

**SARASOTA COUNTY
POLLUTANT LOADING MODEL
OPERATIONS MANUAL**

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TABLE OF CONTENTS

1	INTRODUCTION.....	1
2	POLLUTANT LOADING MODEL.....	1
2.1	Installation and Platform.....	1
2.2	Functionality	2
2.3	Execution.....	2
2.3.1	Quick Startup	2
2.3.2	Further Instruction	8
2.4	Output Reporting.....	9
2.5	Troubleshooting	11
3	LIMITATIONS	12

LIST OF FIGURES

Figure 1.	SIMPLE-Monthly Icon and Model Parameters Tab	4
Figure 2.	Run Model Tab.....	5
Figure 3.	Prompt to Select Basins.....	6
Figure 4.	Run Model Tab after Basin Selection	7
Figure 5.	Symbology Tab	8
Figure 6.	Example Results Export to Excel.....	10
Figure 7.	Example Results Export to Map.....	10

APPENDICES

Appendix A Installation Instructions

1 INTRODUCTION

This document serves as a working guide for users of the monthly time-step pollutant loading model (SIMPLE-Monthly) developed for Sarasota County and Southwest Florida Water Management District. Jones Edmunds recommends that users of this model should be fairly knowledgeable about ArcGIS software and methods, particularly if input data will be edited, and also understand the methodology behind the model's development and calculations. For further details on model development or calibration please refer to the Final Design Report and Model Calibration Report.

In the first phase of the pollutant loading model project, Jones Edmunds developed a County-wide pollutant loading model within a GIS framework for Sarasota County. The model is referred to as the *Spatially Integrated Model for Pollutant Loading Estimates* (SIMPLE) and uses computational methods from the Watershed Management Model (WMM) and the Harvey Harper Method as well as additional methods to predict seasonal and annual loads from point sources, non-point sources (direct runoff and base flow), and septic tanks.

The first component of the second phase added model functionality and changed the model time step from seasonal to monthly to synchronize with the approximate time-sensitivity of the response from the County's bay systems to pollutant loads. Model enhancements included a significant change in the hydrologic calculations, the addition of wet and dry deposition of pollutants directly on the Bays, three forms of irrigation, time-stamping of spatial data, refinements to septic tank loading, and improved output formatting (both geographic and tabular). In essence the second phase of the project added a second mode to SIMPLE. As a naming convention, the two modes of the model are referred to as *SIMPLE-Seasonal* and *SIMPLE-Monthly*.

The second component of the second phase focused on calibrating SIMPLE-Monthly using flow monitoring data collected during the 2007 hydrologic year at multiple sites throughout Sarasota County. This document details the use of the calibrated SIMPLE-Monthly model.

2 POLLUTANT LOADING MODEL

SIMPLE-Monthly is a pollutant loading model working within a GIS framework and capable of simulating runoff, base flow, wet and dry deposition, irrigation, point source, and septic loads. Each load-contributing source is modeled with a separate module within SIMPLE-Monthly.

2.1 INSTALLATION AND PLATFORM

SIMPLE-Monthly is run from an open instance of v10.3.1 ArcMap. Rather than referencing a Visual Basic macro, the model runs as an ArcMap extension developed as a VB.net dll file. The model deployment folder includes all files required for installation. Most importantly, the template geodatabase and installation_instruction.txt files are included.

The template geodatabase stores all input rates and concentrations. Rates and concentrations included in the deployment template geodatabase are the result of calibration to County-wide data. All rates and concentrations can be edited by the user, but Jones Edmunds suggests that the user maintain a copy of the original template database included with the deployment folder.

The deployment package also contains field mapping schemas in text format. During the design phase it was considered necessary to make the application as flexible as possible in regard to the required fields in the source datasets. These schemas describe how the input values will be loaded in the output file geodatabase. The schemas can be edited either directly with a regular text editor or from the first tab of

the application form titled General Setup by choosing the Field Mapping button. After a change has been made, the "Save changes" button needs to be activated. See paragraph 2.3.2 below for more information.

The installation_instruction.txt file details step-by-step installation instructions and basic information required to run SIMPLE-Monthly. This file has been included in this manual as Appendix A.

NOTE: The user will need to install SIMPLE-Monthly in a local directory as the installation source and destination. Due to common administrator privileges, it is unlikely that installation will be successful if the installation files are located on a network or installed to a network location.

2.2 FUNCTIONALITY

Critical functional characteristics of the model include the following:

- The user can perform all functions within ArcMap Version 10.3.1.
- The user has control over drainage basins and groups for which reporting will be done.
- The user can select which drainage basins, land use, soils, BMP, irrigation, point sources, and septic feature classes to use for the calculations.
- The user can specify which months to simulate for January 1989 through December 2016.
- The program automatically generates a log file that will allow quick duplication of a previous run.
- The program automatically validates the user's inputs to verify that all fields required are present.
- The user has control over previously hard-coded parameters such as conversion factors.
- All lookup tables are readily updatable by the user.
- The model supports multiple BMP types, each with its own set of removal efficiencies.
- Items such as land use types, BMP types, and pollutants are readily expandable.

2.3 EXECUTION

The Quick Startup section (2.3.1) is aimed at users wanting to run the model quickly and will guide the user through the main elements of model progression. The Quick Startup section is intended for use with the Jones-Edmunds-provided data for Sarasota County and effectively acts as a tutorial to SIMPLE-Monthly. For more advanced users, the Further Instruction section (2.3.2) offers a more thorough explanation of model setup requirements and capabilities.

