

Users Guide to the NFSEG Automated Water-Use Permit Simulation Tool: Step-by-Step Procedures

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Please report any errors to Lanie Meridth (lmeridth@sjrwmd.com) or Paul Bremner (pbremner@sjrwmd.com) at the St Johns River Water Management District, Douglas Durden (Douglas.Durden@srwmd.org) at the Suwannee River Water Management.

Software Requirements:

ArcGIS Desktop, version 10.0 or later, installed on your local machine (or a computer that you connect with remotely that has ArcGIS installed on it).

Overview of Steps:

Note to the User: If this is the first time running the tool or an update, please read the more detailed instructions (below) first.

1. Navigate to the top-level tool directory
2. Create a formatted User input csv file. Name is flexible, but no spaces are allowed in the name. The "user_input_files" folder is provided with example input files and is the recommended location for new input files.
3. Double-click on the batch file "sim_cup_initiate.bat" to open the tool console
4. Fill-in the User input filename, select whether to replace an existing results directory which possesses the same name as the User input file, and select a projection as prompted.
5. Monitor the output in the console to ensure no errors occur, process takes about 10-20 minutes for each well depending on the size of withdrawal/injection.

6. A completion message appears at the end of a run. The console pauses to allow inspection of the output. If no errors occurred (signified by an error statement on the console) then the User has the option to either enter another User input file to run, or type **exit** to close the console. There is no limit to the number of times new input files may be processed before exiting the console. Each run is processed in its own results directory with its own logfile.
7. Each successful run generates a results directory containing an mxd map of the change in head water levels, two output csv files, and the logfile.

NOTE: Before clicking on the batch file to start the tool, close all related Excel and ArcMap files that are used to setup the Permitting Tool. Any open files could cause program errors. Also, it is sometimes necessary to save Excel csv files in MSDOS csv format.

NOTE: This tool is setup to run the NFSEG v1.1 groundwater model. Using a different model will cause unpredictable errors.

NOTE: The Suwannee River Water Management District (SRWMD) and St Johns River Water Management District (SJRWMD) utilize two different map projections in GIS. X,Y coordinates must correspond to the correct projection. Input the selection when prompted at the command line.

1 = SRWMD is used for State Plane North

2 = SJRWMD is used for UTM Zone 17N meters

Detailed Instructions:

[Initial Setup / Installation of the Tool](#)

NOTE: This process only needs to be done once per tool update.

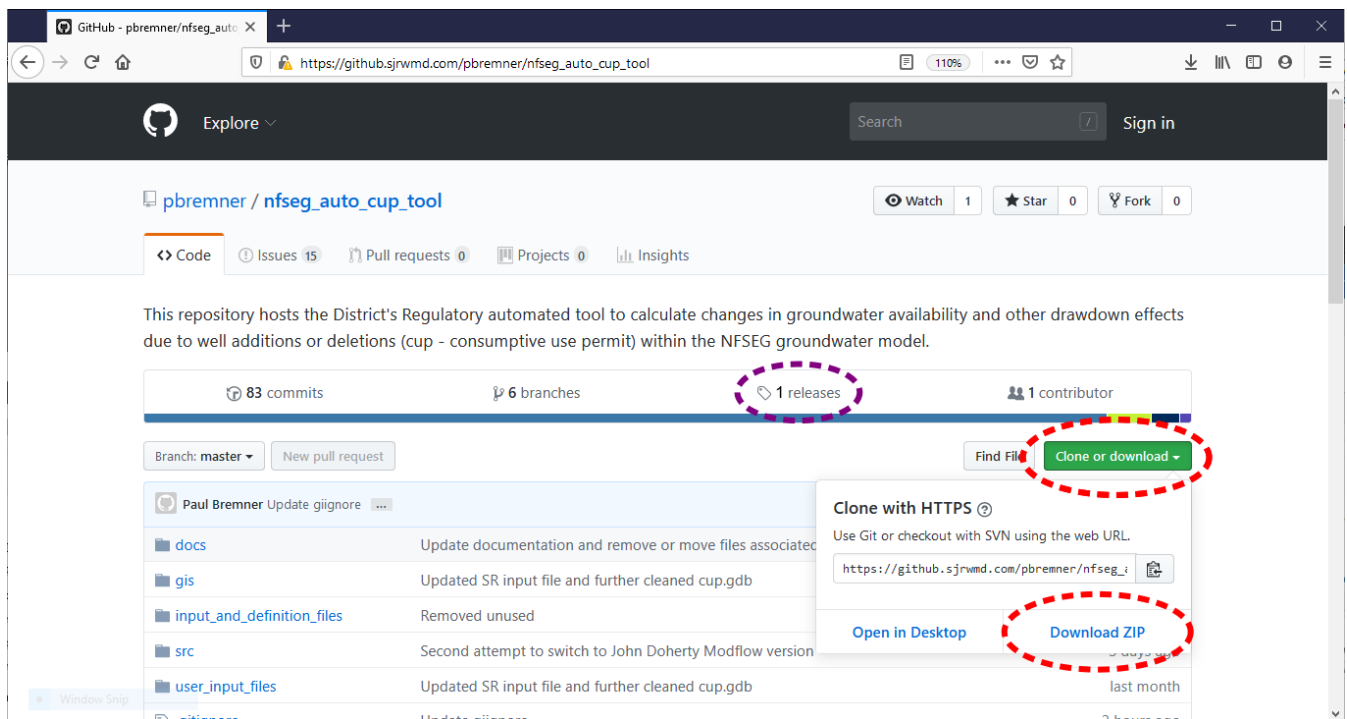
NOTE: This tool uses the Python that is bundled with ArcMap 10.0 or newer. The tool automatically searches for the location of this Python. If that is unsuccessful, then ERRORS will occur. Ensure that ArcMap's Python can be found before running the tool (see steps below).

NOTE: The tool should be downloaded to the local machine's hard drive, such as the local C:\ drive, where ArcMap is generally installed. The tool does not currently support running from a server location (i.e. poseidon or beohome).

1. There are two types of download versions: the development and release versions, each of which can be downloaded as zip files. Navigate to the Tool's GitHub repository (https://github.sjrwmd.com/pbremner/nfseg_auto_cup_tool) and download the zip file. The development version is found by clicking on the green colored "Clone or download" icon (see figure, dashed red circle). The

release version is found by clicking on the “release” icon and downloading the zip file from the desired release version (see figure, dashed purple circle). After the download is complete, unzip the tool to a directory on the local machine’s hard drive. The tool unzips into its own directory, referred to as the *top-level tool directory*. The last portion of the default Windows PATH when unzipping is usually not necessary. Unzip the tool and enter the top-level tool directory.

NOTE: Microsoft Edge or Firefox are the preferred browsers to use to access the District’s GitHub webpage. You may receive a security warning when visiting the page, please proceed to the webpage. If you are using Microsoft Edge, click ‘Details’ and ‘Go on to webpage’ to visit the webpage.



2. Check that the top-level tool directory includes (at a minimum) the following:

- docs (folder) containing this Quick Users Guide
- gis (folder)
- input_and_definition_files (folder)
- model_update.zip (zip file)
- src (folder)
- user_input_files (folder)
- sim_cup_initiate.bat
- setup.bat

NOTE: Additional files will appear in the top-level tool directory following download that are not accessed directly by the tool. This includes a file named ‘README.md’. ‘README.md’ is a markdown file containing a general description of the tool which

appears in its formatted form on the GitHub repository page where the tool is accessed.

