EXPLANATION OF CHANGES TO NFSEG VERSION 1.1 HSPF SURFACE WATER MODELS

Following the completion of the NFSEG v1.1 model and documentation for final peer review, the NFSEG technical team at the St. Johns River Water Management District discovered an error in the HSPF surface water model derived recharge. This error affected five closed basins and was traced back to a unit conversion issue that occurred during post-processing. HSPF derived recharge was redistributed within closed basin areas in the active groundwater model domain in this processing. Furthermore, additional Parameter Estimation (PEST) optimization of the HSPF surface water models was performed, mostly limited to the vicinity of Savannah, GA, after the finalization of the NFSEG v1.1 groundwater model was completed.

To determine the effect of the changes to the NFSEG HSPF model on the groundwater model results, the post-processing error was corrected. New HSPF derived recharge, maximum saturated evapotranspiration (MSATET) and well package components were tested by the groundwater modeling team. Recharge and MSATET difference maps in inches per year (ipy) for the 2001 and 2009 stress periods are shown in Figures 1-4. These maps were generated by subtracting the original calibrated model recharge and MSATET, referred to as 'case007h' scenario, from the new HSPF recharge and MSATET with post-processing errors corrected. The differences in recharge in 2001 and 2009 were primarily located in closed basin areas within the Suwannee and Santa Fe River watersheds. The differences in MSATET in 2001 and 2009 were generally isolated in the region surrounding Savannah, Georgia.

The following steps were taken to evaluate the effect of these differences on model results:

- The 2001 and 2009 calibrated versions of the model, 2010 verification and no-pumping simulations were run one time with updated recharge, MSATET and well package files from the revised HSPF model. The parameter set defined during case007h calibration was used for these simulations.
- Groundwater level, spring flow and baseflow rate residual statistics were compared to case007h residual statistics
- Groundwater level difference maps were generated for the calibration and no-pumping simulations relative to the case007h simulations
- The difference in spring flow and baseflow rates between the calibrated 2009 and no-pumping simulations were compared to the case007h differences
- Simulated flooding in Layer 1 in response to removing the effects of pumping was evaluated for reasonableness and compared to case007h results

Throughout the contents of this addendum, **'case007h'** will refer to the NFSEG v1.1 calibration, verification and no-pumping simulations used to develop the model report that was submitted for peer review. The new simulations with updated recharge, MSATET and well package input files will be referred to as **'case007h-1'** to reflect that these simulations use the same parameter value set developed during case007h calibration.

CALIBRATION RESULTS

The calibration model performance was evaluated by comparing the case007h-1 simulated spring flow, groundwater levels, baseflow rates and mass balance for each stress period to the case007h calibration simulation used to develop the NFSEG v1.1 report.

I. Spring Flows

Spring flows for selected first-magnitude springs and spring groups for the calibration simulation were compared to case007h simulated spring flows. Simulated spring flows remained mostly unchanged or minimally affected in 2001 (Table 1) and 2009 (Table 2). During both stress periods, simulated spring flow slightly decreased in springs located in the Suwannee River and Santa Fe River watersheds. Simulated spring flow for the Ichetucknee Springs group decreased by 1 cfs in 2001 and 3 cfs in 2009 relative to the case007h simulation. However, model-wide residual statistics for measured springflows in 2001 (Table 3, Figure 5) and 2009 (Table 4, Figure 6) were statistically similar. Figures 7 and 8 show a comparison of spring flow residuals at selected springs and spring groups in the Suwannee and Santa Fe River region. The spring flow residuals were statistically similar in both 2001 and 2009.

Table 1. Comparison of simulated and estimated spring flows of selected first-magnitude springs and spring groups, 2001

Important first magnitude springs and spring groups	Water Management District	Estimated Discharge, (cfs)	Case007h Simulated Discharge, (cfs)	Case007h-1 Simulated Discharge (cfs)	Case007h-1 minus Case007h (cfs)
Ichetucknee Springs Group	SR	206	195.3	193.7	-1.6
Crystal River Springs Group	SWF	409	422.8	422.8	0
Rainbow Springs	SWF	544	544.4	544.4	0
Springs on the Santa Fe River between the gauges near Worthington Springs and Fort White	SR	489	500.3	498.2	-2.1
Silver Springs Group	SJR	445	446.7	446.6	-0.1
Lower Santa Fe Springs Group	SR	633	662.1	659.8	-2.3

Important first magnitude springs and spring groups	Water Management District	Estimated Discharge, (cfs)	Case007h Simulated Discharge, (cfs)	Case007h-1 Simulated Discharge (cfs)	Case007h-1 minus Case007h (cfs)
Wacissa Head Spring	SR	94	86.8	86.8	0
Madison Blue Spring	SR	61	58.5	58.4	-0.1
Alexander Spring	SJR	93	104.7	104.7	0
Silver Glen Spring	SJR	103	105.9	105.9	0
St. Marks River Rise	NWF	386	195.9	195.9	0
Alapaha Rise	SR	243	232.3	230.6	-1.7
Holton Creek	SR	71	64.0	63.5	-0.5

Table 2. Comparison of simulated and estimated spring flows of selected first-magnitude springs and spring groups, 2009

Important first magnitude springs and spring groups	Water Management District	Estimated Discharge, (cfs)	Case007h Simulated Discharge, (cfs)	Case007h-1 Simulated Discharge (cfs)	Case007h-1 minus Case007h (cfs)
Wacissa Springs Group	SR	459	447.6	447.6	0
Ichetucknee Springs Group	SR	261	263.6	261.2	-2.4
Crystal River Springs Group	SWF	467	446.9	446.9	0
Rainbow Springs	SWF	561	569.5	569.5	0
Springs on the Santa Fe River between the gauges near Worthington Springs and Fort White	SR	645	640.0	636.9	-3.1
Silver Springs Group	SJR	501	508.6	508.6	0
Lower Santa Fe Springs Group	SR	851	825.4	822.1	-3.3

Important first magnitude springs and spring groups	Water Management District	Estimated Discharge, (cfs)	Case007h Simulated Discharge, (cfs)	Case007h-1 Simulated Discharge (cfs)	Case007h-1 minus Case007h (cfs)
Wakulla Spring Main Vent	NWF	712	716.9	716.9	0
Wacissa Head Spring	SR	170	164.0	164.0	0
Madison Blue Spring	SR	104	104.2	104.1	-0.1
Alexander Spring	SJR	102	102.3	102.3	0
Silver Glen Spring	SJR	103	101.2	101.2	0
St. Marks River Rise	NWF	612	230.1	230.1	0
Spring Creek Springs Group	NWF	451	448.2	448.2	0
Alapaha Rise	SR	244	240.4	239.6	-0.7
Holton Creek	SR	63	66.5	66.3	-0.2

Table 3. Comparison of residual statistics for simulated springflows, 2001

Run	Number of springs	Residual Mean (cfs)	Absolute Residual Mean (cfs)	Residual Standard Deviation (cfs)	R-squared
case007h	365	-0.99	2.44	10.77	0.90
case007h-1	365	-1.02	2.45	10.78	0.90

Table 4. Comparison of residual statistics for simulated springflows, 2009

Run	Number of springs	Residual Mean (cfs)	Absolute Residual Mean (cfs)	Residual Standard Deviation (cfs)	R-squared
case007h	368	-1.08	2.77	20.52	0.89
case007h-1	368	-1.11	2.76	20.51	0.89

II. Groundwater Levels

Model-wide groundwater level residual statistics were compared at target well locations for both sets of calibration simulations. Table 5 provides a comparison of groundwater level residual statistics at all target wells excluding those in Model Layer 2. Table 6 provides a comparison of groundwater level statistics for all target wells in Model Layer 3. There was no statistical difference in model-wide residual groundwater level statistics between the case007h and case007h-1 calibration simulations. The head difference was calculated at each target well location within Model Layer 1, 3 and 5 by subtracting the case007h simulated head from the case007h-1 simulated head. In Model Layer 1, the groundwater water level difference between case007h and case007h-1 was generally within ±0.05 feet at an individual target well across the model domain in 2001 (Figure 9) and 2009 (Figure 11). The maximum cell head difference was in Hamilton County in 2001, where head decreased by 28 feet (Figure 10), while the maximum cell head difference in 2009 was in the region near Savannah, Georgia, where head decreased by over 100 feet (Figure 12).

Model Layer 3 target well head differences were generally within ±0.05 feet across the model domain. Simulated heads in the Suwannee River closed basin regions were generally between 0.1 to 0.5 feet lower in the case007h-1 simulation in 2001 (Figure 13) and 2009 (Figure 17). The maximum Layer 3 cell head difference in 2001 (Figure 16) and 2009 (Figure 20) was in southern Gilchrist County, where simulated head was approximately 1.6 feet lower in the case007h-1 simulation. Groundwater level residuals in the model were compared at target wells in the Suwannee and Santa Fe River watersheds where head difference exceeded ±0.05 feet at an individual target well. Figures 14 and 15 show a comparison of the calculated groundwater level residual (measured minus simulated) at Layer 3 observation target wells in 2001 and Figures 18 and 19 show the groundwater level residual comparison in 2009. There was a general decrease in the magnitude of the groundwater level residual at target wells in these regions in both stress periods.

Model Layer 5 heads were generally unaffected by the changes in HSPF recharge in 2001 (Figure 21). The maximum Model Layer 5 target well head difference was 0.32 feet lower in 2009 (Figure 22).

Table 5. Summary of groundwater level residual statistics for all target wells except Model Layer 2 wells

Statistical Criterion	Proposed Target	Case007h		Case007h-1	
		2001	2009	2001	2009
-5 feet < Residual < 5 feet	80%	74%	76%	74%	76%
-2.5 feet < Residual < 2.5 feet	50%	43%	49%	43%	49%
Mean of Residuals	-	-0.3	-0.7	-0.3	-0.7

Standard Deviation of Residuals	-	5.4	5.0	5.4	5.0
Mean of Absolute Residuals	-	3.9	3.5	3.9	3.5
Number of Targets	-	1263	1284	1263	1284

Table 6. Summary of groundwater layer residual statistics for Model Layer 3 only

Statistical Criterion	Proposed Target	Case007h		Case007h-1	
		2001	2009	2001	2009
-5 feet < Residual < 5 feet	80%	76%	76%	76%	76%
-2.5 feet < Residual < 2.5 feet	50%	43%	49%	43%	49%
Mean of Residuals	-	-0.4	-0.9	-0.4	-0.9
Standard Deviation of Residuals	-	4.8	4.6	4.8	4.6
Mean of Absolute Residuals	-	3.6	3.4	3.6	3.4
Number of Targets	-	977	993	977	993

III. Baseflow Rates

Simulated cumulative baseflow rates for the case007h and case007h-1 simulations are compared in Table 7 and 8. In 2001 and 2009, case007h-1 simulated cumulative baseflows generally decreased relative to the original case007h calibration simulation. Differences exceeding 1 cfs between the two simulations occurred at gauges located on the Suwannee and Santa Fe River, however, the difference in simulated baseflow rate between the two simulations represents less than <0.5% of the total simulated baseflow at any gauge. A comparison of the residual baseflow rate for selected USGS gauges showed no statistical differences in the Suwannee and Santa Fe River region in 2001 (Figure 23) or 2009 (Figure 24).

Table 7. Comparison of simulated cumulative baseflows for selected USGS gauges, 2001

USGS Gauge	Gauge Name	Target Baseflow (cfs)	Case007h Simulated Baseflow (cfs)	Case007h-1 Simulated Baseflow (cfs)	Case007h-1 minus Case007h (cfs)
02228000	Satilla River at Atkinson, Ga	200.32	683.68	683.66	-0.02

USGS Gauge	Gauge Name	Target Baseflow (cfs)	Case007h Simulated Baseflow (cfs)	Case007h-1 Simulated Baseflow (cfs)	Case007h-1 minus Case007h (cfs)
02231000	St. Marys River Near Macclenny, Fl	39.72	49.81	49.81	0
02243000	Orange Creek at Orange Springs, Fl	5.74	10.37	10.36	-0.01
02315500	Suwannee River at White Springs, Fla.	153.67	85.10	85.10	0
02317620	Alapaha River Near Jennings Fla	223.86	464.39	464.39	0
02319000	Withlacoochee River Near Pinetta, Fla.	444.67	627.27	627.09	-0.18
02319500	Suwannee River at Ellaville, Fla	1918.01	2195.53	2190.61	-4.92
02320500	Suwannee River at Branford, Fla.	2966.05	2921.92	2916.11	-5.81
02321500	Santa Fe River at Worthington Springs, Fla.	12.6	10.23	10.22	-0.01
02322500	Santa Fe River Near Fort White, Fla.	562.69	534.48	532.30	-2.18
02323500	Suwannee River Near Wilcox, Fla.	4167	4148.79	4137.28	-11.51

Table 8. Comparison of simulated cumulative baseflows for selected USGS gauges, 2009

USGS Gauge	Gauge Name	Target Baseflow (cfs)	Case007h Simulated Baseflow (cfs)	Case007h-1 Simulated Baseflow (cfs)	Case007h-1 minus Case007h (cfs)
02228000	Satilla River at Atkinson, Ga	659.71	1047.80	1047.82	0.02
02231000	St. Marys River Near Macclenny, Fl	89.70	89.47	89.49	0.02

USGS Gauge	Gauge Name	Target Baseflow (cfs)	Case007h Simulated Baseflow (cfs)	Case007h-1 Simulated Baseflow (cfs)	Case007h-1 minus Case007h (cfs)
02243000	Orange Creek at Orange Springs, Fl	8.40	10.19	10.21	0.02
02315500	Suwannee River at White Springs, Fla.	383.55	162.73	162.70	-0.03
02317620	Alapaha River Near Jennings Fla	341.67	810.42	810.40	-0.02
02319000	Withlacoochee River Near Pinetta, Fla.	482.33	840.81	840.69	-0.12
02319500	Suwannee River at Ellaville, Fla	2551.54	3012.86	3010.13	-2.73
02320500	Suwannee River at Branford, Fla.	3320.41	3920.89	3916.92	-3.97
02321500	Santa Fe River at Worthington Springs, Fla.	76.19	43.52	43.50	-0.02
02322500	Santa Fe River Near Fort White, Fla.	730.42	726.77	723.58	-3.19

Model-wide baseflow pickup residuals were statistically similar in 2001 (Table 9, Figure 25) and 2009 (Table 10, Figure 26). Residual statistics showed a slight improvement in the case007h-1 calibration results for both stress periods and produced a lower residual mean and residual standard deviation compared to case007h.

Table 9. Summary of residual statistics for simulated baseflow pickups, 2001

Run	Number of gauges	Residual Mean (cfs)	Absolute Residual Mean (cfs)	Residual Standard Deviation (cfs)	R-squared
case007h	76	26.00	44.05	88.34	0.79
case007h-1	76	25.78	43.97	88.15	0.79

Table 10. Summary of residual statistics for simulated baseflow pickup, 2009

Run	Number of gauges	Residual Mean (cfs)	Absolute Residual Mean (cfs)	Residual Standard Deviation (cfs)	R-squared
case007h	46	43.94	106.57	173.83	0.66
case007h-1	46	43.67	106.44	173.80	0.66

IV. Mass Balance

The simulated model-wide mass balance showed no significant change in 2001 (Table 11, Figure 27) or 2009 (Table 12, Figure 28) when compared to the case007h simulated mass balance terms. The mass balance was also compared for the groundwater basin (GWB) in the Suwannee and Santa Fe River watersheds where the largest changes in recharge rates were observed, GWB-3. The simulated recharge difference in GWB-3 was 0.03 inches lower in 2001 (Table 13, Figure 29) and 0.04 inches lower in 2009 (Table 14, Figure 30) relative to the case007h simulated recharge. The model fluxes into Layer 3 for both stress periods were 0.02 inches per year lower in 2001 and 2009 in GWB-3.

Table 11. Model-wide mass balance comparison, 2001

Year	Case007h: 2001 (in/yr)	Case007h-1 2001 (in/yr)	Difference (in/yr)
Recharge to Layer 1	9.67	9.67	0.00
Simulated GW evapotranspiration	-4.74	-4.74	0.00
Flux from Layer 2 into Layer 3	1.51	1.50	-0.01
Flux from Layer 4 into Layer 3	0.37	0.37	0.00
Drain flows	-1.66	-1.66	0.00
River flows	-1.63	-1.63	0.00
GHB Flows (Layer 3)	-1.44	-1.44	0.00

*Note: A negative sign indicates net flow out of the model. Positive values indicate net flow into the model.

Table 12. Model-wide mass balance comparison, 2009

Year	Case007h: 2009 (in/yr)	Case007h-1 2009 (in/yr)	Difference (in/yr)
Recharge to Layer 1	13.92	13.91	-0.01
Simulated GW evapotranspiration	-6.86	-6.86	0.00
Flux from Layer 2 into Layer 3	1.78	1.78	0.00
Flux from Layer 4 into Layer 3	0.35	0.35	0.00

Year	Case007h: 2009 (in/yr)	Case007h-1 2009 (in/yr)	Difference (in/yr)
Drain flows	-2.59	-2.59	0.00
River flows	-2.49	-2.49	0.00
GHB Flows (Layer 3)	-1.71	-1.71	0.00

*Note: A negative sign indicates net flow out of the model. Positive values indicate net flow into the model.

Table 13. GWB-3 mass balance comparison, 2001

Year	Case007h: 2001 (in/yr)	Case007h-1 2001 (in/yr)	Difference (in/yr)
Recharge to Layer 1	11.34	11.31	-0.03
Simulated GW evapotranspiration	-4.32	-4.32	0.00
Flux from Layer 2 into Layer 3	5.22	5.20	-0.02
Flux from Layer 4 into Layer 3	0.32	0.32	0.00
Drain flows	-0.86	-0.86	0.00
River flows	-0.64	-0.64	0.00
GHB Flows (Layer 3)	-5.18	-5.16	0.02

*Note: A negative sign indicates net flow out of the model. Positive values indicate net flow into the model.

Table 14. GWB-3 mass balance comparison, 2009

Year	Case007h: 2009 (in/yr)	Case007h-1 2009 (in/yr)	Difference (in/yr)
Recharge to Layer 1	16.67	16.63	-0.04
Simulated GW evapotranspiration	-6.80	-6.78	0.02
Flux from Layer 2 into Layer 3	6.08	6.06	-0.02
Flux from Layer 4 into Layer 3	0.33	0.33	0.00
Drain flows	-1.56	-1.56	0.00
River flows	-1.84	-1.84	0.00
GHB Flows (Layer 3)	-6.31	-6.29	0.02

*Note: A negative sign indicates net flow out of the model. Positive values indicate net flow into the model.

PUMPS OFF NO RETURN FLOWS RESULTS

The case007h-1 no pumping simulation was evaluated by comparing the simulated spring flow, groundwater levels and baseflow rates for each stress period to the case007h no pumping simulation submitted for peer review and used to develop the NFSEG v1.1 report. Simulated flooding depths in Layer 1 in response to the removal of groundwater pumping were also evaluated for reasonableness.

I. Spring Flows

The difference in spring flow between the 2009 and no-pumping case007h and case007h-1 simulations was compared for selected springs in Table 15. Relative differences in simulated spring flow between the 2009 and no-pumping simulations were generally the same. The Lower Santa Fe Spring Group decreased by 3.32 cfs in the case007h-1 2009 calibration simulation and by 4.58 cfs in the case007h-1 2009 no-pumping scenario, a difference of 1.26 cfs.