2.3.1 QUICK STARTUP

Following a successful installation, open an instance of ArcMap and click on the SIMPLE-Monthly Icon. Select "Yes" to the pop-up window requesting: "Will you be loading the source data from the template PGDB?" Navigate to the personal geodatabase containing the input data. This is the recommended method for running the model. Maintaining the input data in the schema provided by this template will ensure proper data formatting. In the March 2011 release of SIMPLE-Monthly, several input files have been made optional when running in this manner (using the input geodatabase). When loading input data from the template, the feature class must be present, but no data are necessary for the model to run. Another way to simulate and ignore certain inputs is to navigate to the input geodatabase, but then select "Ignore" for that feature's drop-down combo-box on the model interface. Optional feature classes may include BMP, Irrigation, Septic, Point Sources, and Non-Compliant Point Sources. Next, save the .mxd locally.

For this tutorial, we will assume the user has navigated to the source data geodatabase provided by Jones Edmunds covering Sarasota County. For a complete run – all modules – of SIMPLE-Monthly, nine feature classes are required. Listings of required fields for each feature class follow in parenthesis below.

1. Basins (DrainID, Name)
2. Soils (Hydrologic Group)
3. Landuse (Year Built, Lawn Health, Acres, Old FLUCCS Code, New FLUCCS Code, Old FLUCCS Description, New FLUCCS Description, "Old FLUCCS Code, Lawn Health", "New FLUCCS Code, Lawn Health")
4. Nexrad Pixels (Pixel ID)
5. Irrigation (Source, Rate, Year Built, Acres)
6. Best Management Practices (BMP Type, Year Built)
7. Septics (Year Built, Year Offline, Failure Rate, Concentration ID)
8. Point Sources (Latitude, Longitude, Facility, Point Source ID)
9. Non-compliant Point Sources (Latitude, Longitude, Facility, Volume, Load Date, Type)

NOTE: The user will need to ensure that all fields are of the appropriate data type, are populated correctly, and that appropriate changes are made to the field mapping files if not using data provided by Jones Edmunds covering Sarasota County. Maintaining the schema of the supplied input data geodatabase will ensure that error checking goes well.

Now that the user has selected the input sources, the template geodatabase location must be selected. Note that this is NOT the input geodatabase template. This is the model template which has been supplied with the installation files, and which carries with it additional input data and the schema for the output. To set the template geodatabase location at the bottom of the Model Parameters tab, users can browse to it using the browse button to the right of the location entry field. When browsing to the location of the output geodatabase, the user should enter the name desired for output storage. While each geodatabase field can be manually edited without browsing through the file explorer, browsing ensures proper file location.

When the Model Parameters tab is filled completely as shown in Figure 1, the user should select the start month and year as well as the end month and year on the Run Model tab, as shown in Figure 2. With the desired time period selected, the user should click the Initialize Model Variables button on the Run Model tab. A period of 6 months is appropriate for first-time users. The status bar at the bottom of the model GUI will keep the user updated on model progress.

