May 7, 2018

During the peer review panel meeting on April 18, 2018, members of the panel expressed a need for additional information that is required for them to complete their review of the model. Specific areas of concern were:

1. Comparison of modeled Upper Floridan aquifer (UFA) transmissivity to available aquifer performance tests (APT's) within the model domain, and;
2. Provide a comparison of observed and modeled baseflows along available drainage conveyances, with the intent of evaluating cumulative baseflows with progression in a downstream direction.

Toward the above stated concerns, we offer the following additional information/clarification.

1. <u>Aquifer Performance Test/Modeled Comparison – UFA Transmissivity</u>

Panel members requested additional analysis of APT's within the model domain, including comparison of the APT database used by the modeling team as well as that used as the basis for an Upper Floridan Aquifer transmissivity map prepared by the USGS. The USGS map is titled, *"Transmissivity of the Upper Floridan Aquifer in Florida and Parts of Georgia, South Carolina, and Alabama"* and designated by the USGS as Scientific Investigations Map 3204. This map and companion APT database map be found here: https://pubs.usgs.gov/sim/3204/pdf/USGS_SIM-3204_Kuniansky_Web.pdf, https://pubs.usgs.gov/sim/3204/TransmissivityMap_data.zip. The noted map, with the NFSEG boundary superimposed on it, is provided as Figure 1.

It is important to note that USGS SIM 3204 was derived from surface interpolation of the APT data points only. Because of this, although the map shows the spatial distribution of transmissivity within a very large area, the accuracy of the transmissivity values shown on the map should be considered very low in the areas where APT data is not available or sparse. The compilation of the map did not consider UFA potentiometric surface gradients, presence or absence of surface drainage networks, or areas of concentrated groundwater discharge from springs, all of which provide useful information for making inferences about the spatial distribution of transmissivity. As such, changes in transmissivities that might be indicated by such data may not be mapped when interpolating between sparsely spaced points. Therefore, it is expected that there will be differences between SIM 3204 and our modeled UFA transmissivity.

The UFA APT values from the USGS database were compared to the NFSEG modeled transmissivity for the confined (Layer 3 only) and unconfined (Layers 1 – 3) portions of the UFA. The comparisons are provided as scatter plots of APT to modeled UFA transmissivity on Figures 2 and 3. Review of Figure 2 indicates that 87 percent of the points were within one order of magnitude of the line of equality in the confined portions of the system. In the unconfined portion of the model, about 75 percent of the points were within one order of magnitude of the line of equality. In both cases, the APT/modeled comparison indicates that modeled UFA transmissivities generally tend to be somewhat greater than the APT values, with points in the unconfined areas exhibiting more of this tendency. This is perhaps not surprising given the karstic nature of the Upper Floridan aquifer, and the tendency for karst features to be more highly developed in unconfined areas. Aquifer performance tests 'sample' a smaller volume of the aquifer than the resolution of the model grid or the scale with which properties might be inferred through calibration with the available data and parameterization scheme. It can also be difficult to stress the system sufficiently in highly transmissive, karstic areas. Thus, aquifer performance tests may not reflect transmissivity contributions from karst features (and their connections) that may occur over longer spatial scales, or may reflect local-scale variability in transmissivity.

In both (confined and unconfined) cases, it is also important to note that limited filtering of APT results was done for SIM 3204 with respect to test duration, number of observations wells, and other information. A more deliberate process was followed during the NFSEG model development, which included additional review and filtering of data from the USGS's APT database, as well as incorporation of additional APT data from the water management districts. In this review, APTs were selected if they contained an observation well in the same zone as the pumping well, with a minimum test duration of 12-24 hours. Exceptions were made in areas where limited data APT was available, such as in the SRWMD.

The UFA transmissivity derived from NFSEG V.1.1 is depicted on Figure 4, using the same color ramp and scale as USGS SIM 3204 (provided herein as Figure 1). Comparison of Figures 1 and 4 indicates similar general geographic patterns in transmissivity values. For example, higher transmissivities are evident in both the SIM 3204 and NFSEG results in southeast Georgia, western Marion County in the Silver and Rainbow springsheds, Wakulla Springs, the Suwannee River valley, and lower Santa Fe and Ichetucknee regions. Low transmissivity areas also occur in both datasets in the Gulf Trough and eastern half of Florida. As described above, geographically sparse APT results make it difficult for direct interpolation methods to represent expected spatial patterns in transmissivity. For example, SIM 3204 does not show some of the areas that are considered to be low transmissivity regions, such as Mallory Swamp in Lafayette County and the Waccasassa Flats in Gilchrist and Levy Counties (and the abrupt transition from the generally high transmissivities bordering these areas). Conversely, some high transmissivity areas in the Woodville Karst plain in Wakulla County are not evident in SIM 3204. This reflects the limited data that were available for interpolation in these areas. As noted earlier, USGS SIM 3204 is based on kriging of roughly filtered APT results, and Figure 4 is from the NFSEG model, which explicitly considers heads, flows, and parameter bounds derived from the APTs. They are not necessarily a one-to-one comparison.

UFA transmissivity values derived from the APT set available after additional filtering based on zonation of APT observation wells and test duration were compared to the modeled values using scatter plots (in the manner described previously for the USGS APT database) in which the results were normalized by layer thickness. Figure 5 provides the APT/modeled UFA transmissivity comparison for the confined area of the model, and Figure 6 provides the same comparison for the unconfined areas. The modeled values generally conform well with the APT tests in the confined portion of the model (Figure 5), with more variability in the unconfined areas (Figure 6).

As a means of depicting this variability on a spatial basis, we compared the ratio of the APT/modeled UFA transmissivity for the database used during the model development, and superimposed that on the UFA confinement zonation used for the project. Figure 7 provides this comparison. Our review of Figure 7 reflects that, in general, the APT/model comparison corresponds well in the confined portions of the system, and less so in unconfined regions. We attribute the higher degree of variability in unconfined regions due to reasons stated previously (different 'sampling scales' and difficulty in stressing highly transmissive systems in karst areas), and to the shallow occurrence and subsequent dissolution of the carbonate sediments that occur at or near land surface in this area.

2. Cumulative Baseflow Comparisons Along Rivers and Streams

To facilitate the peer review panel's evaluation of the quality of simulated baseflows, we mapped estimated and simulated cumulative baseflows for USGS gages that had at least one cumulative baseflow estimate for either 2001 or 2009. The cumulative baseflows were computed by averaging the results of the five baseflow-separation methods approved by the peer review panel in 2017. Figures 8 through 10 summarize the results for 2001, and Figures 11-13 provide results for 2009. Table A lists the USGS gage ID and corresponding name for gages depicted on the maps.

