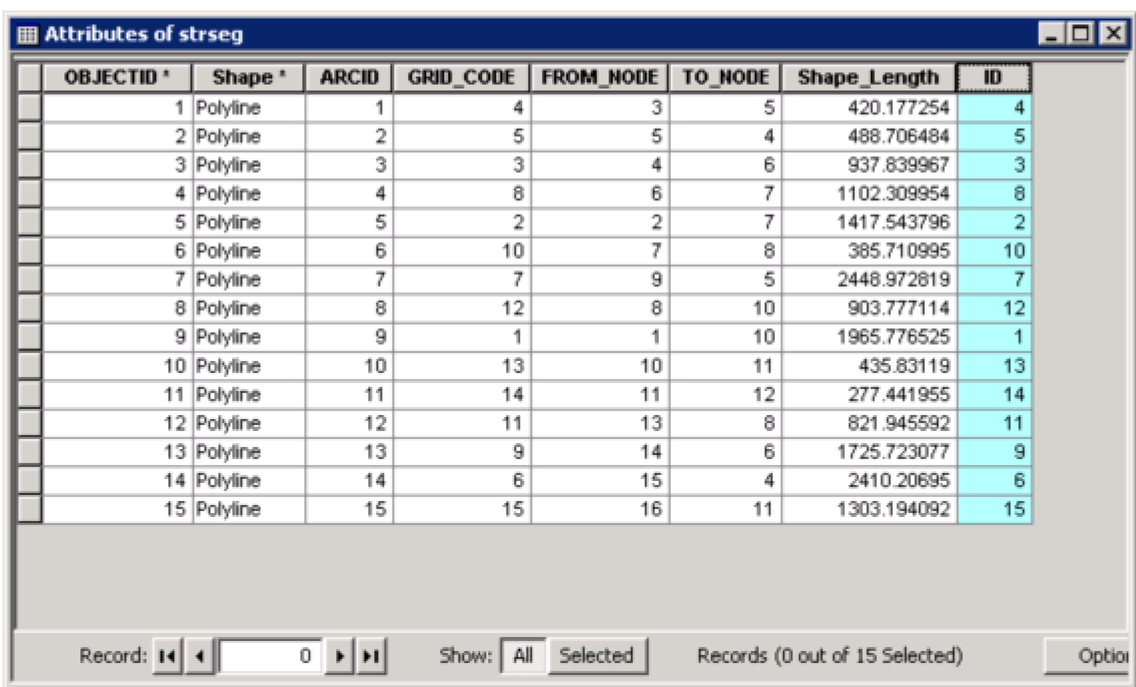
Record: 1 Show: All Selected Records (0 out of 15

The values in the GRID_CODE column will be used as the stream segment IDs. Click on the Down Arrow (in the lower-right corner of the Attributes window) and select Add Field from the pop-up window. Add the new attribute ID as shown below.



Copy the values from GRID_CODE to ID using the Field Calculator.





Attributes of strseg

OBJECTID *	Shape *	ARCID	GRID_CODE	FROM_NODE	TO_NODE	Shape_Length	ID
1	Polyline	1	4	3	5	420.177254	4
2	Polyline	2	5	5	4	488.706484	5
3	Polyline	3	3	4	6	937.839967	3
4	Polyline	4	8	6	7	1102.309954	8
5	Polyline	5	2	2	7	1417.543796	2
6	Polyline	6	10	7	8	385.710995	10
7	Polyline	7	7	9	5	2448.972819	7
8	Polyline	8	12	8	10	903.777114	12
9	Polyline	9	1	1	10	1965.776525	1
10	Polyline	10	13	10	11	435.83119	13
11	Polyline	11	14	11	12	277.441955	14
12	Polyline	12	11	13	8	821.945592	11
13	Polyline	13	9	14	6	1725.723077	9
14	Polyline	14	6	15	4	2410.20695	6
15	Polyline	15	15	16	11	1303.194092	15

Record: 0 Show: All Selected Records (0 out of 15 Selected) Optio

After this map has been created, save the Sagehen ArcMap project by clicking File->Save.

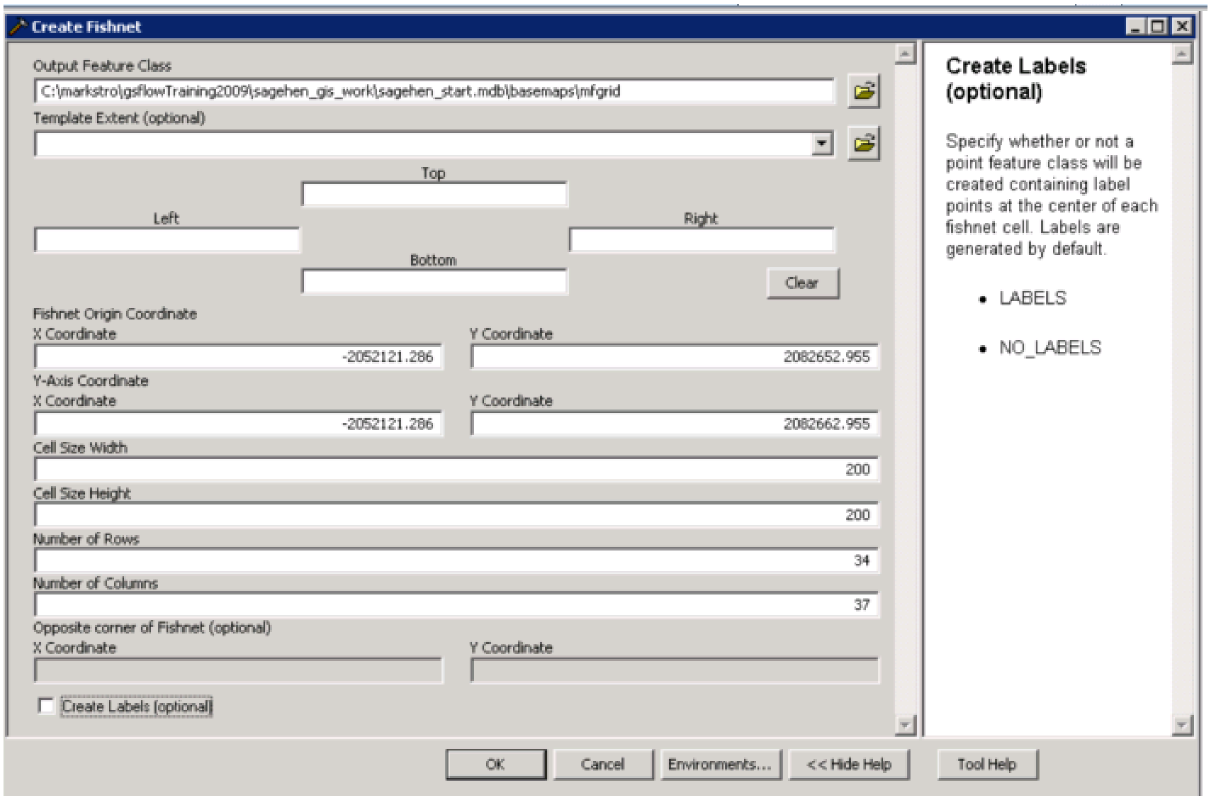
Strseg is the stream segment feature set.

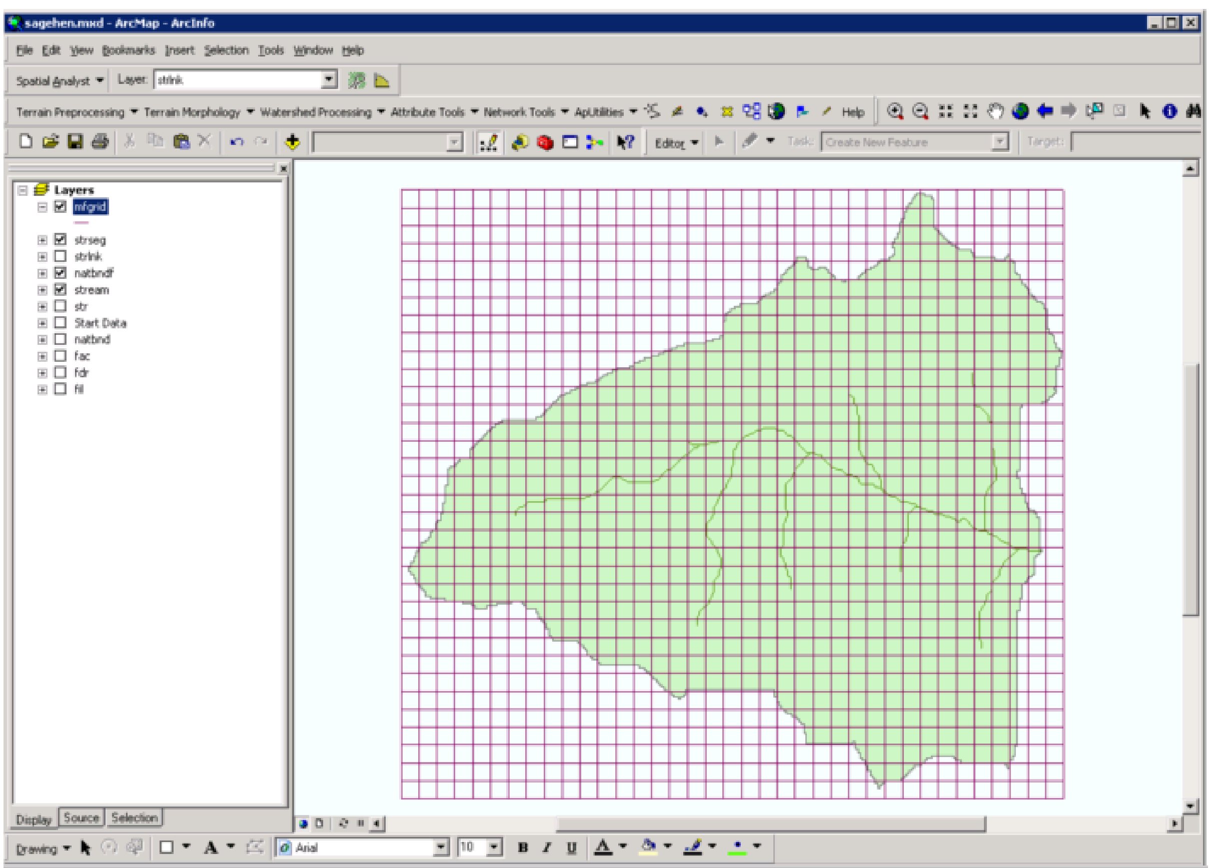
Generation of the MODFLOW Grid Cell map

Use the Create Fishnet (management) tool to create the MODFLOW Grid. The fishnet origin, number of rows, and number of columns have been computed so that the MODFLOW Grid will totally cover the natbndf natural watershed boundary. Use the following settings for the example problem:

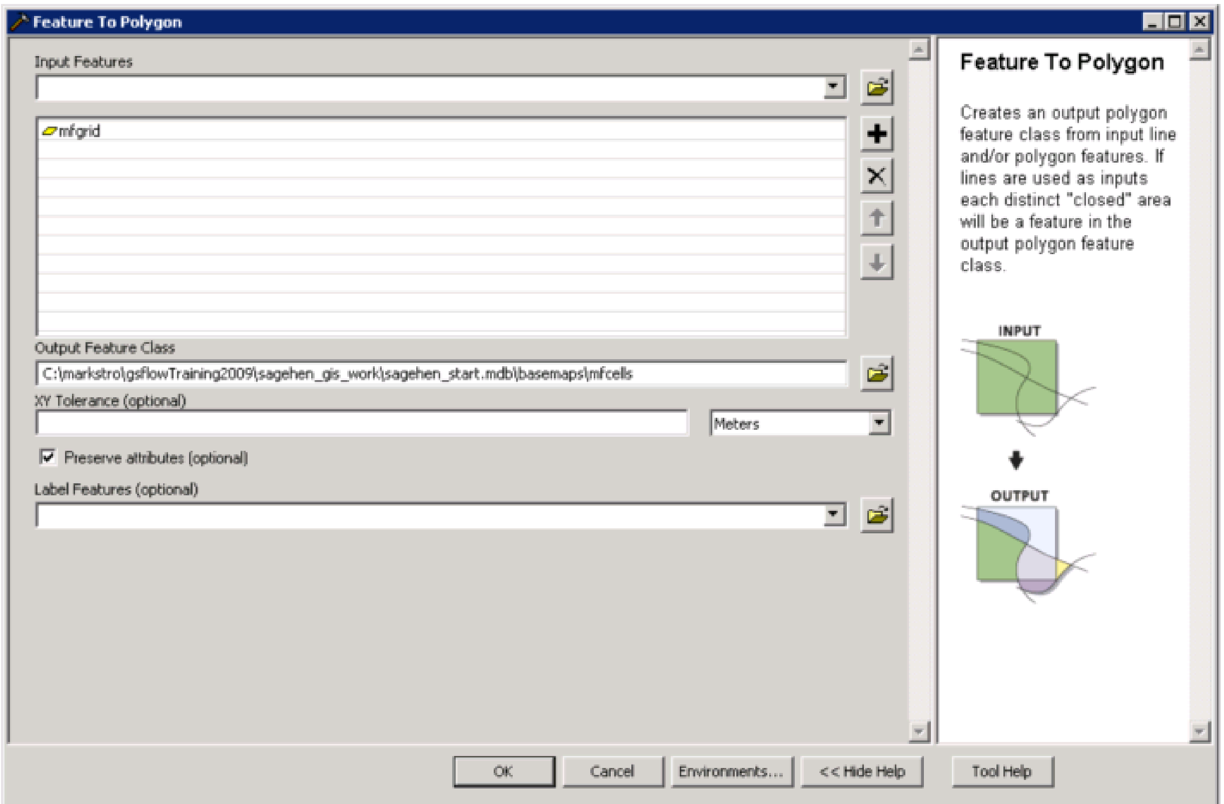
- Set the Output Feature Class to mfgrid
- Set the Fishnet Origin Coordinate to X = -2052121.286 and Y = 2082652.955
- Set the Y-Axis Coordinate to X = -2052121.286 and Y = 2082662.955
- Set the Cell Size Width = 200
- Set the Cell Size Height = 200
- Set the Number of Rows = 34
- Set the Number of Columns = 37
- Uncheck the Create Labels box

Click OK.


Create Fishnet
Output Feature Class
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\basemaps\mfgrid
Template Extent (optional)
Top
Left
Right
Bottom
Clear
Fishnet Origin Coordinate
X Coordinate
-2052121.286
Y Coordinate
2082652.955
Y-Axis Coordinate
X Coordinate
-2052121.286
Y Coordinate
2082662.955
Cell Size Width
200
Cell Size Height
200
Number of Rows
34
Number of Columns
37
Opposite corner of Fishnet (optional)
X Coordinate
Y Coordinate
Create Labels (optional)
OK
Cancel
Environments...
<< Hide Help
Tool Help
Create Labels (optional)
Specify whether or not a point feature class will be created containing label points at the center of each fishnet cell. Labels are generated by default.
LABELS
NO_LABELS


sagehen.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Spatial Analyst
Layer: strlnk
Terrain Preprocessing
Terrain Morphology
Watershed Processing
Attribute Tools
Network Tools
ApUtilities
Help
Editor
Task: Create New Feature
Target:
Layers
mfgrid
strseg
strlnk
natbndf
stream
str
Start Data
natbnd
fac
fdr
fil
Display
Source
Selection
Drawing
Arial
10

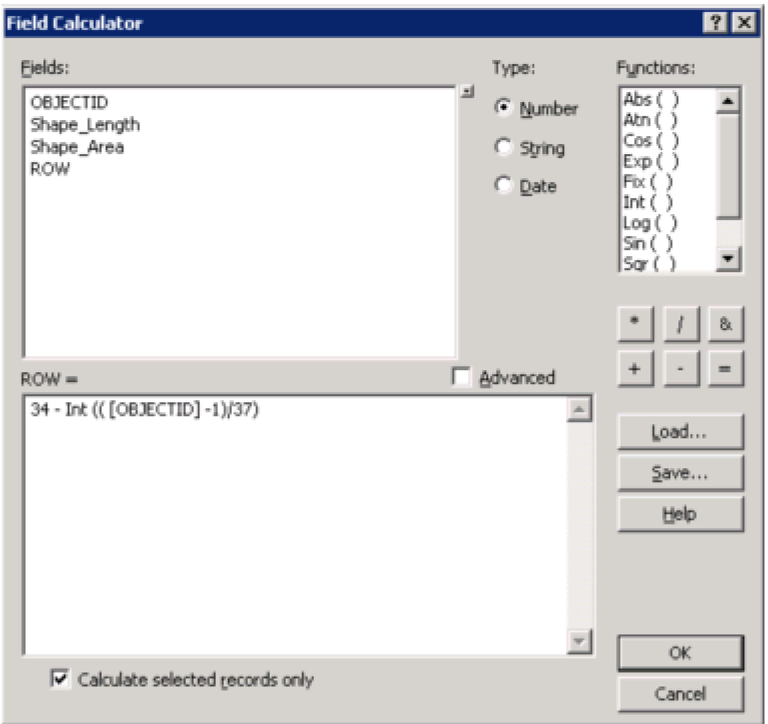
Use the Feature to Polygon (management) tool to create the MODFLOW Grid Cells. Set Input Features to mfgrid. Set Output Feature Class to mfcells. Click OK.



Add the attribute ROW to the table in the Attributes of mfcells window. The row index can be calculated according to:

$$RowIndex = NumberOfRows - Int\left(\frac{Index - 1}{NumberOfColumns}\right)$$

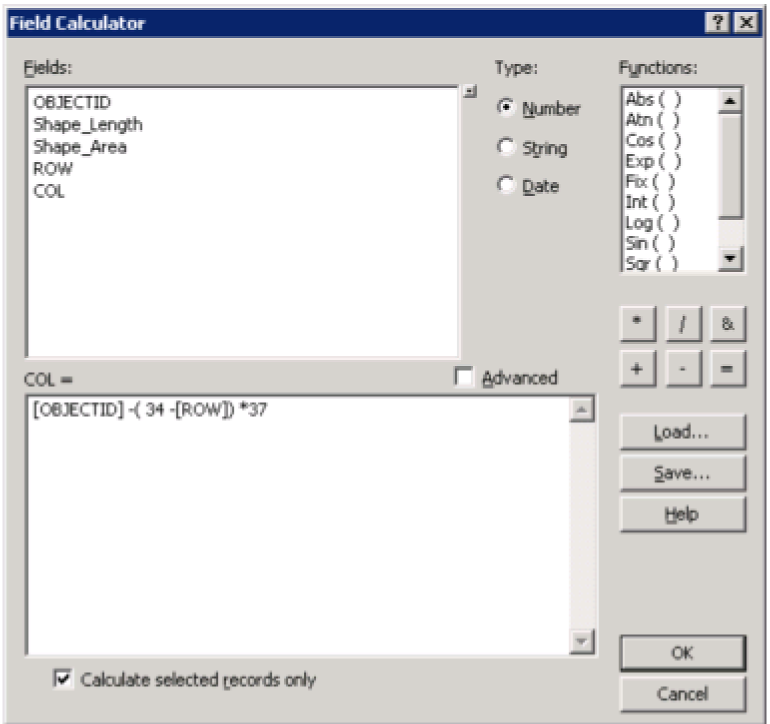
This is what it looks like in the Field Calculator.



Add the attribute COL to the table in the Attributes of mfcells window. The row index can be calculated according to:

$$ColIndex = Index - (NumberOfRows - RowIndex) \times NumberOfColumns$$

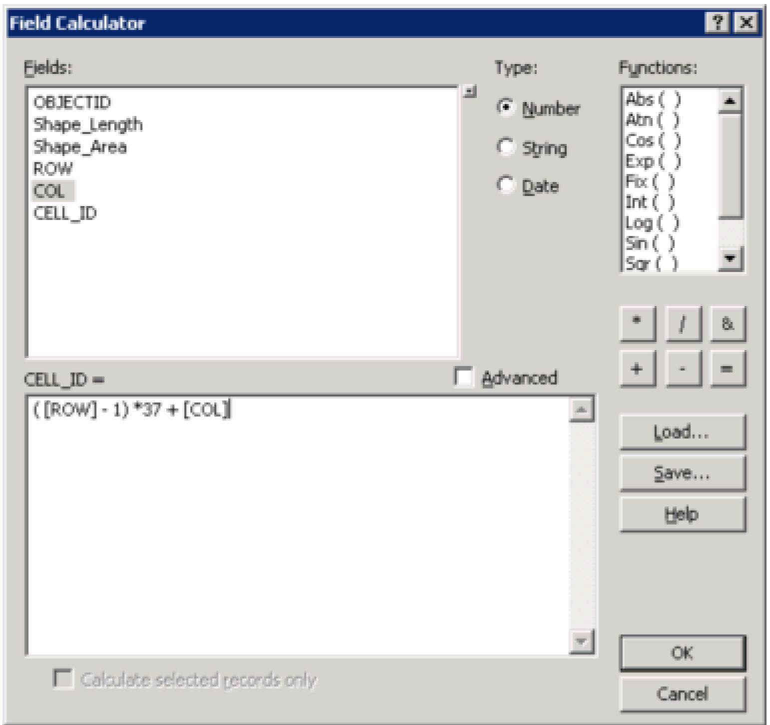
This is what it looks like in the Field Calculator.



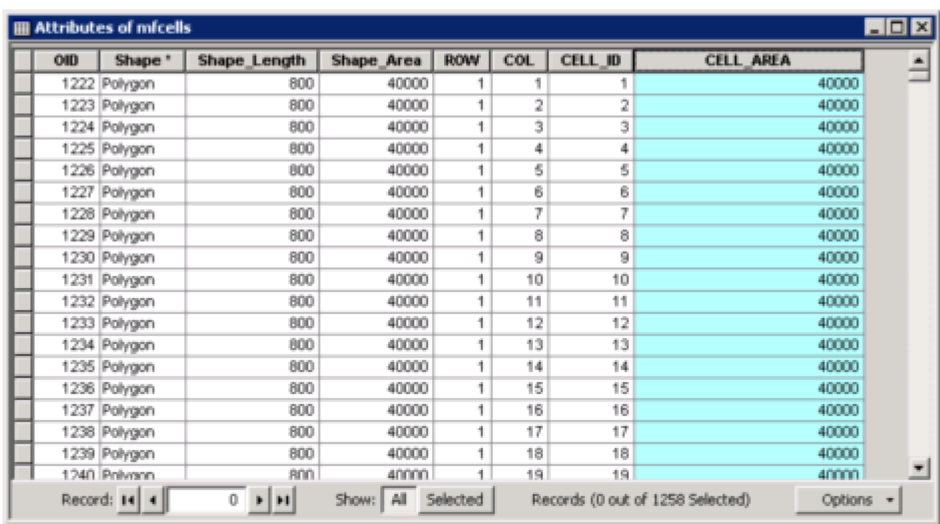
Add the attribute CELL_ID to the table in the Attributes of mfcells window. The cell index can be calculated according to:

$$CELL\_ID = (RowIndex - 1) \times NumberOfColumns + ColIndex$$

This is what it looks like in the Field Calculator.



Add the attribute CELL_AREA to the table in the Attributes of mfcells window. Copy the values from the Shape_Area attribute using the Field Calculator:



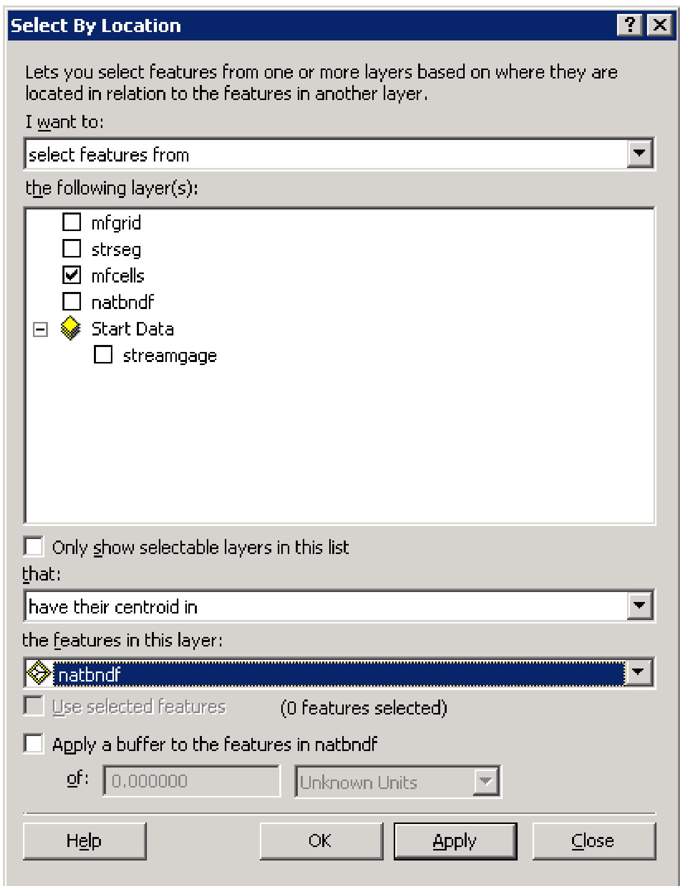
OID	Shape *	Shape_Length	Shape_Area	ROW	COL	CELL_ID	CELL_AREA
1222	Polygon	800	40000	1	1	1	40000
1223	Polygon	800	40000	1	2	2	40000
1224	Polygon	800	40000	1	3	3	40000
1225	Polygon	800	40000	1	4	4	40000
1226	Polygon	800	40000	1	5	5	40000
1227	Polygon	800	40000	1	6	6	40000
1228	Polygon	800	40000	1	7	7	40000
1229	Polygon	800	40000	1	8	8	40000
1230	Polygon	800	40000	1	9	9	40000
1231	Polygon	800	40000	1	10	10	40000
1232	Polygon	800	40000	1	11	11	40000
1233	Polygon	800	40000	1	12	12	40000
1234	Polygon	800	40000	1	13	13	40000
1235	Polygon	800	40000	1	14	14	40000
1236	Polygon	800	40000	1	15	15	40000
1237	Polygon	800	40000	1	16	16	40000
1238	Polygon	800	40000	1	17	17	40000
1239	Polygon	800	40000	1	18	18	40000
1240	Polygon	800	40000	1	19	19	40000

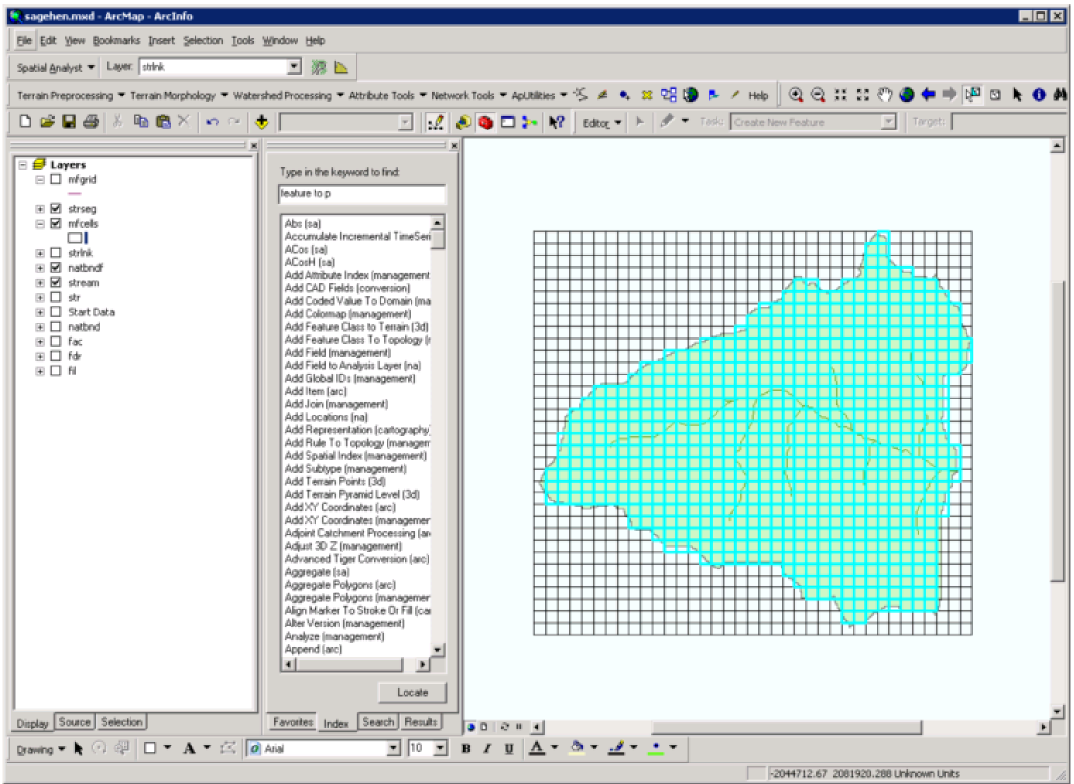
After this map has been created, save the Sagehen ArcMap project by clicking File->Save.

The feature set mfcells is the vector version of the MODFLOW grid cell map.

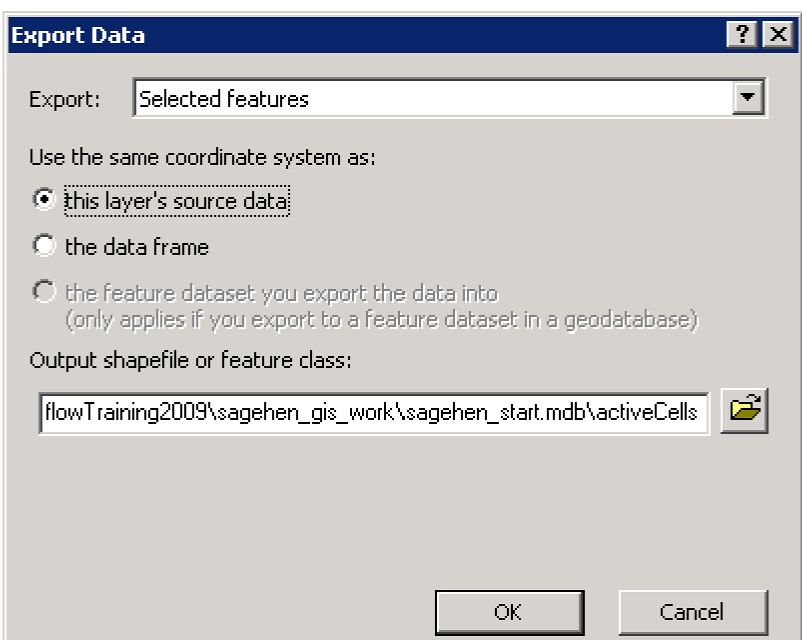
Generation of "Clipped" Model Domain and Active Cells Maps

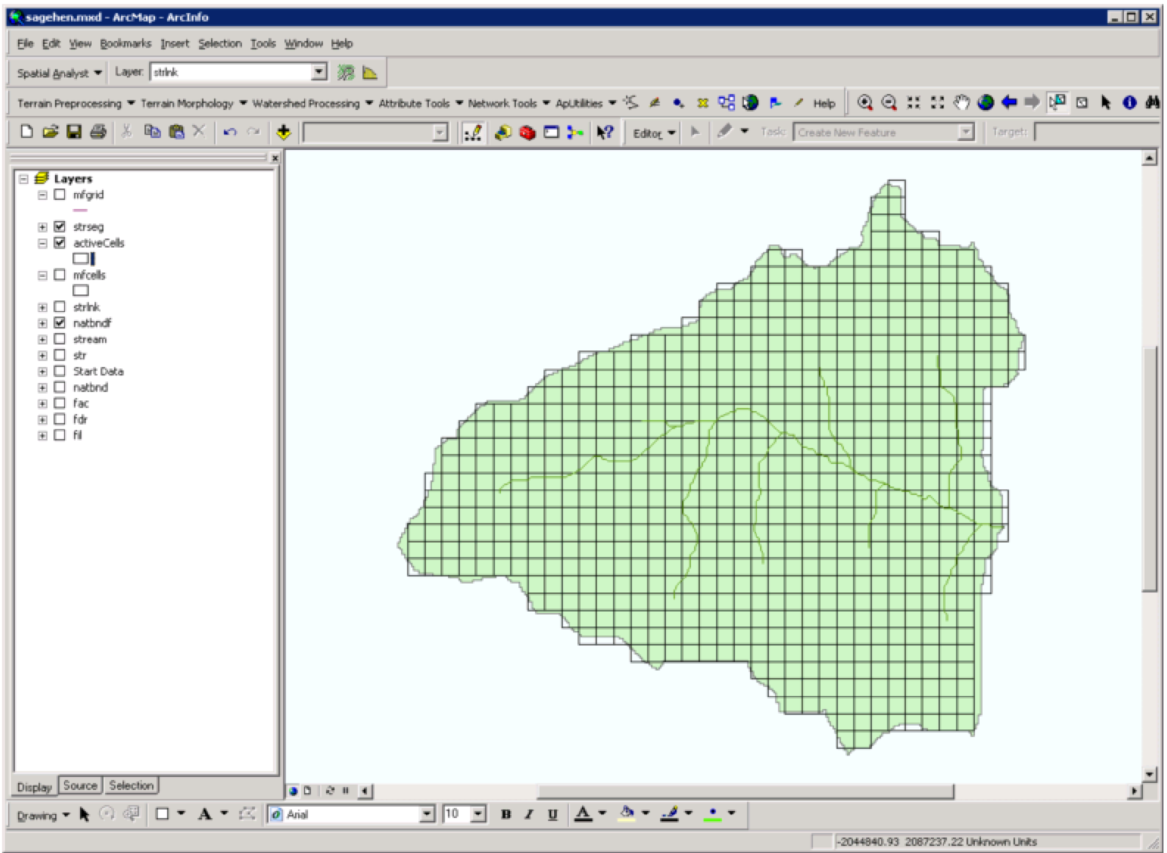
Choose Selection-> Select By Location from the top level ArcMap menu bar. Choose the options specified below:





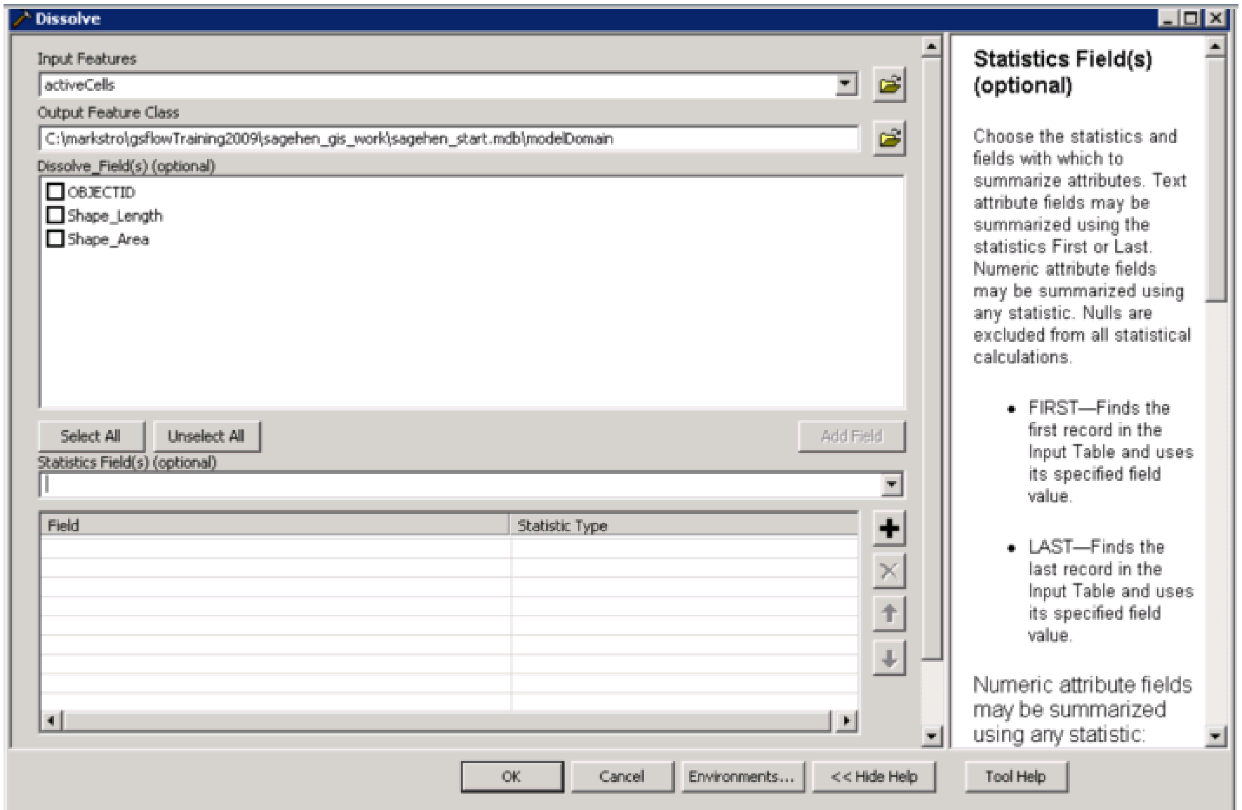
Right click on the mfcells map in the tree. Choose Data->Export Data to make a new feature class of the active cells. Name this activeCells.

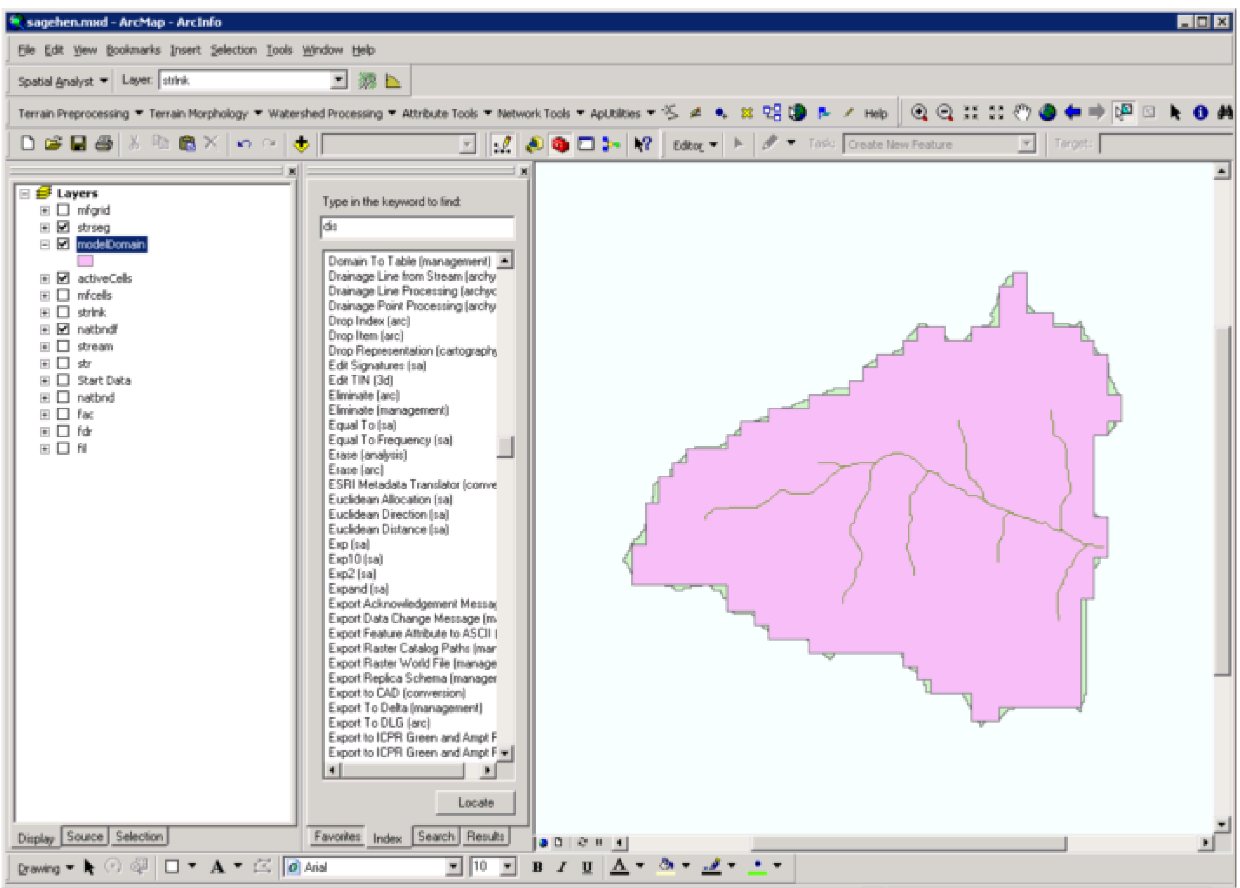




Next, dissolve all of the active cells into one big feature to get the map of the "Clipped" Model Domain.

Use the Dissolve(management) tool to do this. Name the output feature class modelDomain.


Dissolve
Input Features
activeCells
Output Feature Class
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\modelDomain
Dissolve_Field(s) (optional)
OBJECTID
Shape_Length
Shape_Area
Select All
Unselect All
Add Field
Statistics Field(s) (optional)
Field
Statistic Type
OK
Cancel
Environments...
<< Hide Help
Tool Help
Statistics Field(s) (optional)
Choose the statistics and fields with which to summarize attributes. Text attribute fields may be summarized using the statistics First or Last. Numeric attribute fields may be summarized using any statistic. Nulls are excluded from all statistical calculations.
FIRST—Finds the first record in the Input Table and uses its specified field value.
LAST—Finds the last record in the Input Table and uses its specified field value.
Numeric attribute fields may be summarized using any statistic:

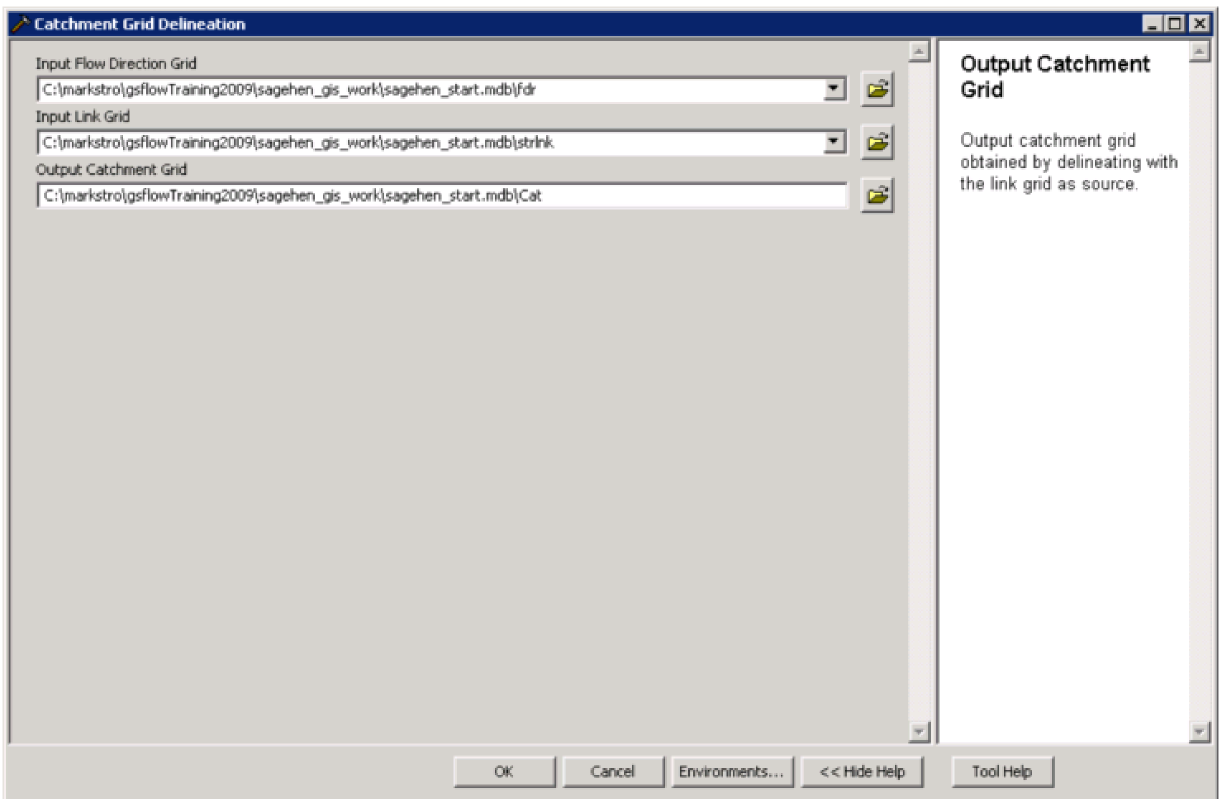

sagehen.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Spatial Analyst
Layer: strlnk
Terrain Preprocessing
Terrain Morphology
Watershed Processing
Attribute Tools
Network Tools
ApUtilities
Help
Editor
Task: Create New Feature
Target:
Layers
mfgrid
strseg
modelDomain
activeCells
mfcells
strlnk
natbndf
stream
str
Start Data
natbnd
fac
fdr
fil
Type in the keyword to find:
dis
Domain To Table (management)
Drainage Line from Stream (archy
Drainage Line Processing (archyc
Drainage Point Processing (archy
Drop Index (arc)
Drop Item (arc)
Drop Representation (cartography
Edit Signatures (sa)
Edit TIN (3d)
Eliminate (arc)
Eliminate (management)
Equal To (sa)
Equal To Frequency (sa)
Erase (analysis)
Erase (arc)
ESRI Metadata Translator (conve
Euclidean Allocation (sa)
Euclidean Direction (sa)
Euclidean Distance (sa)
Exp (sa)
Exp10 (sa)
Exp2 (sa)
Expand (sa)
Export Acknowledgement Messag
Export Data Change Message (m
Export Feature Attribute to ASCII (
Export Raster Catalog Paths (mar
Export Raster World File (manage
Export Replica Schema (manager
Export to CAD (conversion)
Export To Delta (management)
Export To DLG (arc)
Export to ICPR Green and Ampt F
Export to ICPR Green and Ampt F
Locate
Display
Source
Selection
Favorites
Index
Search
Results
Drawing
Arial
10

After this map has been created, save the Sagehen ArcMap project by clicking File->Save.

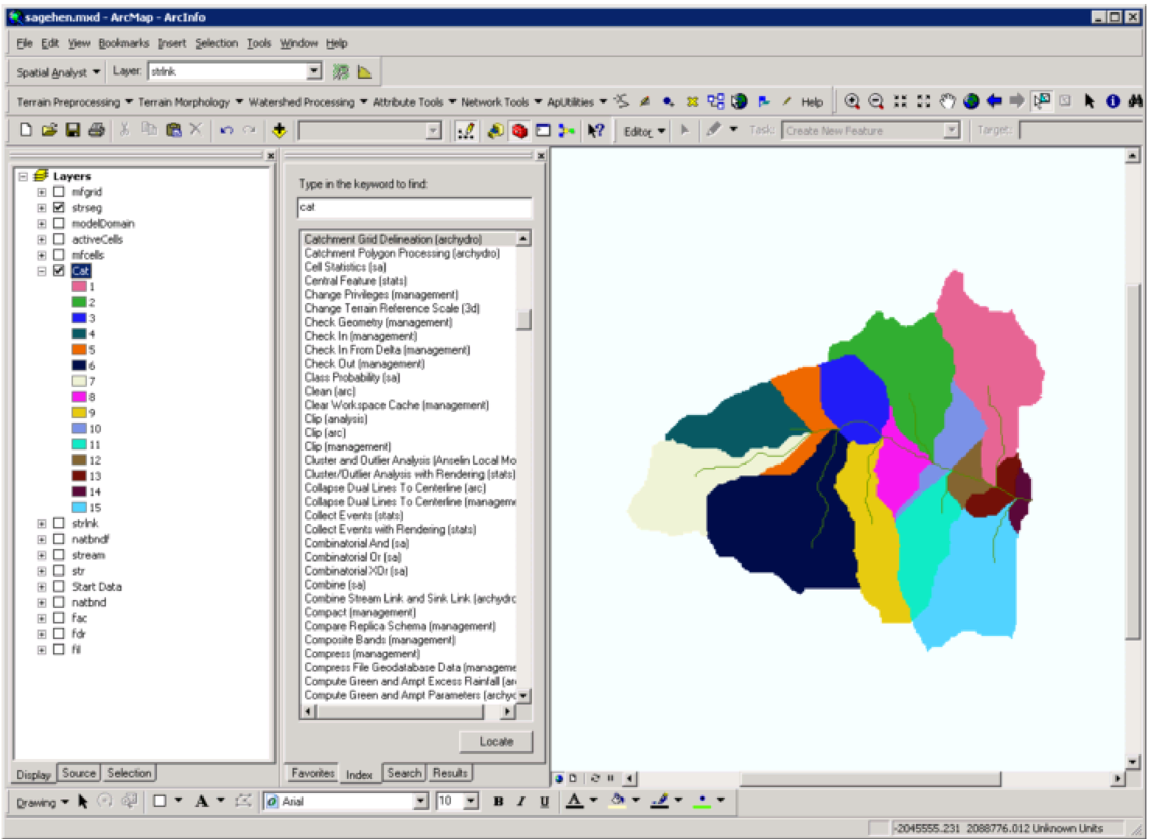
The feature class modelDomain is the vector version of the model domain map. This map defines that areal extent of the Sagehen example problem. The feature class activeCells is the vector version of the cells which are active in the MODFLOW model.

Generation of PRMS HRU map

Make sure that the Spatial Analyst extension is turned on: Tools->Extensions. Check Spatial Analyst. Use the Catchment Grid Delineation (archydro) tool. Specify the flow direction (fdr) and the stream link (strlnk) grids as input. Name the output grid Cat. Click OK.

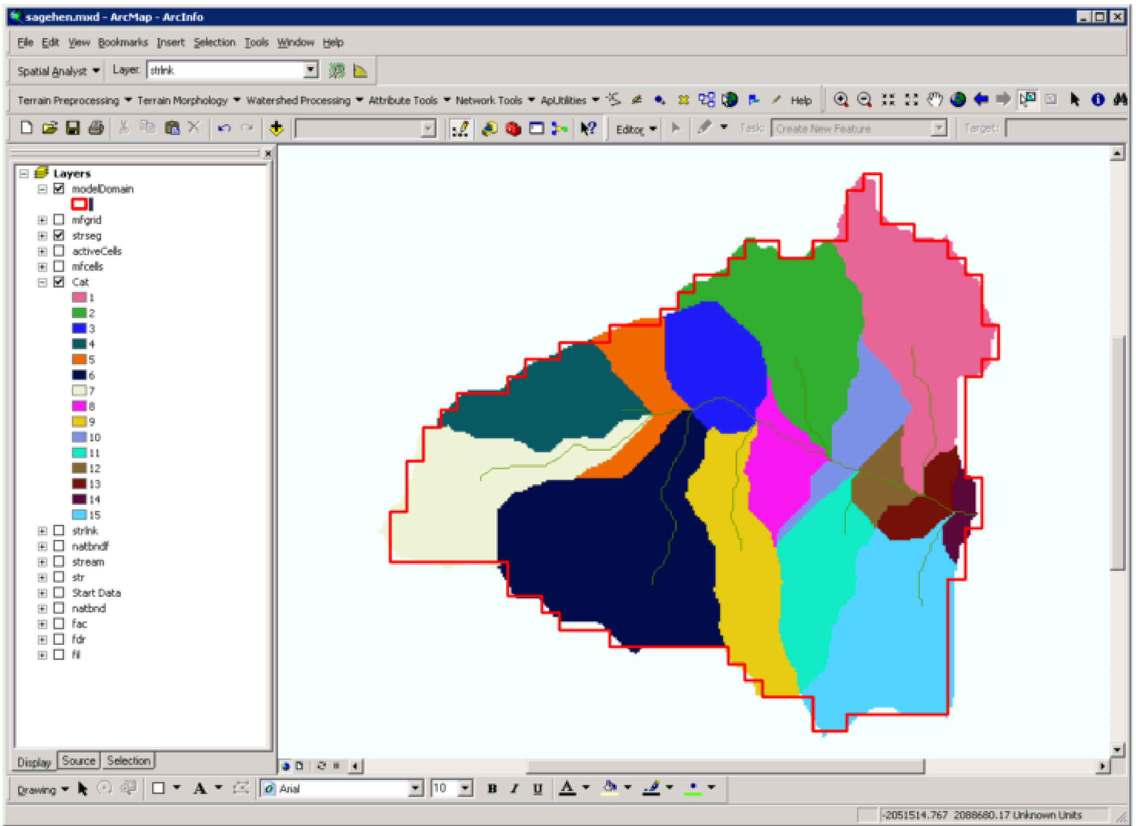


Here is the resulting Cat grid.

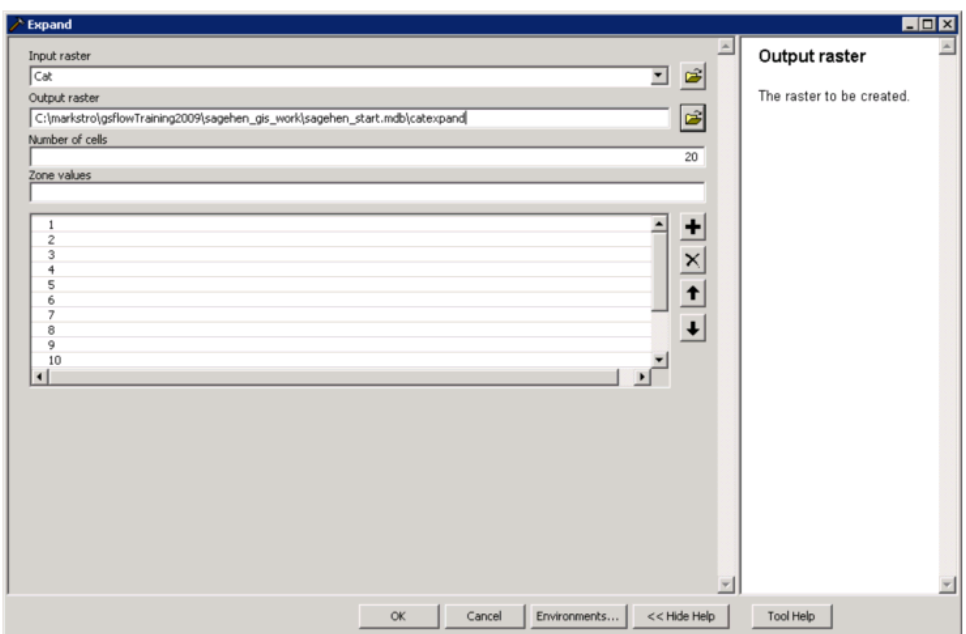


These are the natural HRUs. Note that the HRU Grid code matches the corresponding stream segment that was used to define it. This is because the Catchment Grid Delineation (archydro) tool generates HRUs based on only the contributing area to each stream segment.

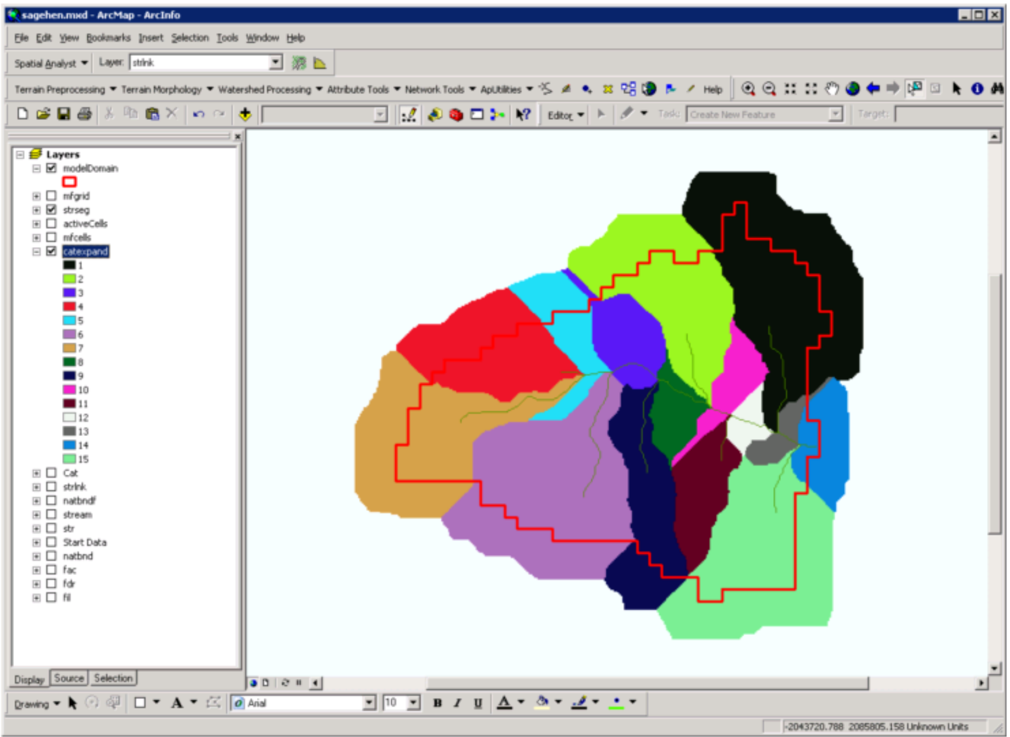
Move the modelDomain feature class to the top of the ArcMap tree stack and make it "hollow". In some areas, the HRUs need to be clipped, while in others, the HRUs need to be extended to the model domain edge.



Use the Expand (sa) tool to fill in the HRUs that don't quite go to the edge. Set the Number of cells to 20 and fill in the Zone values with all 15 categories (HRU IDs). Name this grid CatExpand.

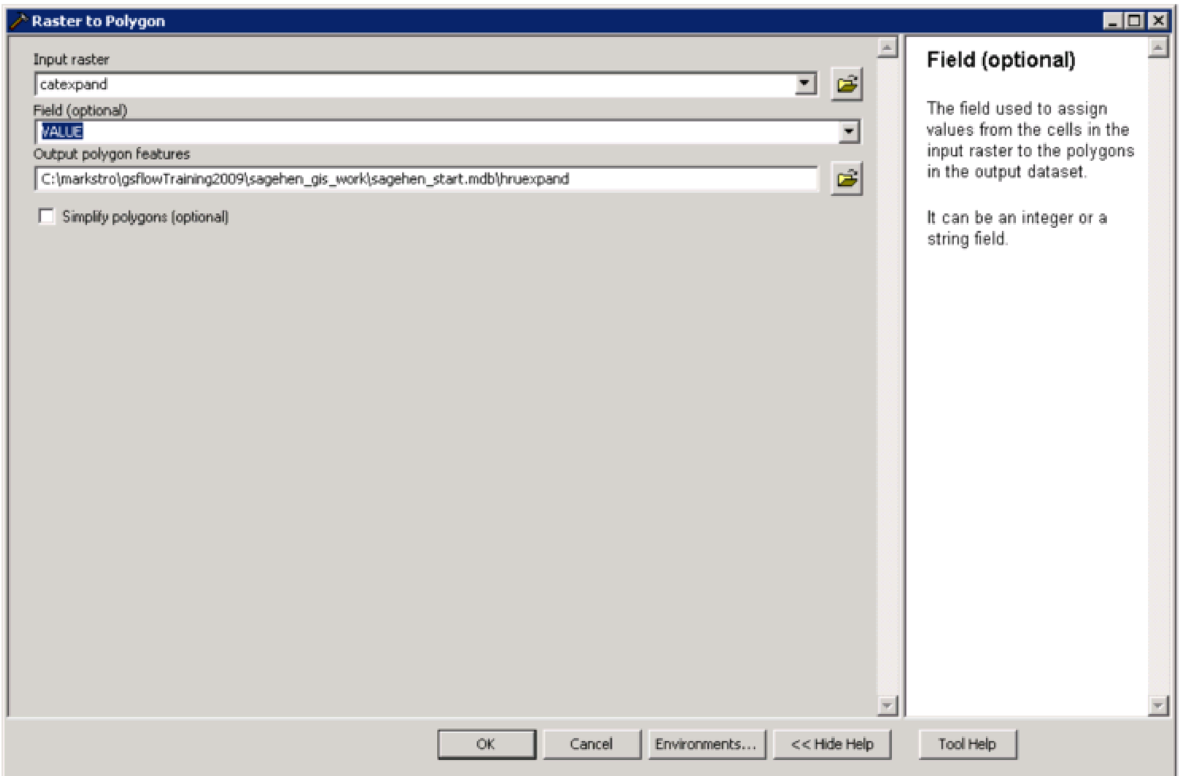


Here is the resulting catexpand grid.