Table 15. Comparison of simulated 2009 and no-pumping spring discharges for selected springs

Spring	2009 Case007h Discharge (cfs)	2009 Case007h-1 Discharge (cfs)	2009 Difference (cfs)	No-Pumping Case007h Discharge (cfs)	No-Pumping Case007h-1 Discharge (cfs)	No-pumping Difference (cfs)
Silver	508.64	508.58	-0.06	531.83	531.75	-0.08
Rainbow	569.53	569.49	-0.03	578.81	578.76	-0.05
Ichetucknee	263.59	261.16	-2.43	279.18	276.39	-2.79
Homosassa	123.54	123.54	0.00	124.23	124.22	0.00
Manatee	128.52	128.23	-0.29	128.93	128.63	-0.30
Silver Glen	101.22	101.22	0.00	102.53	102.53	0.00
Alexander	102.31	102.31	0.00	103.06	103.06	0.00
Juniper	14.70	14.70	0.00	14.87	14.87	0.00
Fanning	67.63	66.99	-0.64	67.99	67.33	-0.66
Salt	91.80	91.80	0.00	92.38	92.38	0.00
Poe	42.67	42.58	-0.09	44.11	44.00	-0.12
Madison Blue	104.18	104.05	-0.13	118.43	118.27	-0.16
White Sulphur	-5.54	-5.57	-0.03	2.09	2.04	-0.05
Suwanacoochee	29.11	29.08	-0.02	31.71	31.68	-0.03
Ponce de Leon	21.40	21.41	0.00	22.42	22.42	0.00

Lower Santa Fe Spring Group	825.40	822.08	-3.32	894.92	890.34	-4.58
Alapaha Rise	240.36	239.64	-0.72	298.82	298.01	-0.81
Holton Creek	66.52	66.30	-0.23	88.47	88.20	-0.27

II. Groundwater Levels

Groundwater levels for the no-pumping simulation were compared by subtracting the case007h simulated head from the case007h-1 simulated head in Model Layer 1 and 3. Model Layer 1 groundwater level differences were generally confined to areas where recharge was modified in the case007h-1 run. The maximum cell head difference in 2001 occurred in Hamilton County, where head decreased by 28 feet in the case007h-1 simulation (Figure 31). The maximum cell head difference in 2009 occurred in the Savannah, Georgia region, where head decreased by 160 feet in the case007h-1 simulation (Figure 32). This HSPF model area does not have any flow observations, and thus could not be calibrated. Parameters were taken from a representative nearby HSPF model, and the representative model selection changed between delivery of results to the groundwater modelers and the model review team. Outside of this region, the maximum cell head difference in Model Layer 1 in 2009 was comparable to what was observed in 2001. Model Layer 3 groundwater level differences were more isolated than in Model Layer 1, and generally located in areas where closed basin recharge was redistributed. The maximum cell head difference in Model Layer 3 in 2001 occurred in southern Gilchrist County, where head decreased by 1.74 feet in 2001 in the case007h-1 no-pumping simulation (Figure 33). The maximum cell head difference in Model Layer 3 in 2009 occurred in the Savannah region, where head decreased by 2.21 feet in the case007h-1 no-pumping simulation (Figure 34).

III. Simulated Flooding in Layer 1

Figure 35 shows the change in simulated flooding depths between the case007h-1 2009 and no-pumping simulations. Changes in simulated Layer 1 flooding depths were comparable to those observed between the case007h 2009 and no-pumping simulations (Figure 5-29 in Chapter 5 of the report). The simulated flooding depth was generally less than 1 foot throughout the area of interest outlined in Figure 35. The largest decrease in simulated flooding depth was 105 feet, which occurred in Hamilton County. The maximum increase in flooding depth was between 7 and 11 feet, which occurred over small localized areas. As explained in Chapter 5 of the model report, large changes could be attributed to localized issues in estimated pumping rates, parametrization or recharge.

IV. Baseflow Rates

The difference in baseflow rate between the 2009 and no-pumping case007h and case007h-1 simulations was compared for selected USGS gauges in Table 16. The relative difference between the 2009 case007h and case007h-1 calibration simulated baseflow and the 2009 no-pumping simulated baseflow were generally the same. The largest discrepancy between the 2009 and no-pumping baseflow rate change occurred at gauge 02322500 on the Santa Fe River near Fort White. Simulated baseflow rate at gauge 02322500 decreased by 3.2 cfs in the case007h-1 2009 calibration simulation and by 4.5 cfs in the case007h-1 2009 no-pumping scenario, a difference of 1.3 cfs.

Table 16. Comparison of simulated 2009 and no-pumping baseflows for selected USGS gauges

USGS Gauge	USGS Gauge Name	2009 Case007h Baseflow (cfs)	2009 Case007h-1 Baseflow (cfs)	2009 Difference (Cfs)	No-Pumping Case007h Baseflow (cfs)	No-Pumping Case007h-1 Baseflow (cfs)	No-pumping Difference (cfs)
2231000	ST. MARYS RIVER NEAR MACCLENNY, FL	89.5	89.5	0	92.9	92.9	0
2246000	NORTH FORK BLACK CREEK NEAR MIDDLEBURG, FL	68.6	68.6	0	70.8	70.8	0
2315500	SUWANNEE RIVER AT WHITE SPRINGS, FL	162.7	162.7	0	162.5	162.5	0
2319000	WITHLACOOCHEE RIVER NEAR PINETTA, FL	840.8	840.7	-0.1	856.8	856.6	-0.2
2319500	SUWANNEE RIVER AT ELLAVILLE, FL	3013	3010	-3	3323	3319	-4
2320500	SUWANNEE RIVER AT BRANFORD, FL	3921	3917	-4	4264	4259	-5
2322500	SANTA FE RIVER NEAR FORT WHITE, FL	726.8	723.6	-3.2	796.8	792.3	-4.5

2010 Verification Results

The case007h-1 verification simulation was evaluated by comparing residual statistics for groundwater levels, spring flows and baseflow rates in 2010 relative to the 2001 and 2009 calibration residual statistics. A similar evaluation was performed for the case007h set of simulations used to develop the NFSEG v.1.1 report (see Chapter 5).

I. Spring Flows

Spring flow residual statistics in 2010 were compared to those in 2001 and 2009 for individual springs in the NFSEG model (Figure 36). Overall, spring flow residual statistics in 2010 were similar to residual statistics in 2001 and 2009. Relative to 2001 and 2009, the 2010 simulation resulted in a higher absolute mean spring flow residual. The 2010 residual mean was lower than 2001 and 2009, but still negative, which suggests an overall underestimation of spring flow. The residual standard deviation of 2010 spring flow was higher than the residual standard deviation in 2001, but lower than the residual standard deviation in 2009 (Figure 36).

II. Groundwater Levels

The groundwater level residual statistics of the 2010 simulation were compared with the groundwater level residual statistics of the 2001 and 2009 calibration simulations (Figure 37). Overall, groundwater level residual statistics in 2010 were comparable to 2001 and 2009 residuals. The 2010 simulation performed slightly better in predicting Layer 1 groundwater levels than in 2009, whereas the 2010 residuals were slightly higher than the 2001 and 2009 residuals in Layers 3 and 5.

III. Baseflow Rates

Figure 38 includes the cumulative baseflow residual statistics for 2010, compared to 2001 and 2009. The mean residual in 2010 was negative, which suggests an overall underestimation of cumulative baseflow, while simulated cumulative baseflow was overestimated in 2001 and 2009. This was consistent with the case007h verification and calibration simulations. The residual standard deviation and residual absolute mean were larger in 2010 relative to 2001 and 2009. As explained in Chapter 5 of the report, baseflow targets were mostly derived as averages of five different baseflow-estimation techniques. Because of likely inaccuracies in the resulting targets, large baseflow residuals can be as or more indicative of poor baseflow targets than of model deficiencies.

The 2010 estimated baseflow pickup residual statistics were also compared with the 2001 and 2009 calibration statistics (Figure 39). Overall, baseflow pickup residual statistics in 2010 were comparable to what was simulated in 2001 and 2009. The residual absolute mean and residual standard deviation in the year 2010 were between the calculated residual values in 2001 and 2009. The residual mean in the year 2010 was negative, which indicates an overall underestimation of baseflow pickups, compared to an overall overestimation of baseflow pickups in 2001 and 2009.

SUMMARY

Following the completion of the NFSEG v1.1 model and documentation for final peer review, it was discovered by the NFSEG modeling team at the St. Johns River Water Management District that the HSPF recharge results used as input for the NFSEG v1.1 groundwater flow model contained a post-processing error that primarily affected five closed basins. An analysis of how model results were affected was performed by correcting the post-processing error and subsequently running the calibration, verification and no-pumping simulations with updated HSPF derived recharge, MSATET and well package files. The model was not recalibrated for this evaluation, and the parameter set developed during calibration of the model that was submitted for peer review was used. Due to the elimination of post-processing errors, the correction of HSPF-derived recharge in the closed basin areas reflects an improved estimation of parameters in the model domain.

To evaluate the effects on model results, simulated groundwater levels, spring flows and baseflow rates were reviewed and compared to the results used to develop the NFSEG v1.1 report and submitted to peer review. Model-wide calibration residual statistics were similar for all observation groups. The region most affected by changes in HSPF recharge were the Suwannee and Santa Fe River watersheds, where groundwater levels and major spring group spring flows decreased in magnitude. The no-pumping simulation predicted a similar flooding response in Layer 1 to what was predicted in the original no-pumping simulation, suggesting the model responded reasonably to the removal of groundwater pumping and return flows. The verification simulation produced similar model-wide residual statistics for groundwater levels, spring flows and baseflow rates to the calibration simulation, suggesting that the model has an acceptable prediction performance given a range of hydrologic conditions. The comparison results for all simulations show that the corrections in HSPF-derived recharge have an insignificant effect on model prediction performance, and therefore, support the decision to not recalibrate the NFSEG v1.1 model.

Figure 1. Difference in recharge in inches per year, 2001. The difference in recharge was calculated by subtracting the case007h recharge from the case007h-1 recharge.

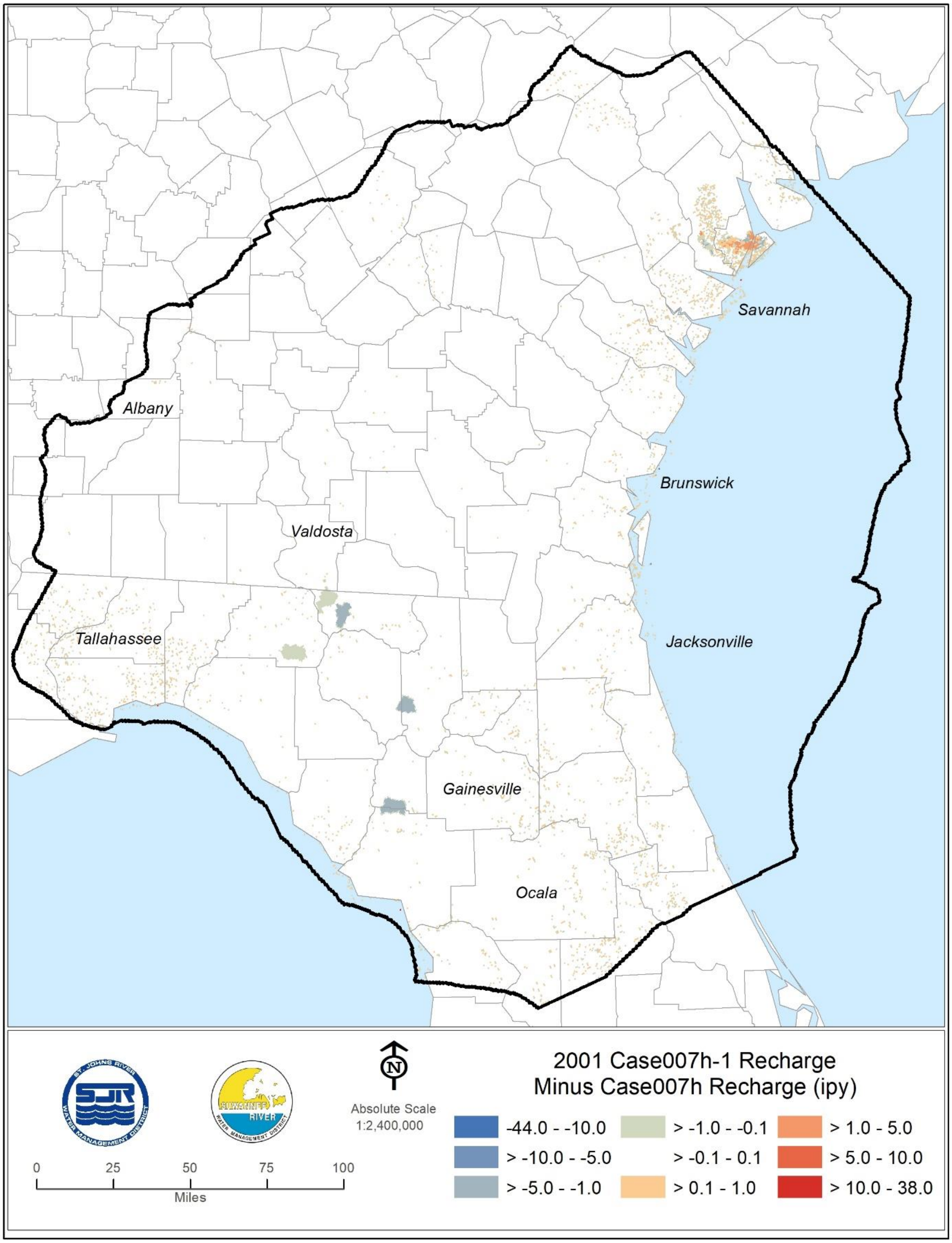

Figure 2. Difference in recharge in inches per year, 2009. The difference in recharge was calculated by subtracting the case007h recharge from the case007h-1 recharge.

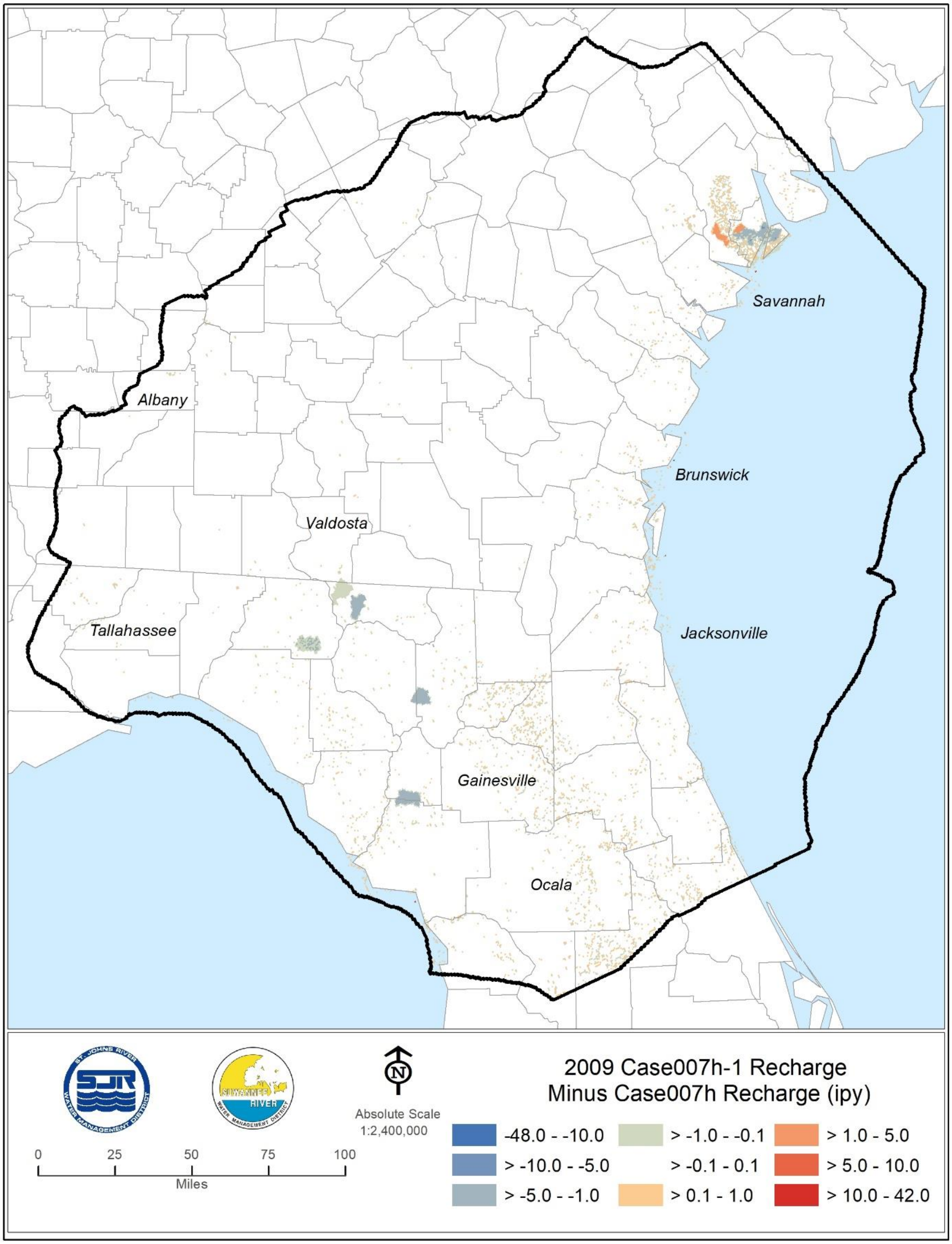

Figure 3. Difference in MSATET in inches per year, 2001. The difference in MSATET was calculated by subtracting the case007h MSATET from the case007h-1 MSATET.

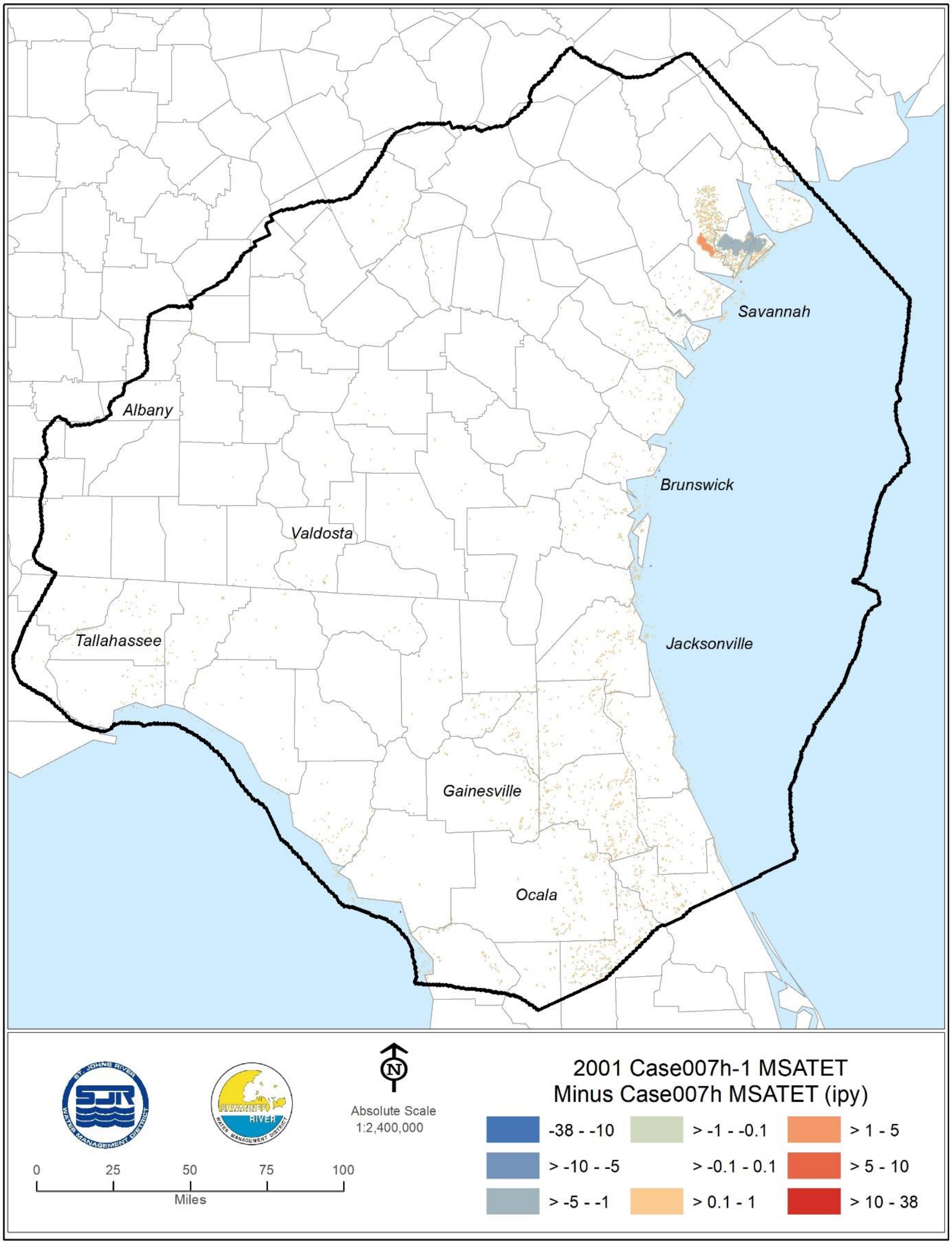

Figure 4. Difference in MSATET in inches per year, 2009. The difference in MSATET was calculated by subtracting the case007h MSATET from the case007h-1 MSATET.