Table A. USGS Gage ID's and Gage Names 1

USGS Gage ID	Gage Name	USGS Gage ID	Gage Name
2176500	COOSAWHATCHIE RIVER NEAR HAMPTON, SC	2312720	WITHLACOOCHEE RIVER AT WYSONG DAM, AT CARLSON, FL
2197500	SAVANNAH R AT BURTONS FERRY BR NR MILLHAVEN, GA	2313000	WITHLACOOCHEE RIVER NEAR HOLDER, FL
2198000	BRIER CREEK AT MILLHAVEN, GA	2313100	RAINBOW RIVER AT DUNNELLON, FL
2198100	BEAVERDAM CREEK NEAR SARDIS, GA	2313230	WITHLACOOCHEE R AT INGLIS DAM NEAR DUNNELLON, FL
2198500	SAVANNAH RIVER NEAR CLYO, GA	2313250	WITHLACOOCHEE R BYPASS CHANNEL NR INGLIS FLA
2198690	EBENEZER CREEK AT SPRINGFIELD, GA	2313700	WACCASASSA RIVER NR GULF HAMMOCK, FLA.
2202500	OGEECHEE RIVER NEAR EDEN, GA	2314500	SUWANNEE RIVER AT US 441, AT FARGO, GA
2202600	BLACK CREEK NEAR BLITCHTON, GA	2315000	SUWANNEE R NR BENTON FLA
2203000	CANOOCHEE RIVER NEAR CLAXTON, GA	2315500	SUWANNEE RIVER AT WHITE SPRINGS, FLA.
2215100	TUCSAWHATCHEE CREEK NEAR HAWKINSVILLE, GA	2317500	ALAPAHA RIVER AT STATENVILLE, GA
2215500	OCMULGEE RIVER AT LUMBER CITY, GA	2317620	ALAPAHA RIVER NEAR JENNINGS FLA
2216180	TURNPIKE CREEK NEAR MCRAE, GA	2318500	WITHLACOOCHEE RIVER AT US 84, NEAR QUITMAN, GA
2223500	OCONEE RIVER AT DUBLIN, GA	2318700	OKAPILCO CREEK AT GA 333, NEAR QUITMAN, GA
2225000	ALTAMAHA RIVER NEAR BAXLEY, GA	2319000	WITHLACOOCHEE RIVER NEAR PINETTA, FLA.
2225500	OHOOPEE RIVER NEAR REIDSVILLE, GA	2319394	WITHLACOOCHEE RIVER NR LEE, FLA
2226000	ALTAMAHA RIVER AT DOCTORTOWN, GA	2319500	SUWANNEE RIVER AT ELLAVILLE, FLA
2226100	PENHOLOWAY CREEK NEAR JESUP, GA	2319800	SUWANNEE RIVER AT DOWLING PARK, FLORIDA
2227500	LITTLE SATILLA RIVER NEAR OFFERMAN, GA	2320000	SUWANNEE RIVER AT LURAVILLE, FLA.
2228000	SATILLA RIVER AT ATKINSON, GA	2320500	SUWANNEE RIVER AT BRANFORD, FLA.
2228500	NORTH PRONG ST. MARYS RIVER AT MONIAC, GA	2320700	SANTA FE RIVER NEAR GRAHAM, FLA.
2229000	MIDDLE PRONG ST MARYS RIVER AT TAYLOR, FL	2321000	NEW RIVER NR LAKE BUTLER FLA
2229250	MIDDLE PRONG ST. MARYS RIVER NEAR TAYLOR, FL	2321500	SANTA FE RIVER AT WORTHINGTON SPRINGS, FLA.
2231000	ST. MARYS RIVER NEAR MACCLENNY, FL	2321975	SANTA FE RIVER AT US HWY 441 NEAR HIGH SPRINGS,FL.
2231268	ALLIGATOR CREEK AT CALLAHAN, FL	2322049	BAD DOG BRANCH NEAR ALACHUA, FL
2231280	THOMAS CREEK NEAR CRAWFORD, FL	2322500	SANTA FE RIVER NEAR FORT WHITE, FLA.
2236000	ST. JOHNS RIVER NEAR DE LAND, FL	2322700	ICHETUCKNEE R @ HWY27 NR HILDRETH, FL
2236125	ST. JOHNS RIVER AT ASTOR, FL	2322800	SANTA FE RIVER NR HILDRETH FLA
2238000	HAYNES CREEK AT LISBON, FL	2323500	SUWANNEE RIVER NEAR WILCOX, FLA.
2238500	OCKLAWAHA RIVER AT MOSS BLUFF, FL	2323592	SUWANNEE RIVER AB GOPHER RIVER NR SUWANNEE FL
2239501	SILVER RIVER NEAR OCALA, FL	2324000	STEINHATCHEE RIVER NEAR CROSS CITY, FLA.
2240000	OCKLAWAHA RIVER NEAR CONNER, FL	2324400	FENHOLLOWAY RIVER NEAR FOLEY, FLA.
2240500	OCKLAWAHA RIVER AT EUREKA, FL	2324500	FENHOLLOWAY RIVER AT FOLEY, FLA.
2240902	PRAIRIE CREEK NEAR GAINESVILLE, FL	2325000	FENHOLLOWAY RIVER NEAR PERRY, FLA
2243000	ORANGE CREEK AT ORANGE SPRINGS, FL	2326000	ECONFINA RIVER NEAR PERRY, FLA.
2244040	ST. JOHNS R AT BUFFALO BLUFF NEAR SATSUMA, FL	2326372	PALMER MILL BRANCH AT MONTICELLO,FL
2244320	MIDDLE HAW CREEK NR KORONA, FLA.	2326500	AUCILLA RIVER AT LAMONT, FLA.
2244420	LITTLE HAW CREEK NEAR SEVILLE, FL	2326900	ST. MARKS RIVER NEAR NEWPORT, FLA.
2244440	DUNNS CREEK NEAR SATSUMA, FL	2327033	LOST CREEK AT ARRAN FLA
2244473	RICE CREEK NEAR SPRINGSIDE	2327100	SOPCHOPPY RIVER NR SOPCHOPPY, FLA.
2245050	ETONIA CREEK AT BARDIN, FL	2327500	OCHLOCKONEE RIVER NEAR THOMASVILLE, GA
2245140	SIMMS CREEK NEAR BARDIN, FL	2328522	OCHLOCKONEE RIVER NR CONCORD, FLA.
2245255	DEEP CREEK NEAR HASTINGS, FL	2329000	OCHLOCKONEE RIVER NR HAVANA, FLA.
2245260	DEEP CREEK AT SPUDS, FL	2329342	LITTLE ATTAPULGUS CREEK AT ATTAPULGUS, GA
2245500	SOUTH FORK BLACK CREEK NEAR PENNEY FARMS, FL	2329558	ST. MATTHEWS CHURCH BRANCH NEAR QUINCY, FL.
2246000	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	2329600	LITTLE RIVER NR MIDWAY, FLA.
2246025	BLACK CREEK NEAR DOCTORS INLET, FL	2330000	OCHLOCKONEE RIVER NR BLOXHAM, FLA.
2246150	BIG DAVIS CREEK AT BAYARD, FL	2330150	OCHLOCKONEE RIVER NR SMITH CREEK, FLA.
2246300	ORTEGA RIVER AT JACKSONVILLE, FL	2349900	TURKEY CREEK AT BYROMVILLE, GA
2246500	ST. JOHNS RIVER AT JACKSONVILLE, FL	2350512	FLINT RIVER AT GA 32, NEAR OAKFIELD, GA
2246828	PABLO CREEK AT JACKSONVILLE, FL	2350900	KINCHAFOONEE CREEK AT PINEWOOD ROAD, NR DAWSON, GA
2246895	SAN SEBASTIAN RIVER AT ST. AUGUSTINE, FL	2351890	MUCKALEE CREEK AT GA 195, NEAR LEESBURG, GA
2247015	MOULTRIE CREEK AT MOULTRIE, FL	2352500	FLINT RIVER AT ALBANY, GA
2247027	MOSES CREEK NEAR MOULTRIE, FL	2353000	FLINT RIVER AT NEWTON, GA
2247222	PELLICER CREEK NEAR ESPANOLA, FL	2353500	ICHAWAYNOCHAWAY CREEK AT MILFORD, GA
2247258	LEHIGH CANAL NEAR FLAGLER BEACH, FL	2354500	CHICKASAWHATCHEE CREEK AT ELMODEL, GA
2247510	TOMOKA RIVER NEAR HOLLY HILL, FL	2354800	ICHAWAYNOCHAWAY CREEK NEAR ELMODEL, GA
2312600	WITHLACOOCHEE RIVER NEAR FLORAL CITY, FL	2355350	ICHAWAYNOCHAWAY CREEK BELOW NEWTON, GA
2312640	JUMPER CREEK CANAL NEAR BUSHNELL, FL	2356000	FLINT RIVER AT BAINBRIDGE, GA
2312667	SHADY BROOK NEAR SUMTERVILLE, FL	2326550	AUCILLA RIVER NR MOUTH NEAR NUTALL RISE, FL
2312700	OUTLET RIVER AT PANACOOCHEE RETREATS, FL		