3. Setup the tool for use by double-clicking the *setup.bat* script in the top-level directory. A message may appear warning you about running the script. Click the **Run-Anyway** option (sometimes this option only appears after clicking **More**).

The setup script does the following:

- a. Unzip the model and preprocess data directories.
- b. Search for the Python bundled with ArcGIS.
- c. Automatically generate a file called *PY_PATH_autogen.txt* to store the PATH. Though the simulation tool does not require the auto-generated file (the tool auto searches for Python when the file is not present), having this file available will decrease the tool runtime significantly. If Python could not be found, then a **Failure** message will appear. If this occurs, or if the version is not the one desired by the User, it will be necessary to manually set Python in the tool to resolve the issue. Please contact the tool maintainers for help.

NOTE: It may take several minutes for the Python version on your computer to be located. To verify that the setup was successful, the *PY_PATH_autogen.txt* text file should be created and when opened should contain the file path to python on your computer. The *model_update.zip* should be unzipped into a folder named "model_update". In the event that "model_update" is chosen to be unzipped manually, remove the final directory name that appears in the default Windows chosen PATH, which inserts the model_update directory into another directory called model_update. Likewise, the preprocess file *wellpkg_update.zip* should be unzipped into a folder named "wellpkg_update" and located in "input_and_definition_files\preproc". If unzipping manually, remove the final directory name that appears in the default Windows chosen PATH to ensure the new directory appears in the expected location.

```
C:\WINDOWS\system32\cmd.exe

C:\SJRWMModels\NFSEG\nfseg_auto_cup_tool-master>echo off

Setting up the NFSEG Reg Tool

This will take a few moments . . .

=====

This script checks that an appropriate Python version is
available for use by the tool.

A message will appear alerting the User whether the
search was successful, or failed.

If Python for ArcMap (arcpy) is found, then the PATH is
written to the file PY_PATH_autogen.txt

If the search failed, then contact the tool
maintainers for help, and then contact IT if the
problem cannot be resolved.

Last Modified by: PMBremner - pbremner@sjrwmd.com
                  DDurden   - Douglas.Durden@srwmd.org
=====

=====

Begin searching for arcpy Python. This may take a moment . . .

Success! The following Python was found:
C:\Python27\ArcGIS10.6\python

Writing the Python PATH to file for lookup by the tool . . .

Finished writing the PATH to: PY_PATH_autogen.txt
This file will be used by the simulation tool when available in order to speed up Python search

=====

This script unpacks zipped directories necessary at runtime.

Last Modified by: PMBremner - pbremner@sjrwmd.com
                  LMeridth  - lmeridth@sjrwmd.com
=====

Unpacking the model directory . . .

Process complete

Press any key to continue . . .
```

[How to setup the User Input File](#)

The User input file is a comma-separated-value (.csv) file created in MS Excel, or equivalent, that lists all the wells needing to be processed for a permit. Table 1 shows an example of the Excel file format, and example csv files are also provided in the

user_input_files folder included in the tool download. The name given to the file is not important, but the name must NOT contain spaces. Instead, use underscores in place of spaces. A descriptive filename of the permit simulation is recommended. The name assigned to the User input file is used to create a new results directory one directory level above the top-level tool directory. Results directories are created outside of the top-level directory to prevent results from being overwritten whenever new release versions of the tool are downloaded and installed by users. The results directory name appends “_results” to the base User input file name. Within the results directory, two csv files are output summarizing the results of the simulation, both of which will be prepended with the base of the User input filename. A logfile with all output from the console is written to the results directory and named with the base User input filename. An mxd map (dh.mxd) showing the change in head in model layers 1, 3, and 5 from the simulation is output to the results gis folder. The area-weighted average heads beneath lakes in the model are output to the postproc dh folder for three different waterbody input files. The change in heads at all model cells in each model layer (DeltaHeads_SP2-SP1_all_layers.csv) is also output to the postproc dh folder. The User input file used for the simulation is also copied to the output results directory.

For example, if the input filename is:

“sim_cup_input_example_srwm.csv”

then the results directory will be named:

“sim_cup_input_example_srwm_results”

and the two output csv files and log file will be named:

“sim_cup_input_example_srwm_delta_q_summary.csv”

“sim_cup_input_example_srwm_global_budget_change.csv”

“sim_cup_input_example_srwm.log”

Example results directory:

| This PC > Windows (C:) > SJRWMDModels > NFSEG > sim_cup_input_example_srwm_results | | | |
|--|-------------------|----------------------|-------|
| Name | Date modified | Type | Size |
| gis | 2/19/2021 2:34 PM | File folder | |
| postproc | 2/19/2021 2:34 PM | File folder | |
| preproc | 2/19/2021 2:34 PM | File folder | |
| sim_cup_input_example_srwm.csv | 2/19/2021 2:32 PM | Microsoft Excel C... | 1 KB |
| sim_cup_input_example_srwm_delta_q_summary.csv | 2/19/2021 2:39 PM | Microsoft Excel C... | 19 KB |
| sim_cup_input_example_srwm_global_budget_change.csv | 2/19/2021 2:39 PM | Microsoft Excel C... | 4 KB |
| sim_cup_input_example_srwm.log | 2/19/2021 2:55 PM | Text Document | 10 KB |

The Rows of the User input file are as follows:

- *Row 1* contains the Permit ID and Name.

- *Row 2* contains a set of header field names describing what information needs to be filled out by the User. The field names **MUST** be in the order and spelling shown in the example.
- *Rows 3+* contain all the need-to-be-processed wells, one well per row.

The Columns of the well data portion (rows 3+) of the User input file are as follows:

- *Col A – WellKey* – an integer counter for each well
- *Col B – WellId* – an identifier for each well
- *Col C/D – Xcoord/Ycoord* – Cartesian coordinate representation of the Lon/Lat well coordinates. For each well, use a GIS program such as ArcMap, to obtain the X,Y coordinates within the NFSEG model. **IMPORTANT:** Reference the NFSEG grid to confirm that any added wells are within the model domain. Including a well in the user input file that is outside of the model domain will result in errors and failure of the tool, with an error message such as “division by zero”.
- *Col E – layer* – model layer the well will interact with
- *Col F – Q_mgd* – amount of water flowing through the well [units = million-gallons-per-day].

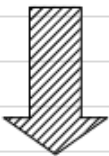
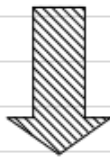
IMPORTANT: The Suwannee River Water Management District (SRWMD) and St Johns River Water Management District (SJRWMD) utilize two different map projections in GIS. Make note of which projection was used in GIS and input the selection when prompted at the command line.

1 = SRWMD is used for State Plane North

2 = SJRWMD is used for UTM Zone 17N meters

NOTE: Use a positive Q_mgd value for withdrawal, and a negative value for injection.