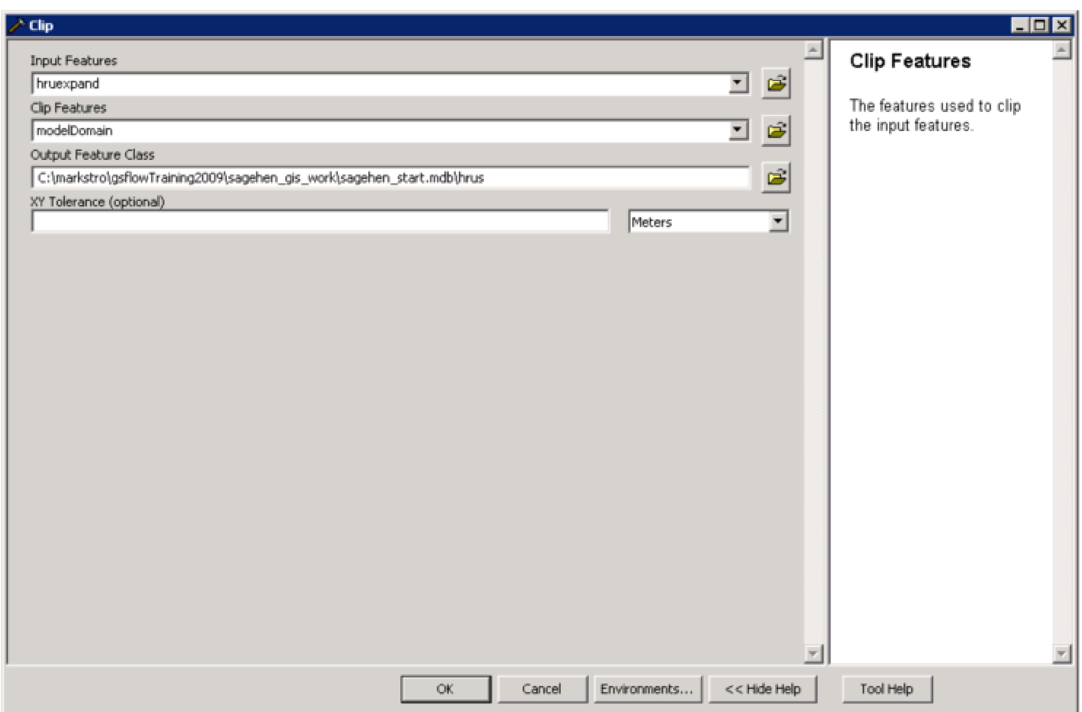


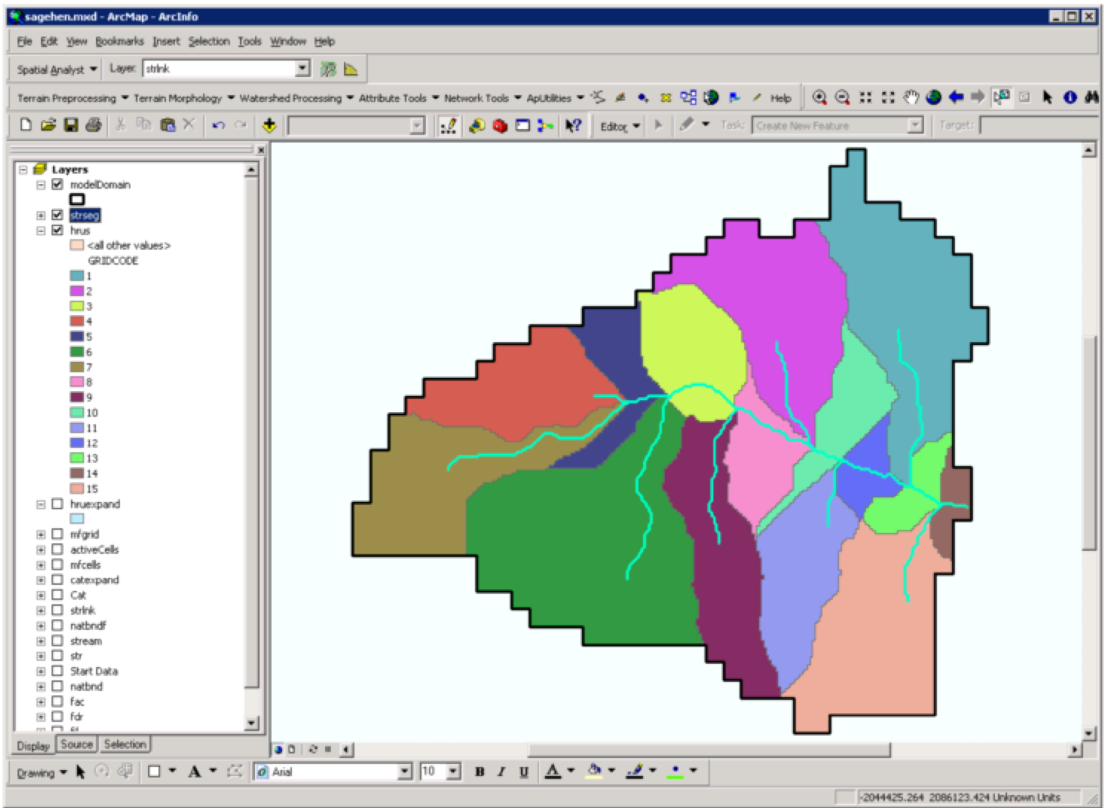
Now there are no holes between the HRUs and the modelDomain.

Use the Raster to Polygon(conversion) tool to make a feature set from catexpand. Set output polygon feature to hruexpand and uncheck Simplify polygons.



Use the Clip (anylsis) tool to make the output feature class hrus. Set the Input Features to hruexpand and the Clip Features to modelDomain.





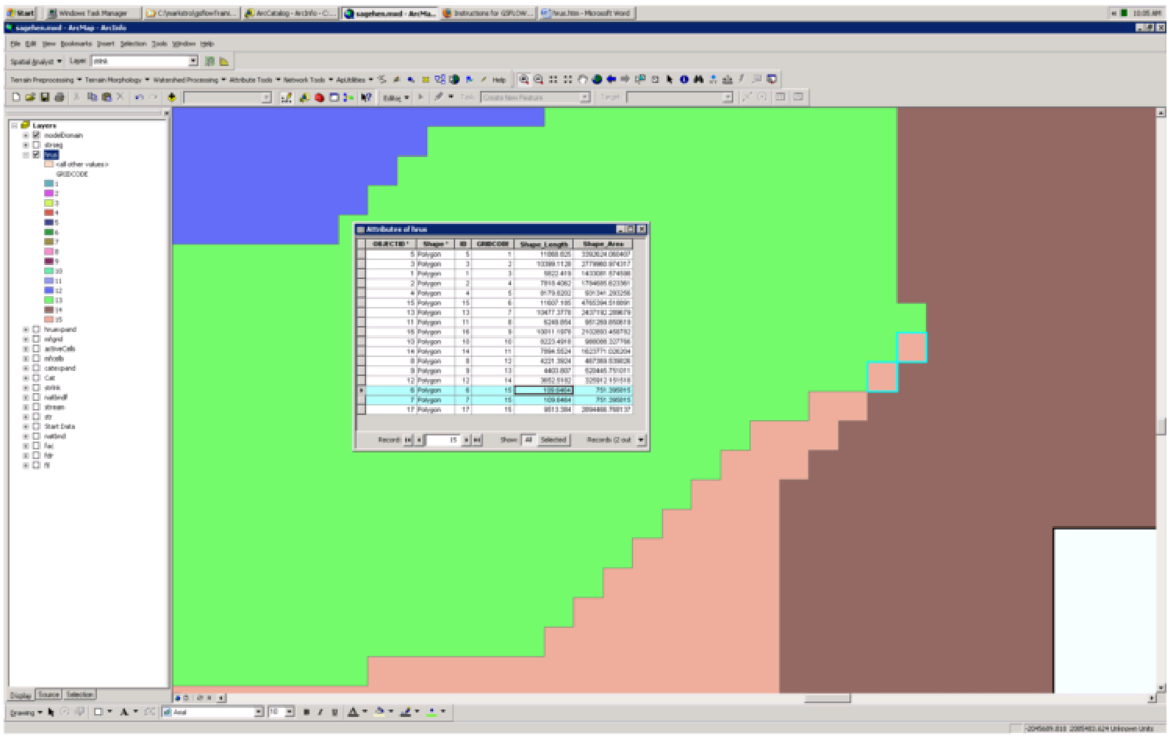
Open the Attributes of hrus window and Sort Ascending on the GRIDCODE attribute. This attribute will be used as the HRU ID.

Attributes of hrus

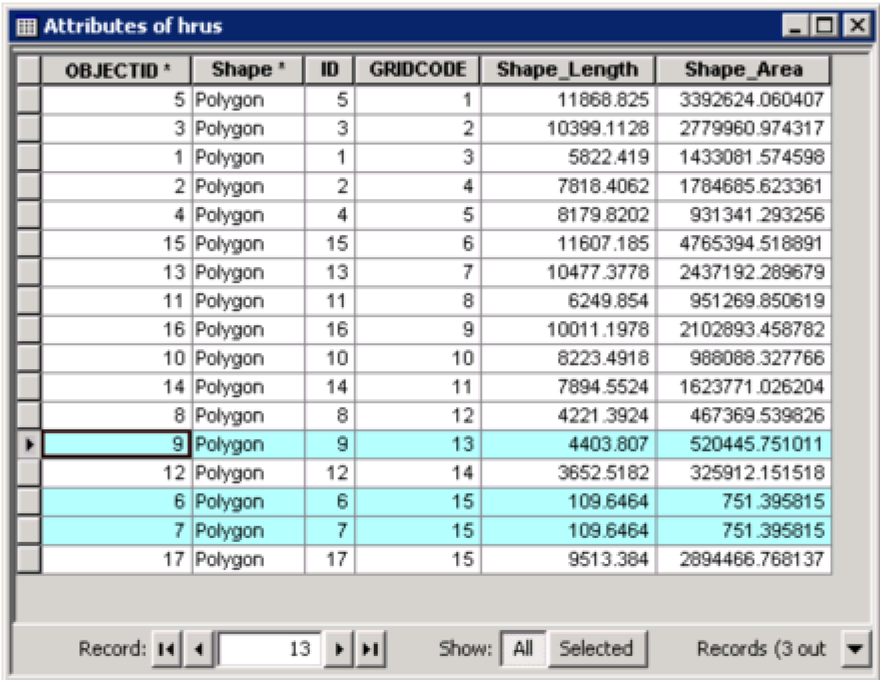
OBJECTID *	Shape *	ID	GRIDCODE	Shape_Length	Shape_Area
5	Polygon	5	1	11868.825	3392624.060407
3	Polygon	3	2	10399.1128	2779960.974317
1	Polygon	1	3	5822.419	1433081.574598
2	Polygon	2	4	7818.4062	1784685.623361
4	Polygon	4	5	8179.8202	931341.293256
15	Polygon	15	6	11607.185	4765394.518891
13	Polygon	13	7	10477.3778	2437192.289679
11	Polygon	11	8	6249.854	951269.850619
16	Polygon	16	9	10011.1978	2102893.458782
10	Polygon	10	10	8223.4918	988088.327766
14	Polygon	14	11	7894.5524	1623771.026204
8	Polygon	8	12	4221.3924	467369.539826
9	Polygon	9	13	4403.807	520445.751011
12	Polygon	12	14	3652.5182	325912.151518
6	Polygon	6	15	109.6464	751.395815
7	Polygon	7	15	109.6464	751.395815
17	Polygon	17	15	9513.384	2894466.768137

Record: 0 Show: All Selected Records (0 out

There are 17 features, but there are only 15 HRUs. This means that some HRUs are split. Notice that there are 3 features assigned to the GRIDCODE attribute values of 15 and that two of these features have a very small comparative area (751 square meters compared to 2,894,467 square meters). Find these small features by selecting them from the Attributes of hrus table.

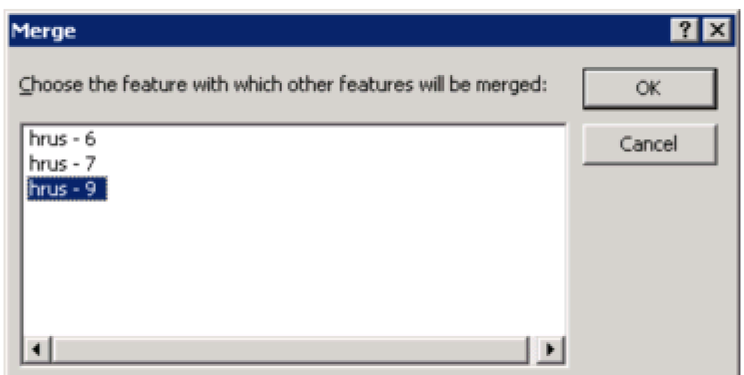


Select the hrus feature class in the ArcMap tree and then choose the XTools Pro -> Start Editing Selected Layer menu option. Select the features with OBJECTID values of 9, 6, and 7.

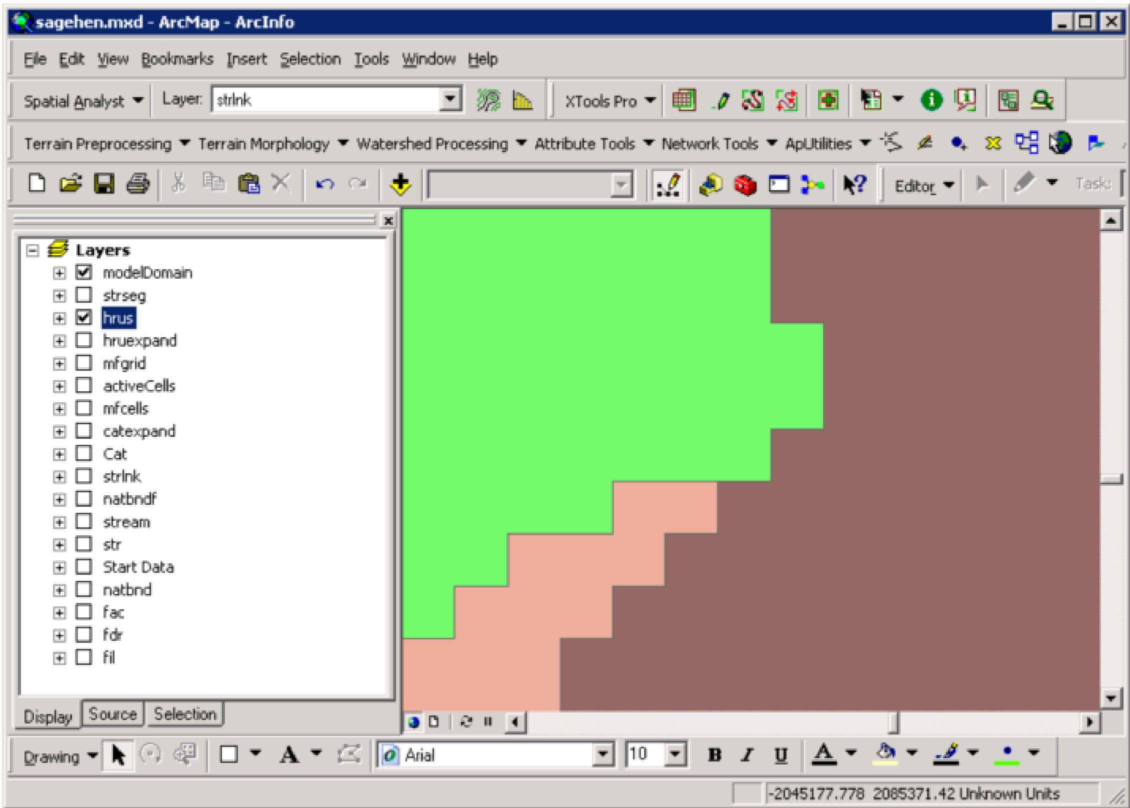


OBJECTID *	Shape *	ID	GRIDCODE	Shape_Length	Shape_Area
5	Polygon	5	1	11868.825	3392624.060407
3	Polygon	3	2	10399.1128	2779960.974317
1	Polygon	1	3	5822.419	1433081.574598
2	Polygon	2	4	7818.4062	1784685.623361
4	Polygon	4	5	8179.8202	931341.293256
15	Polygon	15	6	11607.185	4765394.518891
13	Polygon	13	7	10477.3778	2437192.289679
11	Polygon	11	8	6249.854	951269.850619
16	Polygon	16	9	10011.1978	2102893.458782
10	Polygon	10	10	8223.4918	988088.327766
14	Polygon	14	11	7894.5524	1623771.026204
8	Polygon	8	12	4221.3924	467369.539826
9	Polygon	9	13	4403.807	520445.751011
12	Polygon	12	14	3652.5182	325912.151518
6	Polygon	6	15	109.6464	751.395815
7	Polygon	7	15	109.6464	751.395815
17	Polygon	17	15	9513.384	2894466.768137

Choose the Editor->Merge menu option. Choose hrus 9 in the Merge window. This will dissolve the two small features into the big adjacent one. Click OK.

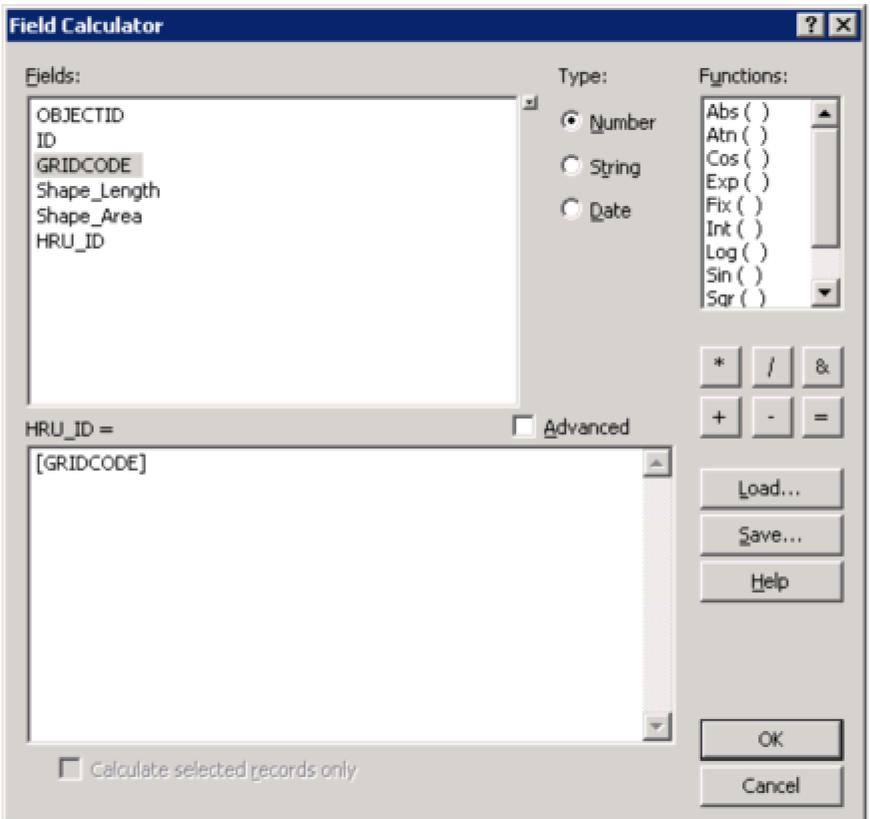


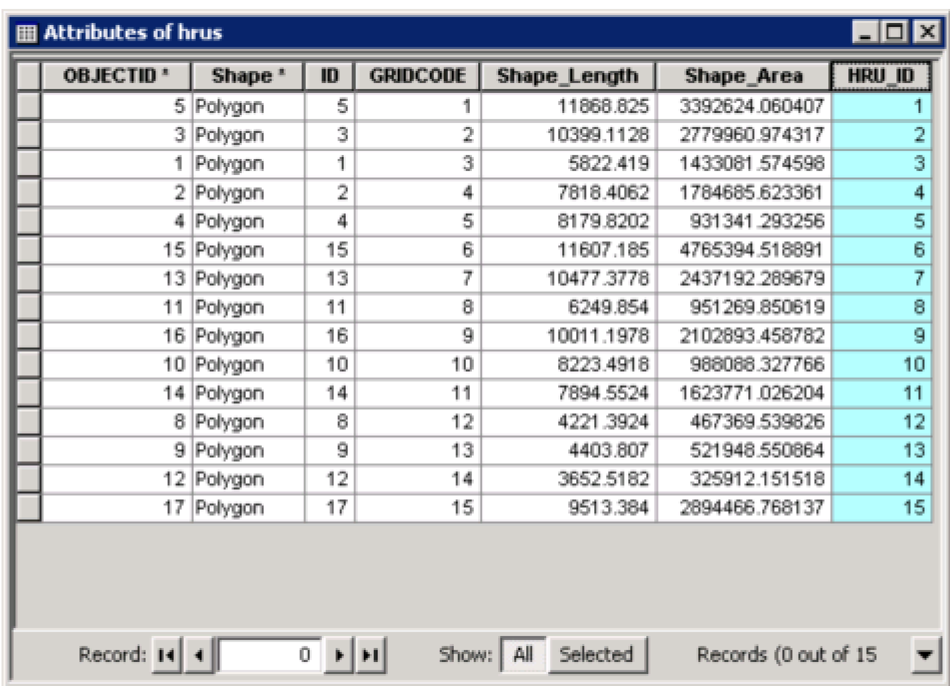
Choose the Editor->Stop Editing to save the edits. The hrus map should look like this:



Click on Editor->Stop Editing when finished.

Add the attribute HRU_ID to the hrus feature class in the Attributes of hrus window. Copy the values from the GRIDCODE attribute to the new HRU_ID attribute.

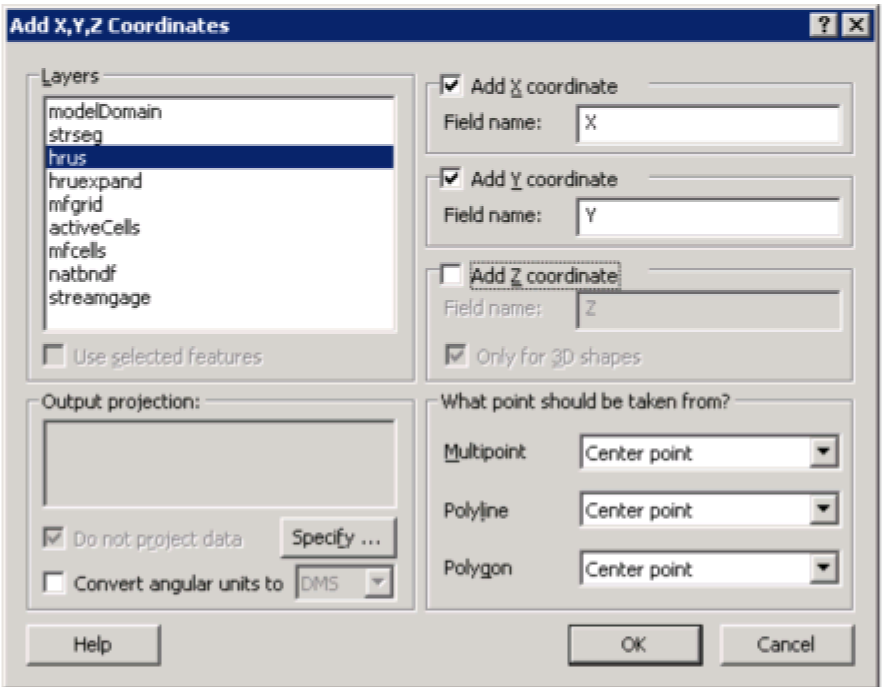



Attributes of hrus

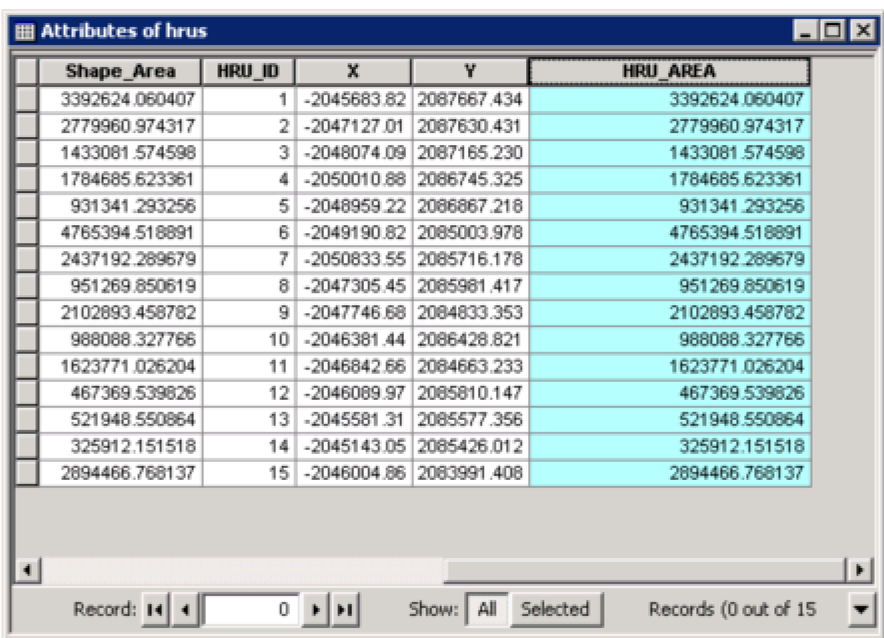
OBJECTID *	Shape *	ID	GRIDCODE	Shape_Length	Shape_Area	HRU_ID
5	Polygon	5	1	11868.825	3392624.060407	1
3	Polygon	3	2	10399.1128	2779960.974317	2
1	Polygon	1	3	5822.419	1433081.574598	3
2	Polygon	2	4	7818.4062	1784685.623361	4
4	Polygon	4	5	8179.8202	931341.293256	5
15	Polygon	15	6	11607.185	4765394.518891	6
13	Polygon	13	7	10477.3778	2437192.289679	7
11	Polygon	11	8	6249.854	951269.850619	8
16	Polygon	16	9	10011.1978	2102893.458782	9
10	Polygon	10	10	8223.4918	988088.327766	10
14	Polygon	14	11	7894.5524	1623771.026204	11
8	Polygon	8	12	4221.3924	467369.539826	12
9	Polygon	9	13	4403.807	521948.550864	13
12	Polygon	12	14	3652.5182	325912.151518	14
17	Polygon	17	15	9513.384	2894466.768137	15

Record: 0 Show: All Selected Records (0 out of 15

Calculate X and Y coordinates for each HRU using XTools Pro Toolbar-> Table Operations ->Add X,Y,Z Coordinates. Select hrus Layers, uncheck Add Z coordinate, and modify X and Y field if desired.



Add the attribute HRU_AREA to the table in the Attributes of hrus window. Copy the values from the Shape_Area attribute using the Field Calculator:



Attributes of hrus

Shape_Area	HRU_ID	X	Y	HRU_AREA
3392624.060407	1	-2045683.82	2087667.434	3392624.060407
2779960.974317	2	-2047127.01	2087630.431	2779960.974317
1433081.574598	3	-2048074.09	2087165.230	1433081.574598
1784685.623361	4	-2050010.88	2086745.325	1784685.623361
931341.293256	5	-2048959.22	2086867.218	931341.293256
4765394.518891	6	-2049190.82	2085003.978	4765394.518891
2437192.289679	7	-2050833.55	2085716.178	2437192.289679
951269.850619	8	-2047305.45	2085981.417	951269.850619
2102893.458782	9	-2047746.68	2084833.353	2102893.458782
988088.327766	10	-2046381.44	2086428.821	988088.327766
1623771.026204	11	-2046842.66	2084663.233	1623771.026204
467369.539826	12	-2046089.97	2085810.147	467369.539826
521948.550864	13	-2045581.31	2085577.356	521948.550864
325912.151518	14	-2045143.05	2085426.012	325912.151518
2894466.768137	15	-2046004.86	2083991.408	2894466.768137

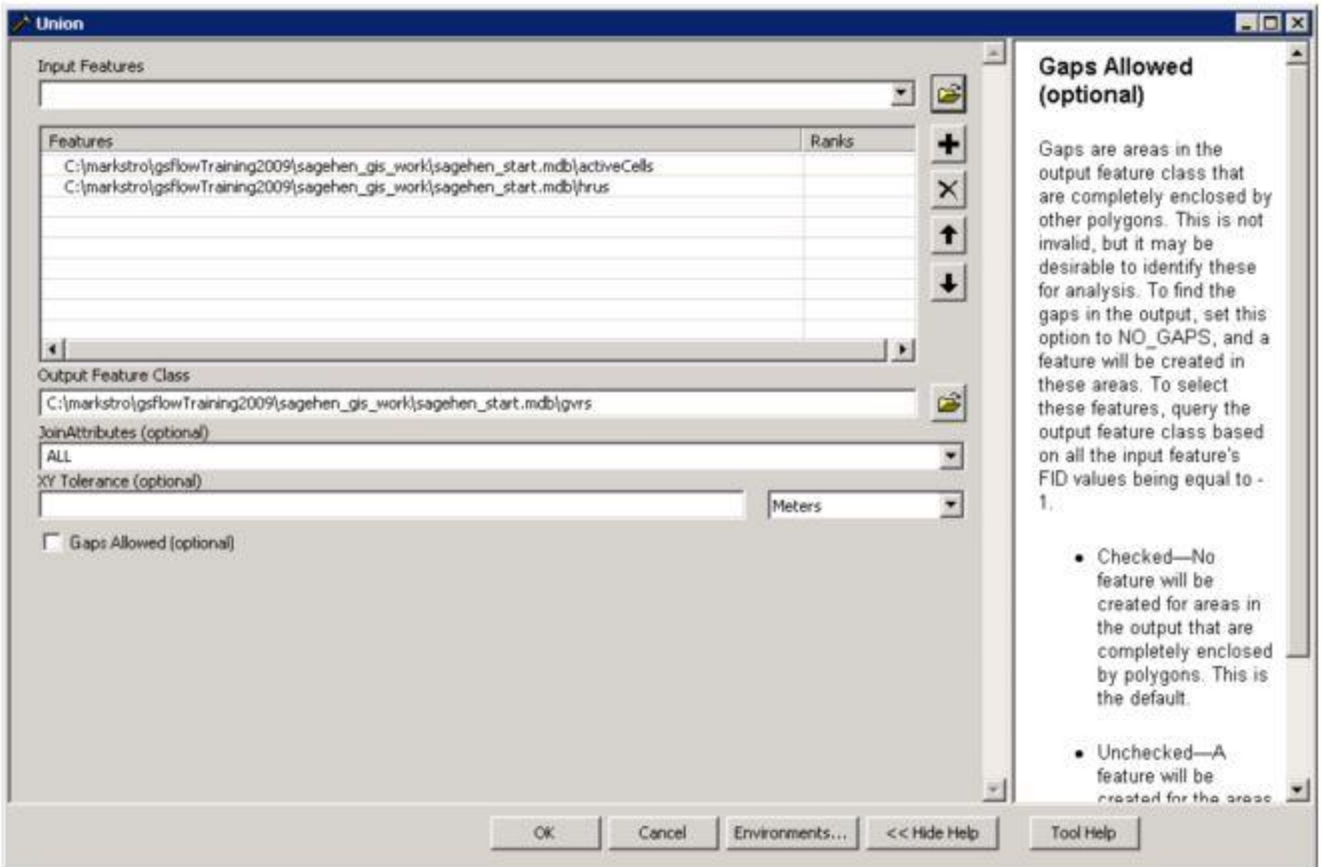
Record: 0 Show: All Selected Records (0 out of 15

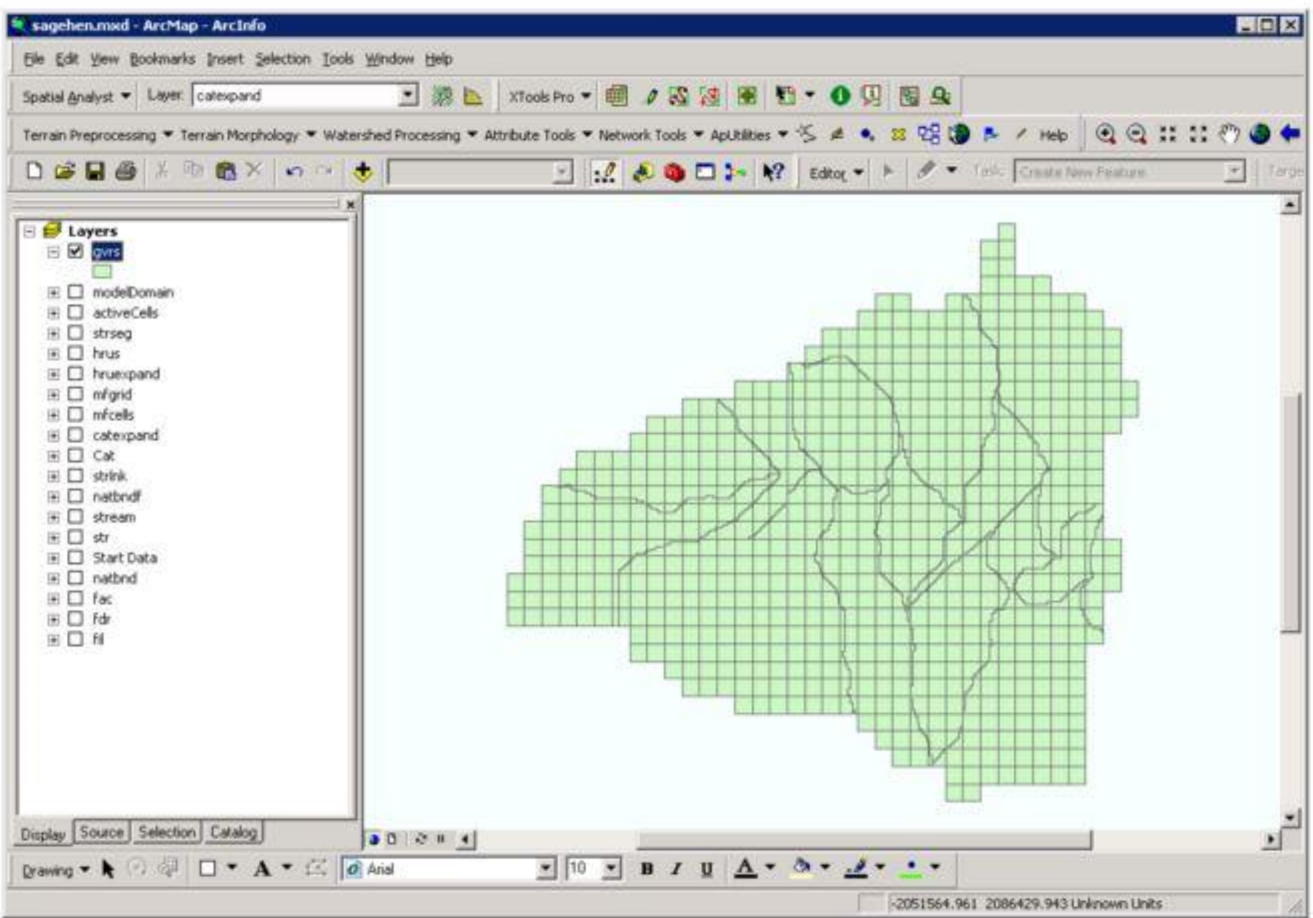
After this map has been created, save the Sagehen ArcMap project by clicking File->Save.

The feature class hrus is the HRU map.

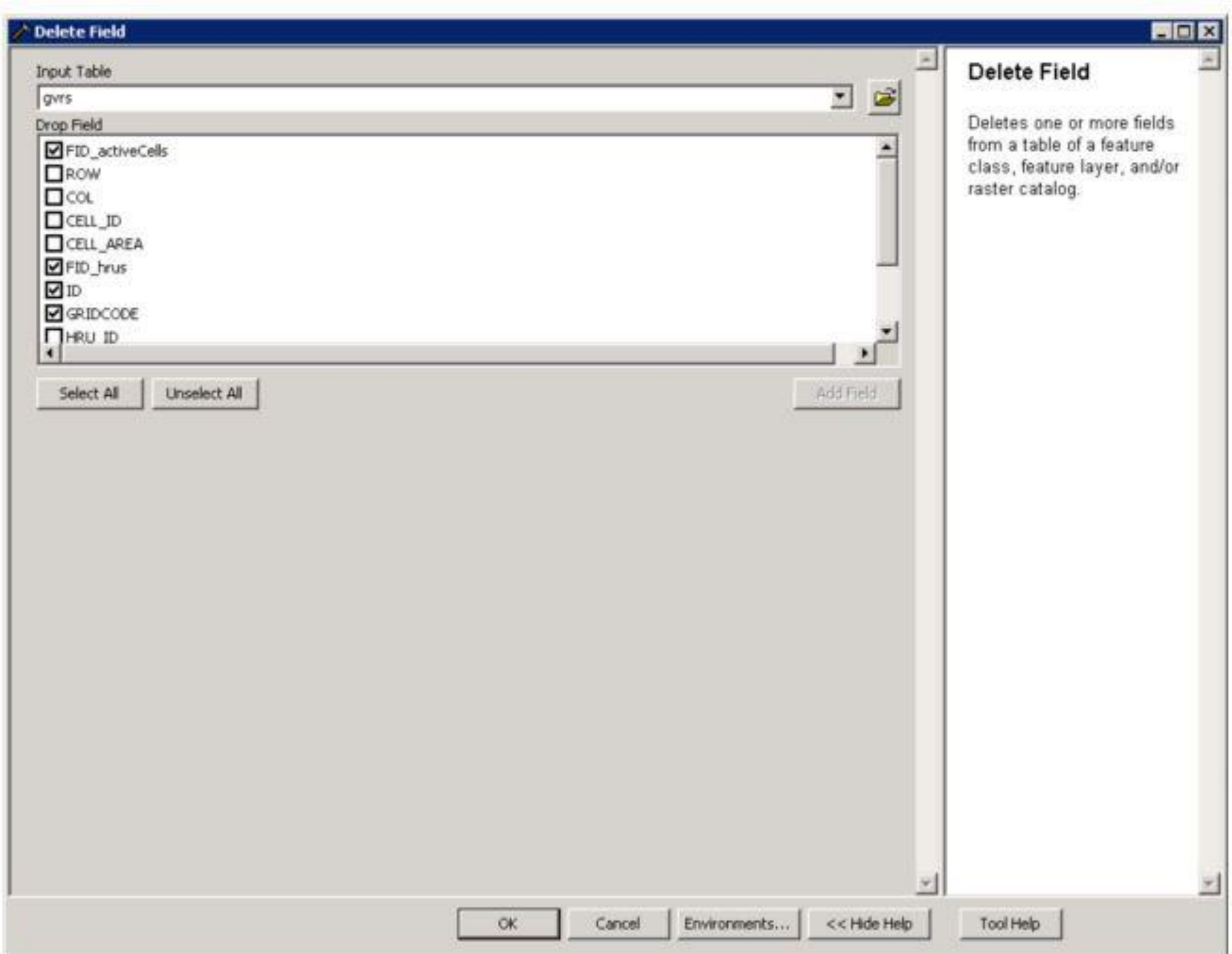
Generation of GSFLOW Gravity Reservoir (GVR) map

Use the Union (analysis) tool to cut the feature class activeCells with the feature class hrus. Click off the Gaps Allowed check box. Name this feature class gvrs. Click OK.


Union
Input Features
Features
Ranks
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\activeCells
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\hrus
Output Feature Class
C:\markstro\gsflowTraining2009\sagehen_gis_work\sagehen_start.mdb\gvrs
JoinAttributes (optional)
ALL
XY Tolerance (optional)
Meters
Gaps Allowed (optional)
Gaps Allowed (optional)
Gaps are areas in the output feature class that are completely enclosed by other polygons. This is not invalid, but it may be desirable to identify these for analysis. To find the gaps in the output, set this option to NO_GAPS, and a feature will be created in these areas. To select these features, query the output feature class based on all the input feature's FID values being equal to -1.
Checked—No feature will be created for areas in the output that are completely enclosed by polygons. This is the default.
Unchecked—A feature will be
OK
Cancel
Environments...
<< Hide Help
Tool Help

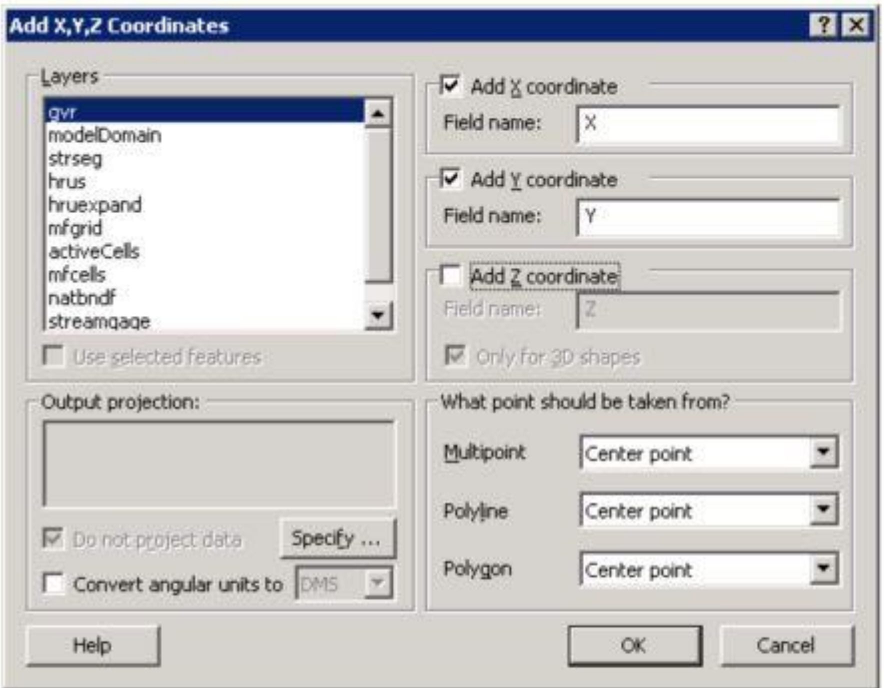

sagehen.mxd - ArcMap - ArcInfo
File Edit View Bookmarks Insert Selection Tools Window Help
Spatial Analyst
Layer: catexpand
XTools Pro
Terrain Preprocessing
Terrain Morphology
Watershed Processing
Attribute Tools
Network Tools
ApUtilities
Help
Editor
Task: Create New Feature
Layers
gvrs
modelDomain
activeCells
strseg
hrus
hruexpand
mfgrid
mfcells
catexpand
Cat
strlnk
natbndf
stream
str
Start Data
natbnd
fac
fdr
fil
Display
Source
Selection
Catalog
Drawing
Arial
10
-2051564.961 2086429.943 Unknown Units

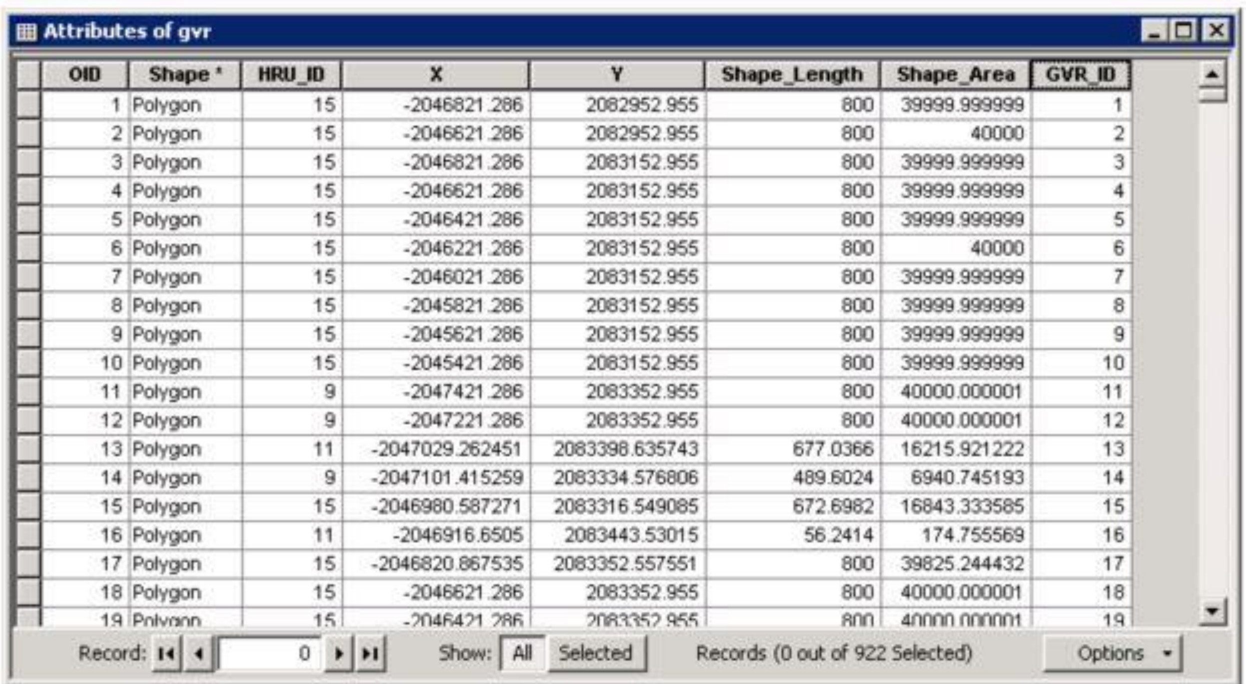
Use the Delete Field (management) tool. Set input table to grvs and select fields to delete. Delete the attributes FID_hrus, ID; GRIDCODE; and FID_activeCells. Click OK.



Add attribute GRV_ID to the gvrs feature class. Use the Field Calculator to copy the values from the OBJECTID attribute to the new GRV_ID attribute.

Calculate X and Y coordinates for each gvrs using XTools Pro Toolbar-> Table Operations ->Add X,Y,Z Coordinates. Select gvrs Layer, uncheck Add Z coordinate, and modify X and Y field if desired. Note make sure to overwrite existing values, as they are remnants and don't represent the correct values.




Attributes of gvr

OID	Shape *	HRU_ID	X	Y	Shape_Length	Shape_Area	GVR_ID
1	Polygon	15	-2046821.286	2082952.955	800	39999.999999	1
2	Polygon	15	-2046621.286	2082952.955	800	40000	2
3	Polygon	15	-2046821.286	2083152.955	800	39999.999999	3
4	Polygon	15	-2046621.286	2083152.955	800	39999.999999	4
5	Polygon	15	-2046421.286	2083152.955	800	39999.999999	5
6	Polygon	15	-2046221.286	2083152.955	800	40000	6
7	Polygon	15	-2046021.286	2083152.955	800	39999.999999	7
8	Polygon	15	-2045821.286	2083152.955	800	39999.999999	8
9	Polygon	15	-2045621.286	2083152.955	800	39999.999999	9
10	Polygon	15	-2045421.286	2083152.955	800	39999.999999	10
11	Polygon	9	-2047421.286	2083352.955	800	40000.000001	11
12	Polygon	9	-2047221.286	2083352.955	800	40000.000001	12
13	Polygon	11	-2047029.262451	2083398.635743	677.0366	16215.921222	13
14	Polygon	9	-2047101.415259	2083334.576806	489.6024	6940.745193	14
15	Polygon	15	-2046980.587271	2083316.549085	672.6982	16843.333585	15
16	Polygon	11	-2046916.6505	2083443.53015	56.2414	174.755569	16
17	Polygon	15	-2046820.867535	2083352.557551	800	39825.244432	17
18	Polygon	15	-2046621.286	2083352.955	800	40000.000001	18
19	Polygon	15	-2046421.286	2083352.955	800	40000.000001	19

Record: 0 Show: All Selected Records (0 out of 922 Selected) Options

After the feature class gvrs has been created, save the Sagehen ArcMap project by clicking File->Save.

The feature class gvrs is the gravity reservoir map.

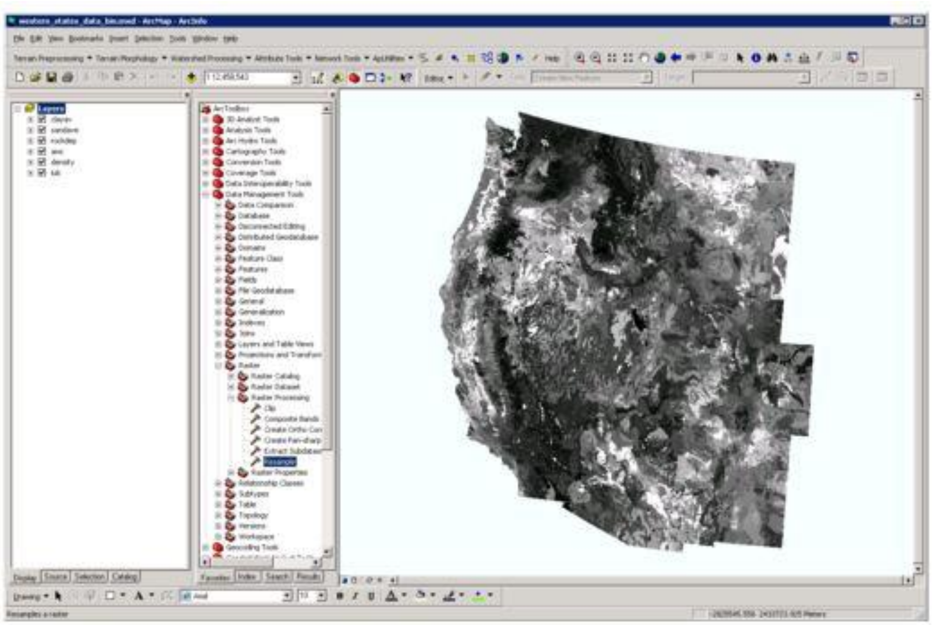
Adding modeling attributes to the GSFLOW maps

HRU map

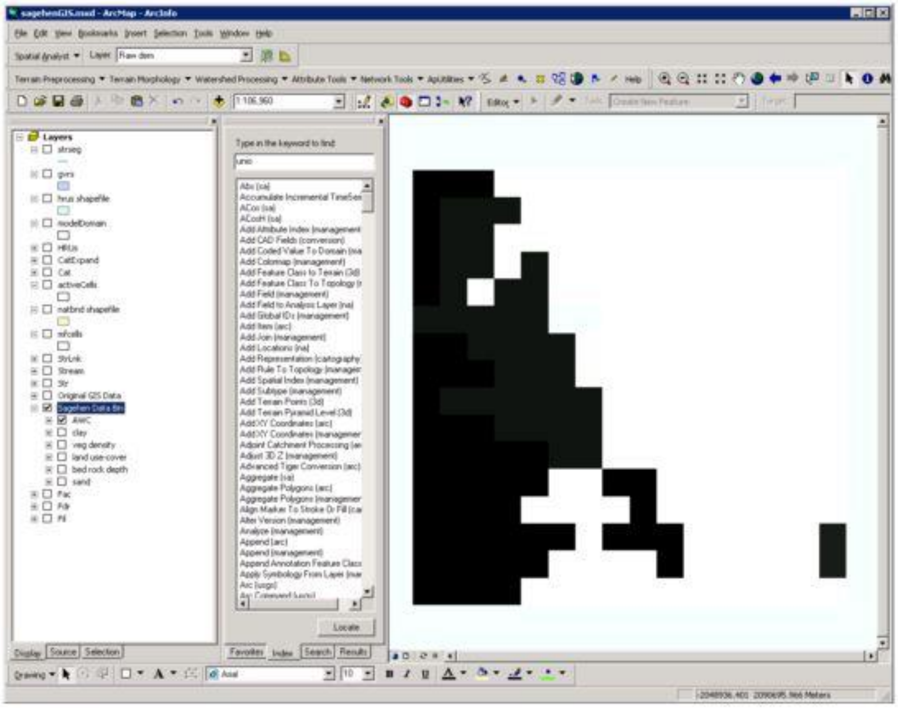
PRMS HRU Parameters (these sections come from unpublished document by Gregg Lamorey).

Several of the PRMS parameters are determined using a DEM and other GIS coverages including coverages of vegetation and soil data. The GIS coverages used in parameterization are available for the US on a 1 km grid. The required coverages are: vegetation type (lulc), vegetation density (density), available water-holding capacity (awc), soil depth (rockdep), sand content (sandave) and clay contents (clayav). These coverages should be projected into the same projection, same extent and same cell resolution as the local DEM used to delineate the basin. The "Environments" setting should be set to the extent and cell size used in the DEM for all coverages generated.

Note: the clipping steps have already been done for the Sagehen example problem and are located in Sagehen Data Bin in the ArcMap tree. All ArcMap analysis tools can be accessed using the ArcMap Search window.



This shows LULC clipped to the extent of the DEM.



Remap tables used to reclassify coverages are also used in the parameterization. The necessary tables are in the folder gis\startData\SagehenDataBin\remap. The cov-den-winter2.rmp, prms-intcp_snow.rmp, prms-intcp_srain.rmp, and prms-intcp_wrain.rmp remap tables are in percent or hundredths of an inch and need to be divided by 100 to obtain the correct values while the temp_adj.rmp remap table is in tenths of degrees and needs to be divided by 10 to obtain the correct values (this was done because of problems reclassing an integer to a real number in ArcMap).

cov_type

The coverage type (0 for bare, 1 for grass, 2 for shrub, 3 for deciduous trees, and 4 for coniferous tress) is determined from the vegetation type coverage. This can be calculated in ArcMap by first using "Spatial Analyst Tools > Reclass > Reclass by ASCII file" with the vegetation species coverage "lulc" as the input raster, "cov-type_new.rmp" as the "Input ASCII remap file", and "cov_type" as the "Output raster."

The values for each HRU can be determined using the Zonal Statistics (Spatial Analyst) tool in ArcMap with the HRU shapefile specified as the "Input raster or feature zone data", the HRU id field as the "Zone field", and "cov_type" specified as the "Input value raster". The output from the zonal statistics is a .dbf file that can be opened in a spreadsheet.

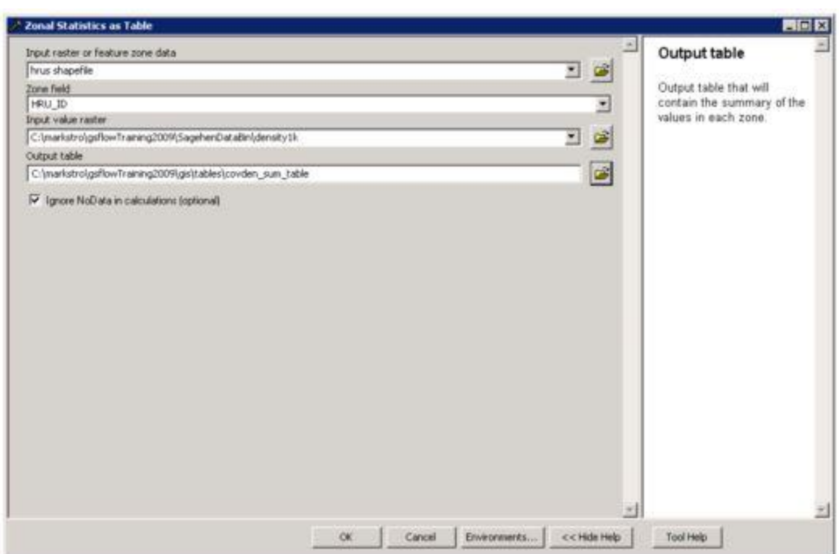
*******Do not modify the .dbf file in excel it will corrupt the data *******

Make a new field "cov_type" in the HRUs shapefile. Join the table made above and bring up the attribute table. Copy the values from the joined "MAJORITY" field into the cov_type field. Unjoin the table from the HRUs shapefile.

covden_sum

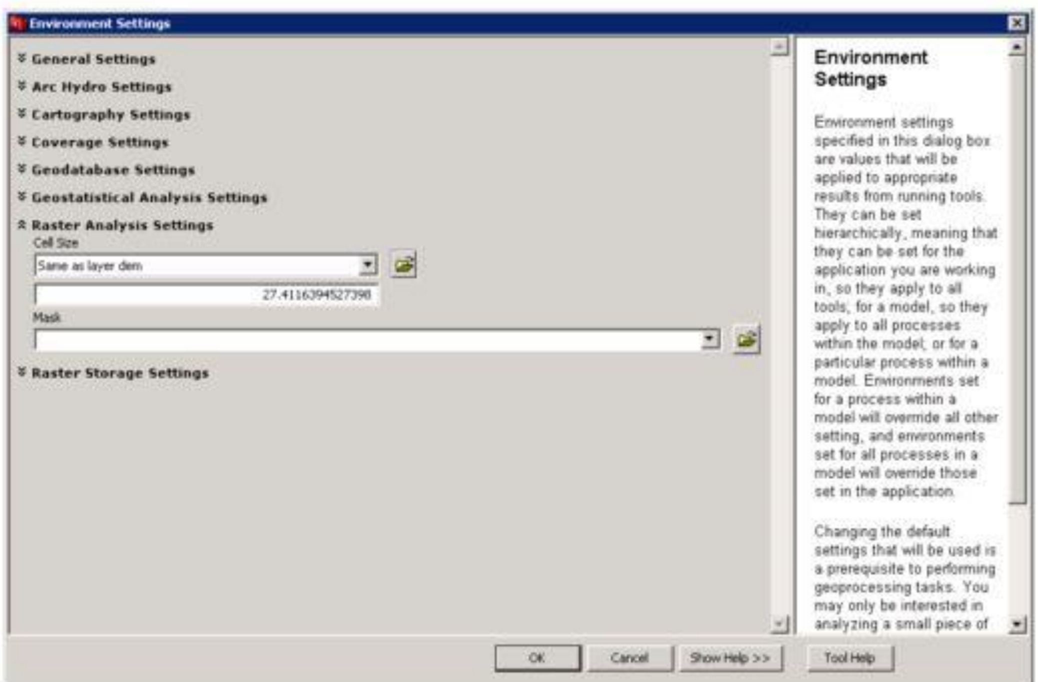
The vegetation coverage density in the summer is the mean value of the vegetation density. This can be calculated Zonal Statistics (Spatial Analyst) tool with the HRU shapefile specified as the "Input raster or feature zone data", the HRU id field as the "Zone field", and "SagehenDataBin\density1k" specified as the "Value raster."

