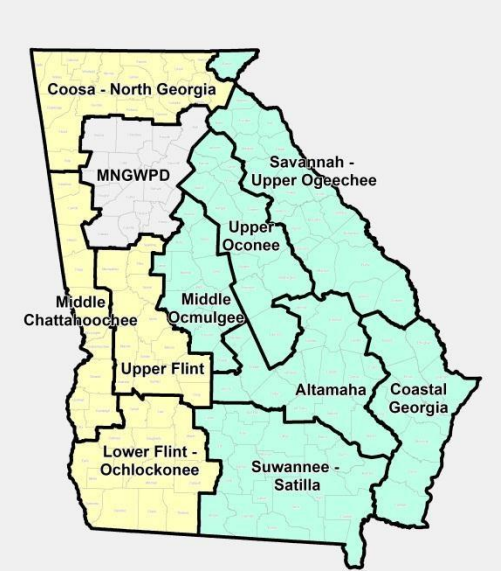
Joint Council Meeting #1 – Eastern Councils
Thursday, June 23, 2016

Dubose Porter Center
Oconee Fall Line Technical College
560 Pinehill Road
Dublin, GA 31021



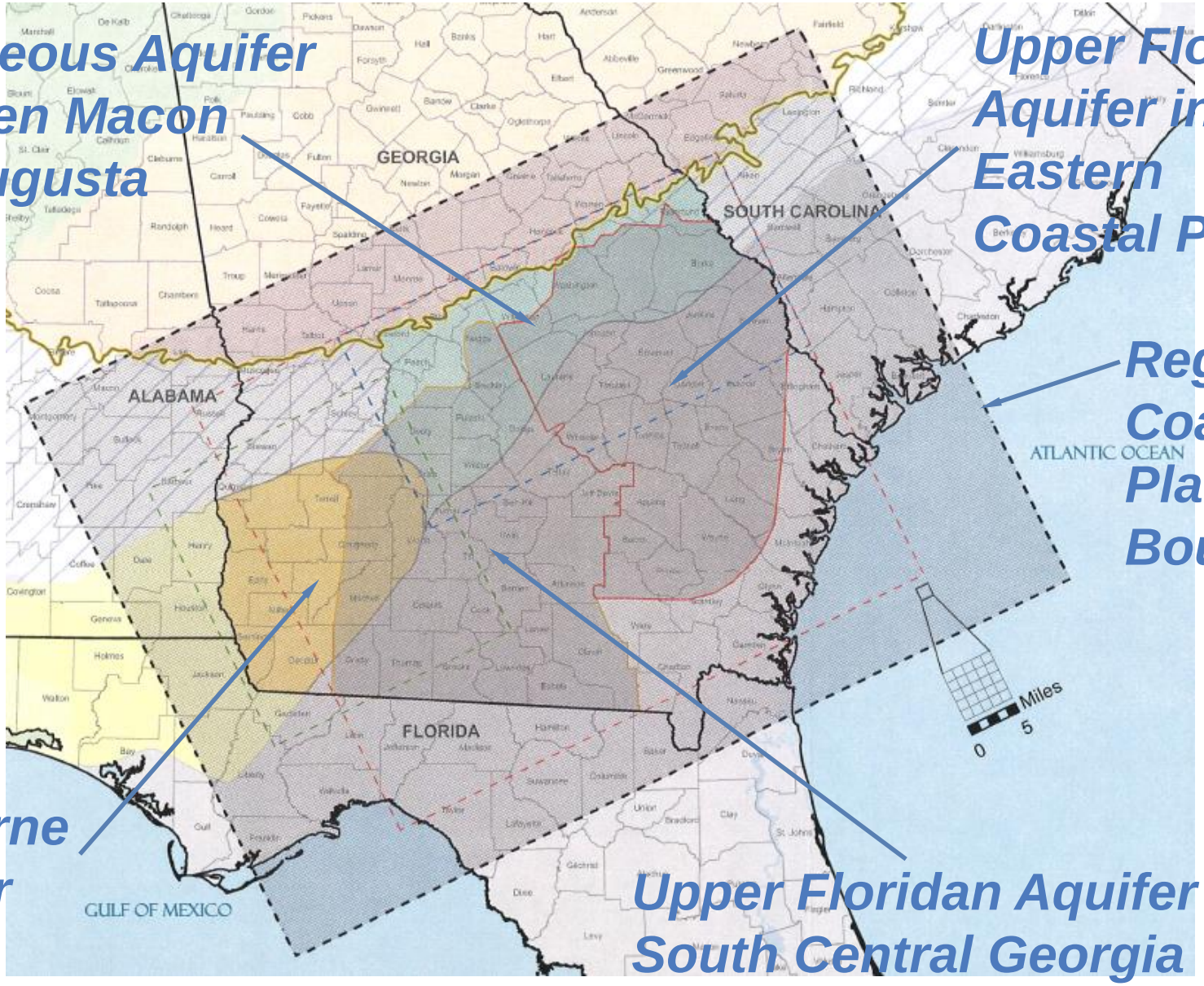
Groundwater Availability Slides – This package includes the following slides presented by Dr. Kennedy:

- Groundwater Availability Resource Assessment
- Slides on Task 1, Task 2 and Task 3, including:
  - Task 1: Claxton Node (Altamaha Council)
  - Task 2: Eden/Kings Ferry Nodes (Coastal Council)
  - Task 3: Cretaceous Aquifer (Middle Ocmulgee Council)

Groundwater Availability Resource Assessment

www.georgiawaterplanning.org

Regional Coastal Plain Model and Aquifers Prioritized to Determine Sustainable Yield



Cretaceous Aquifer Between Macon and Augusta

Upper Floridan Aquifer in the Eastern Coastal Plain

Regional Coastal Plain Model Boundary

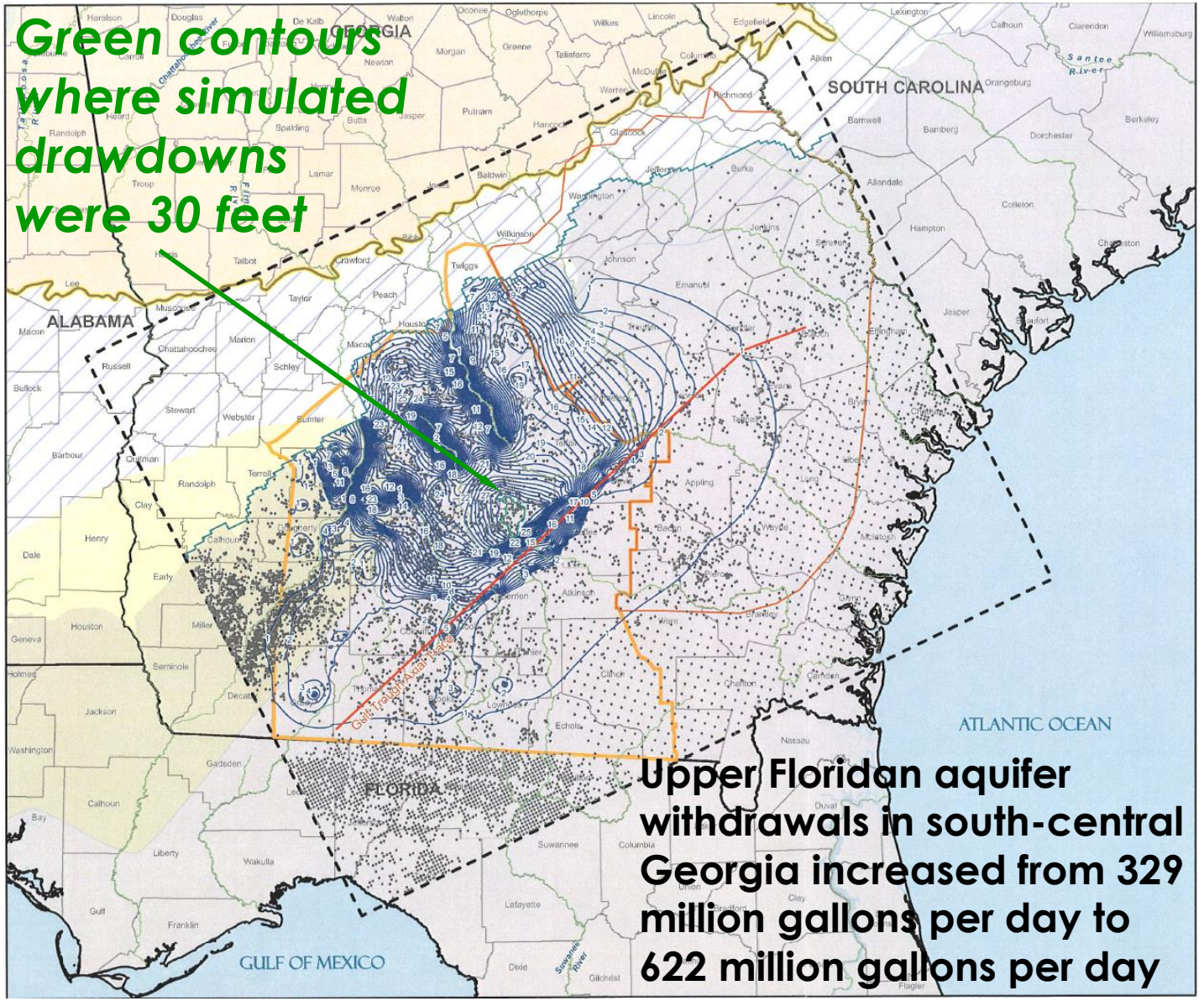
Claiborne Aquifer

Upper Floridan Aquifer in South Central Georgia

Model Simulations Used to Determine Sustainable Yields

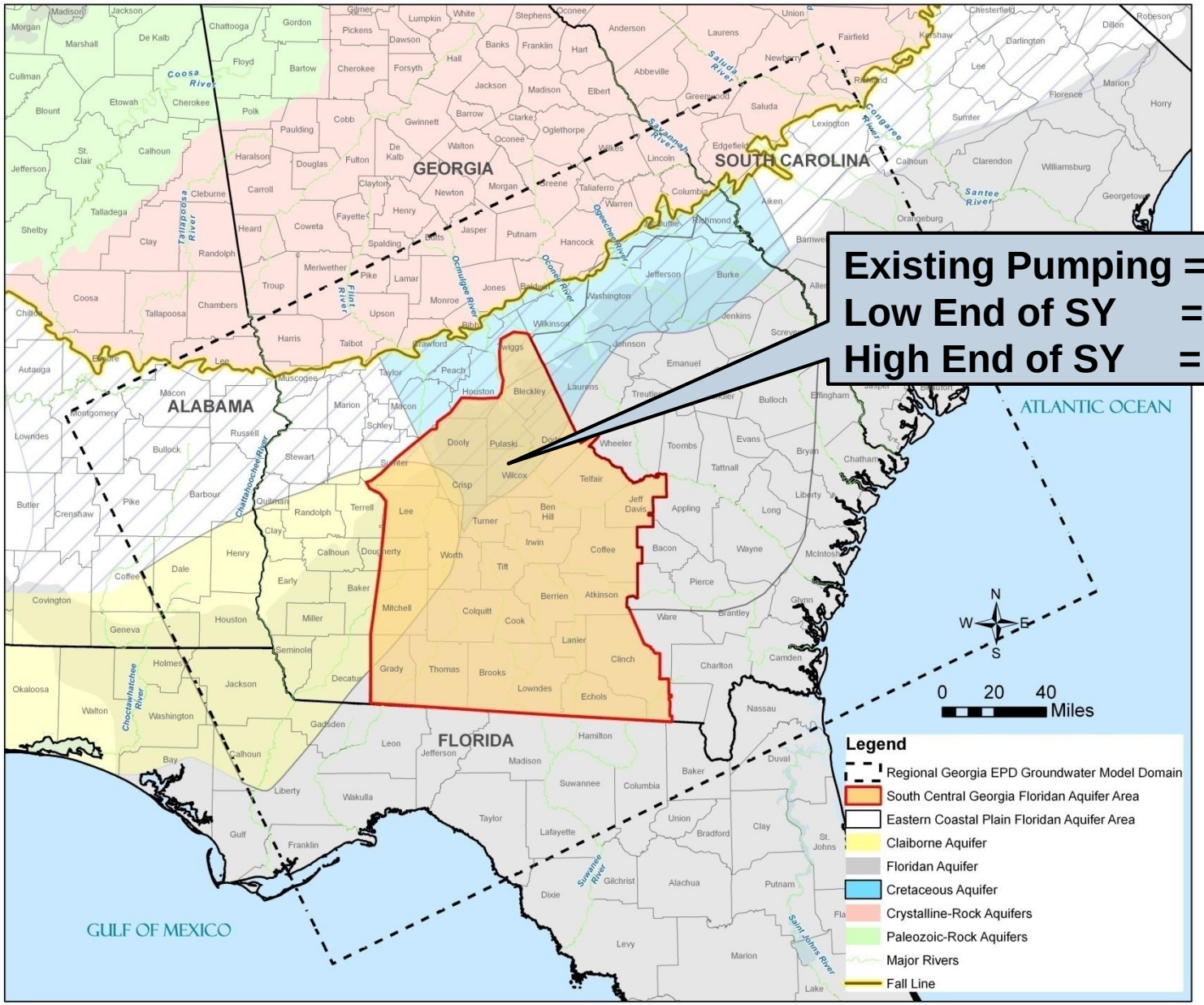
- Increased withdrawals from existing wells in individual prioritized aquifers
- Increased withdrawals from existing and hypothetical new wells in individual prioritized aquifers
- Determined ranges of aquifer sustainable yields
- Simultaneously increased withdrawals from existing wells in all prioritized aquifers in the regional model

