Quick Users Guide to the NFSEG Automated Water-Use Permit Simulation Tool:

Step-by-Step Procedures

Disclaimer

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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 Suwanee 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

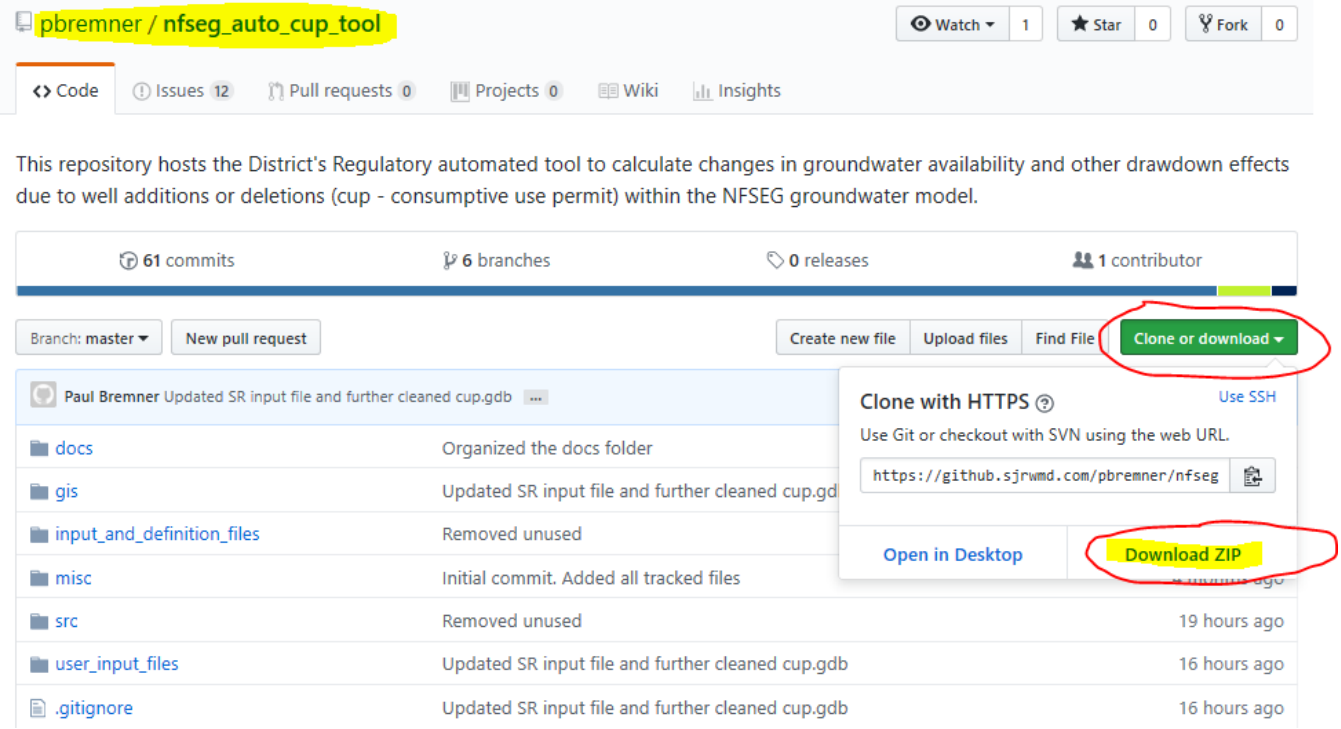
NOTE: This process only needs to be done once per tool update.

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. Navigate to the Tool's GitHub repository (https://github.sjrwmd.com/pbremner/nfseg_auto_cup_tool) and download the zip file. 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 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. Search for the Python bundled with ArcGIS.
b. 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.
c. Unzip the model data directory.

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".