Table 1 User input file example. File should be created in MS Excel, or equivalent, and be saved as a .csv file.

| | A | B | C | D | E | F |
|----|----------------|------------|---|-------------|-------|--------|
| 1 | 2_345_123456_1 | Testing123 | | | | |
| 2 | WellKey | WellId | XCoord | YCoord | layer | Q_mgd |
| 3 | 987654 | w00160 | 436759.1709 | 3284314.454 | 3 | 1.2345 |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | <div>More</div> <div>   </div> | | | |
| 7 | | | | | | |
| 8 | | | | | | |
| 9 | | | | | | |
| 10 | | | | | | |
| 11 | | | | | | |
| 12 | | | | | | |

Running the Water-Use Simulation Permit Simulation

The Automated Water-Use Permit Simulation Tool runs a batch script within a Windows Command Prompt console. In the background, the batch script runs a Python script that controls the processing workflow and manages output. Successive input files may be processed without limit, where each new User input file is able to be entered once the current process is completed. The following are the steps to activate and run the tool:

1. Navigate to the top-level directory of the tool
2. Double click on the batch file *sim_cup_initiate.bat*. A console will pop-up on the screen. When first opened, the tool may take a few moments to initialize before prompting for User input. Note that this step should take place only after the initial setup and installation of the tool has been completed (see [Initial Setup / Installation of the Tool](#))


```
C:\WINDOWS\system32\cmd.exe
Reading from file PY_PATH_autogen.txt
arcpy Python version found: C:\Python27\ArcGIS10.6\python

=====
NFSEG AUTOMATED WATER-USE PERMIT SIMULATION TOOL

This is the main script used to evaluate the impact of adding
new wells to the NFSEG model.

This script is designed to read a user supplied csv file
containing the id, location, and withdrawal rate of the wells
requesting a permit.

New wells are processed utilizing MODFLOW. Results are
summarized in two csv files and an updated mxd. The log and
output files are written to a new results directory.
1. <results>\<user_input_filename>_delta_q_summary.csv
2. <results>\<user_input_filename>_global_budget_change.csv
3. <results>\gis\dh.mxd

For questions contact:
PMBremner - pbremner@sjrwmd.com
LMeridth - lmeridth@sjrwmd.com
DDurden - Douglas.Durden@srwmd.org
=====

Please supply an input csv file name:
```

3. Follow the prompts to input both the User input csv filename, whether to proceed with overwriting an existing results directory possessing the same name (overwrite is currently the only option), as well as the map projection that corresponds to what was used in GIS to obtain the X,Y coordinates of each well. Push Enter after each prompted input.

NOTE: While a User created input csv file may be located anywhere convenient to the User, a directory called “*user_input_files*” that is included with the tool download may be used. When prompted to supply an input csv file name after initiating the tool, type the path to the file in the command line, such as: *input_user_files\User input csv filename* as highlighted in the screenshot below:

```
Select C:\WINDOWS\system32\cmd.exe

C:\MY_CODES\RegTools\nfseg_auto_cup_tool-master>echo off

Reading from file PY_PATH_autogen.txt
arcpy Python version found: C:\Python27\ArcGIS10.6\python

=====
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DDurden - Douglas.Durden@srwmd.org
=====

Please supply an input csv file name: user_input_files\sim cup input example sjrwmd.csv
```

```
Select C:\WINDOWS\system32\cmd.exe

C:\MY_CODES\RegTools\nfseg_auto_cup_tool-master>echo off

Reading from file PY_PATH_autogen.txt

arcpy Python version found: C:\Python27\ArcGIS10.6\python

=====
NFSEG AUTOMATED WATER-USE PERMIT SIMULATION TOOL

This is the main script used to evaluate the impact of adding
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This script is designed to read a user supplied csv file
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1. <results>\<user_input_filename>_delta_q_summary.csv
2. <results>\<user_input_filename>_global_budget_change.csv
3. <results>\gis\dh.mxd

For questions contact:
PMBremner - pbremner@sjrwmd.com
LMeridth - lmeridth@sjrwmd.com
DDurden - Douglas.Durden@srwmd.org
=====

Please supply an input csv file name: user_input_files\sim_cup_input_example_sjrwmd.csv

Preexisting results with the jobname C:\MY_CODES\RegTools\sim_cup_input_example_sjrwmd_results will be overwritten. Proceed?
( Y = yes , N = no )
Y
```

```
Select C:\WINDOWS\system32\cmd.exe

C:\MY_CODES\RegTools\nfseg_auto_cup_tool-master>echo off

Reading from file PY_PATH_autogen.txt

arcpy Python version found: C:\Python27\ArcGIS10.6\python

=====
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1. <results>\<user_input_filename>_delta_q_summary.csv
2. <results>\<user_input_filename>_global_budget_change.csv
3. <results>\gis\dh.mxd

For questions contact:
PMBremner - pbremner@sjrwmd.com
LMeridth - lmeridth@sjrwmd.com
DDurden - Douglas.Durden@srwmd.org
=====

Please supply an input csv file name: user_input_files\sim_cup_input_example_sjrwmd.csv

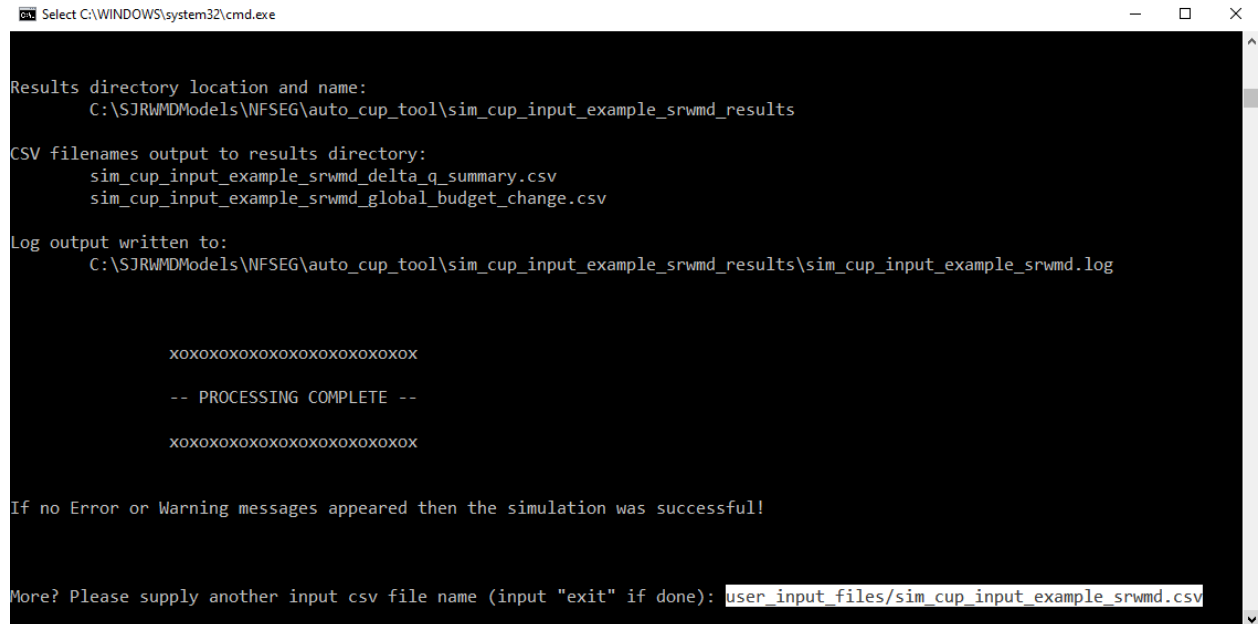
Preexisting results with the jobname C:\MY_CODES\RegTools\sim_cup_input_example_sjrwmd_results will be overwritten. Proceed?
( Y = yes , N = no )
Y

Creating or replacing C:\MY_CODES\RegTools\sim_cup_input_example_sjrwmd_results

Please input the map projection type used - in all caps - or the associated number
(options are 1=SRWMD or 2=SRWMD. Different names result in a poetic exit): 2
```