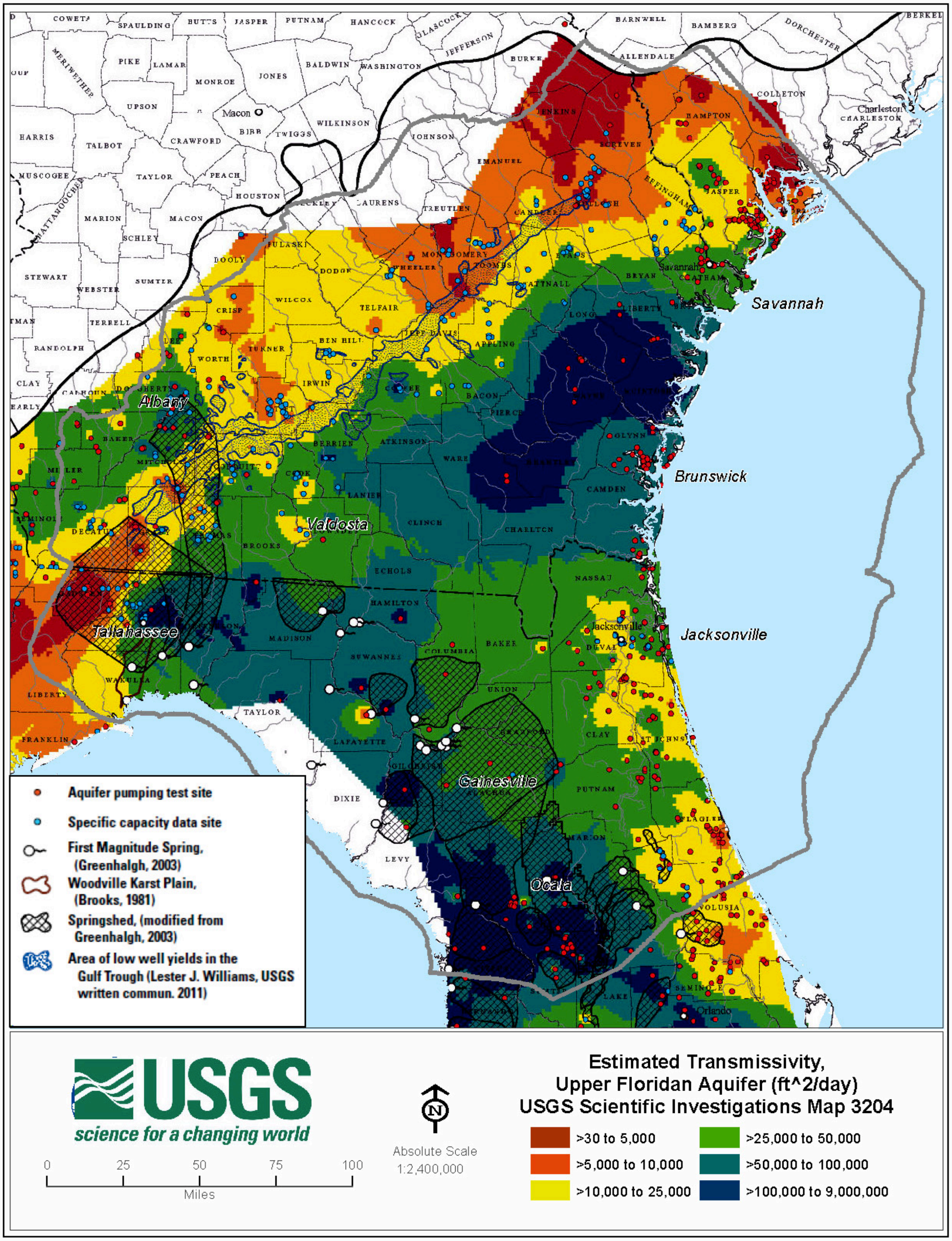

Figure 1. USGS SIM 3204

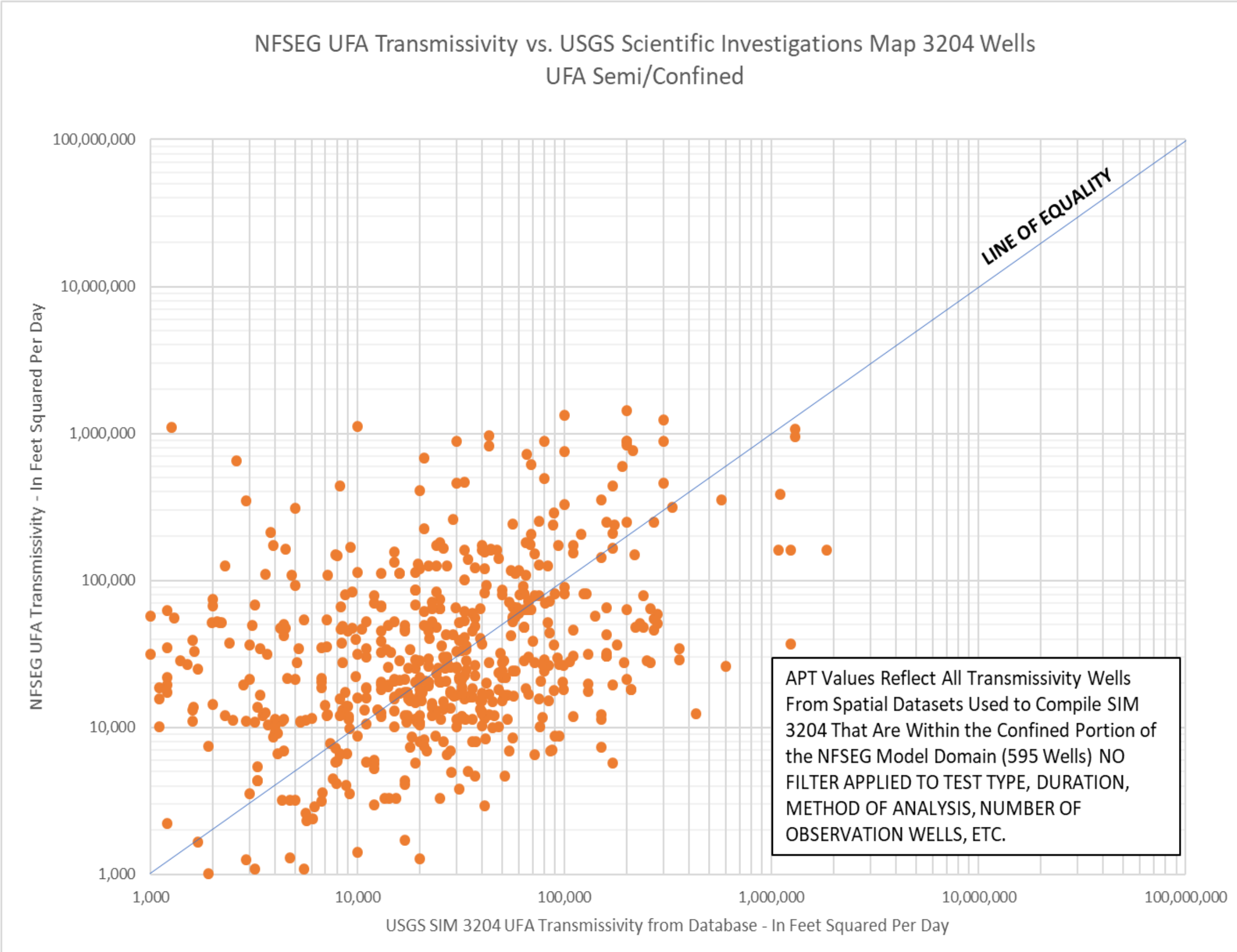

Figure 2. NFSEG UFA Transmissivity vs. USGS Sim 3204 APT Wells – Confined Region