Figure 1. SIMPLE-Monthly Icon and Model Parameters Tab

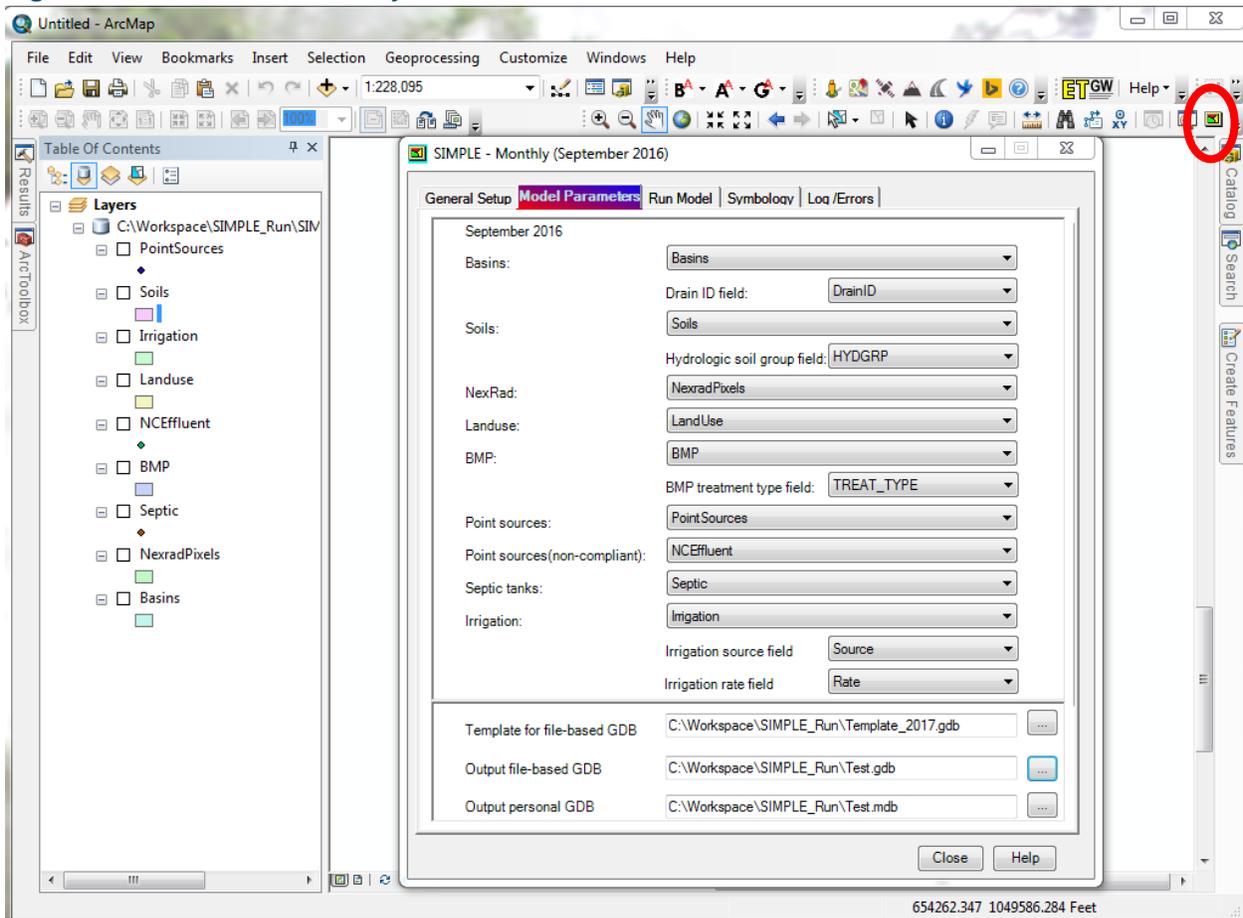
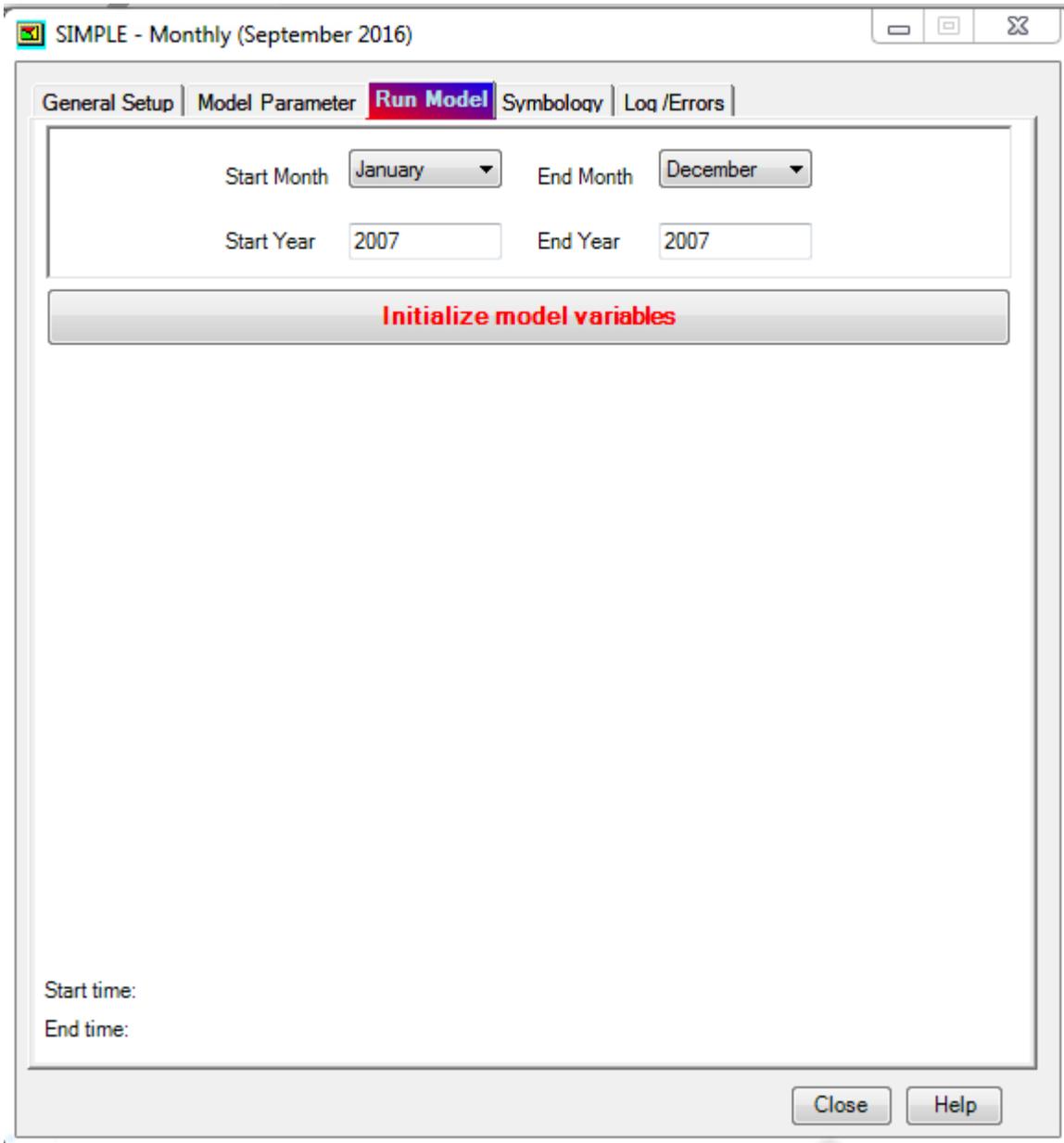


Figure 2. Run Model Tab



Once the model has completed the initialization process, the user will be prompted to select a basin or basins for simulation, as shown in Figure 3. The user must press the OK button before selecting a basin. The first-time user should select a basin with an area less than 1,000 acres. After the user selects OK, the Run Model tab should look like Figure 4.