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 and 3 from the simulation is output to the results gis 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_srwmd.csv”

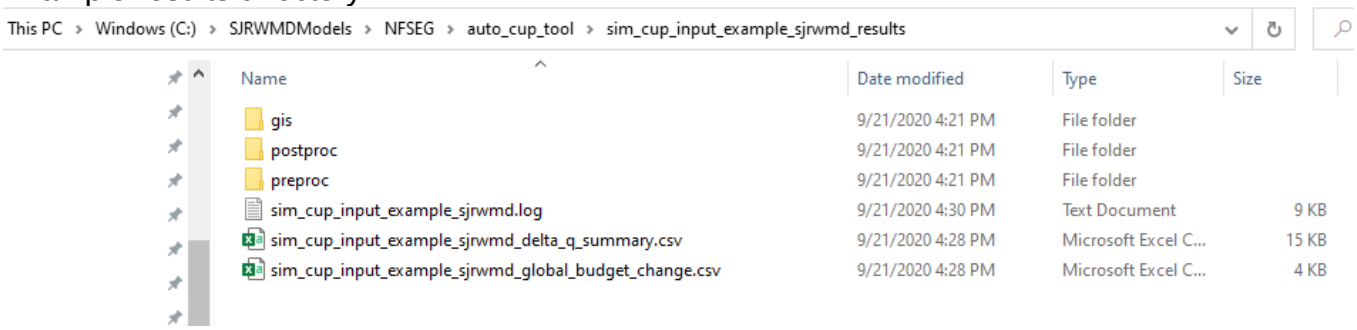
then the results directory will be named:

“sim_cup_input_example_srwmd_results”

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

“sim_cup_input_example_srwmd_delta_q_summary.csv”
“sim_cup_input_example_srwmd_global_budget_change.csv”
“sim_cup_input_example_srwmd.log”

Example results directory:



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].

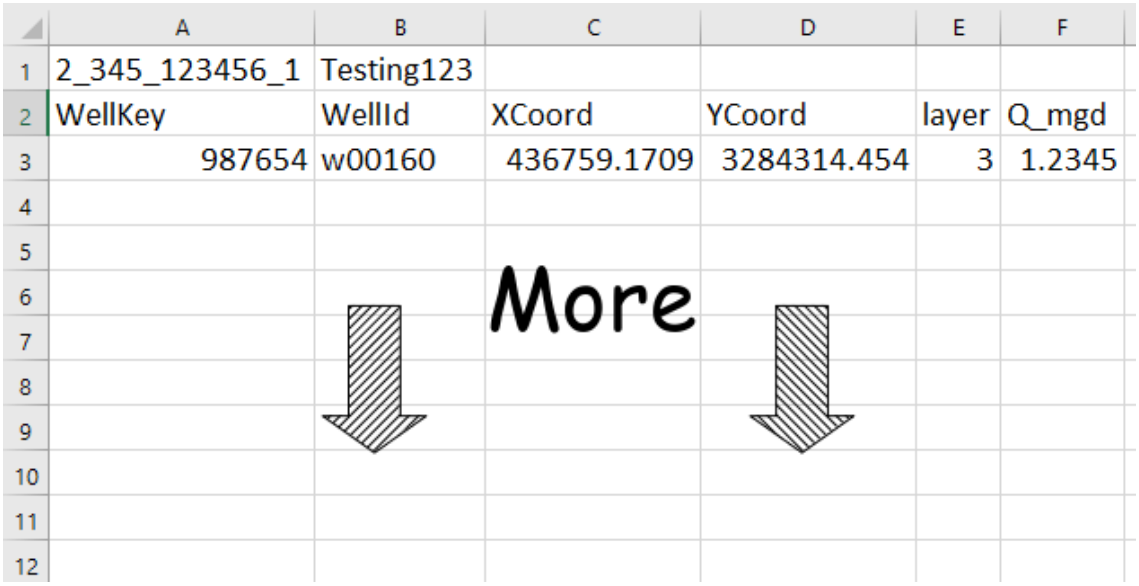
IMPORTANT: The Suwanee River Water Management District (SRWMD) and St Johns River Water Management District (SJRWMD) utilize two different map projections in GIS. Make note of which projection was used in GIS and input the selection when prompted at the command line.

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.