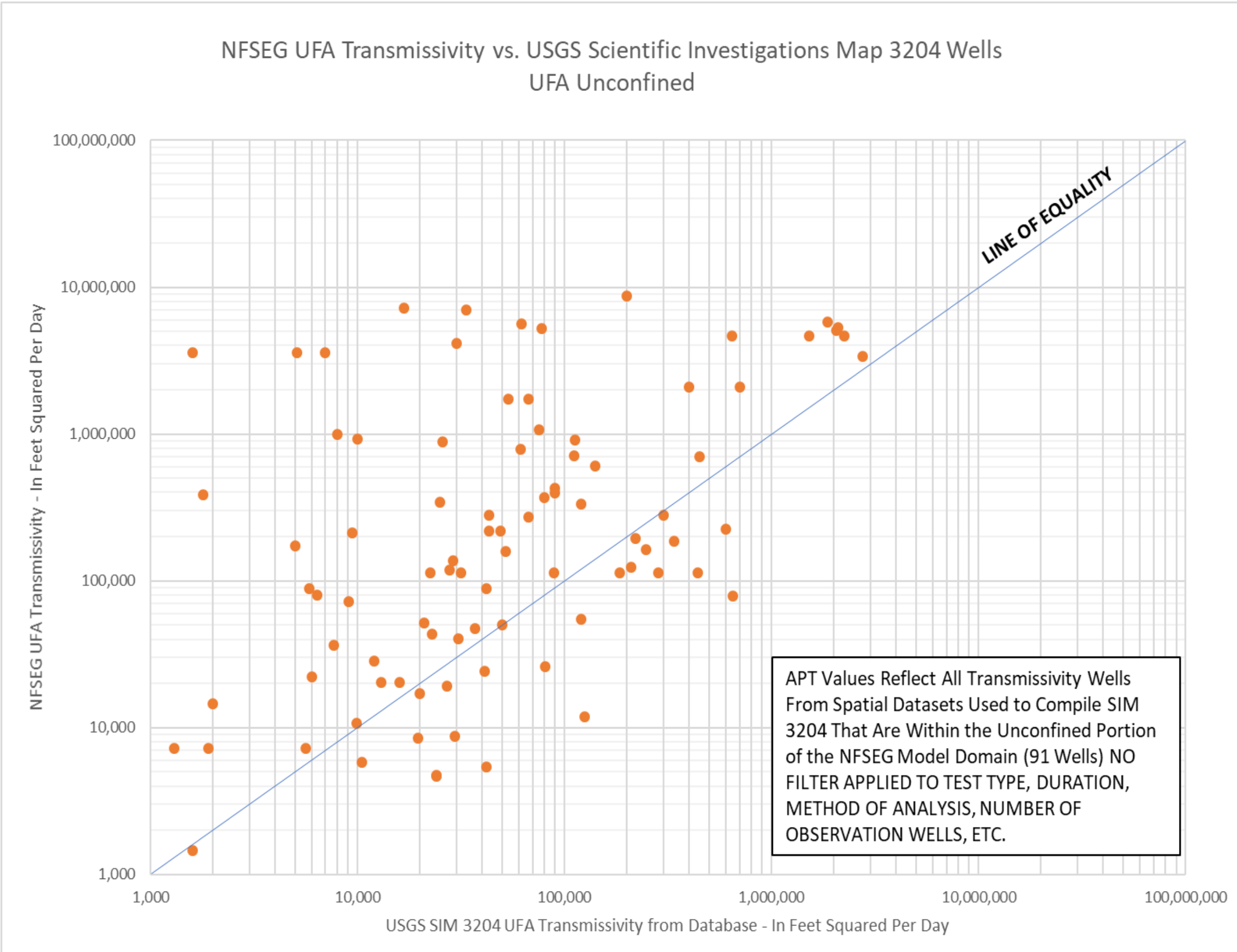

Figure 3. NFSEG UFA Transmissivity vs. USGS SIM 3204 APT Wells - Unconfined Region

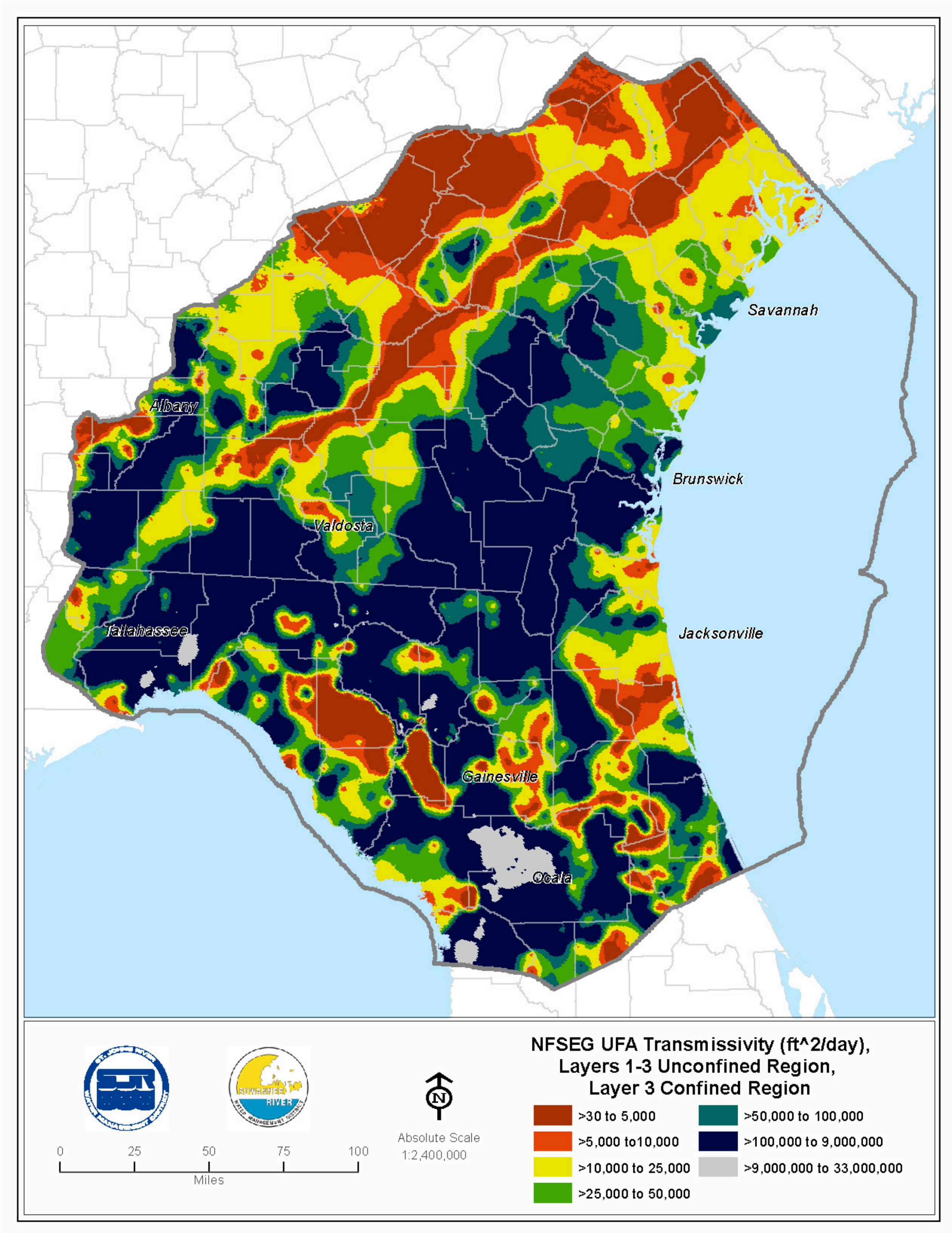

Figure 4. NFSEG V1.1Modeled UFA Transmissivity.