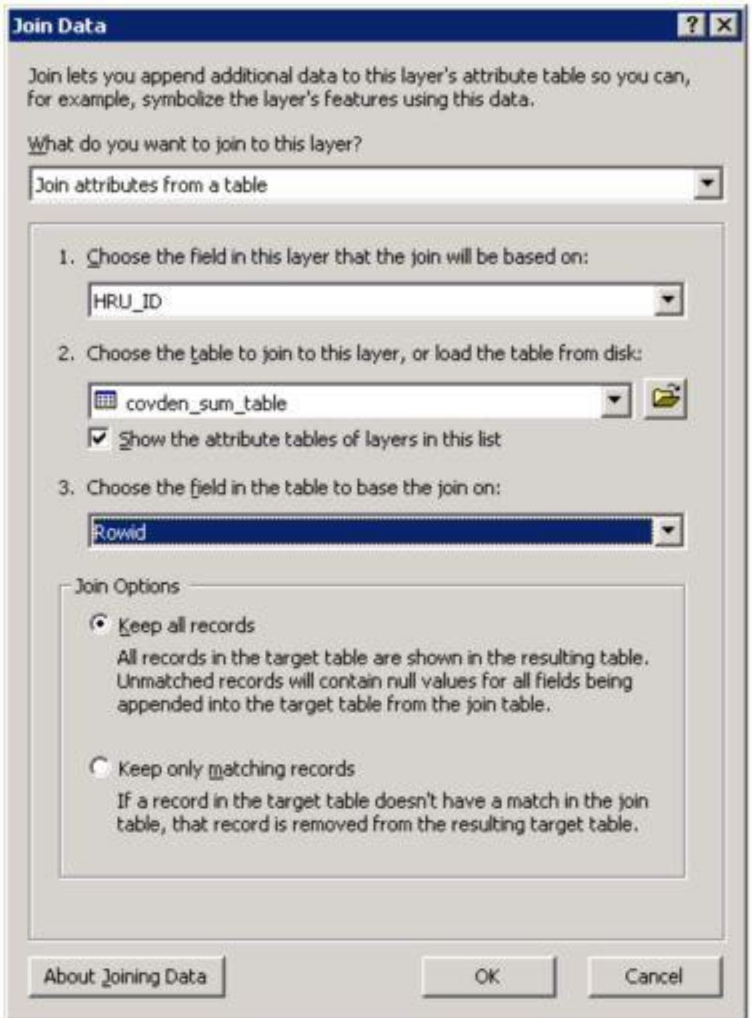
Use the Zonal Statistics as Table tool:



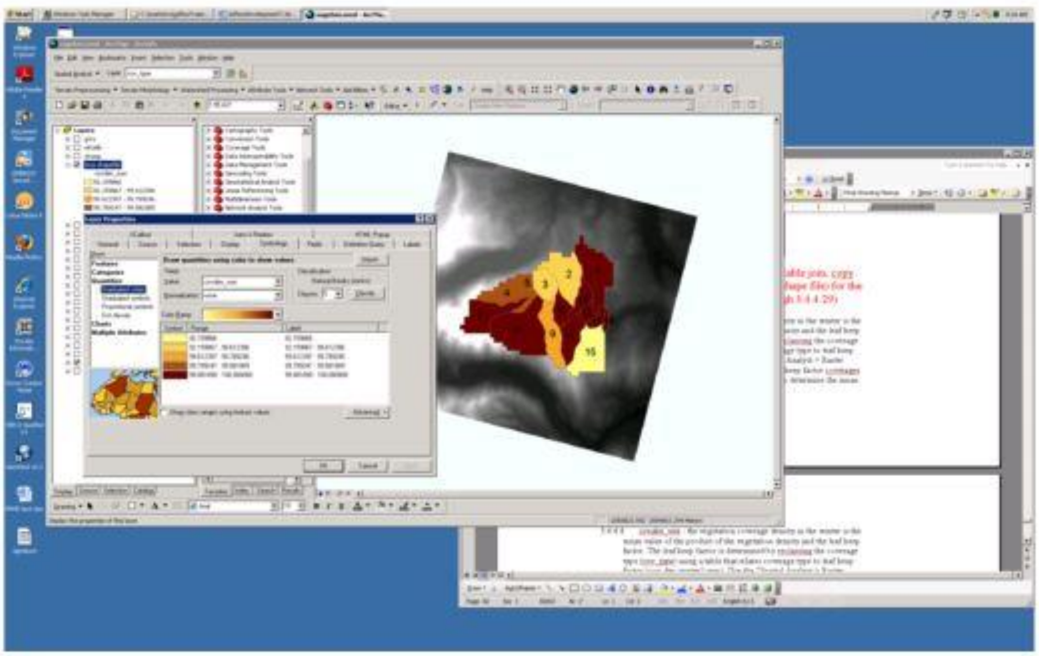
Be sure to set Environments->Raster Analysis Settings -> Cell Size to Same as layer dem. This sets the cell size in the analysis to 27.4… This is important because this tool converts the HRU shapefile to a raster to do the analysis. If the Input value raster is too coarse (in this case it is 1 km2) the HRUs will not be able to be represented and the zonal statistics will be messed up. If the generated zonal statistics table does not have a valid row for each HRU, this is what happened.

Choose the MEAN value from the joined table and using the Field Calculator, divide by 100 (to make decimal fraction out of percent) and copy it into a new field called covden_sum (type double), as for parameter cov_type.





To see the HRUs colored by the parameter values (do this for every parameter), bring up the properties for the HRUs shapefile and set the Symbology to something similar to what is shown:

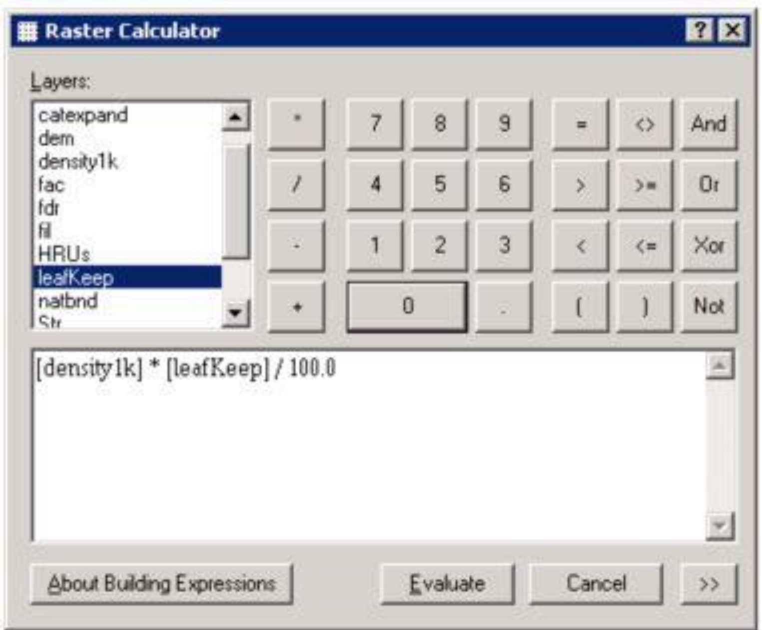


Repeat the above steps (reclass, zonal statictics, table join, copy out the parameter values into fields in the HRU shape file) for the rest of the PRMS parameters (steps 4.13 through 4.1.18)

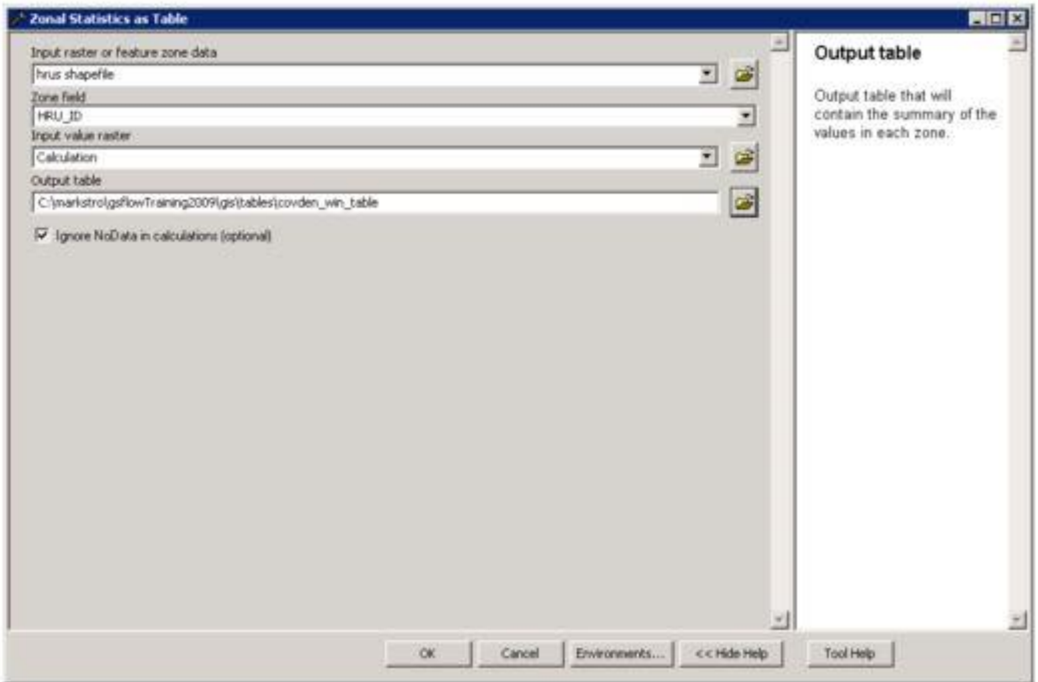
covden_win

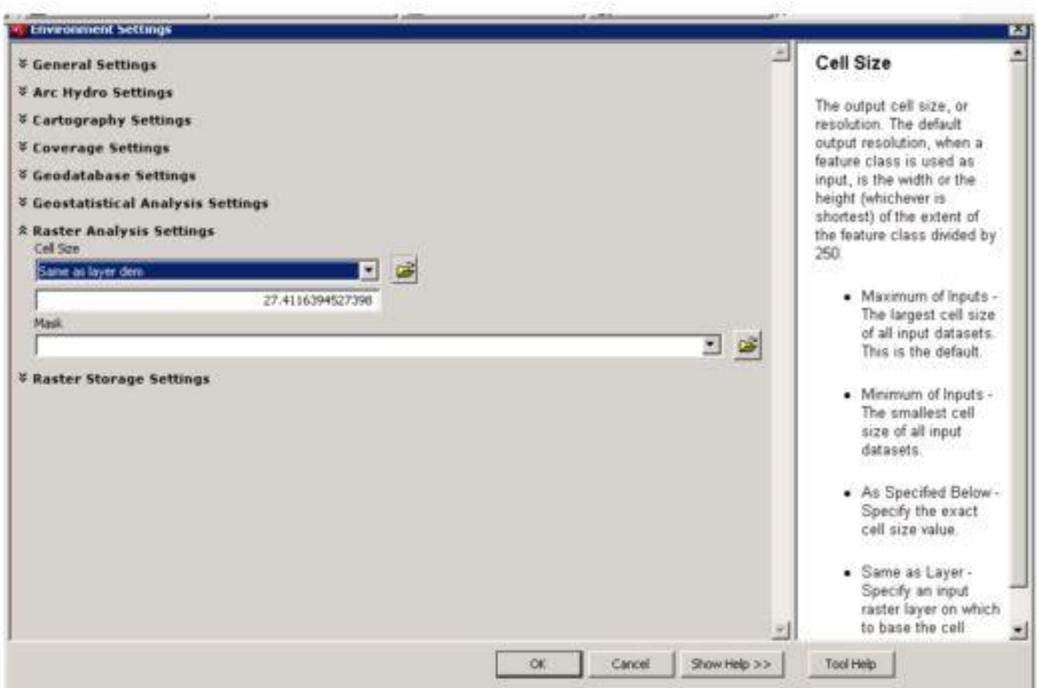
The vegetation coverage density in the winter is the mean value of the product of the vegetation density and the leaf keep factor. The leaf keep factor is determined by reclassing the coverage type (cov_type) using a table that relates coverage type to leaf keep factor (cov-den-winter2.rmp).

Use the Raster Calculator (Spatial Analyst) tool to multiply the vegetation (SagehenDatabin\density1k) and leaf keep factor coverages (divide by 100.0 to keep it as a percentage).



Then use the Zonal Statistics as Table (Spatial Analyst) tool to determine the mean value for each HRU.

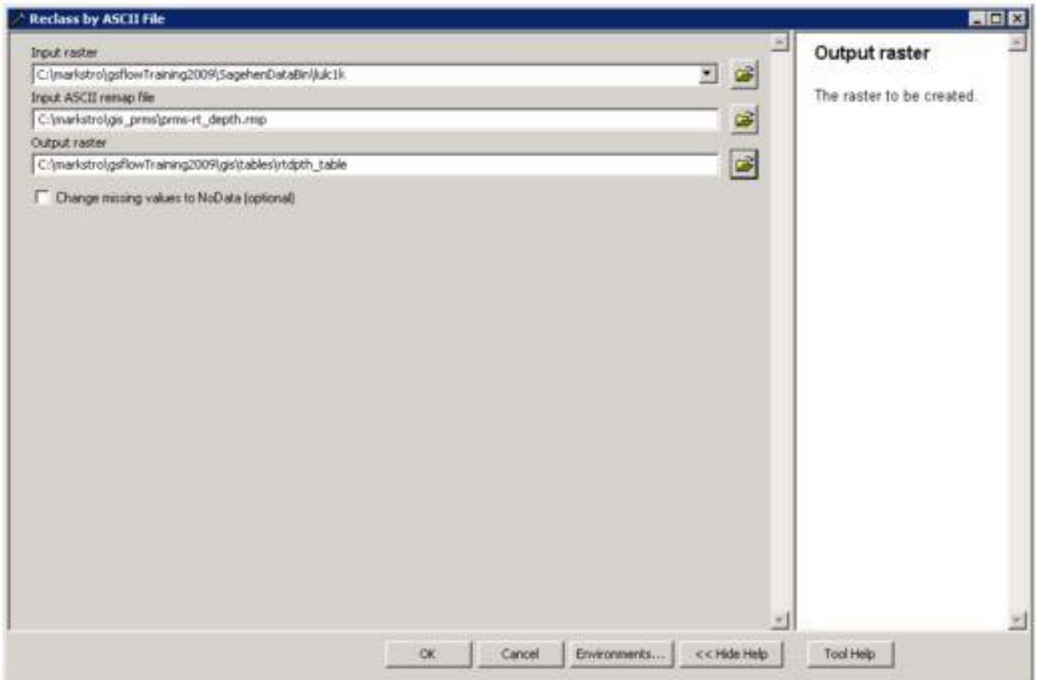




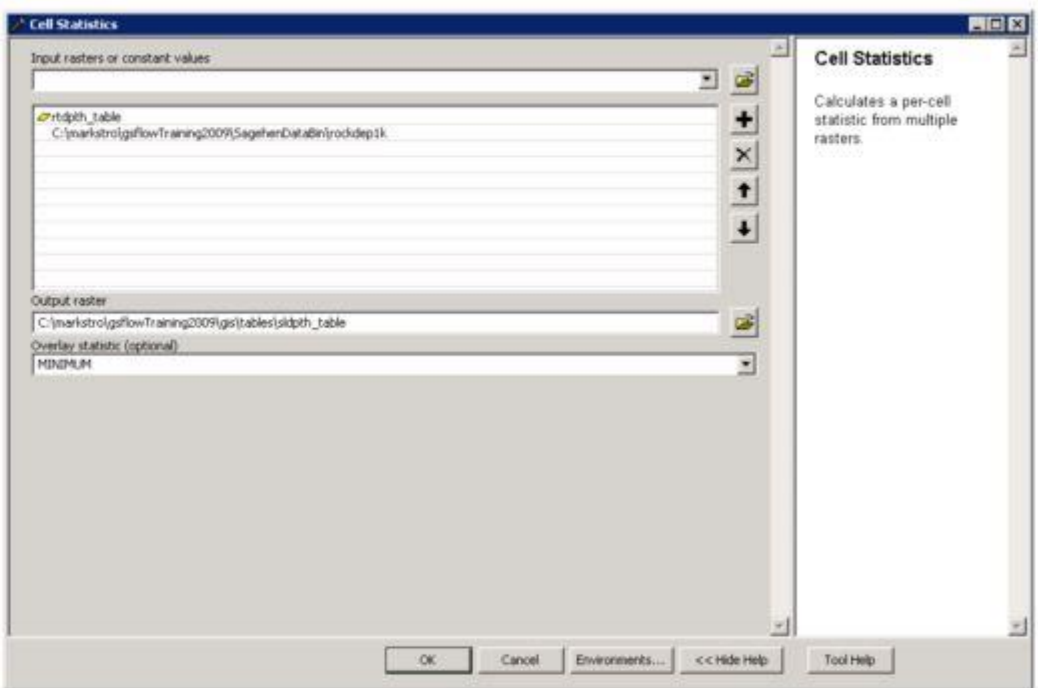
soil_moist_max

The soil moisture maximum is the product of the Available Water Content (awc) and the rooting depth.

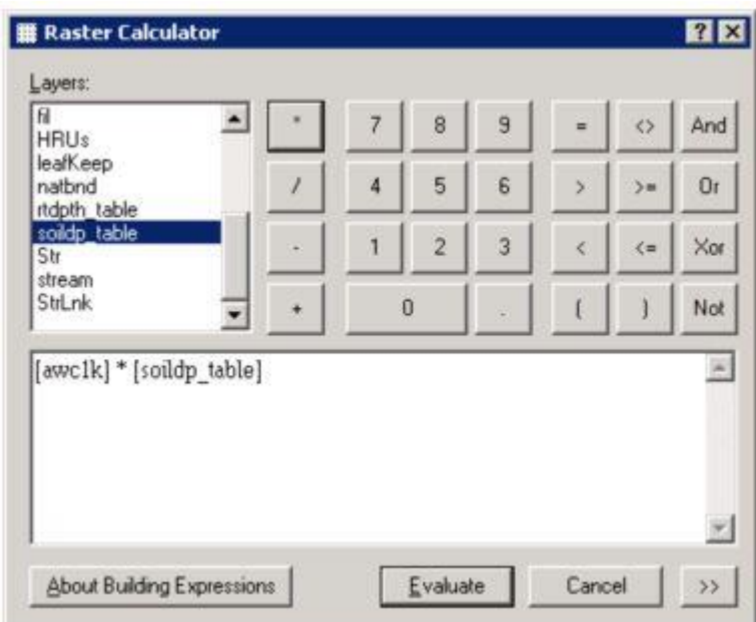
The rooting depth is calculated as the minimum of the root depth and the soil depth. The root depth is determined by reclassing from vegetation species (SagehenDataBin\lulc1k) to root depth using the Reclass by ASCII file (Spatial Analyst) tool with the remap table, prms_rt_depth.rmp.



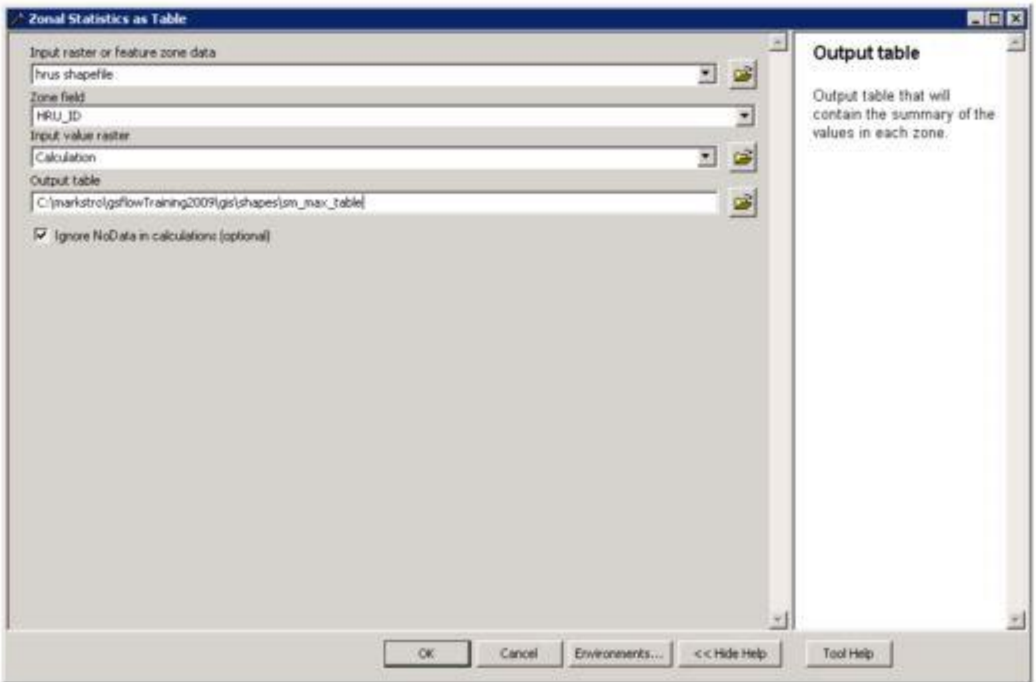
The minimum of root depth and bed rock depth (SagehenDataBin\rockdep1k) coverages can be generated using the Cell Statistics (Spatial Analyst) tool and specifying the two coverages as the input rasters and setting the "Overlay statistic" to "Minimum".

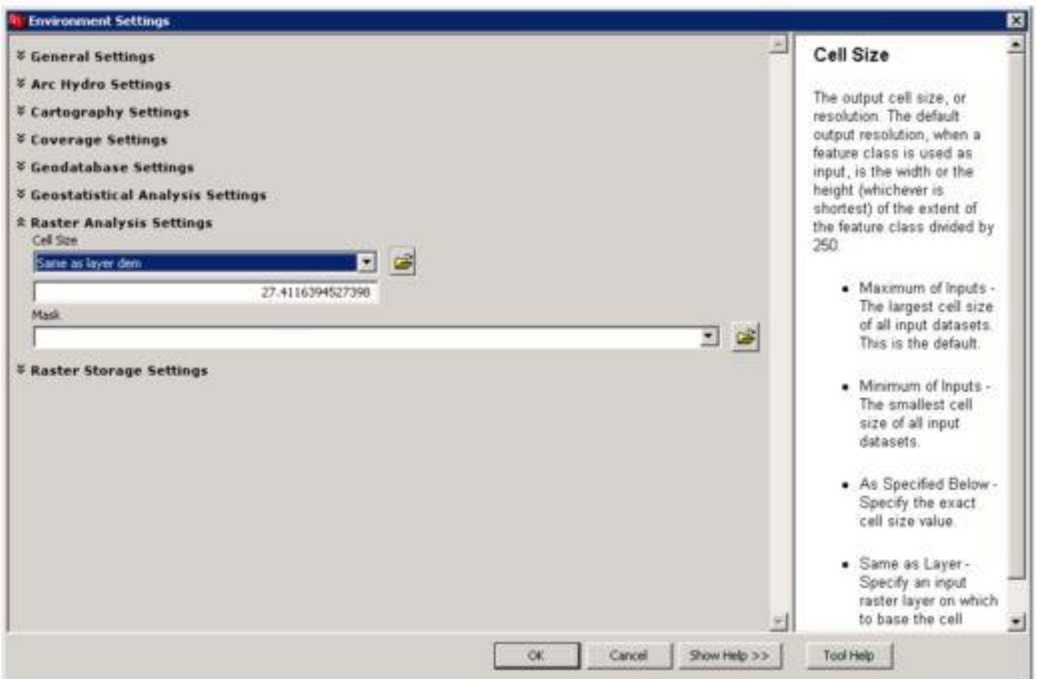


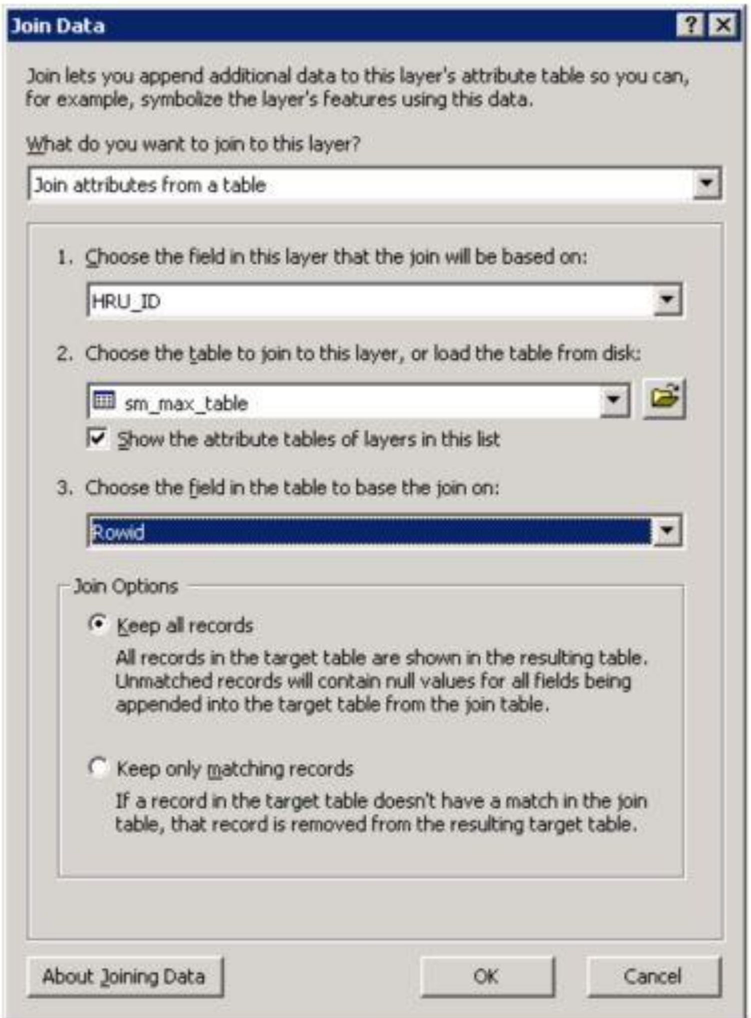
The product of the awc and minimum depth rasters can be determined with the Raster Calculator (Spatial Analyst) tool.



A zonal mean of this raster for each HRU can be calculated using the Zonal Statistics as Table (Spatial Analyst) tool.


Zonal Statistics as Table
Input raster or feature zone data
hrus shapefile
Zone field
HRU_ID
Input value raster
Calculation
Output table
C:\markstro\gsflowTraining2009\gis\shapes\sm_max_table
Ignore NoData in calculations (optional)
Output table
Output table that will contain the summary of the values in each zone.
OK
Cancel
Environments...
<< Hide Help
Tool Help

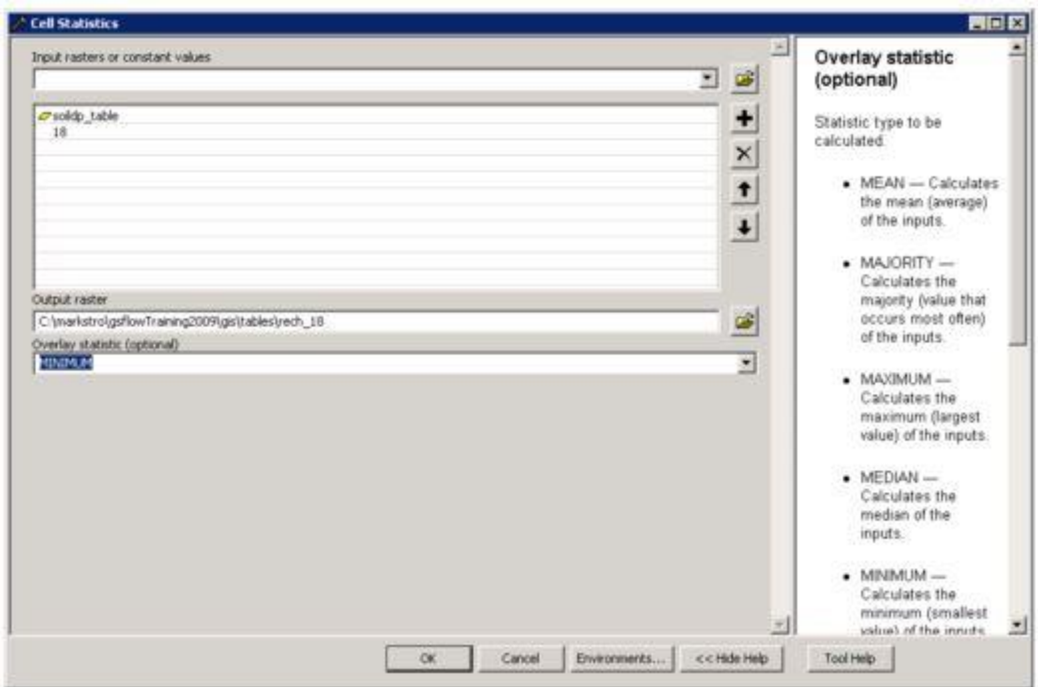

Environment Settings
General Settings
Arc Hydro Settings
Cartography Settings
Coverage Settings
Geodatabase Settings
Geostatistical Analysis Settings
Raster Analysis Settings
Cell Size
Same as layer dem
27.4116394527398
Mask
Raster Storage Settings
Cell Size
The output cell size, or resolution. The default output resolution, when a feature class is used as input, is the width or the height (whichever is shortest) of the extent of the feature class divided by 250.
Maximum of Inputs - The largest cell size of all input datasets. This is the default.
Minimum of Inputs - The smallest cell size of all input datasets.
As Specified Below - Specify the exact cell size value.
Same as Layer - Specify an input raster layer on which to base the cell
OK
Cancel
Show Help >>
Tool Help



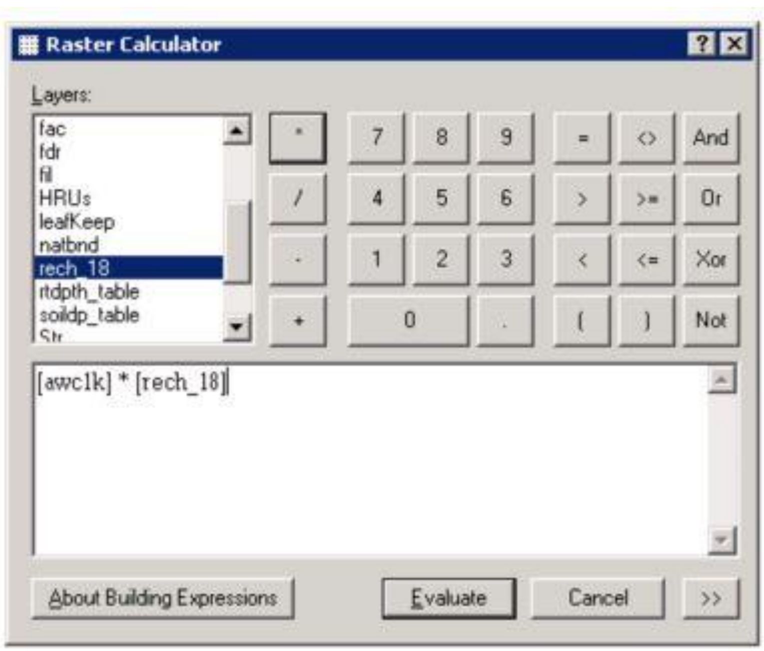
Copy the zonal MEAN value to sm_max (PRMS parameter soil_moist_max) in HRUs shapefile.

soil_rchr_max

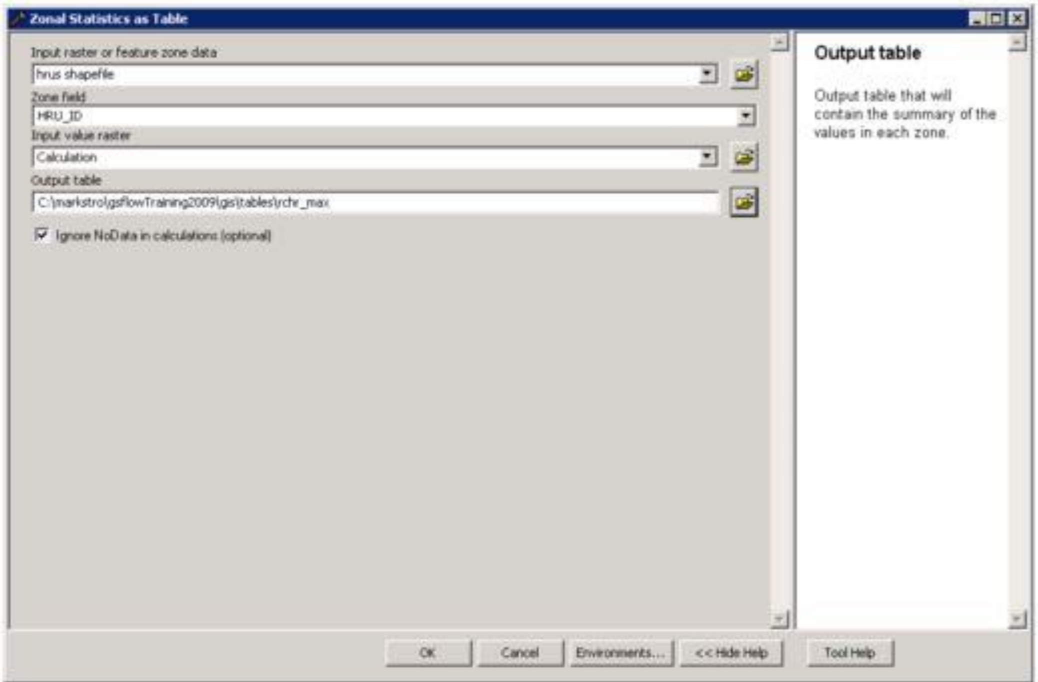
The soil recharge zone maximum value is the minimum of the rooting depth and 18 inches multiplied by AWC. First, the minimum of the rooting depth (determined under soil_moist_max) and 18 inches is calculated usingthe Cell Statistics (Spatial Analyst) tool.

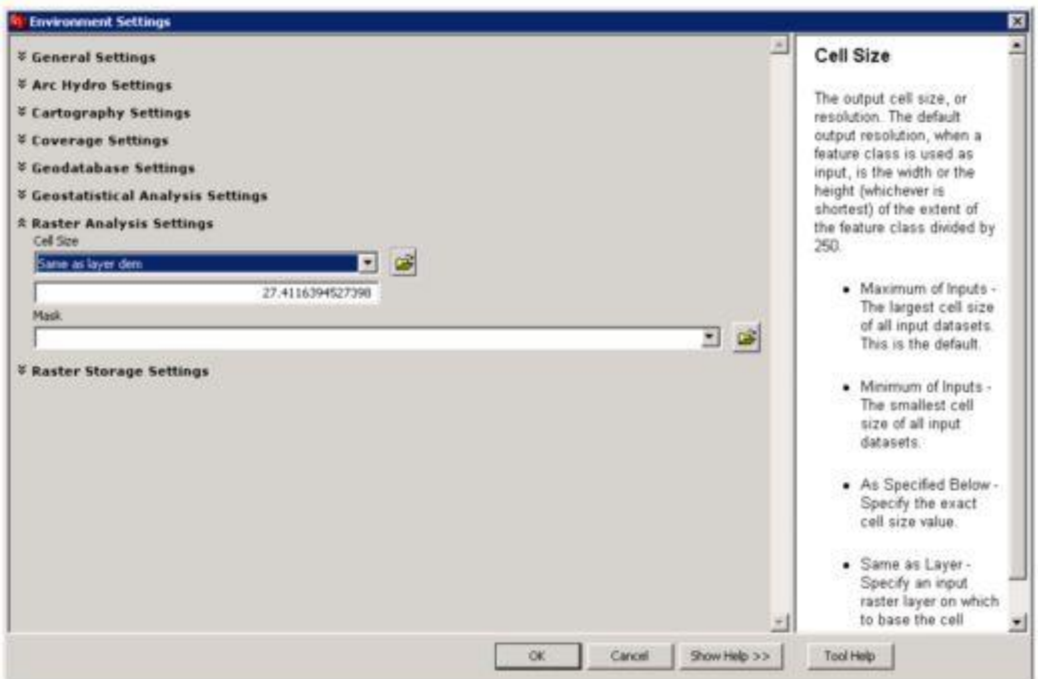


Next, the resulting coverage is multiplied by awc using "Spatial Analyst > Raster Calculator".

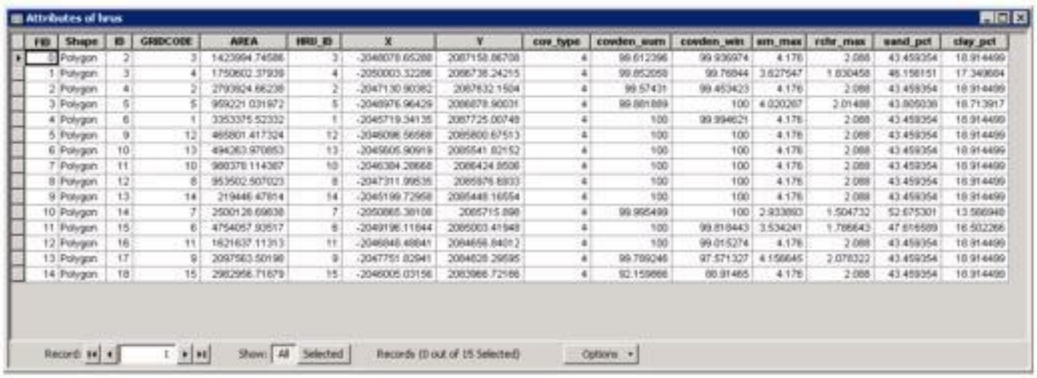


A zonal mean of this raster for each HRU can be calculated using Zonal Statistics as Table (Spatial Analyst) tool





Copy the zonal MEAN value to rchr_max (PRMS parameter soil_rchr_max) in HRUs shapefile.



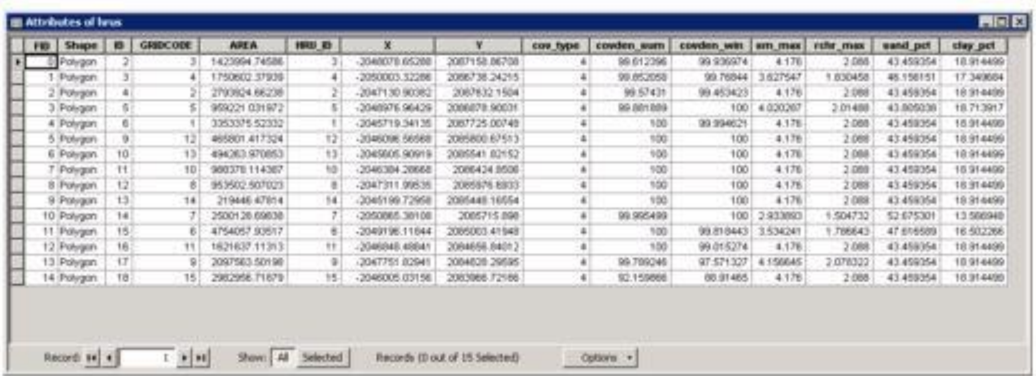
Attributes of hrus

FID	Shape	ID	GRIDCODE	AREA	HRU_ID	X	Y	cov_type	covden_sum	covden_win	srn_max	rchr_max	sand_pct	clay_pct
0	Polygon	2	3	1423994.74586	3	-2048078.65288	2087158.86708	4	99.612396	99.936974	4.176	2.088	43.459354	18.914499
1	Polygon	3	4	1750602.37939	4	-2050003.32288	2086738.24215	4	99.852058	99.76844	3.627547	1.830458	46.158151	17.349684
2	Polygon	4	2	2793924.66238	2	-2047130.90382	2087632.1504	4	99.57431	99.453423	4.176	2.088	43.459354	18.914499
3	Polygon	5	5	959221.031972	5	-2048976.96429	2086878.90031	4	99.881889	100	4.020207	2.01488	43.805038	18.713917
4	Polygon	6	1	3353375.52332	1	-2045719.34135	2087725.00748	4	100	99.994621	4.176	2.088	43.459354	18.914499
5	Polygon	9	12	465801.417324	12	-2046098.56568	2085800.67513	4	100	100	4.176	2.088	43.459354	18.914499
6	Polygon	10	13	494263.970853	13	-2045605.90919	2085541.82152	4	100	100	4.176	2.088	43.459354	18.914499
7	Polygon	11	10	980378.114387	10	-2046384.28668	2086424.8506	4	100	100	4.176	2.088	43.459354	18.914499
8	Polygon	12	8	953502.507023	8	-2047311.99535	2085976.6933	4	100	100	4.176	2.088	43.459354	18.914499
9	Polygon	13	14	219446.47814	14	-2045199.72958	2085448.16554	4	100	100	4.176	2.088	43.459354	18.914499
10	Polygon	14	7	2500128.69838	7	-2050865.38108	2085715.898	4	99.995499	100	2.933893	1.504732	52.675301	13.586948
11	Polygon	15	6	4754057.93517	6	-2049196.11644	2085003.41948	4	100	99.818443	3.534241	1.788843	47.616589	16.502266
12	Polygon	16	11	1621637.11313	11	-2046848.48841	2084656.84012	4	100	99.015274	4.176	2.088	43.459354	18.914499
13	Polygon	17	9	2097563.50198	9	-2047751.82941	2084628.29595	4	99.789246	97.571327	4.156645	2.078322	43.459354	18.914499
14	Polygon	18	15	2982958.71679	15	-2046005.03156	2083986.72186	4	92.159866	88.91465	4.176	2.088	43.459354	18.914499

Record: 1 Show: All Selected Records (0 out of 15 Selected) Options

soil_type

The soil type (1 for sand, 2 for loam, and 3 for clay) is determined by first calculating the zonal means of the sandave and clayav coverages for each HRU using the Zonal Statistics as Table (Spatial Analyst) tool.



Attributes of hrus

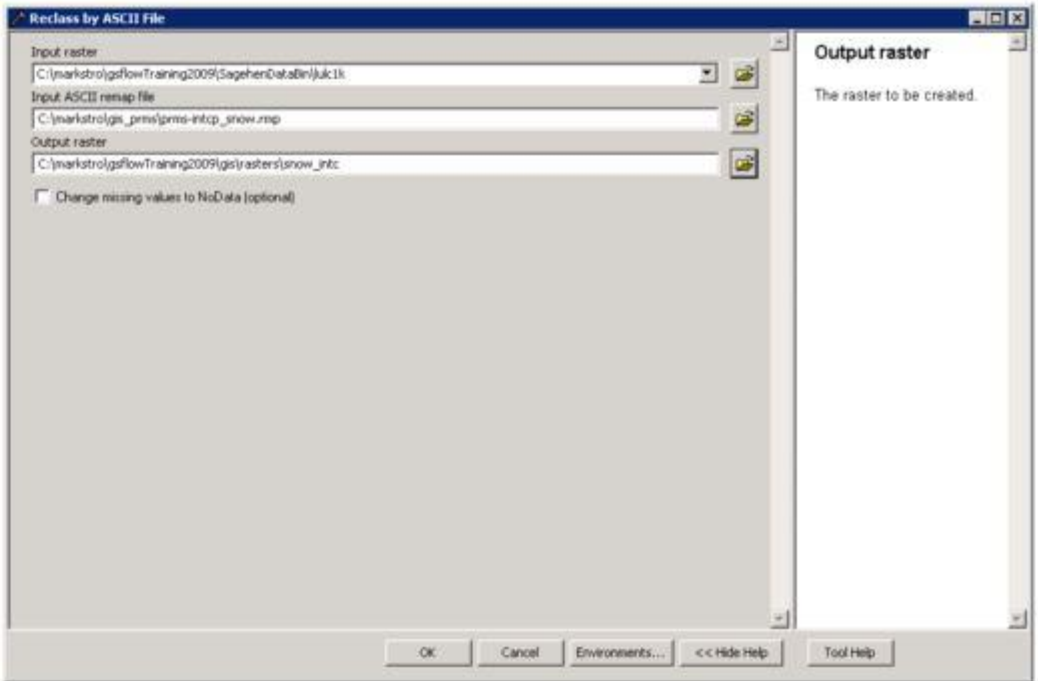
FID	Shape	ID	GRIDCODE	AREA	HRU_ID	X	Y	cov_type	covden_sum	covden_win	srn_max	rchr_max	sand_pct	clay_pct
0	Polygon	2	3	1423994.74586	3	-2048078.65288	2087158.86708	4	99.612396	99.936974	4.176	2.088	43.459354	18.914499
1	Polygon	3	4	1750602.37939	4	-2050003.32288	2086738.24215	4	99.852058	99.76844	3.627547	1.830458	46.158151	17.349684
2	Polygon	4	2	2793924.66238	2	-2047130.90382	2087632.1504	4	99.57431	99.453423	4.176	2.088	43.459354	18.914499
3	Polygon	5	5	959221.031972	5	-2048976.96429	2086878.90031	4	99.881889	100	4.020207	2.01488	43.805038	18.713917
4	Polygon	6	1	3353375.52332	1	-2045719.34135	2087725.00748	4	100	99.994621	4.176	2.088	43.459354	18.914499
5	Polygon	9	12	465801.417324	12	-2046098.56568	2085800.67513	4	100	100	4.176	2.088	43.459354	18.914499
6	Polygon	10	13	494263.970853	13	-2045605.90919	2085541.82152	4	100	100	4.176	2.088	43.459354	18.914499
7	Polygon	11	10	980378.114387	10	-2046384.28668	2086424.8506	4	100	100	4.176	2.088	43.459354	18.914499
8	Polygon	12	8	953502.507023	8	-2047311.99535	2085976.6933	4	100	100	4.176	2.088	43.459354	18.914499
9	Polygon	13	14	219446.47814	14	-2045199.72958	2085448.16554	4	100	100	4.176	2.088	43.459354	18.914499
10	Polygon	14	7	2500128.69838	7	-2050865.38108	2085715.898	4	99.995499	100	2.933893	1.504732	52.675301	13.586948
11	Polygon	15	6	4754057.93517	6	-2049196.11644	2085003.41948	4	100	99.818443	3.534241	1.788843	47.616589	16.502266
12	Polygon	16	11	1621637.11313	11	-2046848.48841	2084656.84012	4	100	99.015274	4.176	2.088	43.459354	18.914499
13	Polygon	17	9	2097563.50198	9	-2047751.82941	2084628.29595	4	99.789246	97.571327	4.156645	2.078322	43.459354	18.914499
14	Polygon	18	15	2982958.71679	15	-2046005.03156	2083986.72186	4	92.159866	88.91465	4.176	2.088	43.459354	18.914499

Record: 1 Show: All Selected Records (0 out of 15 Selected) Options

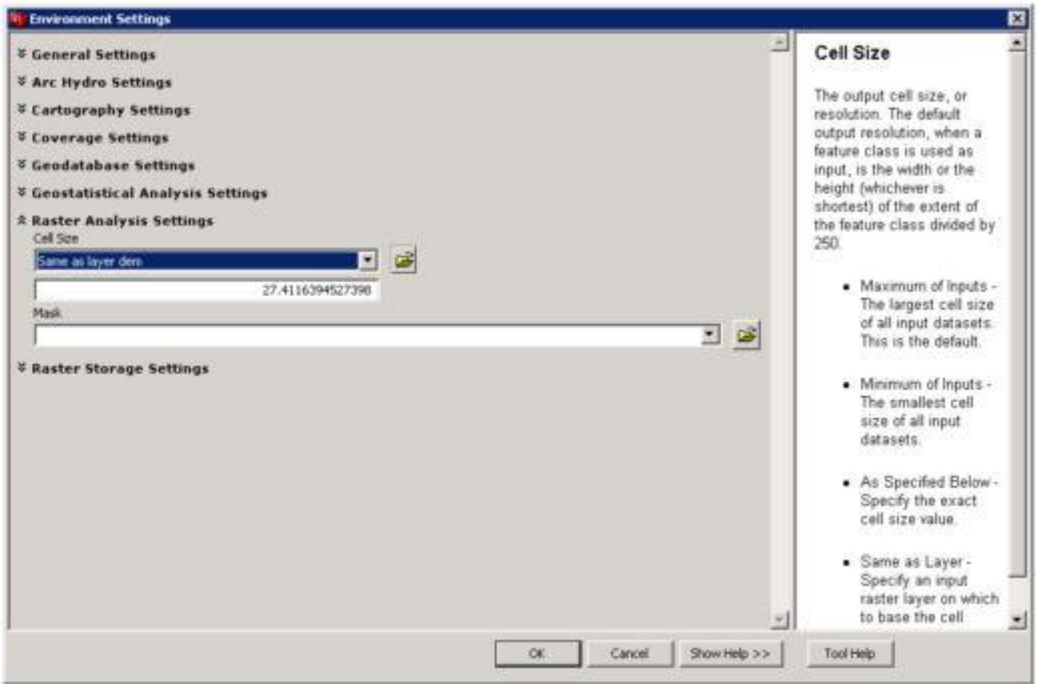
If sandav is greater than 50% then the type is 1, if clayav is greater than 40% then the type is 3, otherwise the type is 2. This calculation can be implemented by hand by sorting the means and setting the corresponding cells.

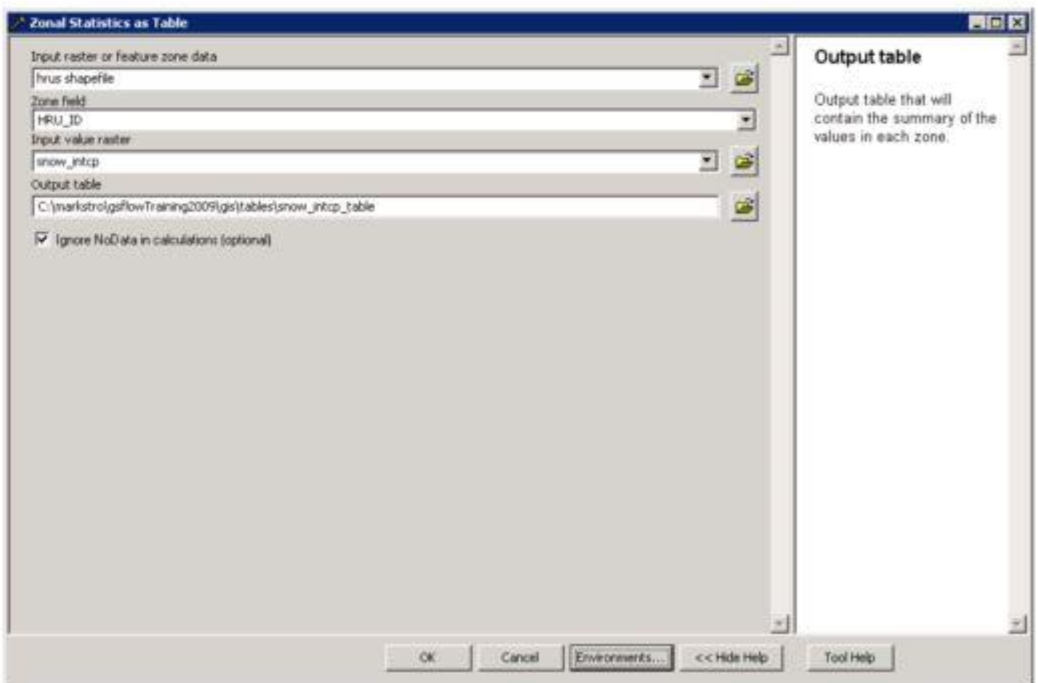
snow_intcp

The snow interception storage capacity is determined by reclassing from vegetation species (lulc) to snow interception storage capacity using the Reclass by ASCII File (Spatial Analyst) tool with the remap table prms-intcp_snow.rmp.



A zonal mean of this raster for each HRU can be calculated using the Zonal Statistics as Table (Spatial Analyst) tool.





Divide these values by 100.0 when copying the zonal mean field into the snow_intcp field.

wrain_intcp

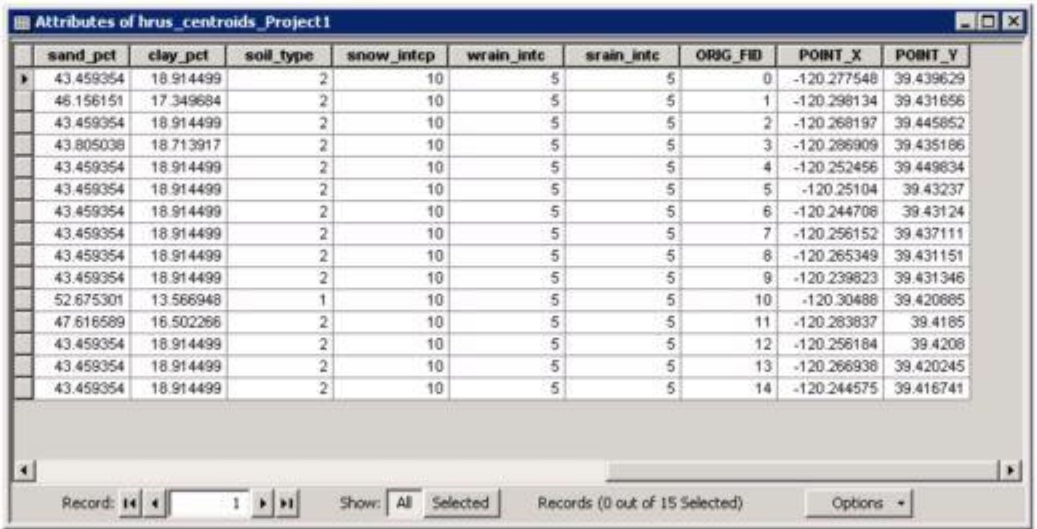
The winter rain interception storage capacity is determined by reclassing from vegetation species (lulc) to winter rain interception storage capacity using the Reclass by ASCII File (Spatial Analyst) tool with the remap table prms-intcp_wrain.rmp. A zonal mean of this raster for each HRU can be calculated using the Zonal Statistics as Table (Spatial Analyst) tool. Divide these values by 100.0 when copying the zonal mean field into the wrain_intcp field.

srain_intcp

The summer rain interception storage capacity is determined by reclassing from vegetation species (lulc) to summer rain interception storage capacity using the Reclass by ASCII File (Spatial Analyst) tool with the remap table prms-intcp_srain.rmp. A zonal mean of this raster for each HRU can be calculated using the Zonal Statistics as Table (Spatial Analyst) tool. Divide these values by 100.0 when copying the zonal mean field into the srain_intcp field.

hru_lat

The latitude of the centroids of the HRU's can be determined by first converting the polygon coverage of the HRU's to centroids using the Feature to Point (Data Managment) tool. The centroid coverage can be projected to latitude and longitude using the Project (Data Management) tool and specifying the output coordinate system (by clicking on the button next to "Output Coordinate System" and selecting the "Select" button on the resulting "Spatial Reference Properties" dialog box) to be "Geographic > North America > North American Datum 1983.prj". The new coordinates can be added to the coverage attribute table using the Add XY Coordinates (Data Management) tool.

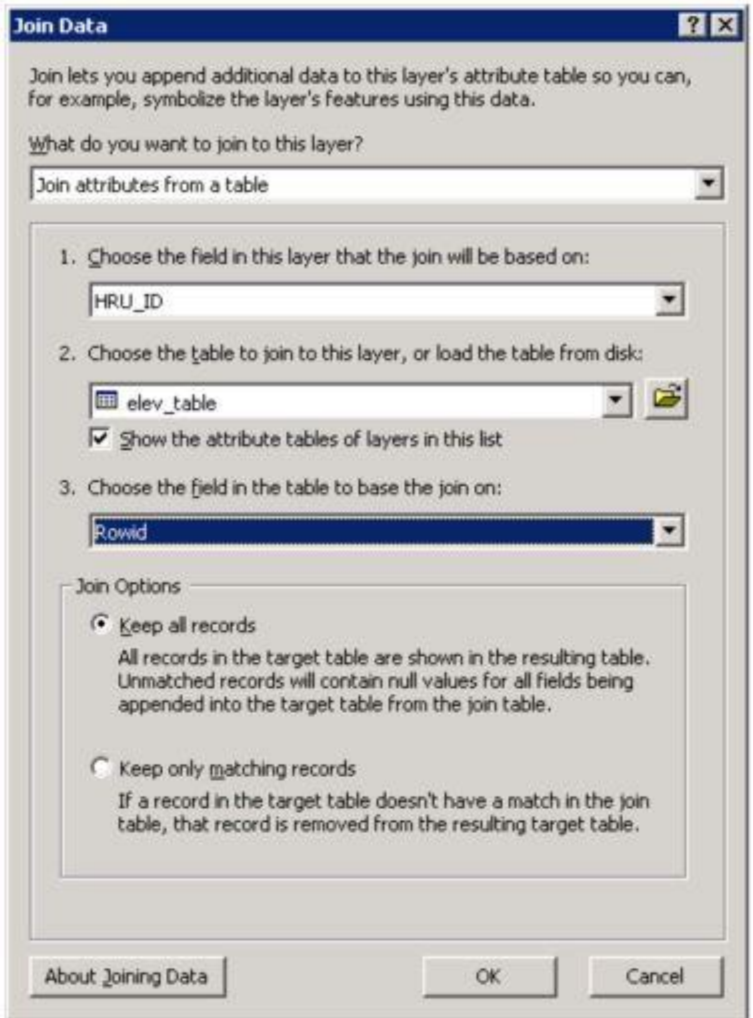

Attributes of hrus_centroids_Project1

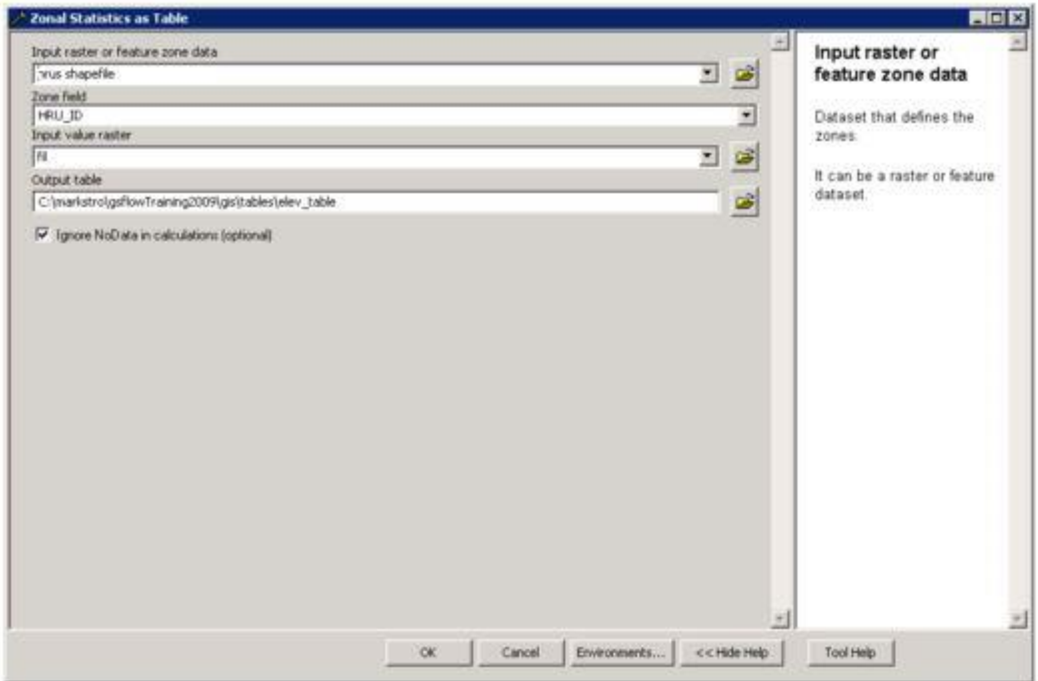
sand_pct	clay_pct	soil_type	snow_intcp	wrain_intc	srain_intc	ORIG_FID	POINT_X	POINT_Y
43.459354	18.914499	2	10	5	5	0	-120.277548	39.439629
46.156151	17.349684	2	10	5	5	1	-120.298134	39.431656
43.459354	18.914499	2	10	5	5	2	-120.268197	39.445852
43.805038	18.713917	2	10	5	5	3	-120.286909	39.435186
43.459354	18.914499	2	10	5	5	4	-120.252456	39.449834
43.459354	18.914499	2	10	5	5	5	-120.25104	39.43237
43.459354	18.914499	2	10	5	5	6	-120.244708	39.43124
43.459354	18.914499	2	10	5	5	7	-120.256152	39.437111
43.459354	18.914499	2	10	5	5	8	-120.265349	39.431151
43.459354	18.914499	2	10	5	5	9	-120.239823	39.431346
52.675301	13.566948	1	10	5	5	10	-120.30488	39.420885
47.616589	16.502266	2	10	5	5	11	-120.283837	39.4185
43.459354	18.914499	2	10	5	5	12	-120.256184	39.4208
43.459354	18.914499	2	10	5	5	13	-120.266938	39.420245
43.459354	18.914499	2	10	5	5	14	-120.244575	39.416741

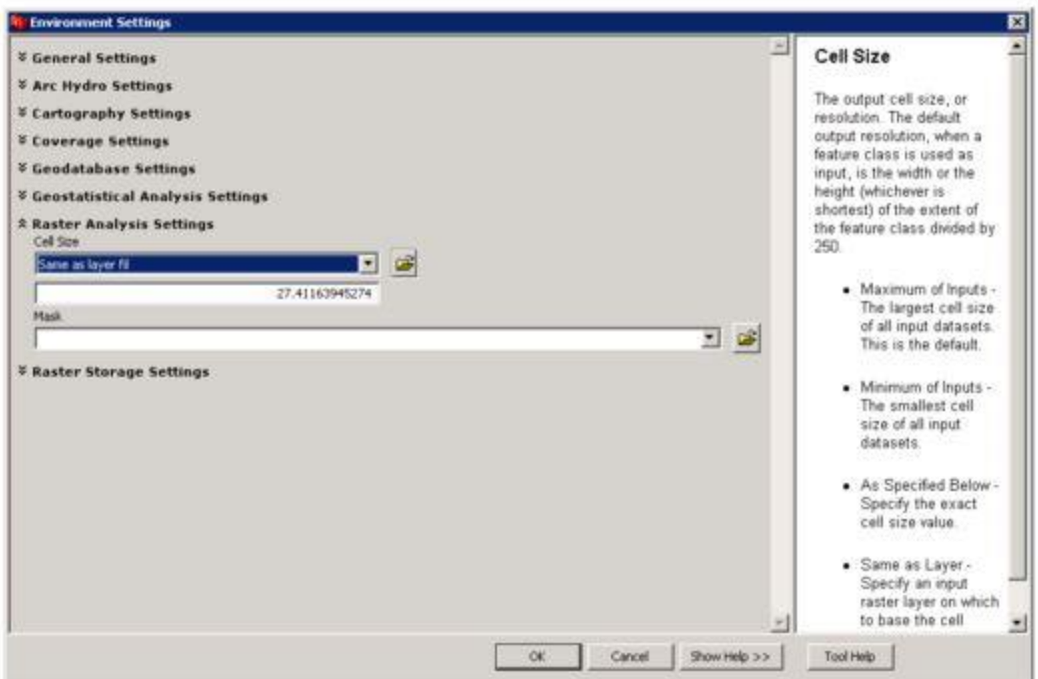
Record: 1 Show: All Selected Records (0 out of 15 Selected) Options

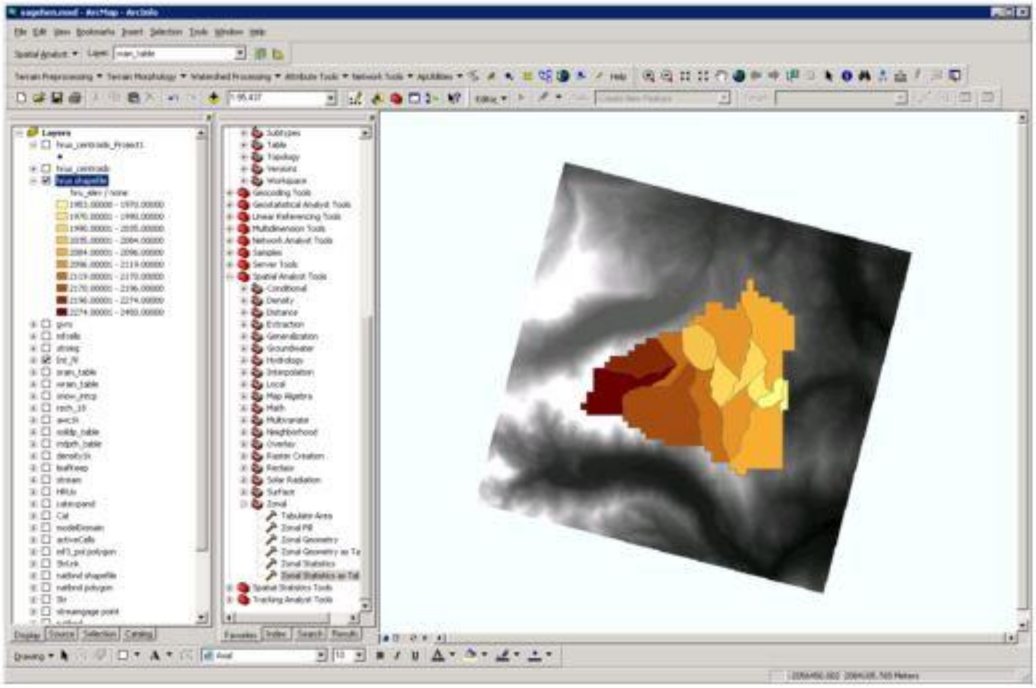
hru_elev

The hru elevation is determined as the zonal median elevation instead of mean elevation because the median is less sensitive to outliers such as a few very high elevation points. To calculate the median elevation, the DEM used to delineate the basin (Fil) must first be converted to an integer coverage using the Int (Spatial Analyst) tool. The zonal median for each HRU can be calculated from this coverage using the Zonal Statistics as Table (Spatial Analyst) tool.


