Floridan Aquifer System Modeling

A User's Guide to Model Results

Vital information to help access and interpret Performance Graphics and Hydrographs

The document is intended to assist interested parties in reviewing and interpreting the East Coast Floridan Model (ECFM) simulation results. The simulations, also called model runs, were developed in support of the 2016 Upper East Coast Water Supply Plan Update.

The ECFM was applied in 2014-2015 to analyze current and future trends of **water level**, **water quality and water flow** within the Floridan Aquifer System (FAS), an important source of water for agricultural interests as well as public drinking water suppliers in the Upper East Coast (UEC) region.

There are three sections within the Modeling Results and Supporting Information link that you have accessed. The first section, How to Access and Interpret the Model Results, contains this User's Guide to the Model Results and a List of Abbreviations, Acronyms and Terms for your convenience. The User's Guide describes how to access and interpret the extensive materials generated to display the results of the model runs. The second section, Model Results, contains the performance graphics and hydrographs for selected wells, which is the major focus of this write up. The third section, Assumptions and other Background Information, provides technical documentation for the ECFM and its development, as well as information on the demand projections. The Demand Projections link includes the 2013 and 2040 demands by county and the many assumptions and projections for public water supply utilities which were used to develop the **2013 (Current) Base Case** and the **2040 (Future) Base Case** simulations.

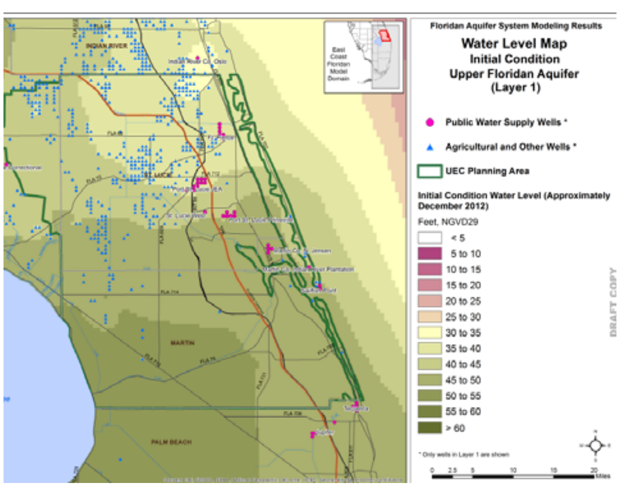

Figure 1. One of the 46 performance graphics.

The ECFM does not simulate surface water or water in the Surficial Aquifer System (SAS). Projections were made for total future (2040) demand, and then adjusted to identify only the portion of demand anticipated to be met from the FAS. Additional detail on the assumptions for each public water supplier using the FAS as a raw water supply can be found in the Base Case assumptions documents. The assumptions also address how agricultural demands on the FAS were estimated.

The model results are depicted as map-based performance graphics and in hydrographs. The map based graphics (see **Figure 1**) show utility wellfields, irrigation well locations, roads, county lines and the UEC planning area boundary. There are 46 separate map-based graphics, each presented as a

PDF file. These files should open with most PDF viewer software such as Adobe Reader or Nuance Power PDF. Most programs will allow you to zoom in and out and to move around the image while zoomed in, although some newer programs may be easier to manipulate than others.

The 184 hydrographs, however, are accessed via a single interactive map. A short description of how to use the interactive hydrograph map is provided at the end this write-up.

Both the 2013 Base Case and the 2040 Base Case runs start with the same water levels and same water quality. The starting point is called the **Initial Condition** and is used to calculate the cumulative changes that occur in each of the Base Case runs as a result the differences in withdrawals among all users. The Initial Condition was established from the results of the model's Calibration Run, a 24-year simulation using estimated historical water withdrawals and climatic conditions from the FAS from 1989 to 2012. As such it represents an estimation of the conditions at the end of 2012, and provides a point from which to launch the 24-year Base Case simulations.

The Base Case model runs simulated what could happen to water levels and water quality with two different sets of demands on the FAS. The 2013 Base Case applied an estimate of the current rate of withdrawal to each year for 24 consecutive years to show the cumulative effect of existing usage. The 2040 Base Case applied the projected 2040 FAS demands annually over the same 24-year period, allowing again for analysis of long-term changes. The total annual demand in each scenario does not increase over time but is repeated in each year of the simulation.

These results are dependent on the assumptions made in developing the Base Cases. Some assumptions, such as future population growth and the resulting 2040 water demand, have considerable uncertainty. The same is true for the agricultural industry's future water needs. The decline in citrus groves, due to hurricanes and disease, the potential for that industry to rebound in the future, and changes to other crops will affect future water needs. Additional uncertainty is created in most of the region because the FAS is widely used by agriculture as a backup source to supplement surface water supplies during the dry season and in droughts.