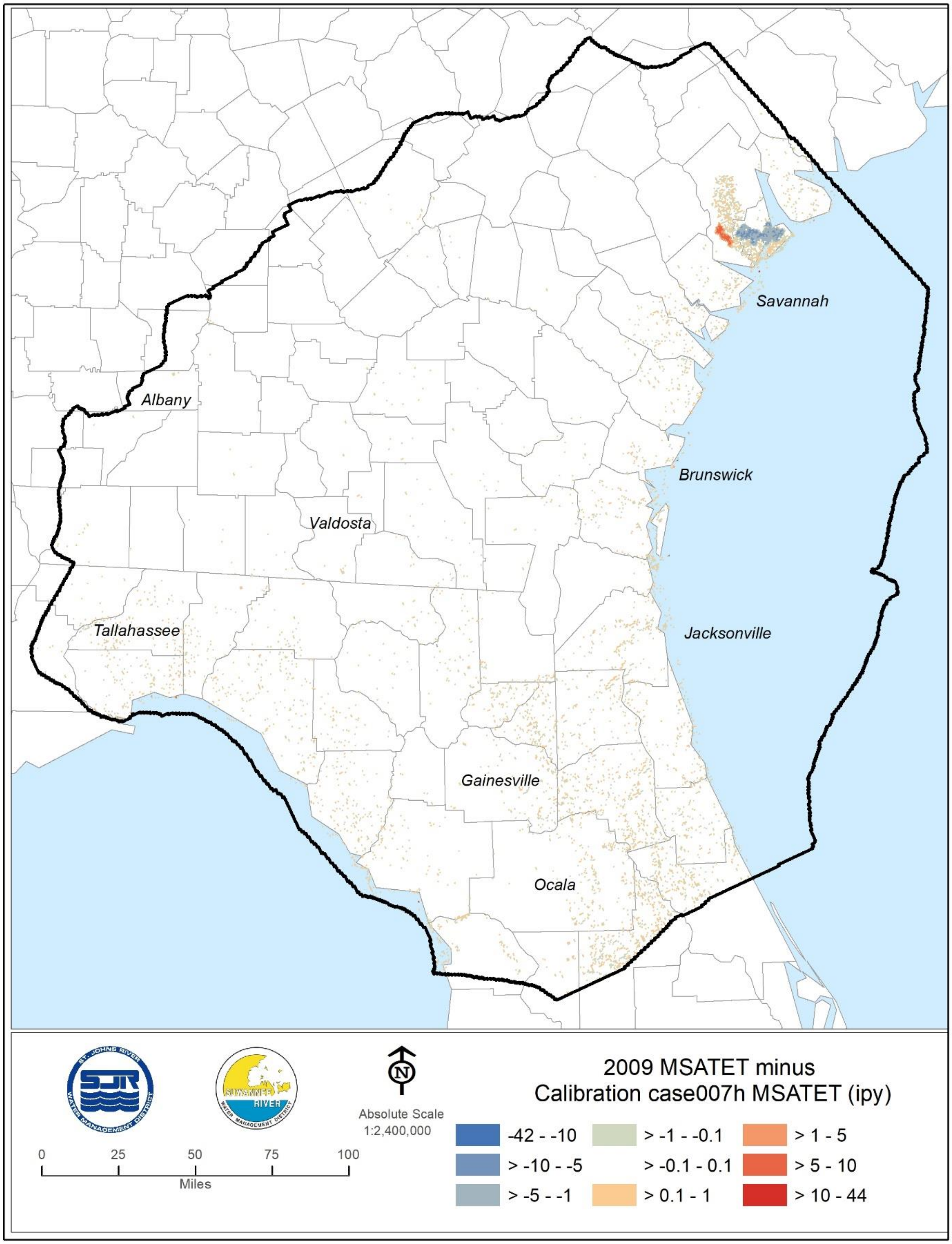

Figure 5. Scatterplot of observed and simulated spring flows for case007h-1, 2001.

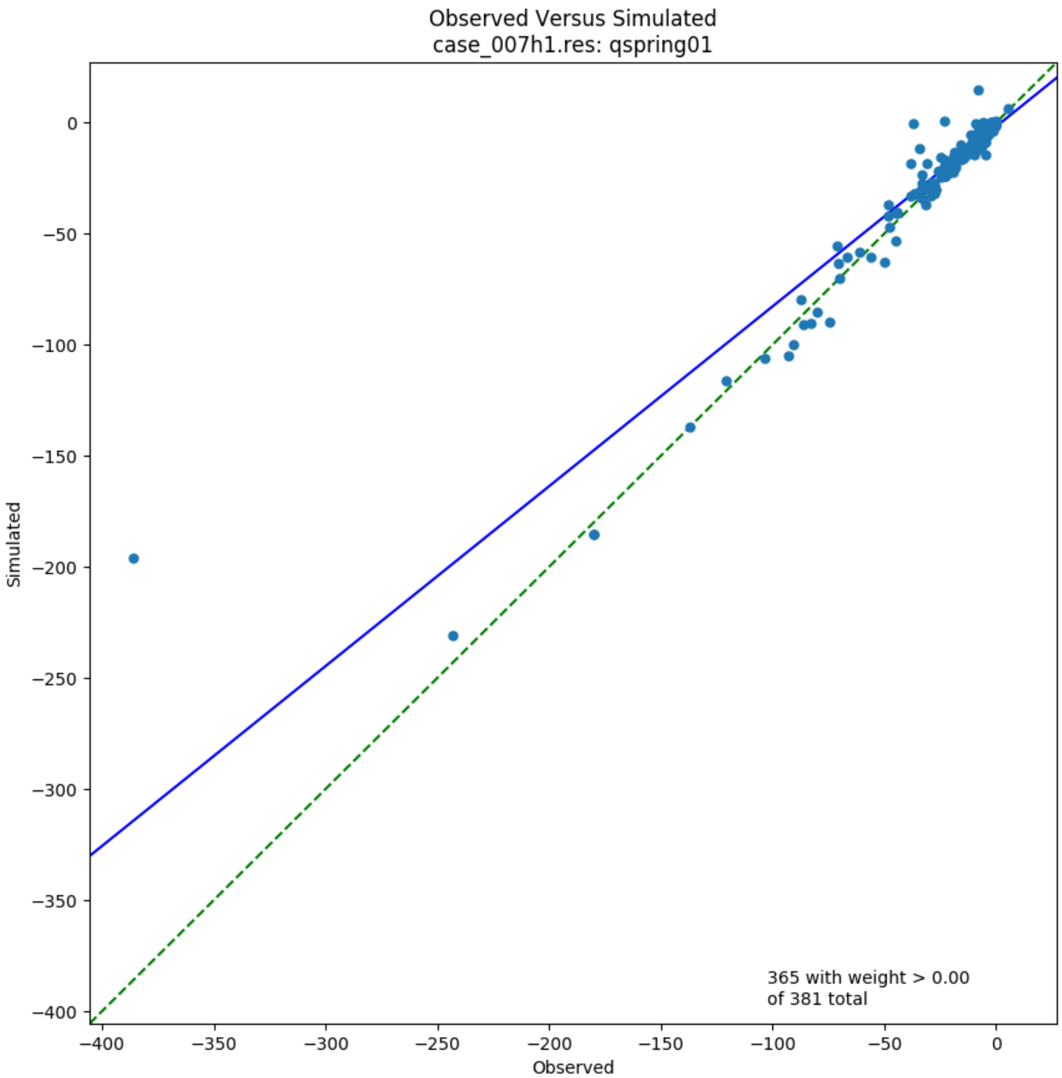

Figure 6. Scatterplot of observed and simulated spring flows for case007h-1, 2009.

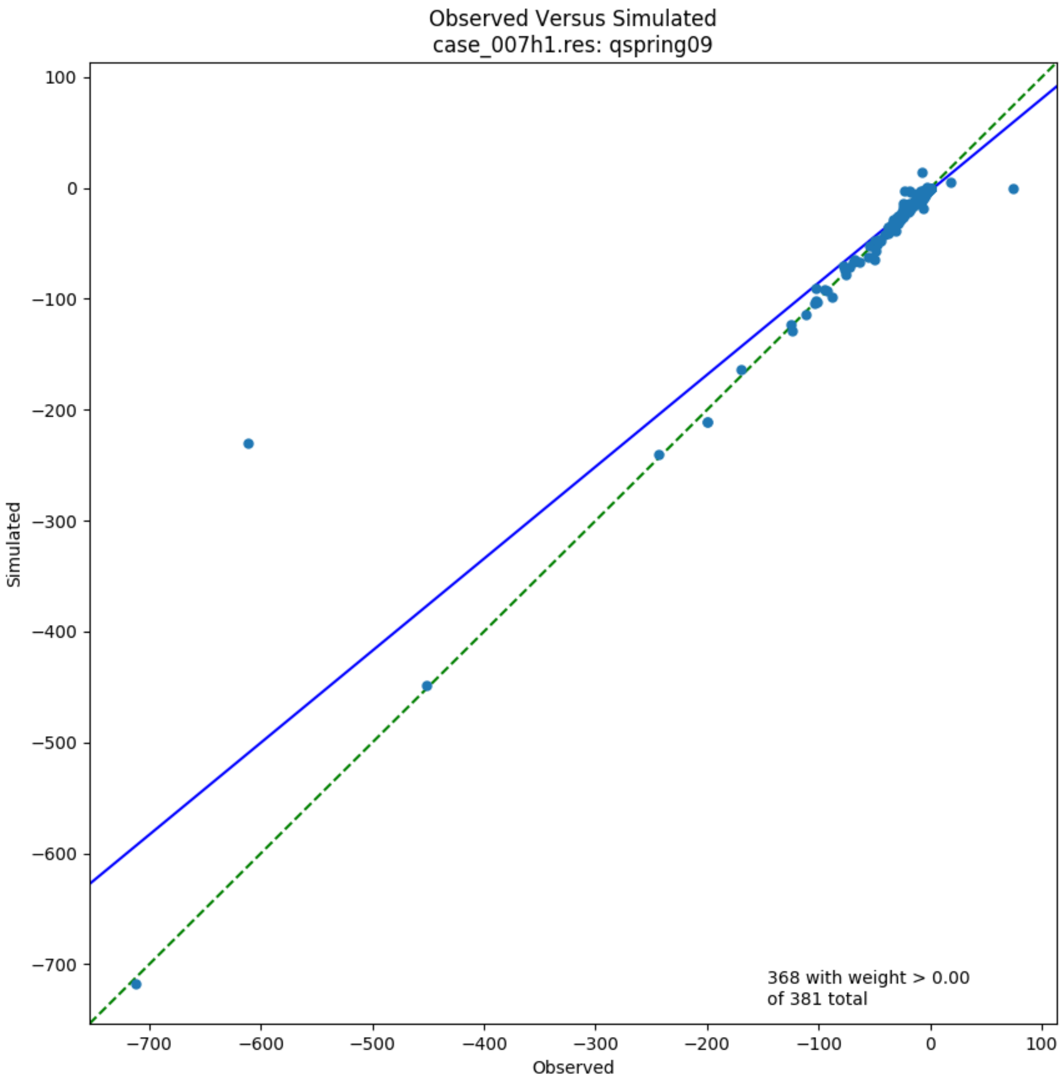

Figure 7. Comparison of residual spring flow at selected springs, 2001. The residual was calculated by subtracting the estimated spring flow from the modelled spring flow.

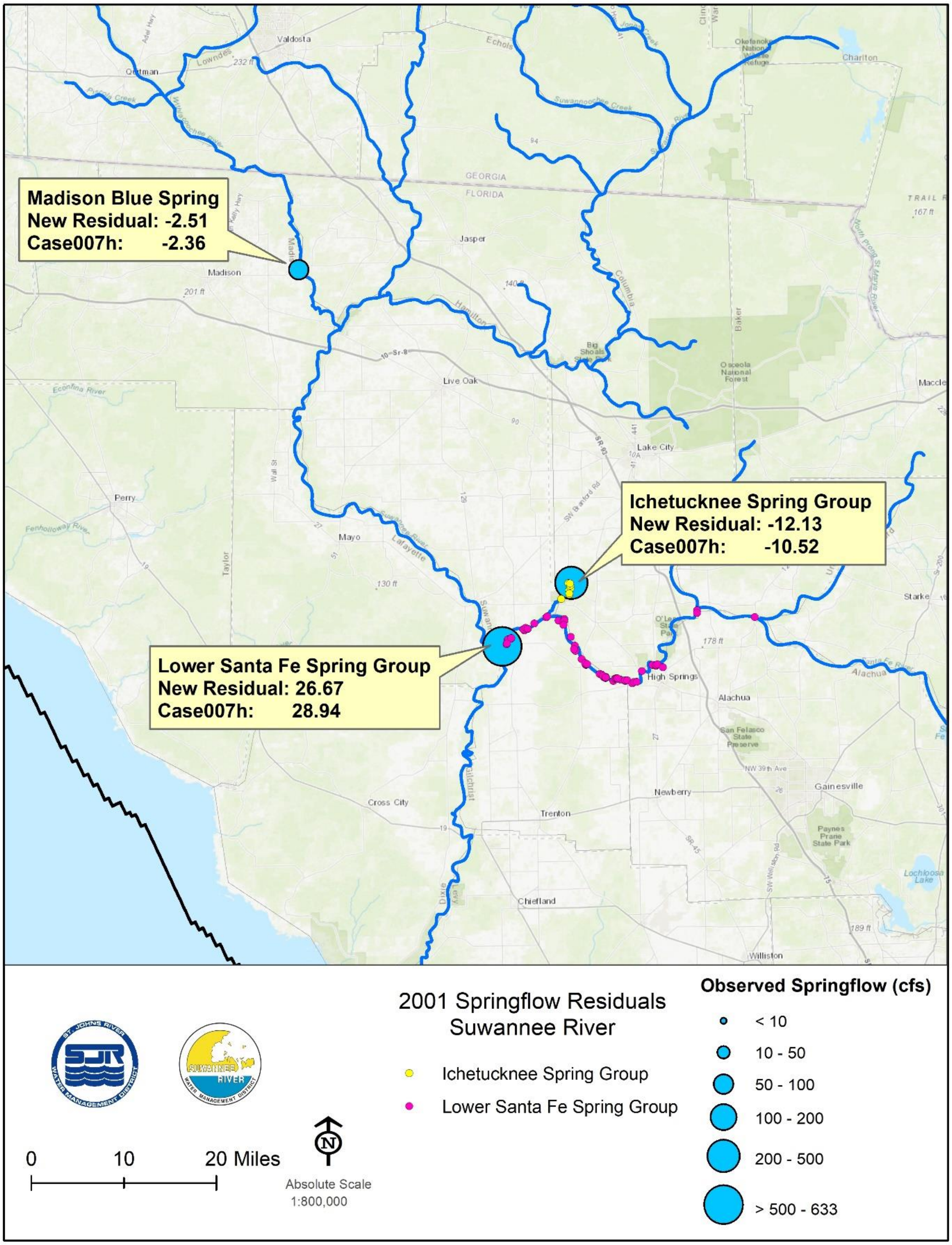

Figure 8. Comparison of residual spring flow at selected springs, 2009. The residual was calculated by subtracting the estimated spring flow from the modelled spring flow.

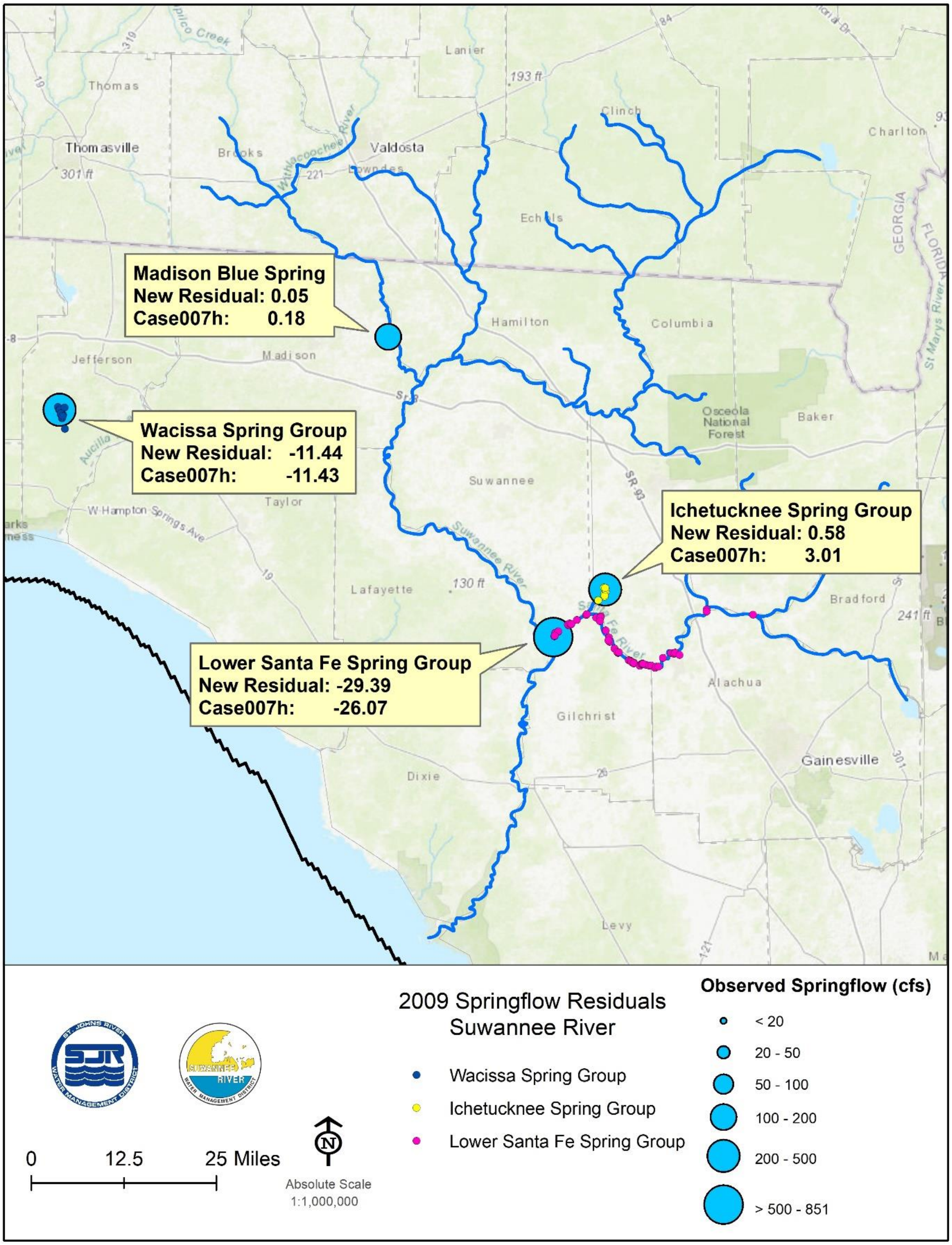

Figure 9. Head difference (in feet) at Model Layer 1 observation targets, 2001. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