4. The simulation proceeds to run. Monitor the output to ensure no error messages appear. If the simulation was successful, then the output files will be written to

the new results folder one level above the top-level tool directory, and a completion message will appear in the console. The output files will be prepended with the User input filename. The user will then be prompted to supply another User input file for processing. If there is no additional user input file to process, type **exit** in the command prompt or close the command terminal to exit.



```
Select C:\WINDOWS\system32\cmd.exe

Results directory location and name:
C:\SJRWMDModels\NFSEG\auto_cup_tool\sim_cup_input_example_srwm_results

CSV filenames output to results directory:
sim_cup_input_example_srwm_delta_q_summary.csv
sim_cup_input_example_srwm_global_budget_change.csv

Log output written to:
C:\SJRWMDModels\NFSEG\auto_cup_tool\sim_cup_input_example_srwm_results\sim_cup_input_example_srwm.log

XOXOXOXOXOXOXOXOXOXOXOXOXOXOXOX
-- PROCESSING COMPLETE --
XOXOXOXOXOXOXOXOXOXOXOXOXOXOXOX

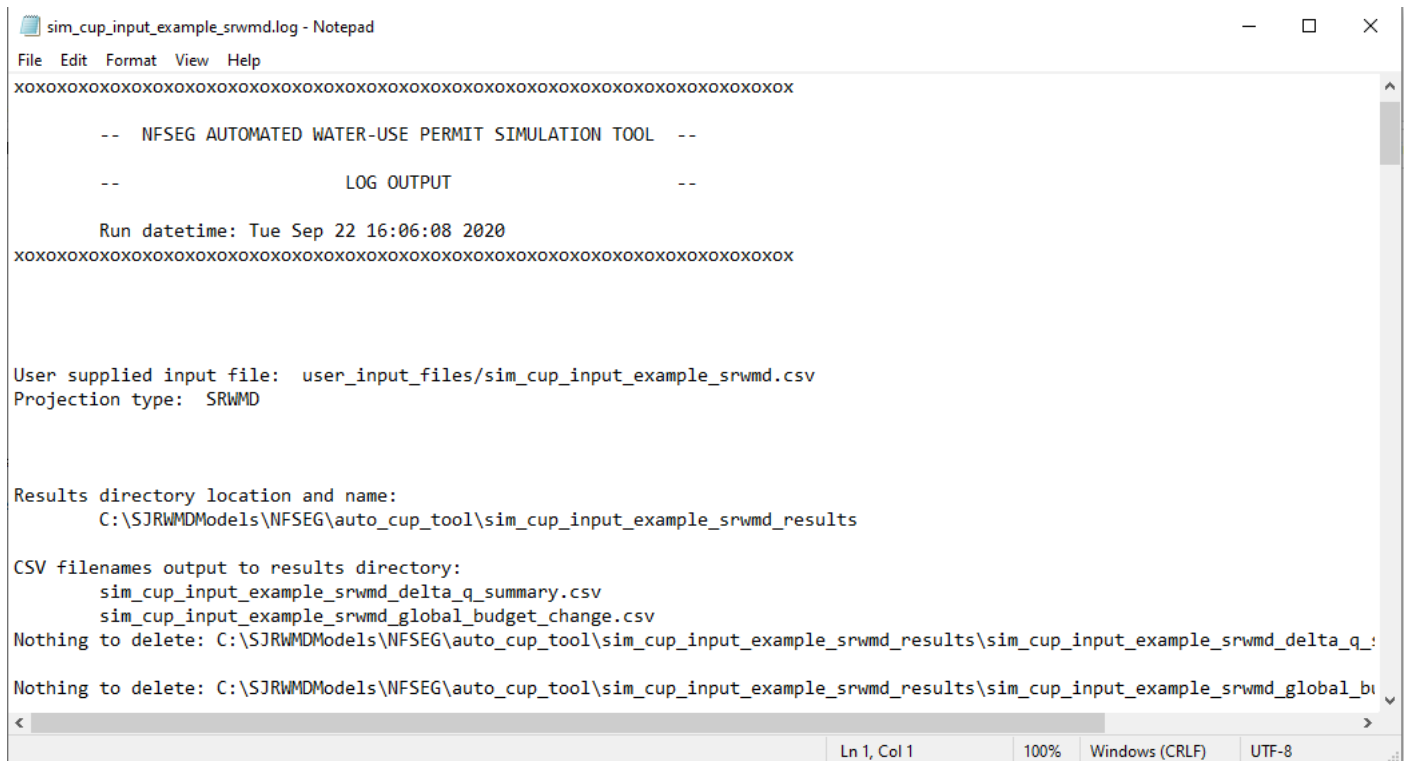
If no Error or Warning messages appeared then the simulation was successful!

More? Please supply another input csv file name (input "exit" if done): user_input_files/sim_cup_input_example_srwm.csv
```

[Water-Use Simulation Permit Simulation Log File](#)

Output from the console, including any error messages, is written to a log file in the results directory that is named with the base User input filename. Error messages and warning messages usually start with one of the following terms: “ERROR”, “Warning”, or “Traceback”. If an error occurs during execution of the tool, and it is not obvious why the error occurred, then the logfile should be examined for additional information. If errors persist, the log file and a description of the issue should be emailed to the tool maintainers.

Example log file:



```
sim_cup_input_example_srwm.log - Notepad
File Edit Format View Help
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-- NFSEG AUTOMATED WATER-USE PERMIT SIMULATION TOOL --
-- LOG OUTPUT --
Run datetime: Tue Sep 22 16:06:08 2020
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

User supplied input file: user_input_files/sim_cup_input_example_srwm.csv
Projection type: SRWMD

Results directory location and name:
C:\SJRWMModels\NFSEG\auto_cup_tool\sim_cup_input_example_srwm_results

CSV filenames output to results directory:
sim_cup_input_example_srwm_delta_q_summary.csv
sim_cup_input_example_srwm_global_budget_change.csv
Nothing to delete: C:\SJRWMModels\NFSEG\auto_cup_tool\sim_cup_input_example_srwm_results\sim_cup_input_example_srwm_delta_q:
Nothing to delete: C:\SJRWMModels\NFSEG\auto_cup_tool\sim_cup_input_example_srwm_results\sim_cup_input_example_srwm_global_b:
Ln 1, Col 1 100% Windows (CRLF) UTF-8
```