Simulated Drawdown in the Upper Floridan Aquifer of South-Central Georgia Due to Increased Withdrawals

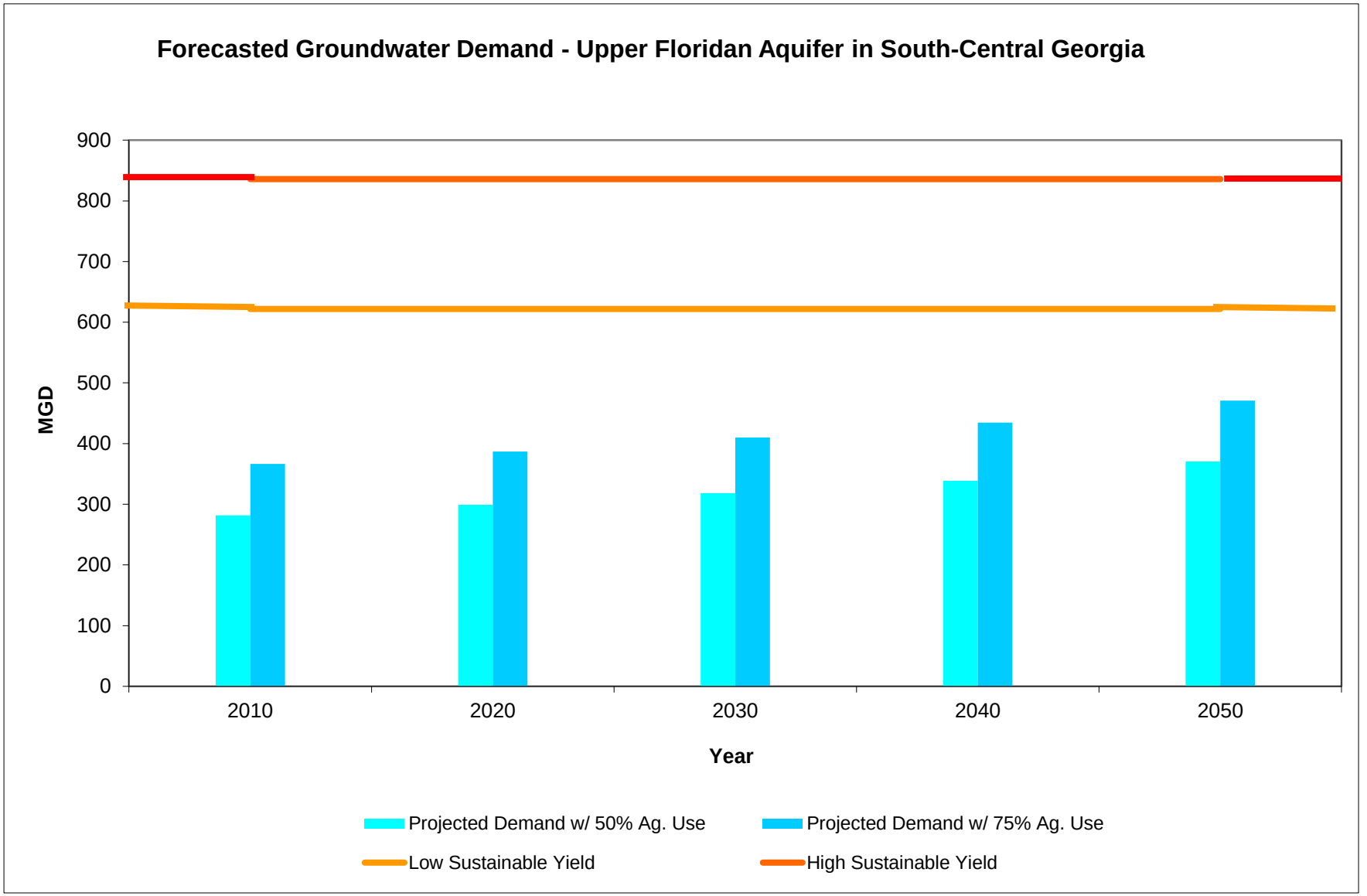


Range of Sustainable Yield

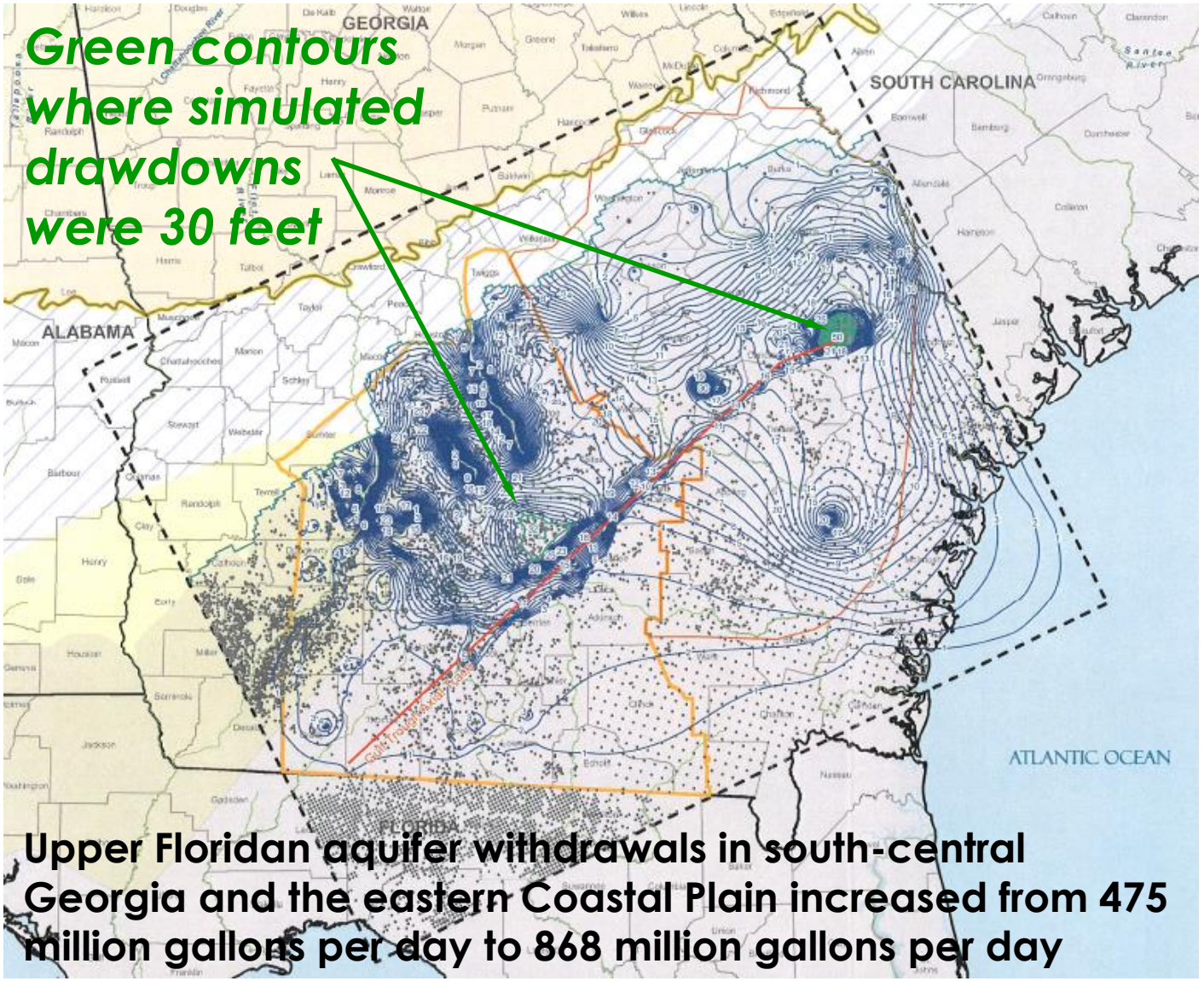
Upper Floridan Aquifer - South Central Georgia



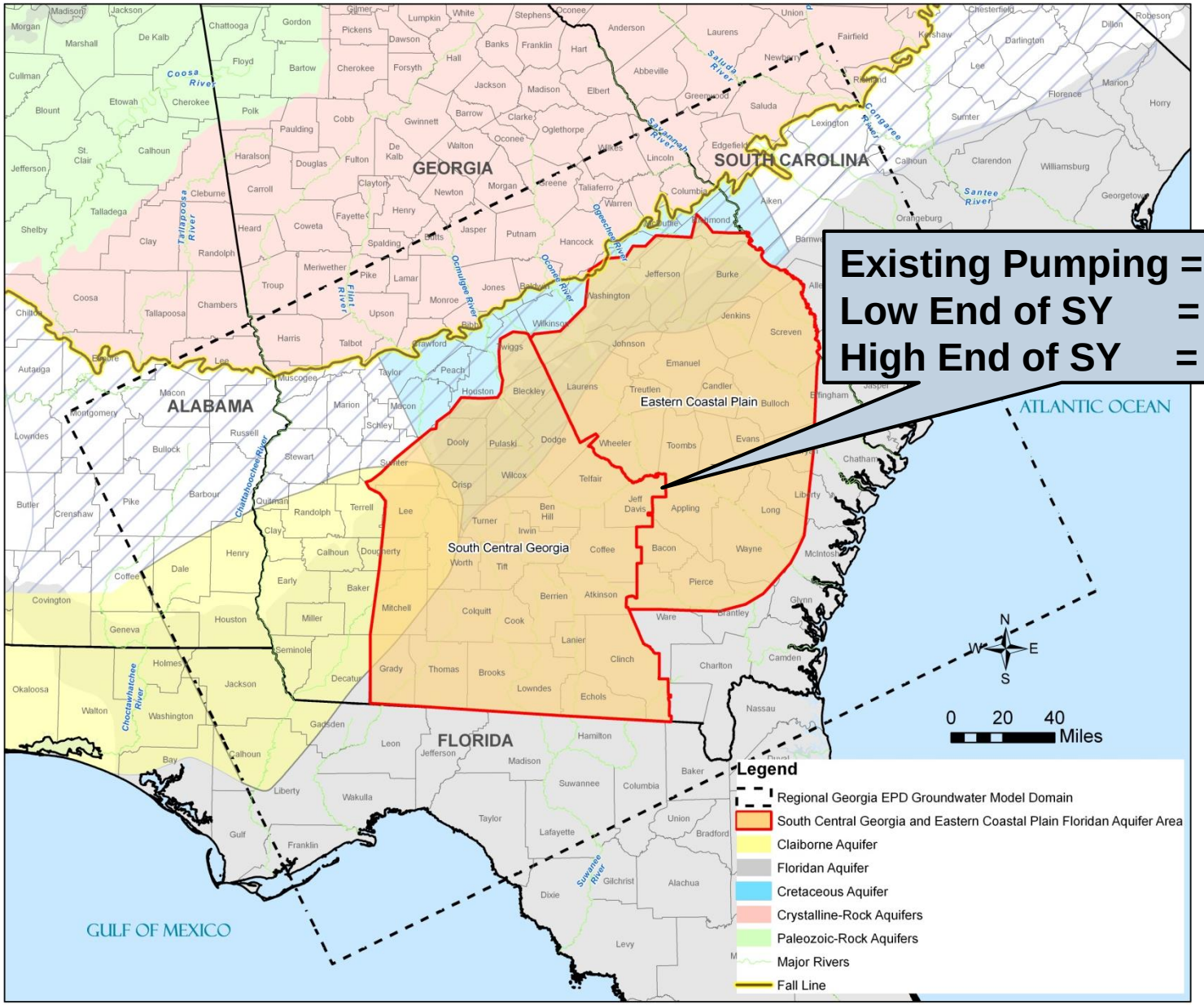
Floridan Aquifer in South-Central Georgia