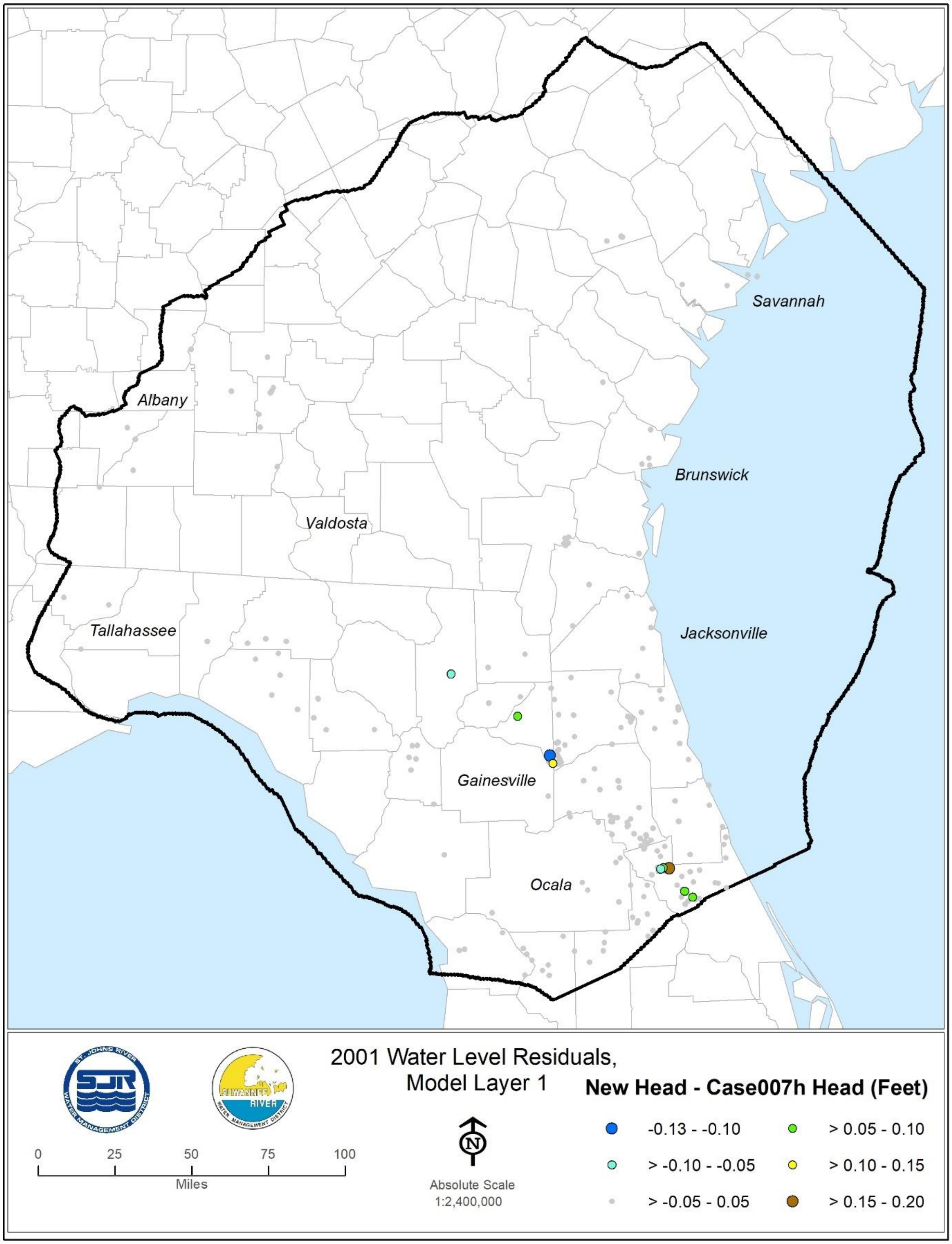

Figure 10. Head difference (in feet) in Model Layer 1, 2001. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

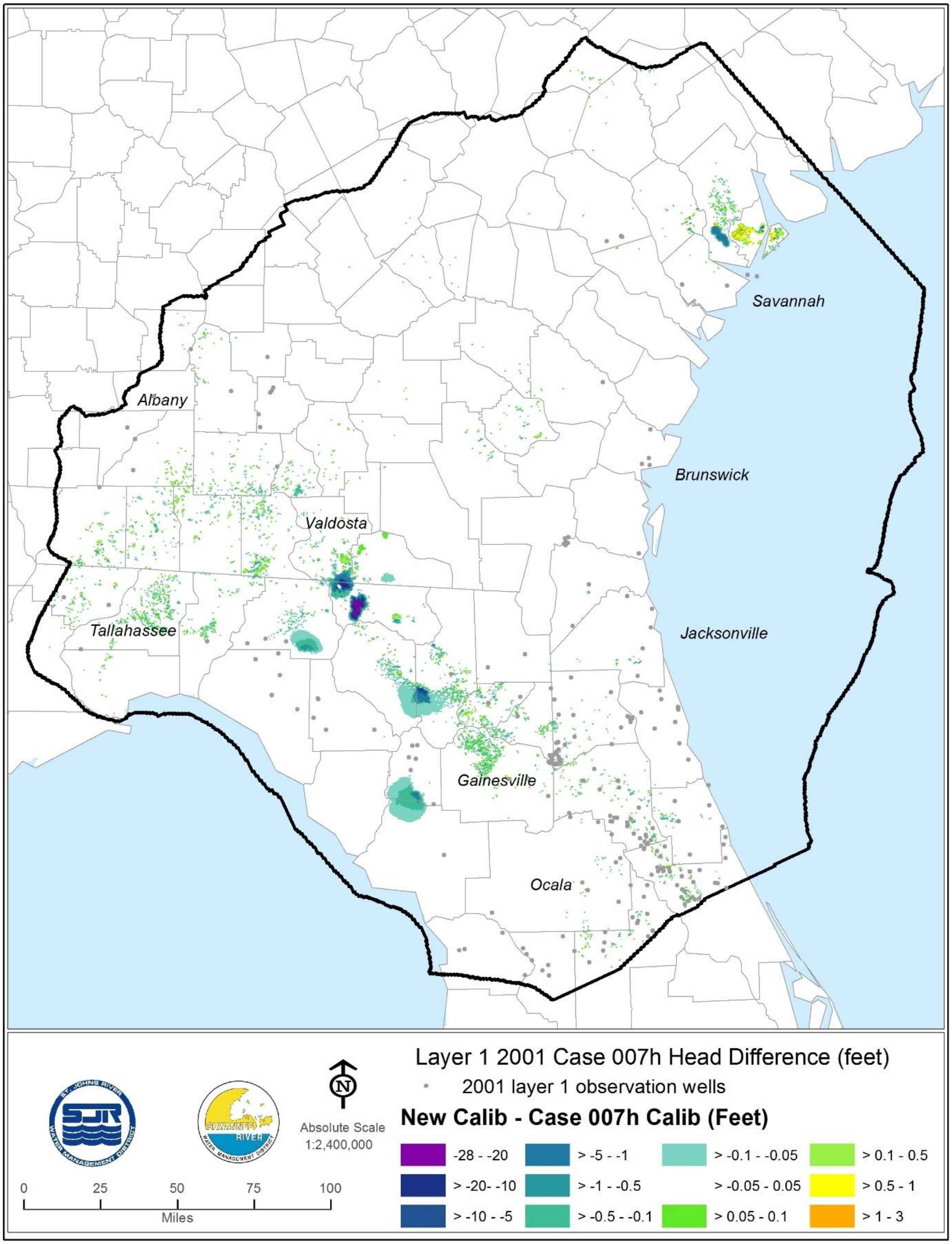

Figure 11. Head difference (in feet) at Model Layer 1 observation targets, 2009. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

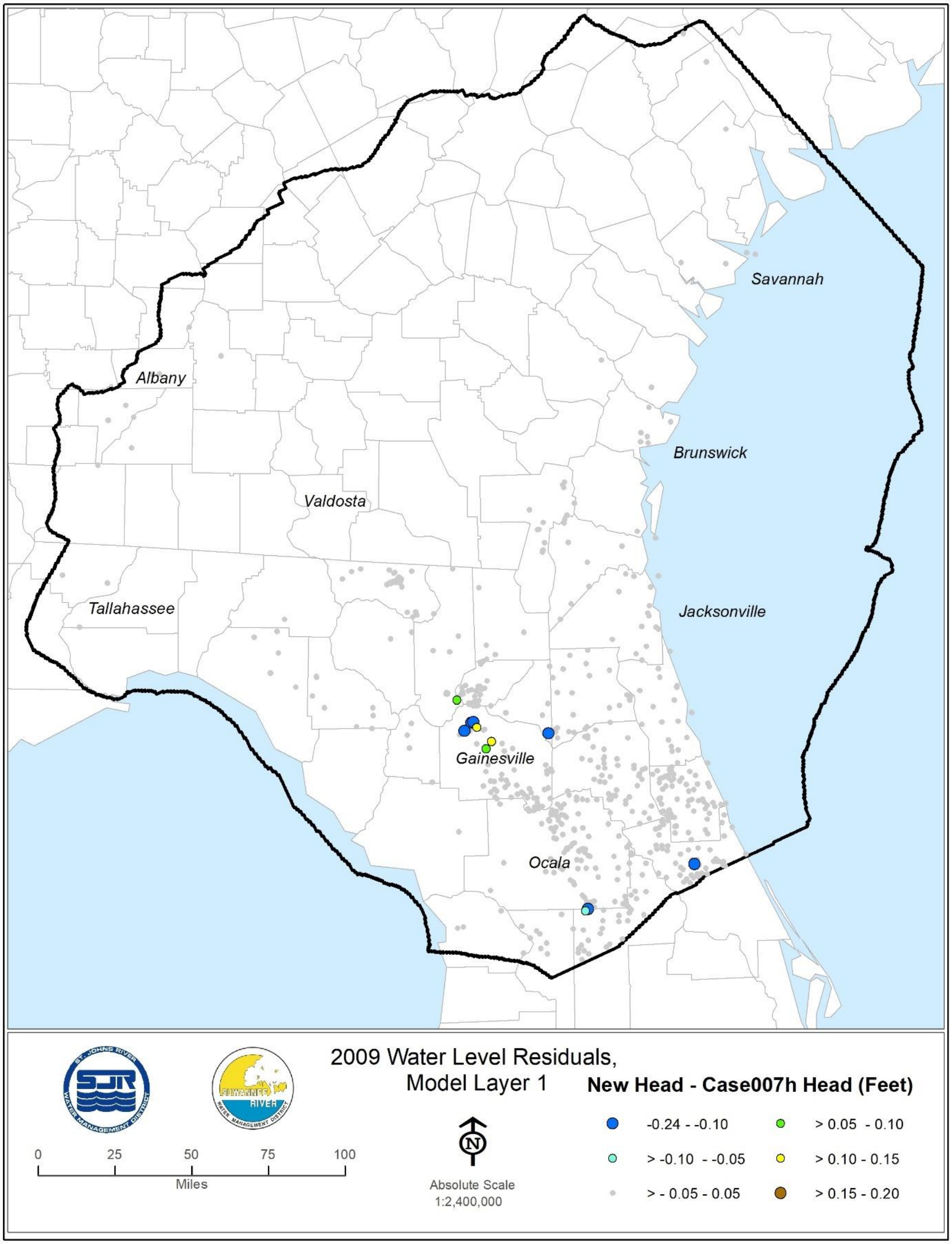

Figure 12. Head difference (in feet) in Model Layer 1, 2009. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

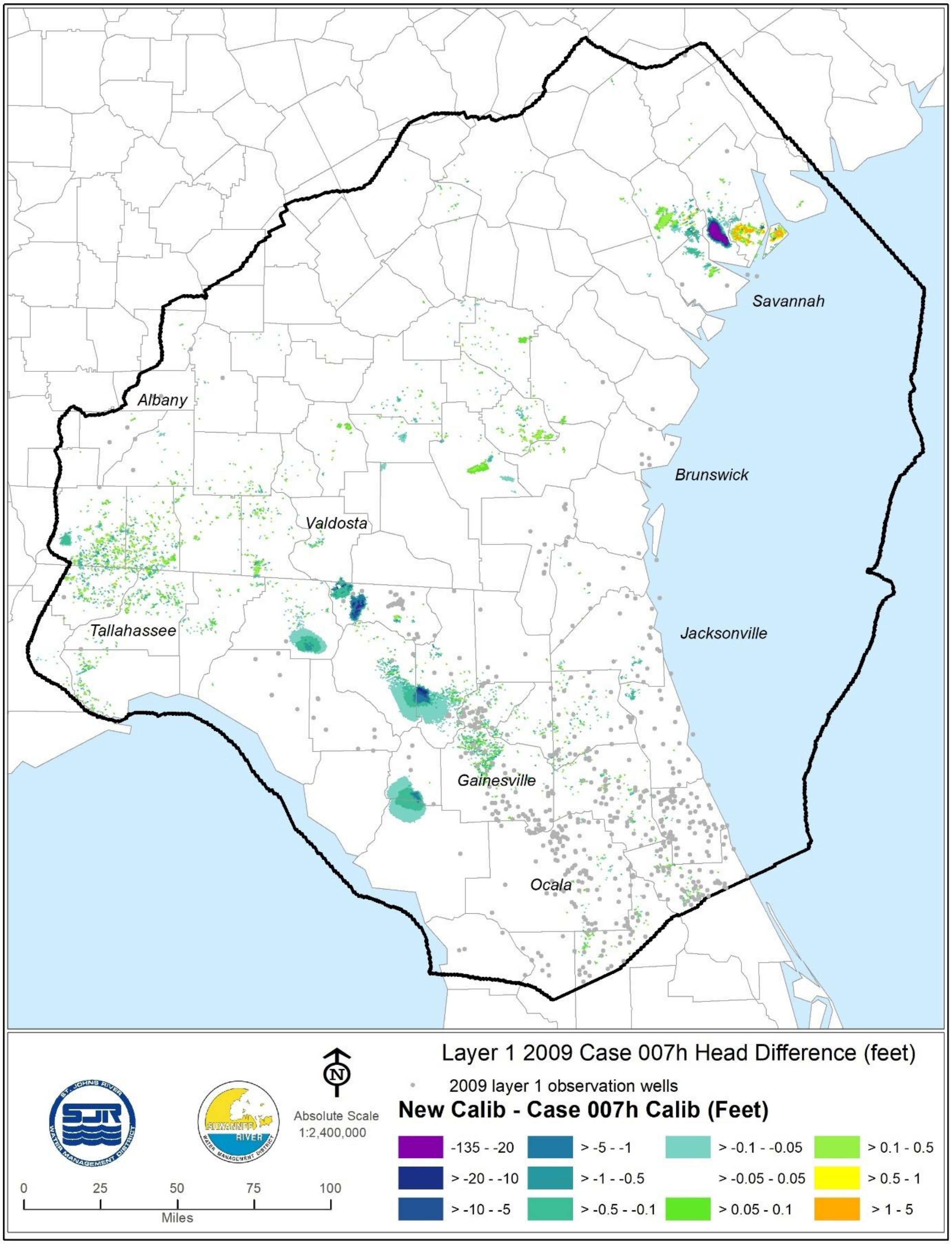

Figure 13. Head difference (in feet) at Model Layer 3 observation targets, 2001. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

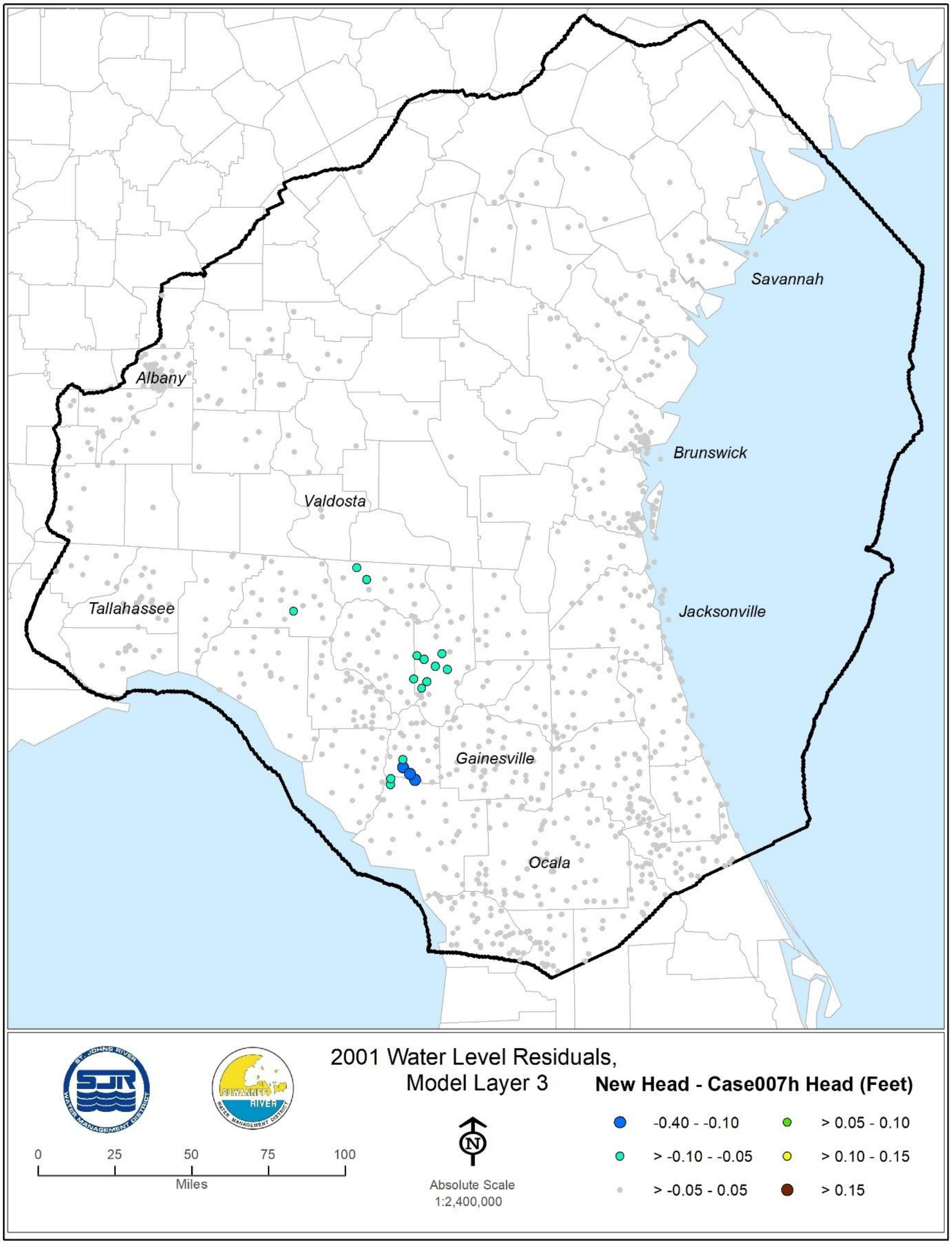

Figure 14. Comparison of groundwater level residuals in Model Layer 3 targets in Suwannee and Columbia County, 2001. The residual was calculated by subtracting the estimated groundwater level from the modelled groundwater level.

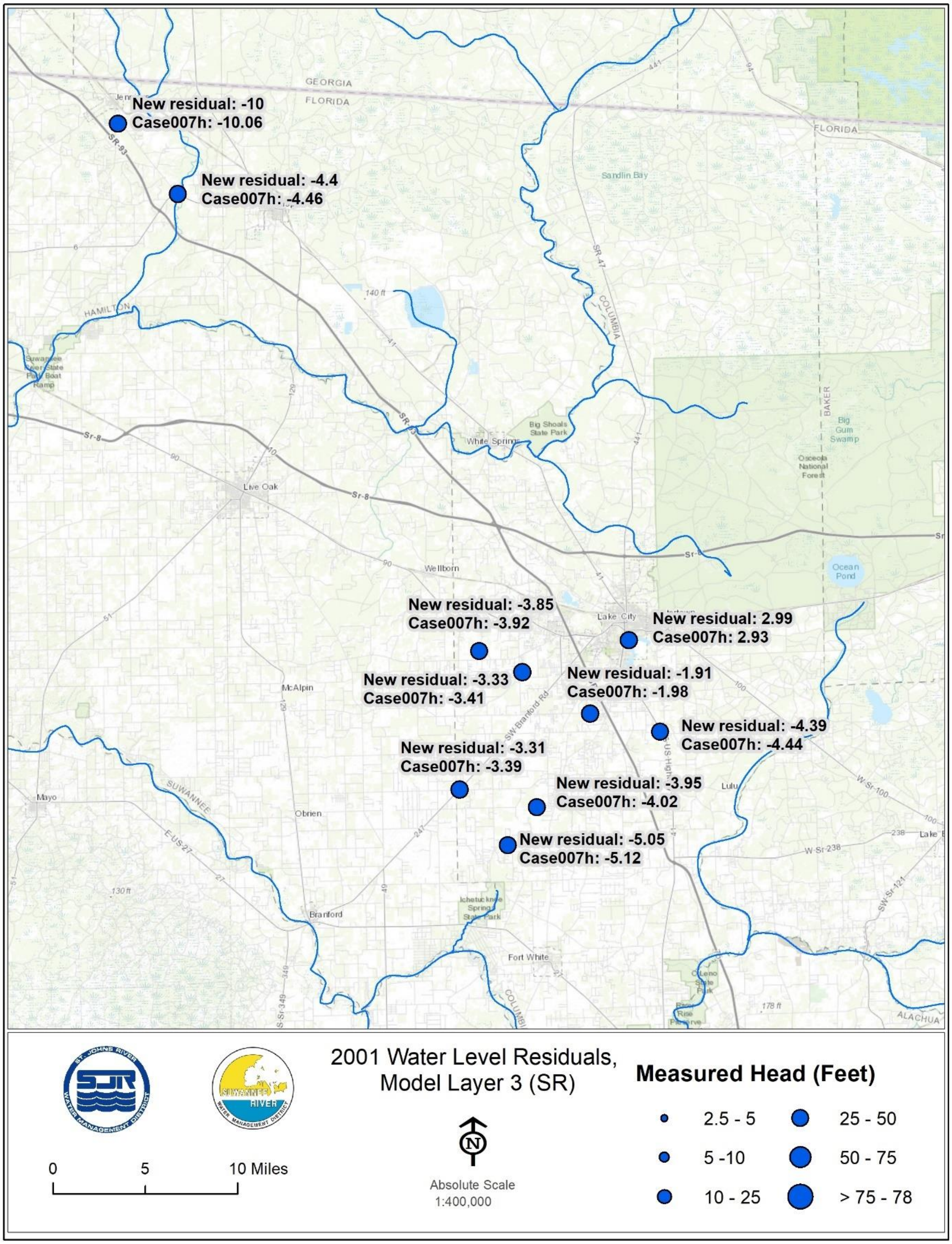

Figure 15. Comparison of groundwater level residuals in Model Layer 3 targets in southern Gilchrist County, 2001. The residual was calculated by subtracting the estimated groundwater level from the modelled groundwater level.