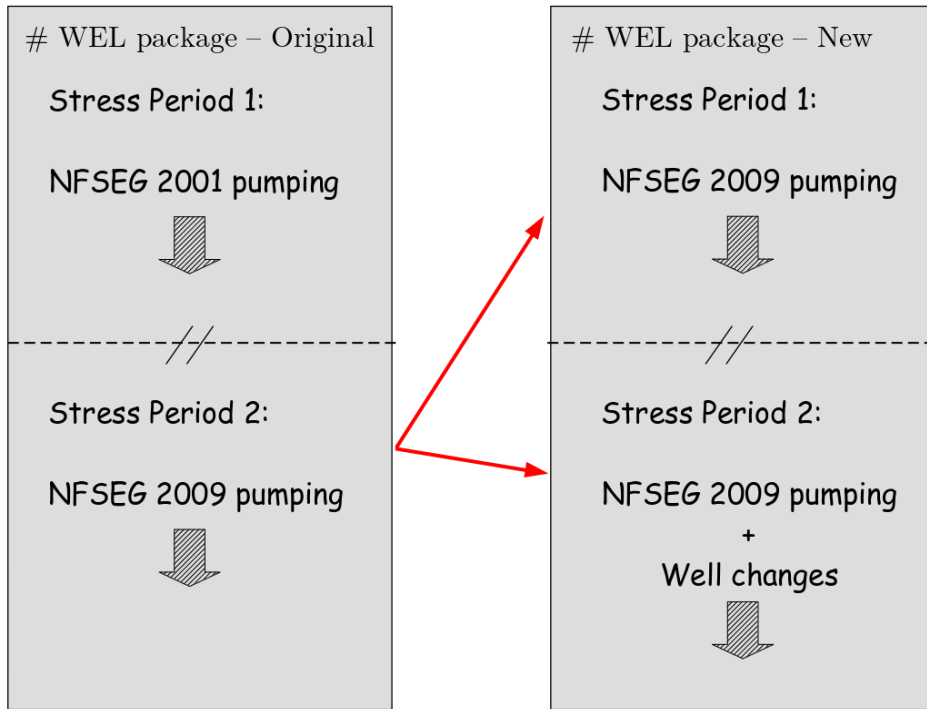
Tool Operations and Results

The NFSEG Automated Water-Use Simulation Tool uses MODFLOW to calculate changes in groundwater availability and other drawdown effects due to well additions or deletions (CUP - consumptive use permit) within the NFSEG groundwater model domain. The tool calculates the cumulative effects of adding one or more new CUP wells within the NFSEG model area, and summarizes results in the following outputs:

- Change in water budget
- Change in flow at river gages and springs
- Change in head in all model layers
- MXD of change in head in model layers 1, 3, and 5
- Change in area-weighted average head beneath lakes in all model layers

The tool can be split into three stages:

1. **Preprocessing** – Processing the input CUP wells in order to setup a new MODFLOW WEL Package. The new WEL Package starts with the calibrated NFSEG 2nd Stress Period (2009), which becomes the new Stress Period 1. The new 2nd Stress Period repeats Calibrated NFSEG 2nd Stress Period plus all the CUP well modifications:



2. **Execute MODFLOW** – Utilize the new WEL Package, but all other packages are unchanged.
3. **Postprocess the results** – Extract and process the global water budget and changes in flow and head from the *.lst* and *.hds* files.
 - a. **Global water budget summary**
 - i. Results are in the top-level results directory in the file named *<user_input_filename>_global_budget_change.csv* (see example below)
 - ii. Global water budget terms are provided in units of cubic feet per day (cfd), cubic feet per second (cfs) and million gallons per day (mgd)

This PC > Windows (C:) > SJRWMDModels > NFSEG > sim_cup_input_example_sjrwmd_results

| Name | Date modified | Type | Size |
|---|-------------------|----------------------|-------|
| gis | 2/19/2021 2:34 PM | File folder | |
| postproc | 2/19/2021 2:34 PM | File folder | |
| preproc | 2/19/2021 2:34 PM | File folder | |
| sim_cup_input_example_sjrwmd.csv | 2/19/2021 2:32 PM | Microsoft Excel C... | 1 KB |
| sim_cup_input_example_sjrwmd_delta_q_summary.csv | 2/19/2021 2:39 PM | Microsoft Excel C... | 19 KB |
| sim_cup_input_example_sjrwmd_global_budget_change.csv | 2/19/2021 2:39 PM | Microsoft Excel C... | 4 KB |
| sim_cup_input_example_sjrwmd.log | 2/19/2021 2:55 PM | Text Document | 10 KB |

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P |
|----|---------------|------------|------------|----------------|------------|----------------|-----------|-----------|-------------------|------------|------------|--------------------|------------|------------|--------------------|---|
| | bc_flux_type | flux_units | timeStep_1 | stressPeriod_1 | timeStep_2 | stressPeriod_2 | in_rate_1 | in_rate_2 | in_rate_2_minus_1 | out_rate_1 | out_rate_2 | out_rate_2_minus_1 | net_rate_1 | net_rate_2 | net_rate_2_minus_1 | net_rate_2_minus_1_fraction_of_netWellPkg |
| 1 | bc_flux_type | flux_units | timeStep_1 | stressPeriod_1 | timeStep_2 | stressPeriod_2 | in_rate_1 | in_rate_2 | in_rate_2_minus_1 | out_rate_1 | out_rate_2 | out_rate_2_minus_1 | net_rate_1 | net_rate_2 | net_rate_2_minus_1 | net_rate_2_minus_1_fraction_of_netWellPkg |
| 2 | CONSTANT H | cfld | 1 | 1 | 1 | 1 | 2 | 5.9E+07 | 5.9E+07 | 108 | 1.4E+08 | 1.4E+08 | -3584 | -81253472 | -81249780 | 3692 |
| 3 | DRAINS | cfld | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 9.9E+08 | 9.9E+08 | -44736 | -986734528 | -986689792 | 44736 |
| 4 | ET | cfld | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 2.6E+09 | 2.6E+09 | -45312 | -2.611E+09 | -2.611E+09 | 45312 |
| 5 | HEAD DEP BC | cfld | 1 | 1 | 1 | 1 | 2 | 1.7E+08 | 1.7E+08 | 3232 | 6.7E+08 | 6.7E+08 | -18304 | -499298480 | -499276944 | 21536 |
| 6 | MNW2 | cfld | 1 | 1 | 1 | 1 | 2 | 3644789 | 3644522 | -267.25 | 2E+07 | 2E+07 | 1874 | -15948449 | -15950591 | -2141.25 |
| 7 | RECHARGE | cfld | 1 | 1 | 1 | 1 | 2 | 5.3E+09 | 5.3E+09 | 0 | 0 | 0 | 0 | 5.298E+09 | 5298147328 | 0 |
| 8 | RIVER LEAKAGE | cfld | 1 | 1 | 1 | 1 | 2 | 2.2E+08 | 2.2E+08 | 3792 | 1.2E+09 | 1.2E+09 | -41088 | -947824048 | -947779168 | 44880 |
| 9 | STORAGE | cfld | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | WELLS | cfld | 1 | 1 | 1 | 1 | 2 | 5.4E+07 | 5.4E+07 | 0 | 2.1E+08 | 2.1E+08 | 165024 | -155672492 | -155837516 | -165024 |
| 11 | CONSTANT H | cfs | 1 | 1 | 1 | 1 | 2 | 681.973 | 681.975 | 0.0013 | 1622.41 | 1622.37 | -0.0415 | -940.4337 | -940.391 | 0.0427 |
| 12 | DRAINS | cfs | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 11420.5 | 11420 | -0.5178 | -11420.539 | -11420.021 | 0.5178 |
| 13 | ET | cfs | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 30224.7 | 30224.2 | -0.5244 | -30224.714 | -30224.19 | 0.5244 |
| 14 | HEAD DEP BC | cfs | 1 | 1 | 1 | 1 | 2 | 2023.78 | 2023.82 | 0.0374 | 7802.7 | 7802.49 | -0.2119 | -5778.9176 | -5778.6683 | 0.2493 |
| 15 | MNW2 | cfs | 1 | 1 | 1 | 1 | 2 | 42.1851 | 42.182 | -0.0031 | 226.774 | 226.795 | 0.0217 | -184.5885 | -184.6133 | -0.0248 |
| 16 | RECHARGE | cfs | 1 | 1 | 1 | 1 | 2 | 61321.1 | 61321.1 | 0 | 0 | 0 | 0 | 61321.15 | 61321.1496 | 0 |
| 17 | RIVER LEAKAGE | cfs | 1 | 1 | 1 | 1 | 2 | 2518.55 | 2518.59 | 0.0439 | 13488.7 | 13488.3 | -0.4756 | -10970.186 | -10969.666 | 0.5194 |
| 18 | STORAGE | cfs | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | WELLS | cfs | 1 | 1 | 1 | 1 | 2 | 625.512 | 625.512 | 0 | 2427.28 | 2429.19 | 1.91 | -1801.765 | -1803.675 | -1.91 |
| 20 | CONSTANT H | mgd | 1 | 1 | 1 | 1 | 2 | 440.771 | 440.772 | 0.0008 | 1048.59 | 1048.56 | -0.0268 | -607.8182 | -607.7906 | 0.0276 |
| 21 | DRAINS | mgd | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 7381.29 | 7380.95 | -0.3346 | -7381.2874 | -7380.9527 | 0.3346 |
| 22 | ET | mgd | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 19534.7 | 19534.4 | -0.339 | -19534.744 | -19534.405 | 0.339 |
| 23 | HEAD DEP BC | mgd | 1 | 1 | 1 | 1 | 2 | 1308 | 1308.03 | 0.0242 | 5043.02 | 5042.88 | -0.1369 | -3735.0123 | -3734.8512 | 0.1611 |
| 24 | MNW2 | mgd | 1 | 1 | 1 | 1 | 2 | 27.2649 | 27.2629 | -0.002 | 146.568 | 146.582 | 0.014 | -119.3027 | -119.3187 | -0.016 |
| 25 | RECHARGE | mgd | 1 | 1 | 1 | 1 | 2 | 39632.9 | 39632.9 | 0 | 0 | 0 | 0 | 39632.897 | 39632.8971 | 0 |
| 26 | RIVER LEAKAGE | mgd | 1 | 1 | 1 | 1 | 2 | 1627.78 | 1627.81 | 0.0284 | 8718 | 8717.69 | -0.3074 | -7090.2167 | -7089.881 | 0.3357 |
| 27 | STORAGE | mgd | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | WELLS | mgd | 1 | 1 | 1 | 1 | 2 | 404.279 | 404.279 | 0 | 1568.79 | 1570.02 | 1.2345 | -1164.5112 | -1165.7457 | -1.2345 |