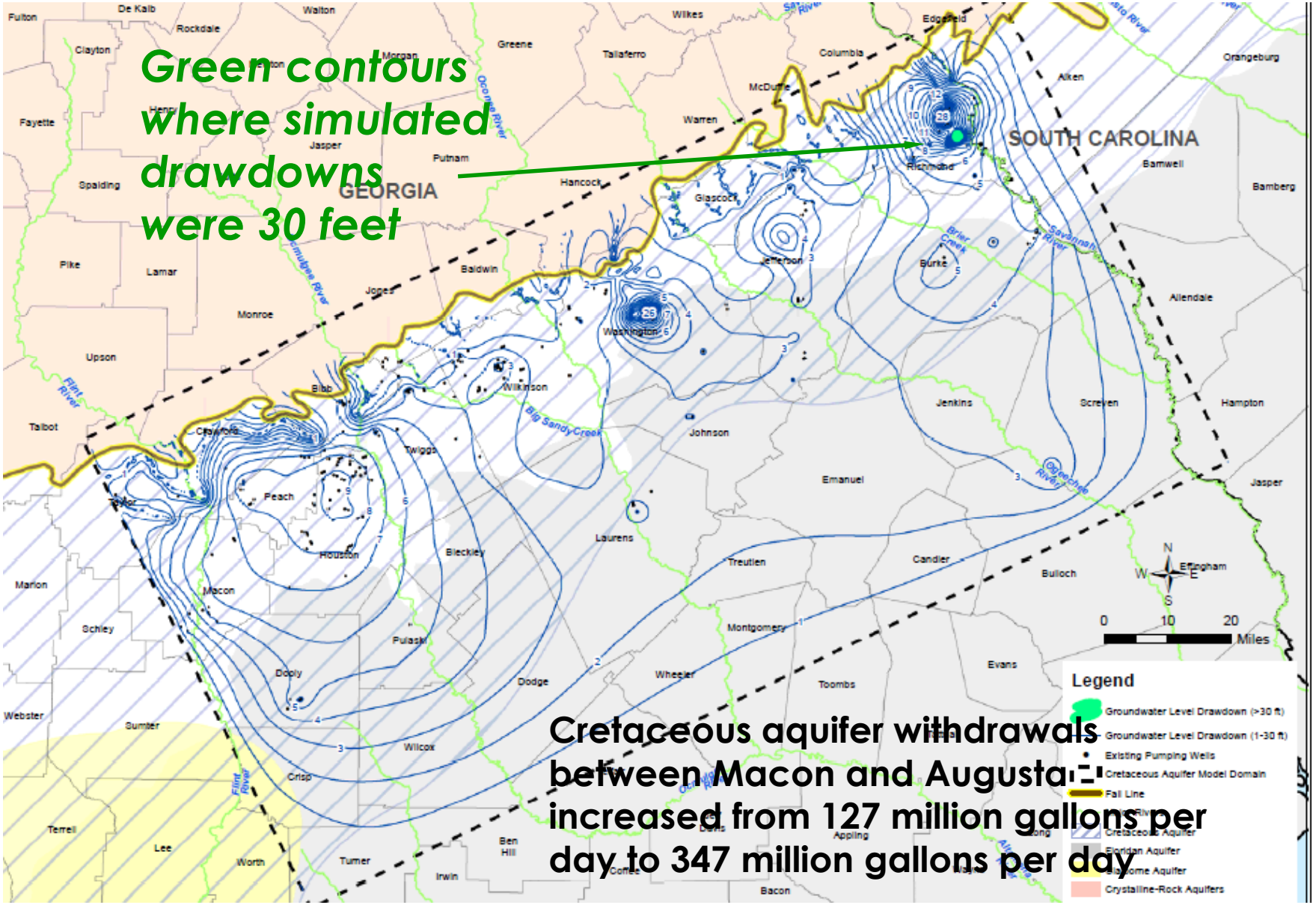
Simulated Drawdown in the Upper Floridan Aquifer of South-Central Georgia and the Eastern Coastal Plain Due to Increased Withdrawals



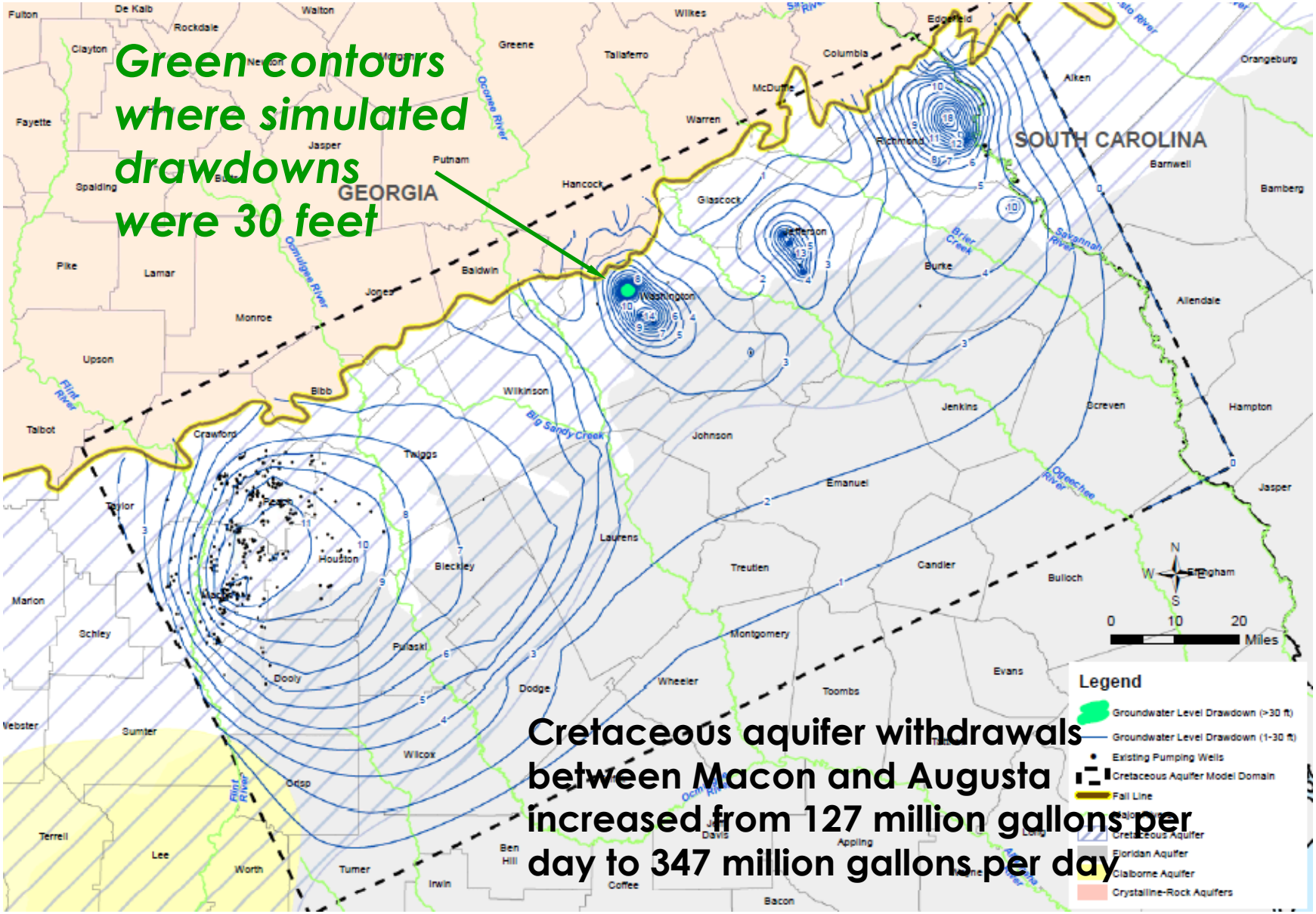
Range of Sustainable Yield - Upper Floridan Aquifer in South Central Georgia & Eastern Coastal Plain



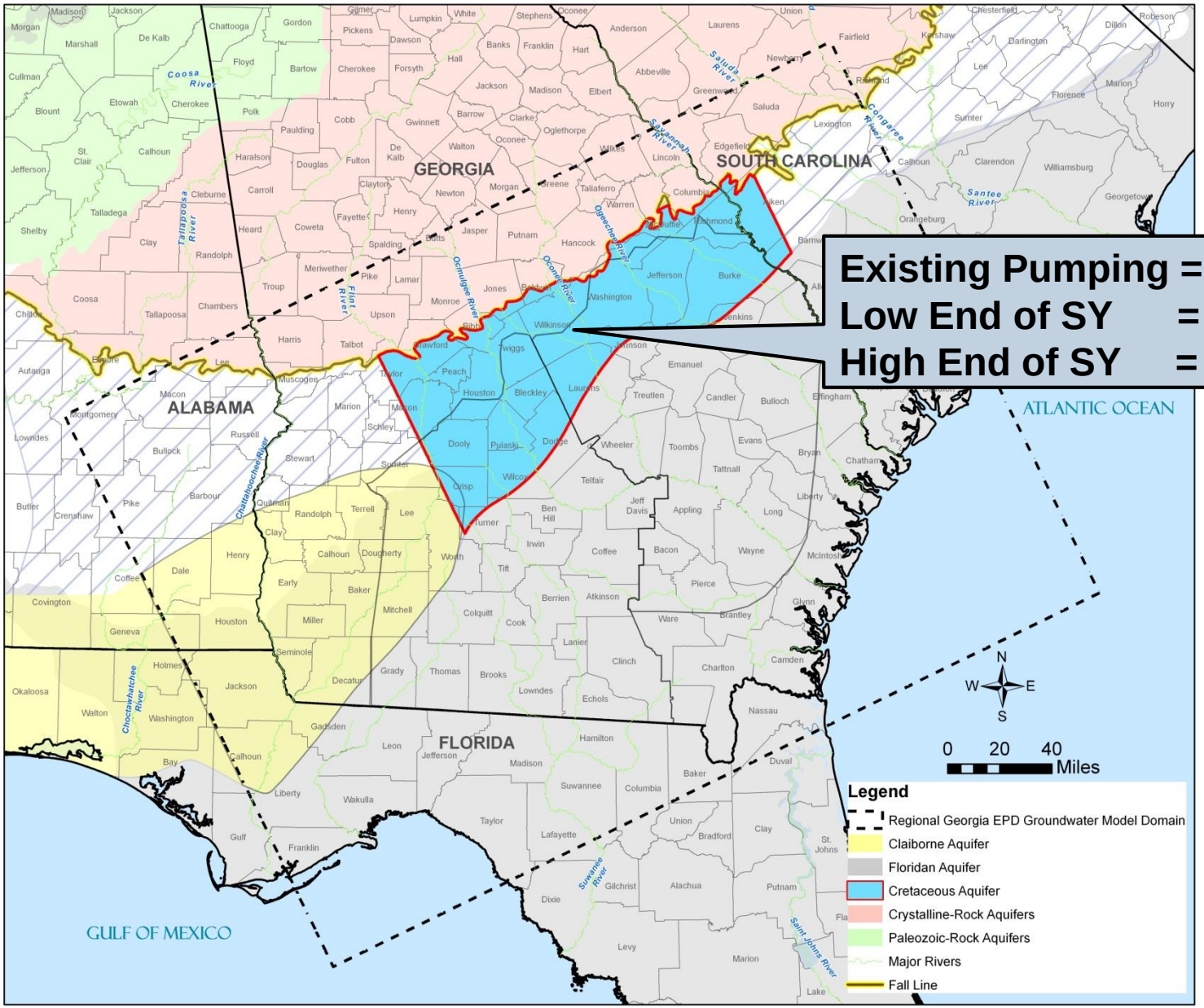
Simulated Drawdown in the Cretaceous Aquifer Layer 5 Between Macon and Augusta Due to Increased Withdrawals