Figure 3. Prompt to Select Basins

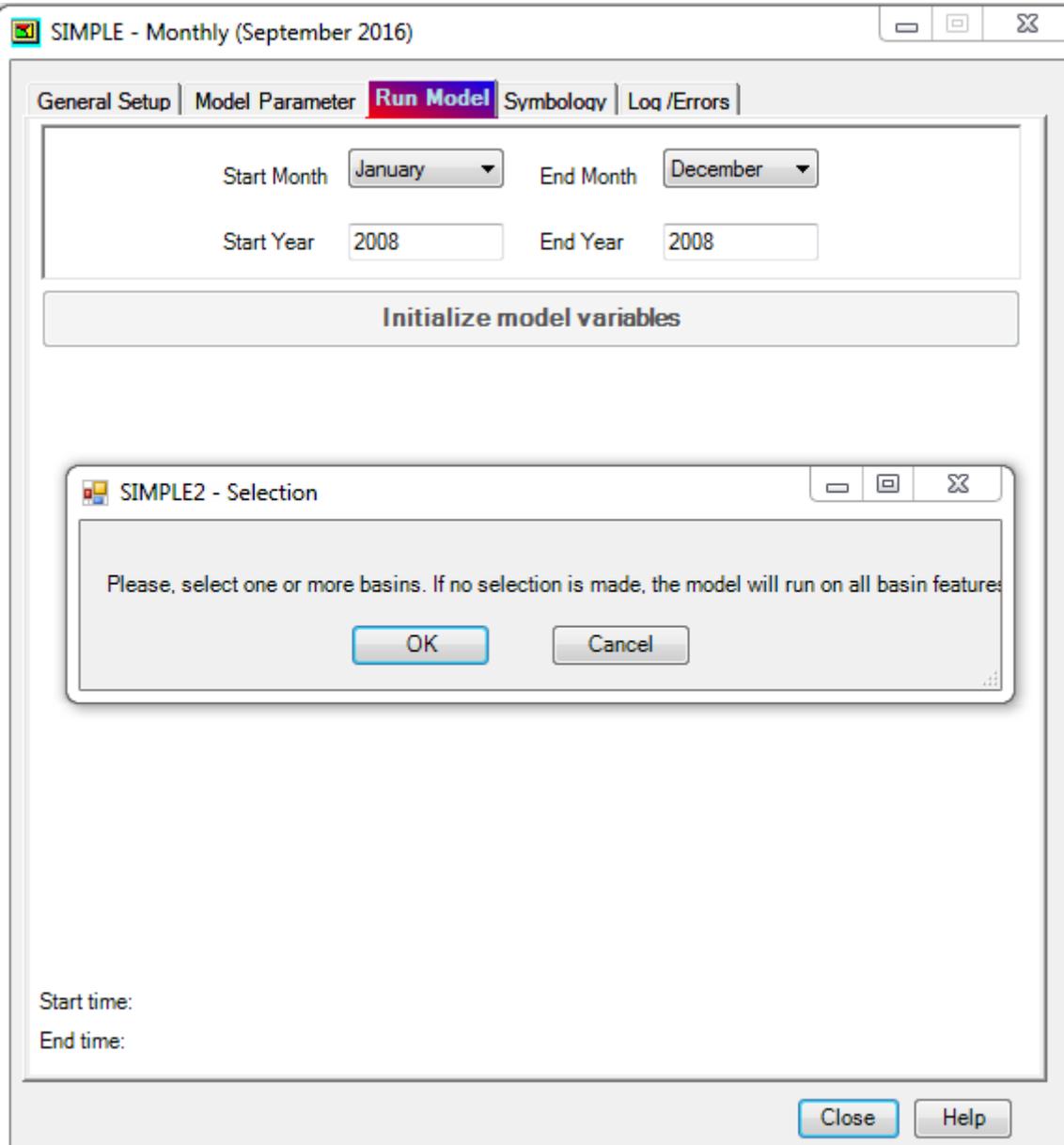
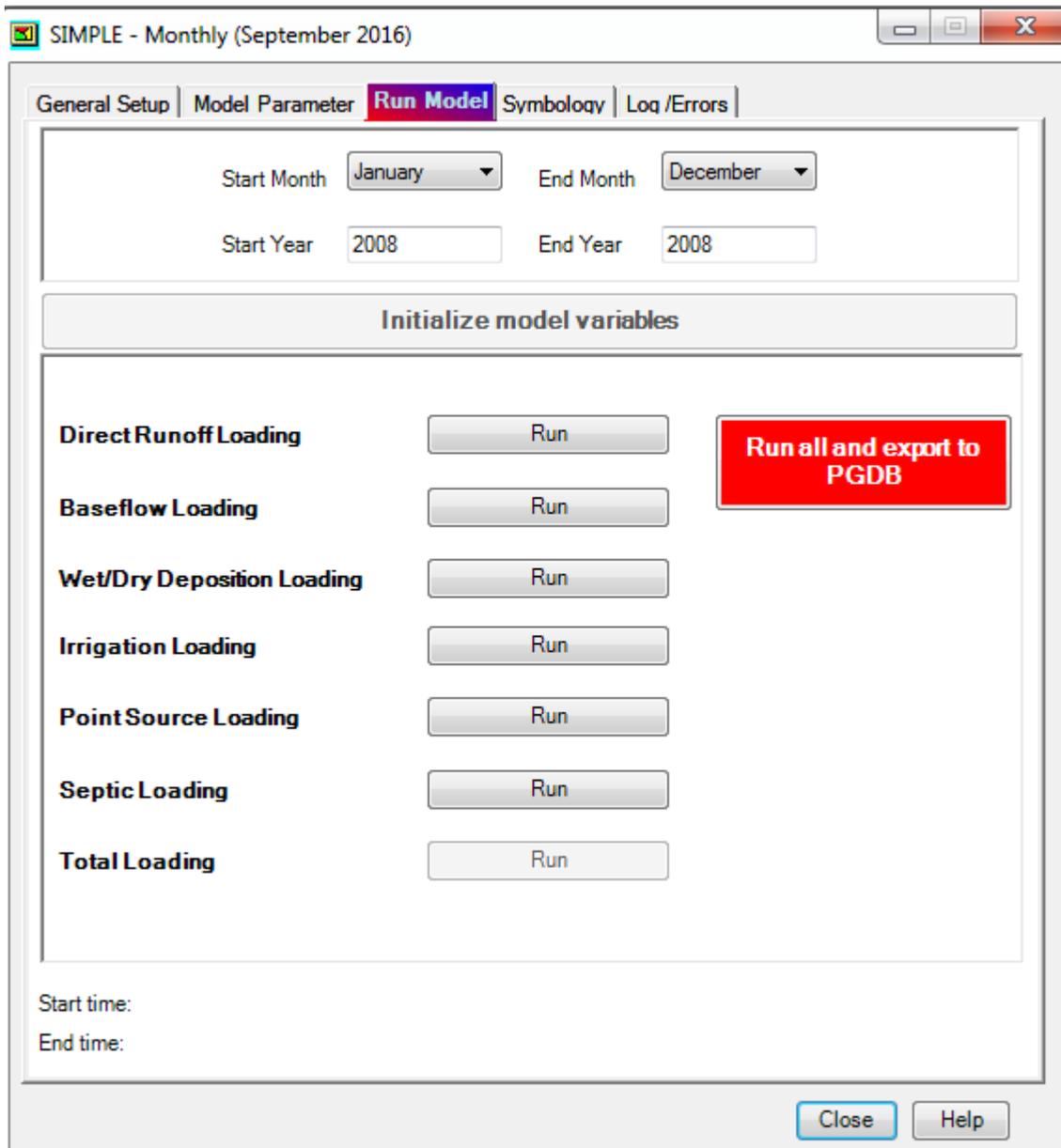