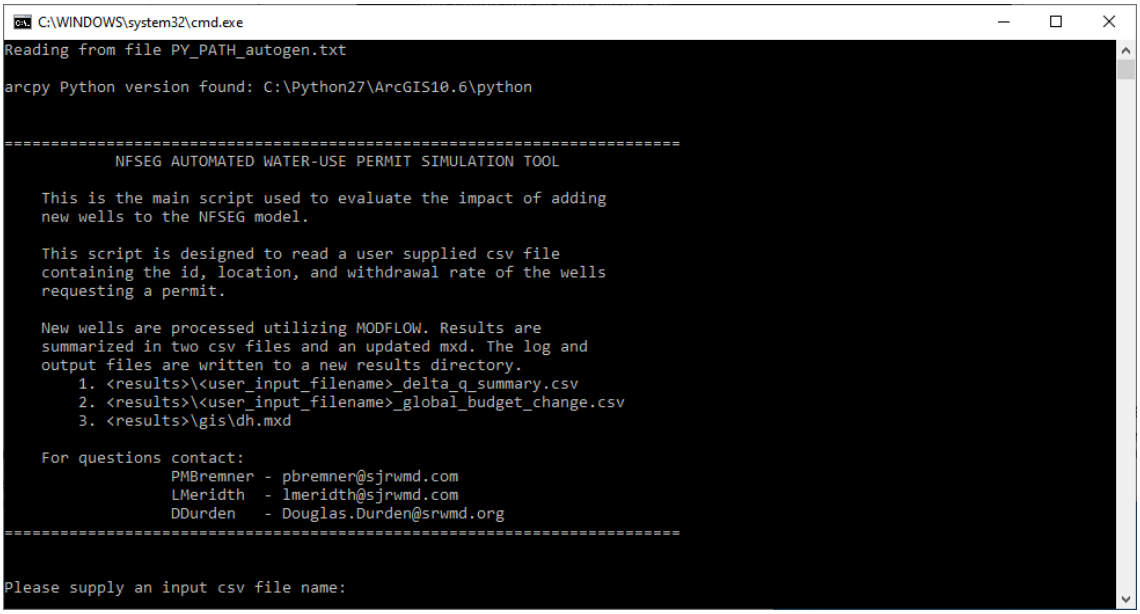
Table 1 User input file example. File should be created in MS Excel, or equivalent, and be saved as a .csv file.



Running the Water-Use Simulation Permit Simulation

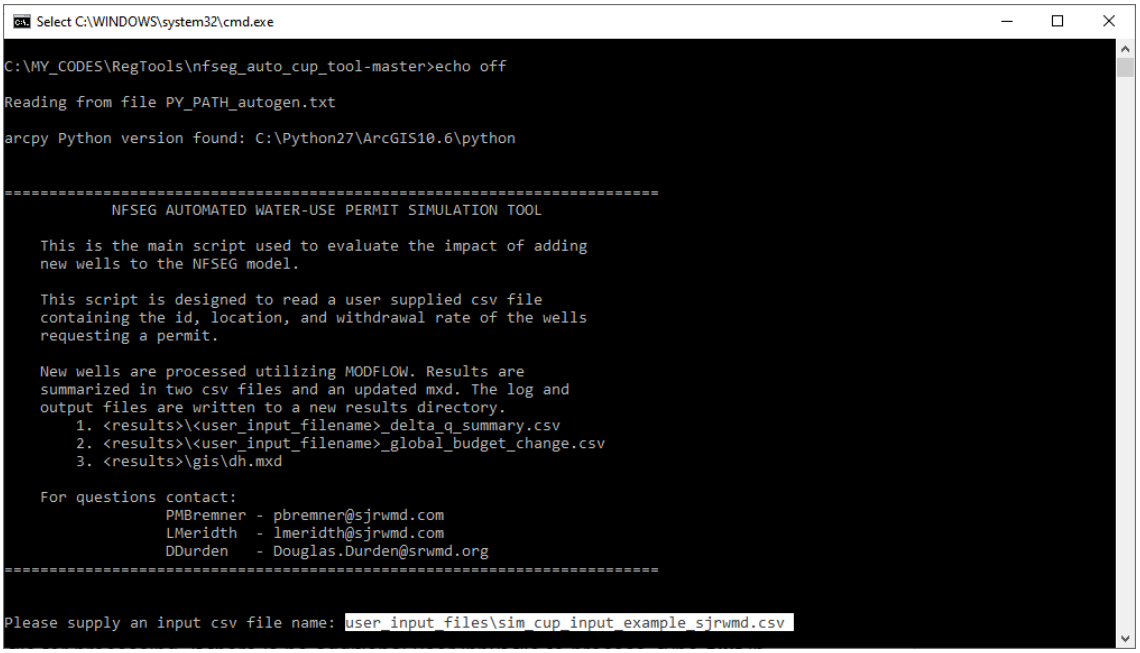
The Automated Water-Use Permit Simulation Tool runs a batch script within a Windows Command Prompt console. In the background, the batch script runs a Python script that controls the processing workflow and manages output. Successive input files may be processed without limit, where each new User input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