b. River gage and spring flow summary

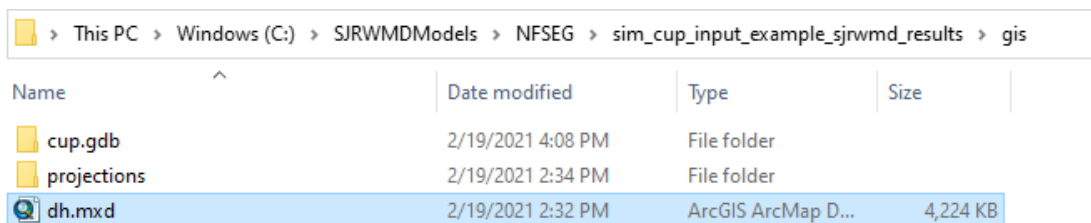
- Results are in the top-level results directory in the file named `<user_input_filename>_delta_q_summary.csv` (see example below):

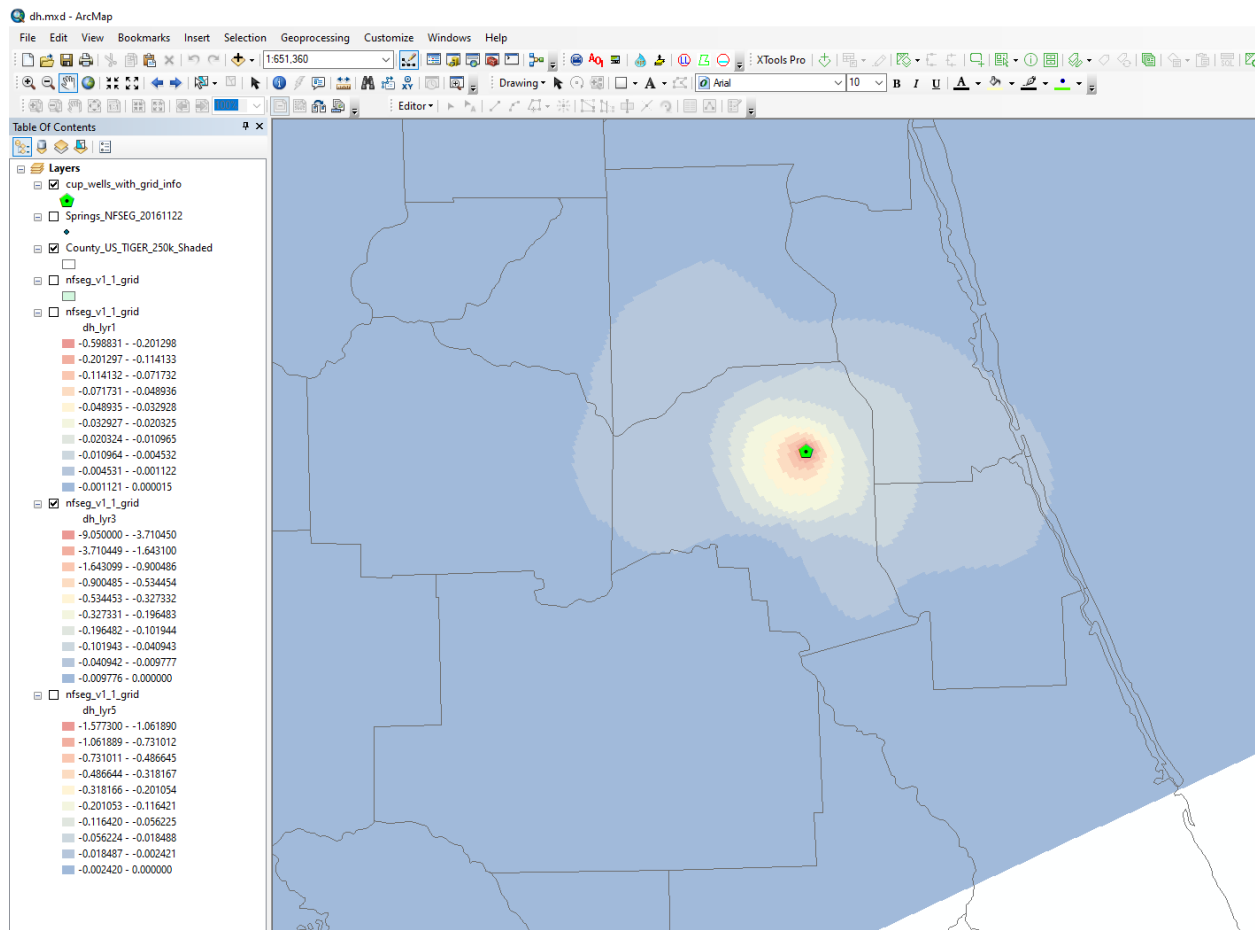
| <div> <div></div> <div>This PC</div> <div>Windows (C:)</div> <div>SJRWMDModels</div> <div>NFSEG</div> <div>sim_cup_input_example_sjrwmd_results</div> </div> | | | |
|--|-------------------|----------------------|-------|
| Name | Date modified | Type | Size |
| gis | 2/19/2021 2:34 PM | File folder | |
| postproc | 2/19/2021 2:34 PM | File folder | |
| preproc | 2/19/2021 2:34 PM | File folder | |
| sim_cup_input_example_sjrwmd.csv | 2/19/2021 2:32 PM | Microsoft Excel C... | 1 KB |
| sim_cup_input_example_sjrwmd_delta_q_summary.csv | 2/19/2021 2:39 PM | Microsoft Excel C... | 19 KB |
| sim_cup_input_example_sjrwmd_global_budget_change.csv | 2/19/2021 2:39 PM | Microsoft Excel C... | 4 KB |
| sim_cup_input_example_sjrwmd.log | 2/19/2021 2:55 PM | Text Document | 10 KB |