Join Data
Join lets you append additional data to this layer's attribute table so you can, for example, symbolize the layer's features using this data.
What do you want to join to this layer?
Join attributes from a table
1. Choose the field in this layer that the join will be based on:
HRU_ID
2. Choose the table to join to this layer, or load the table from disk:
elev_table
Show the attribute tables of layers in this list
3. Choose the field in the table to base the join on:
Rowid
Join Options
Keep all records
All records in the target table are shown in the resulting table. Unmatched records will contain null values for all fields being appended into the target table from the join table.
Keep only matching records
If a record in the target table doesn't have a match in the join table, that record is removed from the resulting target table.
About Joining Data
OK
Cancel

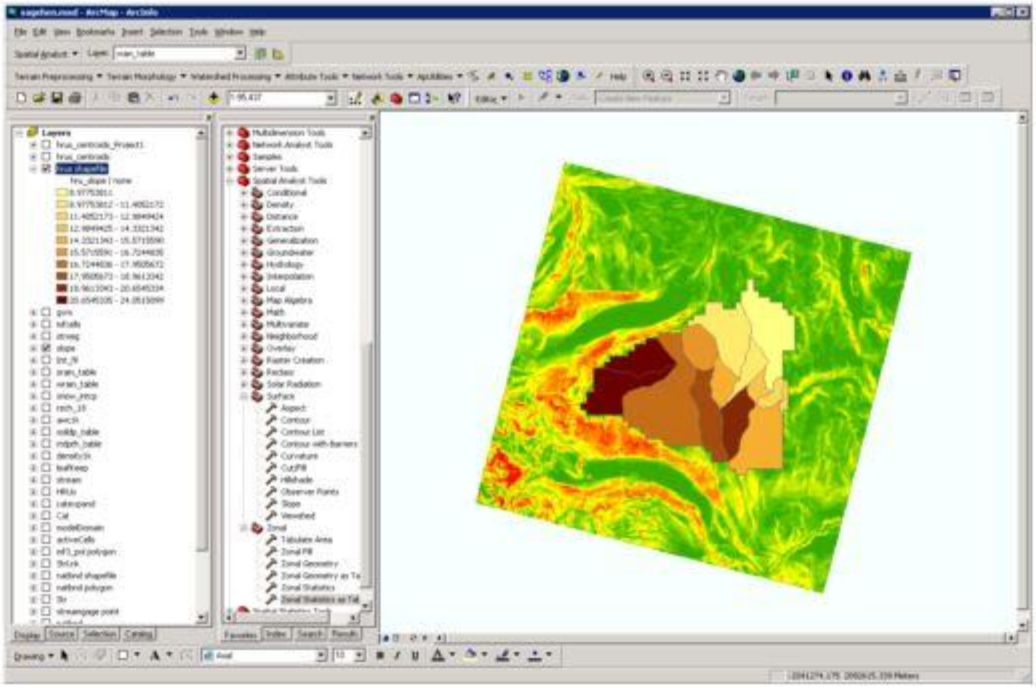

Zonal Statistics as Table
Input raster or feature zone data
Zone field
HRU_ID
Input value raster
Output table
C:\markstro\gsflowTraining2009\gis\tables\elev_table
Ignore NoData in calculations (optional)
Input raster or feature zone data
Dataset that defines the zones.
It can be a raster or feature dataset.
OK
Cancel
Environments...
<< Hide Help
Tool Help


Environment Settings
General Settings
Arc Hydro Settings
Cartography Settings
Coverage Settings
Geodatabase Settings
Geostatistical Analysis Settings
Raster Analysis Settings
Cell Size
27.41163945274
Mask
Raster Storage Settings
Cell Size
The output cell size, or resolution. The default output resolution, when a feature class is used as input, is the width or the height (whichever is shortest) of the extent of the feature class divided by 250.
Maximum of Inputs - The largest cell size of all input datasets. This is the default.
Minimum of Inputs - The smallest cell size of all input datasets.
As Specified Below - Specify the exact cell size value.
Same as Layer - Specify an input raster layer on which to base the cell
OK
Cancel
Show Help >>
Tool Help



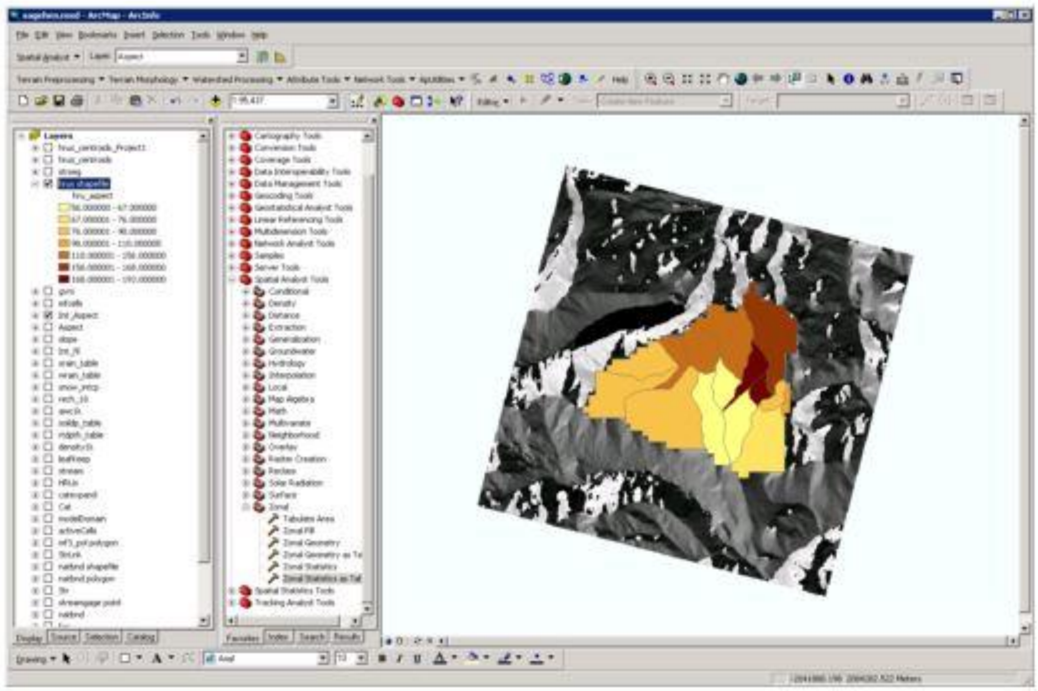
hru_slope

The hru slope can be calculated from Fil using the Slope (Spatial Analyst) tool and select the output measurement as "percent_rise". The zonal mean for each HRU can be calculated from this coverage using the Zonal Statistics as Table (Spatial Analyst) tool. Divide these values by 100.0 when copying the zonal mean field into the hru_slope field.



hru_aspect

The hru aspect can be calculated from Fil using the Aspect (Spatial Analyst) tool. To calculate the median aspect, the Aspect map just created must first be converted to an integer coverage using the Int (Spatial Analyst) tool. The zonal median for each HRU can be calculated from this coverage using the Zonal Statistics as Table (Spatial Analyst) tool.



tmax_adj

tmax_adj is an adjustment made to the hru maximum temperature based on the aspect of the hru. This parameter is estimated with the equation:

$$\text{tmax\_adj} = -1.8 \cos(\text{hru\_aspect} * 0.0175)$$

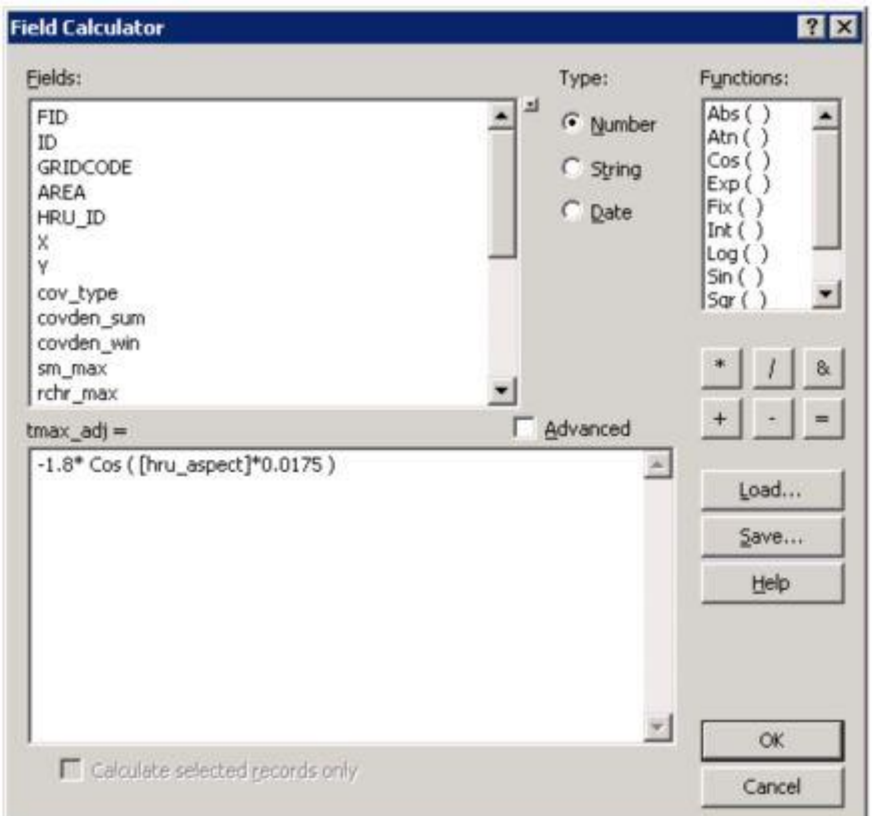
Use the Field Calculator to fill in the tmax_adj field. The multiplier 0.0175 converts degrees to radians.

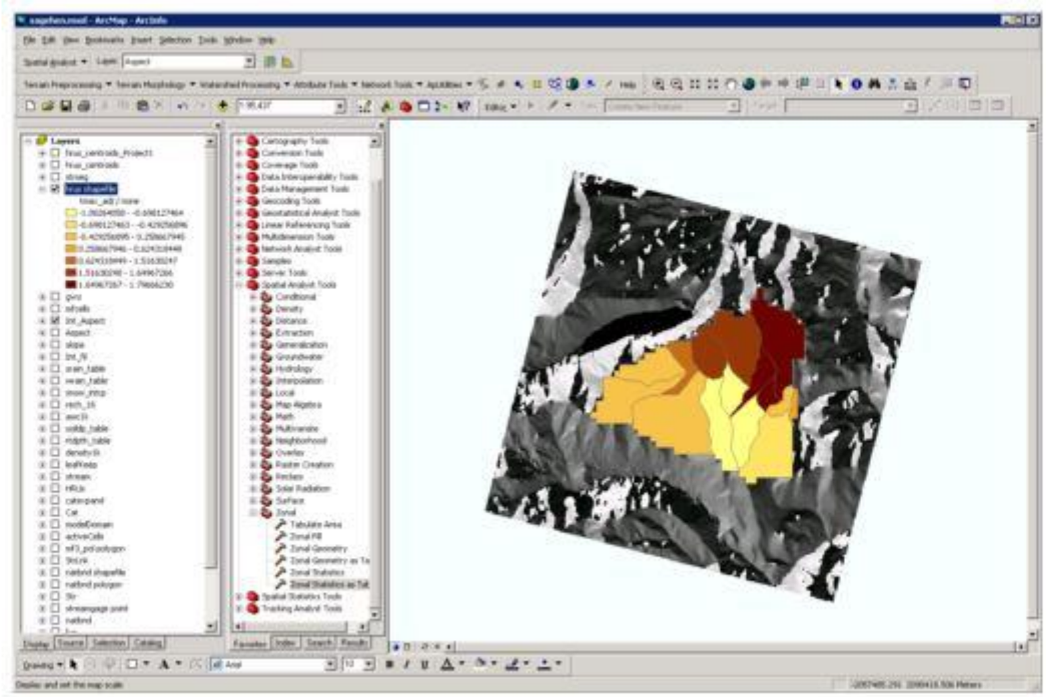
In addition to the tmax_adj method calculated above a more simple method can be employed.

Degree	Direction	tmax_adj
337.5-22.5	North	-1.7
22.5-67.5	Northeast	-1.0
67.5-112.5	East	0.0
112.5-157.5	Southeast	1.0

157.5-202.5	South	1.7
202.5-247.5	Southwest	1.0
2478.5-292.5	West	0.0
292.5-337.5	Northwest	-1.0

This is the method employed in the original GSFLOW Sagehen example problem.



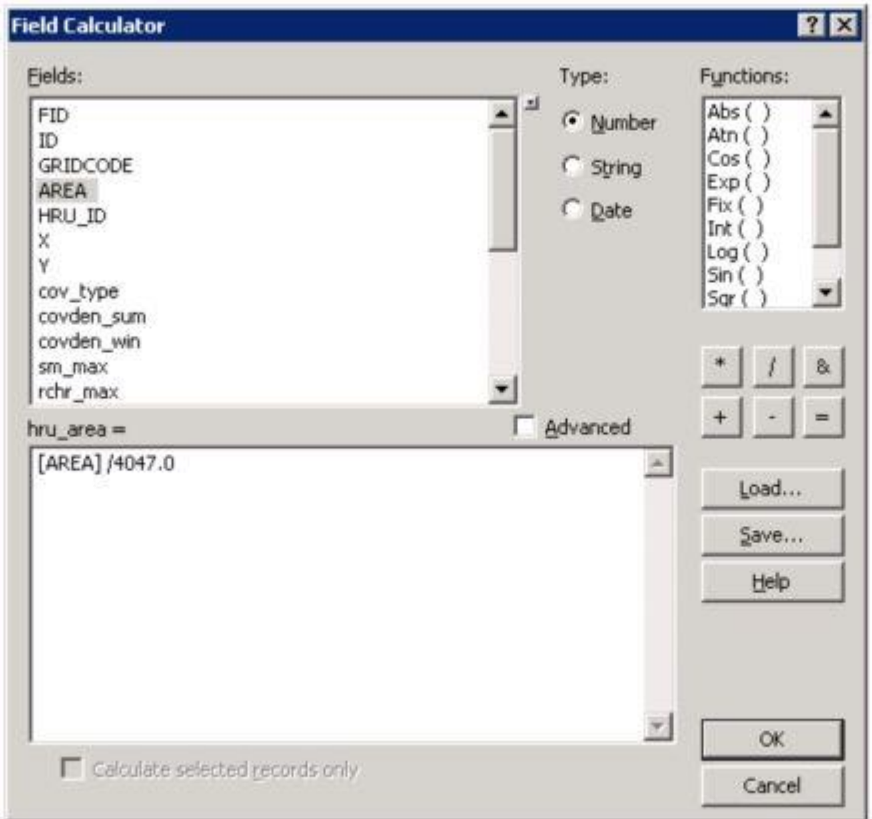


tmin_adj

tmin_adj is an adjustment made to the hru minimum temperature based on the aspect of the hru. The values are the same as calculated for tmax_adj.

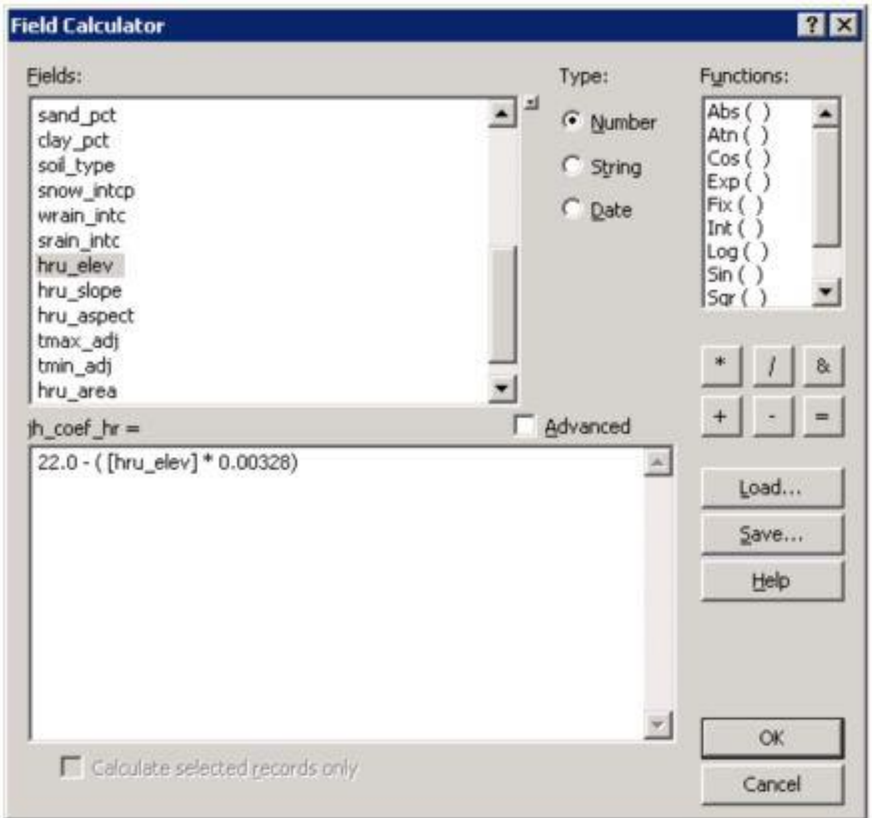
hru_area

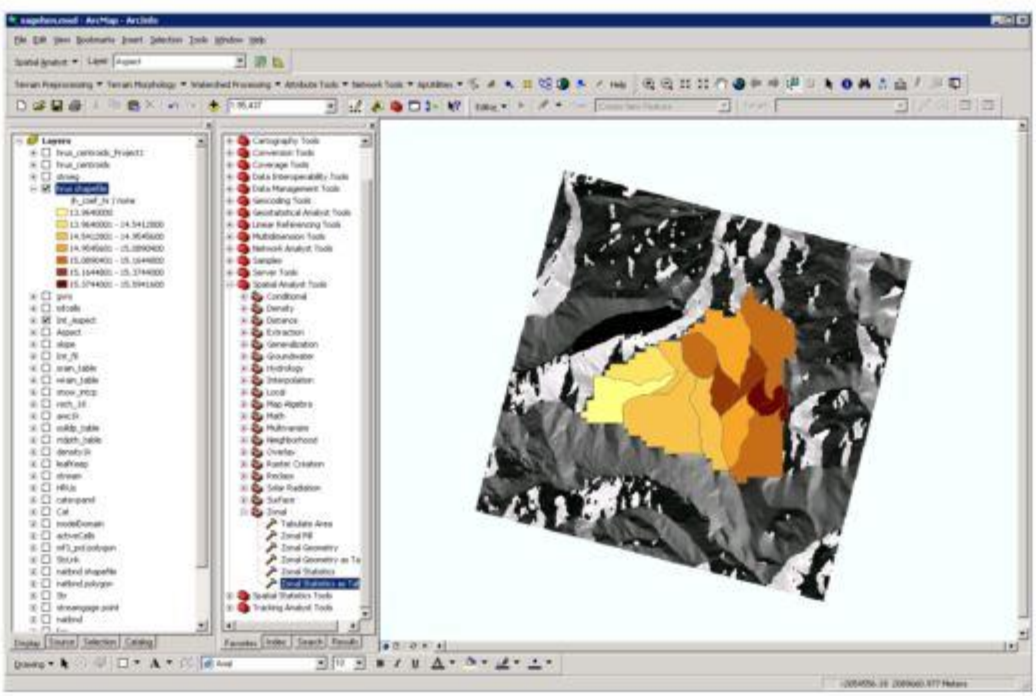
The area of the hru's is already a field in the hru polygon shapefile. The area listed in this field is the number of cells in each hru. This must be converted to acres by first converting to map units (square meters if in UTM) then converting to acres (1 acre = 4047 m2).



jh_coef_hru

This air temperature coefficient used in Jensen-Haise potential evapotranspiration computations can be calculated for each HRU using the following equation: jh_coef_hru = 27.5-0.25*(high_sat - low_sat)-(hru_elev/1000) where high sat is the saturation vapor pressure, in millibars, for the mean maximum air temperature for the warmest month of the year and low_sat is the saturation vapor pressure, in millibars, for the mean minimum air temperature for the warmest month of the year. The saturation vapor pressure can be calculated using sat function = 6.1078exp^[(17.269(x)/(x + 237.3) where x is the temperature. .Assume the minimum temperature is 10 C and maximum temperature is 25 C so that low_sat is 10.02 and high_sat is 31.67. This parameter can be calculated with a spreadsheet since it is only a function of hru_elev. So, if hru_elevation is in meters, the equation is: jh_coef_hru = 22.0 - (hru_elev * 0.00328)


Field Calculator
Fields:
sand_pct
clay_pct
soil_type
snow_intcp
wrain_intc
srain_intc
hru_elev
hru_slope
hru_aspect
tmax_adj
tmin_adj
hru_area
Type:
Number
String
Date
Functions:
Abs ( )
Atn ( )
Cos ( )
Exp ( )
Fix ( )
Int ( )
Log ( )
Sin ( )
Sqr ( )
jh_coef_hr =
Advanced
22.0 - ([hru_elev] * 0.00328)
Load...
Save...
Help
OK
Cancel
Calculate selected records only

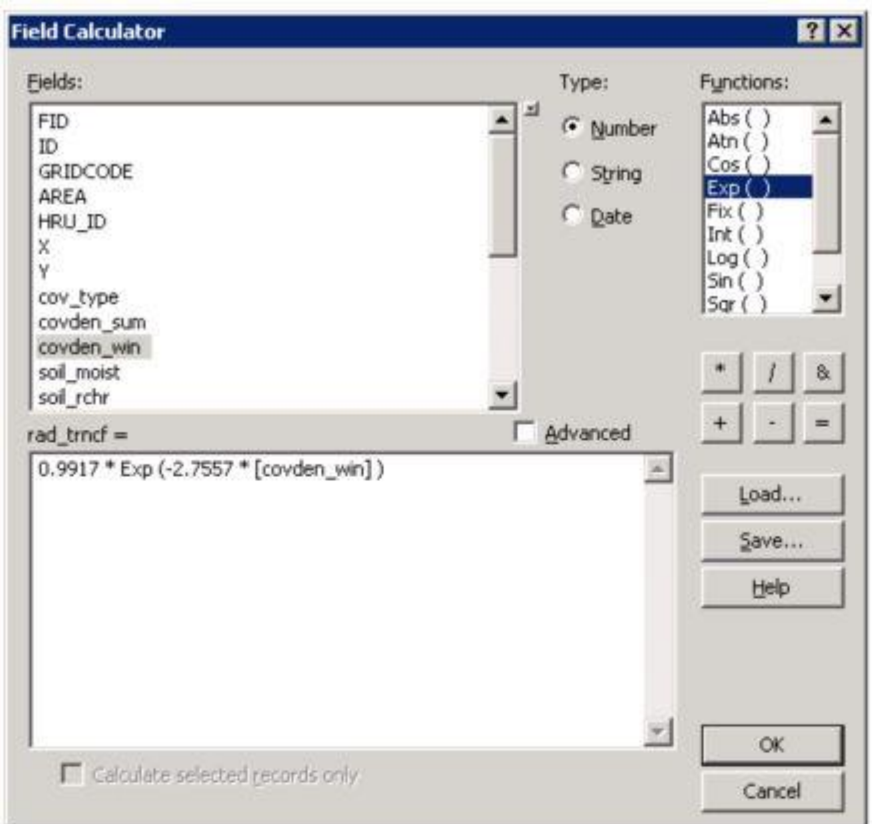


rad_trncf

The transmission coefficient for short-wave radiation through the winter vegetation canopy can be calculated as

rad_trncf = 0.9917 * exp(-2.7557 * covden_win).

This parameter can be calculated with the Field Calculator since it is only a function of covden_win.



MODFLOW Grid Cell map (shapefile mfcells)

Add fields X (double) and Y (double) use Calculate Geometry to fill them in. Add fields ALT (integer), PRECIP (double), ACTIVE (integer), IRUNBND (integer).

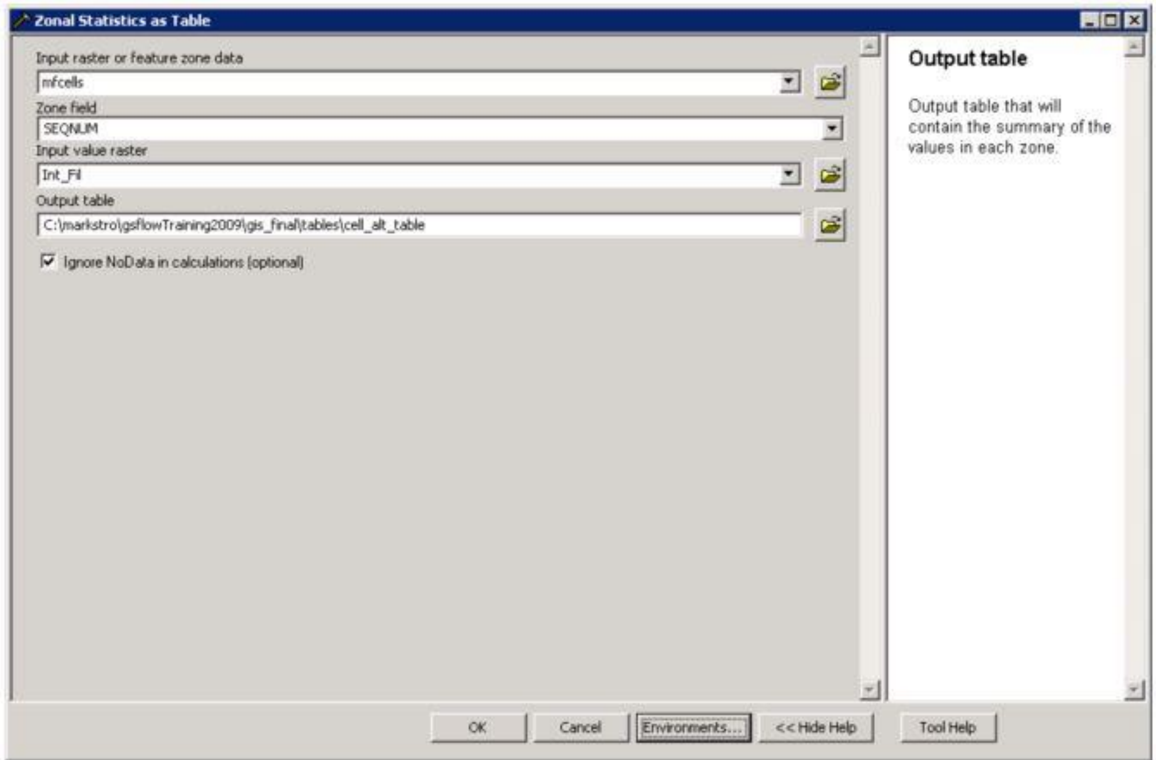
Attributes of mfcells

MF3_POL_ID	ROW	COL	SEQNUM	X	Y	ALT	PRECIP	ACTIVE	IRUNBND
1	1	1	1	-2052171.286	2089352.955	0	0	0	0
2	1	2	2	-2051971.286	2089352.955	0	0	0	0
3	1	3	3	-2051771.286	2089352.955	0	0	0	0
4	1	4	4	-2051571.286	2089352.955	0	0	0	0
5	1	5	5	-2051371.286	2089352.955	0	0	0	0
6	1	6	6	-2051171.286	2089352.955	0	0	0	0
7	1	7	7	-2050971.286	2089352.955	0	0	0	0
8	1	8	8	-2050771.286	2089352.955	0	0	0	0
9	1	9	9	-2050571.286	2089352.955	0	0	0	0
10	1	10	10	-2050371.286	2089352.955	0	0	0	0
11	1	11	11	-2050171.286	2089352.955	0	0	0	0
12	1	12	12	-2049971.286	2089352.955	0	0	0	0
13	1	13	13	-2049771.286	2089352.955	0	0	0	0
14	1	14	14	-2049571.286	2089352.955	0	0	0	0
15	1	15	15	-2049371.286	2089352.955	0	0	0	0
16	1	16	16	-2049171.286	2089352.955	0	0	0	0
17	1	17	17	-2048971.286	2089352.955	0	0	0	0
18	1	18	18	-2048771.286	2089352.955	0	0	0	0
19	1	19	19	-2048571.286	2089352.955	0	0	0	0
20	1	20	20	-2048371.286	2089352.955	0	0	0	0
21	1	21	21	-2048171.286	2089352.955	0	0	0	0
22	1	22	22	-2047971.286	2089352.955	0	0	0	0
23	1	23	23	-2047771.286	2089352.955	0	0	0	0
24	1	24	24	-2047571.286	2089352.955	0	0	0	0
25	1	25	25	-2047371.286	2089352.955	0	0	0	0
26	1	26	26	-2047171.286	2089352.955	0	0	0	0
27	1	27	27	-2046971.286	2089352.955	0	0	0	0
28	1	28	28	-2046771.286	2089352.955	0	0	0	0

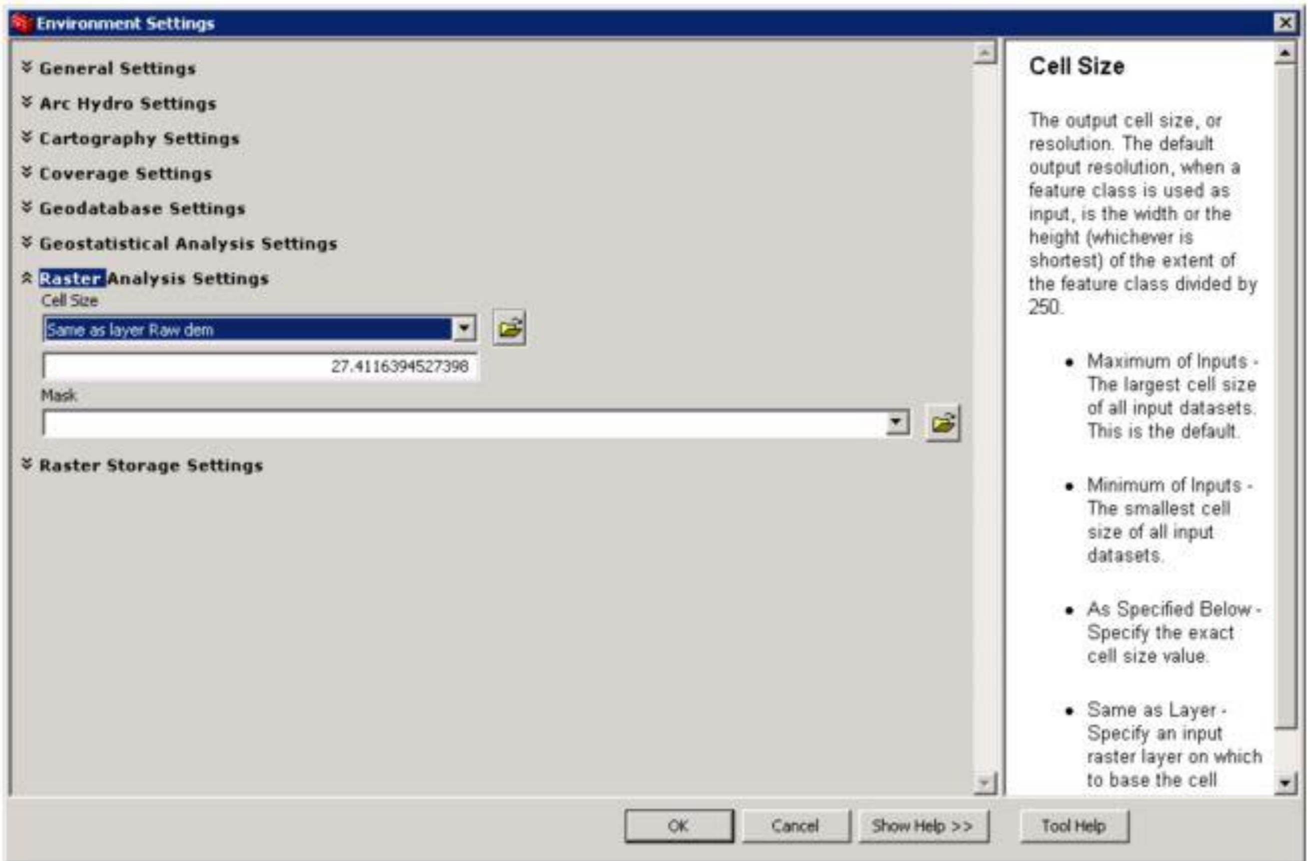
Record: 0 Show: All Selected Records (0 out of 1292 Selected) Options

Fill in the cell altitude attribute (ALT)

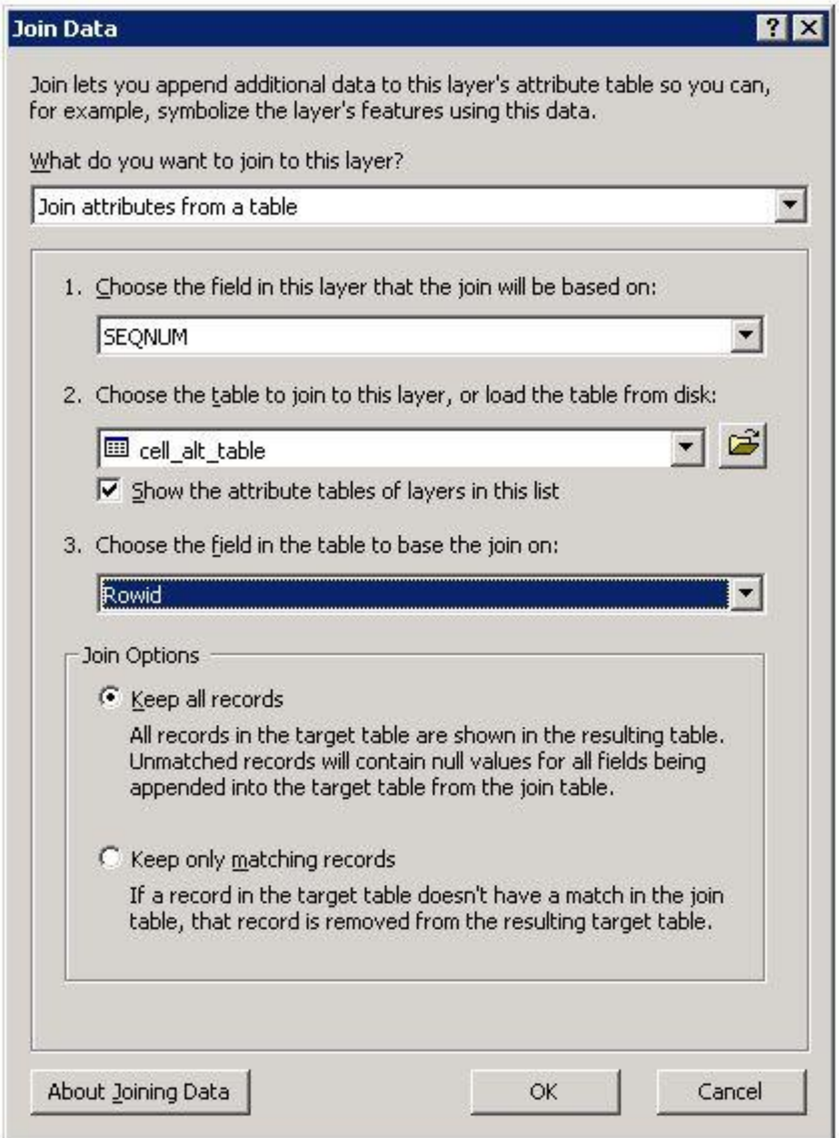
The fiield ALT is the cell top altitude and is determined as the zonal median altitude. To calculate the median altitiude, use the integer version of the DEM (Int_Fil) that was created to determine the parameter hru_elev. The zonal median for each cell can be calculated from this coverage using "Spatial Analyst > Zonal Statistics".



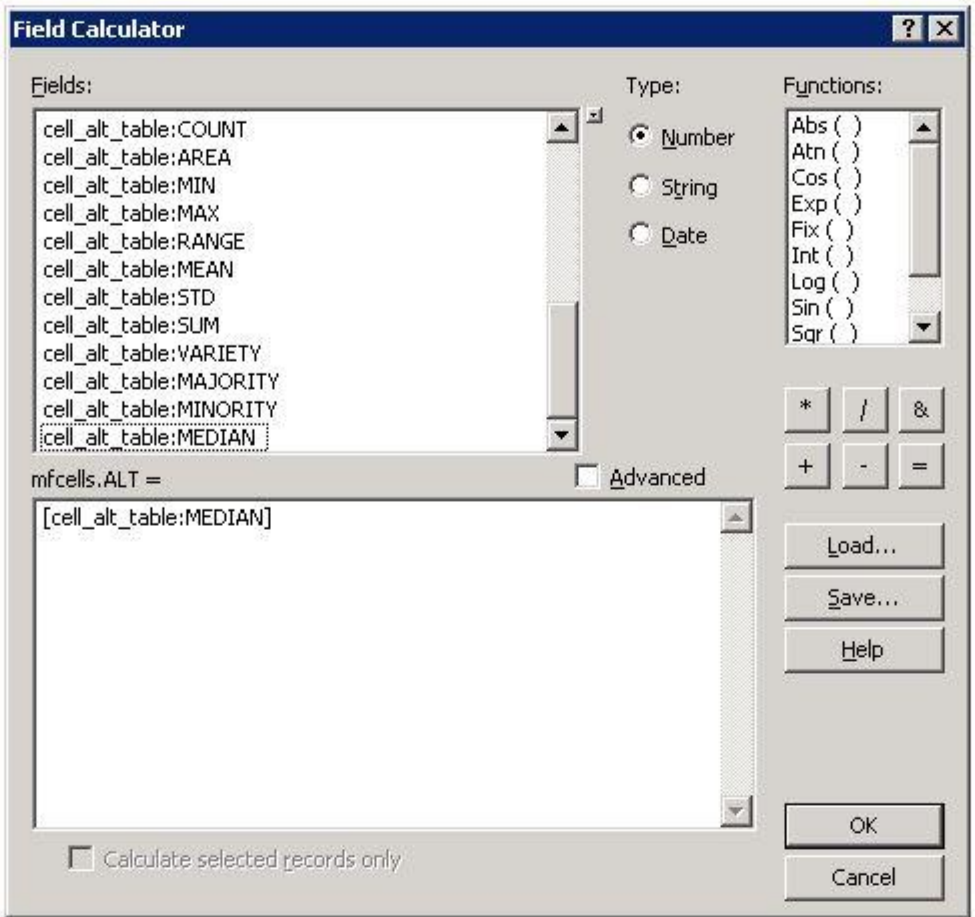
Click on the Environments button to set the Raster Analysis Settings Cell Size



Join the table in the mfcells shapefile to the cell_alt_table attribute table.

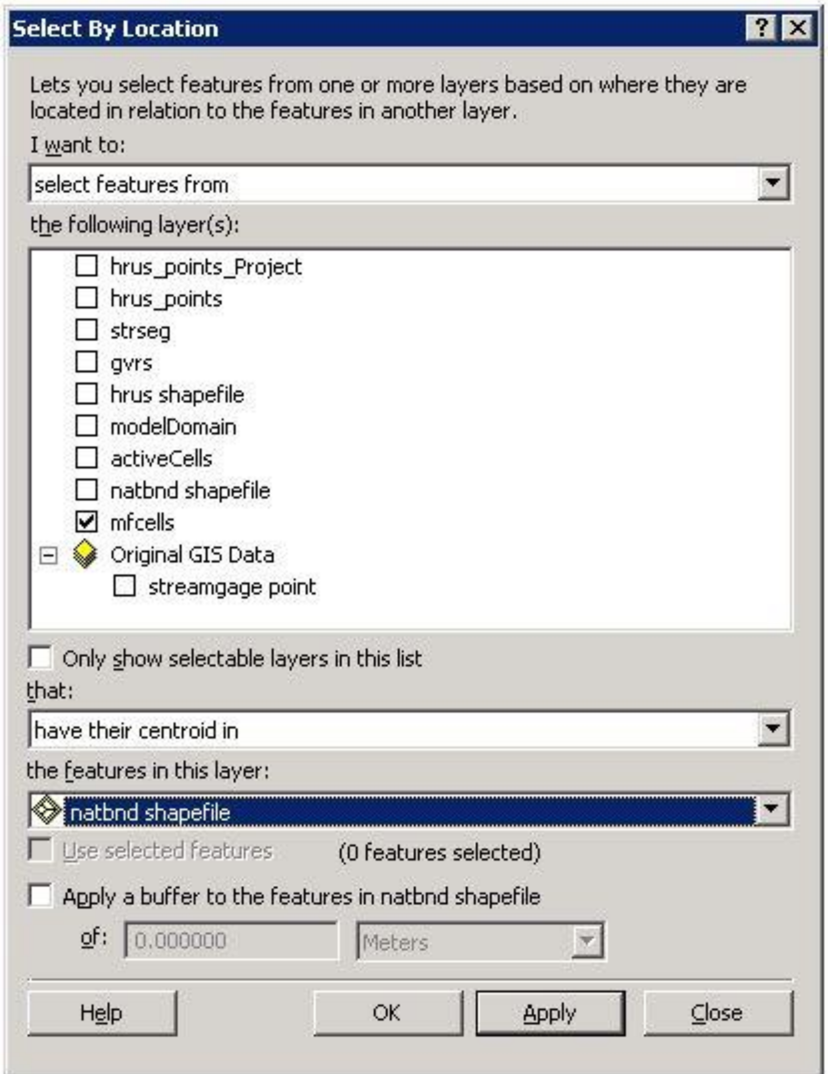


Assign the MEDIAN into the ALT field with the Field Calculator:

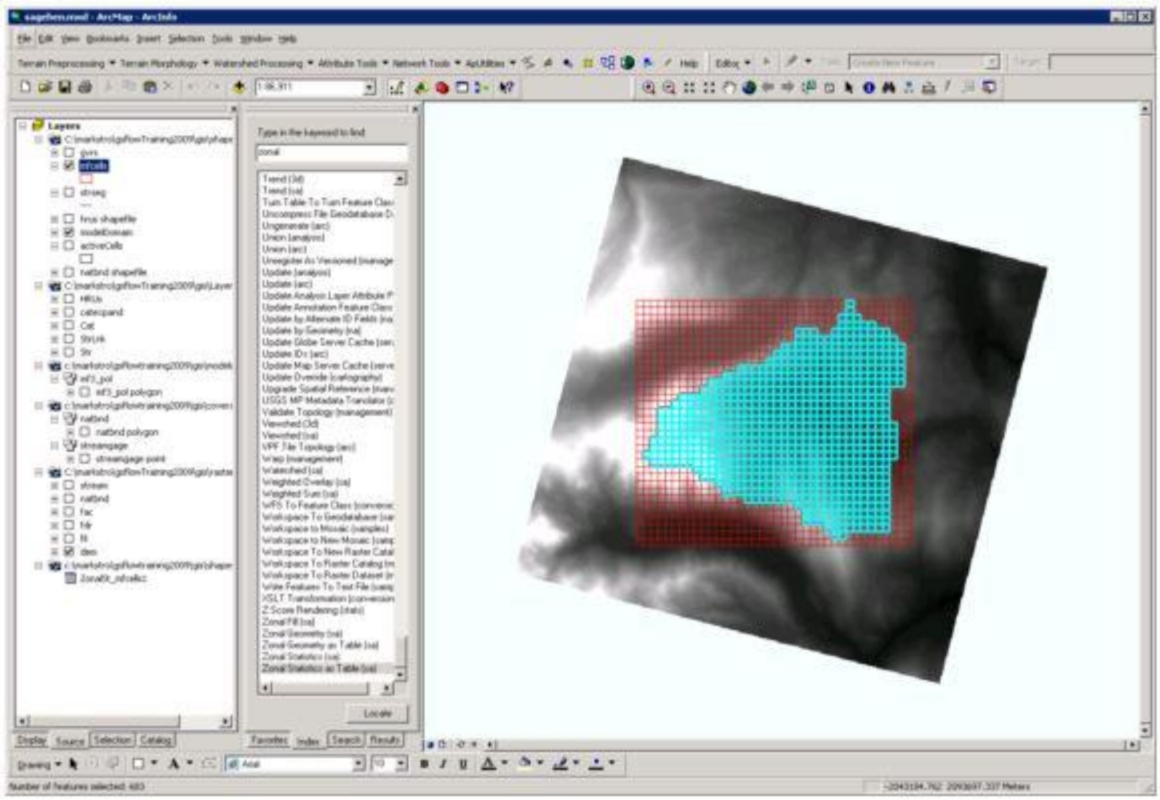


Identify the active cells (ACTIVE)

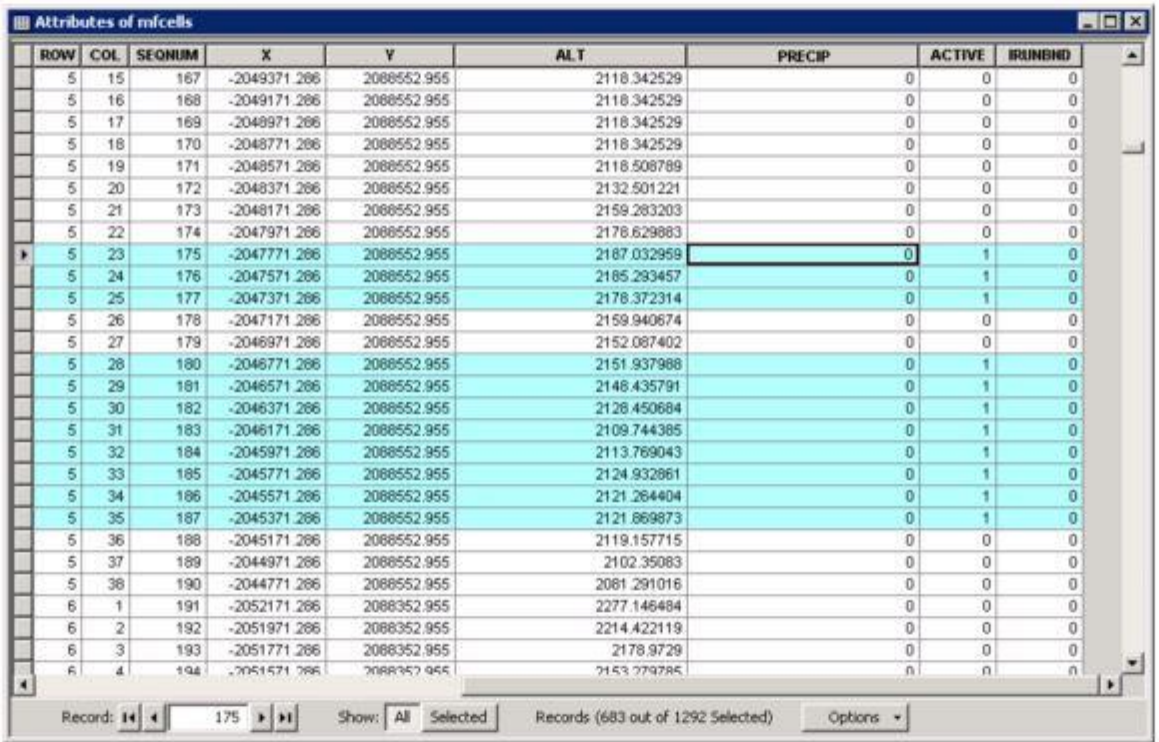
The field ACTIVE defines the active and inactive MODFLOW cells. 1= active cell; 0 = inactive cell. Use the Selection->Select By Location tool to select the active cells in the mfcells shapefile with the modelDomain shapefile.



The selection looks like this.



Bring up the Attributes of mfcells table. Make sure that all of the values in the ACTIVE field are set to 0. Click on the Show: Selected button at the bottom of the window. Use the Field Calculator to set the selected (ACTIVE) cells to 1.



Attributes of mfcells

ROW	COL	SEQNUM	X	Y	ALT	PRECIP	ACTIVE	IRUNBND
5	15	167	-2049371.286	2088552.955	2118.342529	0	0	0
5	16	168	-2049171.286	2088552.955	2118.342529	0	0	0
5	17	169	-2048971.286	2088552.955	2118.342529	0	0	0
5	18	170	-2048771.286	2088552.955	2118.342529	0	0	0
5	19	171	-2048571.286	2088552.955	2118.508789	0	0	0
5	20	172	-2048371.286	2088552.955	2132.501221	0	0	0
5	21	173	-2048171.286	2088552.955	2159.283203	0	0	0
5	22	174	-2047971.286	2088552.955	2178.629883	0	0	0
5	23	175	-2047771.286	2088552.955	2187.032959	0	1	0
5	24	176	-2047571.286	2088552.955	2185.293457	0	1	0
5	25	177	-2047371.286	2088552.955	2178.372314	0	1	0
5	26	178	-2047171.286	2088552.955	2159.940674	0	0	0
5	27	179	-2046971.286	2088552.955	2152.087402	0	0	0
5	28	180	-2046771.286	2088552.955	2151.937988	0	1	0
5	29	181	-2046571.286	2088552.955	2148.435791	0	1	0
5	30	182	-2046371.286	2088552.955	2128.450684	0	1	0
5	31	183	-2046171.286	2088552.955	2109.744385	0	1	0
5	32	184	-2045971.286	2088552.955	2113.769043	0	1	0
5	33	185	-2045771.286	2088552.955	2124.932861	0	1	0
5	34	186	-2045571.286	2088552.955	2121.264404	0	1	0
5	35	187	-2045371.286	2088552.955	2121.869873	0	1	0
5	36	188	-2045171.286	2088552.955	2119.157715	0	0	0
5	37	189	-2044971.286	2088552.955	2102.35083	0	0	0
5	38	190	-2044771.286	2088552.955	2081.291016	0	0	0
6	1	191	-2052171.286	2088352.955	2277.146484	0	0	0
6	2	192	-2051971.286	2088352.955	2214.422119	0	0	0
6	3	193	-2051771.286	2088352.955	2178.9729	0	0	0
6	4	194	-2051571.286	2088352.955	2153.279785	0	0	0

Record: 175 Show: All Selected Records (683 out of 1292 Selected) Options

Fill in the cell precipitation attribute (PRECIP)

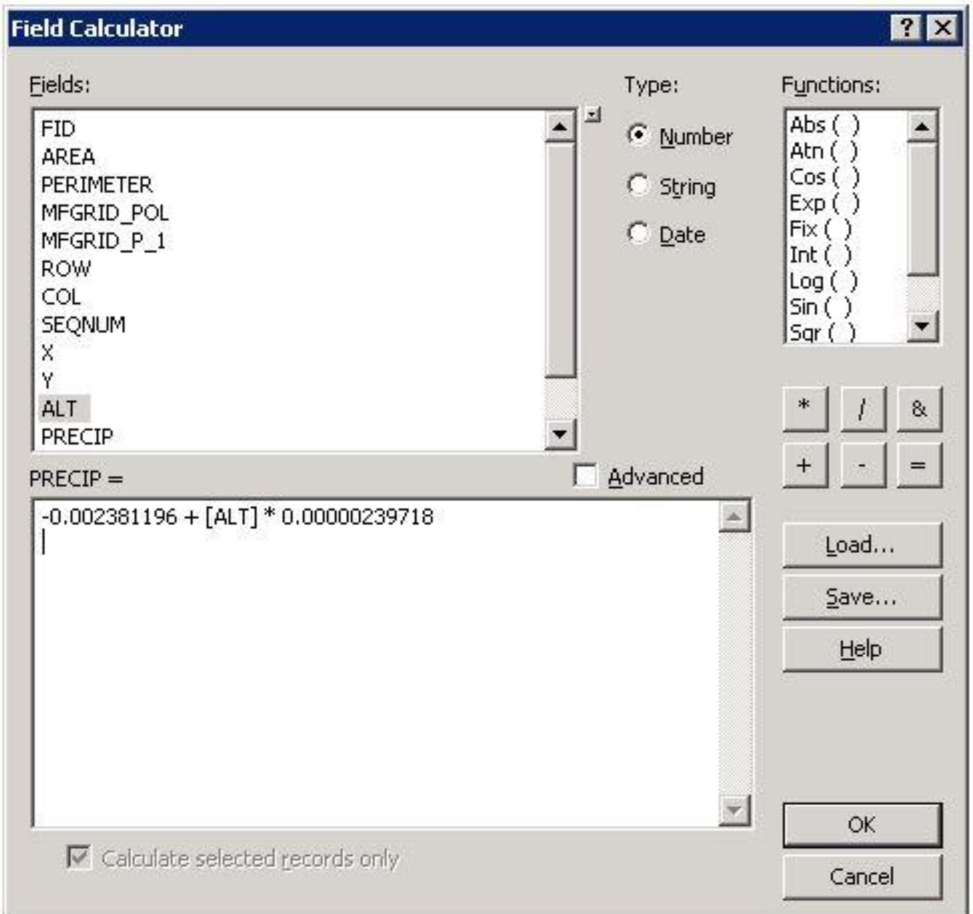
The field PRECIP is used for steady state recharge; only active cells have values; inactive cells are blank Load sagehen.data Data File into excel and compute the long term (period of record) means. This is described in Section 2.2 "Computation of Lapse Rates/Monthly Means using Excel" of this document. Using this information, a relationship can be developed to estimate long term PRECIP (recharge) for calibrating a steady state MODFLOW model. This is based on the lapse rates for the Sagehen Creek COOP station and the cell altitude:

PRECIP = 0.002249 + (ALT-1931.518)* 0.00000239718

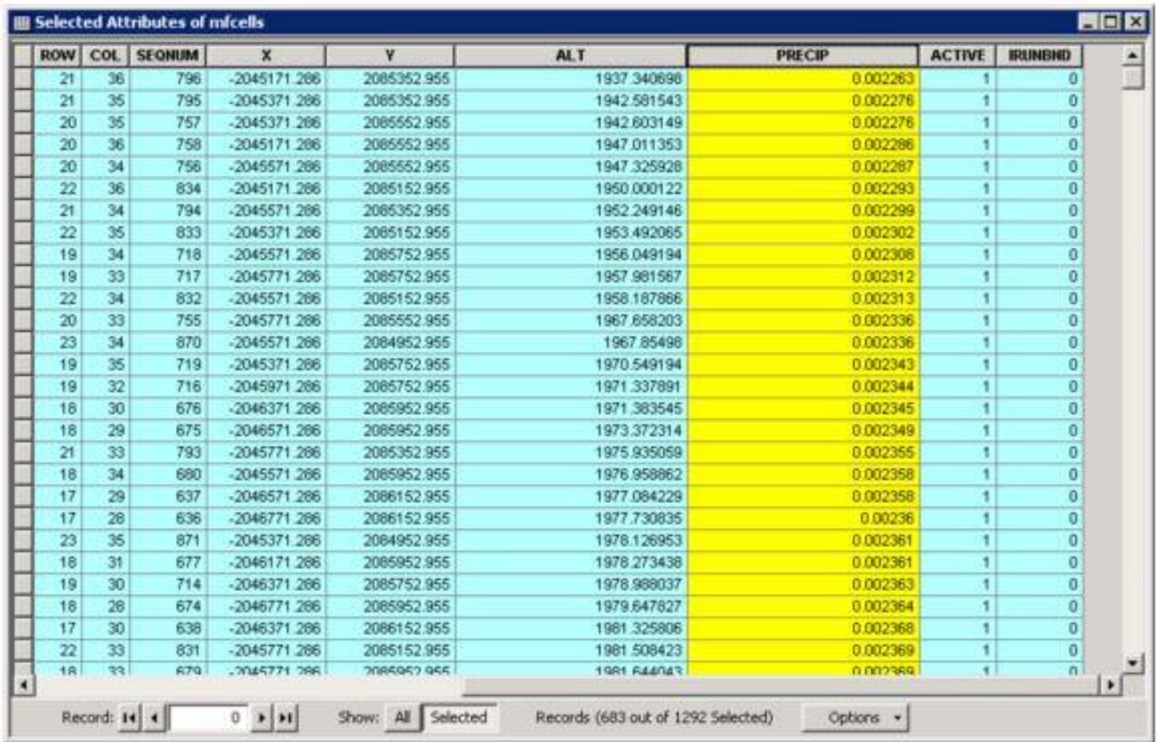
PRECIP = 0. 002249 0.00463019 + ALT * 0.00000239718

PRECIP = -0.002381196+ ALT * 0.00000239718

Select only the ACTIVE cells again. Use the Field Calculator to input the above equation for PRECIP.