In reviewing the performance graphics, you are encouraged to read the legend first. This is necessary to determine which:

- **Model run results are being shown, either a single run or a comparison of two runs.** In most cases, separate graphics are presented for the Initial Condition as well as the 2013 and 2040 Base Case runs. The graphics comparing two runs are referred to as "Difference Maps" and are intended to show the location and magnitude of water quality or water level change.
- **Layer of the model being displayed.** The two layers shown in these results are Layer 1, the Upper Floridan Aquifer (UFA) and Layer 3, the Avon Park Permeable Zone (APPZ). These are the FAS layers used for water supply in this planning region. Separate graphics are presented for these two layers. (See **Figure 2** for a depiction of the model's seven layers.)
- **Parameter is being measured, and the units of measurement.** The water levels are shown in feet. Generally levels are referenced to National Geodetic Vertical Datum of 1929 (NGVD29). For the convenience of water users, another set of maps is provided to show water levels

relative to land surface elevation. Water quality is measured as Total Dissolved Solids (TDS) and is shown in milligrams per liter (mg/l). One important component of TDS is Chlorides. Although the percentage of Chlorides as a component of TDS varies throughout the FAS, a rule of thumb suggests Chlorides make up about 50% of TDS. The results are displayed as ranges and are color coded. Flow is represented by an arrow in each grid cell pointing in the primary flow direction. The arrows are scaled to represent the magnitude of the flow measured in gallons per day.

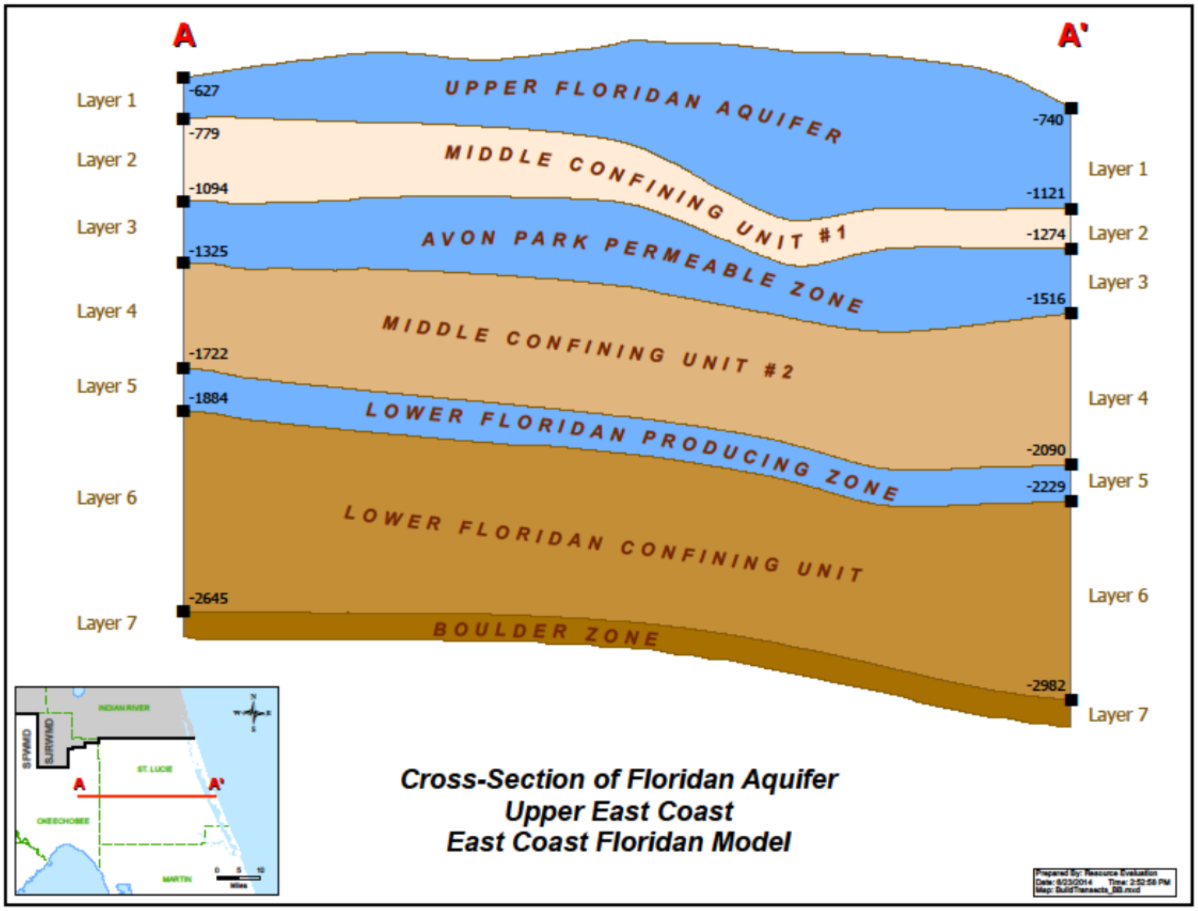

Figure 2. The 7 layers of the ECFM model are shown with a cross section of the FAS in St. Lucie County.