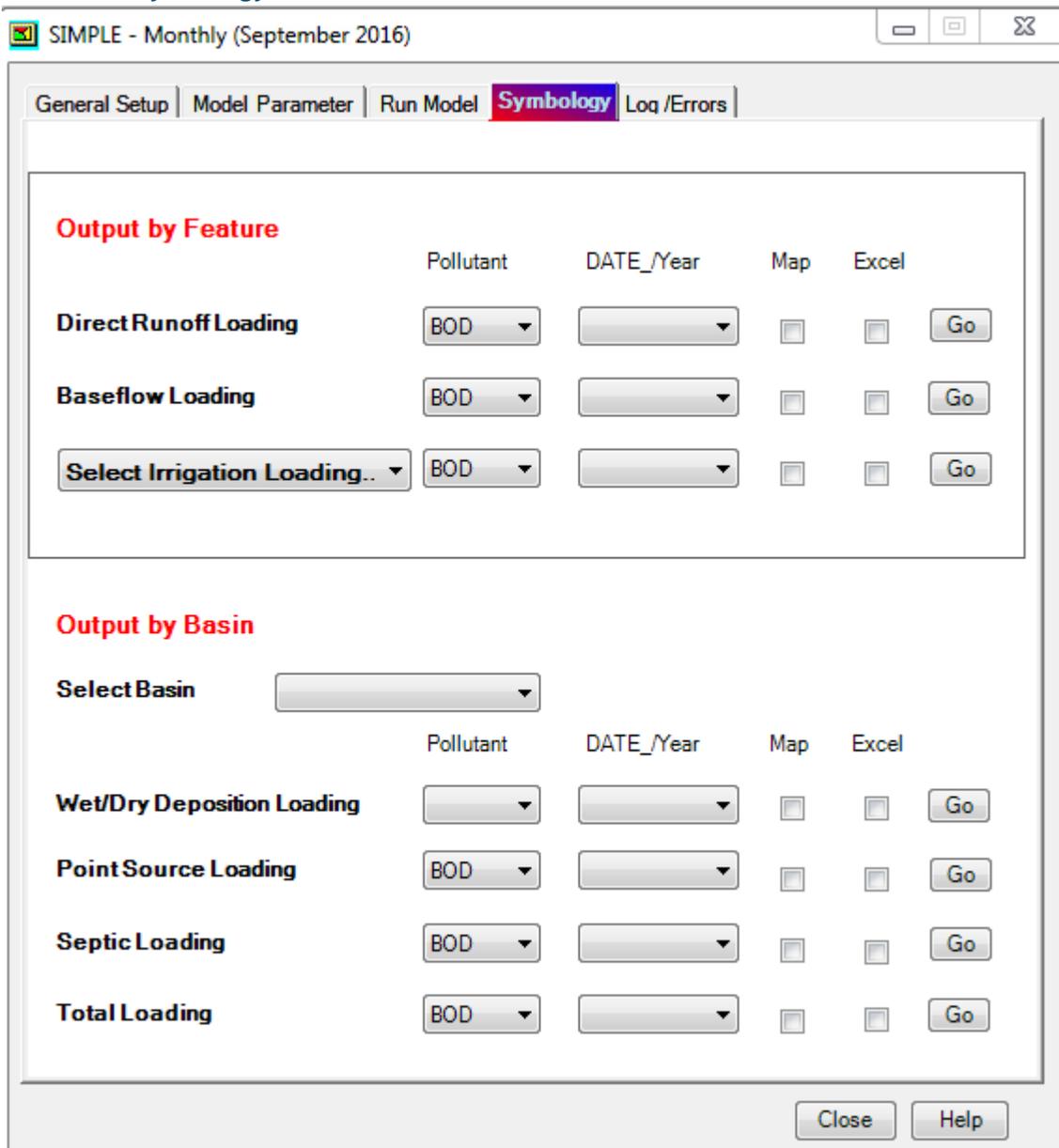
Figure 4. Run Model Tab after Basin Selection



At this point the model is ready for execution. Note that it is not possible to go back to the "Model Parameters" tab and specify different source data. There is an option to run each module individually in order from top to bottom, starting with Direct Runoff Loading, or running all modules in series with the use of the run all button to the right. As each module completes, the status will be updated in the log file available in the Log/Errors tab. After successfully executing the Total Loading module, the user has available a fully populated output geodatabase. All information will be available within the output geodatabase, and the user may close SIMPLE-Monthly at this point if the user does not wish to use the built-in Excel and ArcMap reporting. Closing the form will result in the removal of the hydrology table from the output database. This is done to conserve disk space, as the table is rather large. If the application does not exit in a normal way, the hydrology table will remain in the output FGDB.