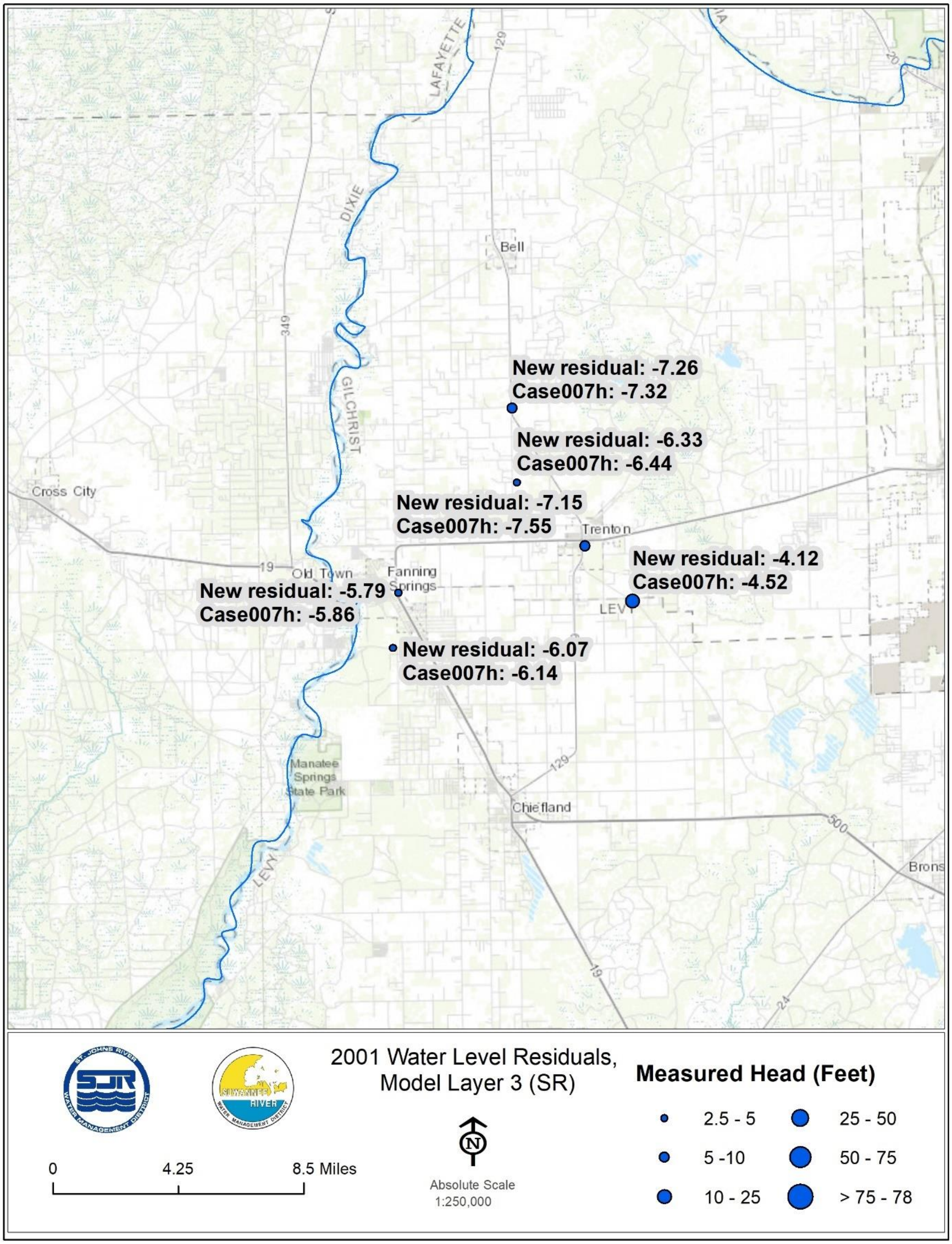

Figure 16. Head difference (in feet) in Model Layer 3, 2001. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

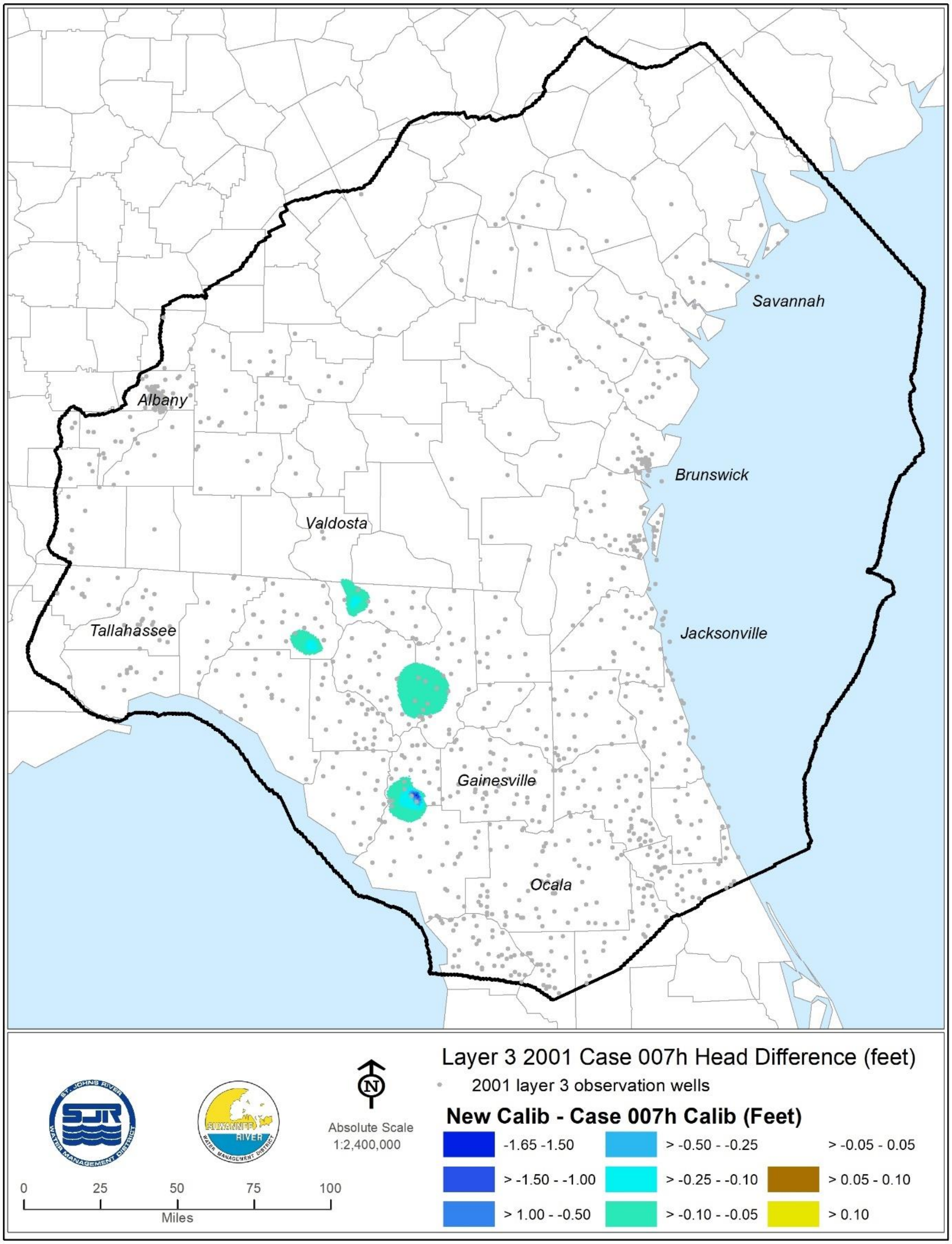

Figure 17. Head difference (in feet) at Model Layer 3 observation targets, 2009. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

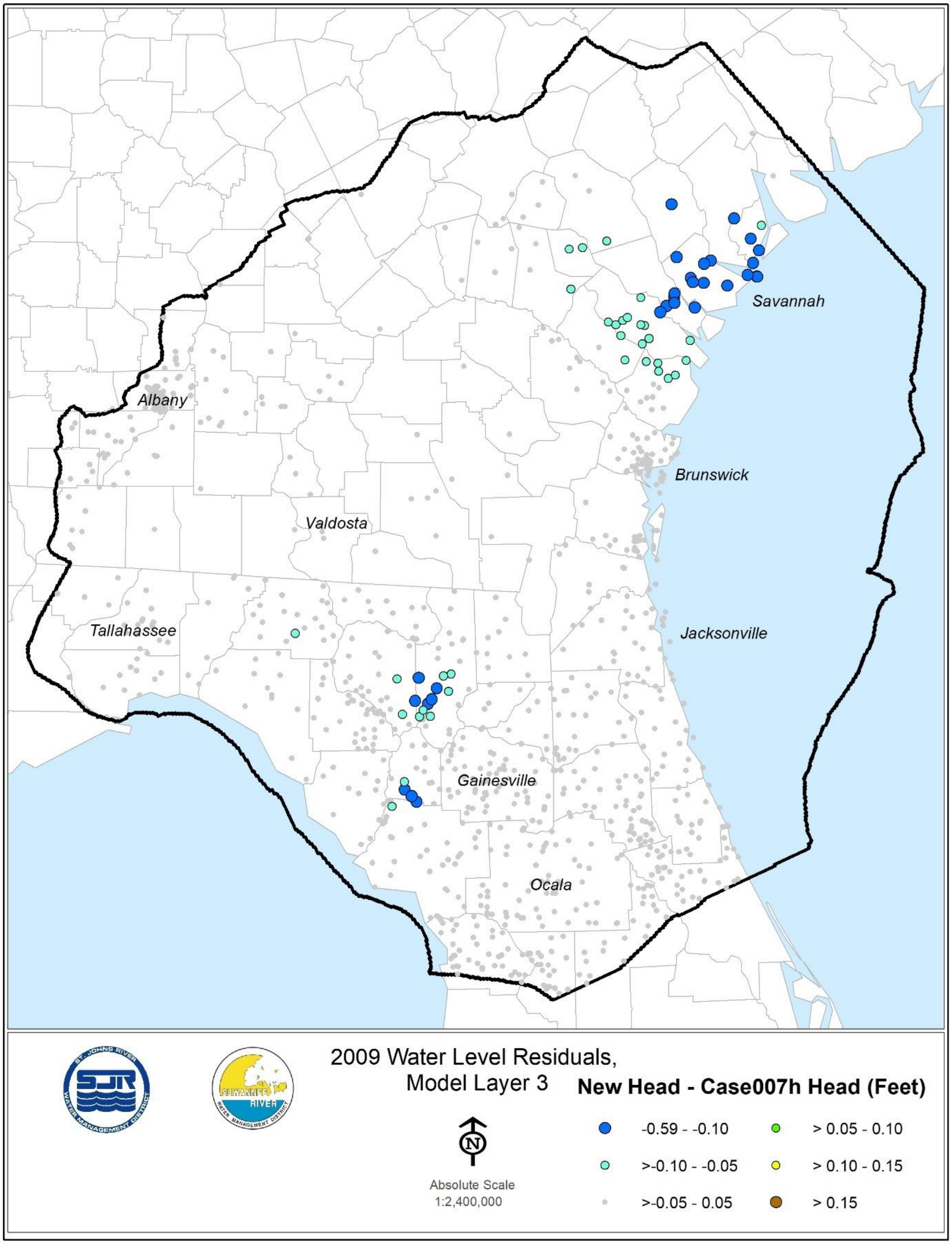

Figure 18. Comparison of groundwater level residuals in Model Layer 3 targets in Suwannee and Columbia County, 2009. The residual was calculated by subtracting the estimated groundwater level from the modelled groundwater level.

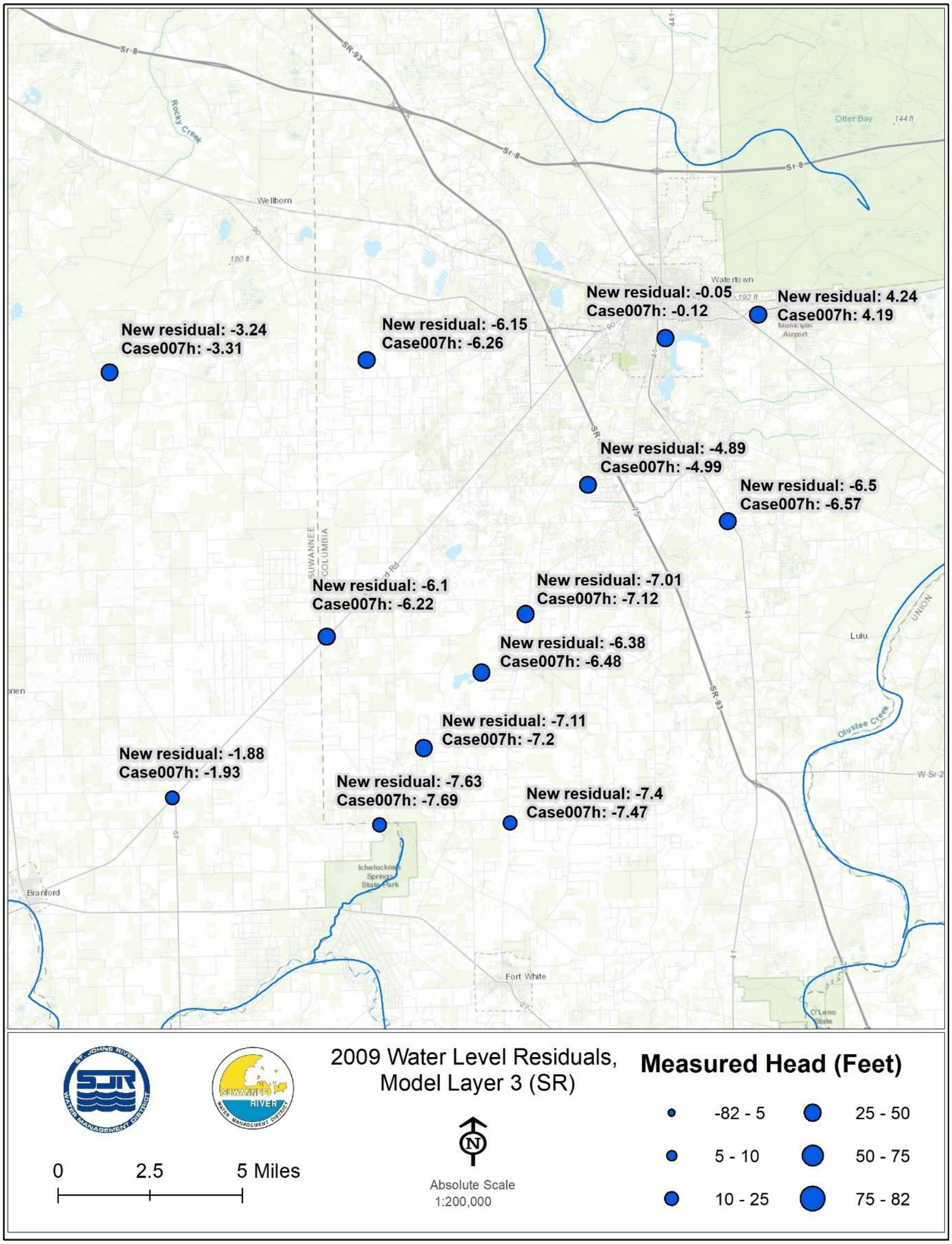

Figure 19. Comparison of groundwater level residuals in Model Layer 3 targets in southern Gilchrist County, 2009. The residual was calculated by subtracting the estimated groundwater level from the modelled groundwater level.

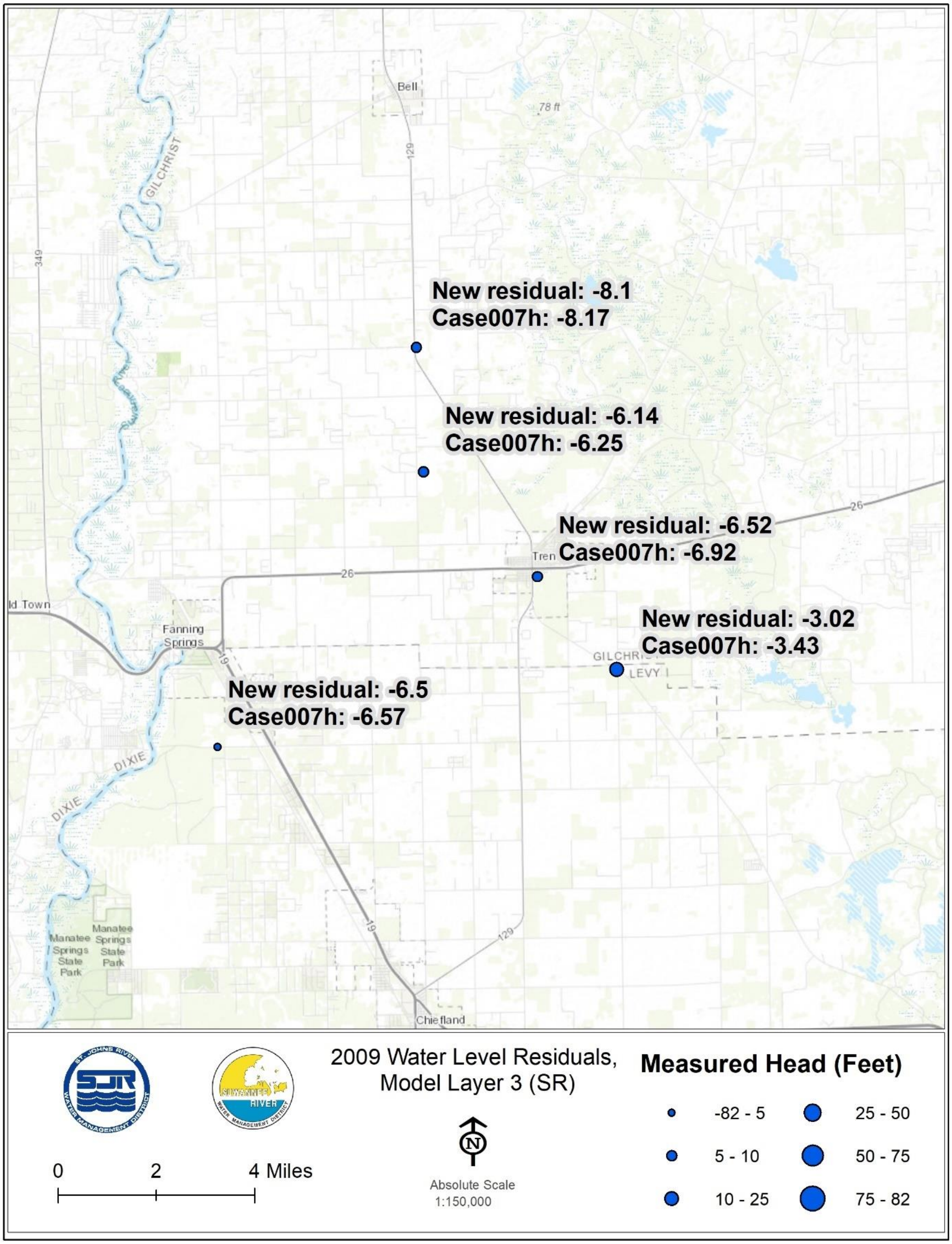

Figure 20. Head difference (in feet) in Model Layer 3, 2009. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