Each graphic has the following:

- **Public water supply wells** that exist in the layer being shown. **PWS wells are represented as dark pink dots.** Individual utility's FAS wellfields are labeled, with specific wellfield names included for utilities with more than one FAS wellfield. Wells are shown only for the layer from which they draw water; however, in several cases, PWS wells withdraw from both layers.
- **Agricultural wells, along with all other water use classes, are shown as blue triangles.** (Wells appear to be on straight lines because they are distributed into the center of the model's 2,400 by 2,400 foot grid cells.) Wells that are permitted as freeze protection only are not included in the model. As with PWS, wells are shown only for the layer from which they draw water.

Three types of maps are posted in the performance graphic section:

- **Water Levels**
- **Water Quality**
- **Water Flow**

The graphics for **Water Levels** are:

- Water Level at the end of simulation (Month 288) for the Initial Condition, 2013 Base and 2040 Base. These graphics show the potentiometric surface elevation in feet referenced to NGVD29. In general terms, this represents a measurement of feet above mean sea level in 1929.
- Water Level Difference Map which show how much the potentiometric surface elevation (in feet) changes when comparing the 2013 Base Case to the Initial Condition; the 2040 Base Case to Initial Condition; and 2040 Base Case to the 2013 Base Case.
- Water Level Relative to Land Surface Elevation (LSE) maps show the end of the simulation (Month 288). This is important to identify areas where artesian flow may be altered due to change in the potentiometric surface.
- Water Levels in dry conditions are shown using results from Month 220. The historic climate data for Month 220 is from the spring of 2007 and represents an approximate 1-in-10 year rainfall deficit. This is referenced to NGVD29 or mean sea level.
- Water Levels Relative to LSE in dry conditions are shown using results from Month 220. The historic climate data for Month 220 is from the spring of 2007 and represents an approximate 1-in-10 year rainfall deficit.

The **Water Quality** graphics include:

- Water Quality maps illustrate TDS concentrations at end of simulation (Month 288) for the Initial Condition, 2013 Base or 2040 Base. The Initial Condition shows the water quality at the start of the Base Cases, while the two Base Case maps show the water quality at the conclusion of the 24 year model runs.
- Water Quality Difference maps show the change in TDS at end of simulation (Month 288) when comparing the 2013 Base Case to Initial Condition, the 2040 Base Case to the Initial Condition, and the 2040 Base Case to the 2013 Base Case. These maps help identify where water quality changes occur and are intended to help display the cumulative impact of the Base Case demands.

The **Water Flow** graphics include:

- Direction and magnitude of horizontal flow from each model cell at the end of the model run (Month 288) for the 2013 and 2040 Base Cases.
- Direction and magnitude of horizontal flow from each model cell during an approximate 1 in 10 year rainfall deficit (Month 220) for the 2013 and 2040 Base Cases.

As previously mentioned, separate maps are provided for Layer 1 (Upper Floridan Aquifer) and Layer 3 (Avon Park Permeable Zone) for each of the 23 graphics listed above, or a total of 46 performance graphics for this review. None of the performance graphics show more than one layer of the model. The

Upper Floridan Aquifer is a source for both PWS and irrigation. The Avon Park Permeable Zone is primarily used for PWS in the UEC region.

Hydrographs

Hydrographs are presented seperately from the performance graphics to allow interested parties to utilize an interactive map to see the simulated change in water levels and water quality over 24 years in a large sample of both production wells and monitoring wells. Each hydrograph shows both the results from the 2013 and 2040 Base Case runs. (See **Figure 3**.)