To use the built-in reporting functions the user should click on the Symbology Tab, which is shown in Figure 5. More information on the functionality of the Symbology Tab is provided in the Output Reporting section (2.4).

Figure 5. Symbology Tab



2.3.2 FURTHER INSTRUCTION

The General Setup tab allows the user to assign fields from input shapefiles to fields in the output geodatabase. While the schema for the input files is completely user-definable, the output geodatabase schema is unchangeable. Therefore, the user must ensure that data types are compatible. When changing the input file schema, it is also important to ensure the data matches the lookup tables contained in the output geodatabase. If the user wishes to simulate loading using data provided by Jones Edmunds covering Sarasota County, no field assignment changes are required. Schema checks are also required for the yellow-highlighted dropdown menus in the Model Parameters tab, which will default to the schema of the Jones-Edmunds-provided data. While SIMPLE-Monthly is not concerned with the proper categorization of the land use, the model does assume that Category 15 is associated with bay areas. All other categorization is editable by the user.

Since the modules in SIMPLE-Monthly are independent, it is possible to execute simulations without including all nine input files. However, five input files—Basins, Landuse, Soils, NEXRAD Pixels, and

BMPs—must be included in the initialization process for any module execution. Conversely, Irrigation, Point Sources, Non-compliant Point Sources, and Septics input files are optional and only required for their respective module execution. Jones Edmunds suggests the user include all input files in the initialization process regardless of which modules are planned for execution because input data cannot be “added” following the initialization process.

The combination of large basins and long simulation periods may exceed ESRI’s temporary file storage capability, which crashes the simulation. For simulations less than a 5-year period, a basin area threshold of 10,000 acres is suggested. For simulations less than a 10-year period, a basin area threshold of 5,000 acres is suggested. For simulations covering longer periods, a basin area threshold of 3,000 acres is suggested. These time and size thresholds are guidelines and may vary depending on the amount of data available for a given area of interest.

For combinations of basin size and simulation time exceeding these thresholds, the simulation should first be segregated temporally into yearly simulations. If this temporal segregation is unsuccessful, the user should proceed with splitting the area of interest into several basins. While the user is not prompted for basin selection until after the initialization process is complete, the user can select the basin before initializing the model parameters and the selection will be maintained through the initialization process. If a selection is made before the model parameter is initialized, the user will still be prompted to select desired basins at that time. If no basin is selected, SIMPLE-Monthly will attempt to execute all basins stored in the Basin feature class individually.

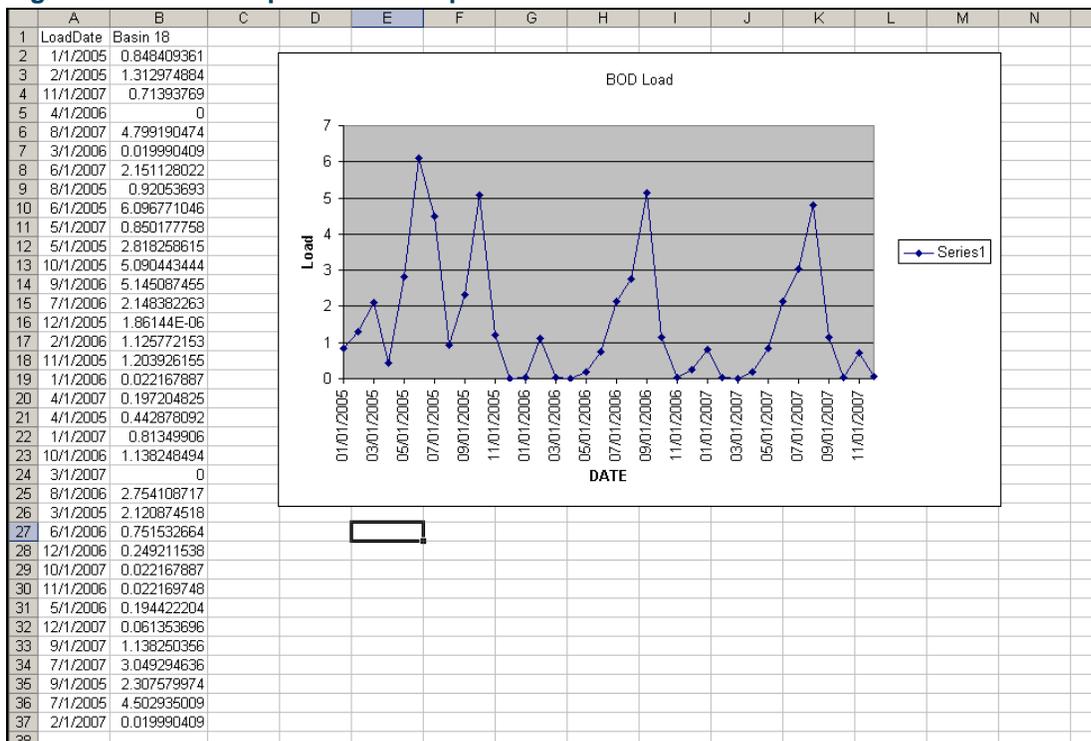
While modules can be run in any order and separately, Jones Edmunds recommends the user use the run all option of the model, so as to consolidate model results. If needed to run each module separately, Jones Edmunds recommends running each module from top to bottom, starting with Direct Runoff loading. The Total Loading module will not be available to run until at least one other module has completed successfully. Once the Total Loading module has been executed for a given simulation, it cannot be executed a second time. The user can exit the model after completing any single module, and populated data will be maintained in the output geodatabase.