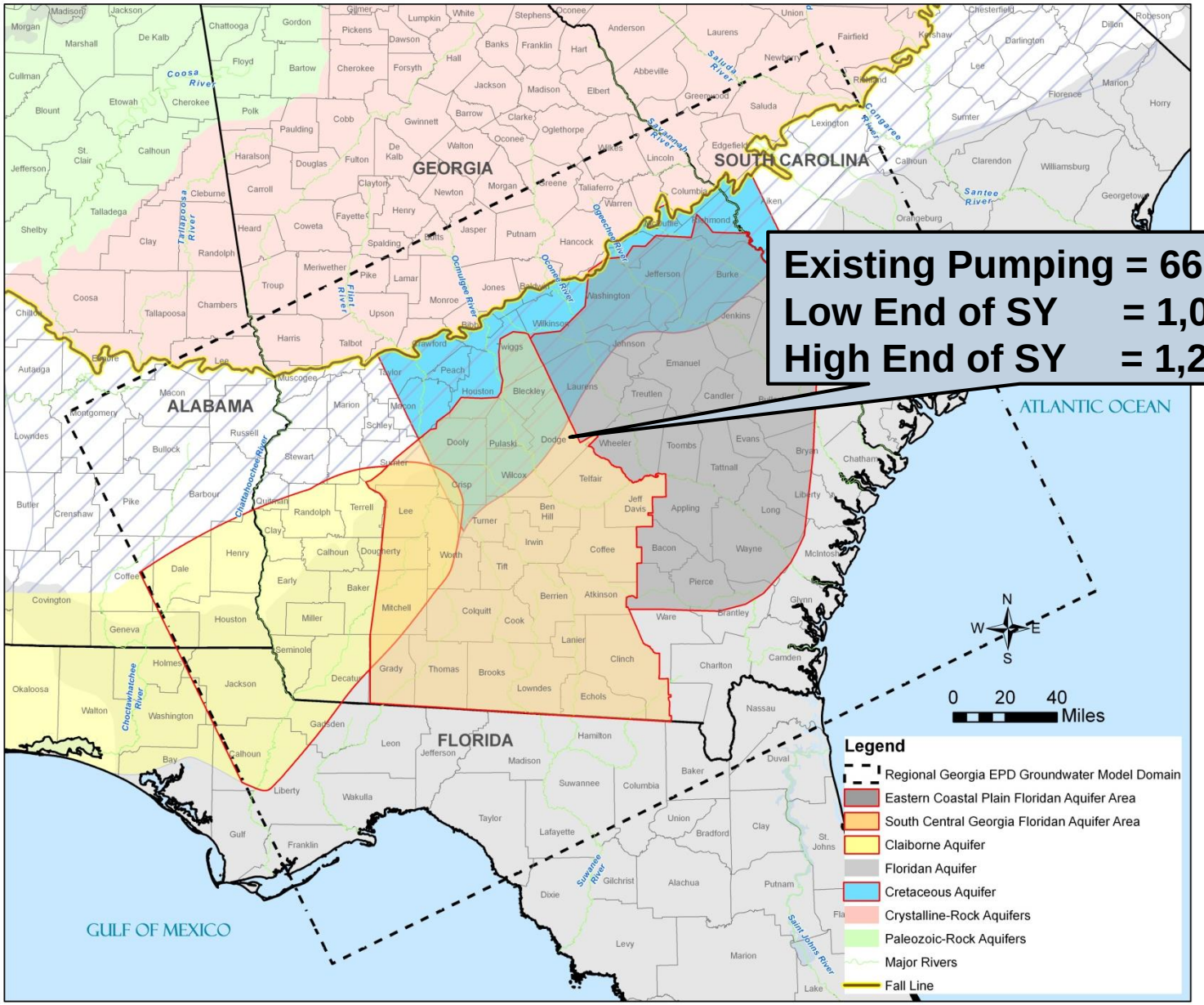
Simulated Drawdown in the Cretaceous Aquifer Layer 6 Between Macon and Augusta Due to Increased Withdrawals



Range of Sustainable Yield – Cretaceous Aquifer Between Macon and Augusta



Range of Sustainable Yield – Withdrawals from All Prioritized Coastal Plain Aquifers

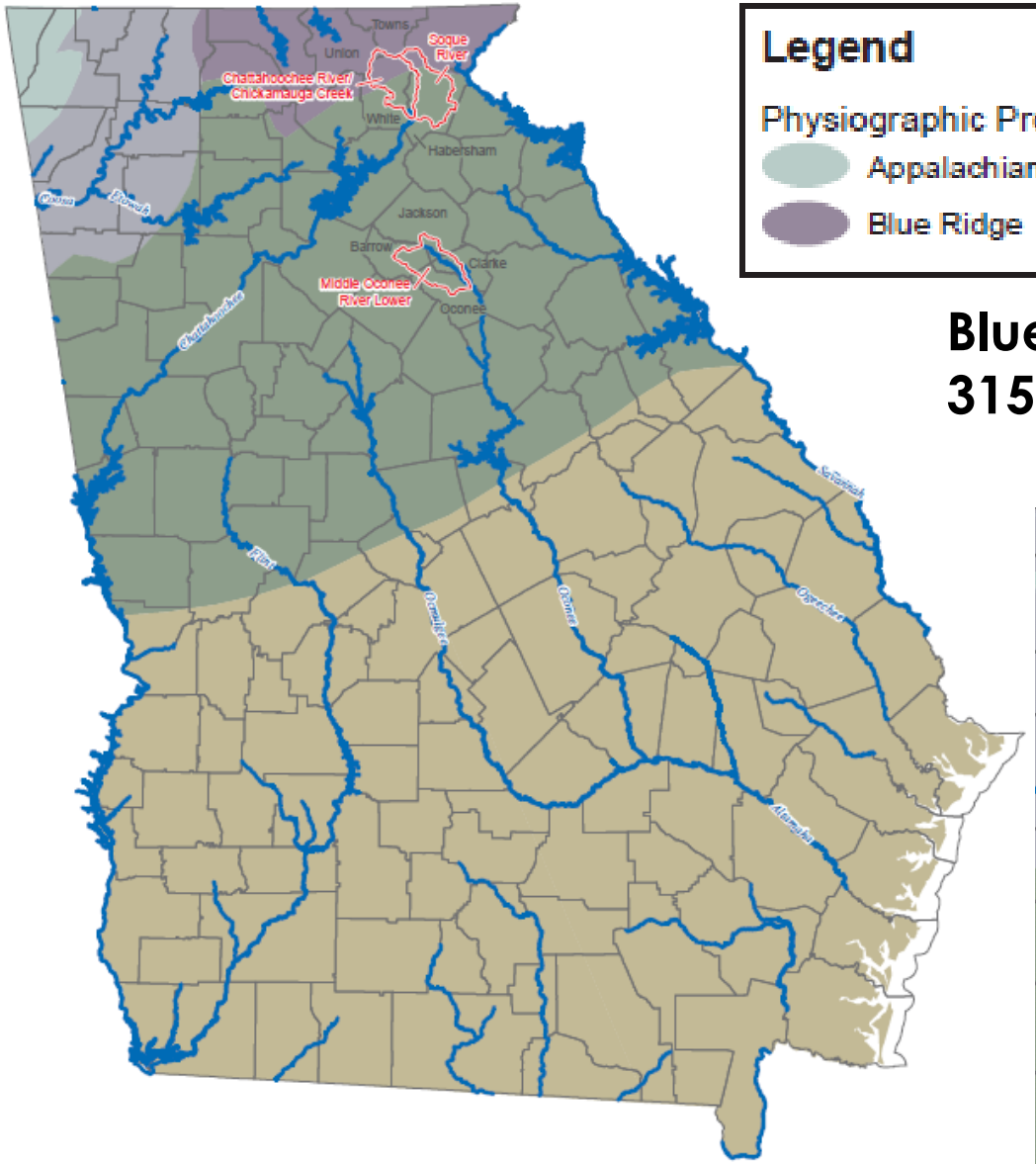


Summary of Total Sustainable Yield of Coastal Plain Aquifers

The Total Sustainable Yield of Prioritized Coastal Plain Aquifers is Smaller if Increased Withdrawals are Simulated Simultaneously for All Aquifers

Total of Sustainable Yields of Individual Prioritized Aquifers with Aquifer Withdrawals Modeled Individually	Min	1,166 mgd
	Max	1,433 mgd
Total of Sustainable Yields of Individual Prioritized Aquifers with Aquifer Withdrawals Modeled Simultaneously	Min	1,055 mgd
	Max	1,240 mgd

Piedmont and Blue Ridge Water Budget Basins



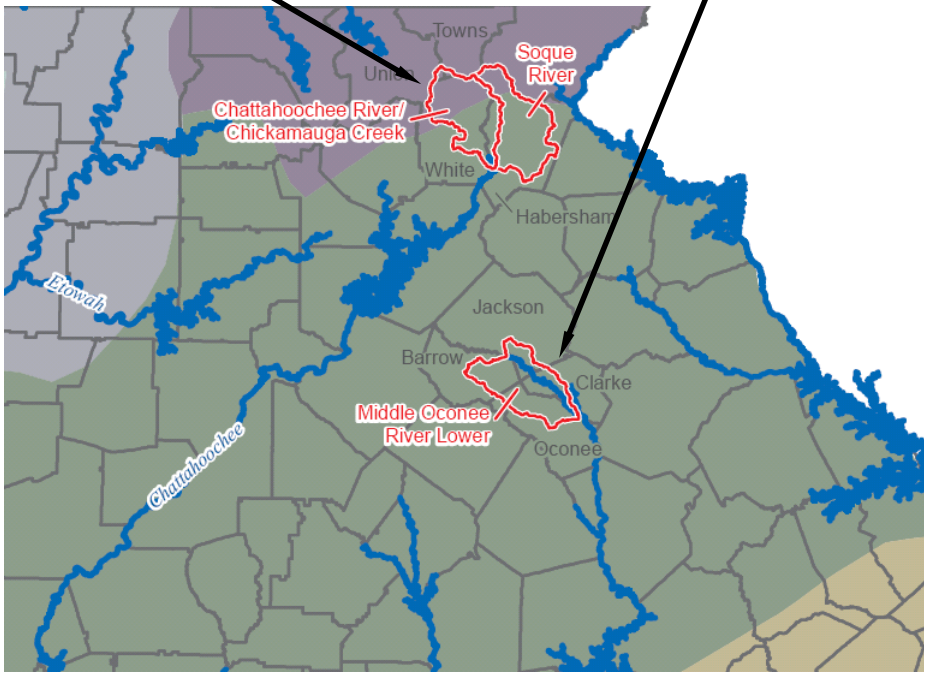
Legend

Physiographic Province
- Appalachian Plateaus
- Blue Ridge
- Valley & Ridge
- Piedmont
- Coastal Plain

- Selected Basin
- Rivers & Lakes

Blue Ridge Basin
315 mi²

Piedmont Basin
163 mi²



Sustainable Yield of the Crystalline Rock Aquifer is Related to Streamflow

- September is usually the month of lowest streamflow in Georgia
- Constraining groundwater recharge from surface water sources to mean September streamflow minus a percentage of the mean annual streamflow would maintain opportunities for surface water use during a month of low streamflow
- Mean September streamflow minus 60 to 40 percent of the mean annual flow is a streamflow metric that can be considered the top end of the range of sustainable yield of the crystalline rock aquifer
- Others managing groundwater resources in crystalline rock aquifers of the eastern United States with hydrogeology similar to the Georgia Piedmont and Blue Ridge have used 20% of the top-end streamflow metric as a sustainable yield

Sustainable Yield of Crystalline Rock Aquifer in the Study Basins

Basin Location	Study Basin Area (mi^2)	Dry Year Groundwater Use (mgd)	Net Groundwater Available for Use Based On Mean September Flow Minus Percentage of Mean Annual Flow			Increase in Net Groundwater Available (mgd)
			(in/yr)	(mgd)	(mgd/mi^2)	
Piedmont	163	1.2	2.7	21.0	0.129	19.8
Blue Ridge	315	2.4	3.4	51.0	0.162	48.6
Basin Provence	**Study Basin Area (mi^2)**	**Dry Year Groundwater Use (mgd)**	**Net Groundwater Available for Use Based On Mean September Flow Minus Percentage of Mean Annual Flow x 20%**			**Increase in Net Groundwater Available**
			(in/yr)	(mgd)	(mgd/mi^2)	
Piedmont	163	1.2	0.5	4.2	0.026	3.0
Blue Ridge	315	2.4	0.7	10.2	0.032	7.8

Sustainable Yield of the Crystalline Rock Aquifer

- More groundwater is available from the crystalline rock aquifer than is currently being withdrawn
- It might be difficult to find sufficient water-bearing fractures in the crystalline rock aquifer to develop the full range of sustainable yield
- Because it might be difficult to find sufficient water-bearing fractures planning for use of groundwater should focus on the lower-end of the sustainable yield range