| | A | B | C | D | E | F | G | H |
|----|----------------|--|-----|-------------------------------|-----------------------------|------------------------------|---|---|
| | station_number | station_name | WMD | simulated_flux_base_condition | simulated_flux_with_cup_cfs | simulated_change_in_flow_cfs | simulated_change_in_flow_as_fraction_of | simulated_change_in_flow_as_a_fraction_of_cup |
| 1 | 2315000 | suwannee river near benton | SR | -125.509979 | -125.509895 | 0.000084 | -0.000001 | 0.000044 |
| 2 | 2315500 | suwannee river at white springs | SR | -162.703548 | -162.703276 | 0.000272 | -0.000002 | 0.000142 |
| 3 | 2317620 | alapaha river near jennings fla | SR | -810.400413 | -810.40019 | 0.000223 | 0 | 0.000117 |
| 4 | 2319000 | withlacoochee river near pinetta fla | SR | -840.685156 | -840.681939 | 0.003217 | -0.000004 | 0.001684 |
| 5 | 2319394 | withlacoochee river nr lee | SR | -1274.527095 | -1274.517004 | 0.010091 | -0.000008 | 0.005283 |
| 6 | 2319500 | suwannee river at ellaville | SR | -3010.126663 | -3010.095574 | 0.031089 | -0.00001 | 0.016277 |
| 7 | 2319800 | suwannee river at dowlng park | SR | -3126.411761 | -3126.38003 | 0.031731 | -0.00001 | 0.016613 |
| 8 | 2320000 | suwannee river at luraville | SR | -3304.500603 | -3304.468535 | 0.032068 | -0.00001 | 0.016789 |
| 9 | 2320500 | suwannee river at branford | SR | -3916.9242 | -3916.891027 | 0.033173 | -0.000008 | 0.017368 |
| 10 | 2320700 | santa fe river near graham | SR | -3.309329 | -3.308515 | 0.000815 | -0.000246 | 0.000426 |
| 11 | 2321000 | new river near lake butler | SR | -16.638419 | -16.638099 | 0.00032 | -0.000019 | 0.000167 |
| 12 | 2322700 | ichetucknee river at us hwy27 near hildreth | SR | -270.155136 | -270.152738 | 0.002398 | -0.000009 | 0.001255 |
| 13 | 2321500 | santa fe river near worthington springs | SR | -43.502116 | -43.50033 | 0.001786 | -0.000041 | 0.000935 |
| 14 | 2321975 | santa fe river at us hwy 441 near high springs | SR | -146.389683 | -146.377849 | 0.011834 | -0.000081 | 0.006196 |
| 15 | 2322500 | santa fe river near fort white | SR | -723.580624 | -723.564397 | 0.016227 | -0.000022 | 0.008496 |
| 16 | 2322800 | santa fe river near hildreth | SR | -1141.0581 | -1141.039076 | 0.019024 | -0.000017 | 0.00996 |
| 17 | 2323500 | suwannee river near wilcox | SR | -5485.65224 | -5485.599734 | 0.052506 | -0.00001 | 0.027489 |
| 18 | 2323592 | suwannee river ab gopher river nr suwannee | SR | -5950.460653 | -5950.407406 | 0.053247 | -0.000009 | 0.027877 |
| 19 | 2313700 | waccasassa river nr gulf hammock | SR | -123.742246 | -123.736499 | 0.005747 | -0.000046 | 0.003009 |
| 20 | 2324000 | steinatchee river near cross city | SR | -62.235365 | -62.235365 | 0 | 0 | 0 |
| 21 | 2324400 | fenholloway river near foley | SR | -2.882957 | -2.882957 | 0 | 0 | 0 |
| 22 | 2324500 | fenholloway river at foley | SR | -9.601852 | -9.601852 | 0 | 0 | 0 |
| 23 | 2325000 | fenholloway river near perry | SR | -69.334619 | -69.334619 | 0 | 0 | 0 |
| 24 | 2326000 | econfina river near perry | SR | -49.552804 | -49.552791 | 0.000013 | 0 | 0.000007 |
| 25 | 2326526 | wacissa river nr wacissa | SR | -447.556424 | -447.555833 | 0.000591 | -0.000001 | 0.000309 |
| 26 | 2326500 | aucilla river at lamont | SR | -93.658734 | -93.658349 | 0.000385 | -0.000004 | 0.000202 |
| 27 | 2326550 | aucilla river nr mouth near nutall rise | SR | -1467.814163 | -1467.812707 | 0.001456 | -0.000001 | 0.000762 |
| 28 | n011117008 | madison blue spring nr blue springs fl | SR | -104.052824 | -104.051748 | 0.001076 | -0.00001 | 0.000563 |
| 29 | n011120012 | pot spring | SR | -35.833808 | -35.833438 | 0.00037 | -0.00001 | 0.000194 |
| 30 | n011121006 | tanner spring | SR | -98.428738 | -98.427639 | 0.001099 | -0.000011 | 0.000576 |
| 31 | s020302004 | wacissa headspring | SR | -163.959259 | -163.959028 | 0.000231 | -0.000001 | 0.000121 |

c. Model-wide change in heads

- The change in head levels of layers 1, 3, and 5 are viewable from the *dh.mxd* located in the gis folder (see example below).
- NOTE:** The change in head feature layers generated during post-processing (*dh_layerX*, where *X* represents the model layer number) may need to be rescaled in the *dh.mxd* file. This can happen if calculated changes in head are outside of the range of values in the legend, resulting is some cells showing as blank or unclassified in the map. This should be verified in the symbology classification tab for the feature layer. Also note that the *dh_layerX* feature layer is semi-transparent to enable the user to add base maps or reference layers.
- The change in head for all model cells in each layer is also output to the file 'DeltaHeads_SP2-SP1_all_layers.csv' located *postproc/dh* in the results directory.




































d. **Change in area-weighted average heads beneath lakes**

- i. Lake results are viewable in the *postproc/dh* results folder (see below)
- ii. The change in area-weighted average head beneath lakes is processed from three lists of waterbodies (WaterBodiesFromJohnGood.dat, WaterBodiesFromTrey.dat, WaterBodiesFromVito.dat) and output files are generated for each list at each layer in the model.
- iii. Each line within each of the input files lists the NFSEG grid row and column for a given LakeID, along with the fraction of the lake's area within the model cell. Each lake has a unique ID.
- iv. Each input file list has a corresponding .csv file that can be used to match each unique lake ID with the appropriate lake name. The reference files are named 'WaterBodiesFromJohnGoodList.csv', 'WaterBodiesFromTreyList.csv' and 'WaterBodiesFromVitoList.csv' and are saved in the *postproc/dh* folder.
- v. Each output file lists the area-weighted average head for each Stress Period beneath each LakeID, as well as the difference between SP2 and SP1 average heads beneath the lake.