Results look like this in the table.



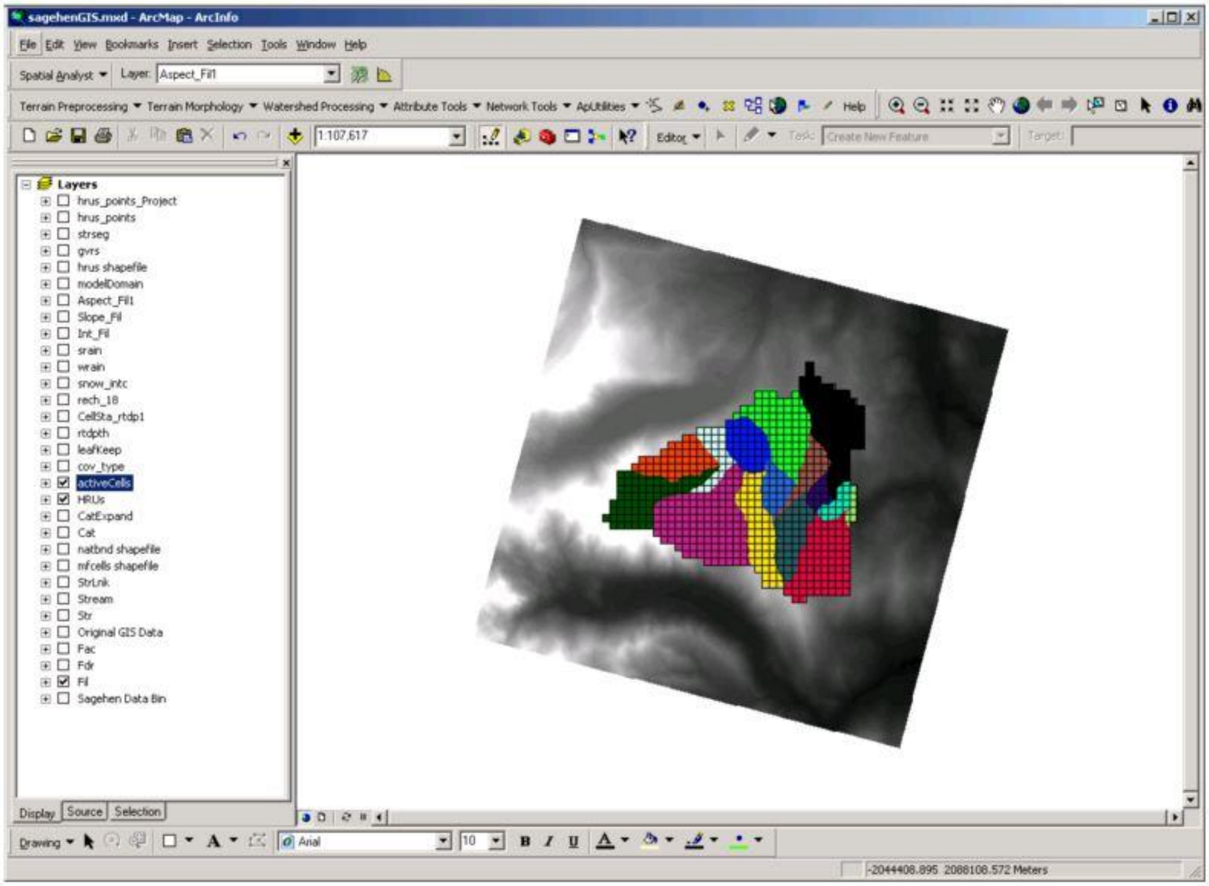
Selected Attributes of mfcells

ROW	COL	SEQNUM	X	Y	ALT	PRECIP	ACTIVE	IRUNBND
21	36	796	-2045171.286	2085352.955	1937.340698	0.002263	1	0
21	35	795	-2045371.286	2085352.955	1942.581543	0.002276	1	0
20	35	757	-2045371.286	2085552.955	1942.603149	0.002276	1	0
20	36	758	-2045171.286	2085552.955	1947.011353	0.002286	1	0
20	34	756	-2045571.286	2085552.955	1947.325928	0.002287	1	0
22	36	834	-2045171.286	2085152.955	1950.000122	0.002293	1	0
21	34	794	-2045571.286	2085352.955	1952.249146	0.002299	1	0
22	35	833	-2045371.286	2085152.955	1953.492065	0.002302	1	0
19	34	718	-2045571.286	2085752.955	1956.049194	0.002308	1	0
19	33	717	-2045771.286	2085752.955	1957.981567	0.002312	1	0
22	34	832	-2045571.286	2085152.955	1958.187866	0.002313	1	0
20	33	755	-2045771.286	2085552.955	1967.658203	0.002336	1	0
23	34	870	-2045571.286	2084952.955	1967.85498	0.002336	1	0
19	35	719	-2045371.286	2085752.955	1970.549194	0.002343	1	0
19	32	716	-2045971.286	2085752.955	1971.337891	0.002344	1	0
18	30	676	-2046371.286	2085952.955	1971.383545	0.002345	1	0
18	29	675	-2046571.286	2085952.955	1973.372314	0.002349	1	0
21	33	793	-2045771.286	2085352.955	1975.935059	0.002355	1	0
18	34	680	-2045571.286	2085952.955	1976.958862	0.002358	1	0
17	29	637	-2046571.286	2086152.955	1977.084229	0.002358	1	0
17	28	636	-2046771.286	2086152.955	1977.730835	0.00236	1	0
23	35	871	-2045371.286	2084952.955	1978.126953	0.002361	1	0
18	31	677	-2046171.286	2085952.955	1978.273438	0.002361	1	0
19	30	714	-2046371.286	2085752.955	1978.988037	0.002363	1	0
18	28	674	-2046771.286	2085952.955	1979.647827	0.002364	1	0
17	30	638	-2046371.286	2086152.955	1981.325806	0.002368	1	0
22	33	831	-2045771.286	2085152.955	1981.508423	0.002369	1	0
18	33	679	-2045771.286	2085952.955	1981.644043	0.002369	1	0

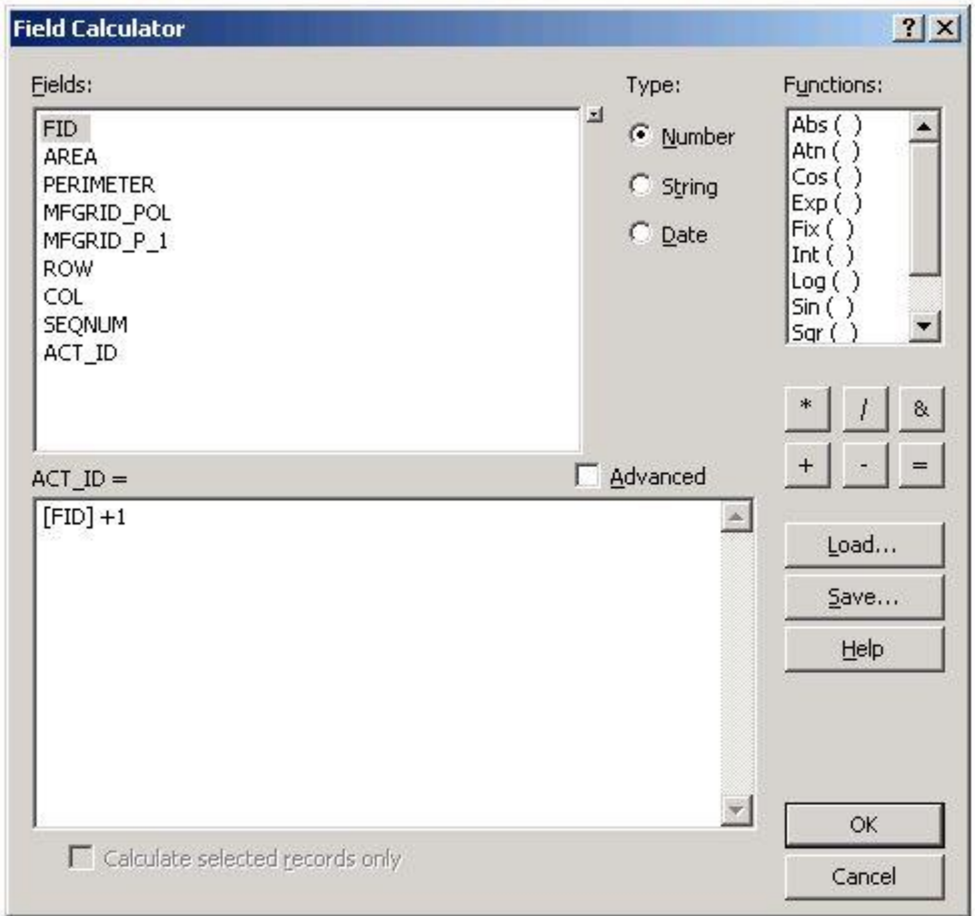
Record: 0 Show: All Selected Records (683 out of 1292 Selected) Options

Fill in the cell IRUNBND attribute

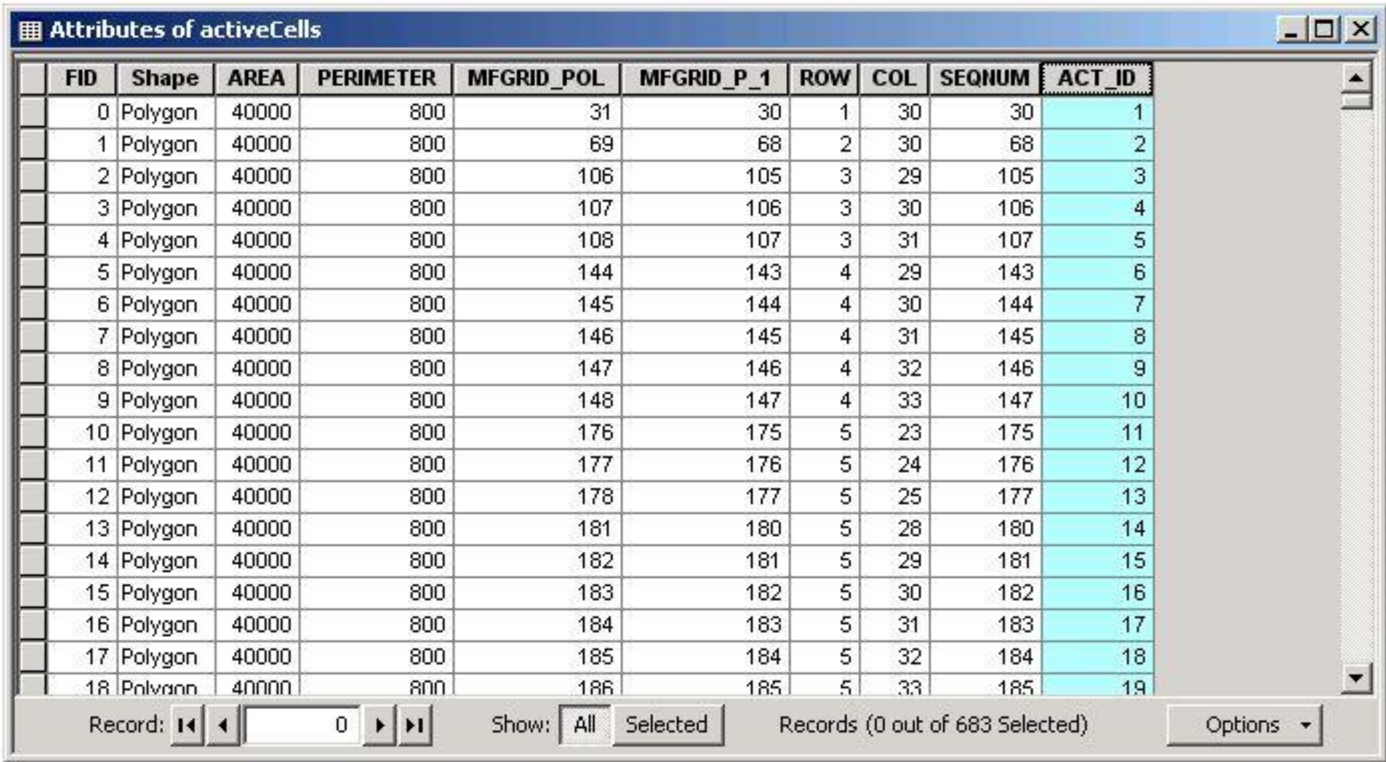
Bring up the HRUs raster (not shapefile) and the activeCell shapefile. The activeCell shapefile was made in step 3.3.4.



Open up the Attributes of activeCell table and add the field ACT_ID (short integer). Use the Field Calculator to set the values in ACT_ID to FID + 1.

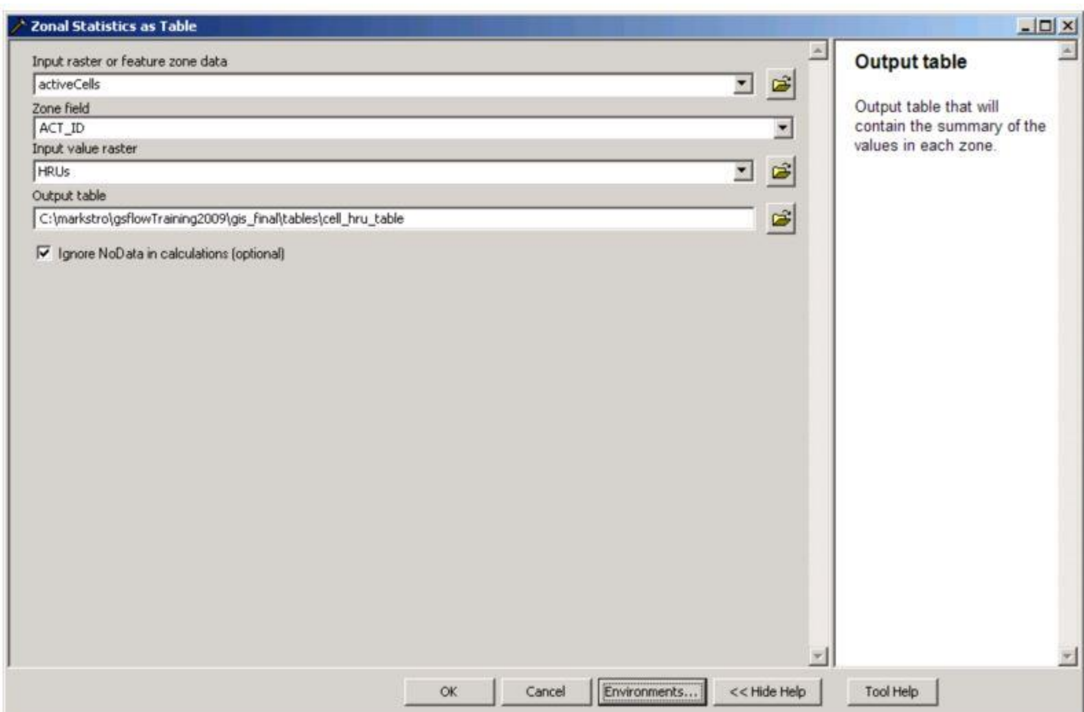


The field ACT_ID will be used in a double-table join using the field SEQNUM.

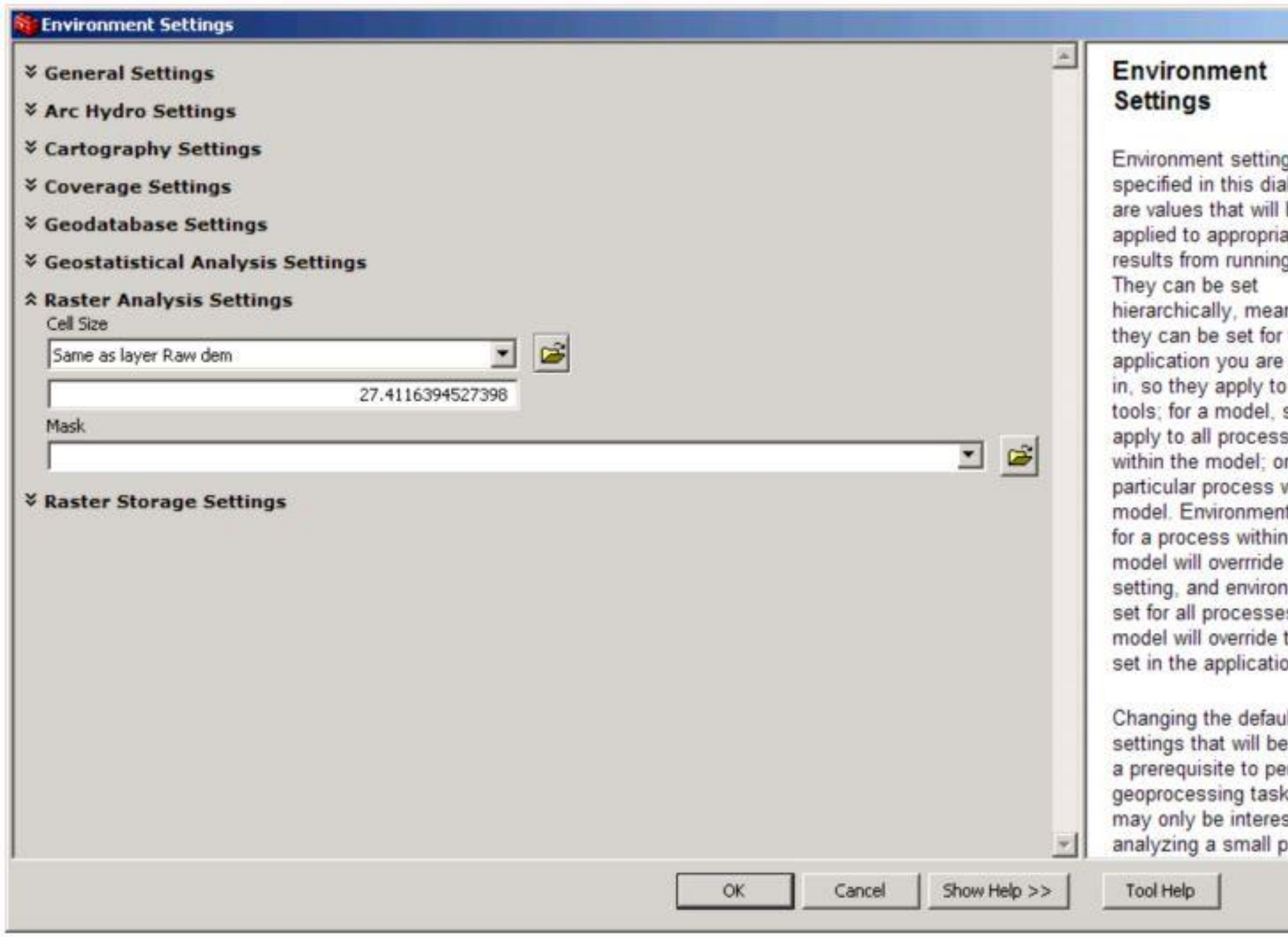


FID	Shape	AREA	PERIMETER	MFGRID_POL	MFGRID_P_1	ROW	COL	SEQNUM	ACT_ID
0	Polygon	40000	800	31	30	1	30	30	1
1	Polygon	40000	800	69	68	2	30	68	2
2	Polygon	40000	800	106	105	3	29	105	3
3	Polygon	40000	800	107	106	3	30	106	4
4	Polygon	40000	800	108	107	3	31	107	5
5	Polygon	40000	800	144	143	4	29	143	6
6	Polygon	40000	800	145	144	4	30	144	7
7	Polygon	40000	800	146	145	4	31	145	8
8	Polygon	40000	800	147	146	4	32	146	9
9	Polygon	40000	800	148	147	4	33	147	10
10	Polygon	40000	800	176	175	5	23	175	11
11	Polygon	40000	800	177	176	5	24	176	12
12	Polygon	40000	800	178	177	5	25	177	13
13	Polygon	40000	800	181	180	5	28	180	14
14	Polygon	40000	800	182	181	5	29	181	15
15	Polygon	40000	800	183	182	5	30	182	16
16	Polygon	40000	800	184	183	5	31	183	17
17	Polygon	40000	800	185	184	5	32	184	18
18	Polygon	40000	800	186	185	5	33	185	19

Now, use the Zonal Statistics as Table(sa) tool using the activeCells shapefile as input. The Zone field is ACT_ID. The Input value raster is HRUs. Name this table tables\cell_hru_table.

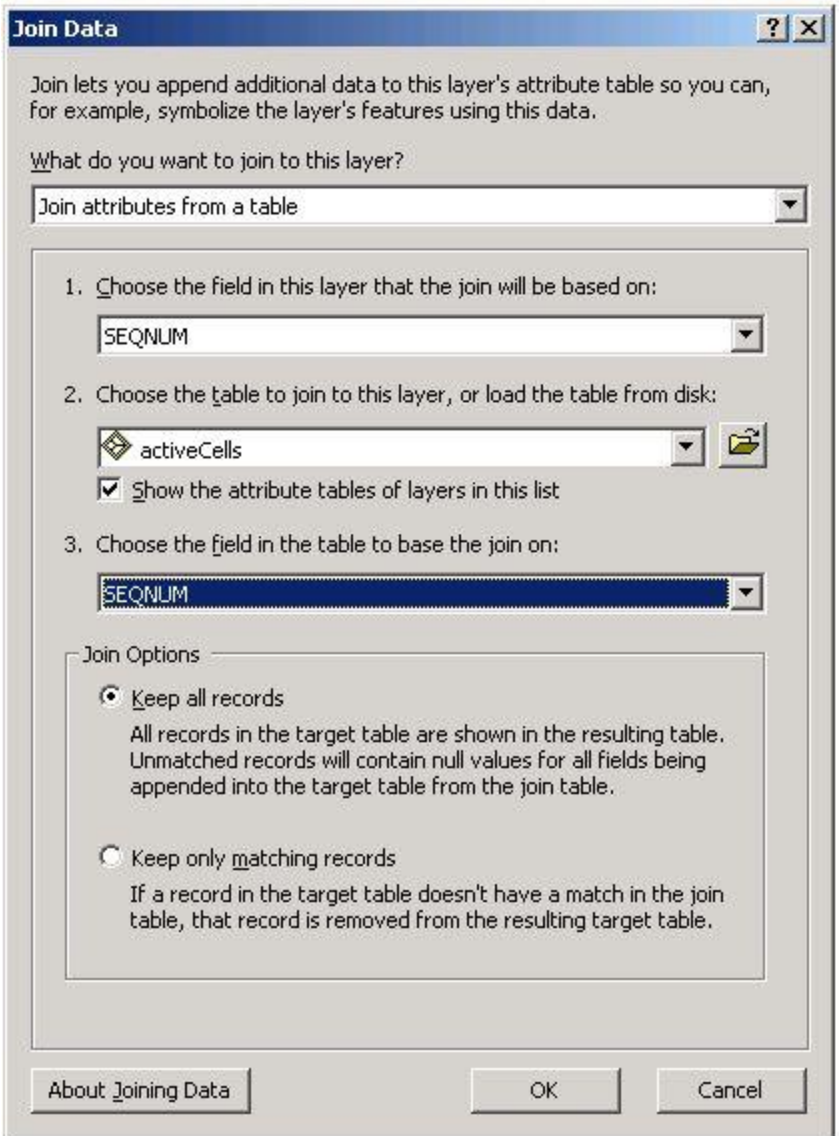


Set the Raster Analysis Cell Size to the Raw DEM.

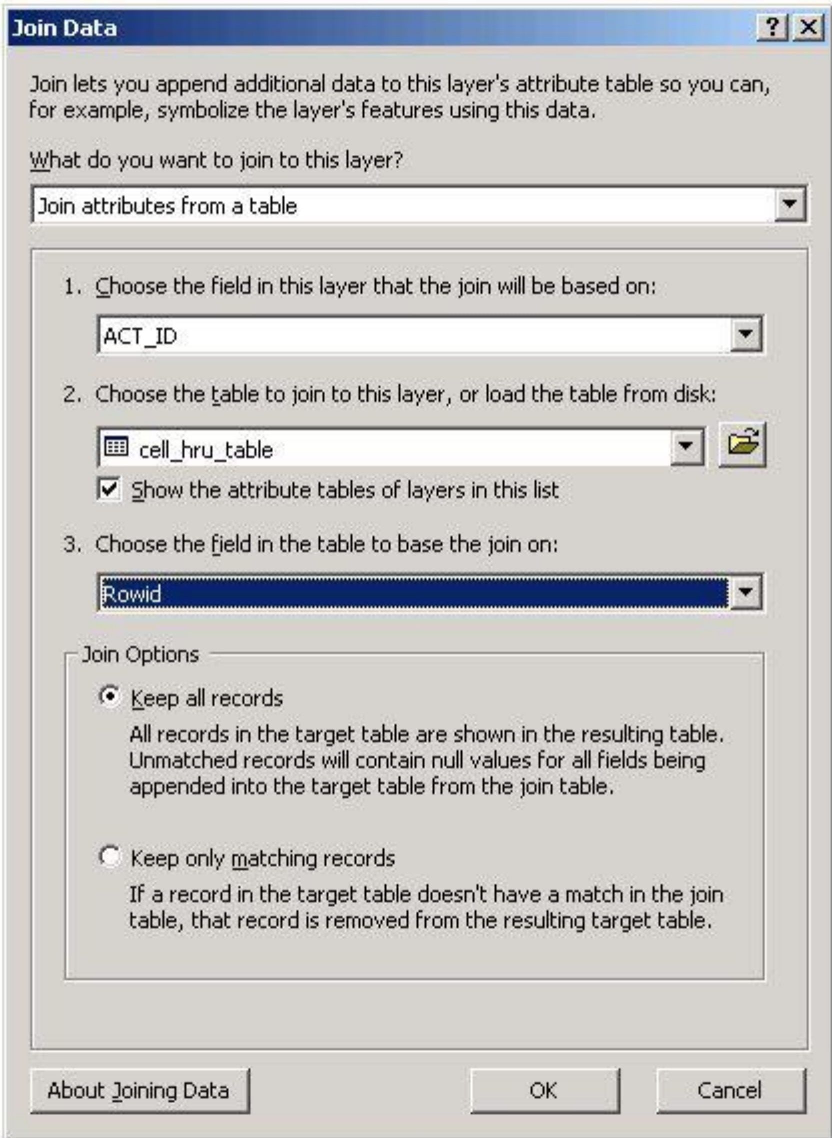


Do a double-join to get the HRU ID information into the mfcells shapefile.

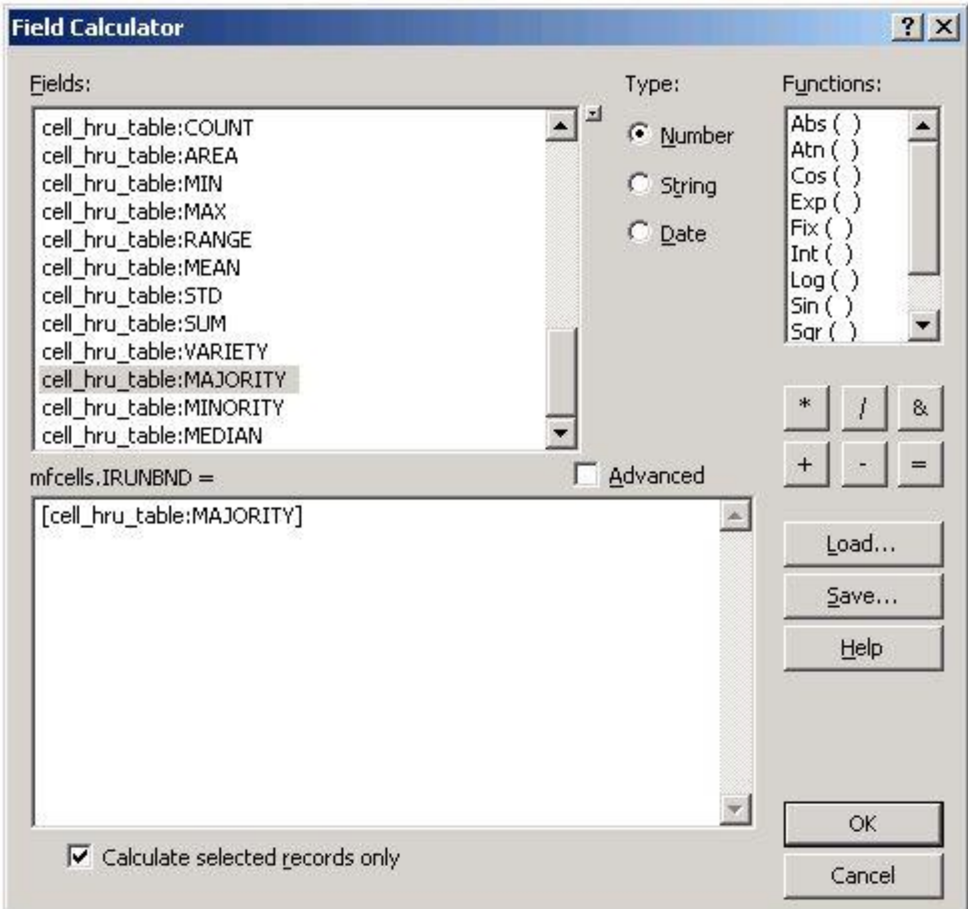
First, join the table in the mfcells shapefile to the table in the activeCells shapefile using the field SEQNUM.



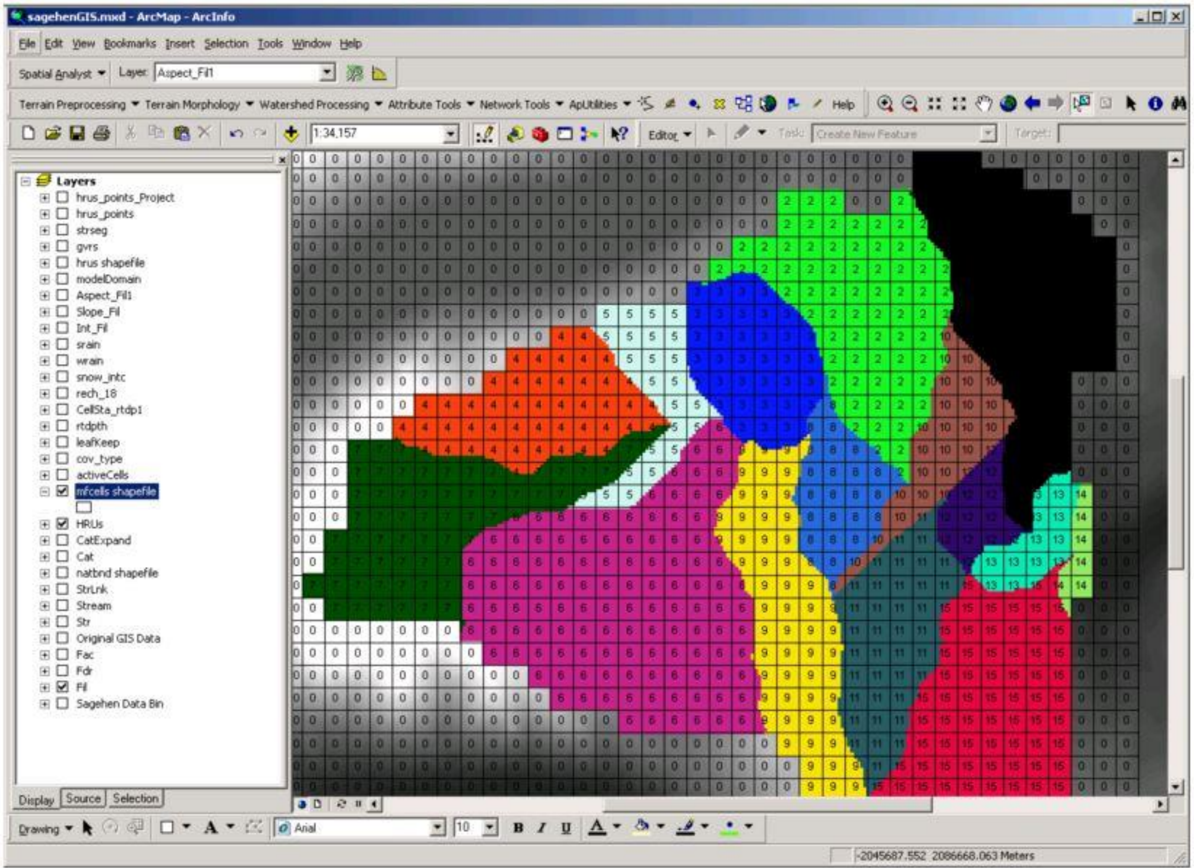
Now, join the table in the mfcells shapefile (field ACT_ID) to the table cell_hru_table (using field Rowid).



Use the Field Calculator to copy the values from cell_hru_table:Majority into the field IRUNBND.



Remove the joins on the mfcells shapefile. Use IRUNBND to label the cells in mfcells. It should look like this.

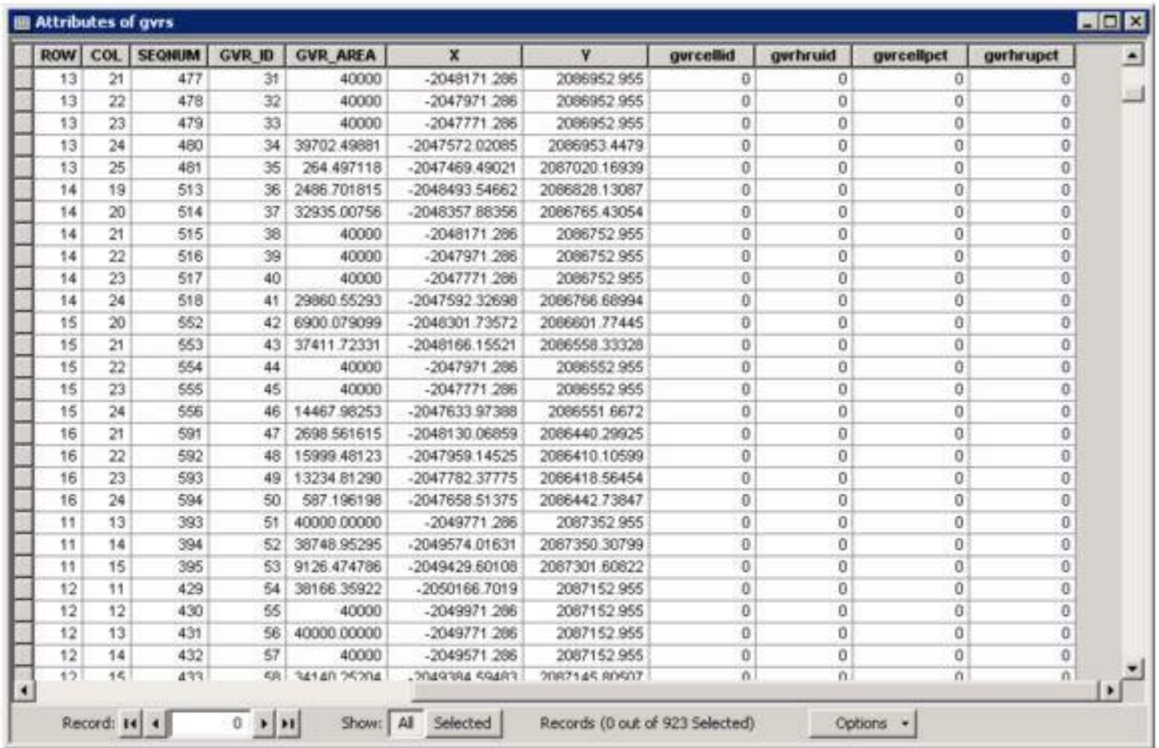


After this map has been created, save the Sagehen ArcMap project by clicking File->Save.

The shapefile gis\shapes\mfcells is the vector version of the MODFLOW cell map. The attributes that were added to this shapefile can be used in ModelMuse.

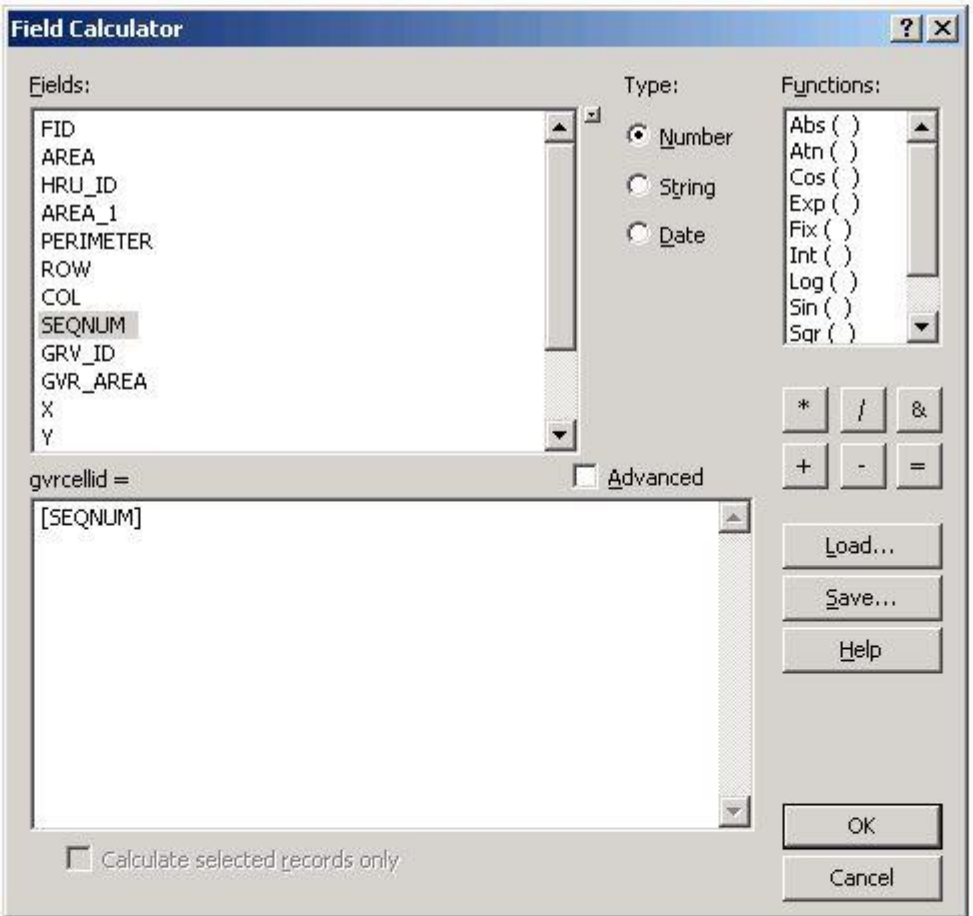
GVR map

Add four fields to the gvrs shapefile attribute table: gvrhruid (short integer), gvrcellid (short integer), gvrcellpct (double), gvrhrupct (double).

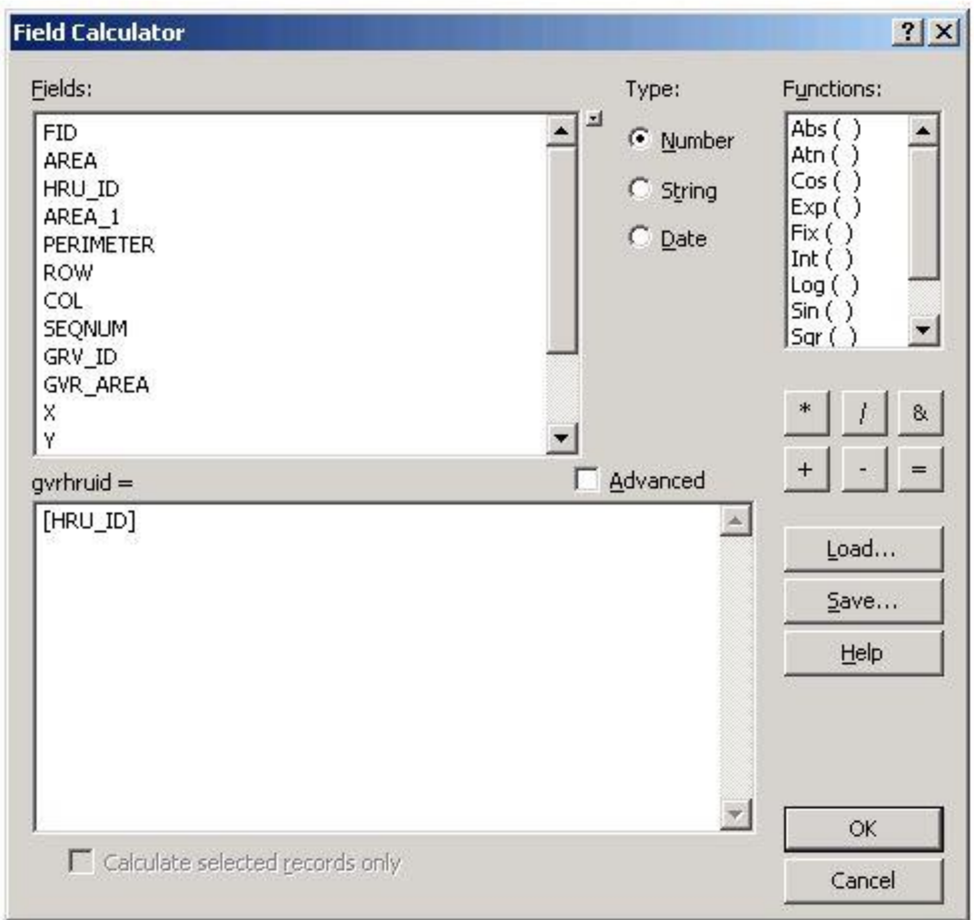


ROW	COL	SEQNUM	GVR_ID	GVR_AREA	X	Y	gvrcellid	gvrhruid	gvrcellpct	gvrhrupct
13	21	477	31	40000	-2048171.286	2086952.955	0	0	0	0
13	22	478	32	40000	-2047971.286	2086952.955	0	0	0	0
13	23	479	33	40000	-2047771.286	2086952.955	0	0	0	0
13	24	480	34	39702.49881	-2047572.02085	2086953.4479	0	0	0	0
13	25	481	35	264.497118	-2047469.49021	2087020.16939	0	0	0	0
14	19	513	36	2486.701815	-2048493.54662	2086828.13087	0	0	0	0
14	20	514	37	32935.00756	-2048357.88356	2086765.43054	0	0	0	0
14	21	515	38	40000	-2048171.286	2086752.955	0	0	0	0
14	22	516	39	40000	-2047971.286	2086752.955	0	0	0	0
14	23	517	40	40000	-2047771.286	2086752.955	0	0	0	0
14	24	518	41	29860.55293	-2047592.32698	2086766.68994	0	0	0	0
15	20	552	42	6900.079099	-2048301.73572	2086601.77445	0	0	0	0
15	21	553	43	37411.72331	-2048166.15521	2086558.33328	0	0	0	0
15	22	554	44	40000	-2047971.286	2086552.955	0	0	0	0
15	23	555	45	40000	-2047771.286	2086552.955	0	0	0	0
15	24	556	46	14467.98253	-2047633.97388	2086551.6672	0	0	0	0
16	21	591	47	2698.561615	-2048130.06859	2086440.29925	0	0	0	0
16	22	592	48	15999.48123	-2047959.14525	2086410.10599	0	0	0	0
16	23	593	49	13234.81290	-2047782.37775	2086418.56454	0	0	0	0
16	24	594	50	587.196198	-2047658.51375	2086442.73847	0	0	0	0
11	13	393	51	40000.00000	-2049771.286	2087352.955	0	0	0	0
11	14	394	52	38748.95295	-2049574.01631	2087350.30799	0	0	0	0
11	15	395	53	9126.474786	-2049429.60108	2087301.60822	0	0	0	0
12	11	429	54	38166.35922	-2050166.7019	2087152.955	0	0	0	0
12	12	430	55	40000	-2049971.286	2087152.955	0	0	0	0
12	13	431	56	40000.00000	-2049771.286	2087152.955	0	0	0	0
12	14	432	57	40000	-2049571.286	2087152.955	0	0	0	0
12	15	433	58	34140.25204	-2049384.59483	2087145.80507	0	0	0	0

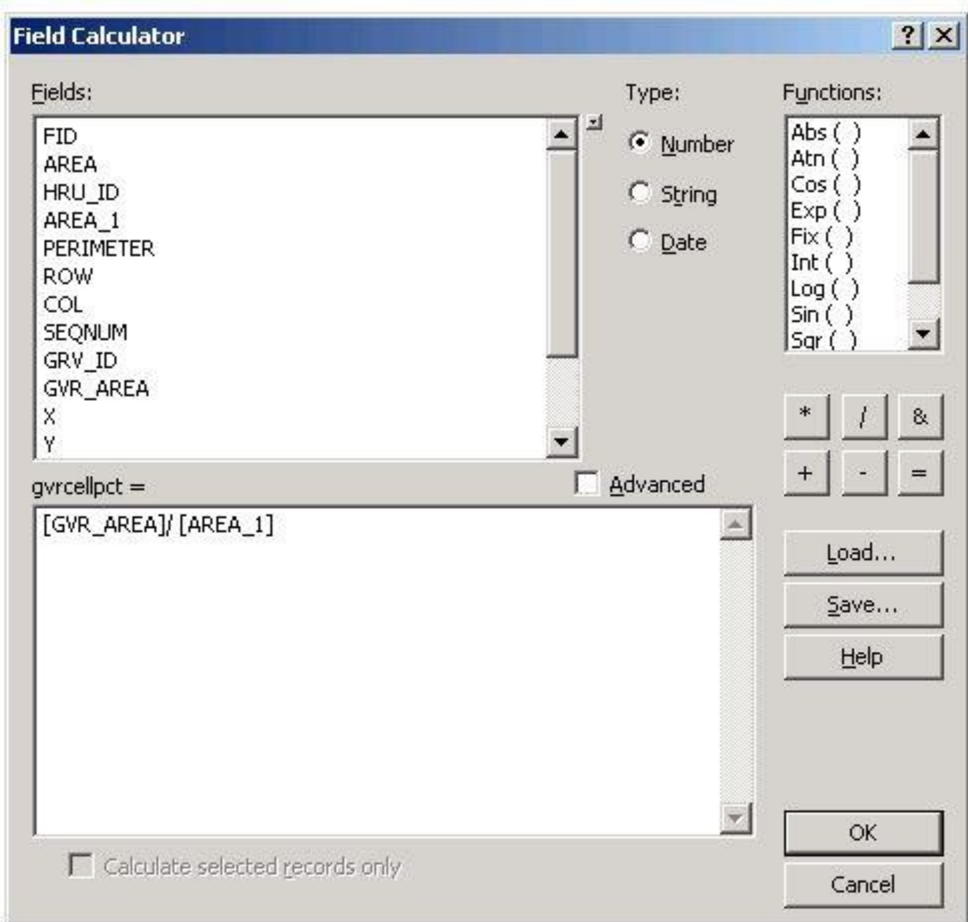
Gvrcellid is the MODFLOW cell id (SEQNUM) which corresponds to the GVR. Set gvrcellid = SEQNUM using the Field Calculator.



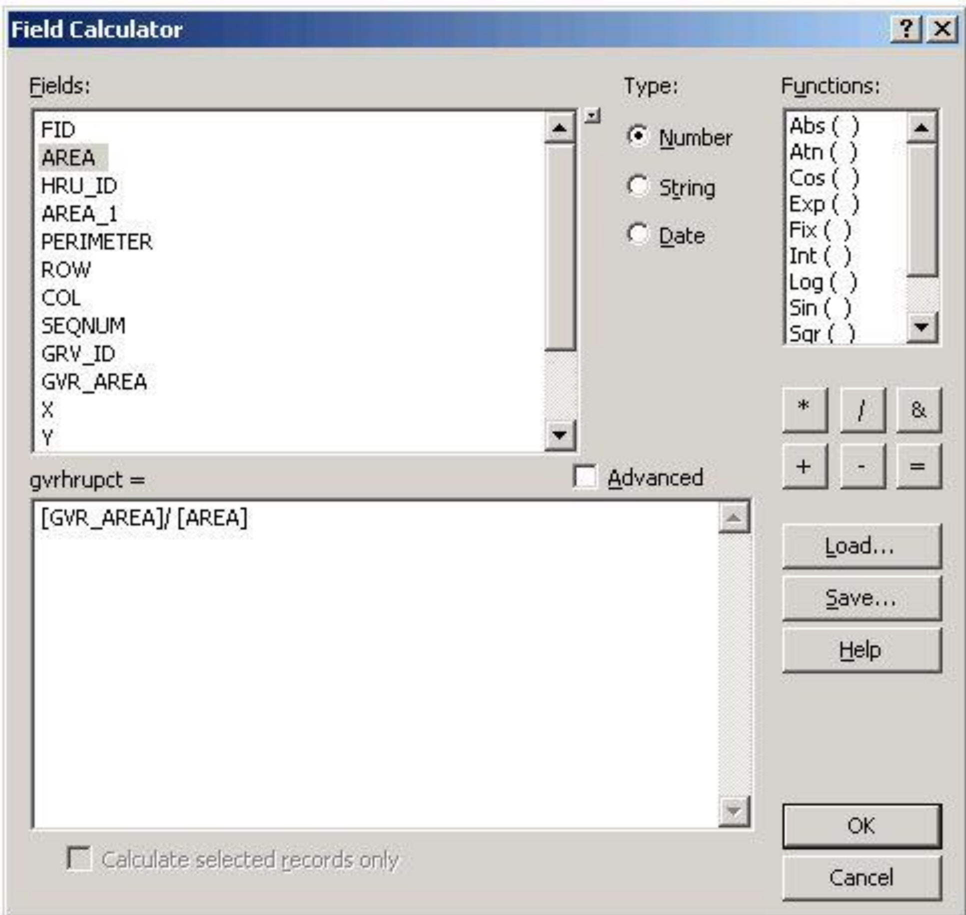
Gvrhruid is the PRMS HRU id (HRU_ID) which corresponds to the GVR. Set gvrhruid = HRU_ID using the Field Calculator.



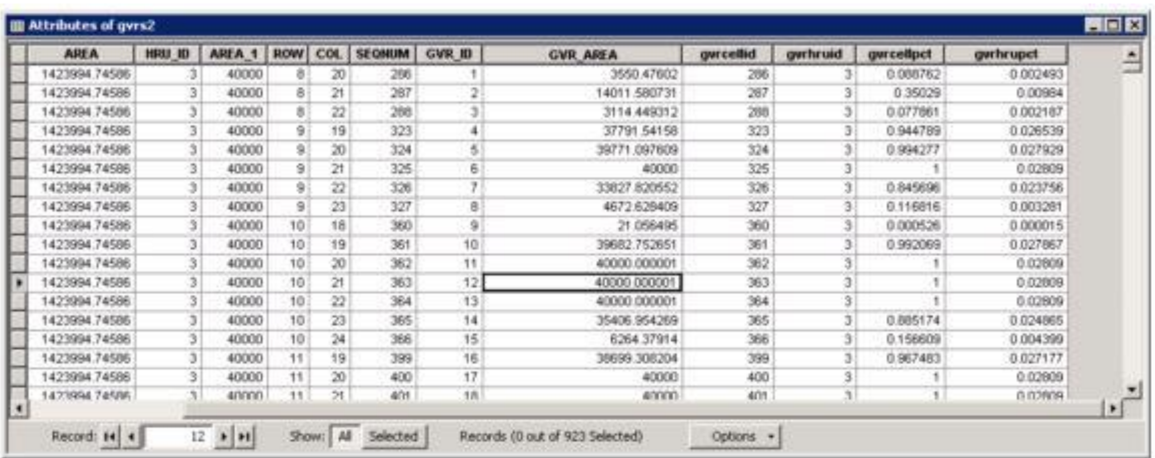
Gvrcellpct is the decimal fraction that the GVR area covers the MODFLOW cell area. Set gvrcellpct = GVR_AREA / AREA_1 using the Field Calculator. AREA_1 is the area of the MODFLOW cell (40,000 meters2)



Gvrhrupct is the decimal fraction that the GVR area covers the PRMS HRU area. Set gvrhrupct = GVR_AREA / AREA using the Field Calculator. AREA is the area of the HRU.



The gvrs shapefile attribute table should look like this when finished.



Attributes of gvrs2

AREA	HRU_ID	AREA_1	ROW	COL	SEQNUM	GVR_ID	GVR_AREA	gvrcellid	gvrhruid	gvrcellpct	gvrhrupct
1423994.74586	3	40000	8	20	286	1	3550.47602	286	3	0.088762	0.002493
1423994.74586	3	40000	8	21	287	2	14011.580731	287	3	0.35029	0.00984
1423994.74586	3	40000	8	22	288	3	3114.449312	288	3	0.077861	0.002187
1423994.74586	3	40000	9	19	323	4	37791.54158	323	3	0.944789	0.026539
1423994.74586	3	40000	9	20	324	5	39771.097609	324	3	0.994277	0.027929
1423994.74586	3	40000	9	21	325	6	40000	325	3	1	0.02809
1423994.74586	3	40000	9	22	326	7	33827.820552	326	3	0.845696	0.023756
1423994.74586	3	40000	9	23	327	8	4672.629409	327	3	0.116816	0.003281
1423994.74586	3	40000	10	18	360	9	21.058495	360	3	0.000526	0.000015
1423994.74586	3	40000	10	19	361	10	39682.752651	361	3	0.992069	0.027867
1423994.74586	3	40000	10	20	362	11	40000.000001	362	3	1	0.02809
1423994.74586	3	40000	10	21	363	12	40000.000001	363	3	1	0.02809
1423994.74586	3	40000	10	22	364	13	40000.000001	364	3	1	0.02809
1423994.74586	3	40000	10	23	365	14	35406.954269	365	3	0.885174	0.024865
1423994.74586	3	40000	10	24	366	15	6264.37914	366	3	0.156609	0.004399
1423994.74586	3	40000	11	19	399	16	38699.308204	399	3	0.967483	0.027177
1423994.74586	3	40000	11	20	400	17	40000	400	3	1	0.02809
1423994.74586	3	40000	11	21	401	18	40000	401	3	1	0.02809

Record: 12 Show: All Selected Records (0 out of 923 Selected) Options

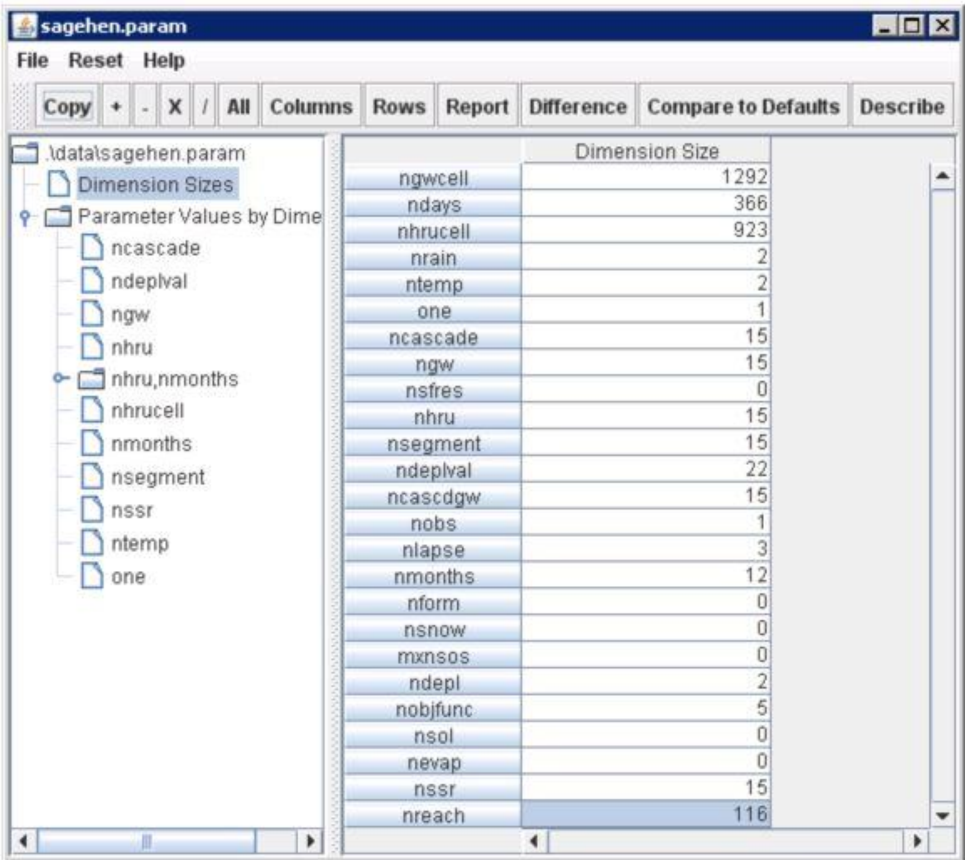
After this information has been created, save the Sagehen ArcMap project by clicking File->Save.

Making the PRMS Parameter File

Dimension sizes

Start the paramtool by double-clicking on classProblem\paramtool.bat

Set the Dimension Sizes as follows. For this problem, always click on Default when asked about Resize Dimension:



This step is setting the dimension sizes (array sizes) in the PRMS modules. To find out what these dimensions are, left-click in a table cell (select it) and then click on the Describe button in the tool bar.