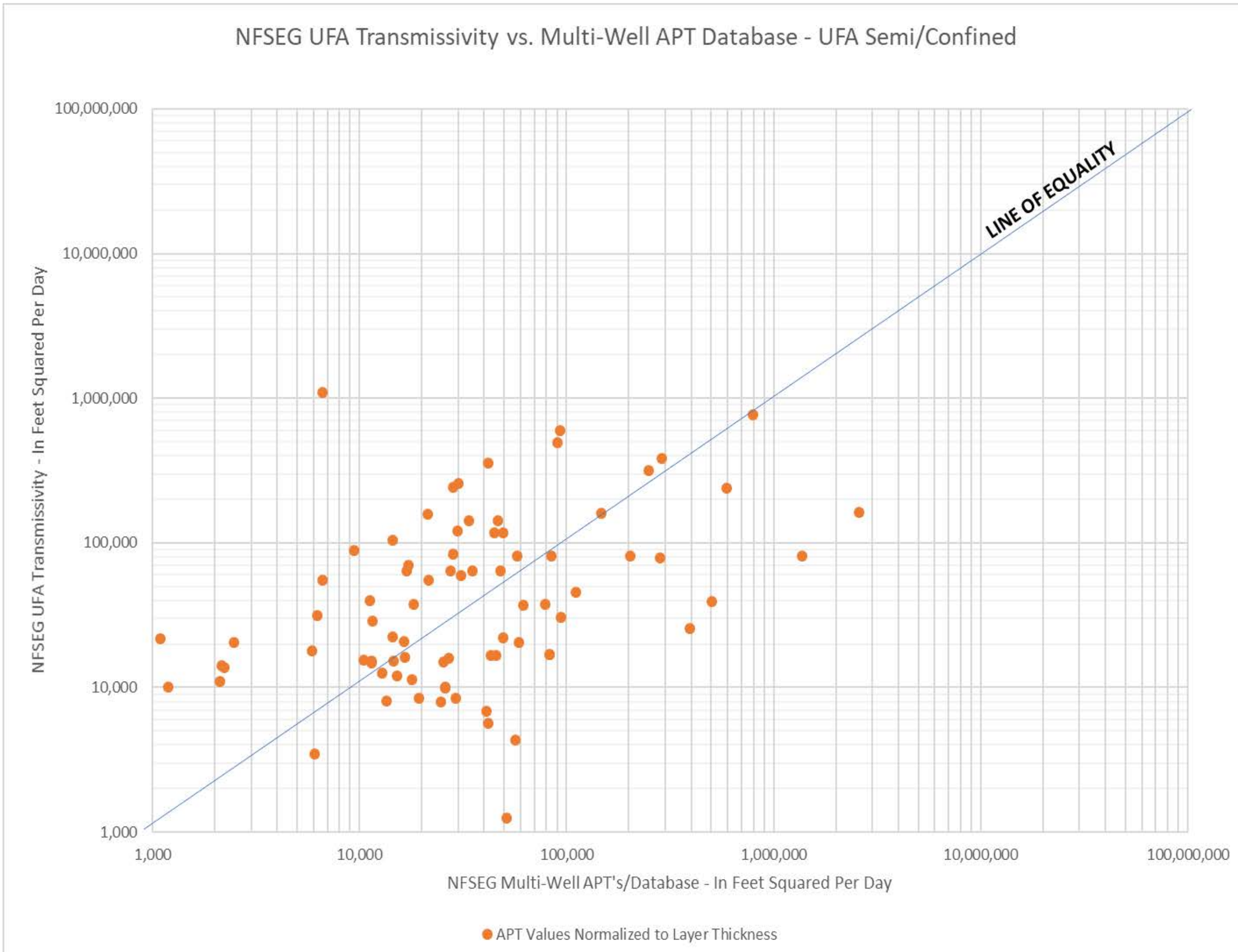

Figure 5. NFSEG UFA Transmissivity vs. NFSEG APT Database – Confined Region

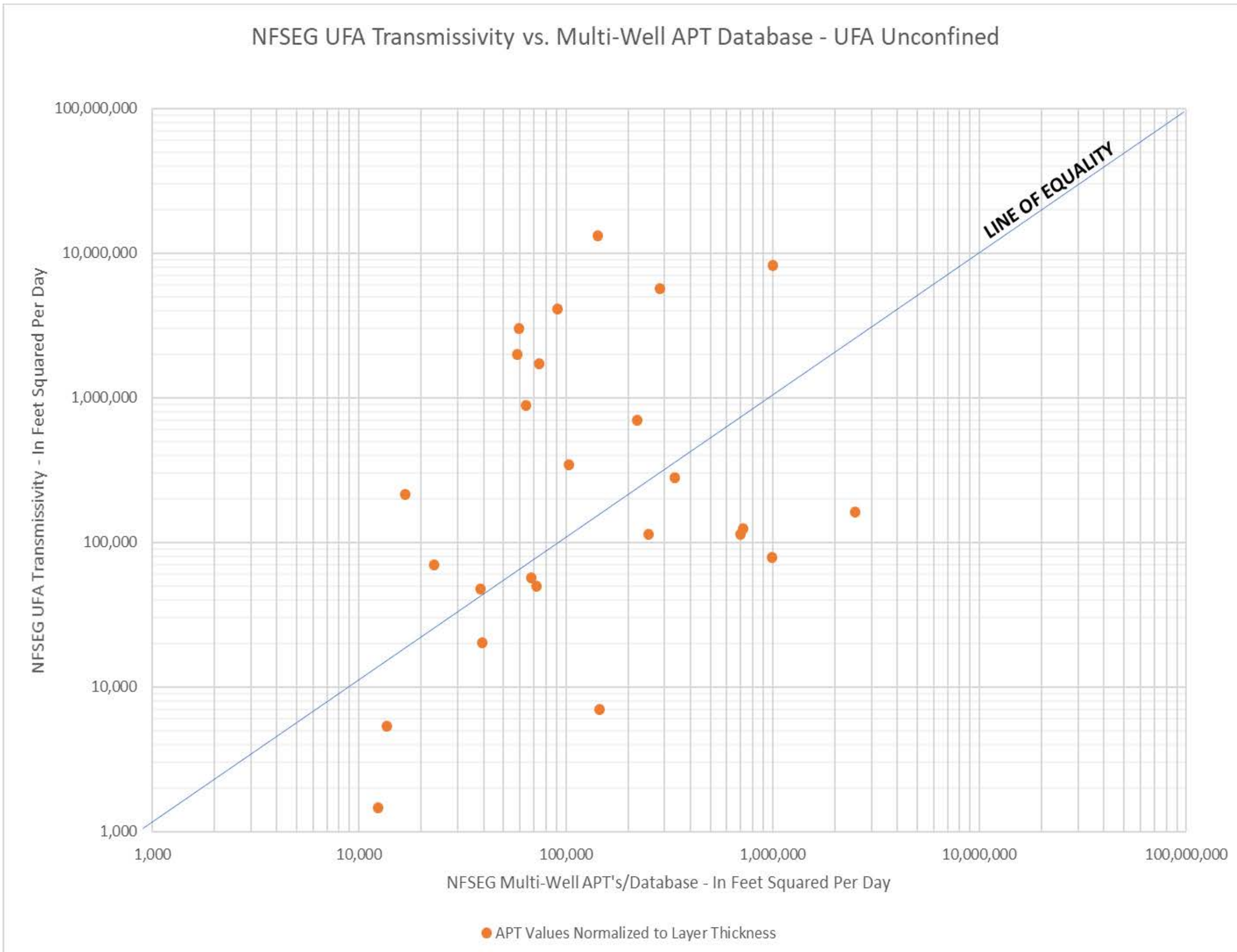

Figure 6. NFSEG UFA Transmissivity vs. NFSEG APT Database - Unconfined Region