- vi. Each output file is named with the prefix corresponding to the input waterbody file followed by the suffix '_mod_layer_X.txt', where X represents one of the NFSEG model layers 1-7. For example, to view results from the input waterbody list 'WaterBodiesFromVito.dat' at model layer 3, the file to access is named: 'WaterBodiesFromVito_mod_layer_3.txt'.

|  > This PC > Windows (C:) > SJRWMDModels > NFSEG > sim_cup_input_example_sjrwmd_results > postproc > dh | | | | |
|--|-------------------|----------------------|-----------|--|
| Name | Date modified | Type | Size | |
|  DeltaHeads_SP2-SP1_all_layers.csv | 2/19/2021 2:39 PM | Microsoft Excel C... | 39,162 KB | |
|  hds_processing_control_file.txt | 2/19/2021 2:32 PM | TXT File | 2 KB | |
|  nfseg_auto.hds | 2/19/2021 2:39 PM | HDS File | 28,953 KB | |
|  WaterBodiesFromJohnGood.dat | 2/19/2021 2:32 PM | DAT File | 2 KB | |
|  WaterBodiesFromJohnGood_mod_layer_... | 2/19/2021 2:39 PM | TXT File | 1 KB | |
|  WaterBodiesFromJohnGood_mod_layer_... | 2/19/2021 2:39 PM | TXT File | 1 KB | |
|  WaterBodiesFromJohnGood_mod_layer_... | 2/19/2021 2:39 PM | TXT File | 1 KB | |
|  WaterBodiesFromJohnGood_mod_layer_... | 2/19/2021 2:39 PM | TXT File | 1 KB | |
|  WaterBodiesFromJohnGood_mod_layer_... | 2/19/2021 2:39 PM | TXT File | 1 KB | |
|  WaterBodiesFromJohnGood_mod_layer_... | 2/19/2021 2:39 PM | TXT File | 1 KB | |
|  WaterBodiesFromJohnGood_mod_layer_... | 2/19/2021 2:39 PM | TXT File | 1 KB | |
|  WaterBodiesFromJohnGoodList.csv | 2/19/2021 2:32 PM | Microsoft Excel C... | 1 KB | |
|  WaterBodiesFromTrey.dat | 2/19/2021 2:32 PM | DAT File | 129 KB | |
|  WaterBodiesFromTrey_mod_layer_1.txt | 2/19/2021 2:39 PM | TXT File | 10 KB | |
|  WaterBodiesFromTrey_mod_layer_2.txt | 2/19/2021 2:39 PM | TXT File | 11 KB | |
|  WaterBodiesFromTrey_mod_layer_3.txt | 2/19/2021 2:39 PM | TXT File | 11 KB | |
|  WaterBodiesFromTrey_mod_layer_4.txt | 2/19/2021 2:39 PM | TXT File | 11 KB | |
|  WaterBodiesFromTrey_mod_layer_5.txt | 2/19/2021 2:39 PM | TXT File | 11 KB | |
|  WaterBodiesFromTrey_mod_layer_6.txt | 2/19/2021 2:39 PM | TXT File | 12 KB | |
|  WaterBodiesFromTrey_mod_layer_7.txt | 2/19/2021 2:39 PM | TXT File | 12 KB | |
|  WaterBodiesFromTreyList.csv | 2/19/2021 2:32 PM | Microsoft Excel C... | 6 KB | |
|  WaterBodiesFromVito.dat | 2/19/2021 2:32 PM | DAT File | 23 KB | |
|  WaterBodiesFromVito_mod_layer_1.txt | 2/19/2021 2:39 PM | TXT File | 4 KB | |
|  WaterBodiesFromVito_mod_layer_2.txt | 2/19/2021 2:39 PM | TXT File | 4 KB | |
|  WaterBodiesFromVito_mod_layer_3.txt | 2/19/2021 2:39 PM | TXT File | 4 KB | |
|  WaterBodiesFromVito_mod_layer_4.txt | 2/19/2021 2:39 PM | TXT File | 4 KB | |
|  WaterBodiesFromVito_mod_layer_5.txt | 2/19/2021 2:39 PM | TXT File | 4 KB | |
|  WaterBodiesFromVito_mod_layer_6.txt | 2/19/2021 2:39 PM | TXT File | 4 KB | |
|  WaterBodiesFromVito_mod_layer_7.txt | 2/19/2021 2:39 PM | TXT File | 4 KB | |
|  WaterBodiesFromVitoList.csv | 2/19/2021 2:32 PM | Microsoft Excel C... | 3 KB | |

Left: Input file

| 1 | LakeID | row | col | AreaRatio |
|----|--------|-----|-----|-------------|
| 2 | 1 | 667 | 346 | 0.410721207 |
| 3 | 1 | 667 | 347 | 0.589278793 |
| 4 | 2 | 600 | 326 | 0.053270891 |
| 5 | 2 | 600 | 327 | 0.006602863 |
| 6 | 2 | 600 | 328 | 0.003736122 |
| 7 | 2 | 601 | 326 | 0.039475764 |
| 8 | 2 | 601 | 327 | 0.356996443 |
| 9 | 2 | 601 | 328 | 0.176070058 |
| 10 | 2 | 602 | 327 | 0.140998759 |
| 11 | 2 | 602 | 328 | 0.165612569 |
| 12 | 2 | 603 | 327 | 0.035219784 |
| 13 | 2 | 603 | 328 | 0.022016745 |
| 14 | 3 | 675 | 350 | 0.509295915 |
| 15 | 3 | 676 | 350 | 0.490704085 |
| 16 | 4 | 589 | 319 | 6.70597E-05 |
| 17 | 4 | 589 | 320 | 0.132416504 |
| 18 | 4 | 590 | 319 | 0.006522296 |
| 19 | 4 | 590 | 320 | 0.546793444 |
| 20 | 4 | 590 | 321 | 0.260882152 |

Right: Example output file

| 1 | LakeID | Head_SP1 | Head_SP2 | SP2-SP1 |
|----|--------|------------|------------|-----------------|
| 2 | 1 | 24.7393475 | 24.7195854 | -0.19762039E-01 |
| 3 | 2 | 74.5836411 | 74.5674744 | -0.16166687E-01 |
| 4 | 3 | 24.4769096 | 24.4633064 | -0.13603210E-01 |
| 5 | 4 | 74.3933563 | 74.3825607 | -0.10795593E-01 |
| 6 | 5 | 48.5086479 | 48.5081062 | -0.54168701E-03 |
| 7 | 6 | 24.7302284 | 24.7157402 | -0.14488220E-01 |
| 8 | 7 | 22.3175220 | 22.3173447 | -0.17738342E-03 |
| 9 | 8 | 23.0317097 | 23.0307198 | -0.98991394E-03 |
| 10 | 9 | 75.3910904 | 75.3739090 | -0.17181396E-01 |
| 11 | 10 | 23.4532032 | 23.4505329 | -0.26702881E-02 |
| 12 | 11 | 25.1041222 | 25.0831337 | -0.20988464E-01 |
| 13 | 12 | 23.3322315 | 23.3196392 | -0.12592316E-01 |
| 14 | 13 | 25.7418613 | 25.7415829 | -0.27847290E-03 |
| 15 | 14 | 24.9907188 | 24.9694271 | -0.21291733E-01 |
| 16 | 15 | 73.8239746 | 73.7968674 | -0.27107239E-01 |
| 17 | 16 | 10.3331909 | 10.3266621 | -0.65288544E-02 |
| 18 | 17 | 43.3228607 | 43.3218536 | -0.10070801E-02 |
| 19 | 18 | 22.5555153 | 22.5553055 | -0.20980835E-03 |
| 20 | 19 | 20.0438347 | 20.0429497 | -0.88500977E-03 |
| 21 | 20 | 20.9334354 | 20.9332638 | -0.17166138E-03 |
| 22 | 21 | 23.1942368 | 23.1778316 | -0.16405106E-01 |