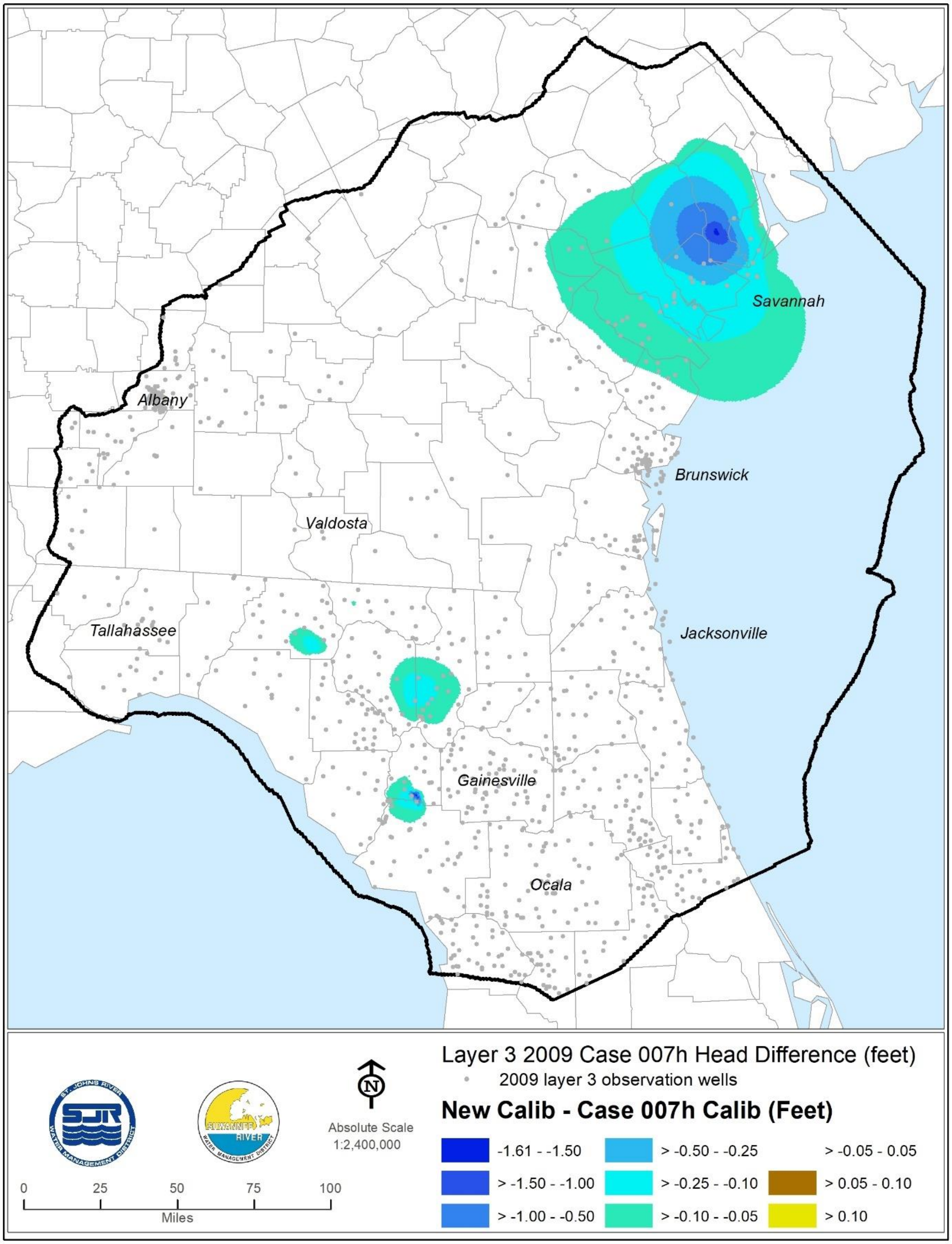

Figure 21. Head difference (in feet) at Model Layer 5 observation targets, 2001. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

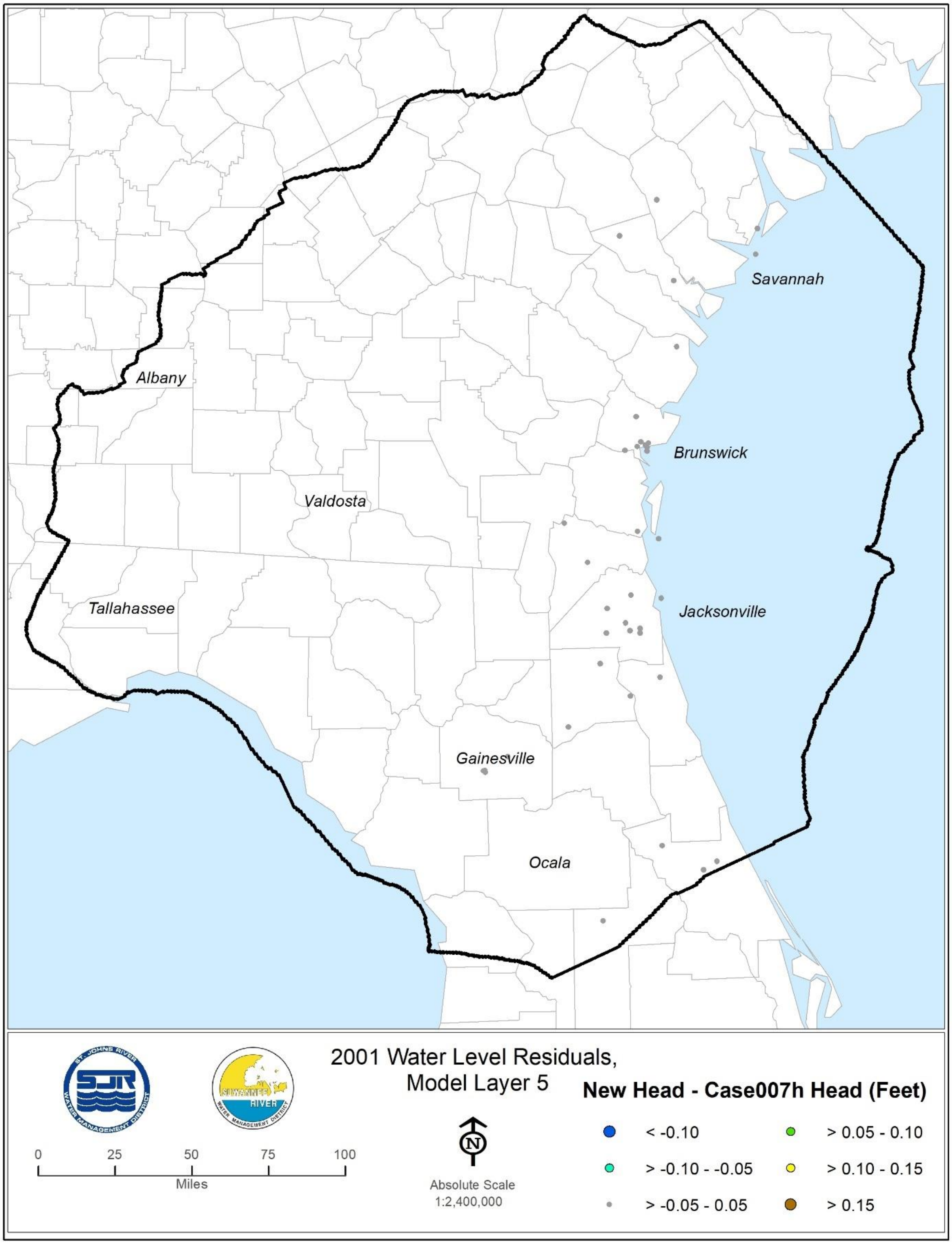

Figure 22. Head difference (in feet) at Model Layer 5 observation targets, 2009. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

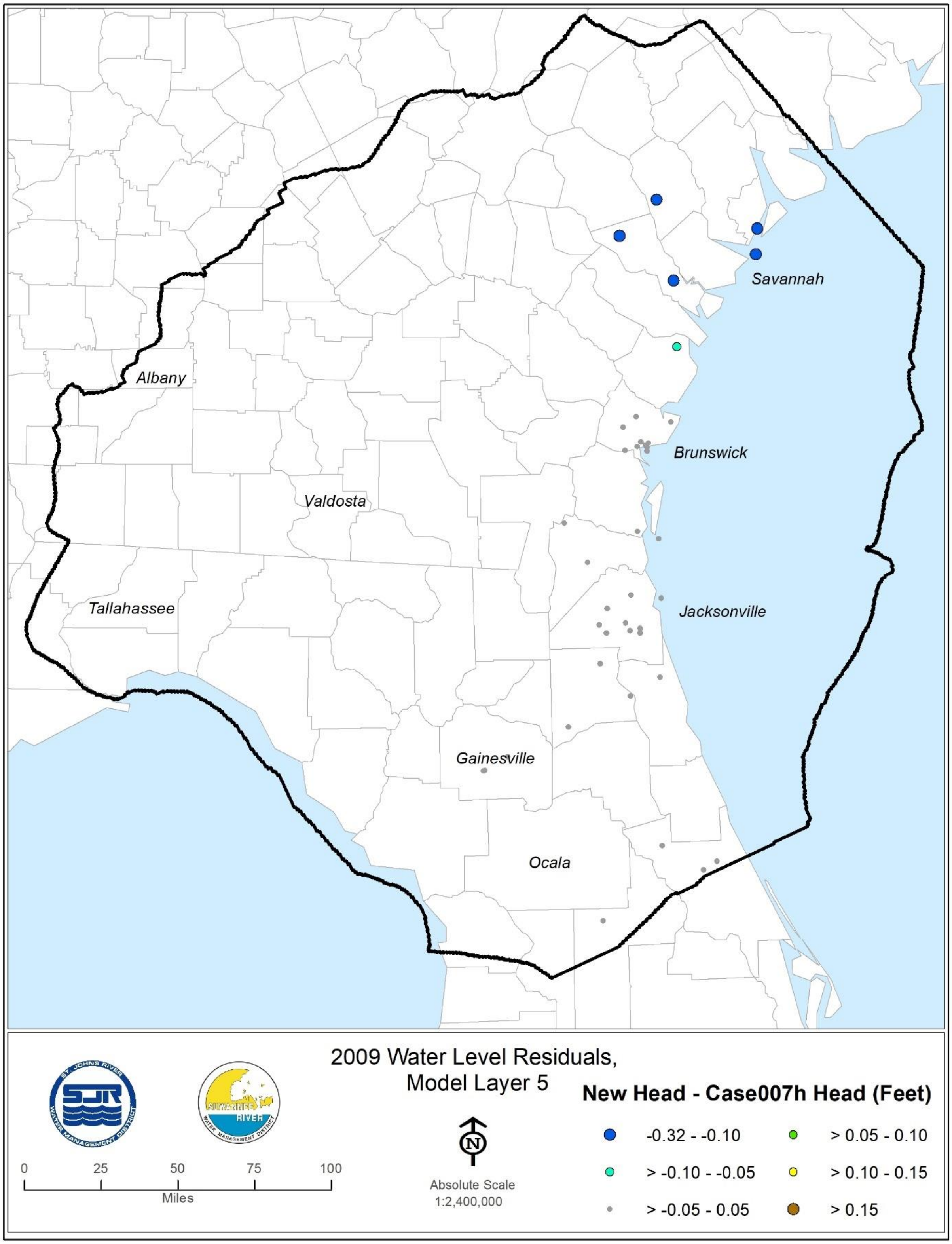

Figure 23. Comparison of cumulative baseflow rate residuals for selected USGS gauges, 2001. The residual was calculated by subtracting the estimated baseflow rate from the modelled baseflow rate.

Figure 24. Comparison of cumulative baseflow rate residuals for selected USGS gauges, 2009. The residual was calculated by subtracting the estimated baseflow rate from the modelled baseflow rate.