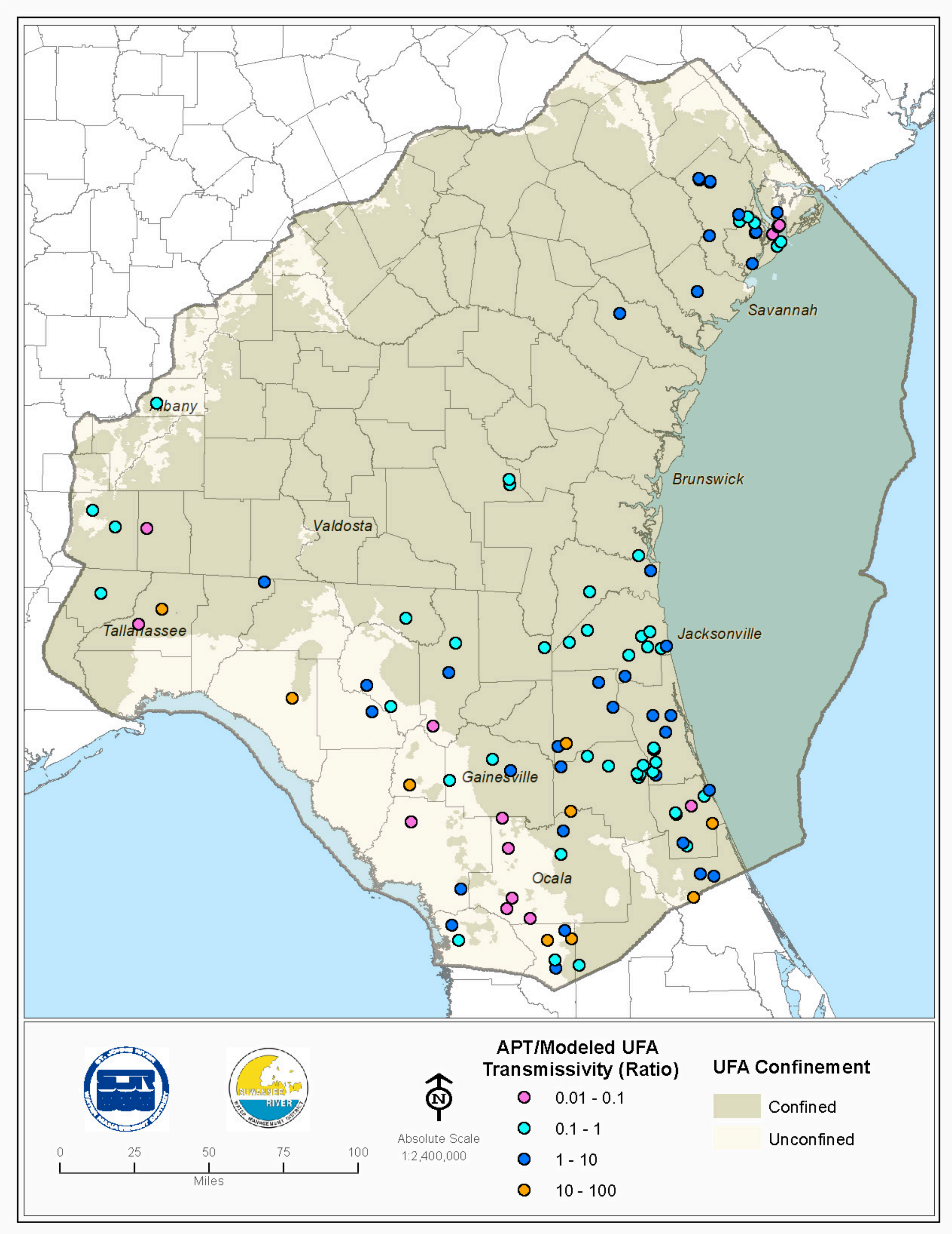

Figure 7. APT/Modeled UFA Transmissivity Ratio

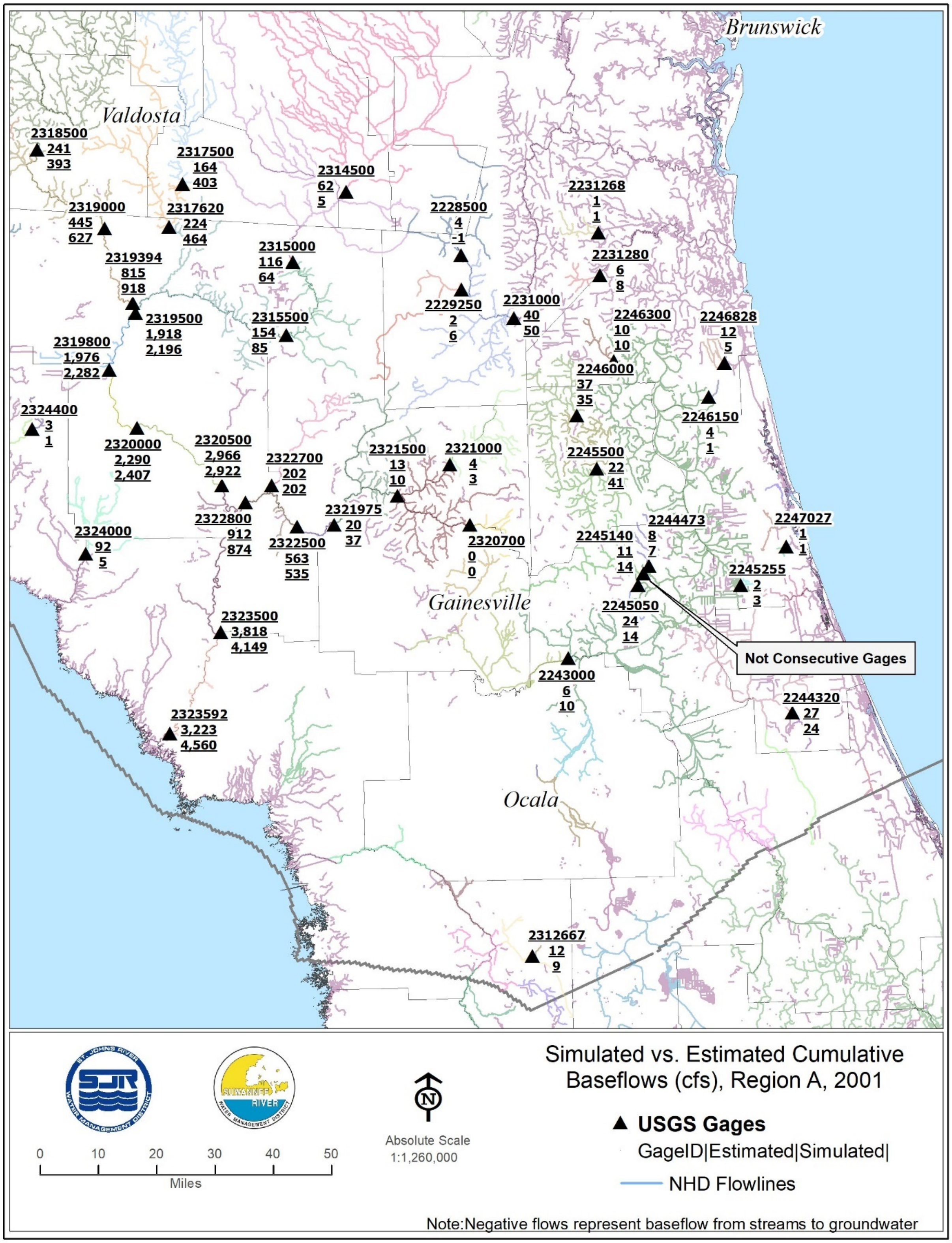

Figure 8. Simulated vs. Estimated Cumulative Baseflows, Region A, 2001

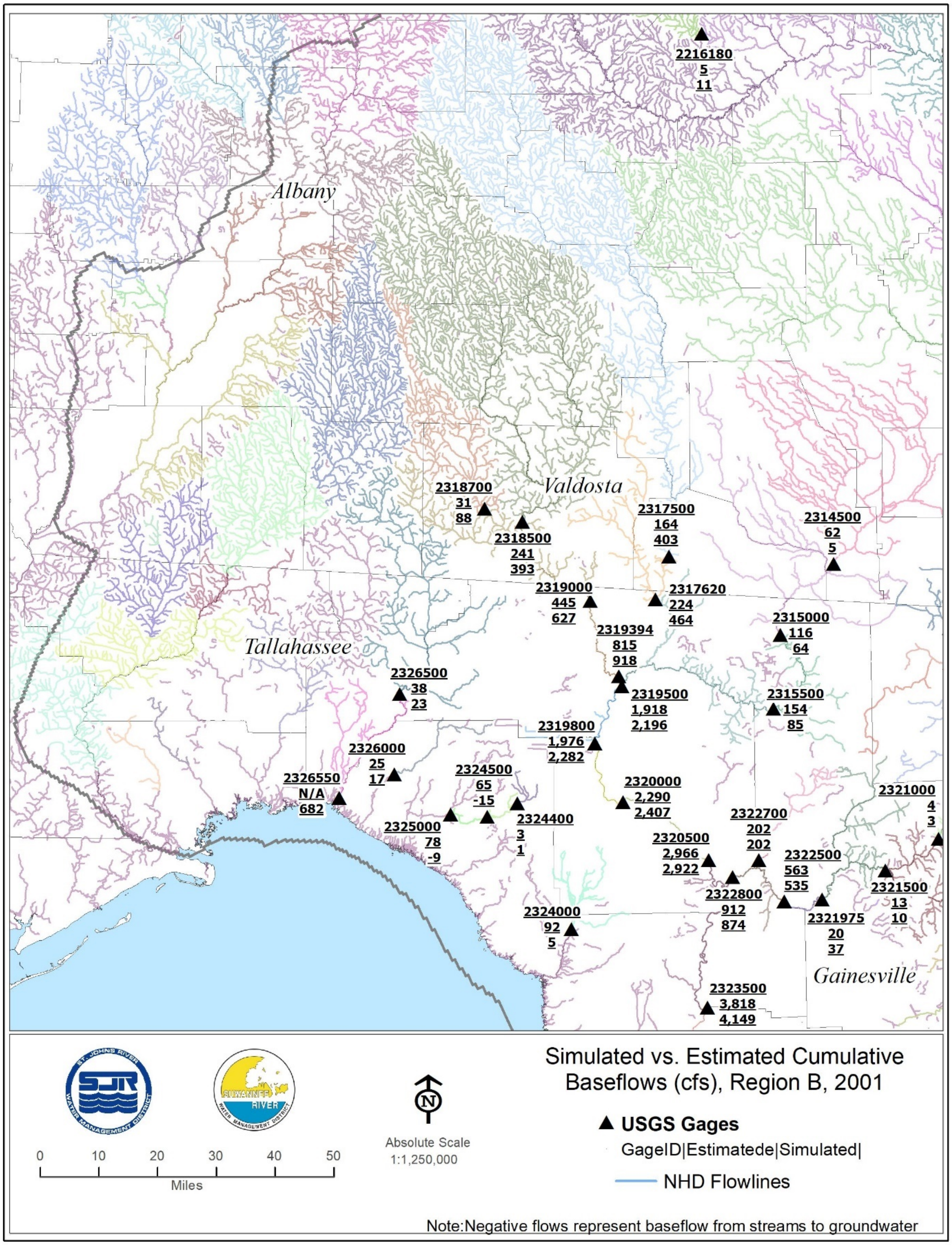