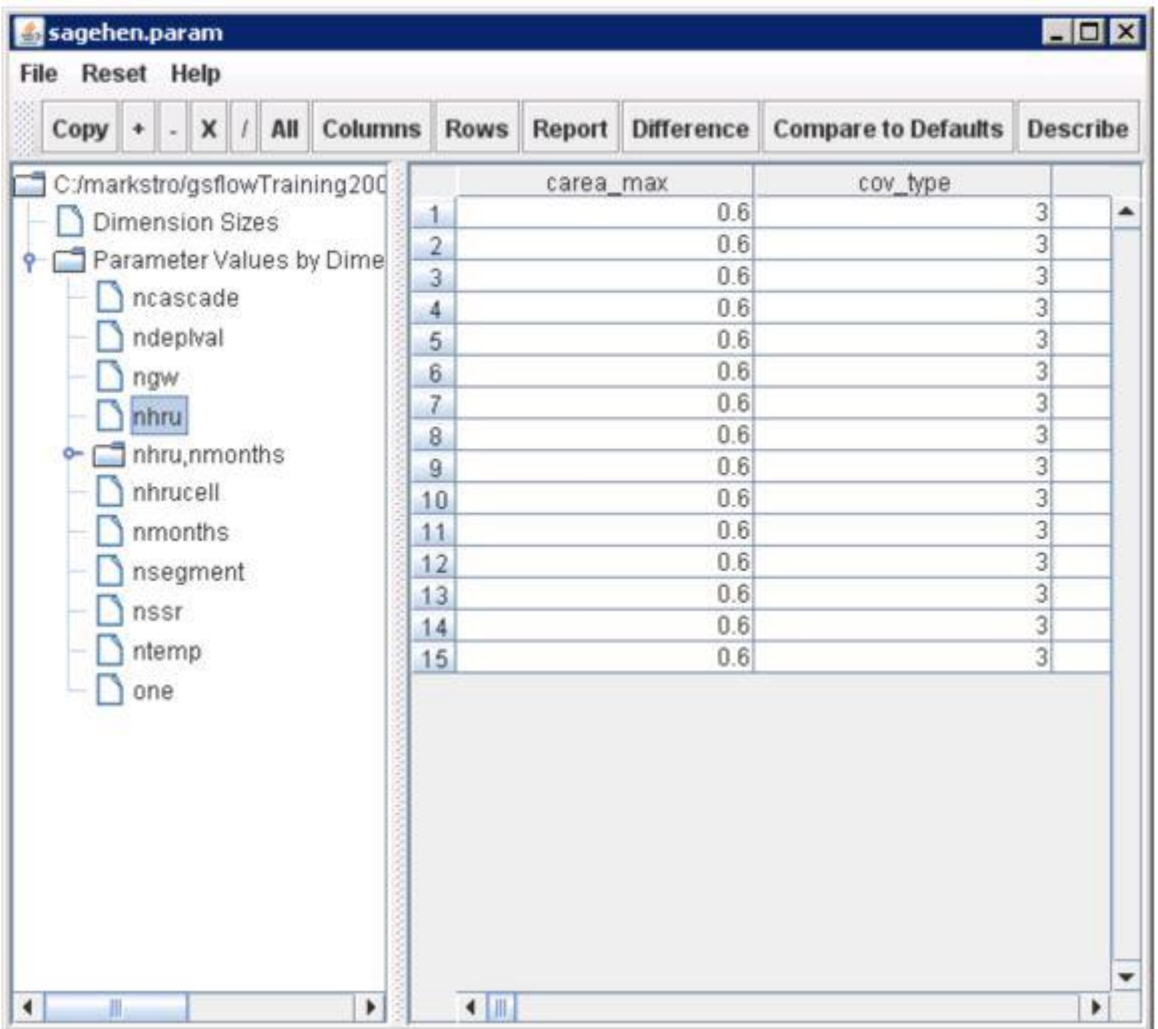
Click on the menu item File->Save when finished. Remember that all edit made in the paramtool tables must be saved to the Parameter File for the edits to take effect when the model runs.

Spatial parameters

Transfer the spatial attributes developed in section 4 to the PRMS Parameter File.

HRU parameters

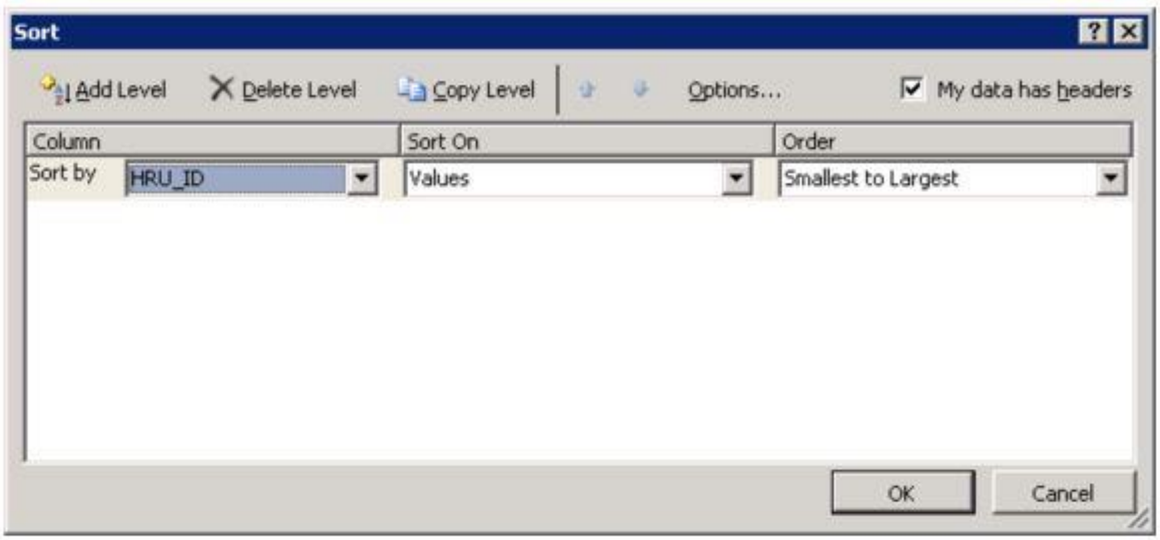
Start the paramtool by double-clicking on classProblem\paramtool.bat. Click on Parameter Values by Dimension->nhru in the paramtool tree.

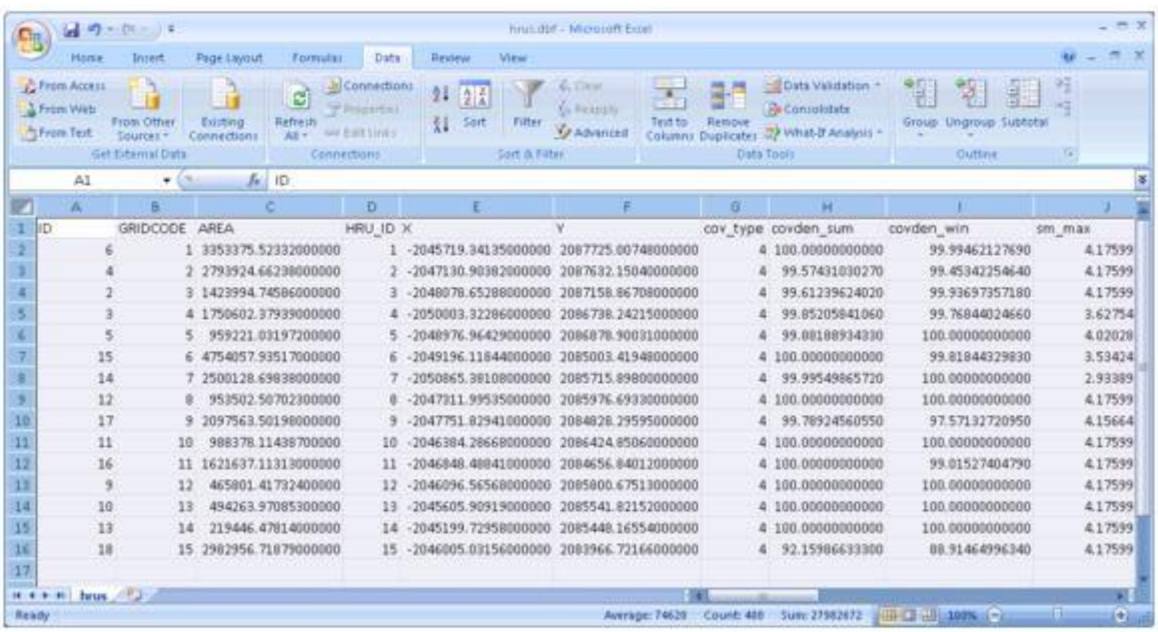


Open the gis\shapes\hrus.dbf in excel. This file contains all of the attribute values that were derived for the gis\shapes\hrus shapefile.

REALLY IMPORTANT: Sort the excel worksheet in ascending order on the HRU_ID column (not the ID column). This will insure that that spatial attributes will be pasted into the PRMS Parameter File in the correct order.

It is also REALLY IMPORTANT that these .dbf files are not save from excel after the content is sorted.





Copy the attributes values, column by column, out of excel and into the appropriate column in the paramtool using cut and paste (ctrl-c and ctrl-v). There are 18 HRU parameters to transfer over:

1. cov_type
2. covden_sum (divide by 100 if needed - needs to be decimal fraction, not percent)
3. covden_win (divide by 100 if needed - needs to be decimal fraction, not percent)
4. hru_area (use the values in acres, not m2)
5. hru_aspect
6. hru_elev
7. hru_slope
8. jh_coef_hru
9. rad_trncf
10. snow_intcp (divide by 100 - needs to be decimal fraction, not percent)
11. soil_moist_max
12. soil_rech_max
13. soil_type
14. srain_intcp (divide by 100 if needed)
15. tmax_adj
16. tmin_adj
17. wrain_intcp (divide by 100 if needed)

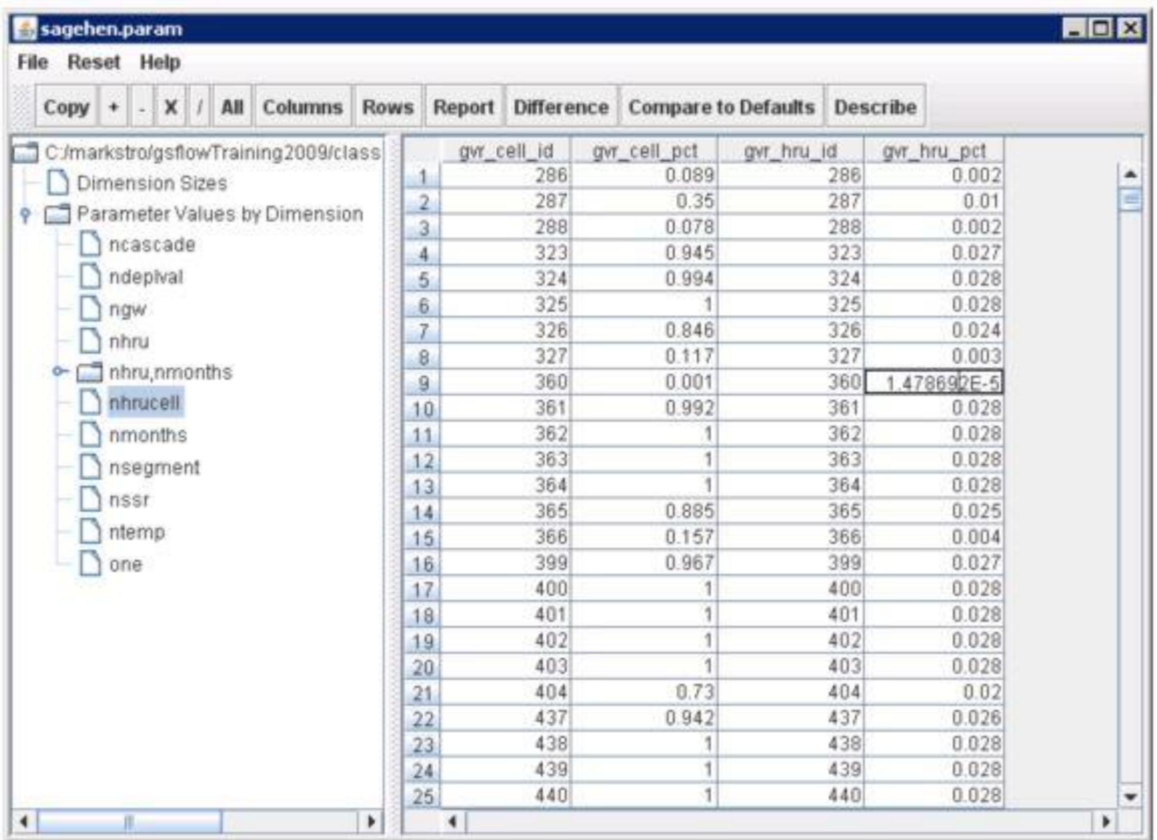
Open the gis\shapes\hru_centoid_project.dbf in excel.

18. hru_lat - this in the Y coordinate of the HRU in geographical coordinates (Don't forget to sort them by HRU_ID)

Parameters that come from the Gravity Reservoir (gis\shapes\gvrs.dbf) map and go into the nhrucell dimension

Use excel to open the gis\shapes\gvrs.dbf file. Sort the columns on GVR_ID. In the paramtool, click on Parameter Values by Dimension->nhrucell.

1. Find the column gvrcellid in excel. Copy and paste the values into the gvr_cell_id column in the paramtool table.
2. Find the column gvrcellpct in excel. Copy and paste the values into the gvr_cell_pct column in the paramtool table.
3. Find the column gvrhruid in excel. Copy and paste the values into the gvr_hru_id column in the paramtool table.
4. Find the column gvrhrupct in excel. Copy and paste the values into the gvr_hru_pct column in the paramtool table.



	gvr_cell_id	gvr_cell_pct	gvr_hru_id	gvr_hru_pct
1	286	0.089	286	0.002
2	287	0.35	287	0.01
3	288	0.078	288	0.002
4	323	0.945	323	0.027
5	324	0.994	324	0.028
6	325	1	325	0.028
7	326	0.846	326	0.024
8	327	0.117	327	0.003
9	360	0.001	360	1.478692E-5
10	361	0.992	361	0.028
11	362	1	362	0.028
12	363	1	363	0.028
13	364	1	364	0.028
14	365	0.885	365	0.025
15	366	0.157	366	0.004
16	399	0.967	399	0.027
17	400	1	400	0.028
18	401	1	401	0.028
19	402	1	402	0.028
20	403	1	403	0.028
21	404	0.73	404	0.02
22	437	0.942	437	0.026
23	438	1	438	0.028
24	439	1	439	0.028
25	440	1	440	0.028

To find out what these parameters are, left-click in a table cell (select it) and then click on the Describe button in the tool bar.

Click on the menu item File->Save when finished. Remember that all edit made in the paramtool tables must be saved to the Parameter File for the edits to take effect when the model runs.

Cascade parameters

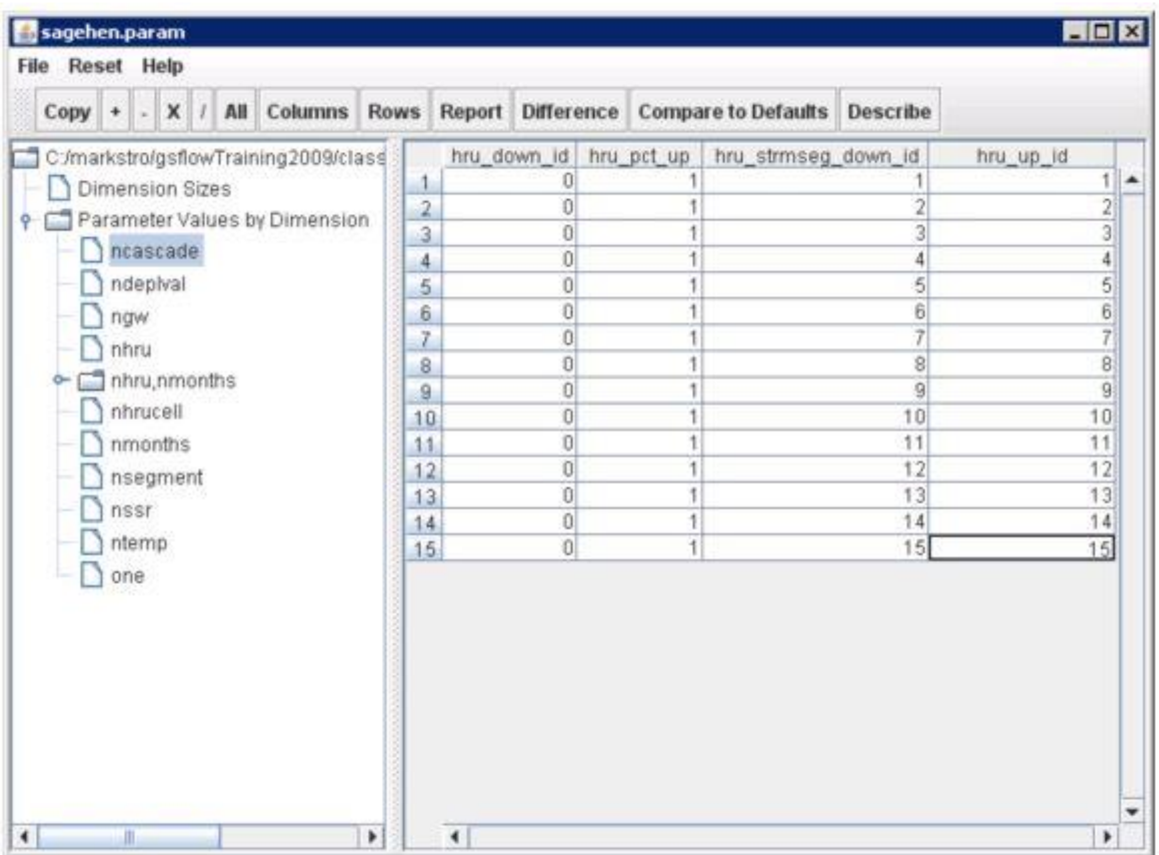
Normally the cascade parameters (click on Parameter Values by Dimension->ncascade in paramtool) would come from GIS (or other analysis). At this time, the current methods for doing this GIS analysis are beyond a reasonable exercise for this class. Because of the way that the HRU and stream segment IDs were were assigned, it will be quite easy to do this by hand.

Set all the values (15 of them) in the hru_down_id column to the value 0. Because of the way that the HRUs were delineated, all of them drain (cascade) into stream segments (not HRUs).

Set all of the values in the hru_pct_up column to the value 1. This is because there is only one cascade coming from each HRU and all of the area from the HRU contributes to each the cascade.

Set the values in the hru_strmseg_down_id column to be the cascade number: 1 for row 1, 2 for row 2, 3 for row 3, etc. all the way to 15. This is because there is only one destination for each cascade, and it is the stream segment with the ID corresponding to the cascade ID.

Copy the values from the hru_strmseg_down_id column to the hru_up_id column. In the example problem, each cascade connects the corresponding HRU to the corresponding stream segment.



Remember that this only works out this way because of the simple way that HRUs and stream segments were developed for this problem.

Repeat the instructions above for the ground water cascade parameters (click on Parameter Values by Dimension->ncascadgw in paramtool). These parameters describe how PRMS routes groundwater from HRU to HRU to streams. Usually these should be set to the same as the surface cascades. If your PRMS model has swales or lakes, you will need to set these different. In the class problem, used the same routing scheme as the surface parameters (ncascade).

Click on the menu item File->Save when finished. Remember that all edit made in the paramtool tables must be saved to the Parameter File for the edits to take effect when the model runs.

Non-spatial parameters

By nhru (click on Parameter Values by Dimension->nhru in paramtool):

1. hru_psta set all of these to "1". This means that the "base" precipitation station is the first one (Independence Lake SNOTEL) specified in the Data File.
2. hru_plaps set all of these to "2". This means that the "lapse" precipitation station is the second one (Sagehen COOP) specified in the Data File.
3. hru_tsta set all of these to "1". This means that the "base" temperature station is the first one (Independence Lake SNOTEL) specified in the Data File.
4. hru_tlaps set all of these to "2". This means that the "lapse" temperature station is the second one (Sagehen COOP) specified in the Data File.

By nrain (click on Parameter Values by Dimension->nrain in paramtool):

psta_elev Independence Lake SNOTEL (index = 1) is at 2576 meters. Sagehen COOP (index = 2) is at 1932 meters. Make sure that these units match the units used for parameter hru_elev. The units are meters in the example problem.

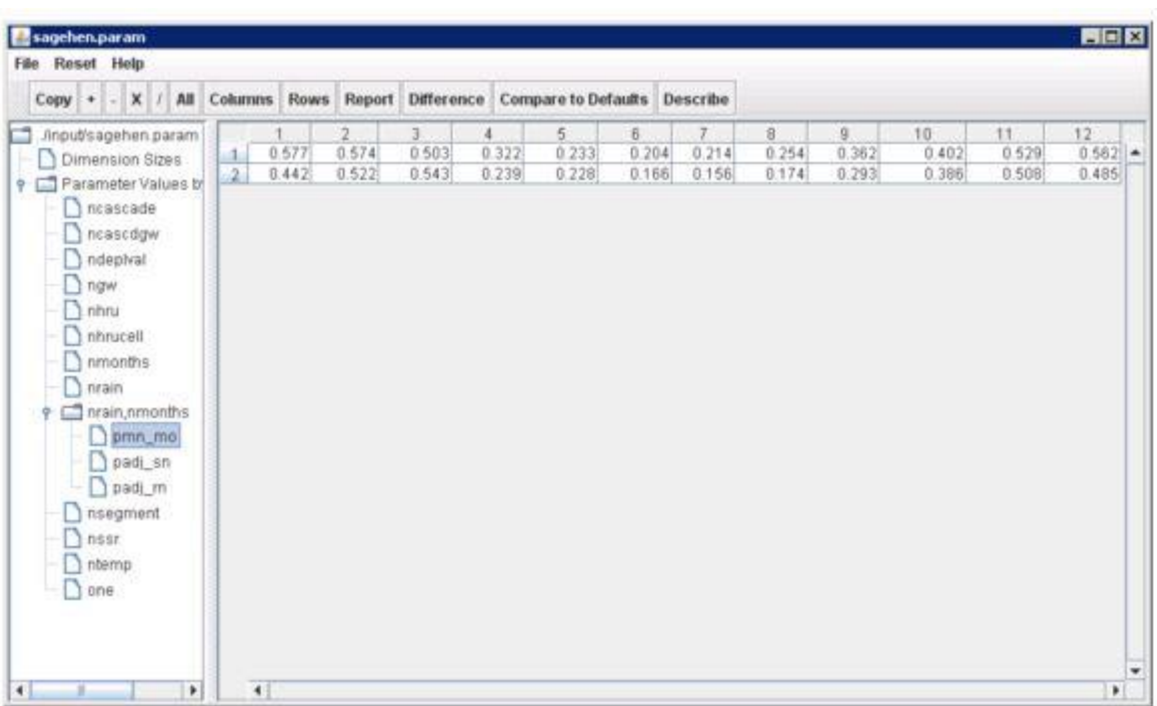
By ntemp (click on Parameter Values by Dimension->ntemp in paramtool):

tsta_elev Independence Lake SNOTEL (index = 1) is at 2576 meters. Sagehen COOP (index = 2) is at 1932 meters. Make sure that these units match the units used for parameter hru_elev. The units are meters in the example problem.

By nrain,nmonths (click on Parameter Values by Dimension->nrain,nmonth in paramtool):

pmn_mo These are the mean monthly precipitation on days with precipitation (storm size) for Independence Lake SNOTEL (index = 1) and Sagehen COOP (index = 2).

These values (calculated according to Step 2.2) are in the excel file sagehenLapseRates.xls. Copy and paste them into the pmn_mo table using the paramtool.



Click on the menu item File->Save when finished. Remember that all edit made in the paramtool tables must be saved to the Parameter File for the edits to take effect when the model runs.

Making the MODFLOW Files

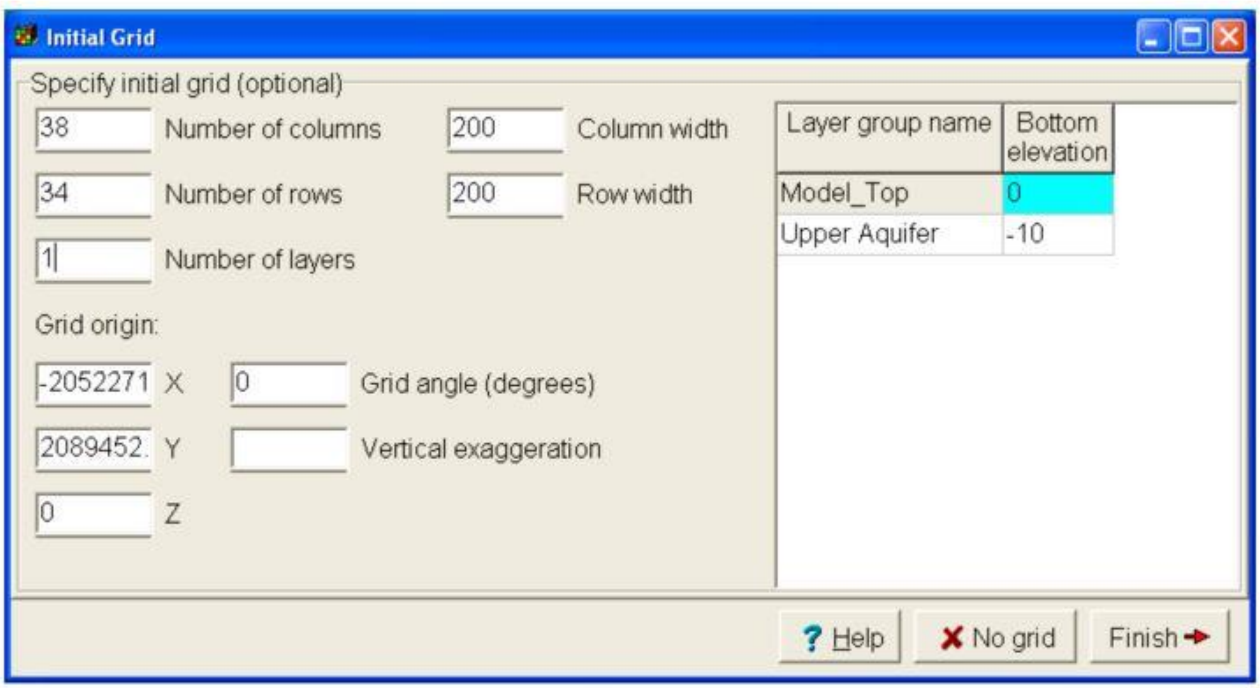
Create the MODFLOW Grid Cell map (ModelMuse method)

1. Open ModelMuse
2. Choose New Modflow Model
3. Set data for MODFLOW Grid:

X origin = -2052271.286

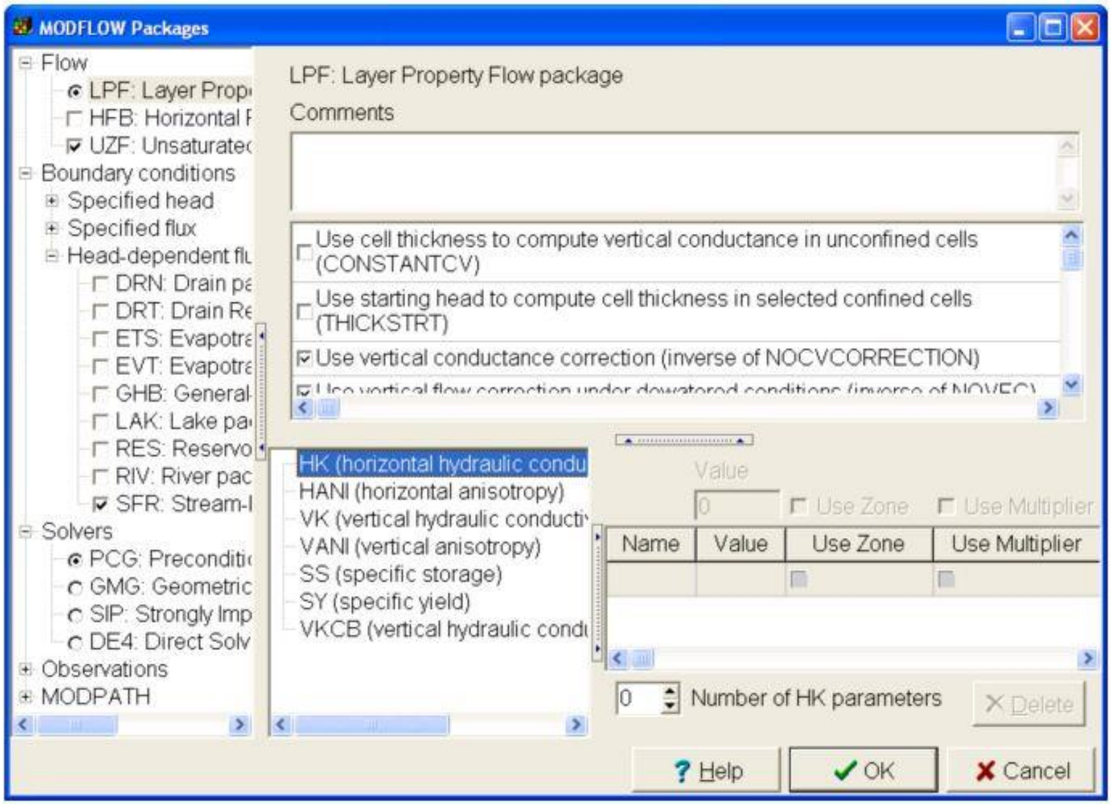
Y origin = 2089452.995

This origin is determined from ARC, and is the upper left corner of the model domain in ModelMuse.



Select MODFLOW packages

1. Choose "Model|Modflow packages and programs"
2. Select "LPF: Layer Property Flow"



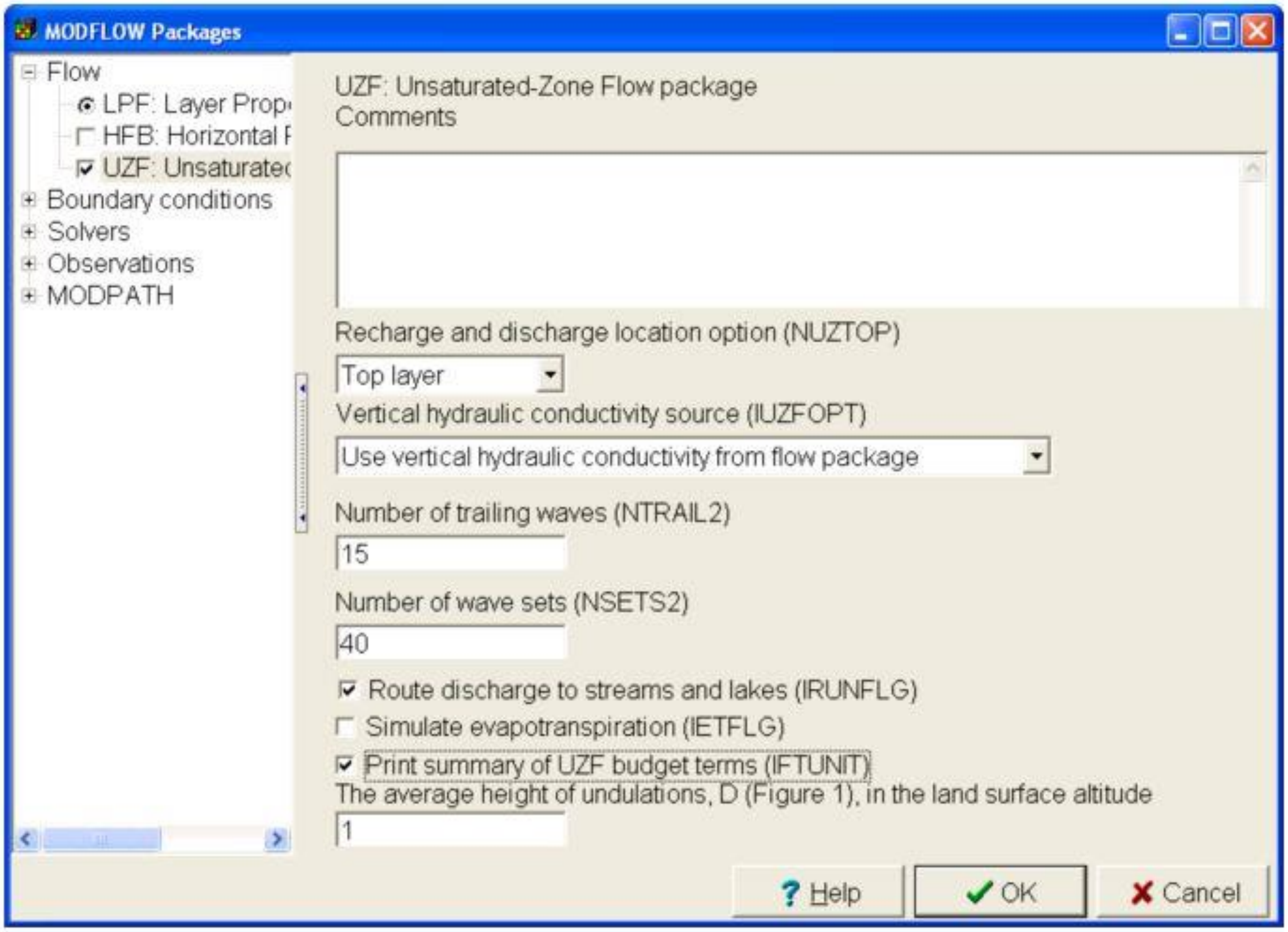
3. Select "UZF: Unsaturated-Zone Flow"

4. Choose "Use vertical hydraulic conductivity from flow package"

5. Change "NSETS2" to 40

6. Remove check from "Simulate evapotranspiration"

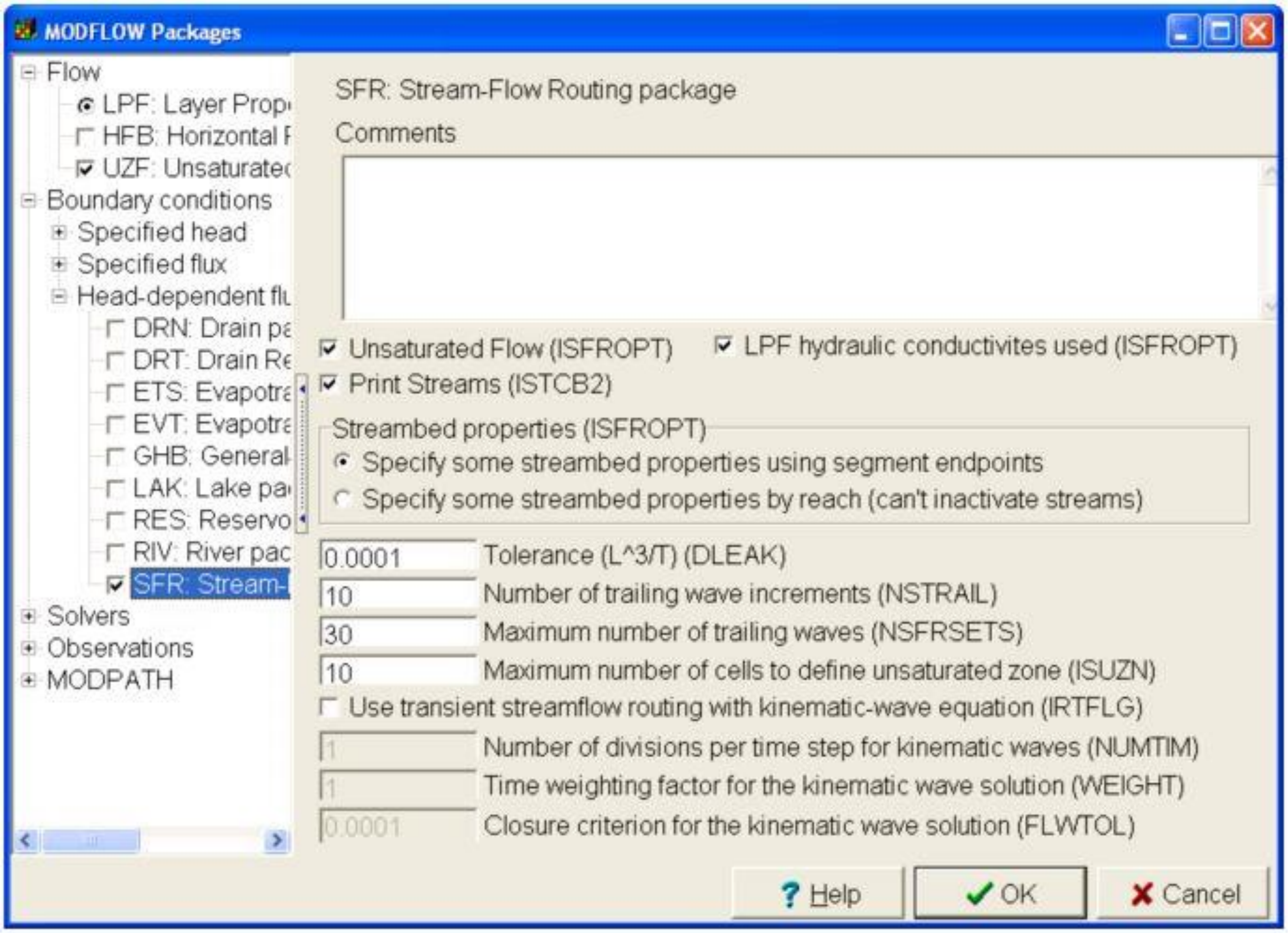
7. Add check to "Print summary UZF budget terms"



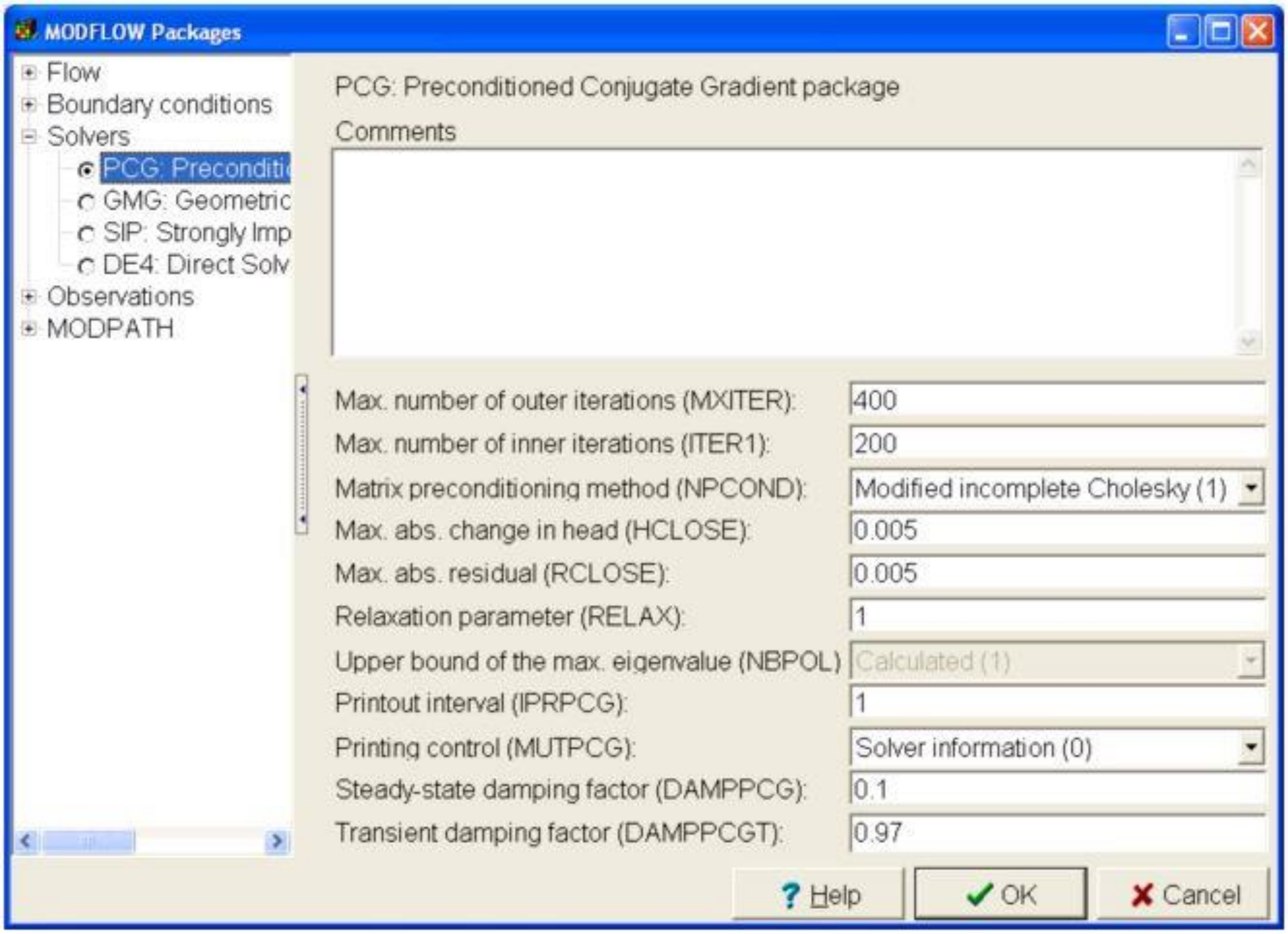
8. Select "Boundary conditions|Head-dependent flux|SFR: Streamflow-Routing"

9. Include "Unsaturated Flow" beneath streams

10. Add check to "Print Streams"



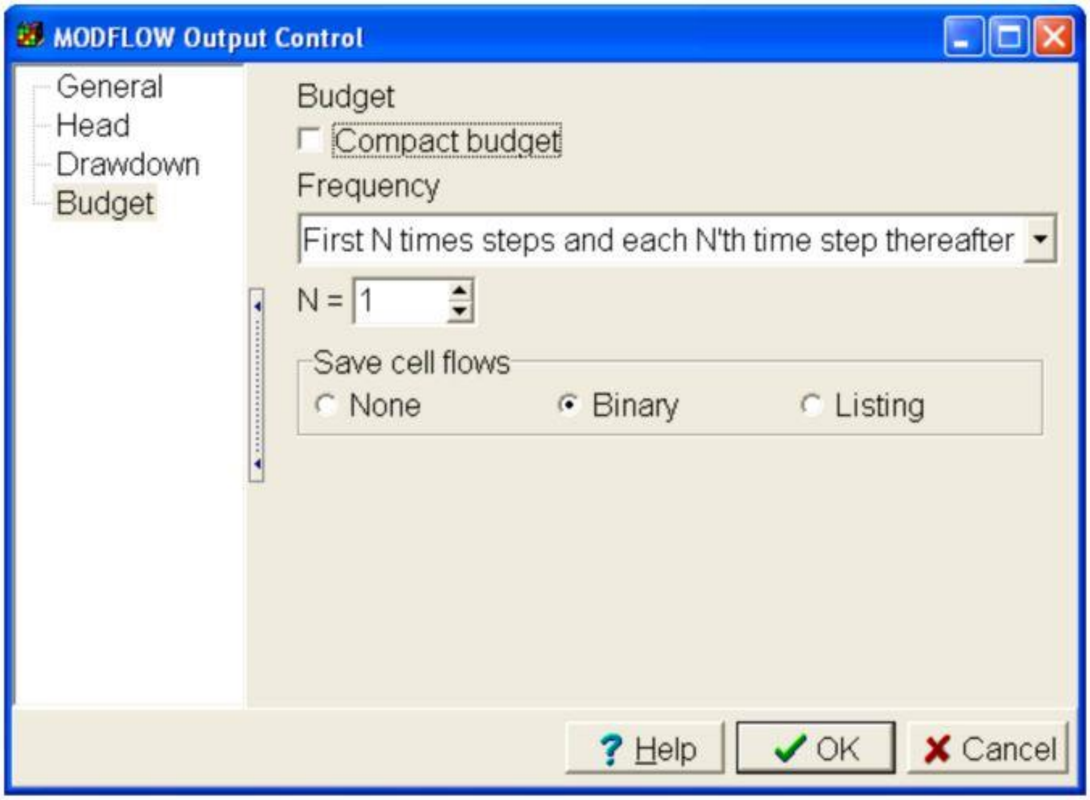
11. Select "PCG: Preconditioned Conjugate Gradient" and type values as shown below.



Set MODFLOW Output Control

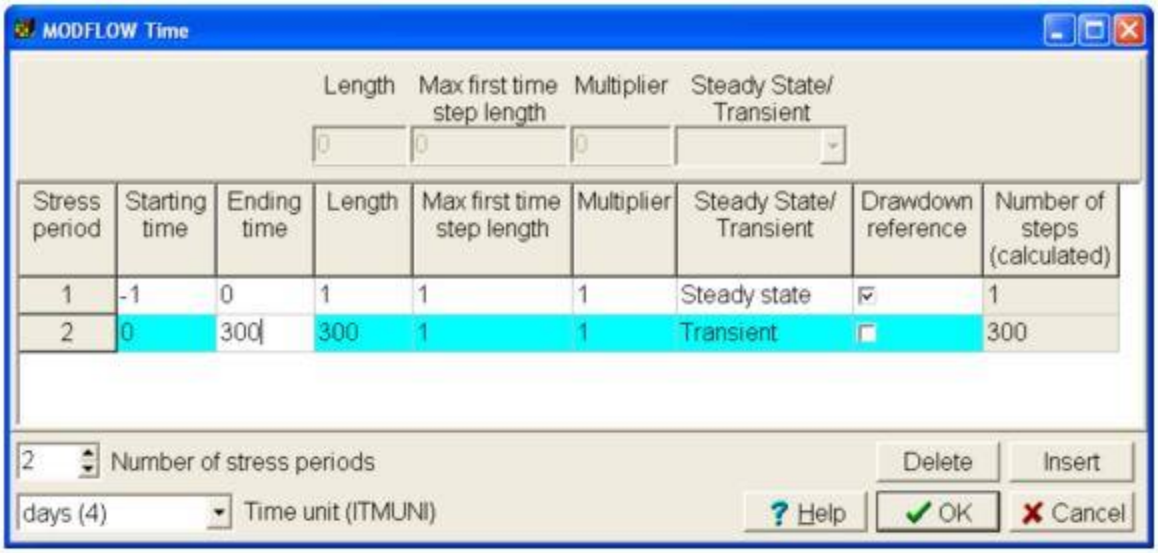
1. Select "Model|Modflow Output Control"

2. Unselect "Compact Budget"



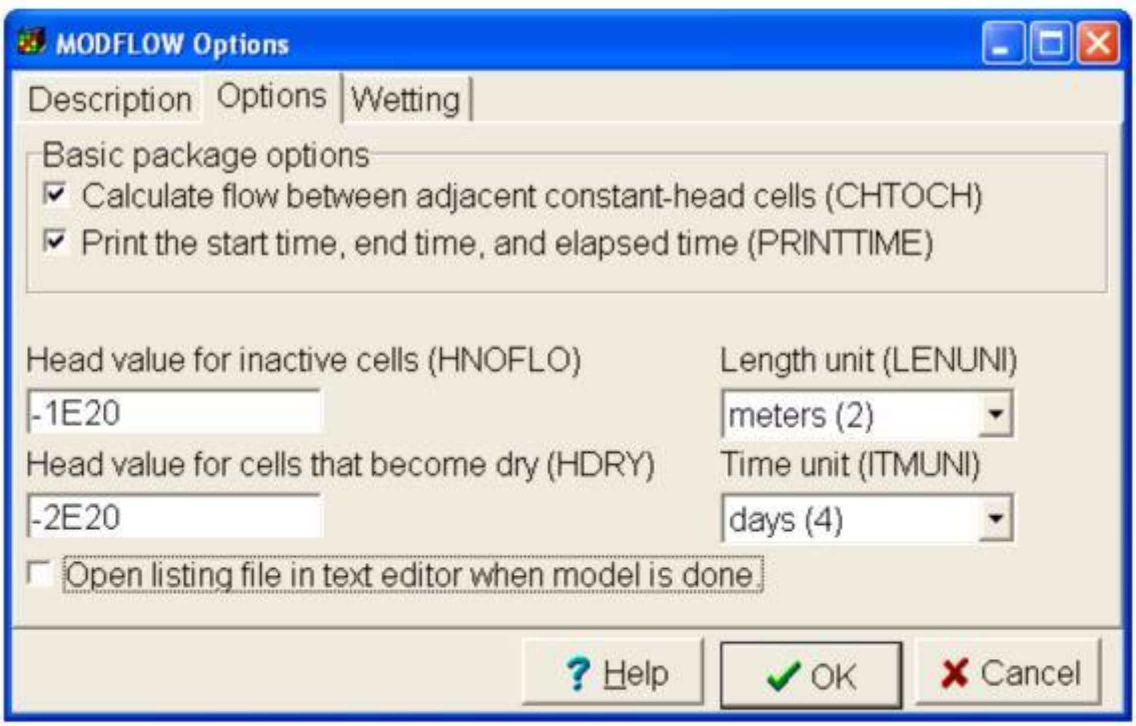
Set MODFLOW Units and Other Options

1. Select "Model|Modflow Time"
2. Set # of stress periods = 2
3. Choose "days (4)" for "ITMUNI"
4. First stress period -1 to 0
5. Second stress period 0 to 300



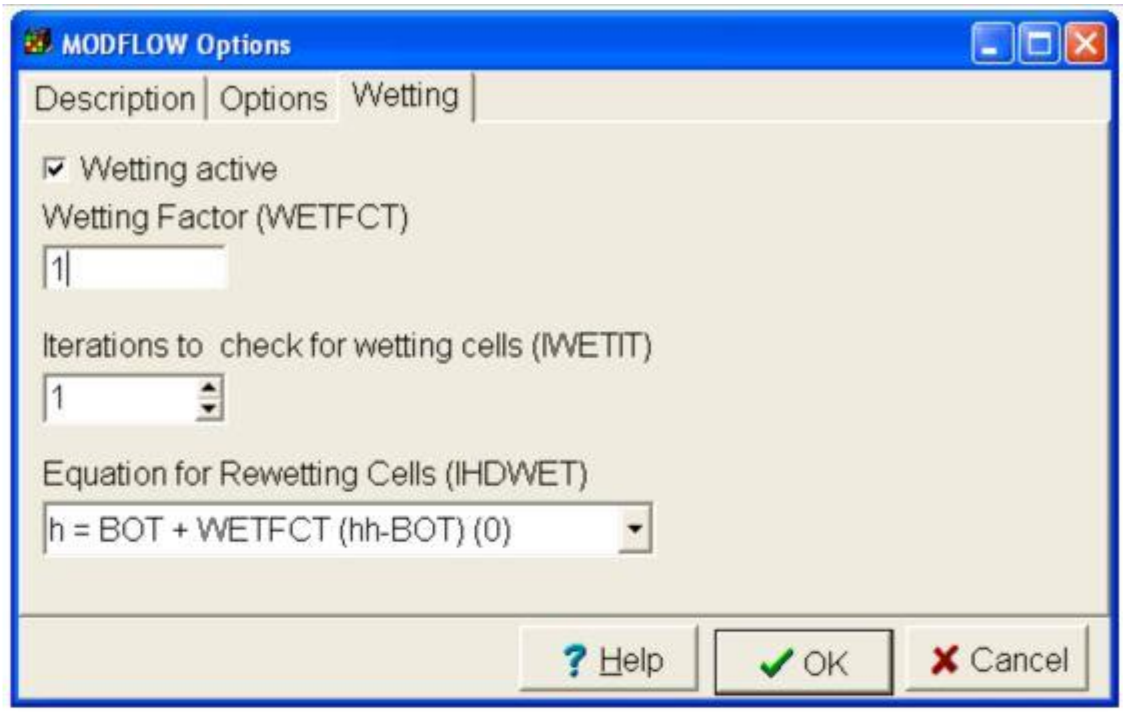
6. Select "Model|Modflow Options"

7. Set "LENUNI" = "meters (2)"



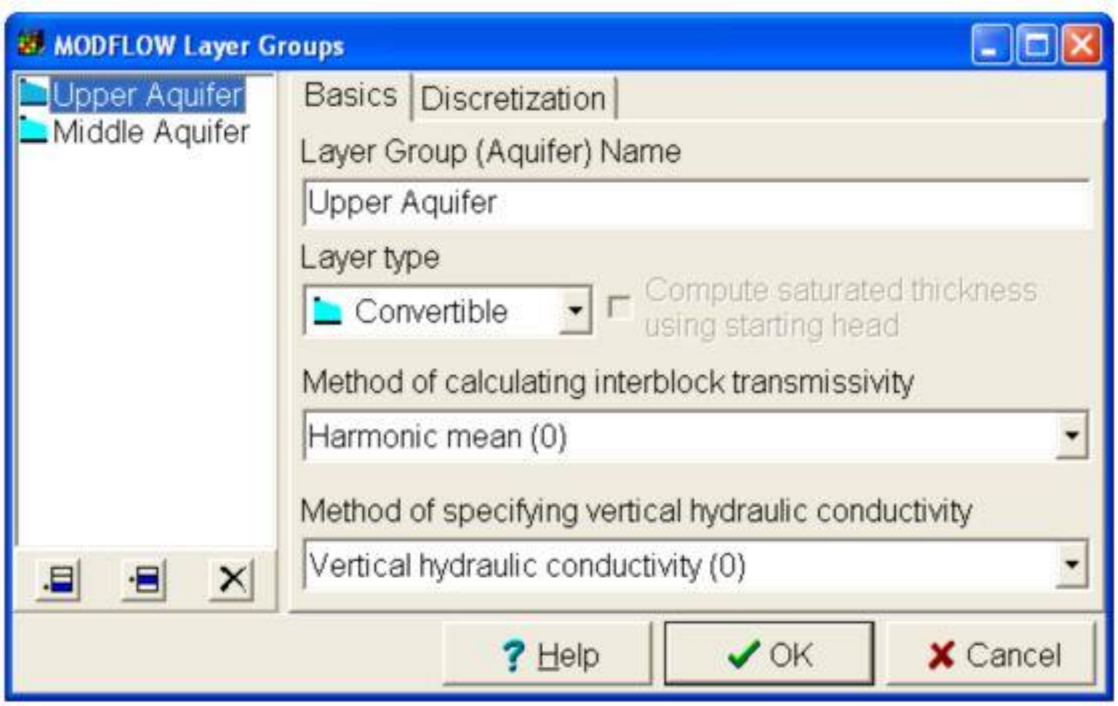
8. Continue with: "Model|Modflow Options"

9. Add check mark to "Wetting Active"



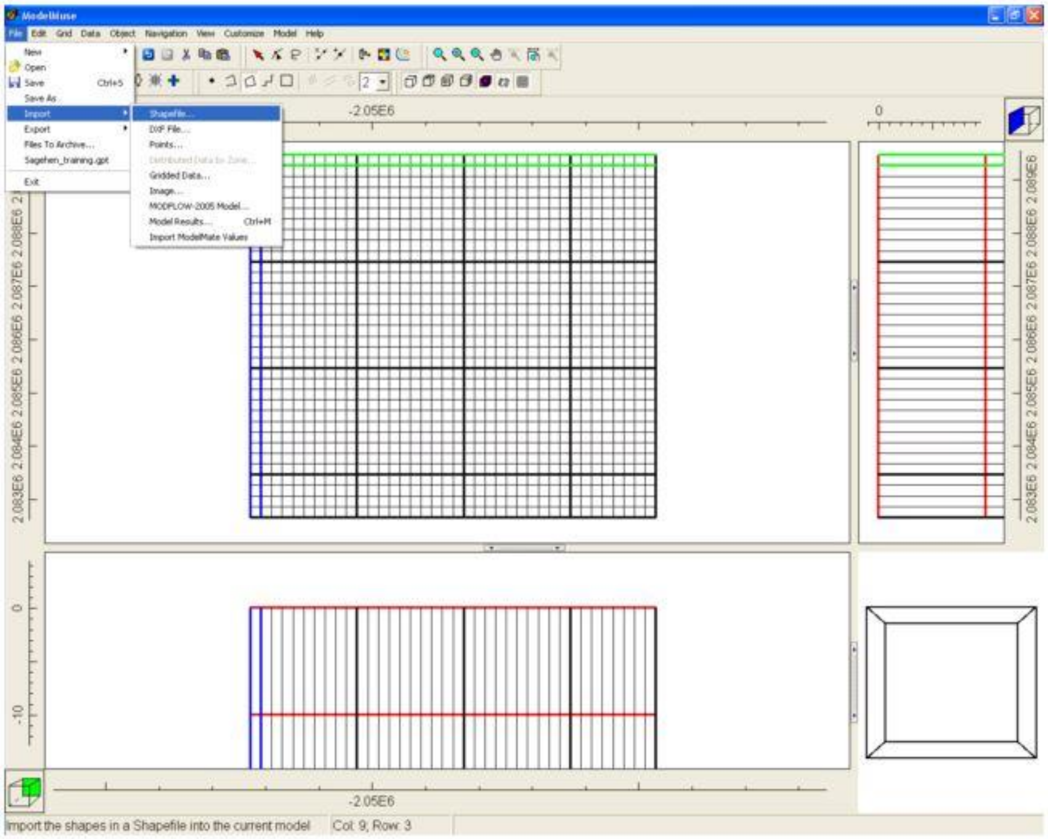
10. Select "Model|Modflow Layer Groups"

11. Make LAYTYP convertible

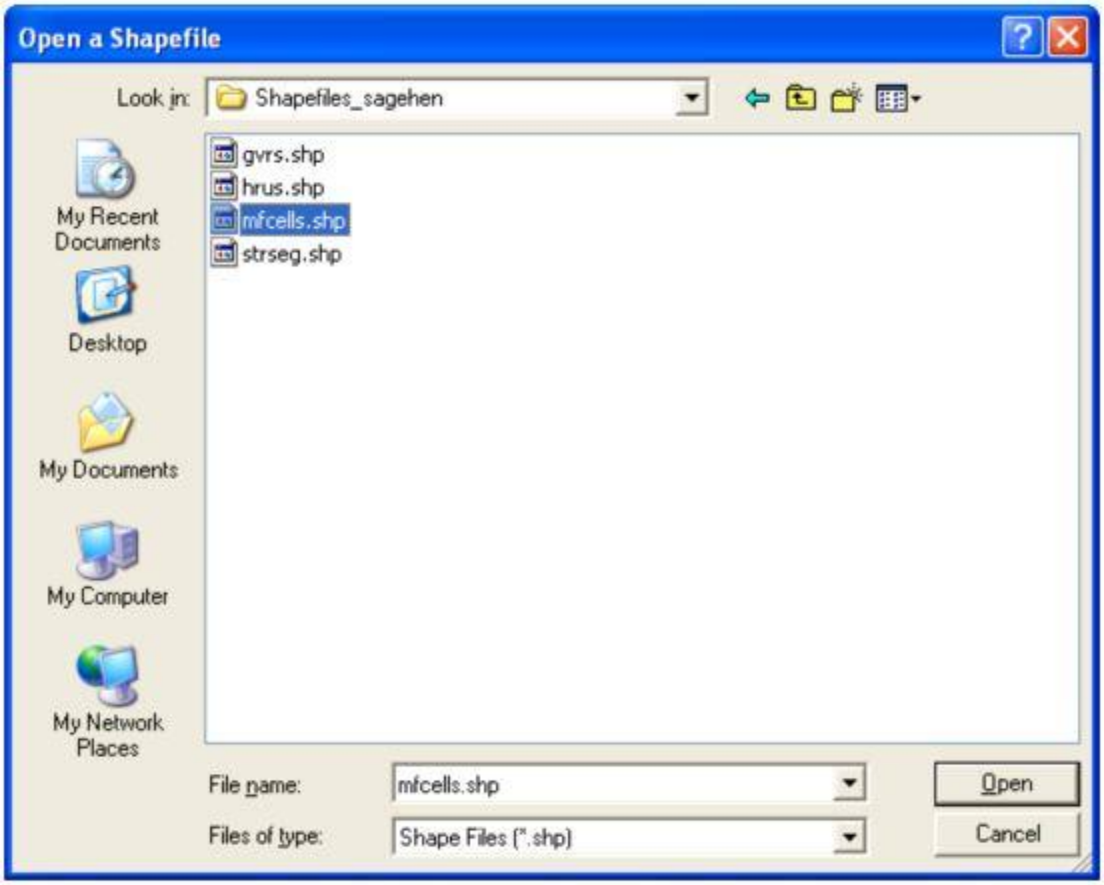


Importing Shapefiles in ModelMuse

1. Select: "File|Import|Shapefiles"



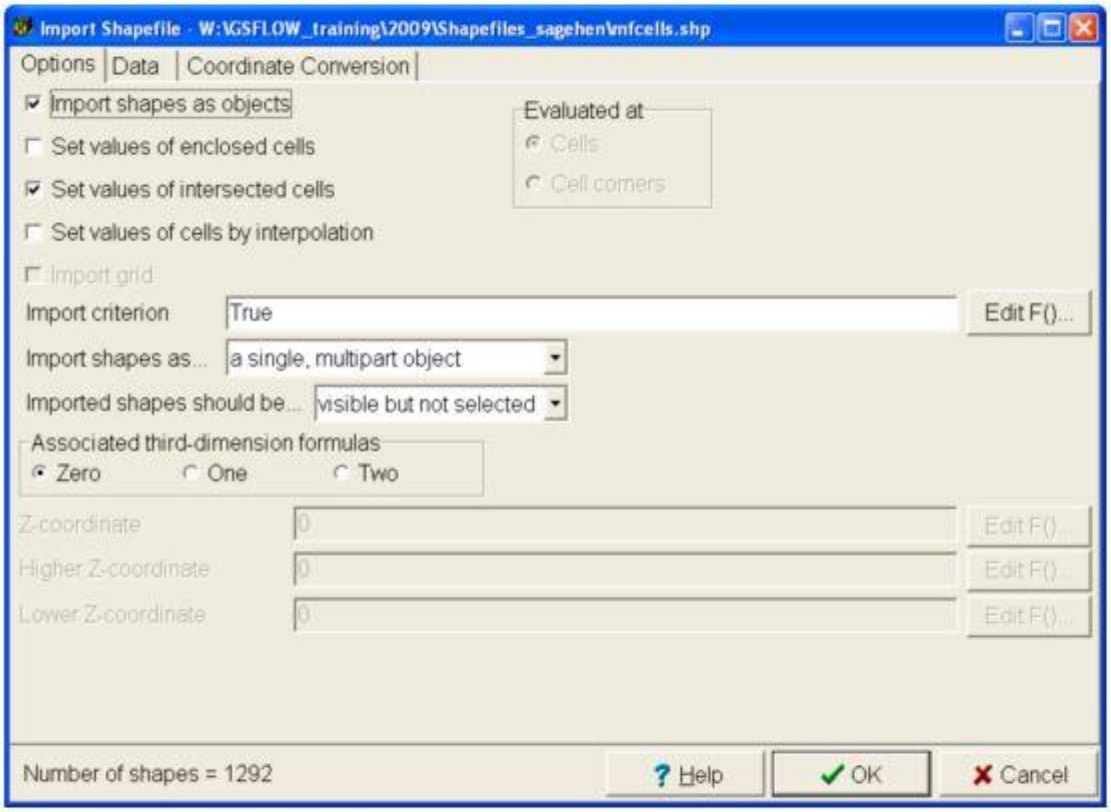
2. Import "mfcells.shp"