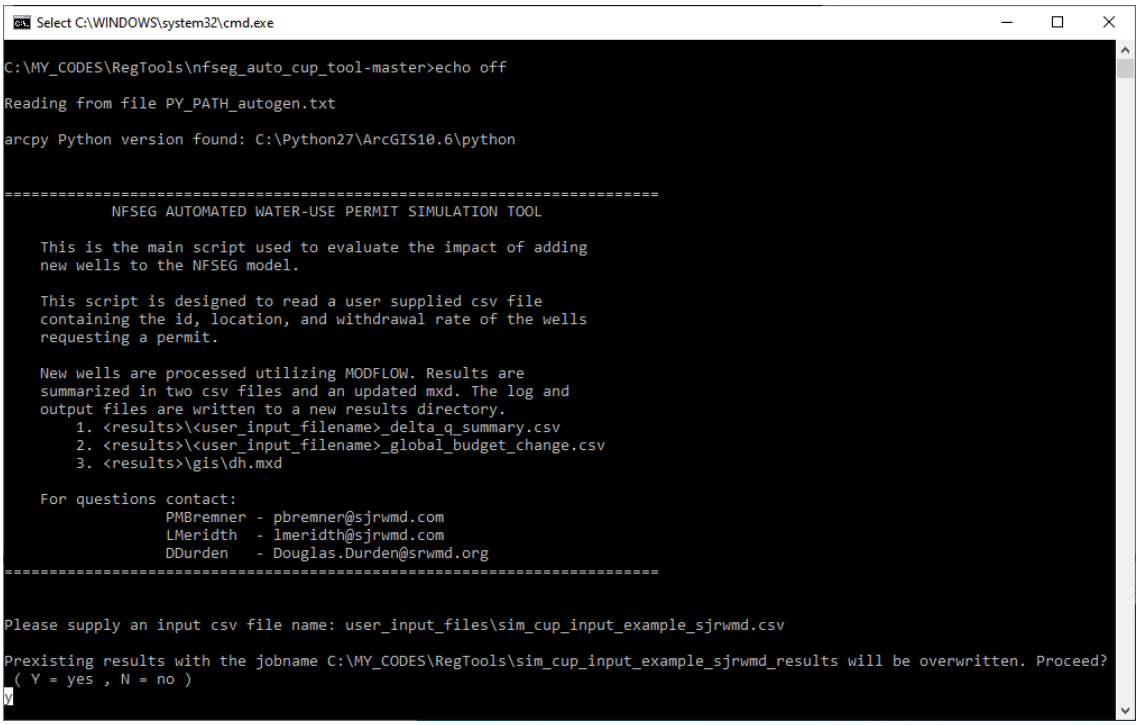
1. Navigate to the top-level directory of the tool
2. Double click on the batch file *sim_cup_initiate.bat*. A console will pop-up on the screen. When first opened, the tool may take a few moments to initialize before prompting for User input.