Figure 9. Simulated vs. Estimated Cumulative Baseflows, Region B, 2001

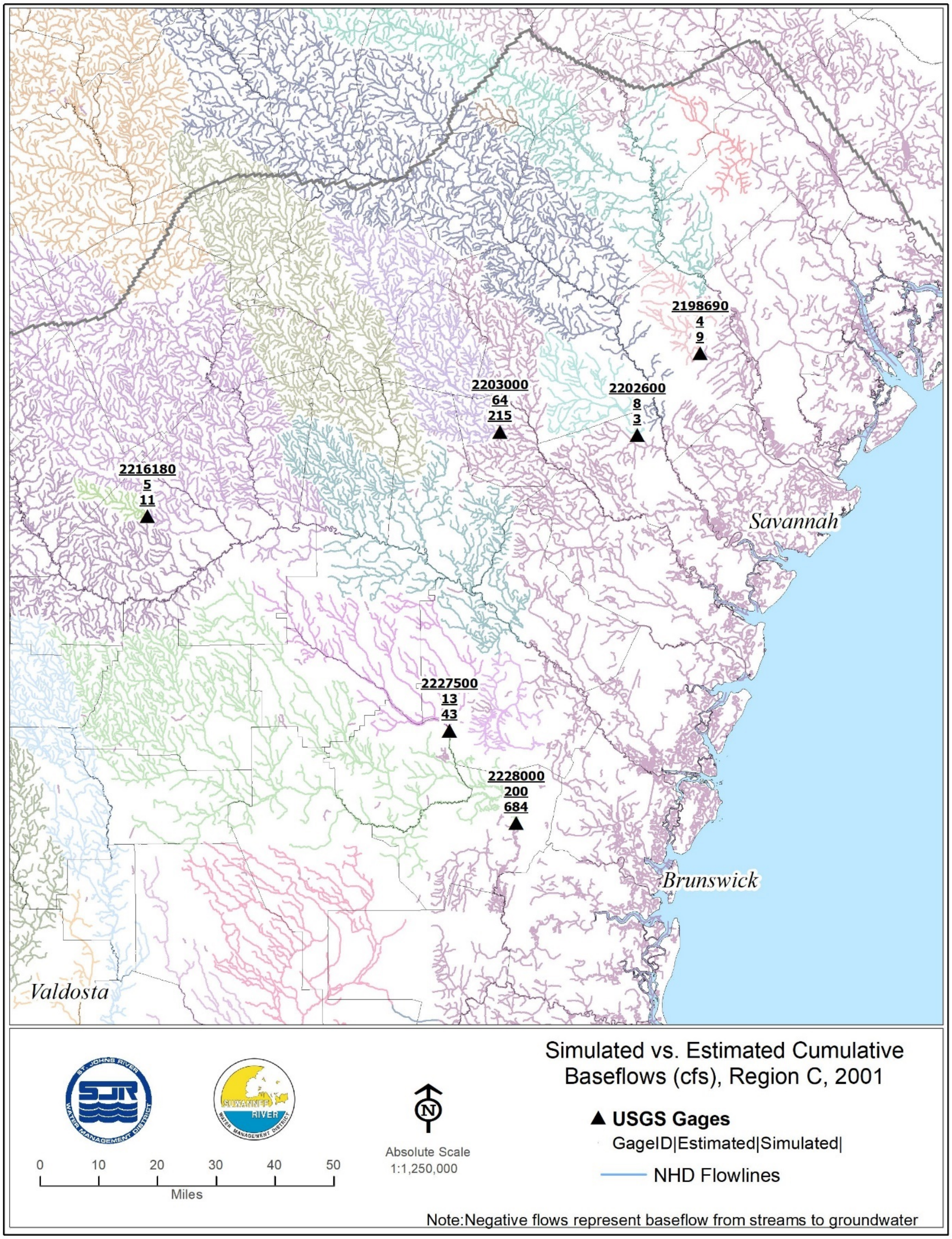

Figure 10. Simulated vs. Estimated Cumulative Baseflows, Region C, 2001

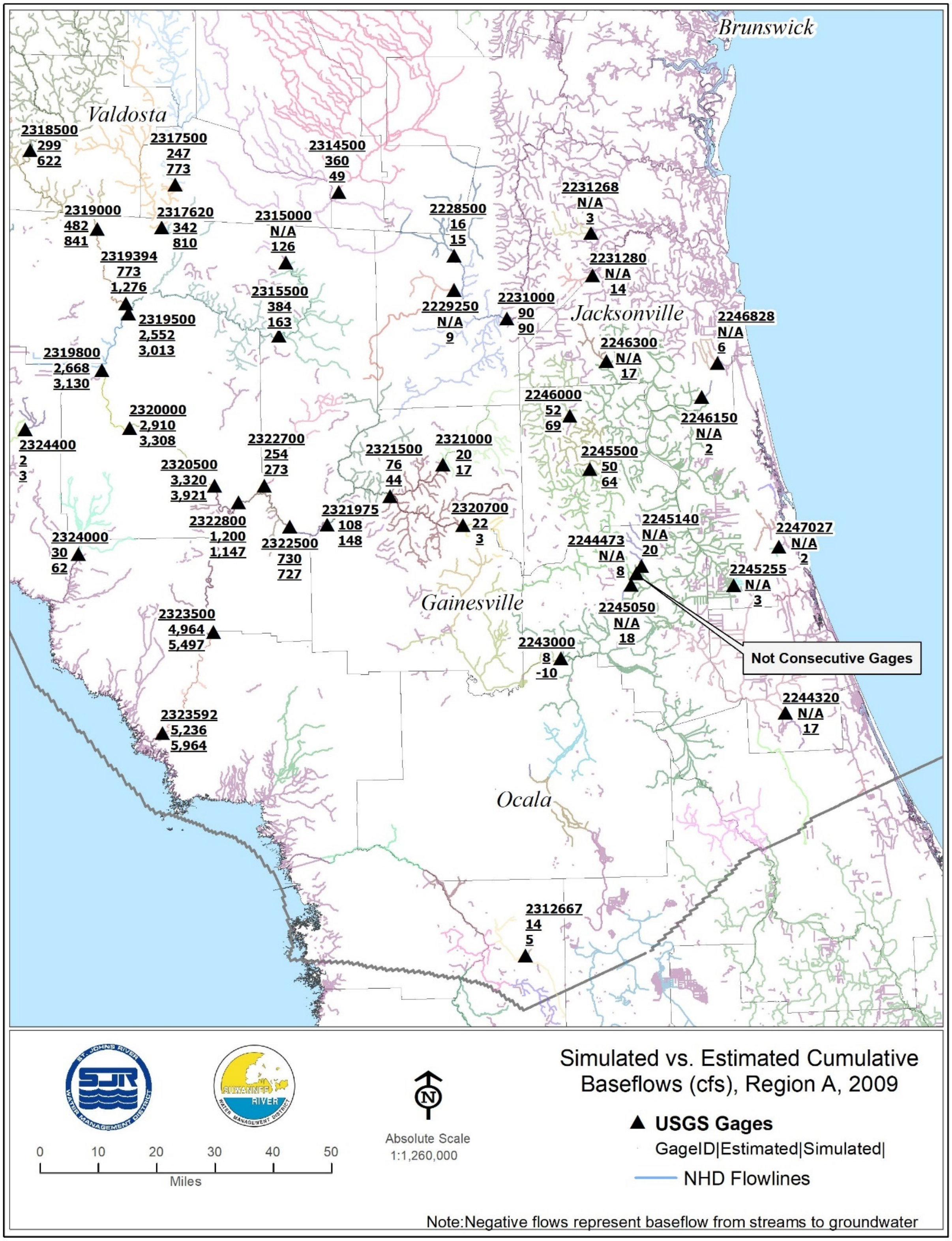