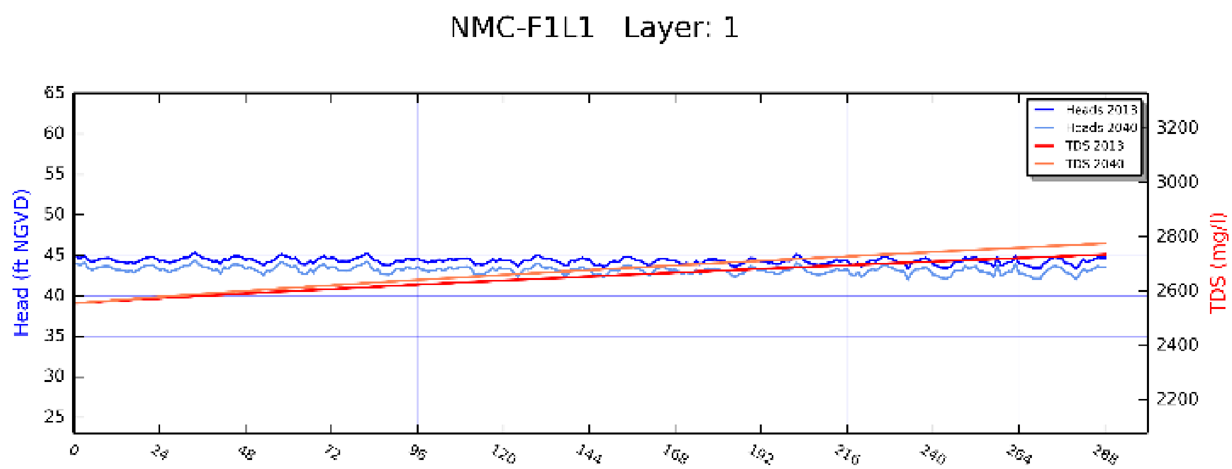

Figure 3. One of 184 hydrographs available for review.

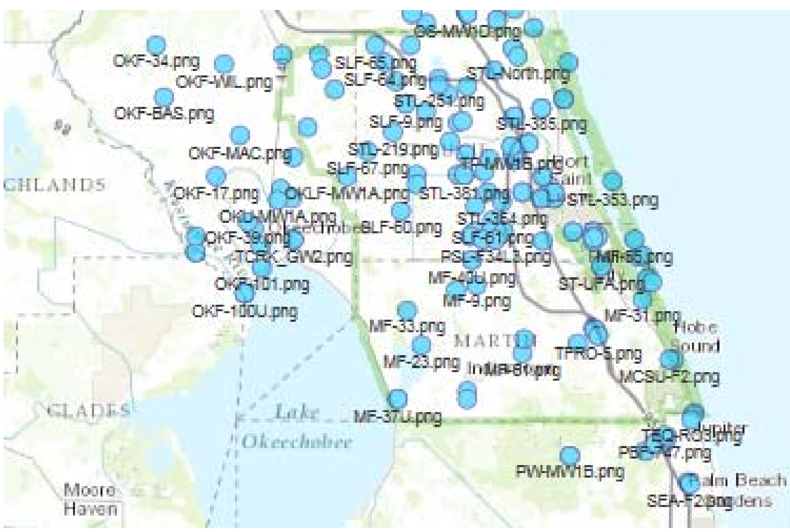

Figure 4. Interactive map for viewing hydrographs (zoomed out view).

Due to the wide range of TDS levels in the different layers of the FAS, the water quality scale on the hydrographs vary. The water levels shown in the hydrographs are potentiometric surface elevation in feet referenced to NGVD29, while the water quality is represented by TDS in milligrams per liter (mg/l).

It will be necessary to use the zoom feature on the hydrograph map to see all of the wells for which a hydrograph is provided (Figure 4). (Due to the number of FAS wells in the region, a subset of wells was identified for inclusion on the map.)

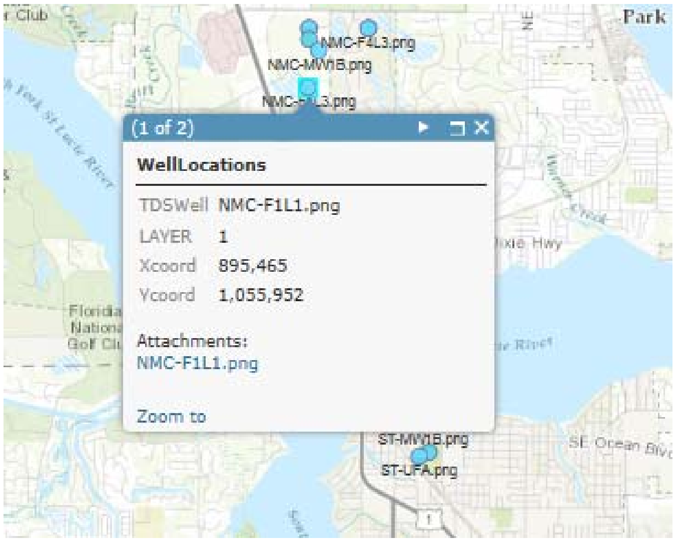

Figure 5. A pop-up window provides the link to a hydrograph.

To access a hydrograph, zoom into an area of interest and click on any well symbol (blue dot). A window will pop-up on the map as shown in Figure 5. Click on the file name under "Attachments:" and the hydrograph for that site will appear. Several of the dots will have more than one hydrograph attached. If so, the top of the window will show: (1 of 2), with an arrow to click.

In closing, reviewers are reminded that the ECFM is a regional scale model which averages water quality and water levels within a model grid cell measuring 2,440 by 2,440 feet. That's nearly 0.5 by 0.5 miles. The hydrographs should be considered as supplemental information in support of the performance graphics.