2016 Estimate of 2015 Groundwater Use

Upper Floridan Aquifer in South-Central Georgia

Year	Range of Suatainable Yield (mgd)		Forecasted Groundwater Demand (mgd by use category)						Total Forecasted Demand (mgd)	
			Agricultural Use				Self-Supplied			
	Low	High	50%	75%	Municipal	Industrial		Energy	50% Ag.	75% Ag.
2010	622	836	207.67	292.36	45.23	15.14	13.56	0.00	281.60	366.29
2020	622	836	215.13	302.90	51.37	17.40	15.11	0.00	299.00	386.77
2030	622	836	224.56	316.19	58.04	19.05	16.76	0.00	318.41	410.04
2040	622	836	234.99	330.86	64.66	20.72	18.28	0.00	338.64	434.51
2050	622	836	246.51	347.05	71.63	32.57	19.79	0.00	370.50	471.04
Year 2015 Estimated in 2016				283.07	44.65		18,92	0.00		

Upper Floridan Aquifer in South-Central Georgia & Eastern Coastal Plain

Year	Range of Suatainable Yield (mgd)		Forecasted Groundwater Demand (mgd by use category)						Total Forecasted Demand (mgd)	
			Agricultural Use				Self-Supplied			
	Low	High	50%	75%	Municipal	Industrial		Energy	50% Ag.	75% Ag.
2010	868	982	270.20	381.12	75.38	93.85	29.43	0.18	468.85	579.77
2020	868	982	279.01	393.68	86.62	101.49	33.47	0.18	500.59	615.26
2030	868	982	290.27	409.71	98.72	105.42	37.81	0.18	532.23	651.67
2040	868	982	302.74	427.42	110.49	108.88	41.89	0.18	564.00	688.68
2050	868	982	316.53	446.99	123.03	122.73	46.20	0.18	608.49	738.95
Year 2015 Estimated in 2016				405.29	80.95		34.79	0.01		

Cretaceous Aquifer Between Macon and Augusta

Projected in 2010	Range of Suatainable Yield (mgd)		Forecasted Groundwater Demand (mgd by use category)						Total Forecasted Demand (mgd)	
			Agricultural Use				Self-Supplied			
	Low	High	50%	75%	Municipal	Industrial		Energy	50% Ag.	75% Ag.
2010	347	445	95.69	128.97	43.84	64.25	8.95	0.84	213.57	246.85
2020	347	445	97.09	130.96	49.37	64.94	10.11	0.84	222.35	256.22
2030	347	445	98.78	133.38	55.13	77.46	11.26	0.84	243.48	278.08
2040	347	445	100.62	136.02	60.64	83.95	12.25	0.84	258.29	293.69
2050	347	445	102.63	138.89	66.65	83.72	13.22	0.84	267.06	303.32
Year 2015 Estimated in 2016				101.14	43.67		11.18	0.20		

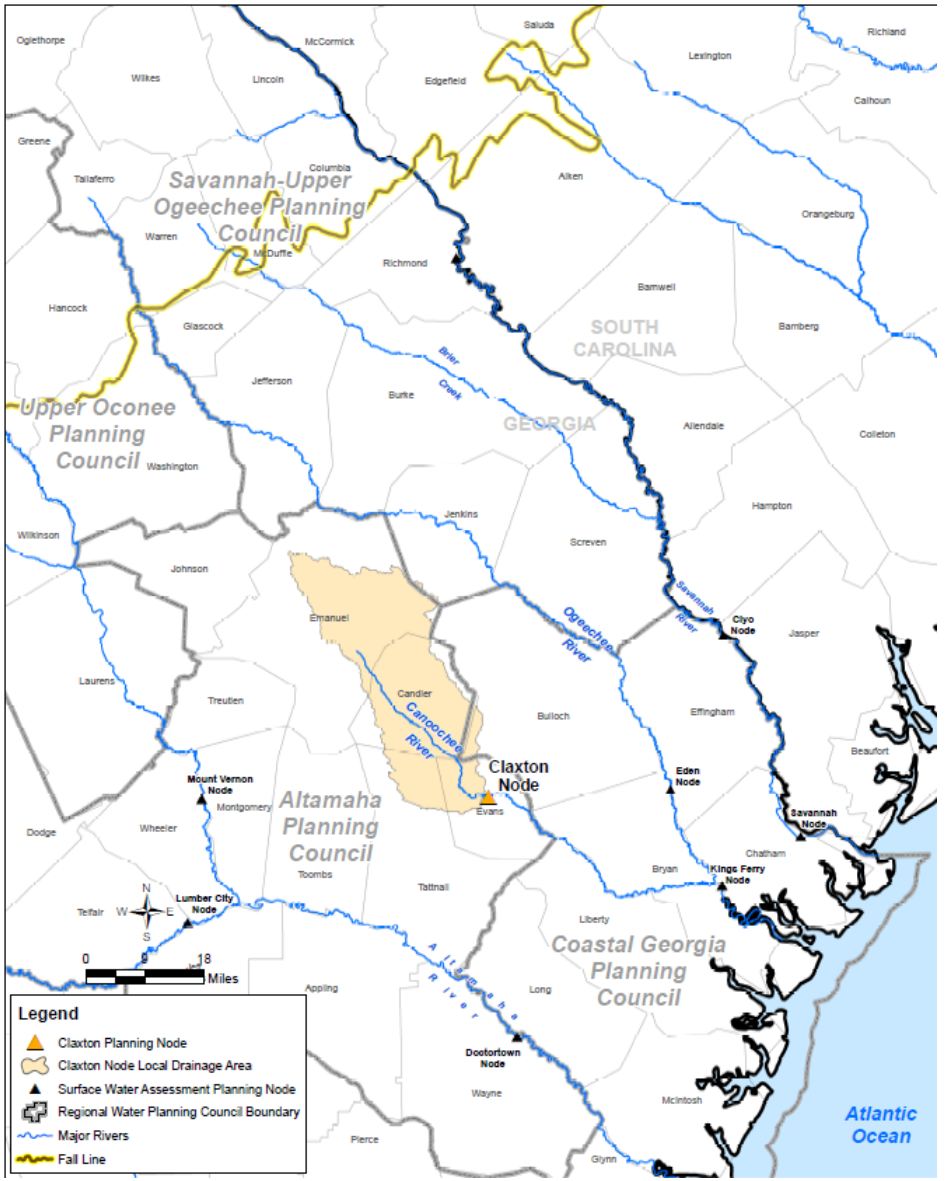
State Water Plan
Future Work
Tasks 1, 2, and 3

James Kennedy, Ph.D., P.G.
State Geologist
Georgia Environmental Protection Division

Council Concerns Addressed

- Task 1: Claxton Node (Altamaha Council)
  - Evaluate capacity of Floridan aquifer to replace surface water withdrawals
- Task 2: Eden/Kings Ferry Nodes (Coastal Council)
  - Evaluate capacity of Floridan and Cretaceous aquifers to replace surface water withdrawals
- Task 3: Cretaceous Aquifer (Middle Ocmulgee Council)
  - Provide recommendations for long-term monitoring of Cretaceous aquifer to evaluate potential impacts of increased groundwater withdrawals

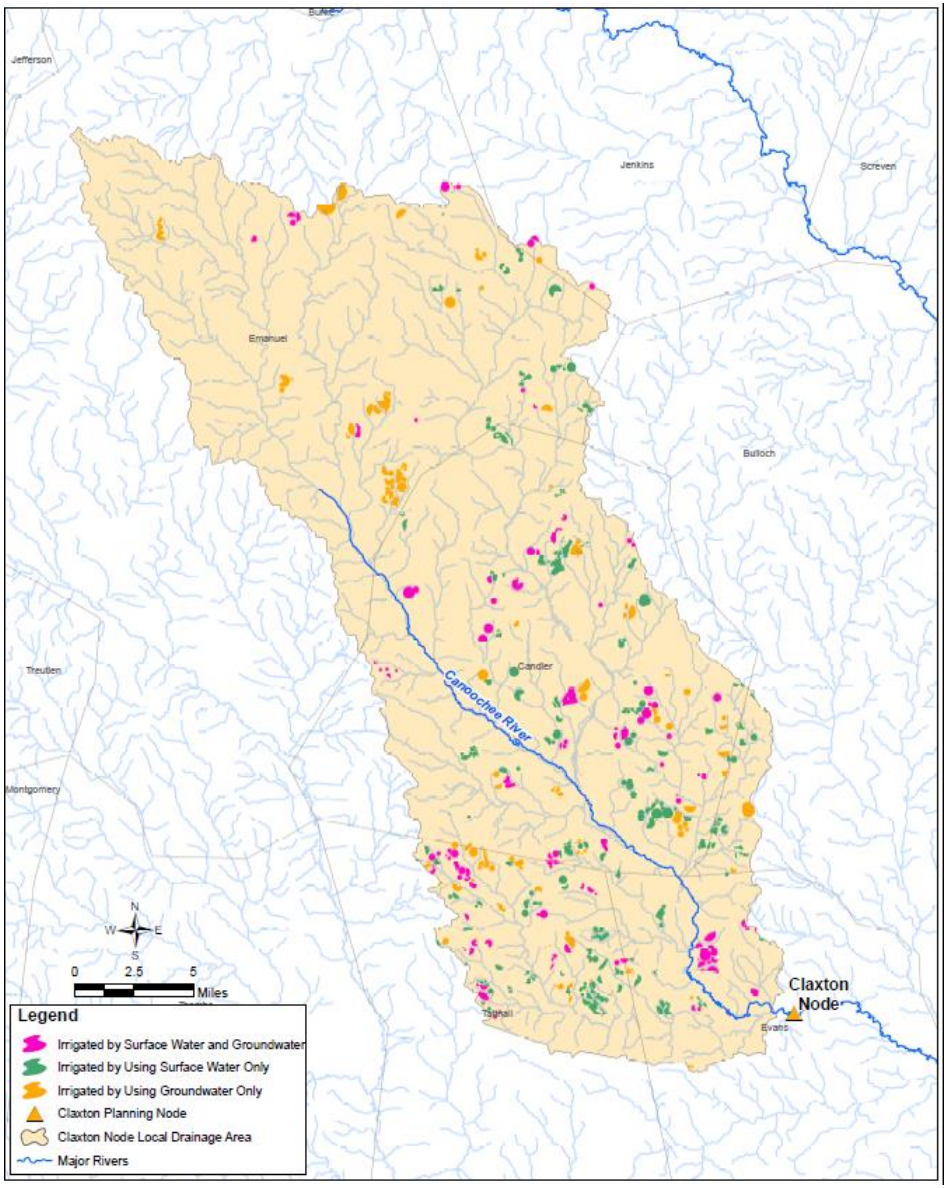
Task 1: Claxton Planning Node



In 2010, the average shortfall at the Claxton Node was:

- Under 2010 demands:
  - 5 cfs (3.2 MGD)
- Under 2050 demands:
  - 11 cfs (7.1 MGD)

Irrigated Areas Upstream of Claxton Node



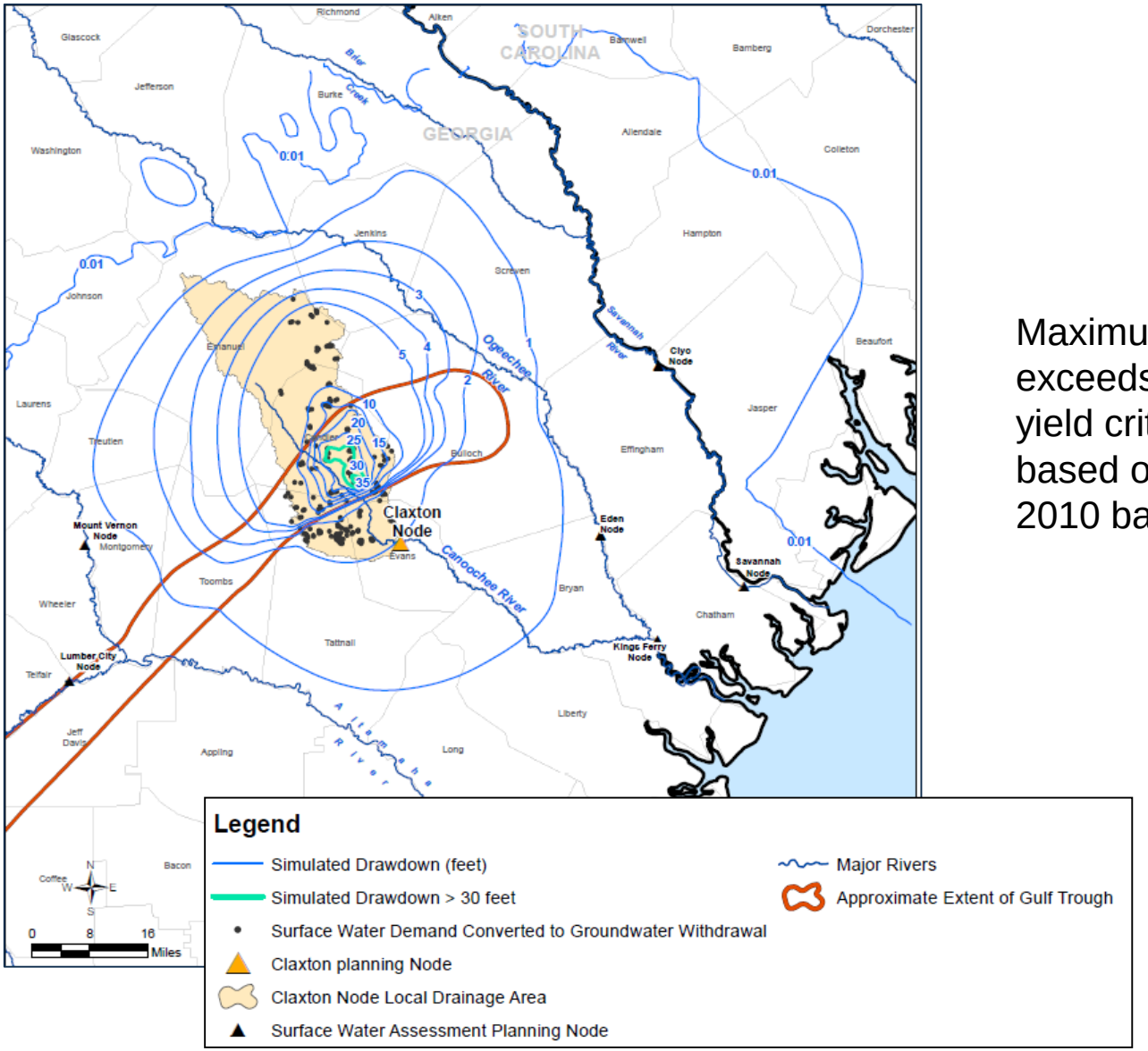
- No permitted Municipal or Industrial surface water withdrawals in the watershed
- Focus on agricultural (surface water only) withdrawals