Figure 11. Simulated vs. Estimated Baseflows, Region A, 2009

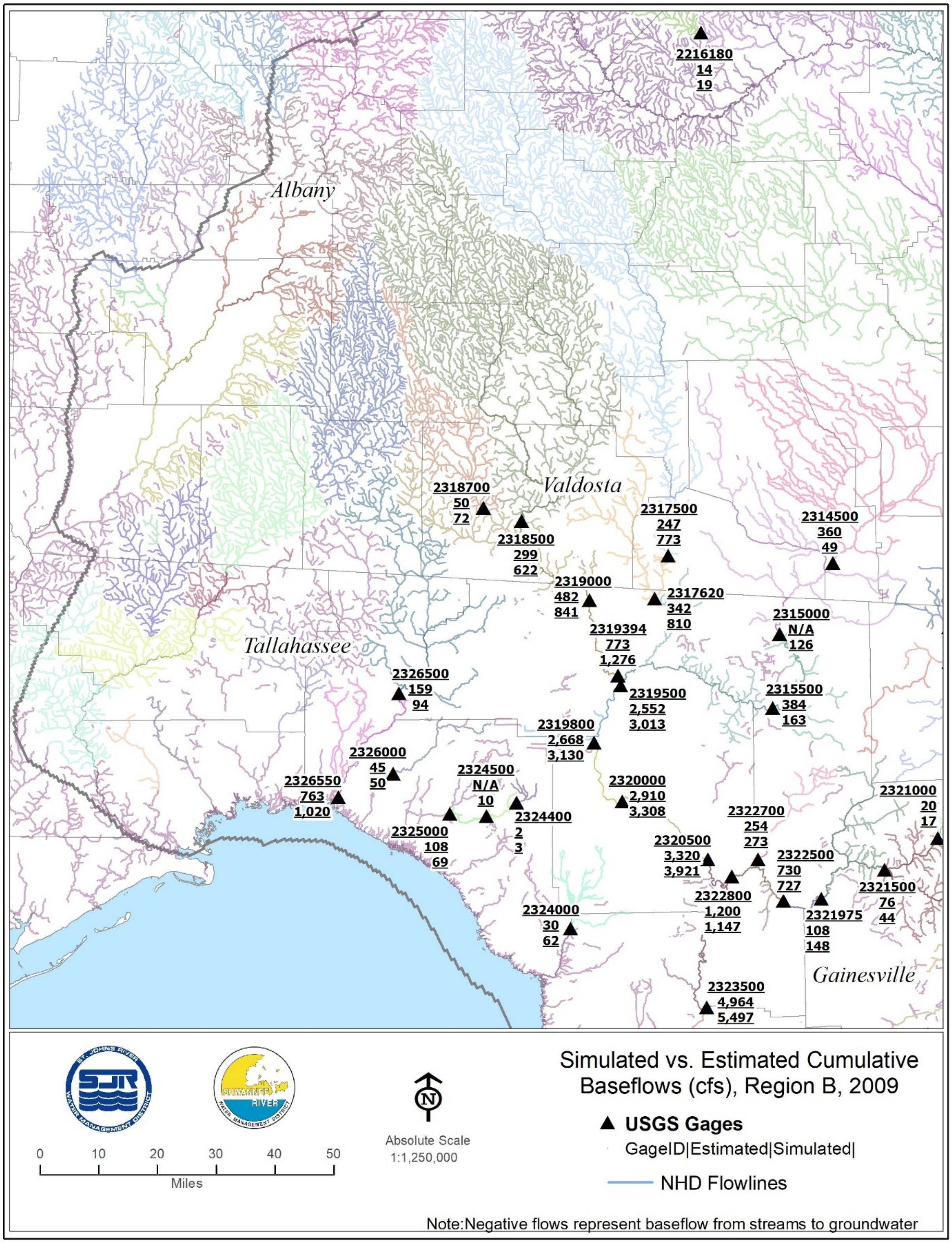

Figure 12. Simulated vs. Estimated Baseflows, Region B, 2009

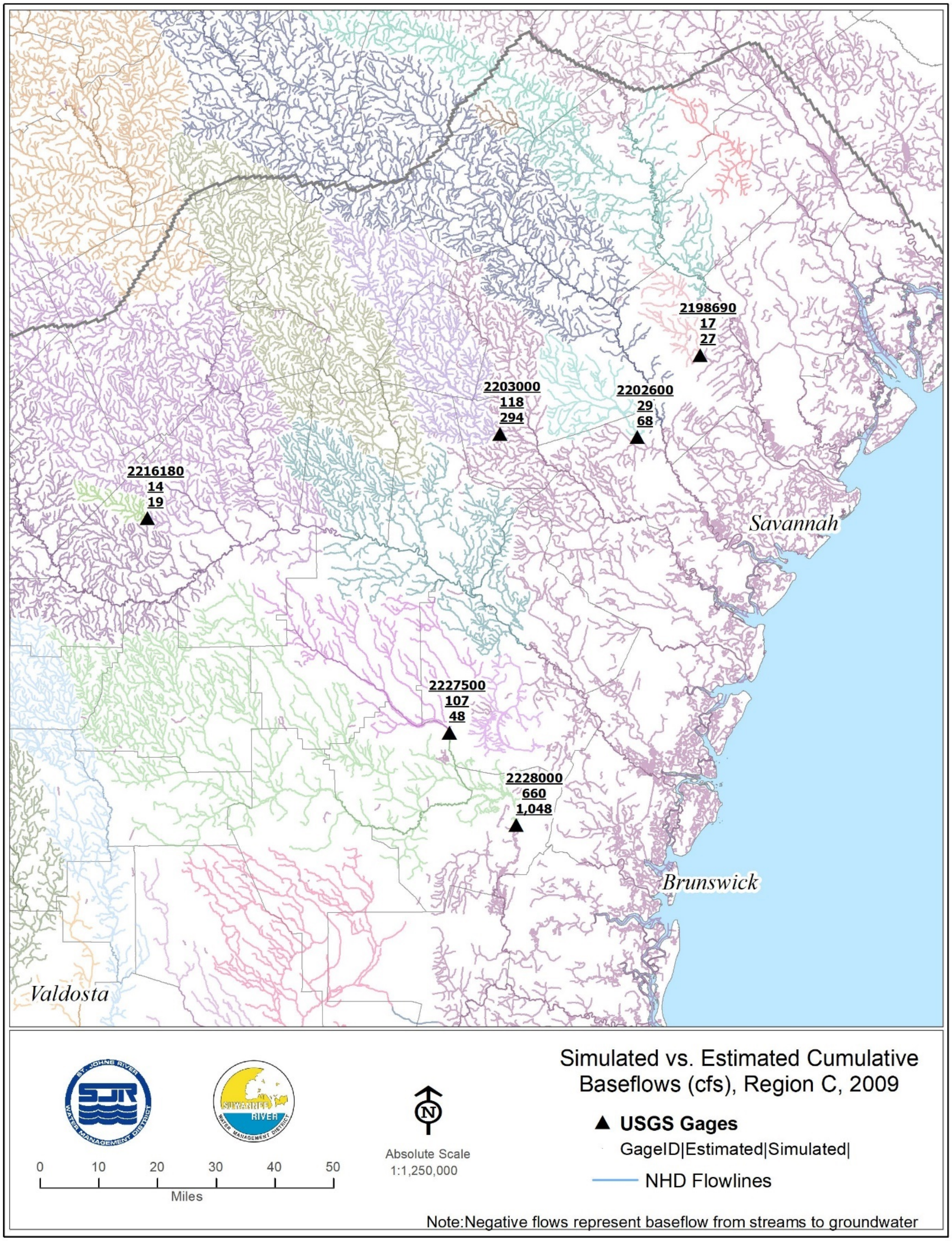

Figure 13. Simulated vs. Estimated Baseflows, Region C, 2009