Figure 25. Case007h-1 simulated versus estimated baseflow pickup rates, 2001

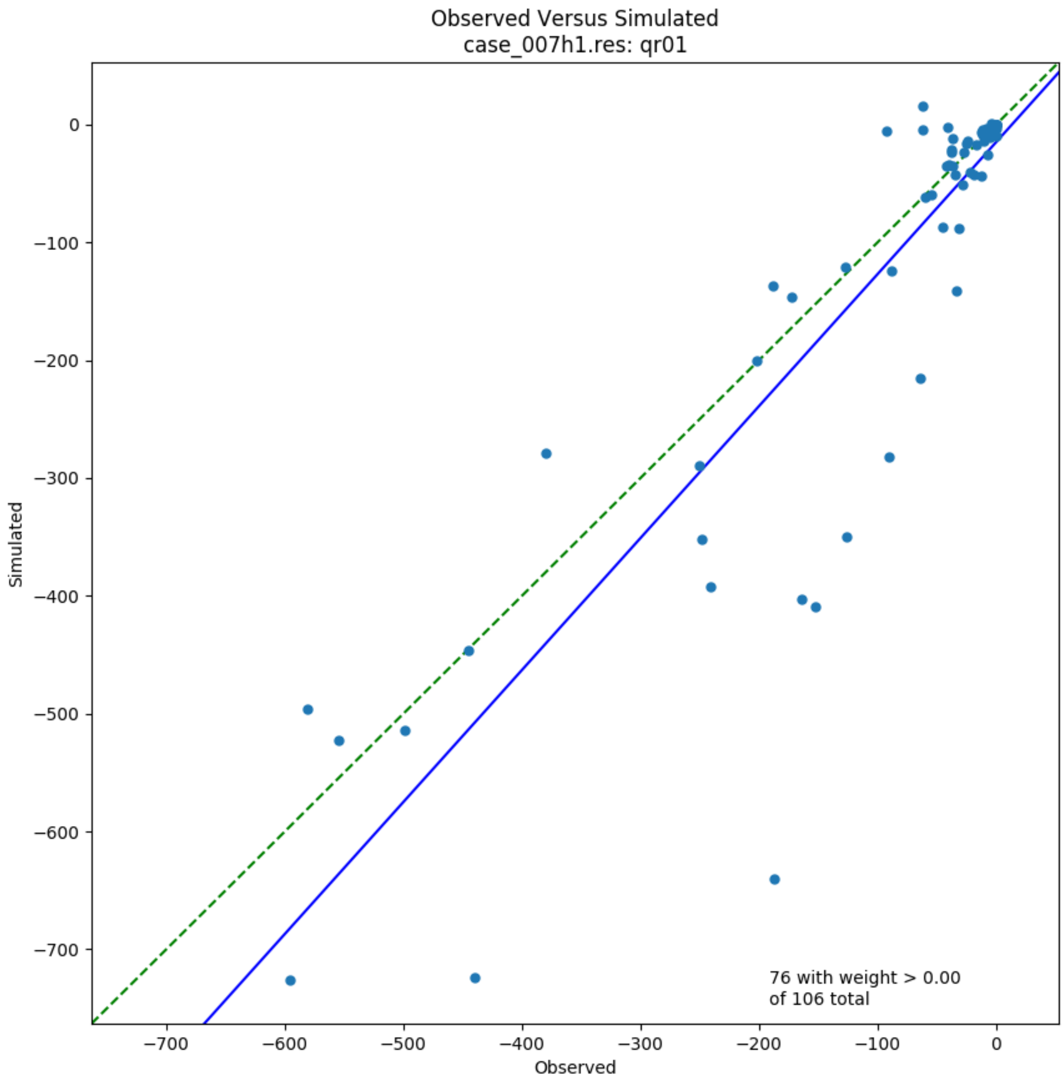

Figure 26. Case007h-1 simulated versus estimated baseflow pickup rates, 2009

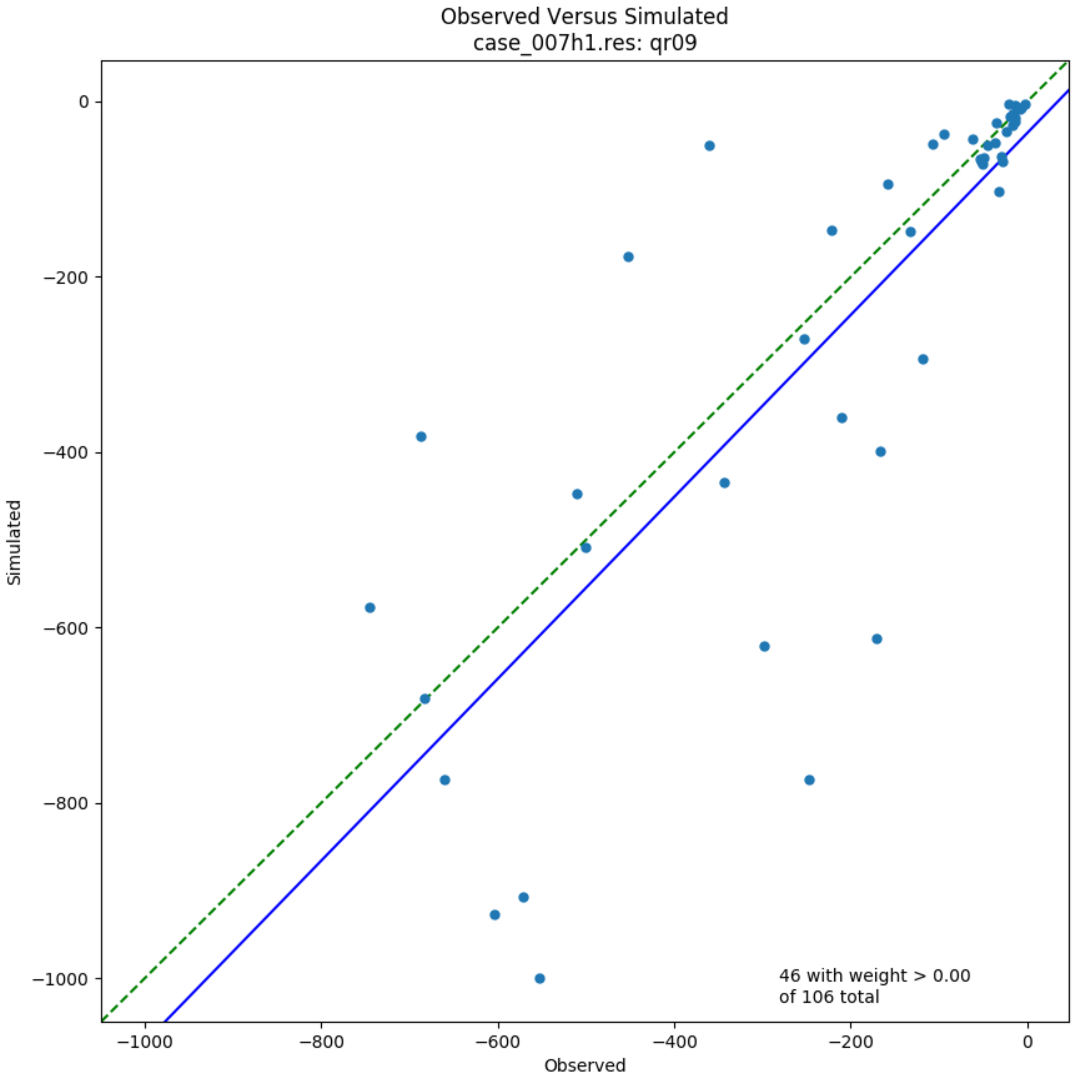

Figure 27. Model-wide mass balance for case007h-1, 2001

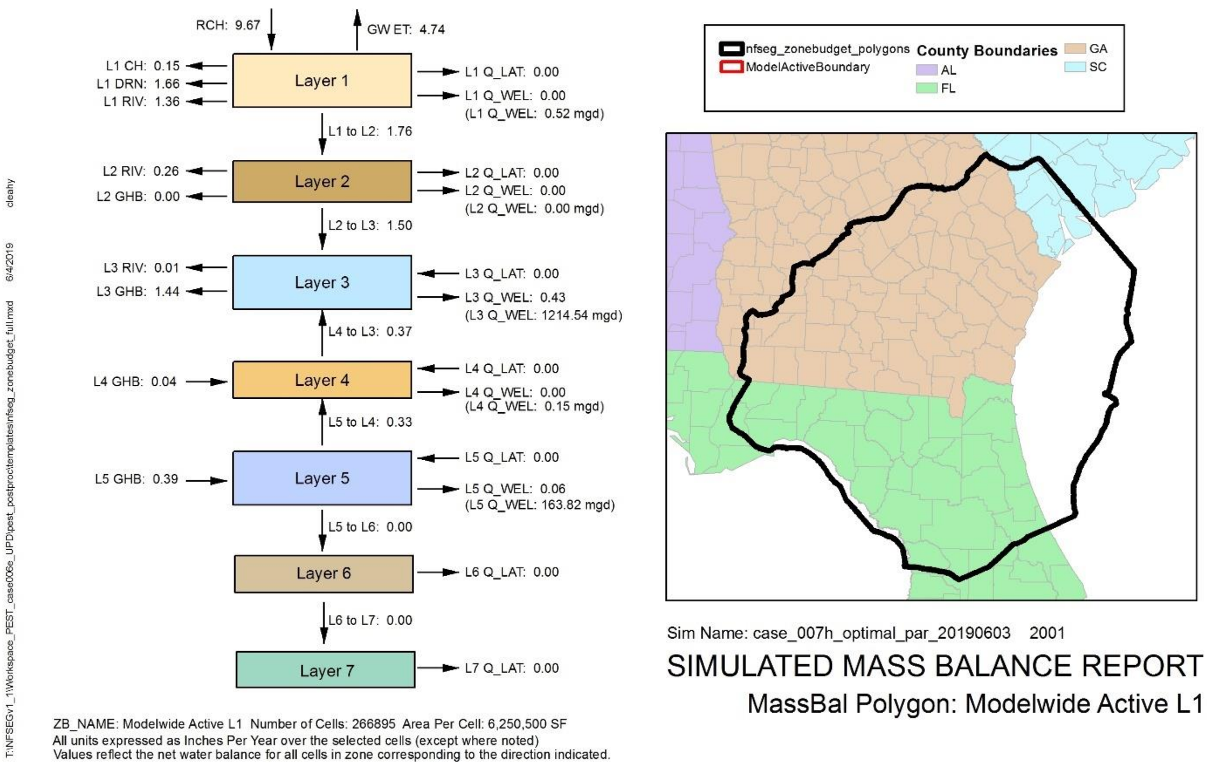

Figure 28. Model-wide mass balance for case007h-1, 2009

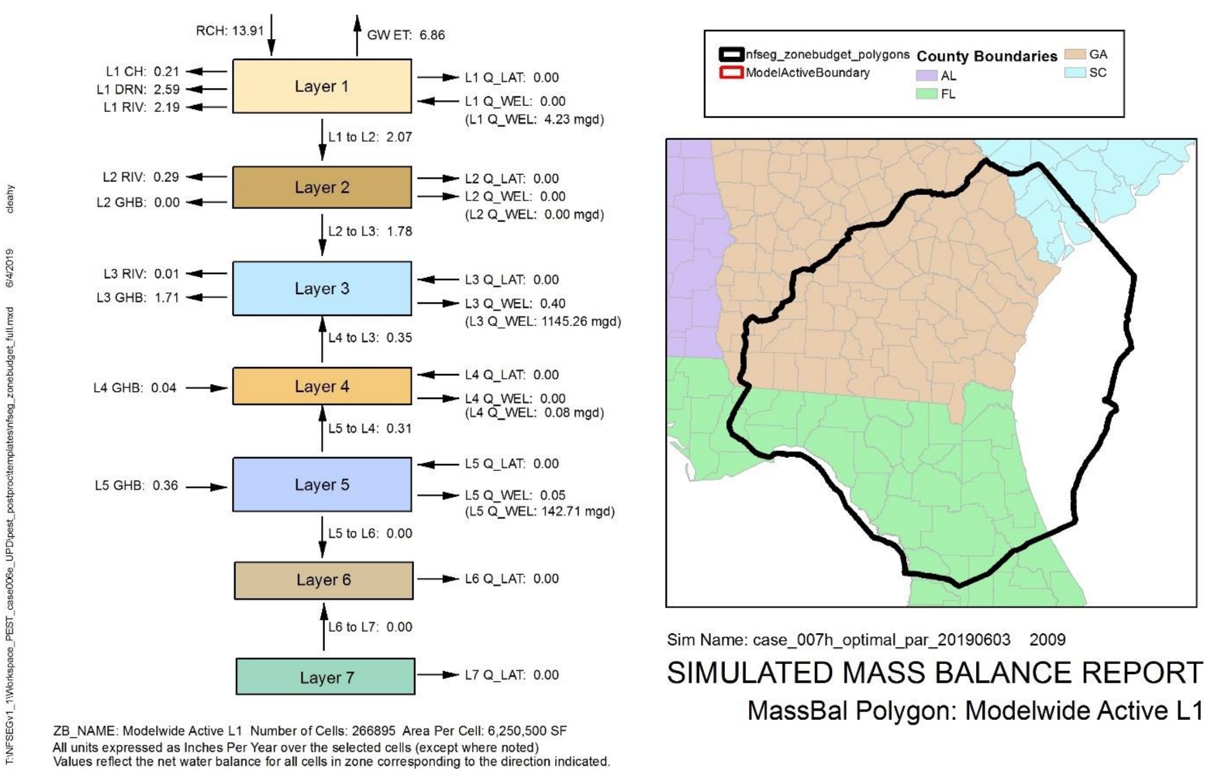

Figure 29. GWB-3 mass balance for case007h-1, 2001

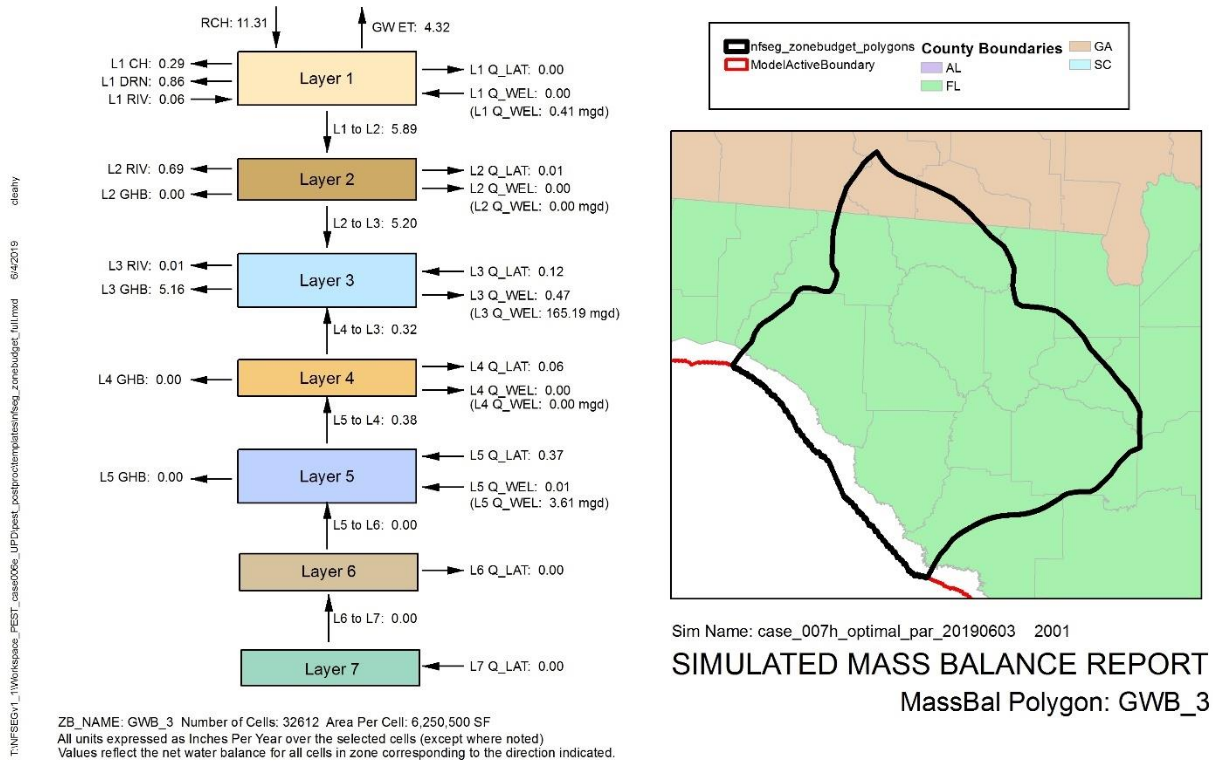

Figure 30. GWB-3 mass balance for case007h-1, 2009

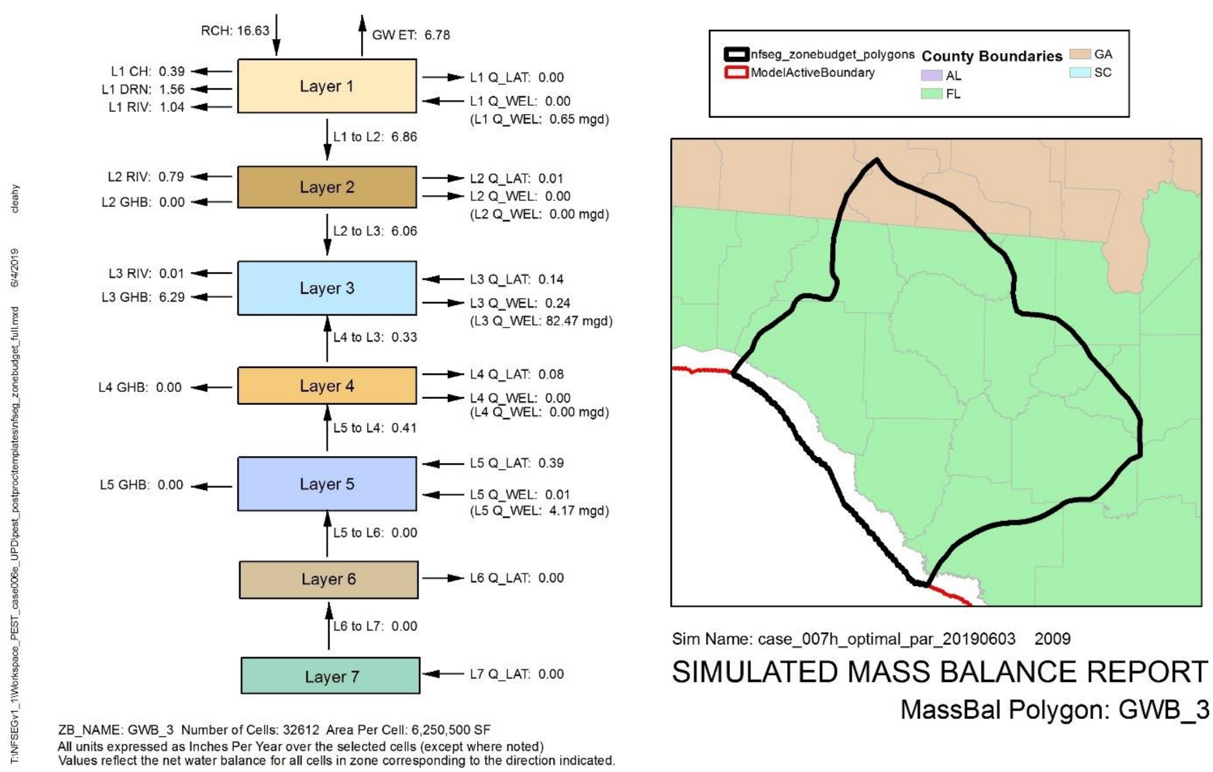

Figure 31. No-pumping head difference (in feet) in Model Layer 1, 2001. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

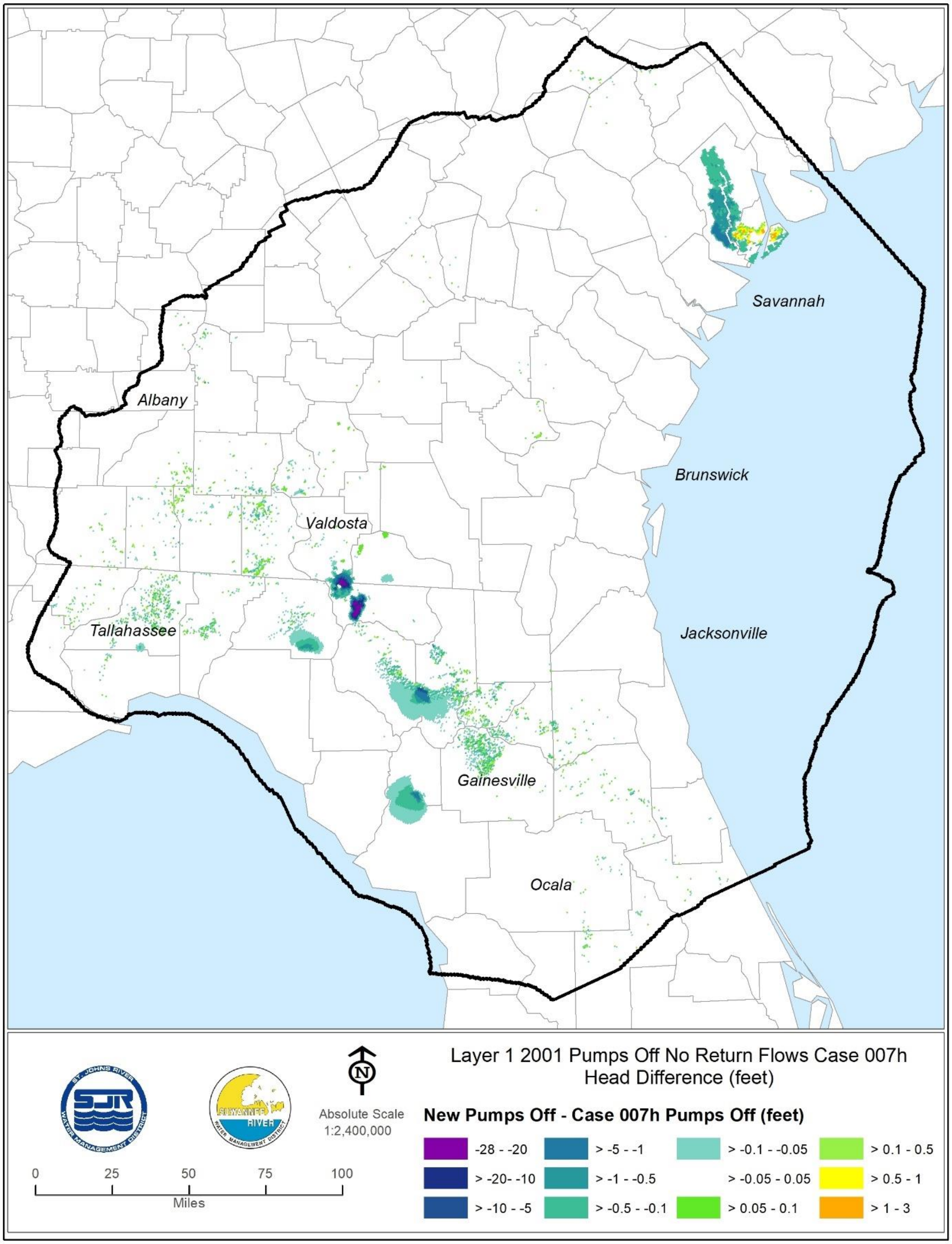

Figure 32. No-pumping head difference (in feet) in Model Layer 1, 2009. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

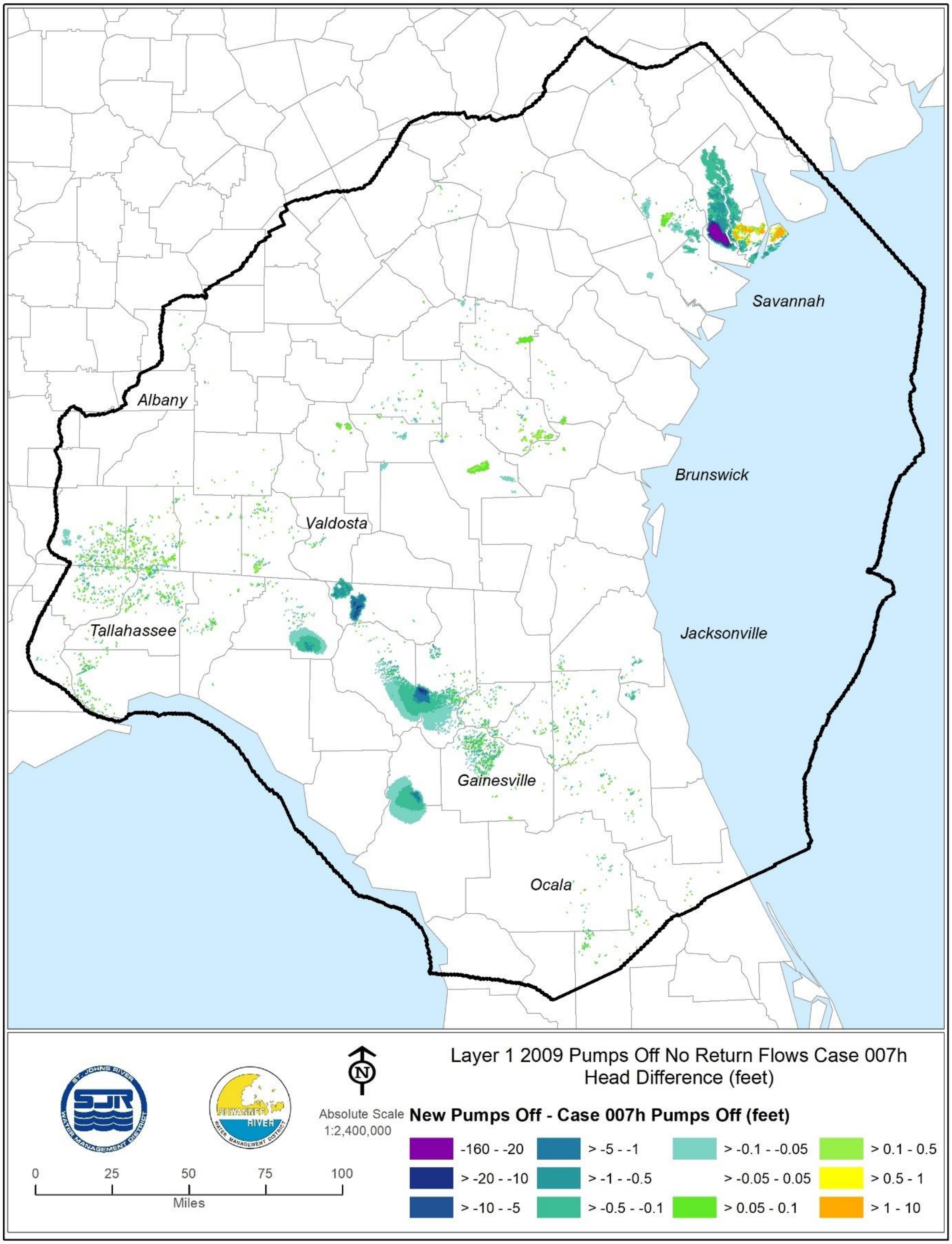

Figure 33. No-pumping head difference (in feet) in Model Layer 3, 2001. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

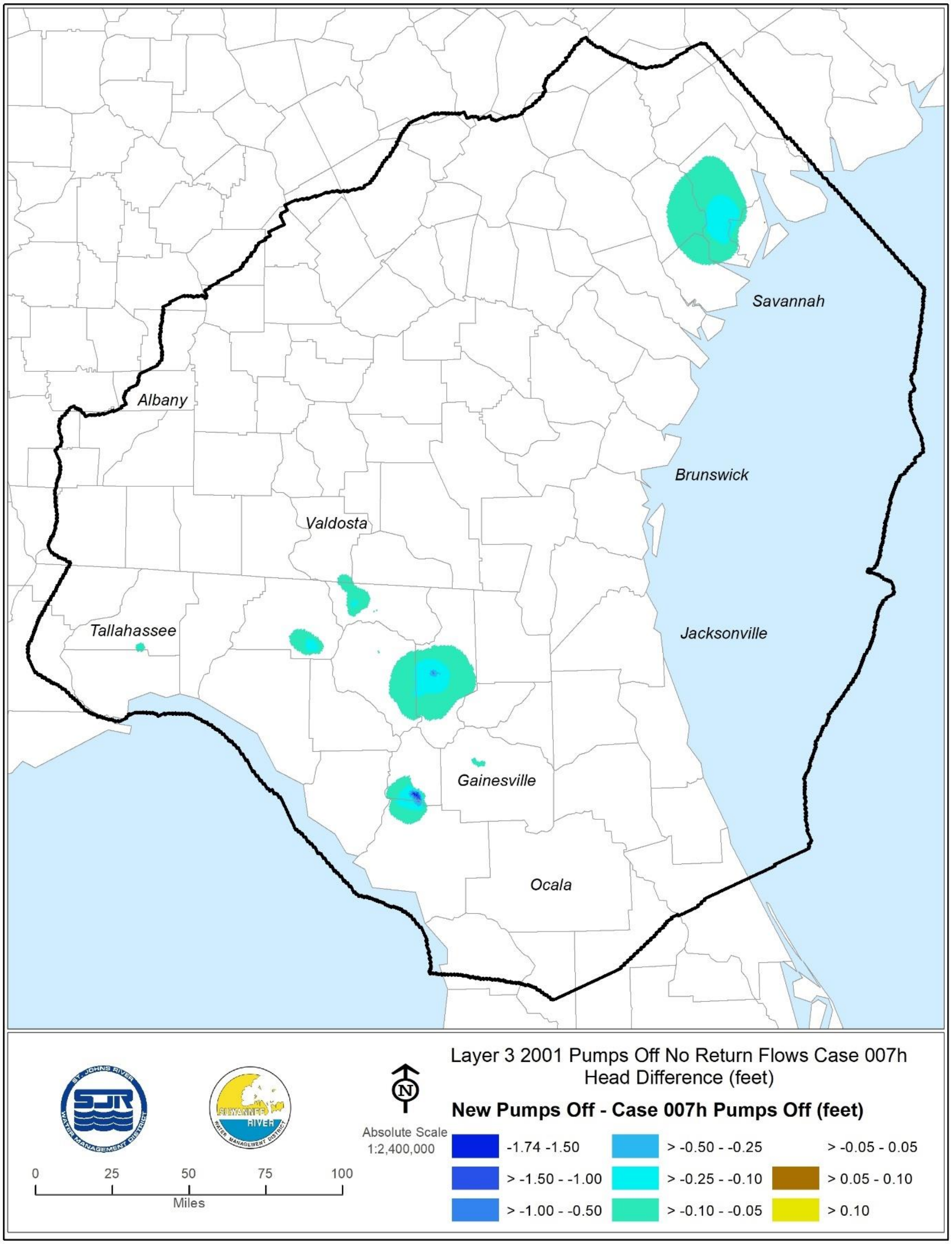

Figure 34. No-pumping head difference (in feet) in Model Layer 3, 2009. The head difference was calculated by subtracting the case007h simulated head from the case007h-1 simulated head.