2.4 OUTPUT REPORTING

There are two options for automated reporting in SIMPLE-Monthly: mapping within the .mxd and Excel export. Each pollutant loading module is capable of reporting in both fashions. Reports are displayed by checking either the Map or Excel box next to the loading module to be reported and clicking the associated Go button, as shown in Figure 5. Only one module can be displayed at a time, but Excel and Map reports can be created for a single module simultaneously. Jones Edmunds recommends the user run all desired modules before reporting any results.

Excel reporting is executed for each module individually. When exporting to Excel the results for a single pollutant (or Volume) for all simulated months will be exported to a new worksheet in the active Excel workbook. If no workbook is active, a new workbook will be created. The exported worksheet will carry the name of the exported pollutant and loading module. A graph of pollutant loads over time will also be created within the worksheet by default, as shown in Figure 6. This process can be repeated as new pollutants are selected from the dropdown menu for a given loading module. Each new report exported to Excel will be placed in the active workbook.

Figure 6. Example Results Export to Excel



Map reporting within the mxd is also executed for each module individually, but when reporting to the map only one month will display at a time. Similar to Excel reporting, the pollutant of interest (or Volume) is selected from the dropdown menu of the desired loading module. The desired month will also need to be selected from the dropdown menu of the desired loading module. When the associated Go button is pressed, loads for the selected pollutant and month will be displayed by calculation unit in the mxd, as shown in Figure 7.

Figure 7. Example Results Export to Map



2.5 TROUBLESHOOTING

The following problems arose during testing of SIMPLE-Monthly. Each solution follows a typical question users may ask.

I am having trouble installing SIMPLE-Monthly. How do I know if I am an administrator?

Commonly, the biggest hurdle during installation is gaining administrator privileges. A Visual Basic script (VerifyLocalAdmin.vbs) is provided with the installation files that will verify the privilege status of the logged user. The user should double click on the .vbs file to execute the script. Also the user should be sure to copy all installation files locally before installation, since the operating system may consider a remote installation from the network to be a security threat.

After a successful simulation I see results for a Basin 0. What is this?

During testing of SIMPLE-Monthly, users noticed that following successful simulations – no logged error messages – for a single basin model results would list two basins. One basin would be the basin of interest and the other would be a mysterious Basin 0. Further testing by Jones Edmunds isolated the problem to ArcMap Service Pack 2 users. The user should execute the Visual Basic script CheckArcMapversion.vbs provided with the installation files to determine which Service Pack is installed. The CheckArcMapversion_readme.txt file describes the script output.

Detailed testing determined the Basin 0 results from an error during the Union of intersected shape files. We noted that some calculation units did not carry over the basin of interest name during the Union – again Jones Edmunds related this back to Service Pack 2. This means if a user continually receives the Basin 0 in the output tables by mistake for a given area and the user has eliminated Service Pack issues as a possible cause there remains a work around. The user will need to simulate one basin at a time for the given data set causing this problem. If only one basin is simulated, the output files will contain the simulated basin plus Basin 0. The user can then summarize the results by month to receive the true model output for the given basin.

I am only able to complete one simulation successfully. Every following simulation returns errors during different modules. Why is this happening?

Unfortunately, SIMPLE-Monthly is limited by the capabilities of ArcMap. One frequent problem encountered during testing was increased errors during multiple simulation runs within a single instance of an open ArcMap .mxd. For this reason Jones Edmunds recommends closing ArcMap after each SIMPLE-Monthly simulation as a preventative measure. While more than one successful simulation is achievable in a single instance of an open ArcMap .mxd, frequently closing the .mxd has been observed to adequately prevent errors related to page file overloads.

Running the same basin on the same data set, I have achieved successful simulations and run into errors. Why is this happening?

As noted, SIMPLE-Monthly is limited by the capabilities of ArcMap. During testing, Jones Edmunds discovered that occasionally SIMPLE-Monthly appears to “hang-up” when writing temporary files required for simulation. On these occasions the model tends to either return a read-write error or crash without returning any error message. It has also been observed that following the first crash for read-write errors, simulations are generally unsuccessful until all temporary files have been cleaned. For this reason Jones Edmunds recommends cleaning temporary files written by ArcMap after every few SIMPLE-Monthly simulations. Should the user run into a read-write error as described above, we also recommend that the user not only destroy all ArcMap temporary files but also restart the machine.

Jones Edmunds has also found that on some computers the application will not run at all, even though all the hardware and software configurations are either identical or quite similar. It is possible that there are conflicts between miscellaneous patches and service packs not specifically outlined in this document.