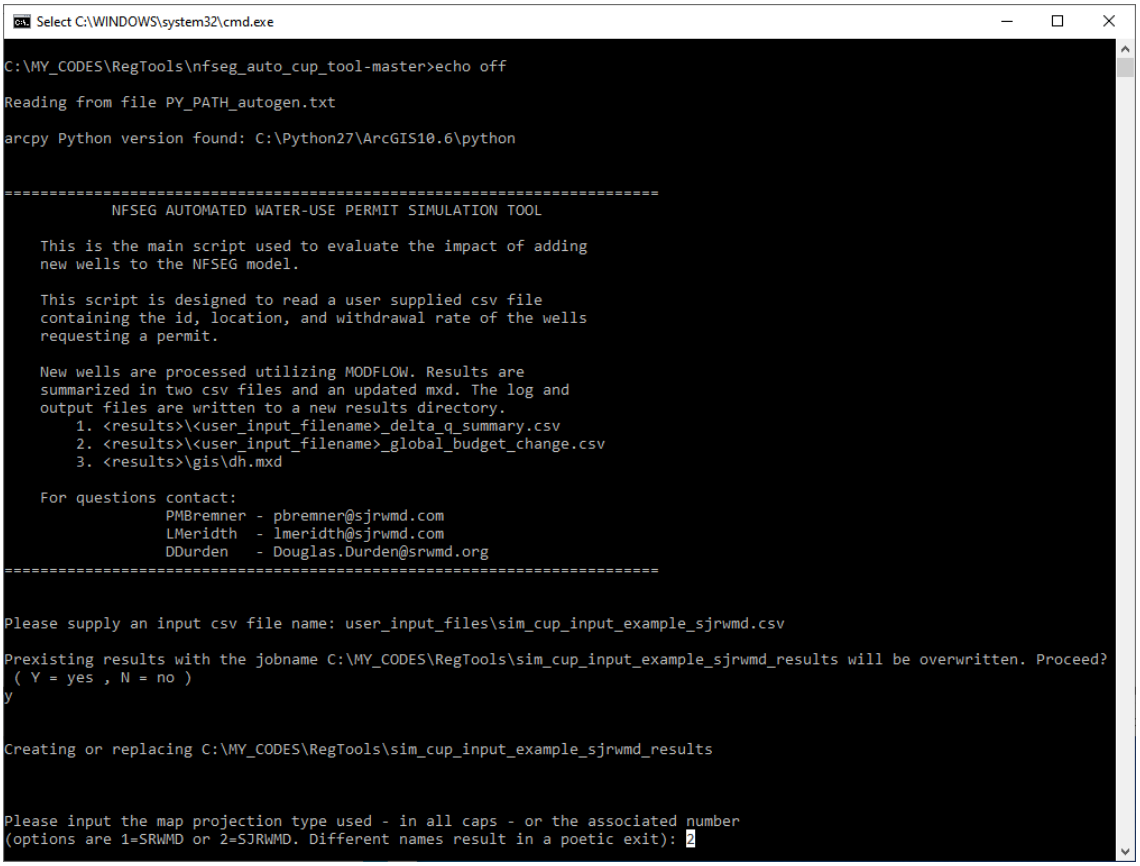


3. Follow the prompts to input both the User input csv filename, whether to proceed with overwriting an existing results directory possessing the same name (overwrite is currently the only option), as well as the map projection that corresponds to what was used in GIS to obtain the X,Y coordinates of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

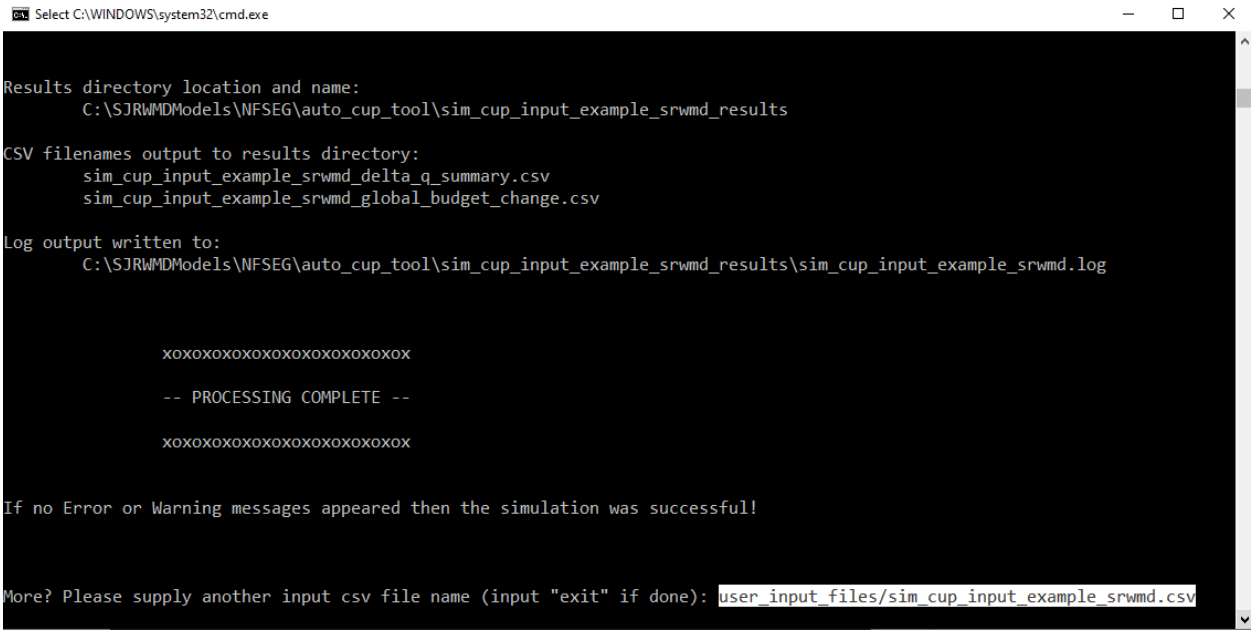






4. The simulation proceeds to run. Monitor the output to ensure no error messages appear. If the simulation was successful, then the output files will be written to

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.