Calculated Irrigation Demand of Surface Water Only Parcels – Claxton Node LDA

Including Pumping from the Gulf Trough Area

	Number of Parcels	Total Irrigated Area	Mean Irrigation Depth		Total Irrigation Demand	
			(May - August)	(September - April)	(May - August)	(September - April)
Units	-	(acres)	(inches/month)	(inches/month)	(MGD)	(MGD)
Surface Water Only Parcels that will be Replaced by Groundwater	214	6,080	1.39	0.35	7.44	1.90

Simulated Drawdown in Floridan Aquifer Heads – Pumping 7.44 MGD



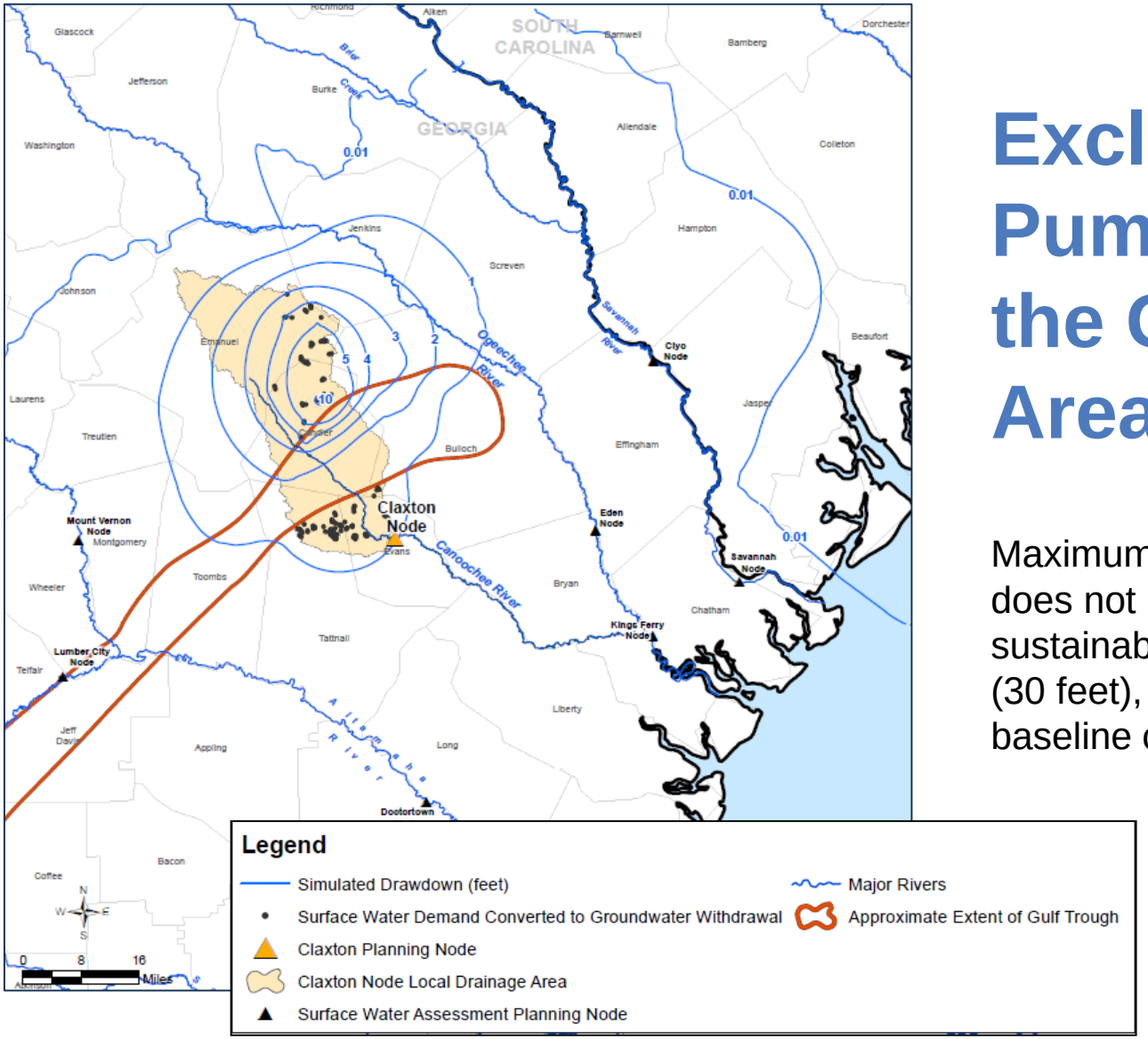
Maximum drawdown exceeds sustainable yield criterion (30 feet), based on simulated 2010 baseline

Calculated Irrigation Demand of Surface Water Only Parcels – Calxton Node LDA

Excluding Pumping from the Gulf Trough Area

	Number of Parcels	Total Irrigated Area	Mean Irrigation Depth		Total Additional Groundwater Demand	
			(May - August)	(September -April)	(May - August)	(September - April)
Units	-	(acres)	(inches/month)	(inches/month)	(MGD)	(MGD)
Surface Water Only Parcels that will be Replaced by Groundwater	121	2,980	1.39	0.35	3.65	0.93

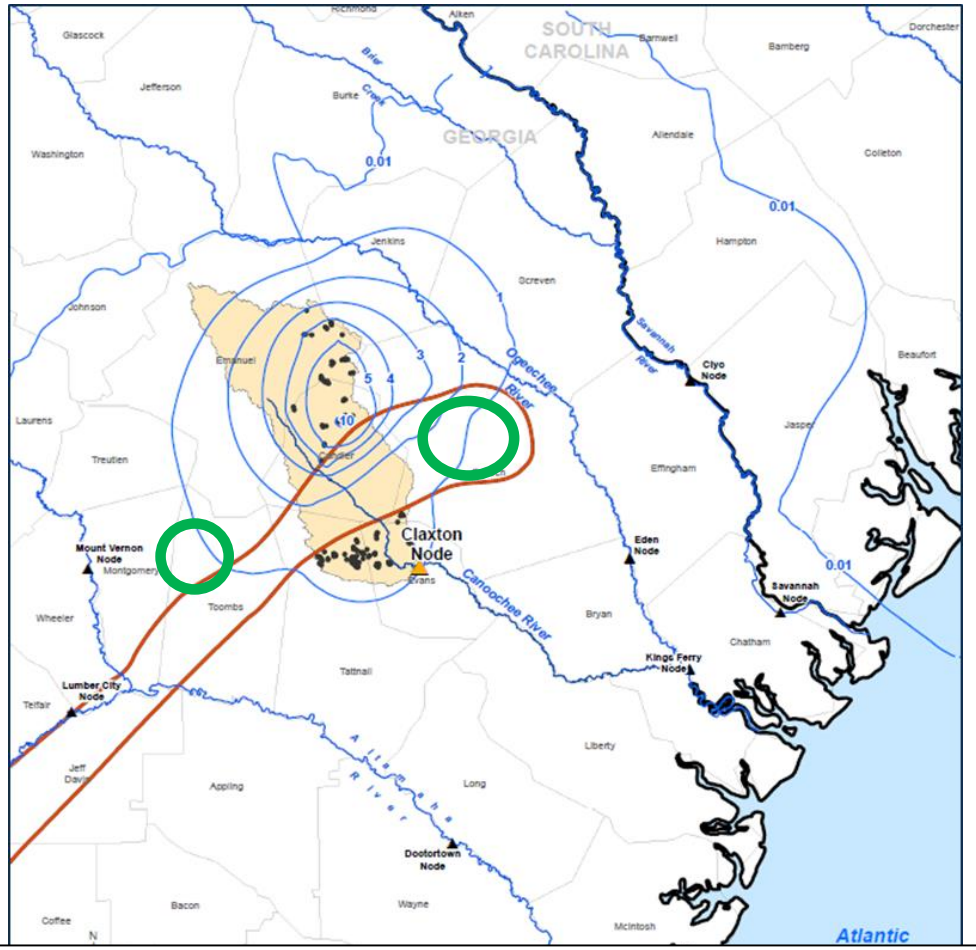
Simulated Drawdown in Floridan Aquifer Heads – Pumping 3.65 MGD

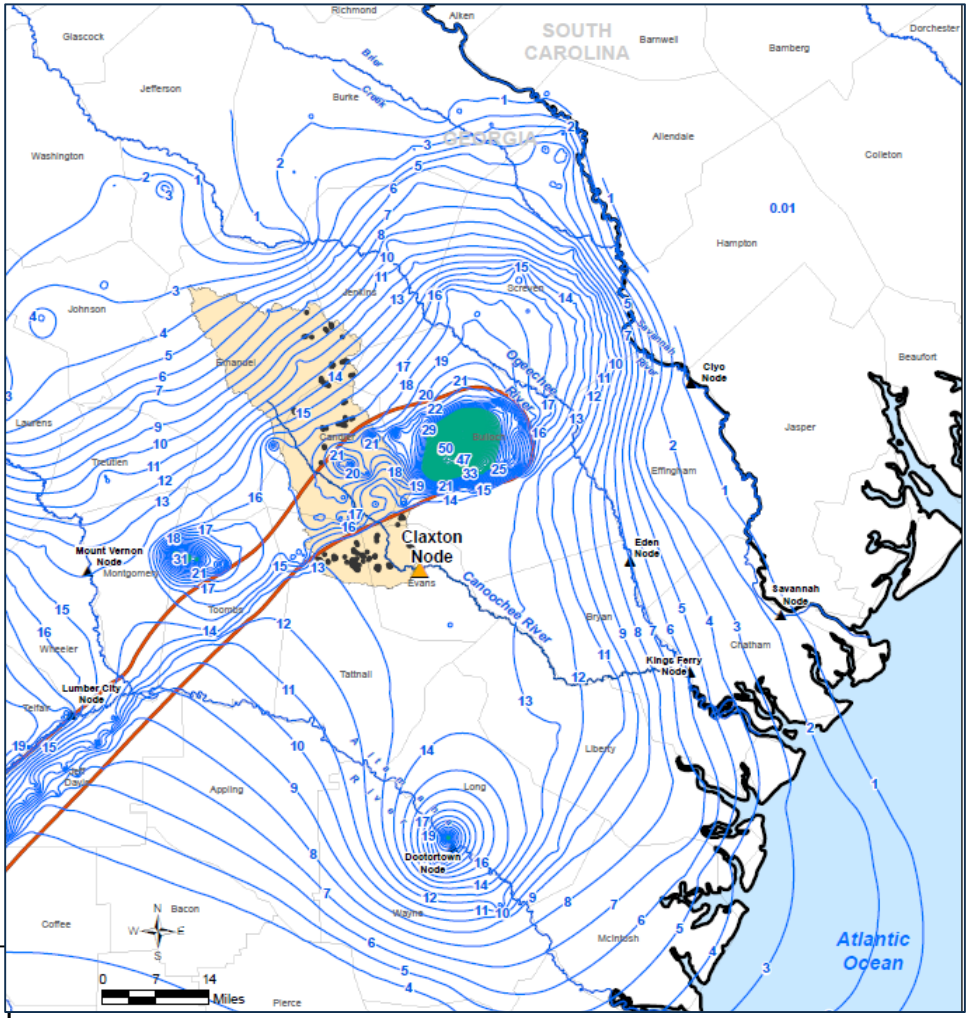


Excluding Pumping from the Gulf Trough Area

Maximum drawdown does not exceed sustainable yield criterion (30 feet), based on 2010 baseline condition