3 LIMITATIONS

Like any software, SIMPLE-Monthly has its limitations:

- Computer capacity – Due to the nature of the processes involved, SIMPLE-Monthly requires significant amounts of memory and disk storage space for most applications. The user can typically get around the memory and storage limitations by reducing the size of the analysis area and/or the length simulation. Results from different locations and/or time scales can be readily merged using standard GIS and database tools.
- ESRI software – Since SIMPLE-Monthly is run through the ArcMap interface and uses multiple ESRI library routines, it inherits any limitations associated with those products. These types of limitations are left to ESRI documentation.
- Spatial discretization – As with any model, there is a tradeoff between data development costs, computation efficiency, and model accuracy. The hydrologic engine, which serves as a key component of SIMPLE-Monthly, runs on a unique intersection of land use, soil hydrologic group, and NEXRAD pixel—collectively referred to as a *calculation unit*. Additionally, SWFWMD-defined land uses are lumped into one of the 16 EMC land use categories for parameterization of the model version developed for the County. At this scale, each of the three data sources has an inherent amount of limitations as a result of lumping similar but not identical data into larger groups with respect to the hydrologic properties carried through the hydrologic engine. For example, a commercial park in one part of the County may have different hydrologic properties (e.g., DCIA) from one in another part of the County, but each would receive the same hydrologic properties and thus predict like flows. Spatial discretization limitations may also exist for irrigation and septic returns since they are dependent on land use in SIMPLE-Monthly.
- Hydrologic methods – The hydrologic engine used to develop the runoff and rainfall-derived base flow time series uses a modified, continuous-simulation version of the Curve Number Method for runoff and the Dupuit-Forcheimer equation for base flow. Each method carries its own assumptions and limitations. Since the engine predicts runoff and base flow from a single calculation unit (e.g., a coupled surface water/groundwater unit), it is also limited by the assumption that the surface water and groundwater basins are similar for a given area of interest. There may also be some scaling issues associated with the groundwater portion of the calculation units (see the Design Report for more information).
- Decoupled base flow components – To track loads from separate sources, irrigation and septic flows are not inputs into the groundwater portion of the hydrologic engine. In reality, these flows would be combined in the surficial aquifer with infiltrated water. By keeping the components decoupled, the model may slightly underpredict base flow during wet periods and slightly overpredict during dry periods.
- In-stream processes— Physical, chemical, and biological processes that may occur in the receiving water bodies are not accounted for in this model. Constituents are considered to be conservative and to remain in the water column. If modeling of in-stream processes is considered important for the application, a second receiving water model would need to be coupled with the results from this model. The simplified approach to a second model is to apply delivery ratios, which are discussed briefly in the Calibration Report.

- Constant concentrations for most sources – With the exception of point sources, SIMPLE-Monthly uses constant concentrations. In reality, constituent concentrations will vary from event to event and perhaps from season to season. However, the sources of the variability are not fully understood, difficult to characterize in a pollutant loading model, and very expensive to characterize through monitoring. The simplifying assumption of constant concentrations is often adequate for the needed analysis when considering these factors.
- Influent concentrations for BMPs – SIMPLE-Monthly uses removal efficiencies that vary by BMP type and constituent only. In reality, removal is often also a function of the influent concentration. Although the model does not account for this directly, it is possible to create separate BMPs of the same type that could account for influent concentrations. For example, the user could input wet detention ponds that serve residential areas as a separate type from those that serve industrial areas and use different efficiencies for each.
- Cumulative BMPs in series – SIMPLE-Monthly does not explicitly calculate BMPs in series. In these instances the collective removal needs to be calculated outside of the model and then input to the model so that the BMPs in series collectively act like a single BMP covering a particular area.
- Septic loading accuracy – The approach to septic loading in SIMPLE-Monthly is generalized for user input. However, actual septic loads were difficult to verify due to their small signature within the overall measured base flow.

Appendix A
Installation Instructions

IMPORTANT: Do not install from a network location. Make sure your login name is a member of the Local Administrators group (follow all the steps below).

ArcInfo license required for the multiple joins! ArcEditor is not adequate, it can only support joins for two layers.

INSTALLATION INSTRUCTIONS

1. A regular domain user has limited, if any, installation privileges. Only a local administrator may register external .dll files. Run the script VerifyLocalAdmin.vbs to verify the status of the currently logged in user.
2. If you have a previous installation of SIMPLE-Monthly, go to its folder and double-click on SIMPLE2_uninstall.bat.
3. Create a new folder and copy there all the installation files. Alternatively, overwrite files from a previous version in an existing folder. Do not run the batch file from the network location - you will get errors due to permission settings in the operating system.
4. Custom ArcMap applications in .dll and .exe format, such as SIMPLE-Monthly, will not run unless the machine has NET support installed PRIOR to installing ArcMap. Otherwise you may not be able to see the application in the Customize dialog. Double-click on the file CheckArcMapversion.vbs to run it and verify the status of ArcMap, latest service pack, NET framework, and NET support.
5. To install SIMPLE-Monthly, double-click on SIMPLE2_install.bat.
6. Open any .mxd file, select Tools/Customize/Commands tab/JonesEdmunds category, then drag the 'Pollutant loading module' icon to an existing toolbar.
7. As an FGDB template, use the one included on this DVD. SIMPLE_Calib.gdb is the result of Jones Edmunds calibration of Simple-Monthly.
8. Make sure that the output databases are specified through the button and not merely by entering the name in the textbox. This way, the full name to the FGDB will be correctly entered.

NOTE: Please do not copy these files in separate dated folders if you want to keep track of the application version. If you do, the application button in ArcMap will be pointing to a previous version of the dll; if it has been properly uninstalled, ArcMap may crash.

NECESSARY INPUT

DIRECT RUNOFF, BASE FLOW, WET/DRY

- Basins, Land use, Soils, BMP, NexRad
- Note: in this release BMP can be optional. Select item "Ignore" from the combobox.

IRRIGATION

- Basins, Land use, Soils, Irrigation

POINT SOURCES

- Basins, Regular points, NCE (non-compliant effluent) points

SEPTIC TANKS

- Basins, Land Use, Septic Tanks