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_srwmd.log - Notepad
File  Edit  Format  View  Help
xoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxox

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

        --                     LOG OUTPUT                    --

        Run datetime: Tue Sep 22 16:06:08 2020
xoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxoxox




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



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

CSV filenames output to results directory:
        sim_cup_input_example_srwmd_delta_q_summary.csv
        sim_cup_input_example_srwmd_global_budget_change.csv
Nothing to delete: C:\SJRWMDModels\NFSEG\auto_cup_tool\sim_cup_input_example_srwmd_results\sim_cup_input_example_srwmd_delta_q_s

Nothing to delete: C:\SJRWMDModels\NFSEG\auto_cup_tool\sim_cup_input_example_srwmd_results\sim_cup_input_example_srwmd_global_bu
Ln 1, Col 1    100%    Windows (CRLF)    UTF-8
```

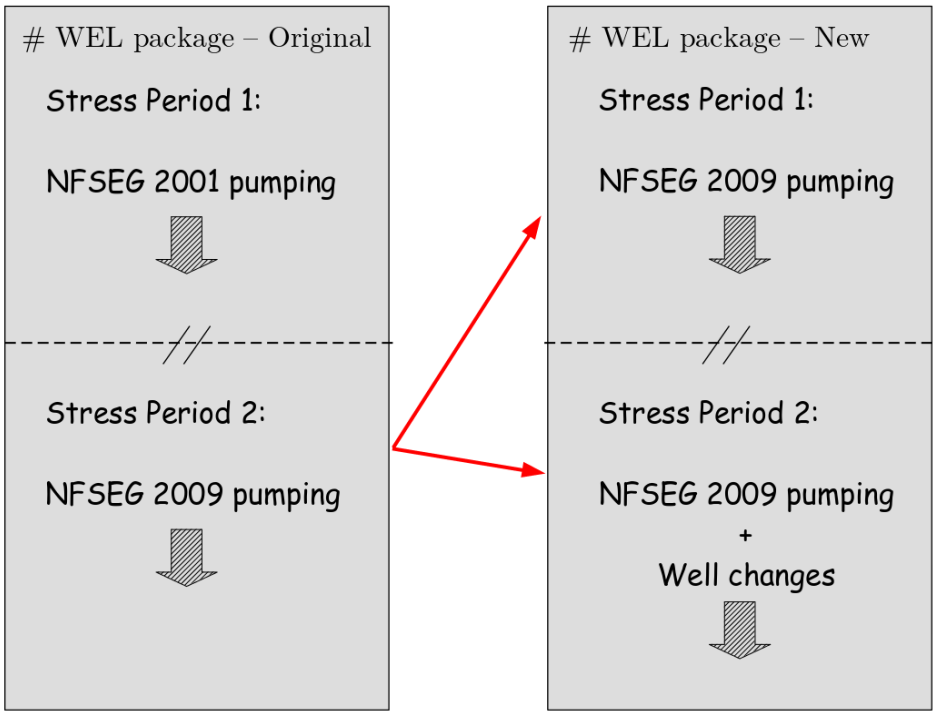
Tool Operations and Results

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 and spring flow gages
- Change in head water levels in model layers 1 and 3

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 2^{nd} Stress Period (2009), which becomes the new Stress Period 1. The new 2^{nd} Stress Period repeats Calibrated NFSEG 2^{nd} 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 flow changes from the *.lst* and *.hds* files.
   a. The global water budget is summarized in the *<user_input_filename>_global_budget_change.csv* (see example):

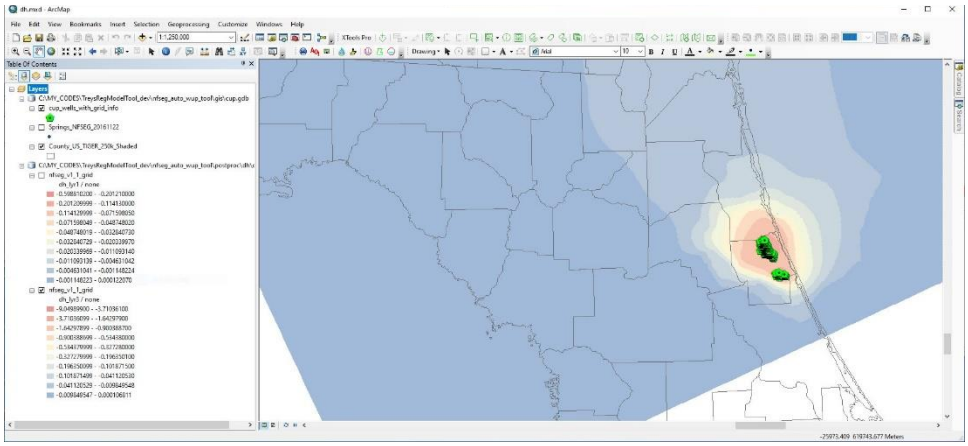
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	bc_flux_type	flux_units	timeStep_1	stressPeriod_1	timeStep_2	stressPeriod_2	in_rate_1	in_rate_2	in_rate_2_minus_1	out_rate_1	out_rate_2	out_rate_2_minus_1	net_rate_1	net_rate_2	net_rate_2_minus_1	net_rate_2_minus_1_fraction_of_netWellPkg
2	CONSTANT HEAD	cfd	1	1	1	2	58922484	58922604	120	140176128	140172416	-3712	-81253644	-81249812	3832	-0.02
3	DRAINS	cfd	1	1	1	2	0	0	0	986734720	986689792	-44928	-986734720	-986689792	44928	-0.27
4	ET	cfd	1	1	1	2	0	0	0	2611415808	2611369984	-45824	-2611415808	-2611369984	45824	-0.28