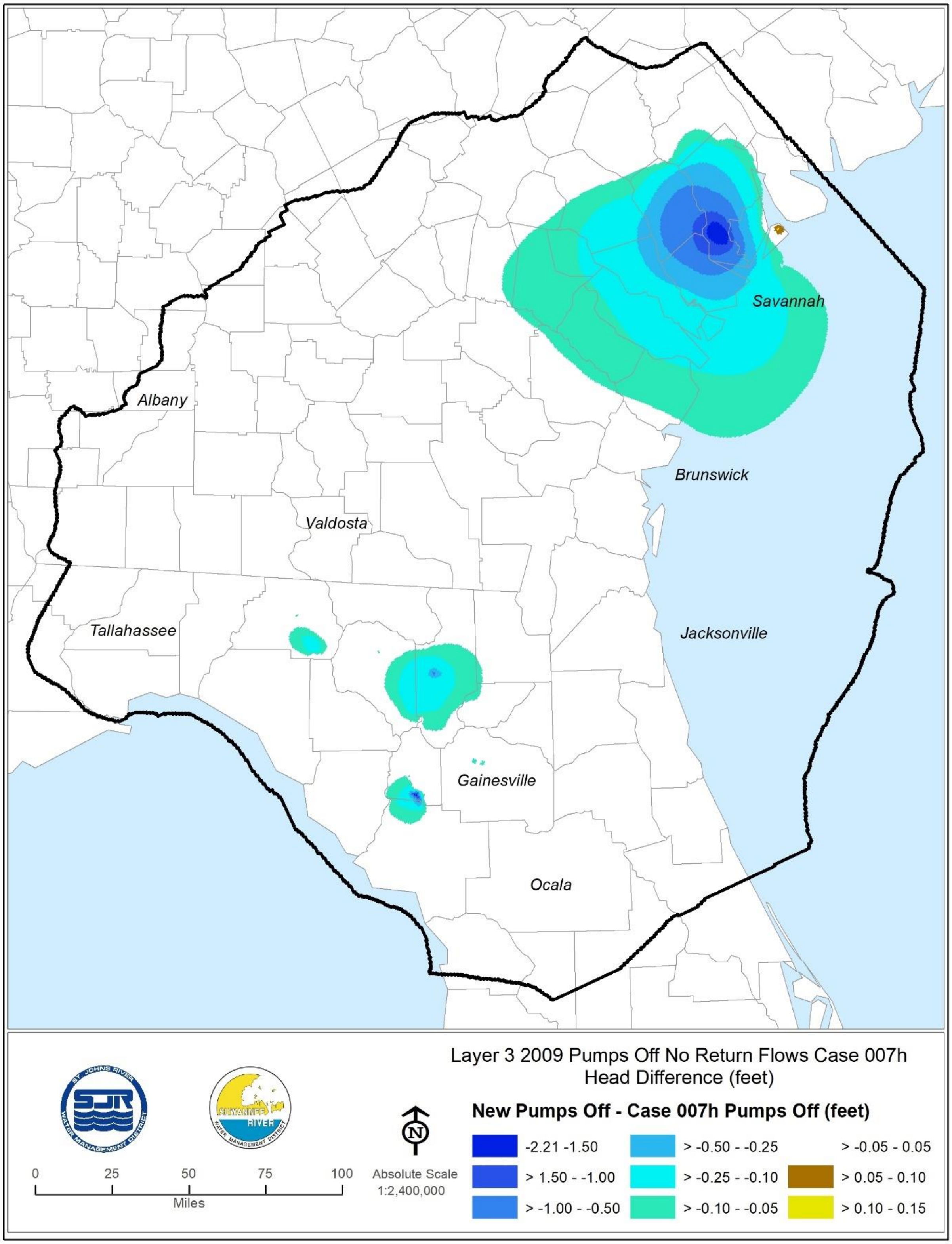

Figure 35. Change in simulated Model Layer 1 flooding between the case007h-1 2009 and no-pumping simulation.

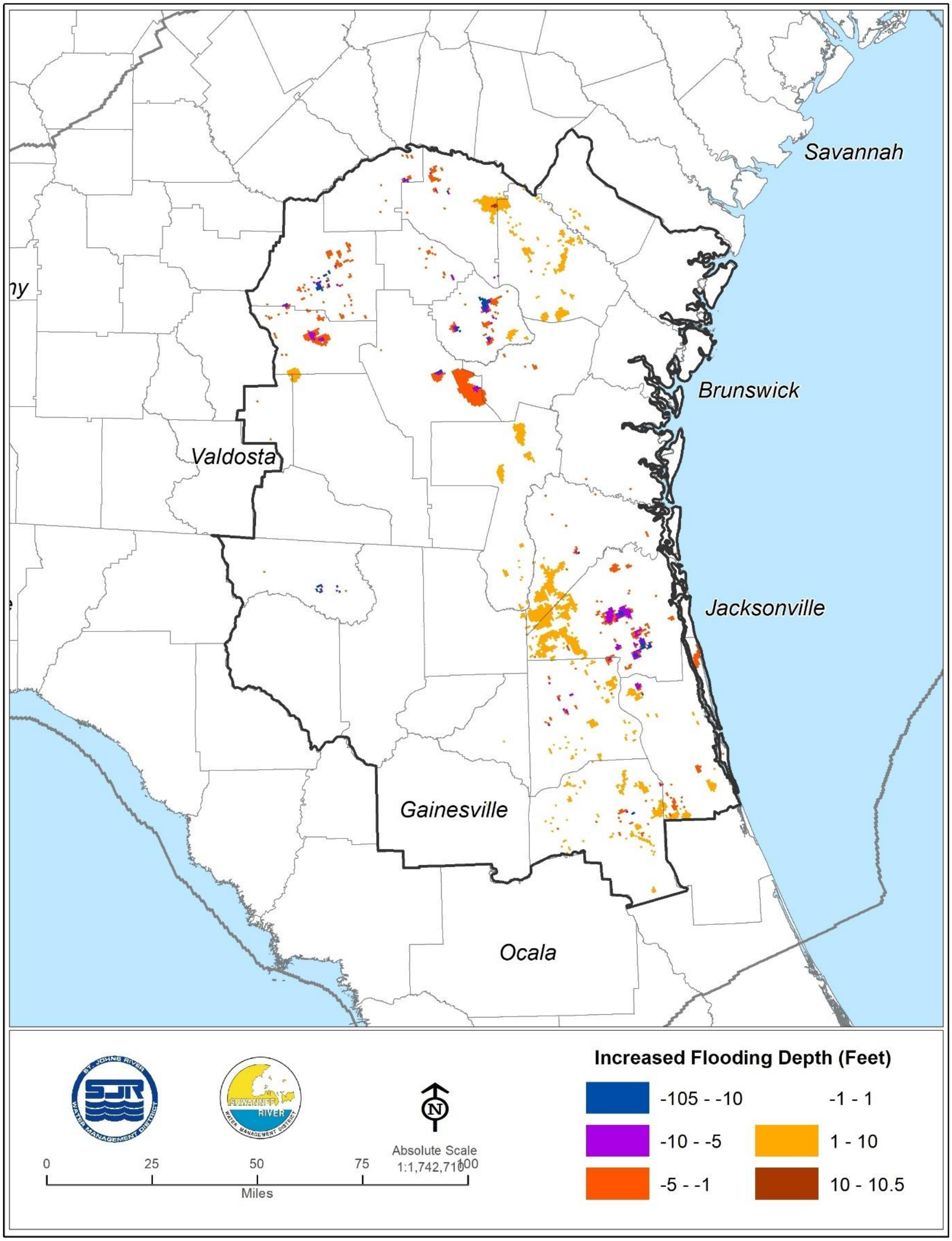

Figure 36. Comparison of case007h-1 spring flow residual statistics for 2001, 2009 and 2010.

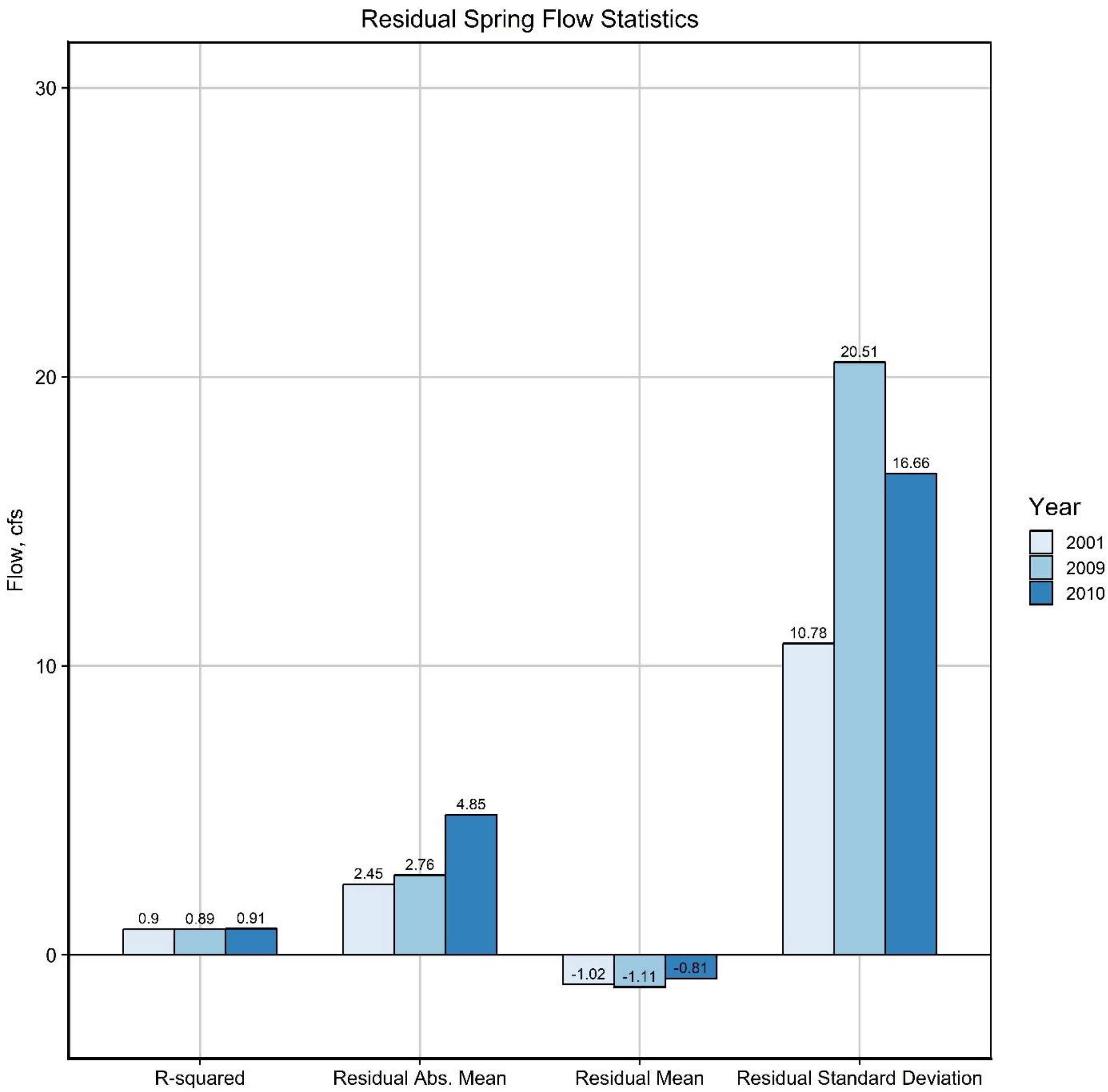

Figure 37. Comparison of case007h-1 groundwater level residual statistics at observation targets for Model Layers 1, 3 and 5 in 2001, 2009 and 2010.

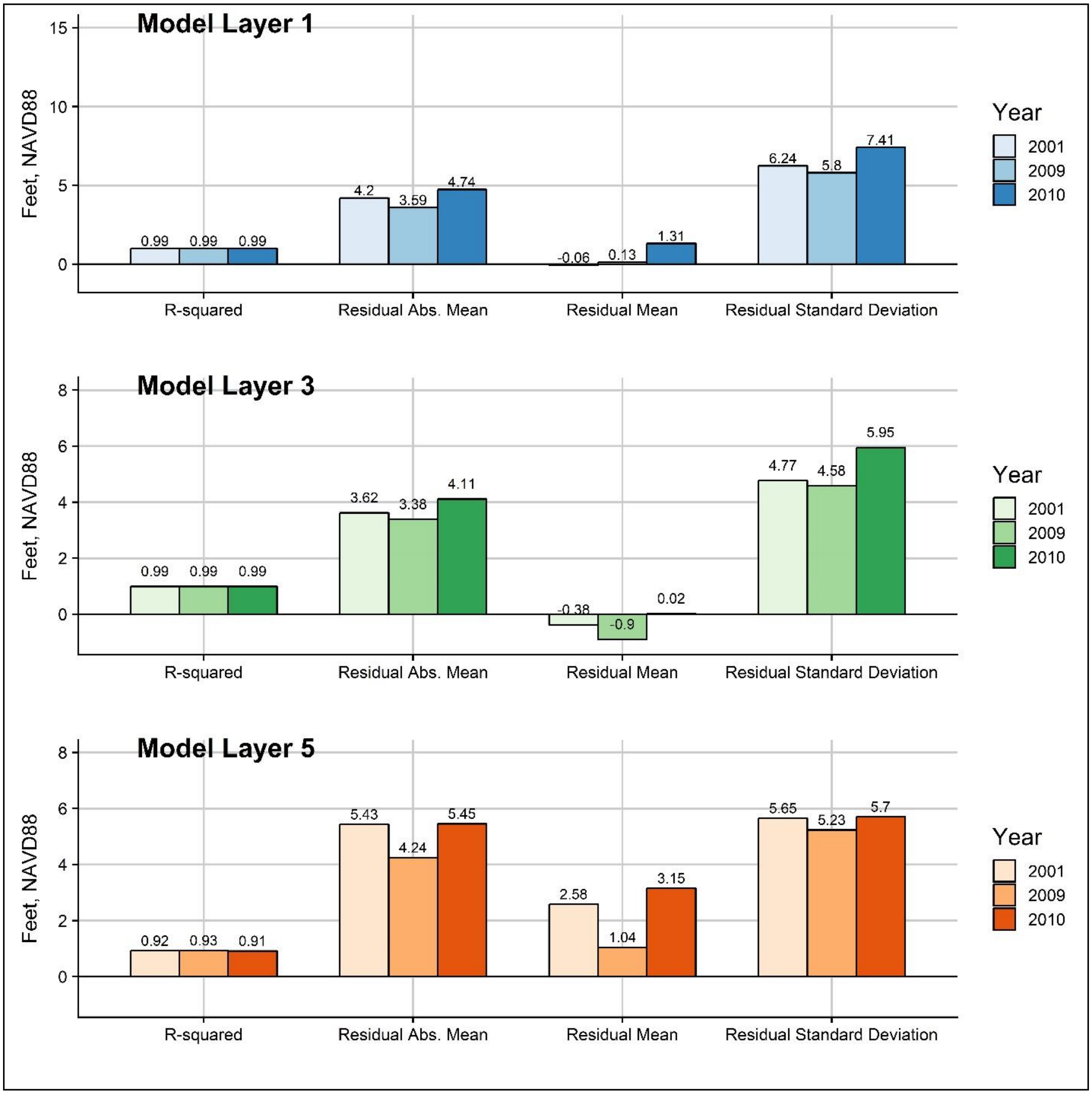

Figure 38. Comparison of case007h-1 cumulative baseflow rate residual statistics for 2001, 2009 and 2010.

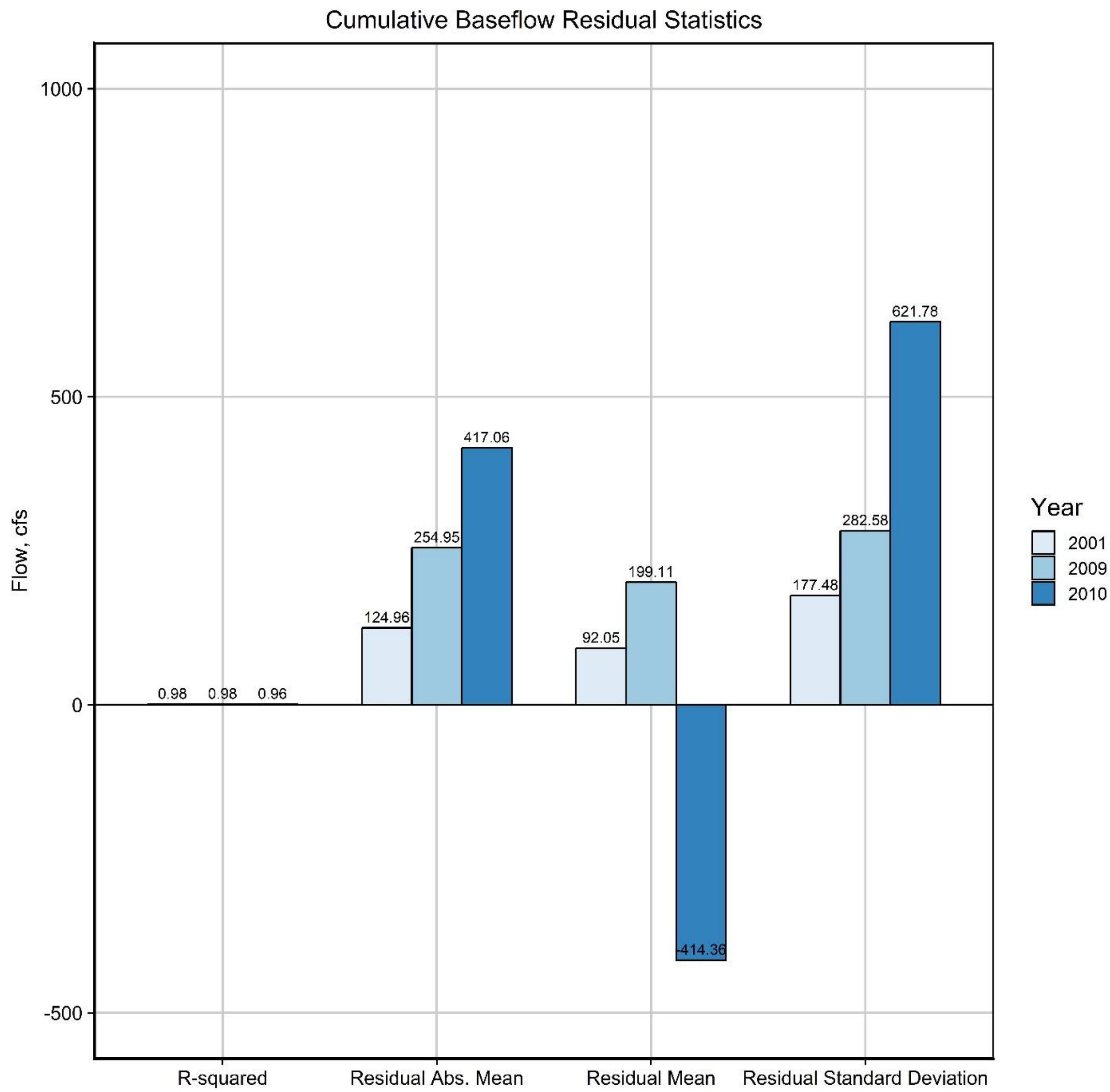

Figure 39. Comparison of case007h-1 baseflow pickup rate residual statistics for 2001, 2009 and 2010.