3. Choose "Options" Tab

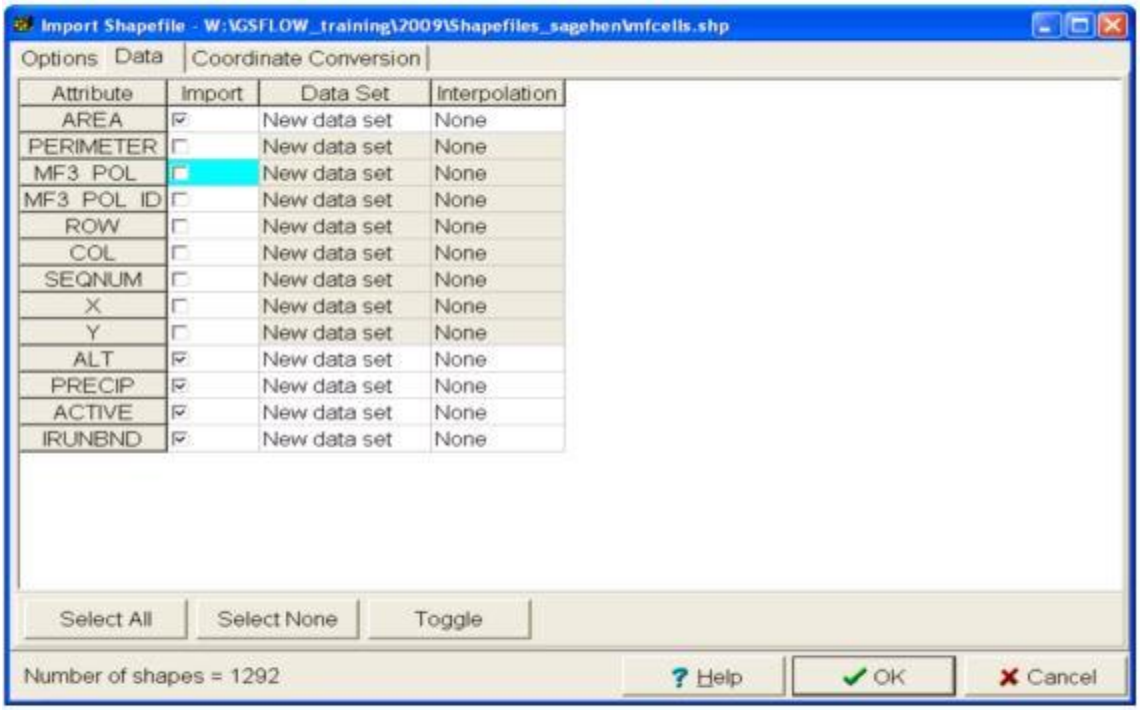
4. Select "import shapes as Objects"

5. Choose "Set Values to Intersected Cells"

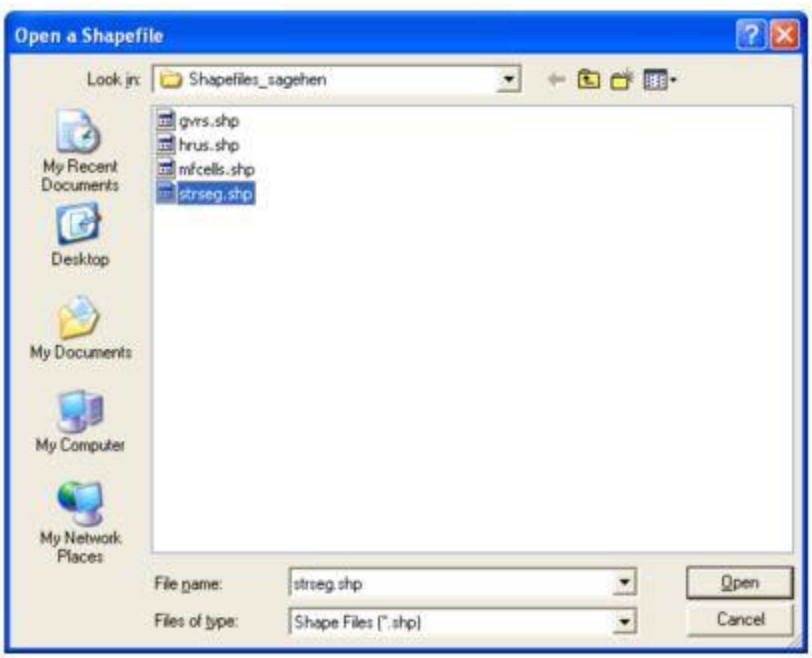


6. Select "Data" Tab

7. Add check to "ALT", "PRECIP", "ACTIVE", and "IRUNBND"

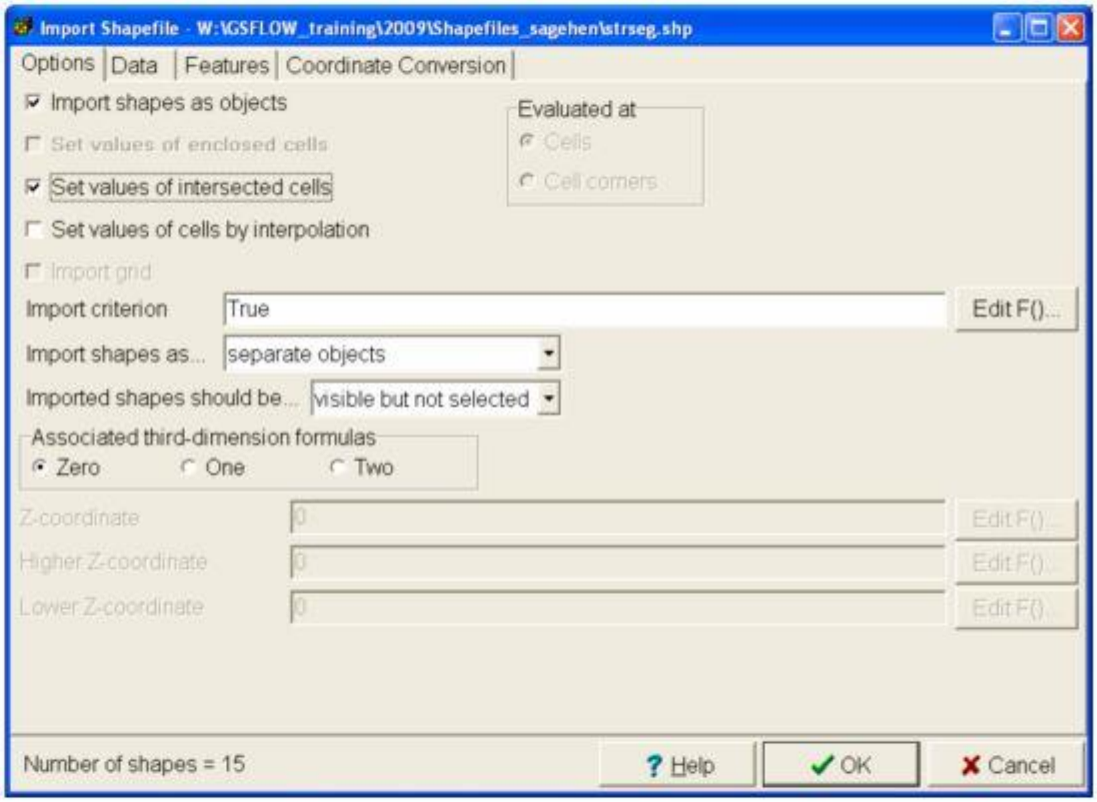


8. Import "strseg.shp"



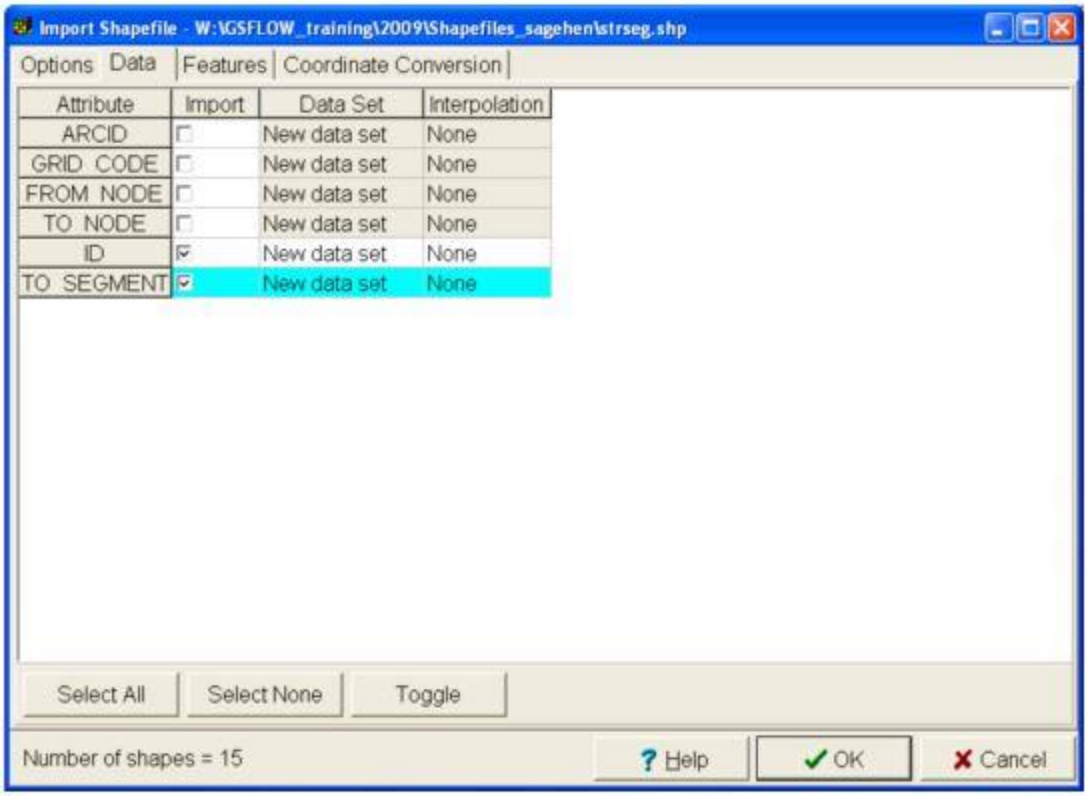
9. Select "Import Shapes as Separate Objects"

10. Select "set values of intersected cells"

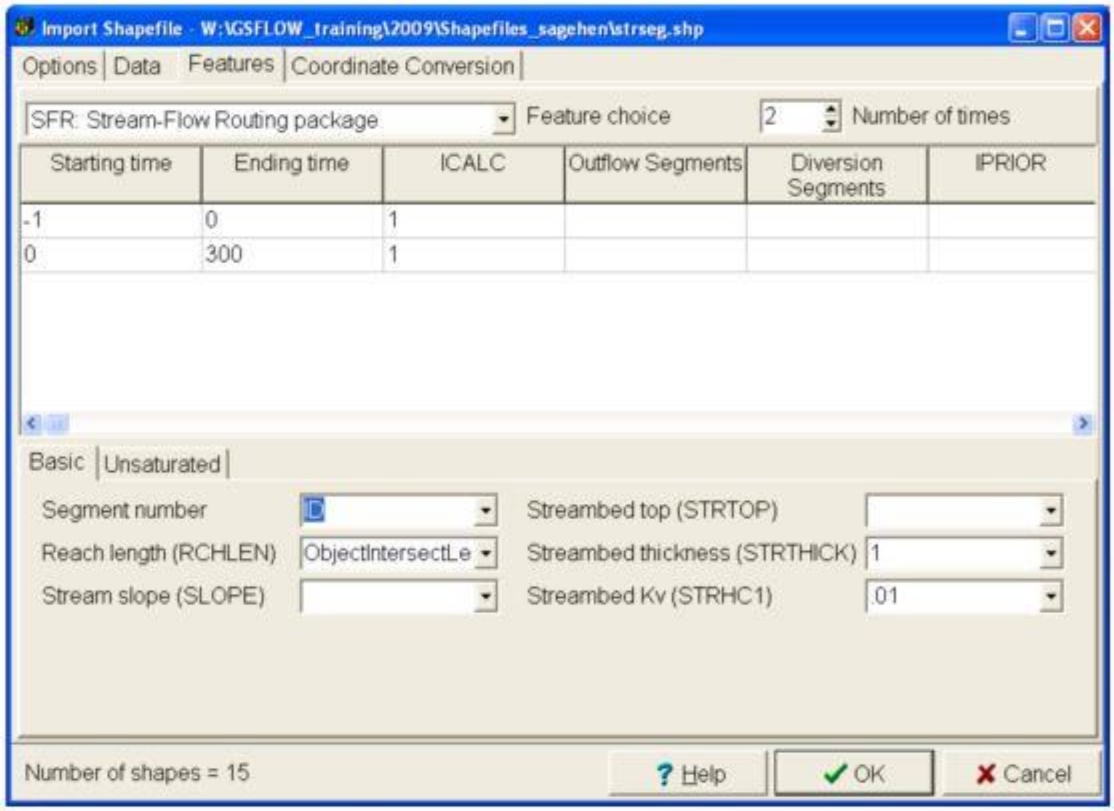


11. Select "Data" Tab

12. Add check mark to "ID"



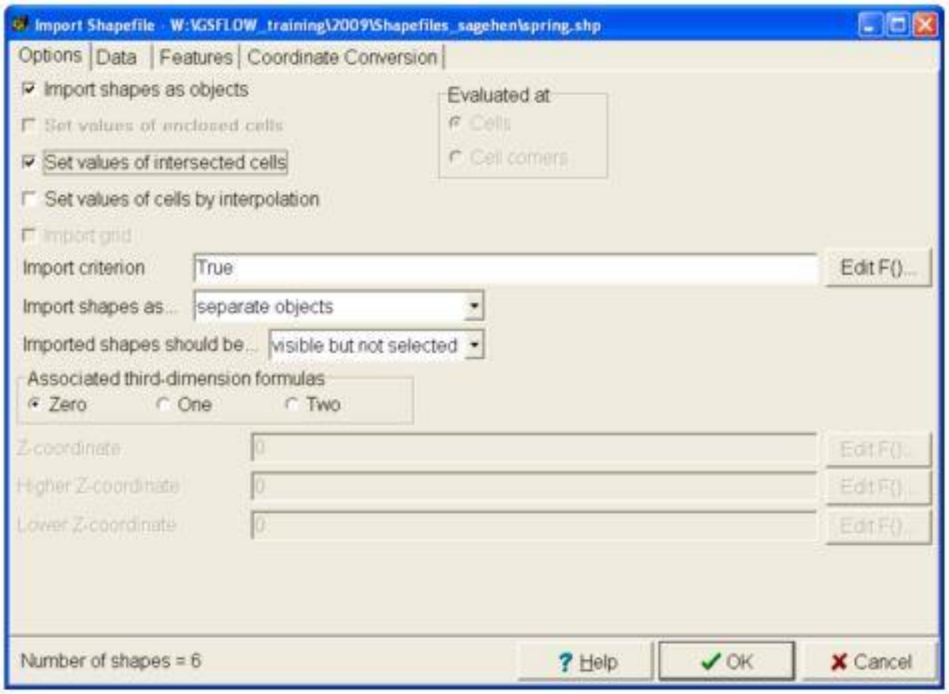
13. "Features" tab: Define segment #s time data and ICALC (scroll to right)



14. Import "spring.shp"

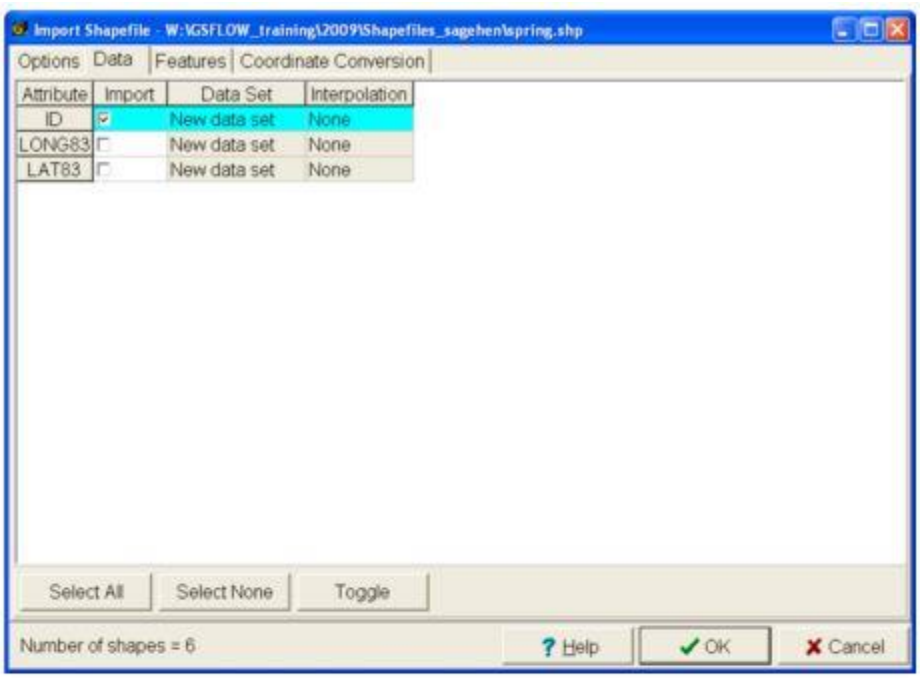
15. Check "Import Shapes as Objects"

16. Check "Set values to intersected cells"



17. Choose "Data" tab

18. Check "ID", which will become "ID2" because ID is already a data set.



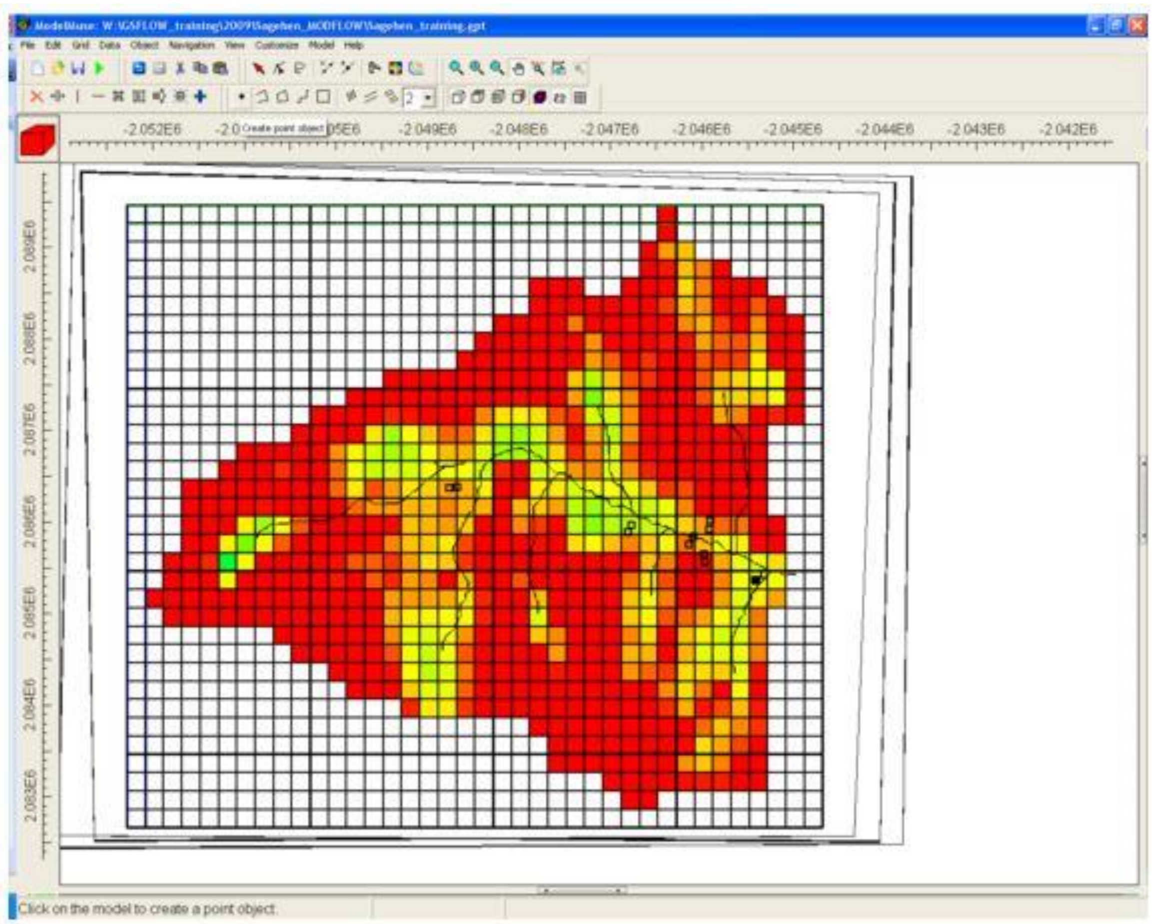
Create Point Objects for Cells with Springs

19. Select "Object|Select Object by Name"

20. Choose "Select none"

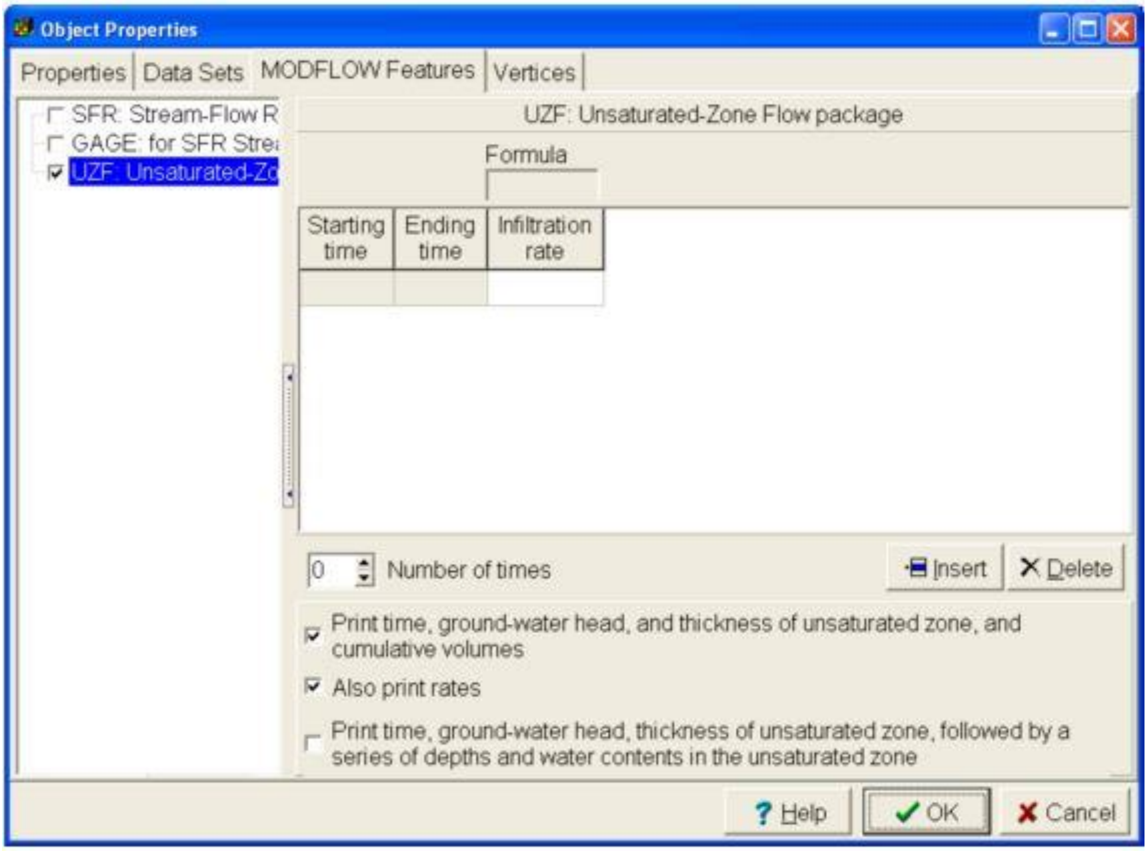
21. Select all spring objects

22. Select "Create Point Object"



23. Select each cell with a Springs in it.

24. Add check to UZF gages (Print volumes and rates)



Add Additional Springs not Mapped on Topo Map

25. Select "Create Point Object"

26. Select anywhere on map

27. Select "Vertices" tab, and enter in UTM coordinates shown below.

X, Y coordinates:

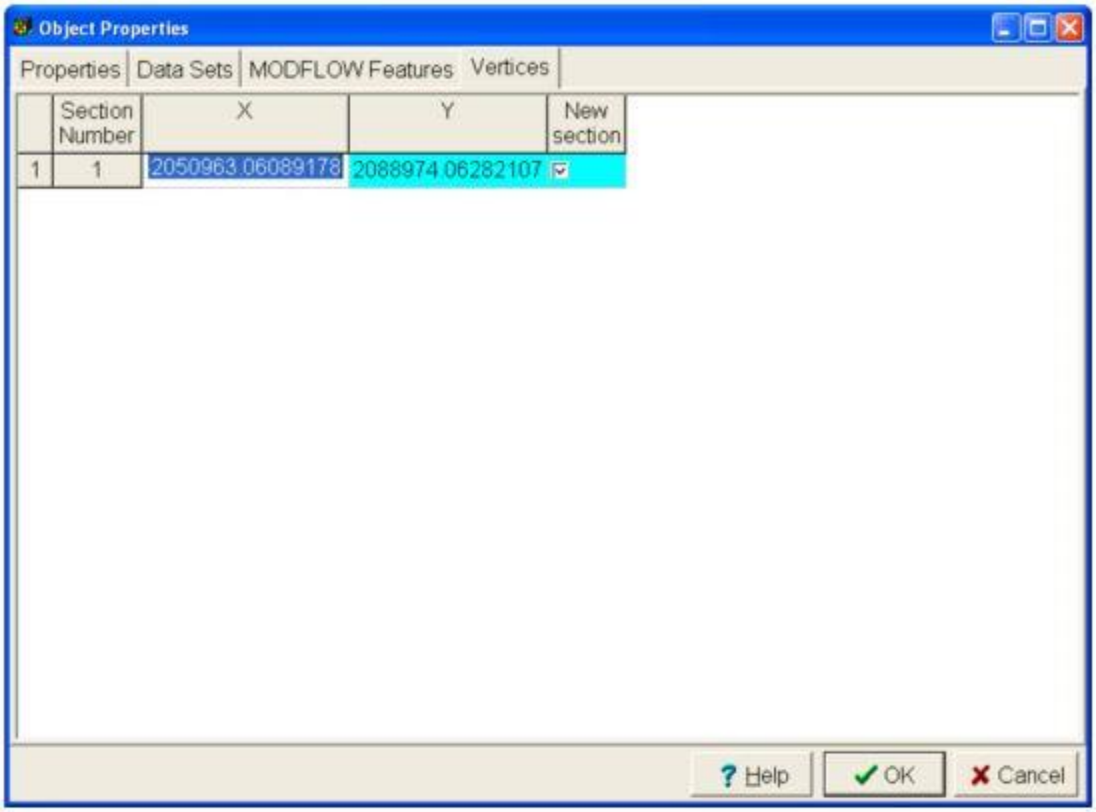
28. -2051196.10562, 2085539.7193 (Spring7)

29. -2049368.54429, 2086950.2532 (Spring8)

30. -2046167.2455, 2083356.4582 (Spring9)

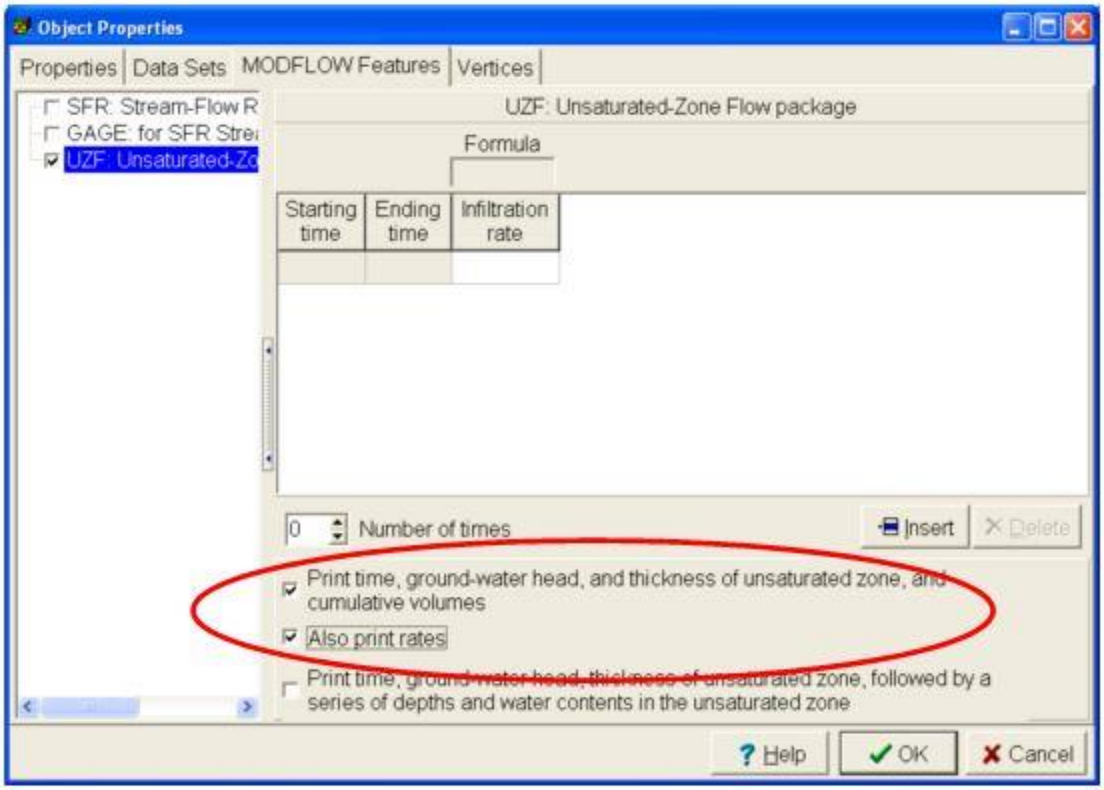
31. -2047553.2484, 2084533.9473 (Spring10)

Don't select "OK" yet. Goto "MODFLOW Features" tab



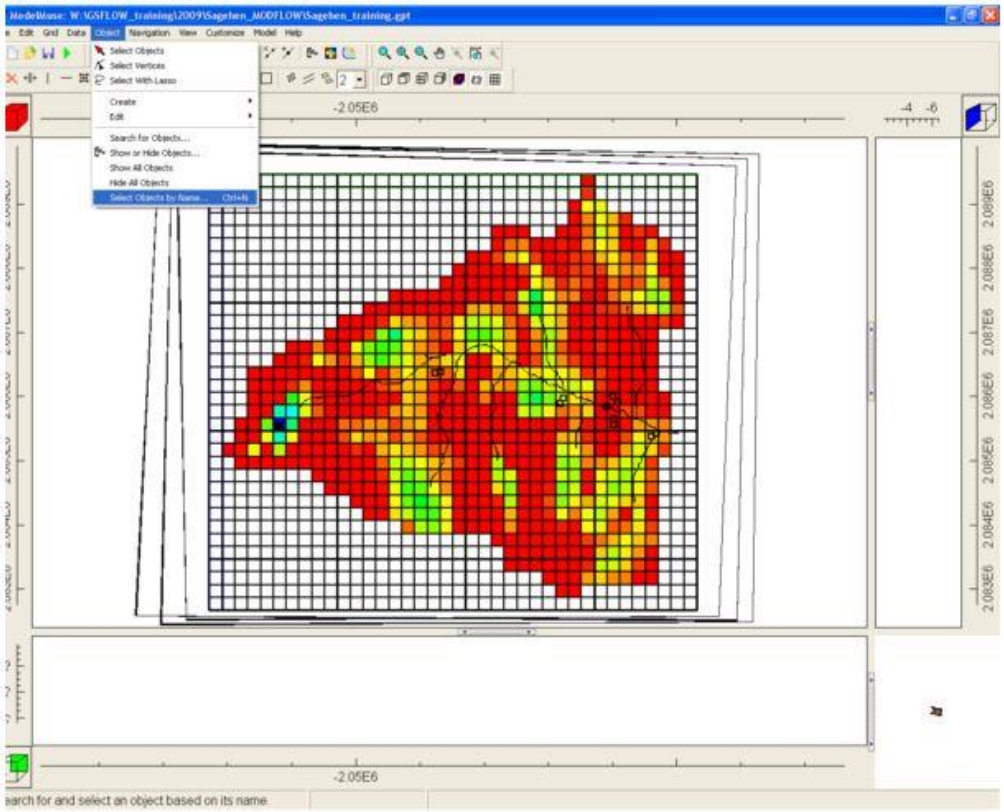
Create UZF gages for Added Springs

1. Select "MODFLOW Features" Tab
2. Select "UZF: Unsaturated Zone"
3. Add check to UZF gages (Print volumes and rates)



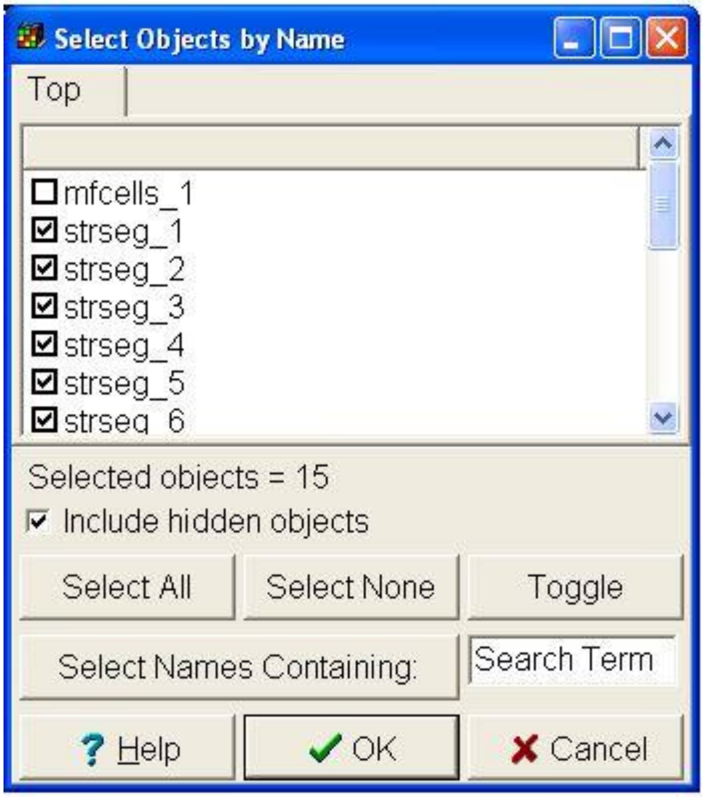
Set Stream Segment Information

1. Choose "Object|Select Objects by Name"



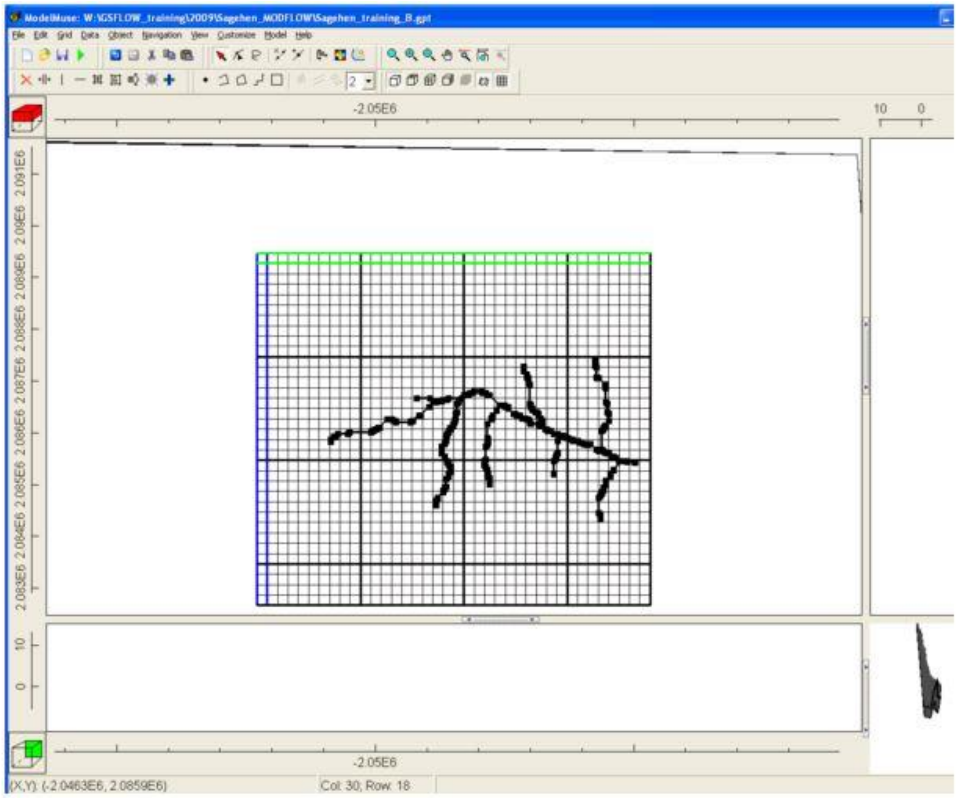
2. Click on "Select None"

3. Add check mark to all "strseg_" objects



4. Choose arrow selection tool

5. Double click on highlighted segments

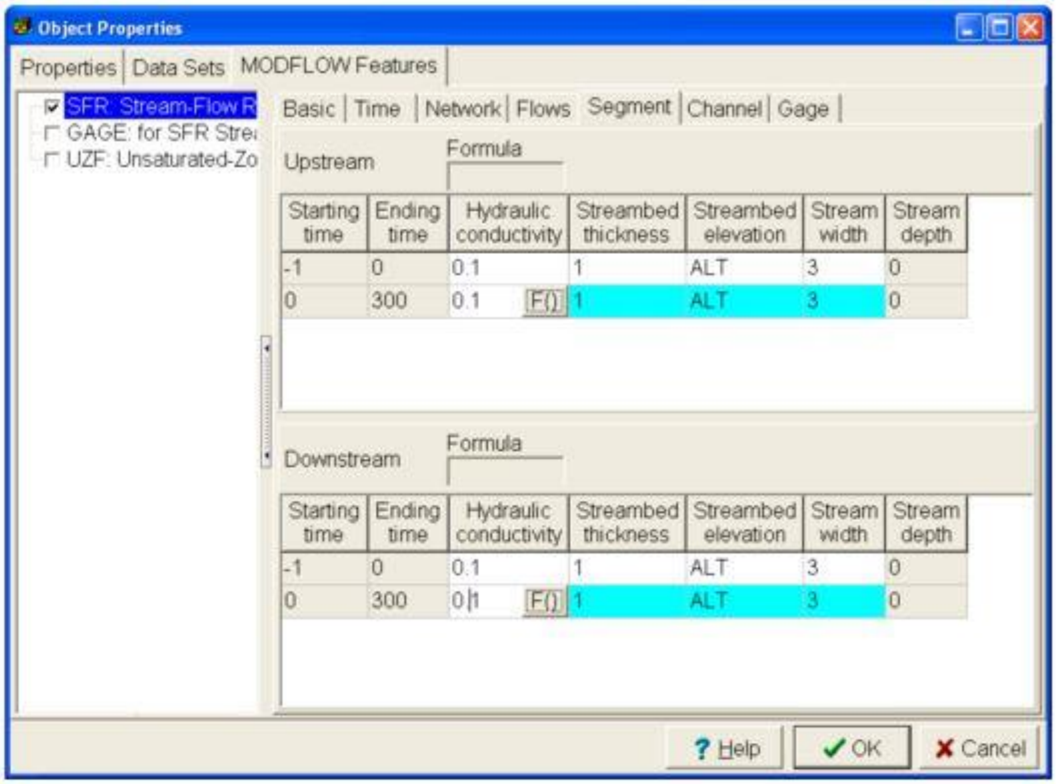


Specify Segment Information

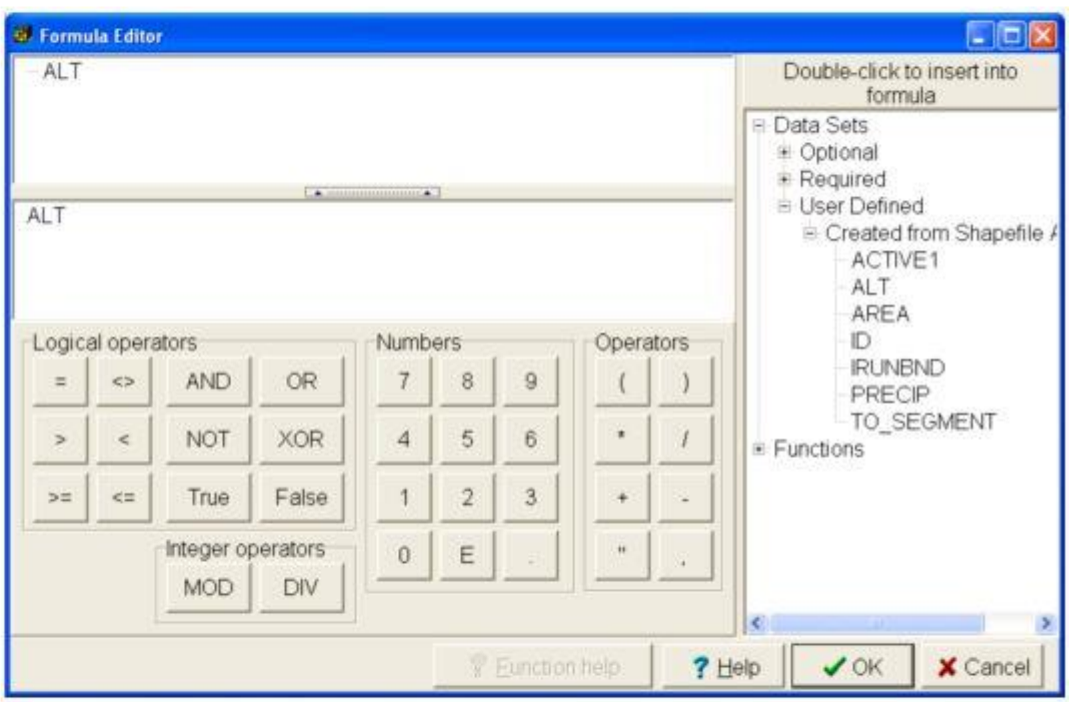
6. Select "MODFLOW Features" tab

7. Select "SFR: Streamflow Routing" Select on F() under "Streambed elevation"

8. Select "Segment" sub tab



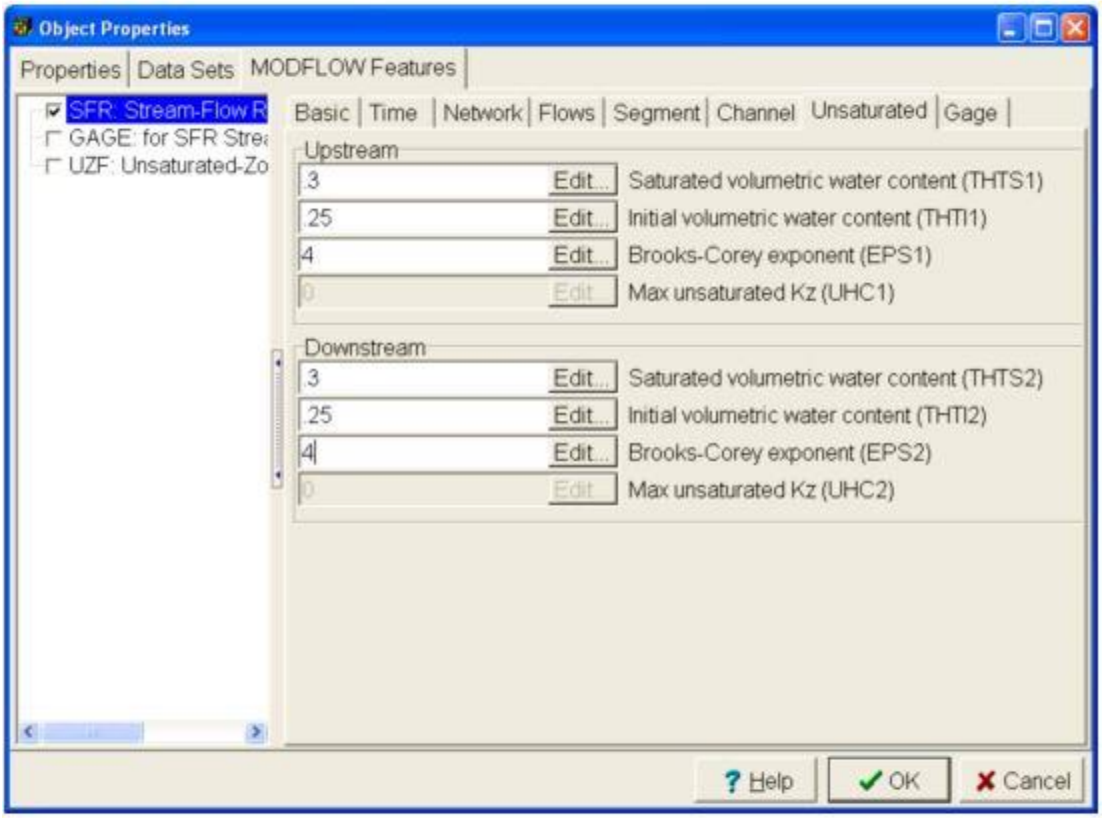
9. Set streambed Elevation with User defined "ALT" data set



10. Continue with: "Modflow Features" tab.

11. Select: "Unsaturated" sub tab and input values for unsaturated zone beneath streams

12. Select "OK"



Set Gage to last Reach in Outflow Segment

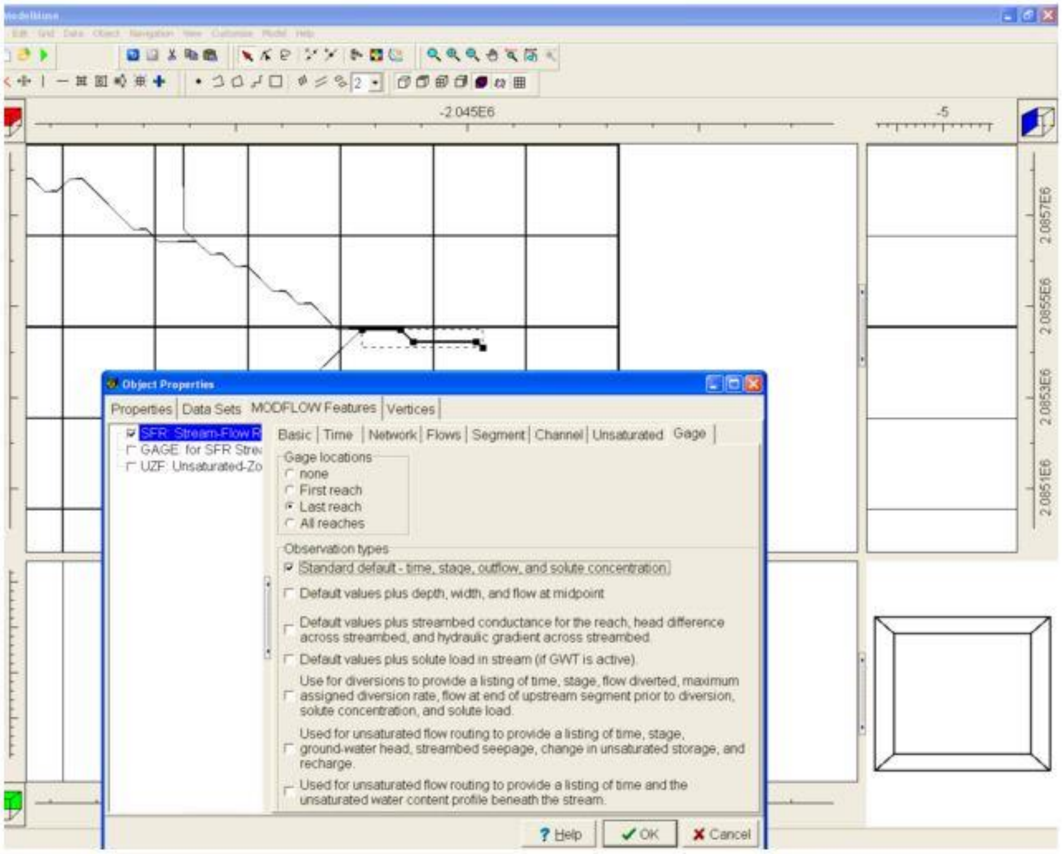
13. Use Selection arrow double click on last outflow segment

14. Choose "MODFLOW Features" tab

15. Click on "SFR: Streamflow Routing"

16. Select "Gage" sub tab

17. Add check mark for "Standard default" output



Set Hydraulic Conductivity for Aquifers

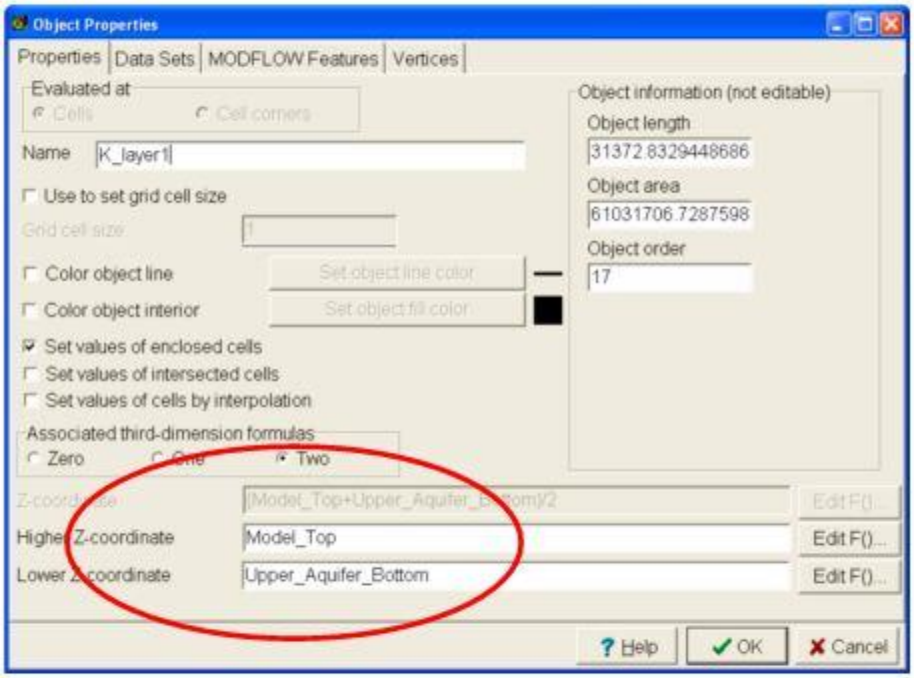
1. Select "Create Polygon Object"

2. Create Polygon containing all of model grid

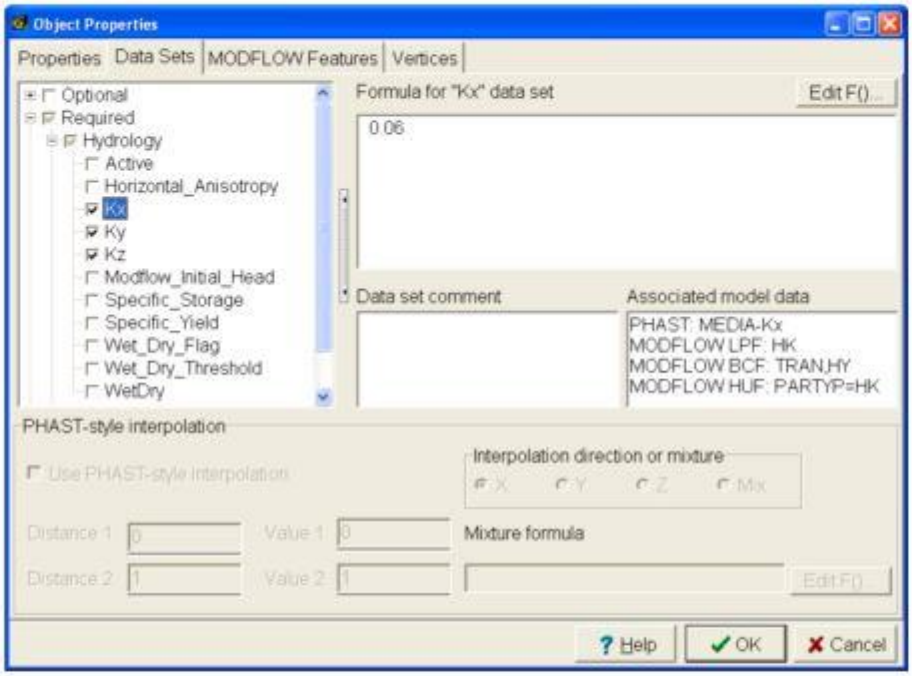
3. Double click new polygon

4. Name object "K_layer1"

Notice range for which object applies. This will be important for multi-layer models

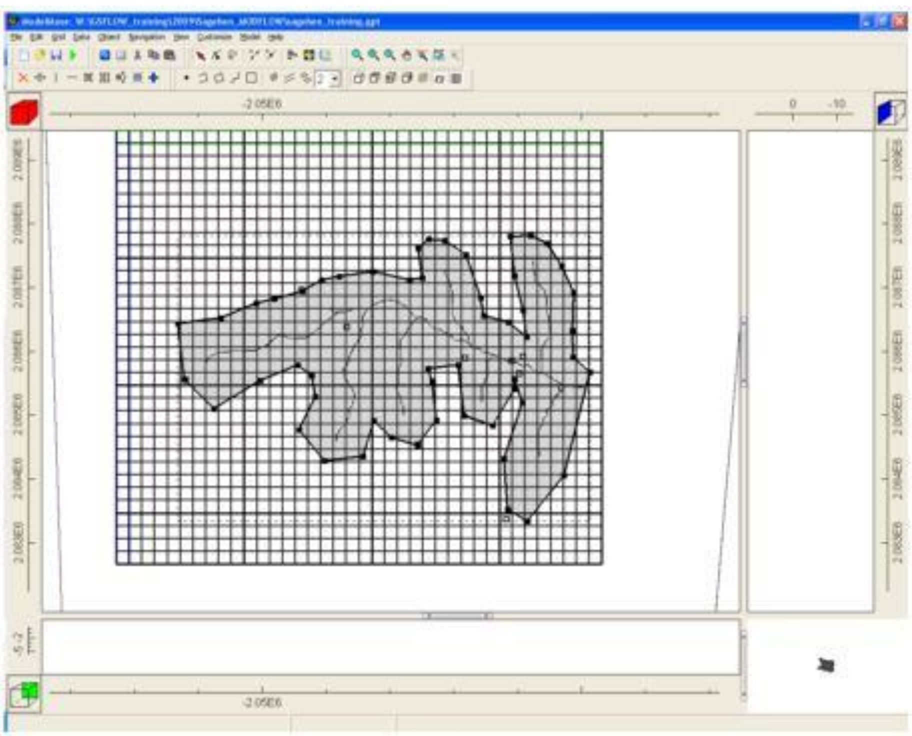


5. Select "Data Sets" tab
6. Choose "Required|Hydrology"
7. Add check to variable "Kx" and specify value of "0.06"
8. Add checks to "Ky" and "Kz" and set Kz= Kx / 2



9. Select "Create Polygon Object"

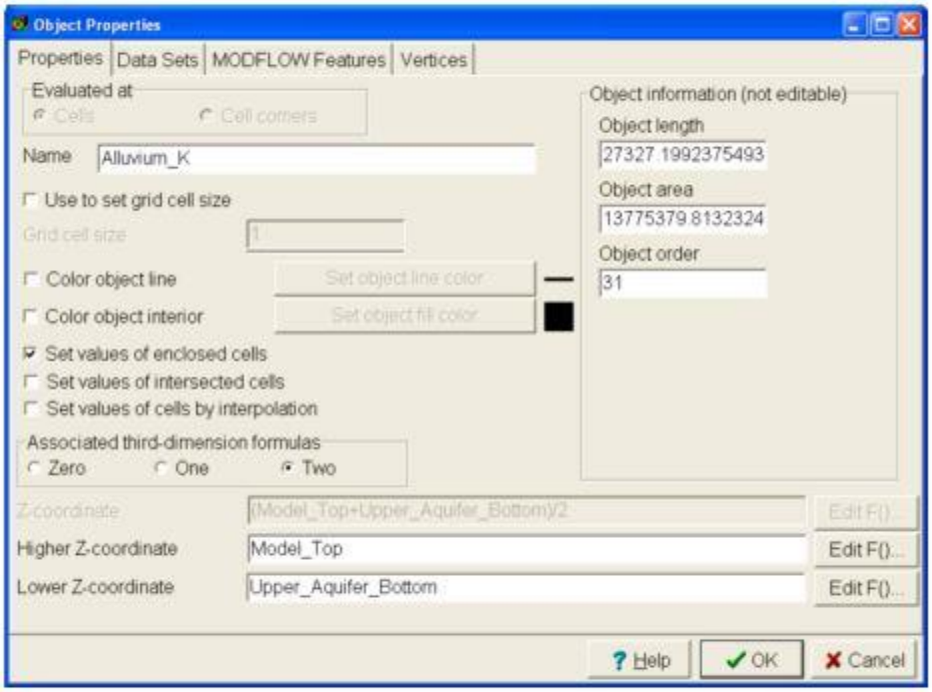
10. Create 2-3 cell buffer around streams



11. Select "Select Objects" arrow

12. Double click new polygon object

13. Name object "Alluvium_K"

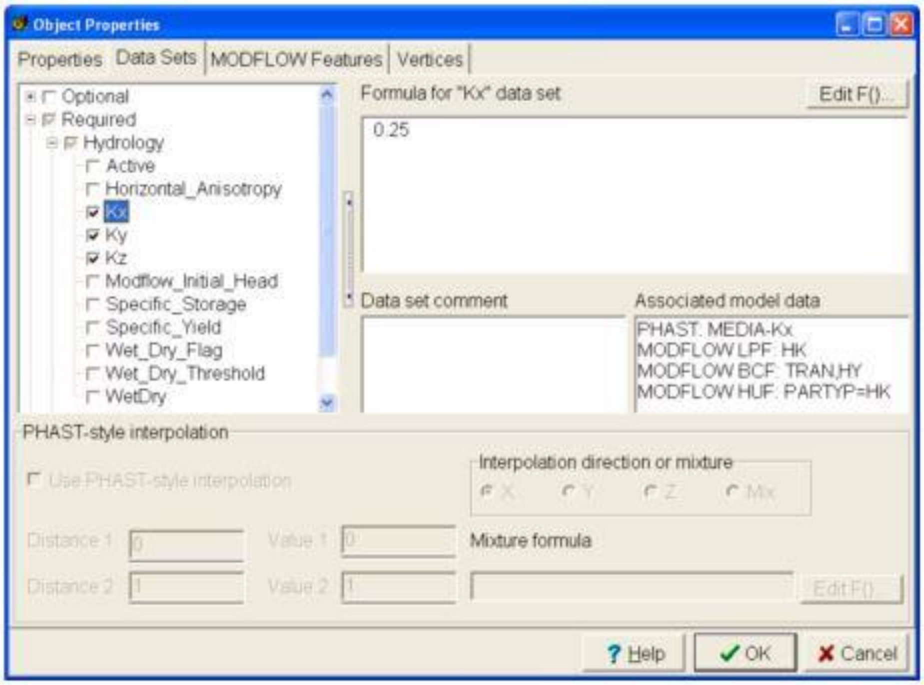


14. Select "Data Sets" tab

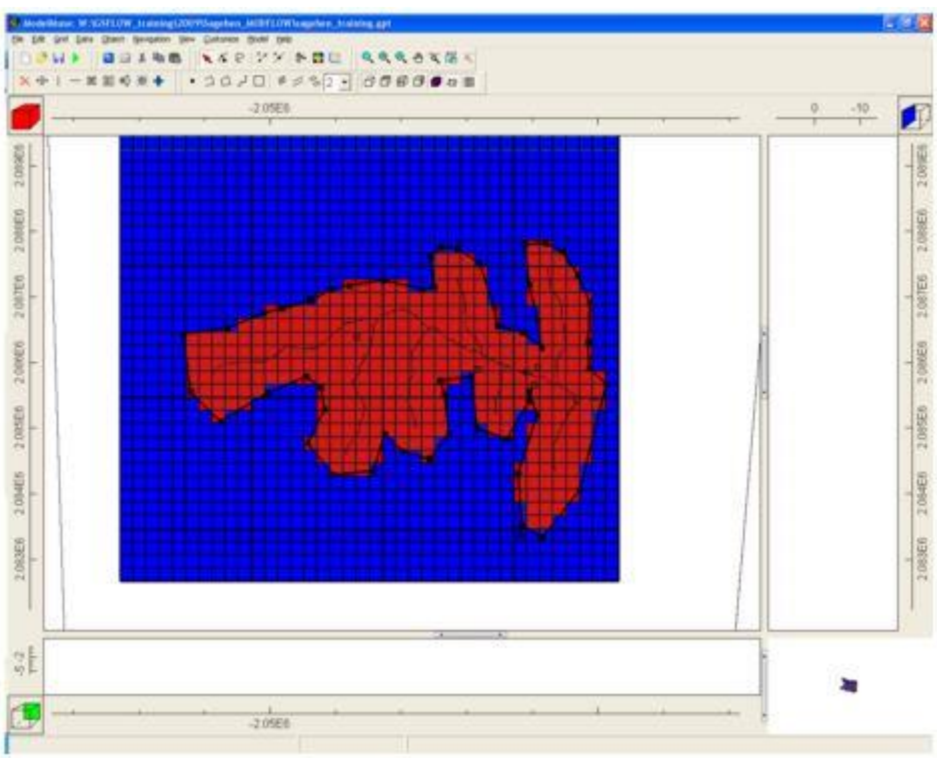
15. Click on "Required|Hydrology|Kx" and add check mark.