5	HEAD DEP BOUNDS	cfd	1	1	1	2	174854640	174857904	3264	674153728	674134976	-18752	-499299088	-499277072	22016	-0.13
6	MNW2	cfd	1	1	1	2	3644703.75	3644517.5	-186.25	19595294	19595108	-186	-15950590.25	-15950590.5	-0.25	0
7	RECHARGE	cfd	1	1	1	2	5298147328	5298147328	0	0	0	0	5298147328	5298147328	0	0
8	RIVER LEAKAGE	cfd	1	1	1	2	217602304	217606160	3856	1165426688	1165385344	-41344	-947824384	-947779184	45200	-0.27
9	STORAGE	cfd	1	1	1	2	0	0	0	0	0	0	0	0	0	0
10	WELLS	cfd	1	1	1	2	54044196	54044196	0	209716688	209881712	165024	-155672492	-155837516	-165024	1

   b. The change in flow is summarized in *<user_input_filename>_delta_q_summary.csv* (see example):

	A	B	C	D	E	F	G
1	station_number	station_name	simulated_flux_base_condition_cfs	simulated_flux_with_cup_cfs	simulated_change_in_flow_cfs	simulated_change_in_flow_as_fraction_of_flow	simulated_change_in_flow_as_a_fraction_of_cup
2	2315000	suwannee river near benton	-10844063.83	-10844055.12	8.71	-0.000001	4.560081
3	2315500	suwannee river at white springs	-14057591.11	-14057563.86	27.25	-0.000002	14.266615
4	2317620	alapaha river near jennings fla	-70018600.69	-70018577.36	23.33	0	12.214317
5	2319000	withlacoochee river near pinetta fla	-72635267.35	-72634928.86	338.49	-0.000005	177.214919
6	2319394	withlacoochee river nr lee	-110119358.1	-110118303.8	1054.29	-0.00001	551.968792
7	2319500	suwannee river at ellaville	-260075567.4	-260072360.3	3207.07	-0.000012	1679.047088
8	2319800	suwannee river at dowling park	-270122613.4	-270119339.4	3273.97	-0.000012	1714.072283
9	2320000	suwannee river at luraville	-285509495.7	-285506189.3	3306.37	-0.000012	1731.035157
10	2320500	suwannee river at branford	-338422913.9	-338419497.7	3416.17	-0.00001	1788.520454
11	2320700	santa fe river near graham	-285926.635	-285855.788	70.847	-0.000248	37.091629
12	2321000	new river near lake butler	-1437561.57	-1437532.06	29.51	-0.000021	15.449828
13	2322700	ichetucknee river at us hwy27 near hildreth	-23341434.1	-23341201.6	232.5	-0.00001	121.72433
14	2321500	santa fe river near worthington springs	-3758588.415	-3758429.368	159.047	-0.000042	83.268342