16. Type "0.25" in "Formula for "Kx" data set

17. Add check mark to "Ky" and "Kz" and set Kz= Kx / 5

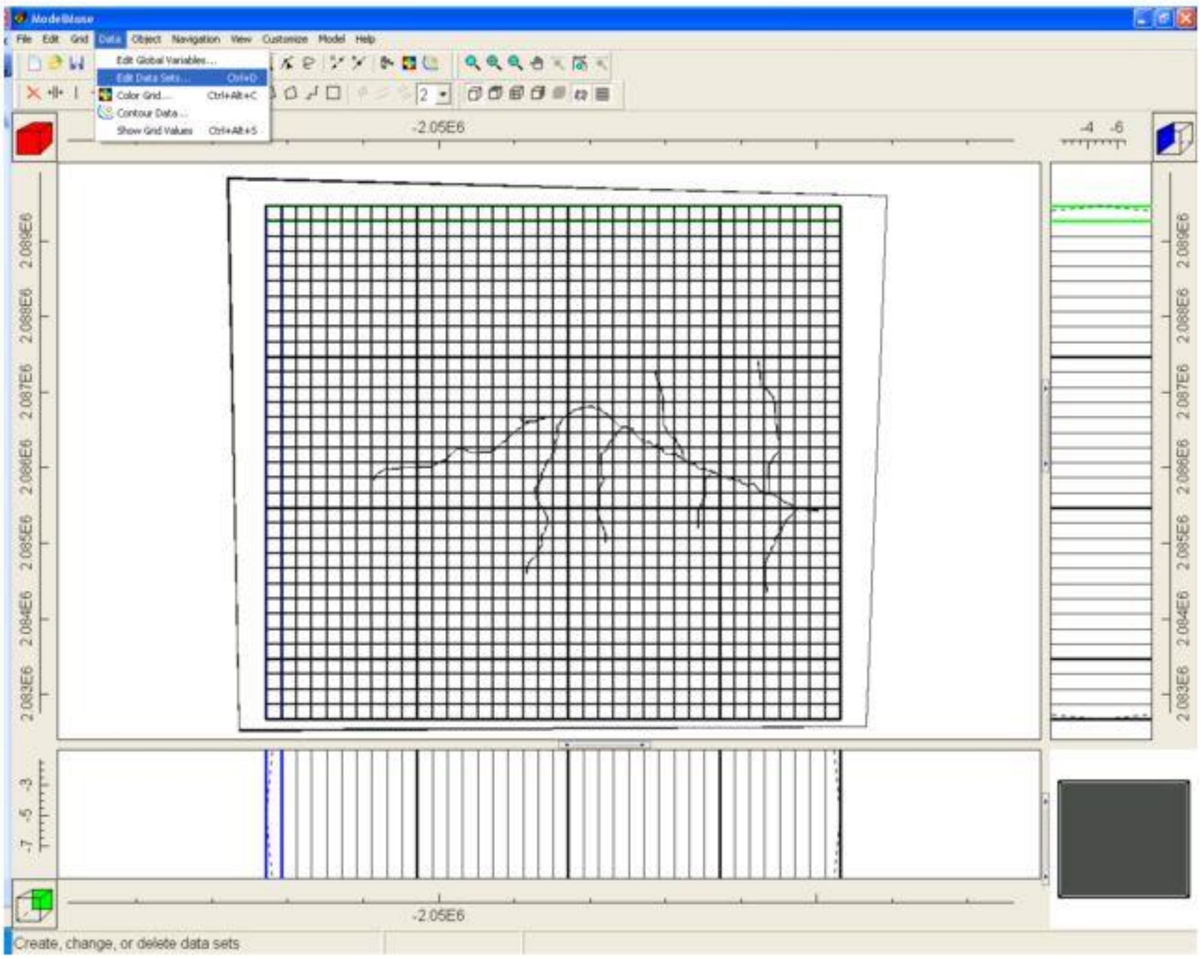


18. Use "Color grid" to verify Kx

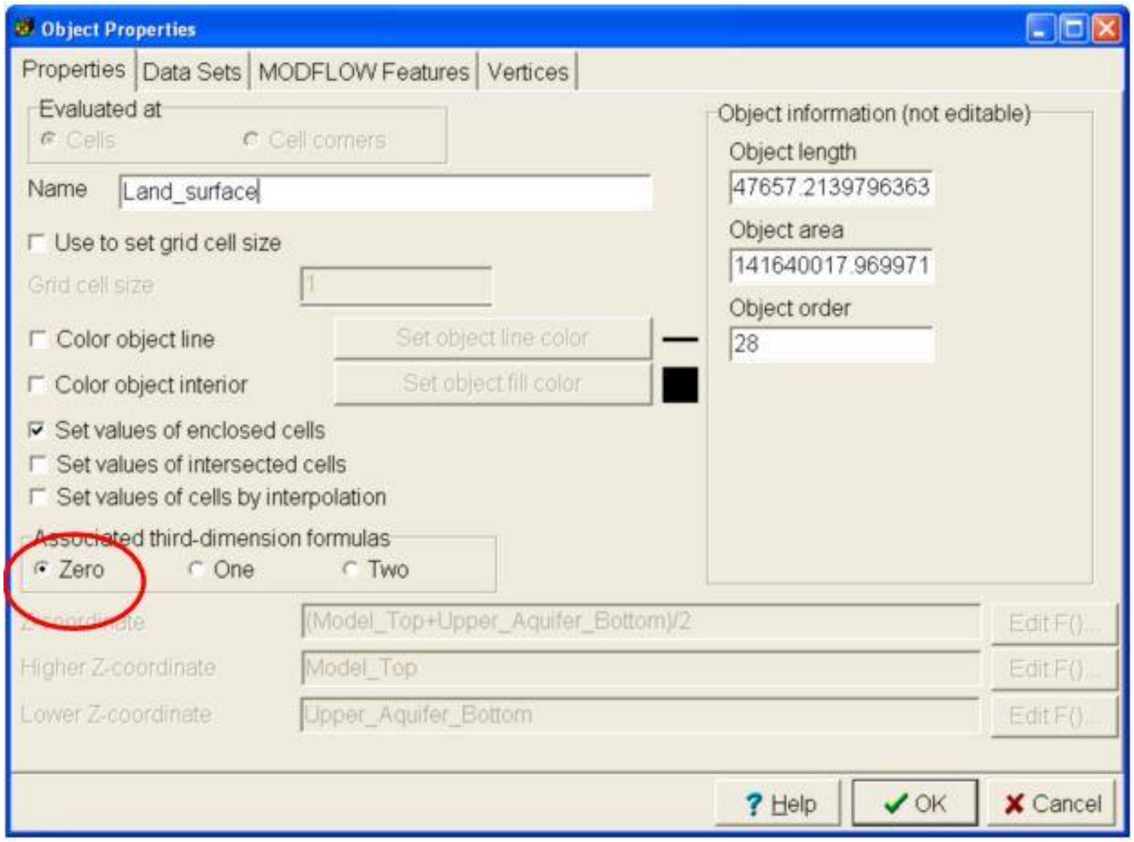


Set Layer Top and Bottom Altitudes

1. Choose "Create Polygon Object"
2. Put polygon around model grid
3. Double click selected polygon



The associated third-dimension formulas should be set to "zero"

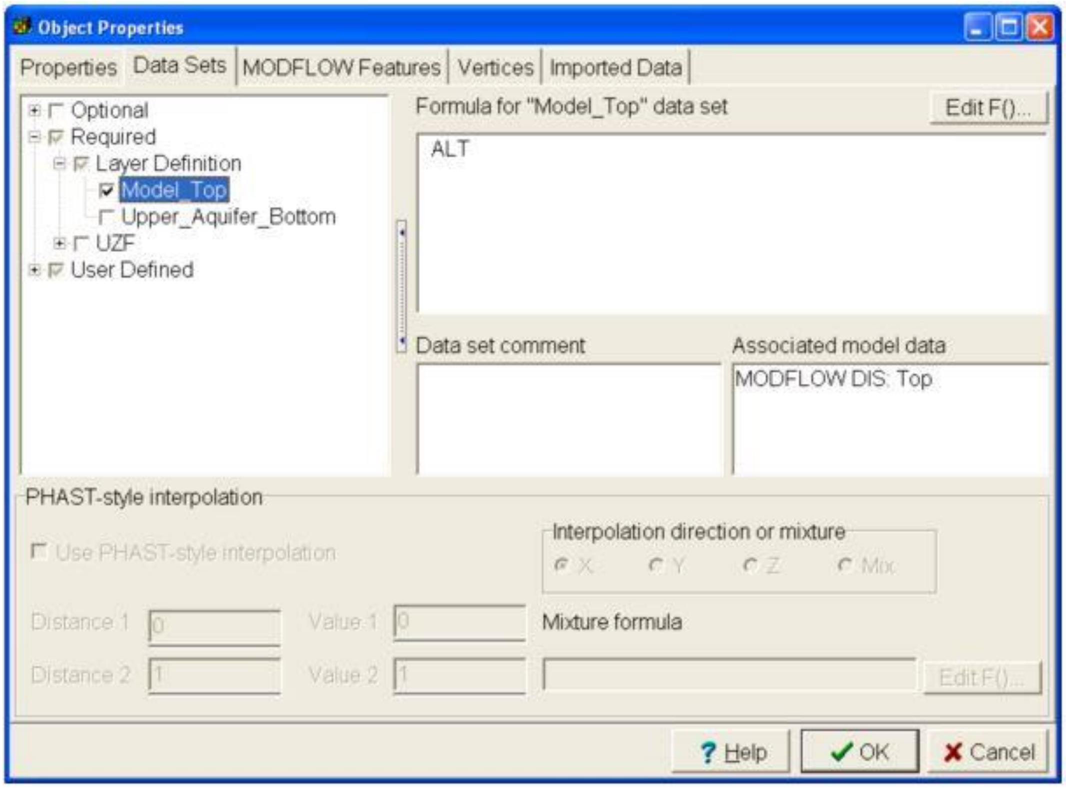


4. Select "Data Sets" tab

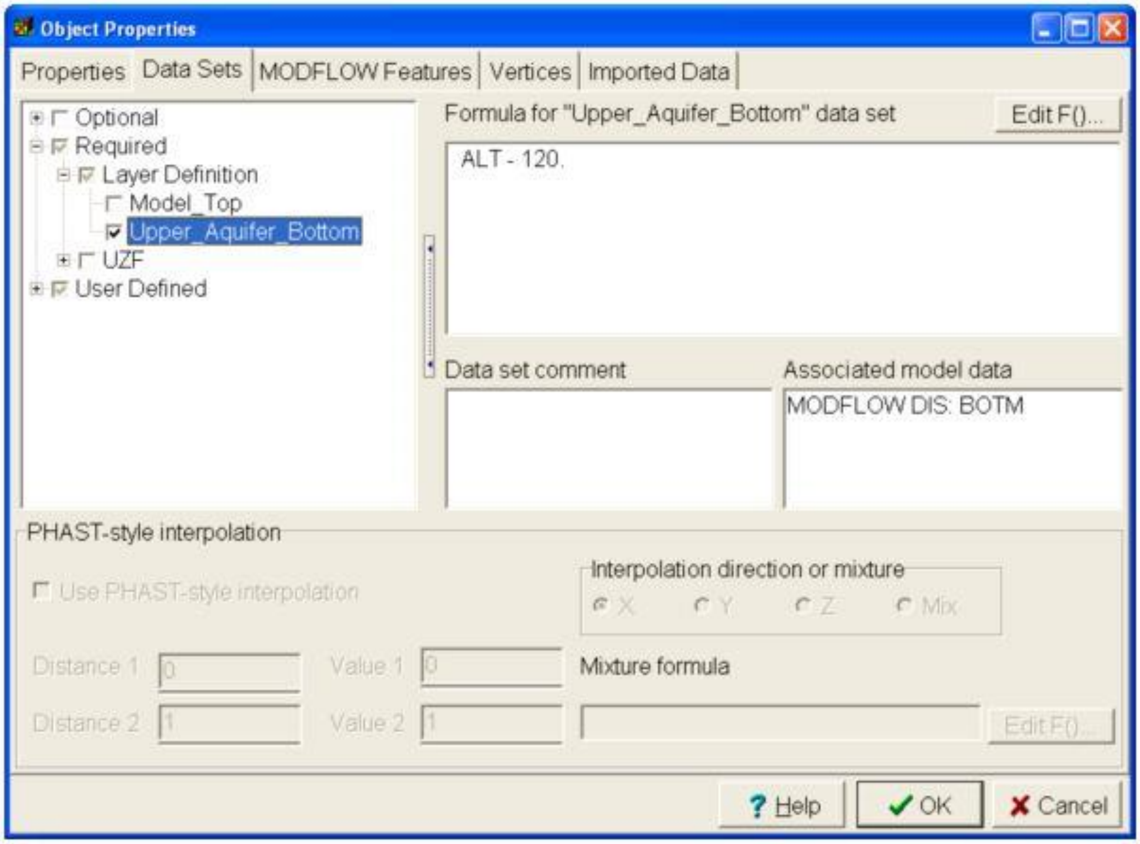
5. Select "Required|Layer Definition"

6. Select "Model_Top" and click on "Edit formula"

7. Choose "User Defined| Created from Shapefile" and double click "ALT"

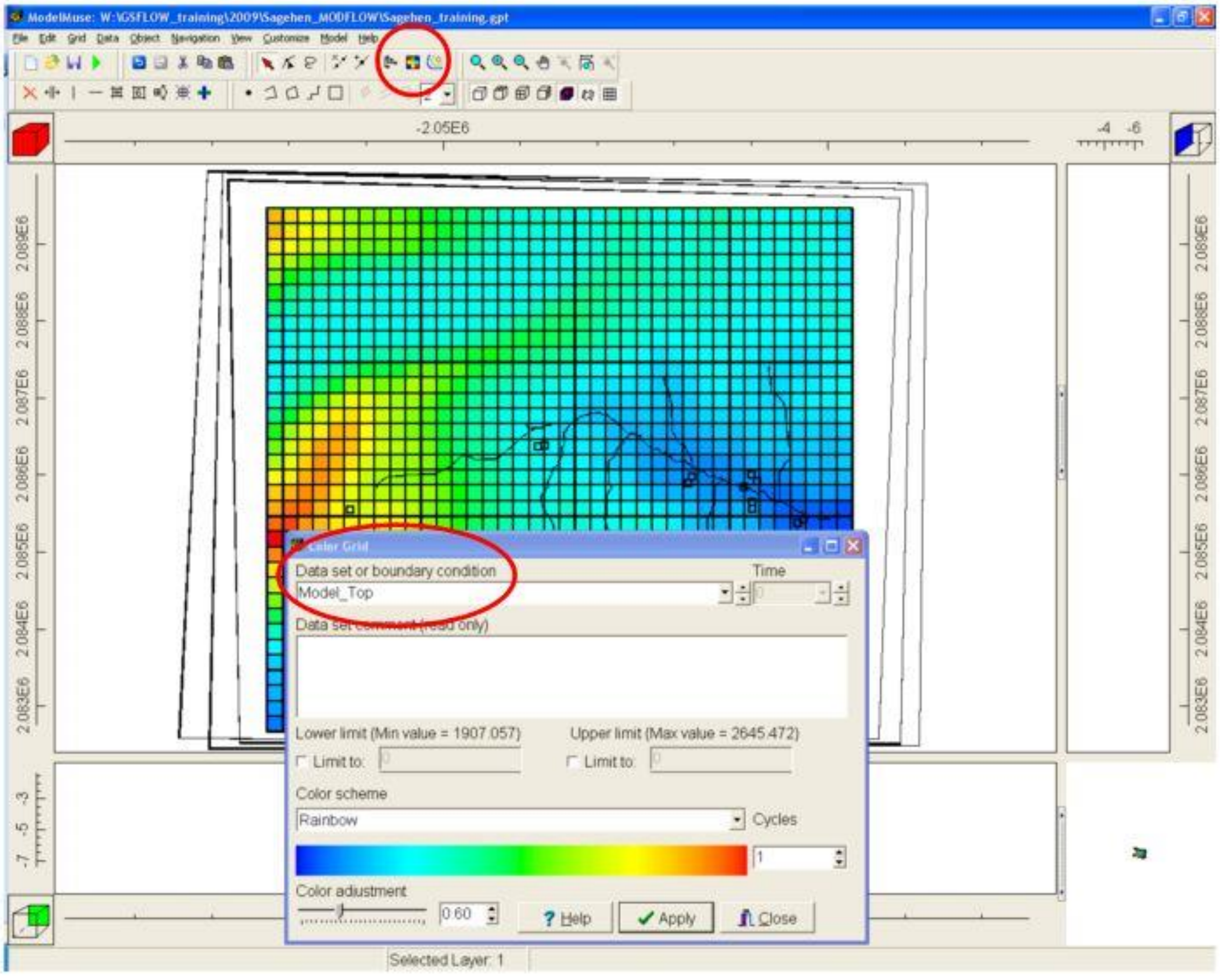


8. Repeat for "Upper_aquifer_bottom" Set to ALT-120



Check Layer Altitudes

9. Select "Color Grid"
10. Choose "Data Sets|Requied|Layer definition|Model Top"
11. Select "Apply"



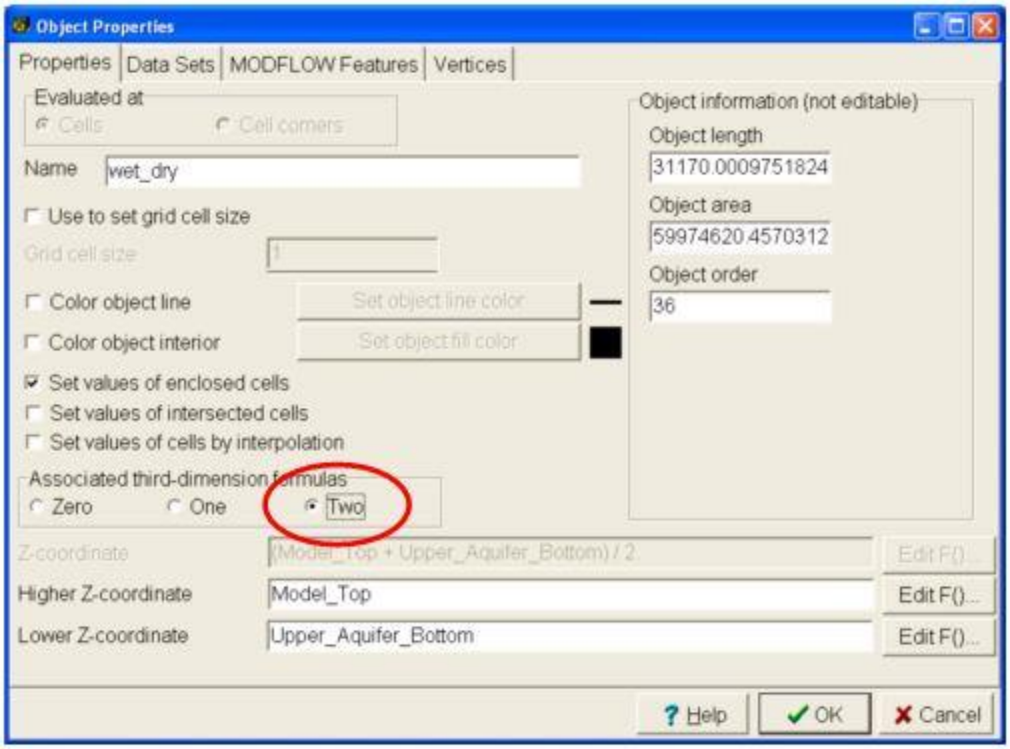
Set Wet_Dry Data

12. Choose "Create Polygon Object"

13. Put polygon around model grid

14. Double click selected polygon

15. Set associated third-dimension formulas to "Two"

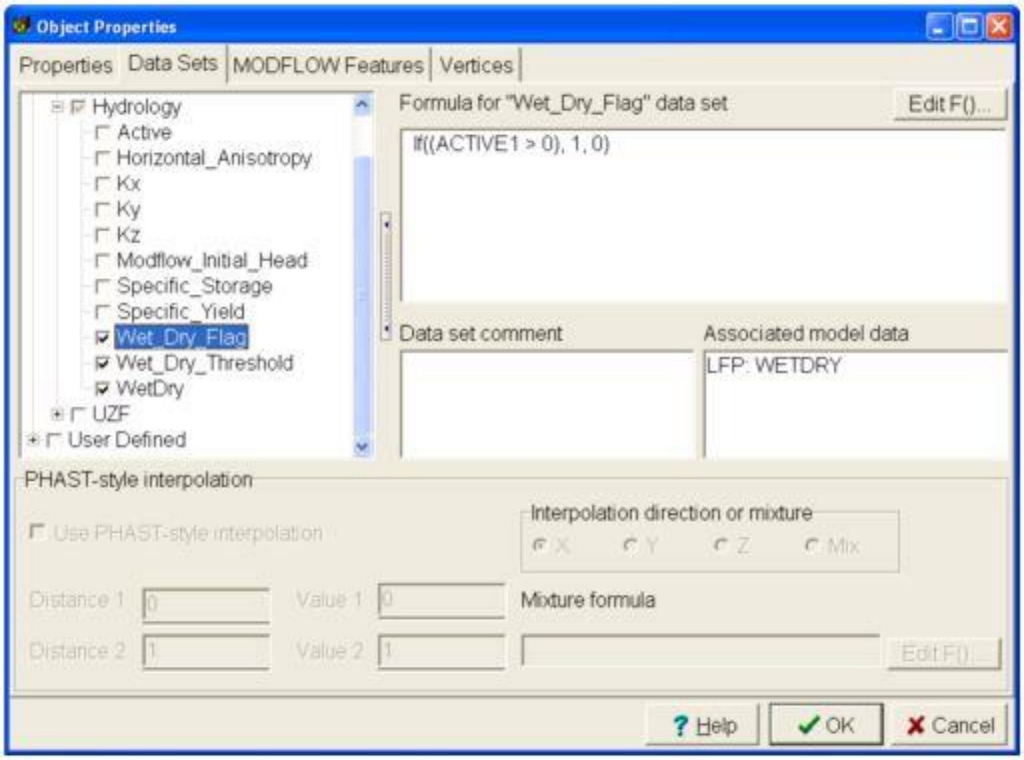


16. Choose "Data sets" tab

17. Choose "Required|Hydrology|Wet_Dry_Flag"

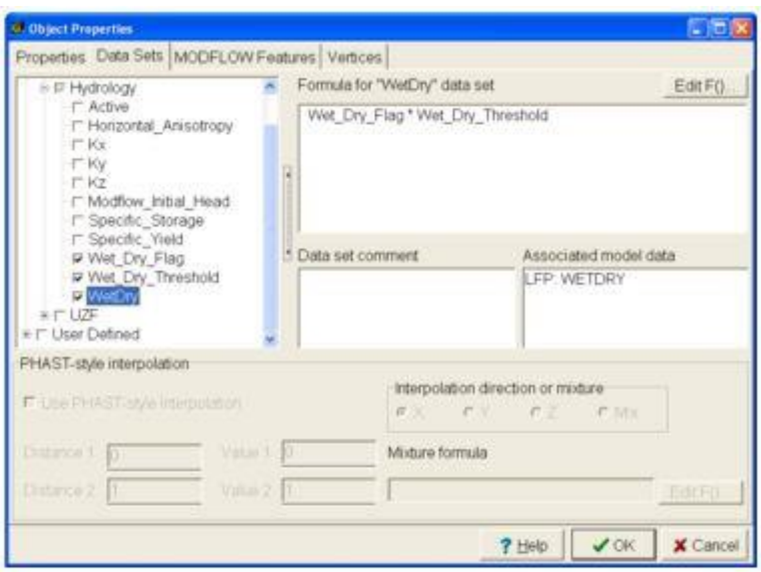
18. Click on "Edit formula"

19. Type if((ACTIVE1>0),1,0)



20. Set Wet_Dry_Threshold=0.01

21. Set Wet_Dry =Wet_Dry_Flag*Wet_Dry_Threshold



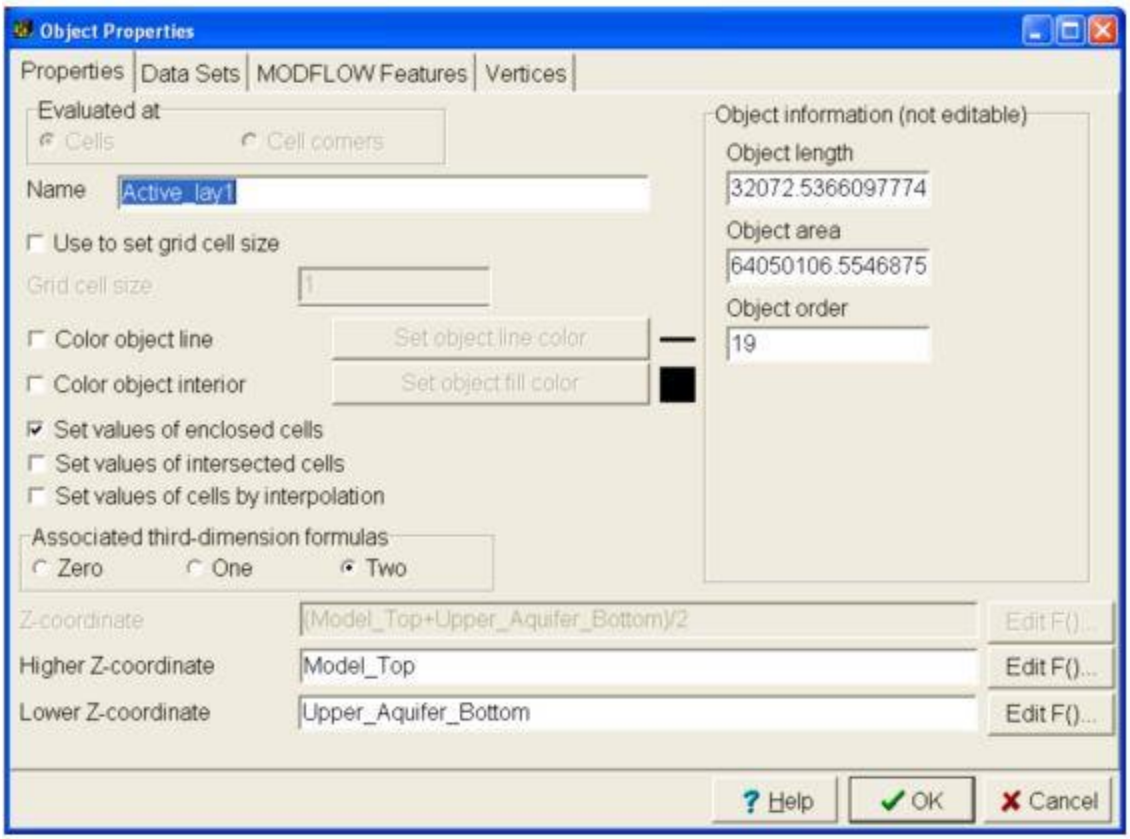
Set Active Cells

1. Select "Create polygon object" tool

2. Put polygon around model grid

3. Double click on selected object

4. In "Properties tab" Name object "Active_lay1"



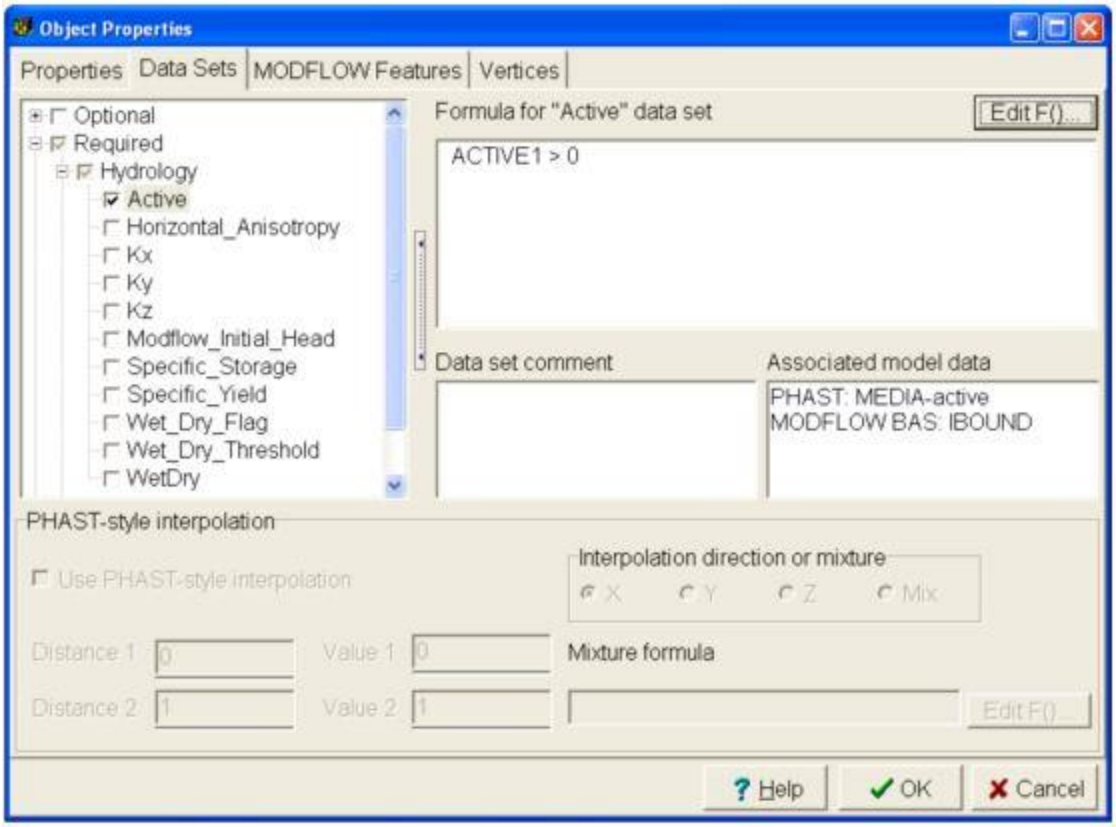
5. Select "Data Sets" tab

6. Choose (with check mark) "Required|Hyrology|Active"

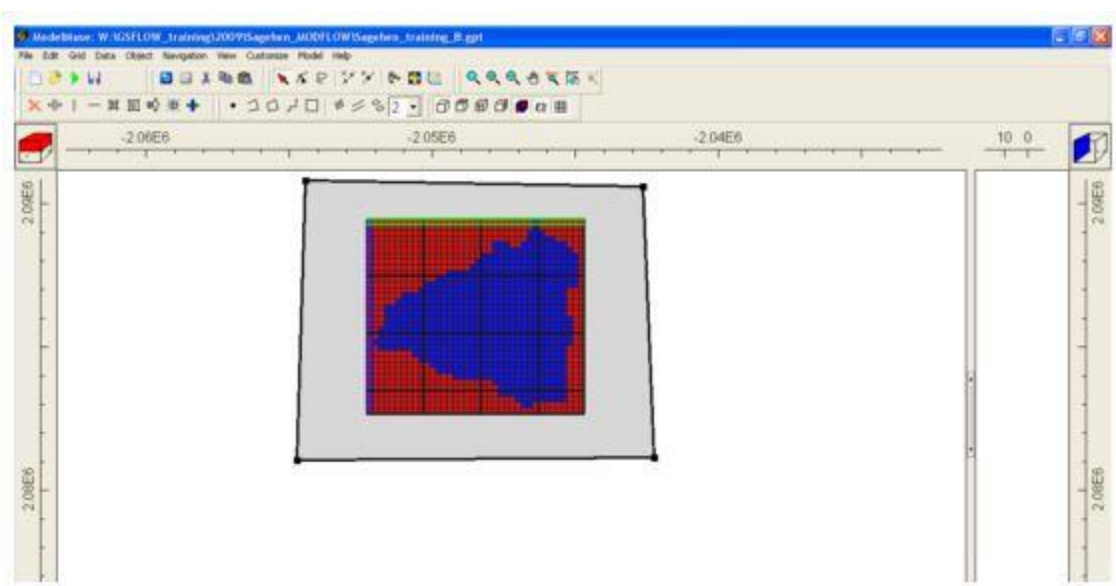
7. Select Edit F()

8. Choose "User Defined| Created from Shapefile" and double click on "ACTIVE1"

9. Type ">0" so formula reads "ACTIVE1>0"



Use "Color Grid" again to check that IBOUND was set correctly



Set All other Cell Property Data

Layer 1

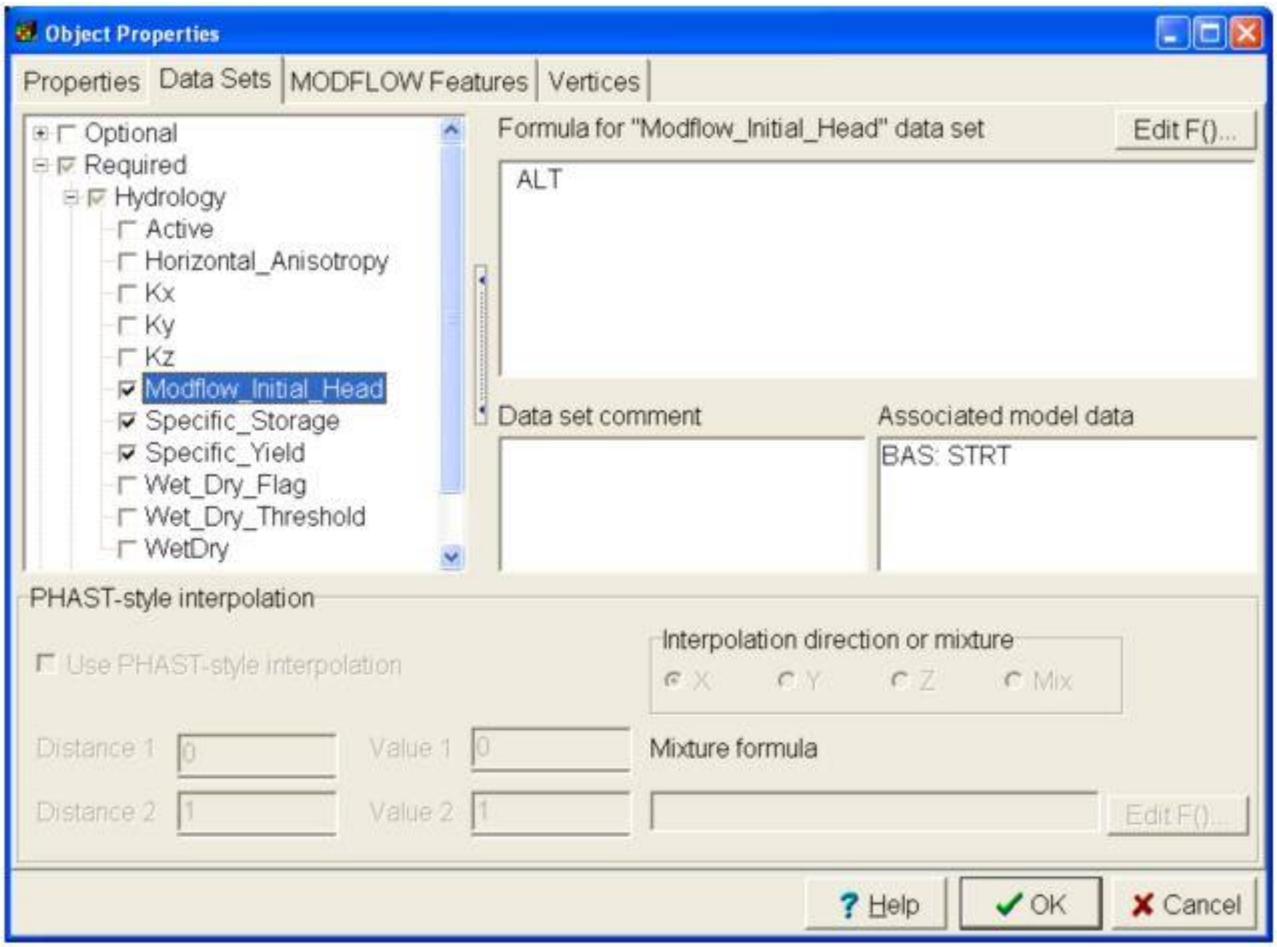
1. Select "Data Sets" tab
2. Select "Create Polygon Object"
3. Put polygon around model grid
4. Double click polygon
5. Name object "All_other_properties"

6. Select "Data Sets" tab
7. Choose "Required|Hydrology|MODFLOW_Initial_Head"

8. Type: "ALT"

9. Add check to "Specific_Storage" and use default values

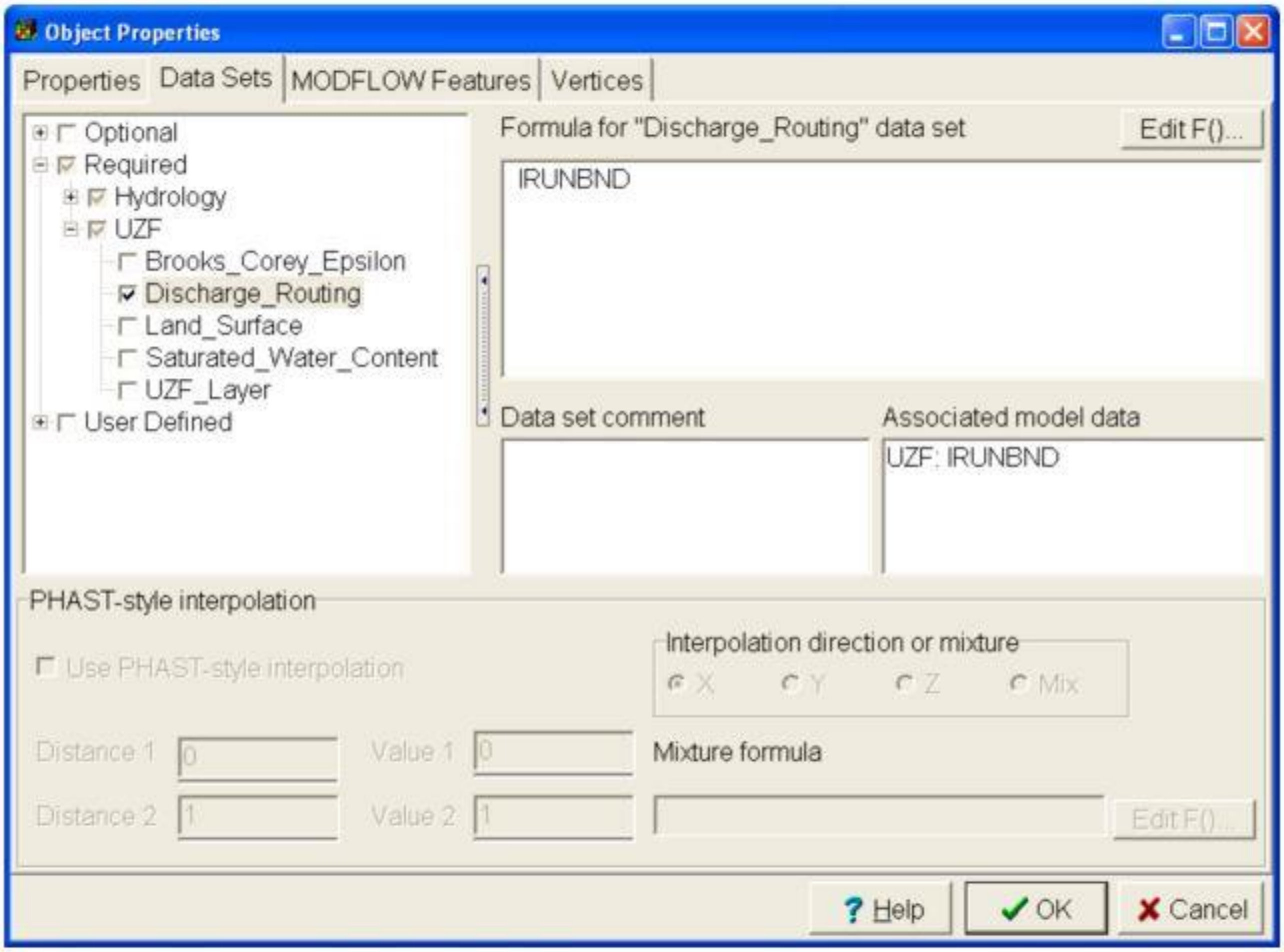
10. Add check to "Specific_Yield" and use default value



11. Add check to "UZF" and select "Discharge_Routing"

12. Type "IRUNBND"

Don't choose OK YET!



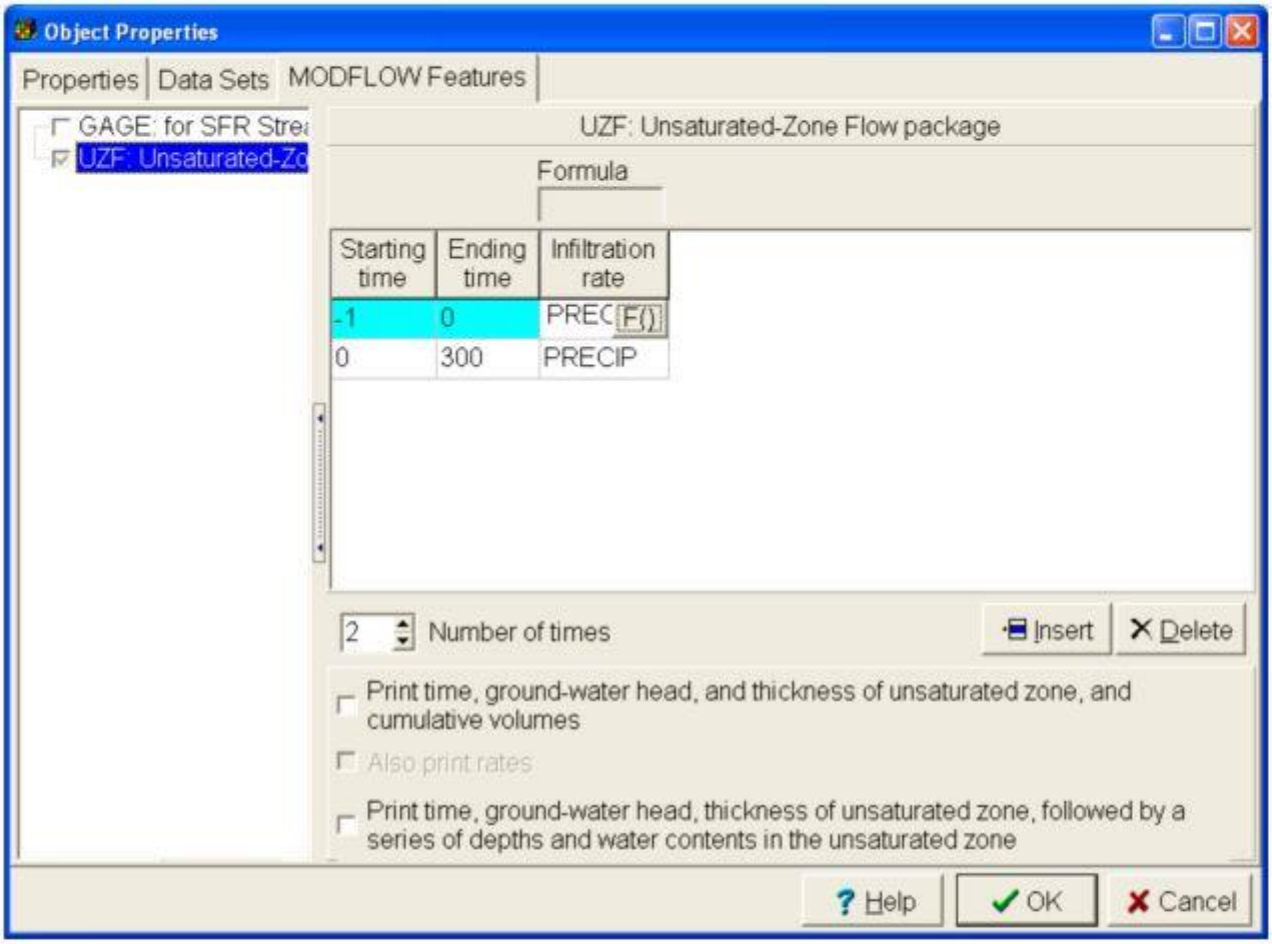
13. Choose "MODFLOW Features"

14. Add check to "UZF: Unsaturated-Zone Flow"

15. Increase "Number of times" to 2

16. Set "Infiltration rate" to "PRECIP*0.55" for both times

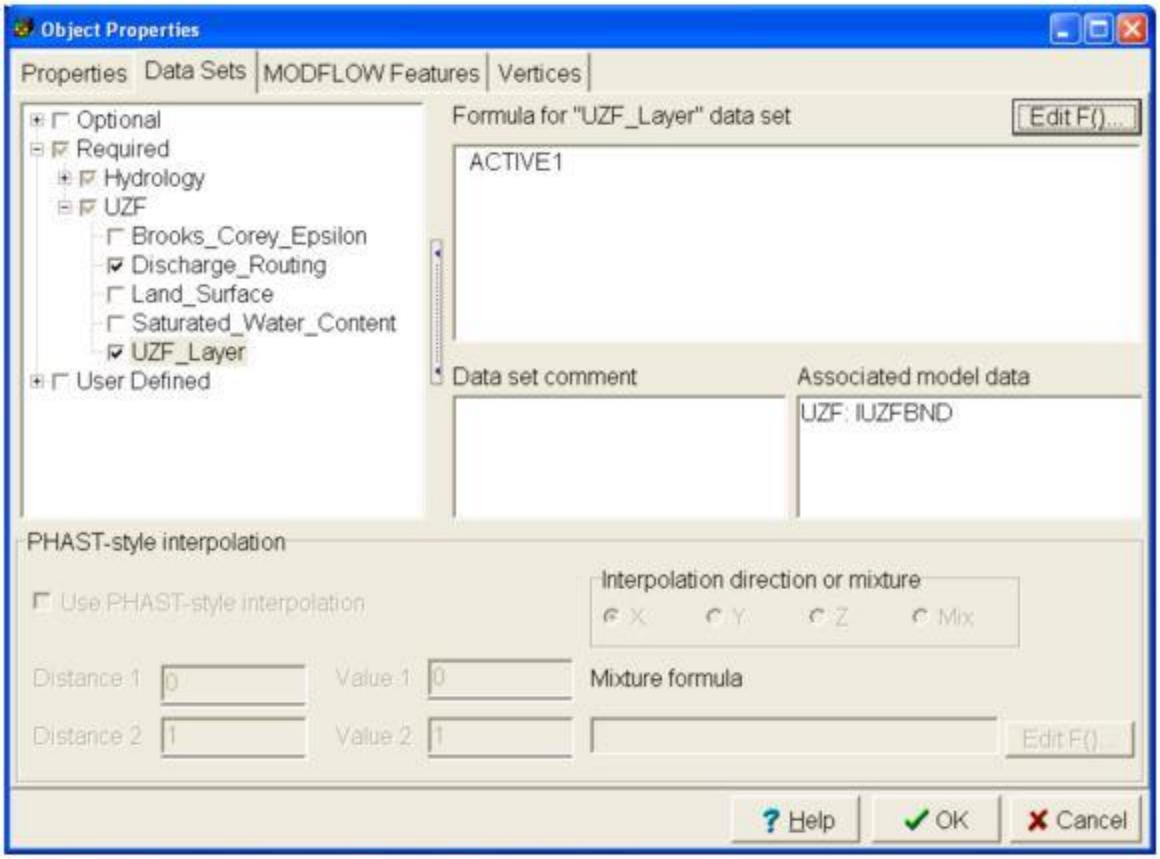
Don't choose OK YET!



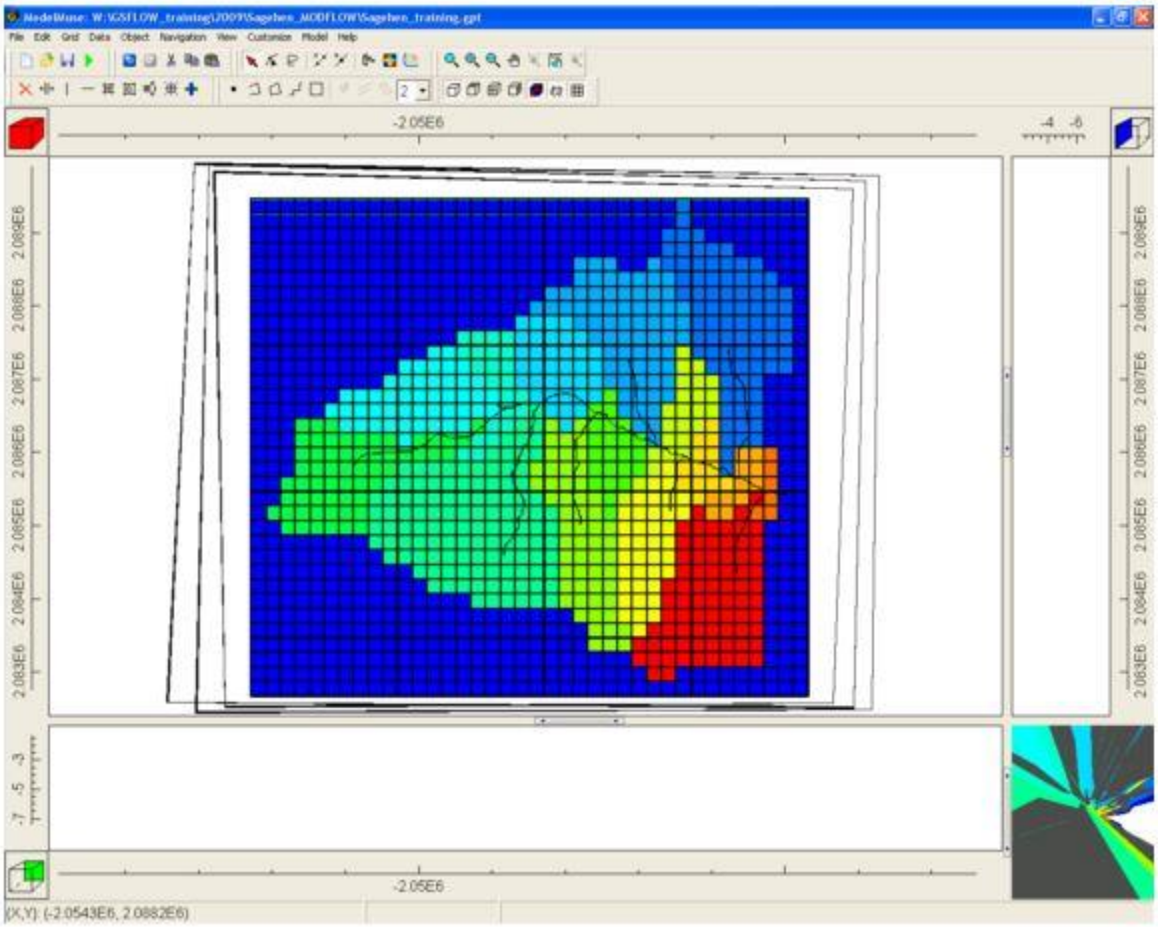
Set IUZFBND for UZF

17. Select "Data Sets" tab
18. Choose "Required|UZF|UZF_Layer"
19. Type in "ACTIVE1" in to "Formula for UZF_Layer" data set
20. Choose "OK"

Note: The other option would be to set "UZF_Layer" to imported data set "ALT" and ModelMuse will determine which layer for each column is the land surface cell.



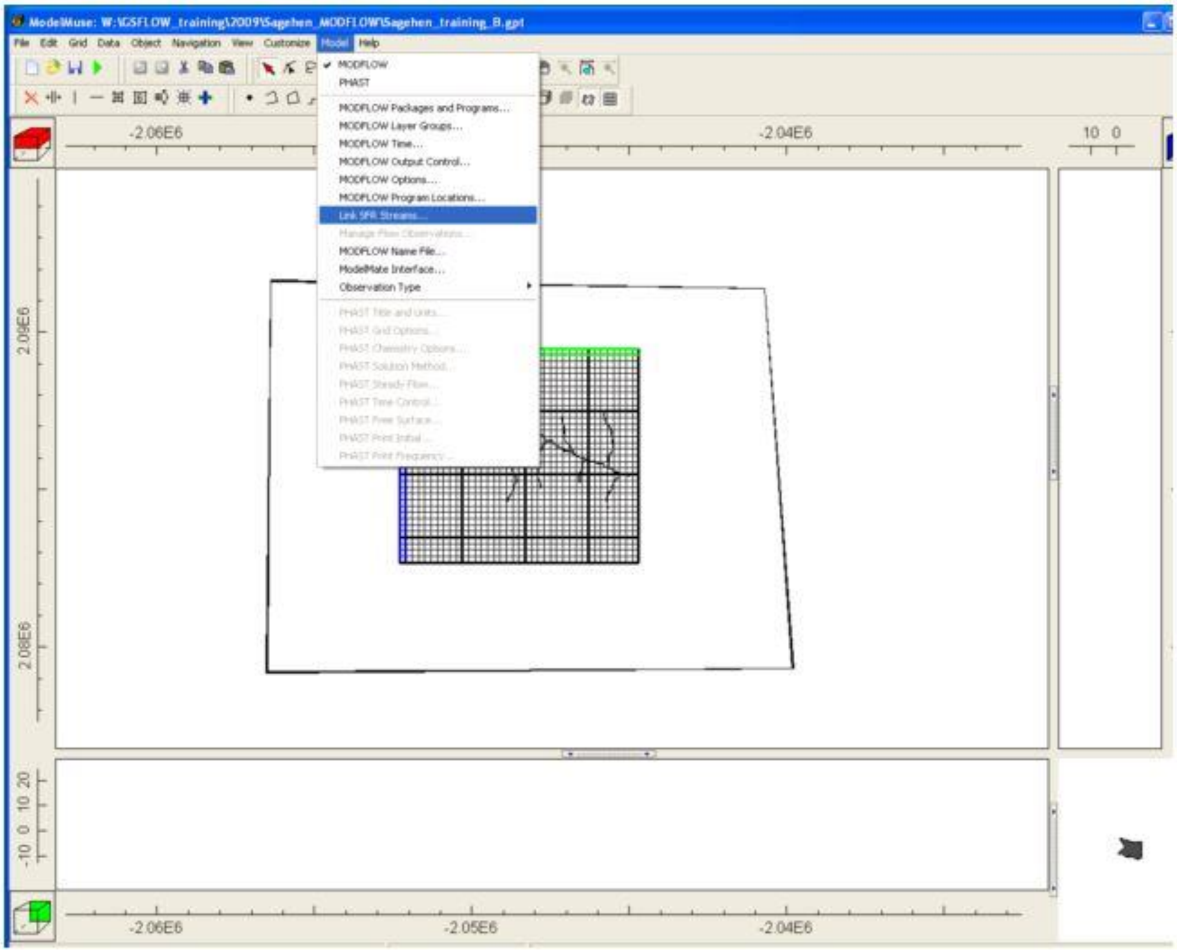
Use Color Grid to check that IRUNBND was set correctly



Link Outflow Segments

1. This determines the outflow segment for each segment.

2. Choose "All streams"


ModelMuse: W:\GSFLOW_training\2009\Sagehen_MODFLOW\Sagehen_training_8.gpt
File Edit Grid Data Object Navigation View Customize Model Help
MODFLOW
PHAST
MODFLOW Packages and Programs...
MODFLOW Layer Groups...
MODFLOW Time...
MODFLOW Output Control...
MODFLOW Options...
MODFLOW Program Locations...
Link SFR Streams...
MODFLOW Name File...
ModelMate Interface...
Observation Type
-2.06E6
-2.05E6
-2.04E6
2.09E6
2.08E6


Link Streams
What to link
All streams
Selected streams
Link tolerance
100
Keep existing linkages
Help
Apply
Close