15	2321975	santa fe river at us hwy 441 near high springs	-12648148.06	-12647062.51	1085.547	-0.000086	568.333254
16	2322500	santa fe river near fort white	-62517471.06	-62515986.31	1484.747	-0.000024	777.33262
17	2322800	santa fe river near hildreth	-98587560.66	-98585803.61	1757.047	-0.000018	919.894062
18	2323500	suwannee river near wilcox	-473961157.4	-473955957.3	5200.117	-0.000011	2722.49789
19	2323592	suwannee river ab gopher river nr suwannee	-514120604.3	-514115340.2	5264.117	-0.00001	2756.004802
20	2313700	waccasassa river nr gulf hammock	-10691330	-10690833.6	496.4	-0.000046	259.88799
21	2324000	steinhatchee river near cross city	-5377135.54	-5377135.54	0	0	0

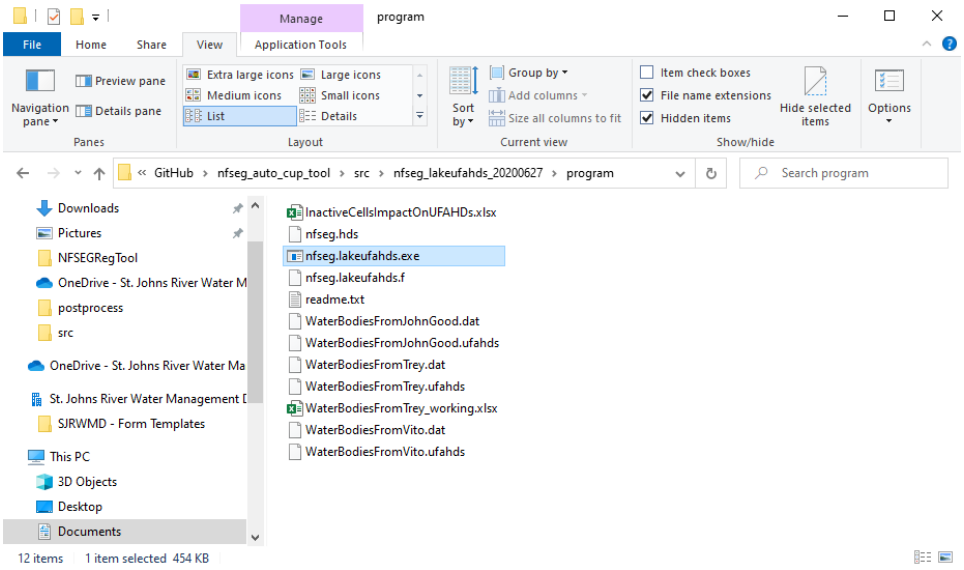
   c. The change in head levels of layers 1 or 3 are viewable from the *dh.mxd* (see example below). **NOTE**: The change in head feature layers generated during post-processing (*dh_layerX, where X represents the model layer number*) may need to be rescaled in the *dh.mxd* file. This can

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.



Lake-UFA Head Extraction

A separate, standalone tool that extracts the Lake-UFA head levels is bundled with this Tool. To navigate to the extraction tool, start from the top-level tool directory and enter into the subdirectory *src\nfseg_lakeufahds\program:*



To use the extraction tool:

- Copy the heads file produced by the MODFLOW run into the extraction tool program directory:
  - From the results directory, copy *postproc\dh\nfseg_auto.hds* to the tool program directory
  - Rename as *nfseg.hds*.

- Double click the Fortran executable file, *nfseg.lakeufahds.exe*, to run the extraction tool.
- Once the process is complete, the output may be moved back to the results directory.

Currently, the tool processes from three lists of lakes, and creates an output file for each of them. Each output filename has the suffix *.ufahds*. Below is an example of the input and output files.

- The input file (left) lists the NFSEG grid rows and columns, as well as the area that make up each lake. Each lake has a unique ID.
- The output file (right) lists the average UFA head levels for each Stress Period beneath each LakeID