Simulated Drawdown in Floridan Aquifer Heads – Pumping 3.65 MGD



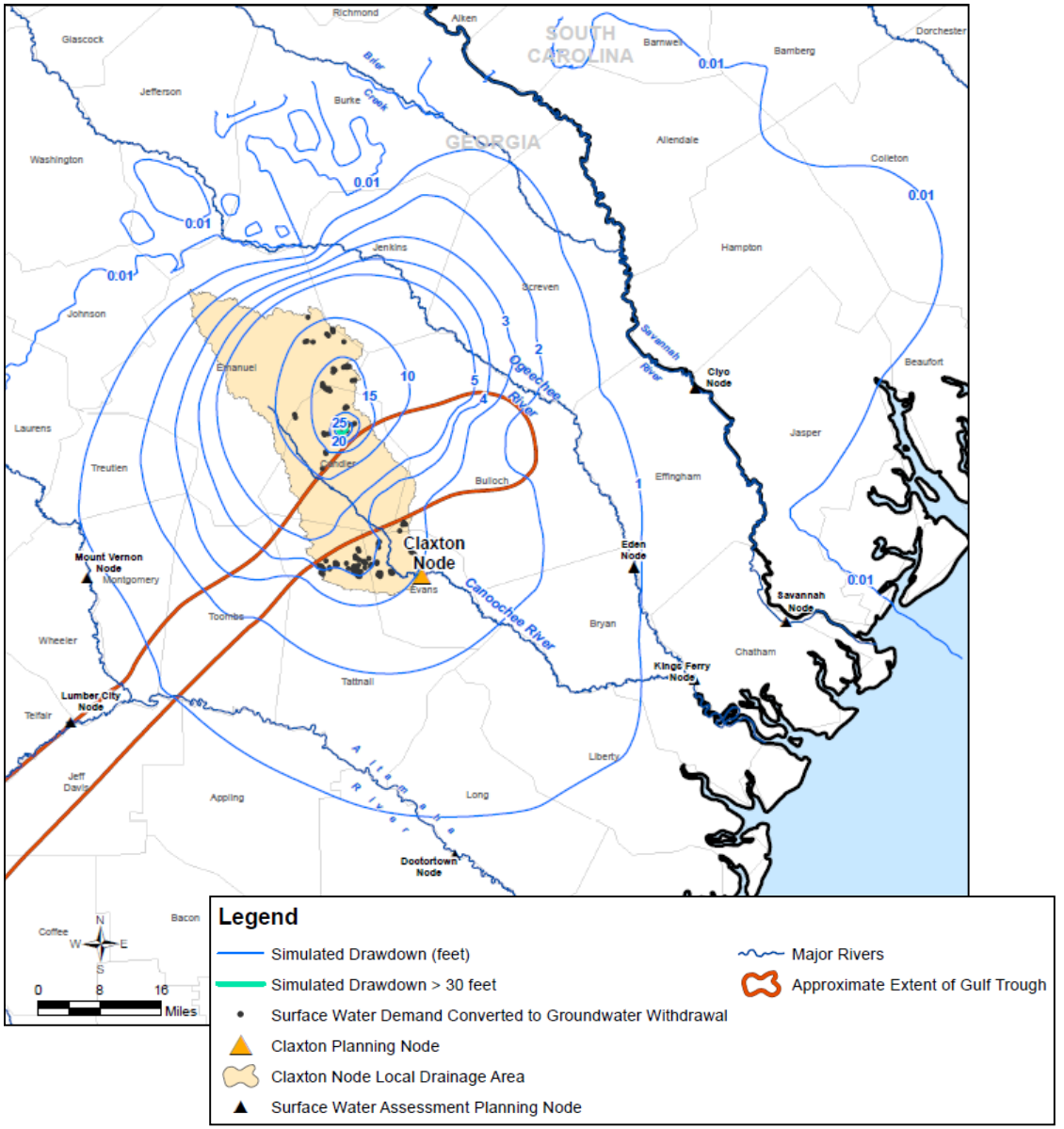


Legend

- Simulated Drawdown (feet)
- Surface Water Demand Converted to Groundwater Withdrawal
- Claxton Planning Node
- Claxton Node Local Drainage Area
- Surface Water Assessment Planning Node
- Major Rivers
- Approximate Extent of Gulf Trough

Potential minor incremental drawdown increase, when added to sustainable yield simulated drawdown

Simulated Drawdown in Floridan Aquifer Heads – Pumping 10.51 MGD

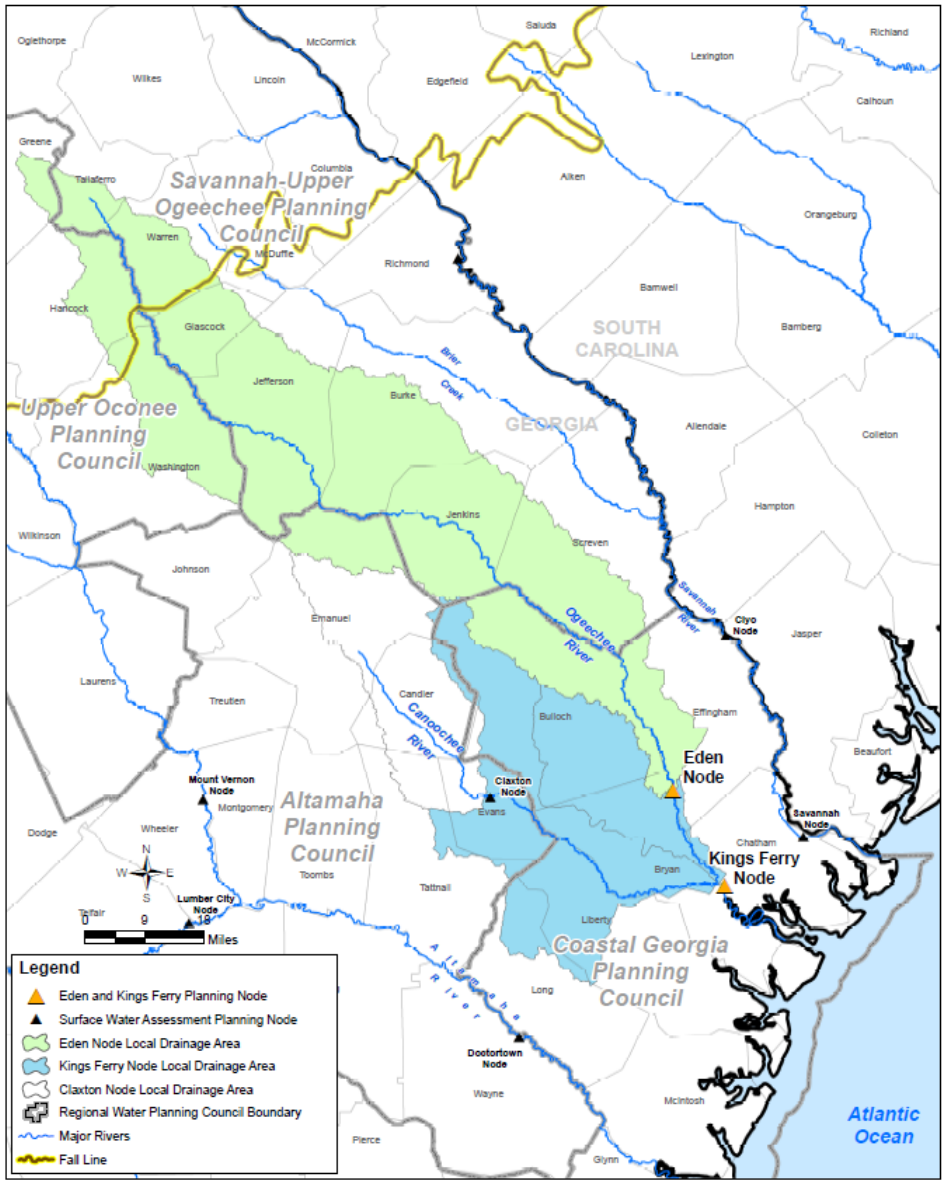


Excluding Pumping from the Gulf Trough Area

Maximum drawdown at sustainable yield criterion (30 feet) based on 2010 baseline condition

Maximum drawdown will exceed criterion when added to simulated sustainable yield drawdown

Task 2: Eden and Kings Ferry Planning Nodes



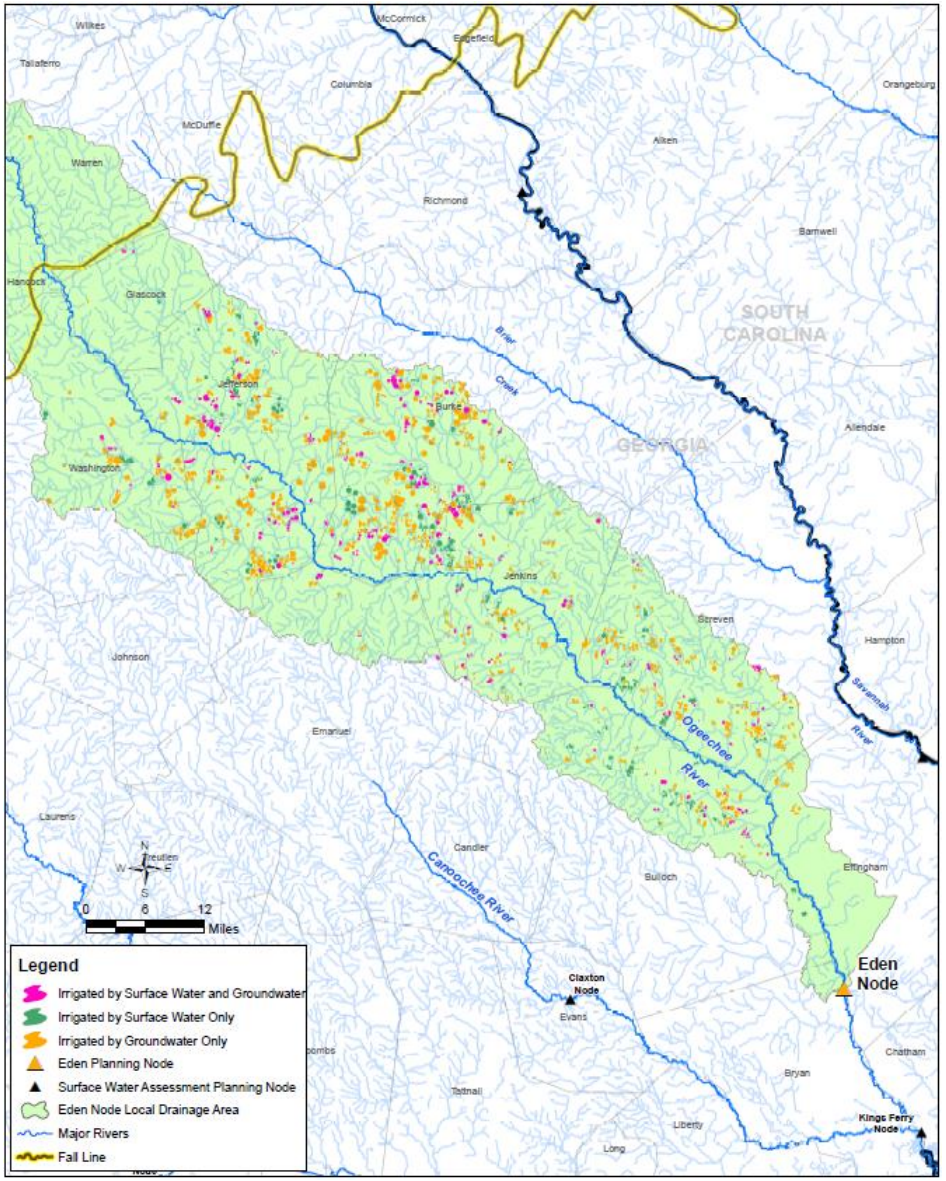
In 2010, the average shortfall at the Eden Node was:

- Under 2010 demands:
  - 19 cfs (12.3 MGD)
- Under 2050 demands:
  - 31 cfs (20 MGD)

In 2010, the average shortfall at the Kings Ferry Node was:

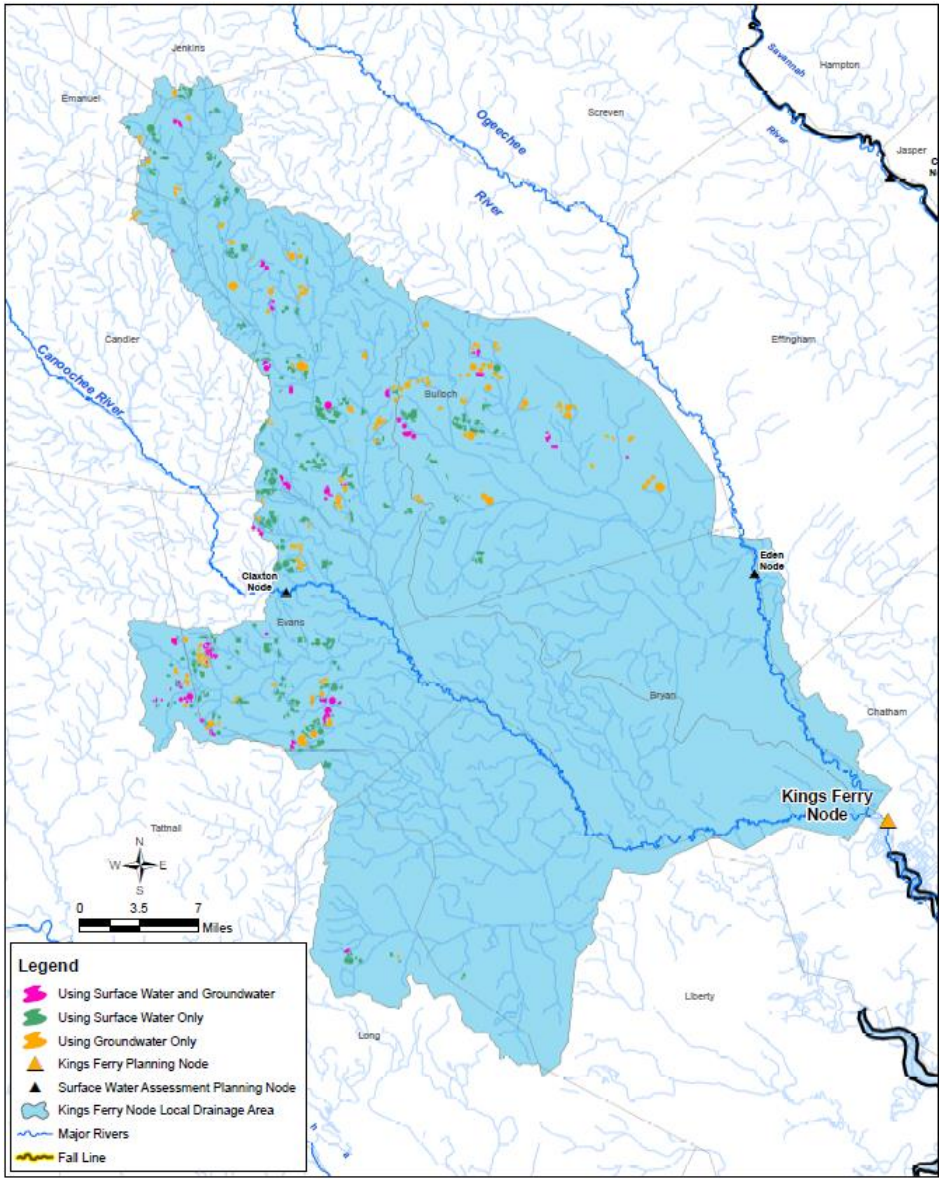
- Under 2010 demands:
  - 35 cfs (22.6 MGD)
- Under 2050 demands:
  - 47 cfs (30.4 MGD)

Irrigated Areas Upstream of Eden Node



- No permitted Municipal or Industrial surface water withdrawals in the watershed
- Focus on agricultural (surface water only) withdrawals

Irrigated Areas Upstream of Kings Ferry Node

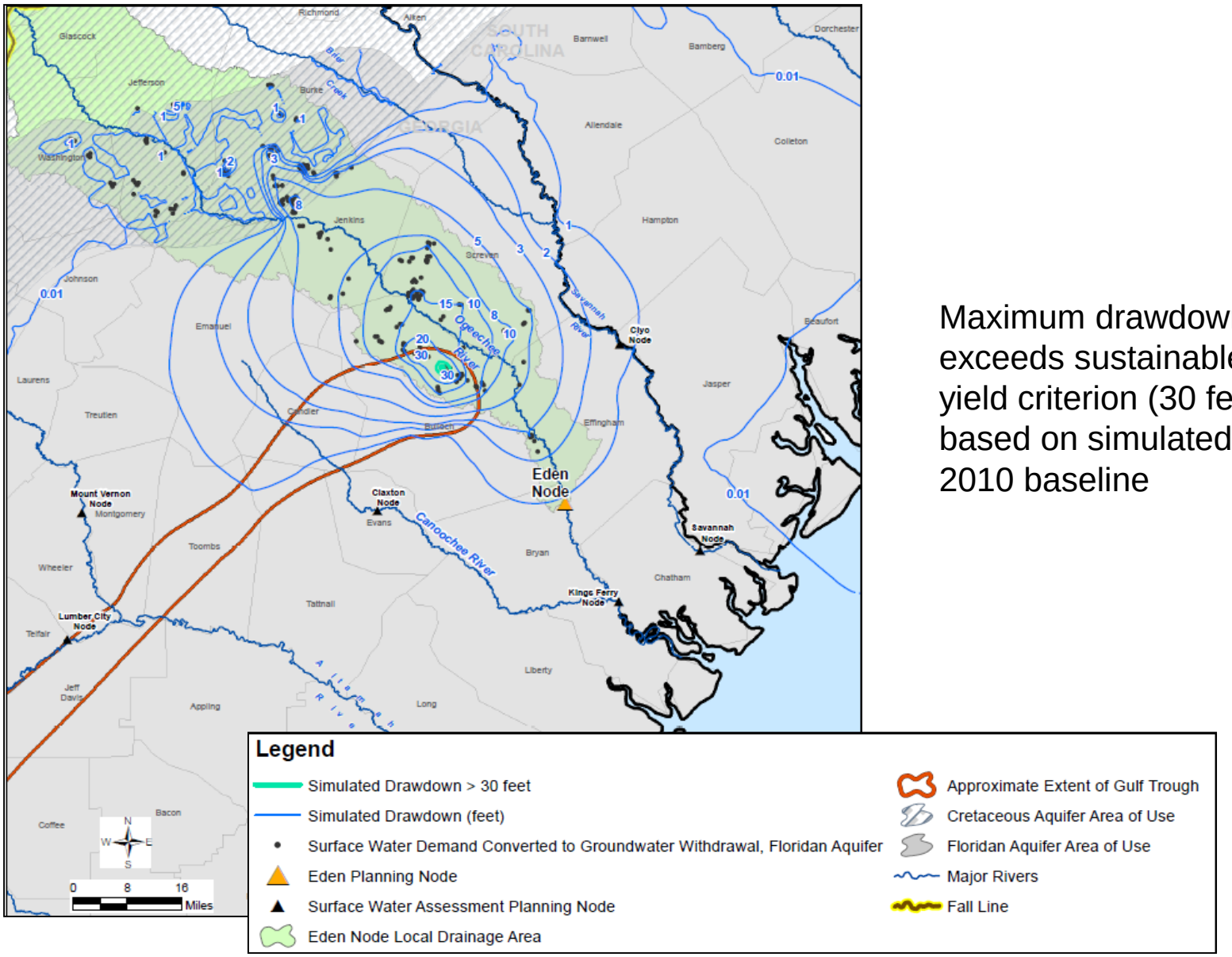


- No permitted Municipal or Industrial surface water withdrawals in the watershed
- Focus on agricultural (surface water only) withdrawals

Calculated Irrigation Demand of Surface Water Only Parcels – Eden Node LDA

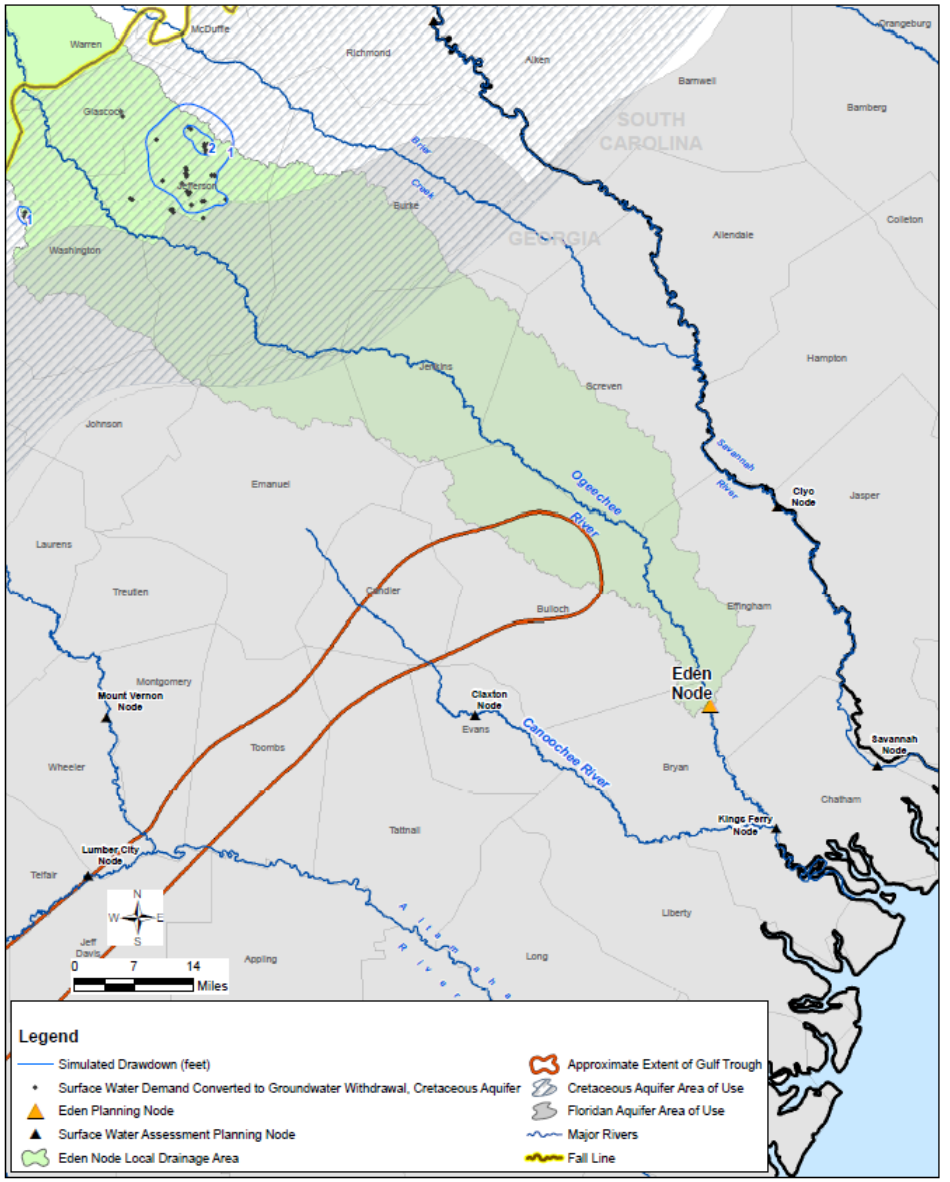
	Number of Parcels	Total Irrigated Area	Mean Irrigation Depth		Total Irrigation Demand	
			(May - August)	(September - April)	(May - August)	(September - April)
Units	-	(acres)	(inches/month)	(inches/month)	(MGD)	(MGD)
Surface Water Only Parcels that will be Replaced by Groundwater from the Floridan Aquifer	242	12,030	1.39	0.35	14.71	3.76
Surface Water Only Parcels that will be Replaced by Groundwater from the Cretaceous Aquifer	35	1,740	1.39	0.35	2.13	0.54
Total	**277**	**13,770**	**1.39**	**0.35**	**16.84**	**4.30**

Simulated Drawdown in Floridan Aquifer Heads – Pumping 14.7 MGD



Maximum drawdown exceeds sustainable yield criterion (30 feet), based on simulated 2010 baseline

Simulated Drawdown in Cretaceous Aquifer Heads – Pumping 2.1 MGD

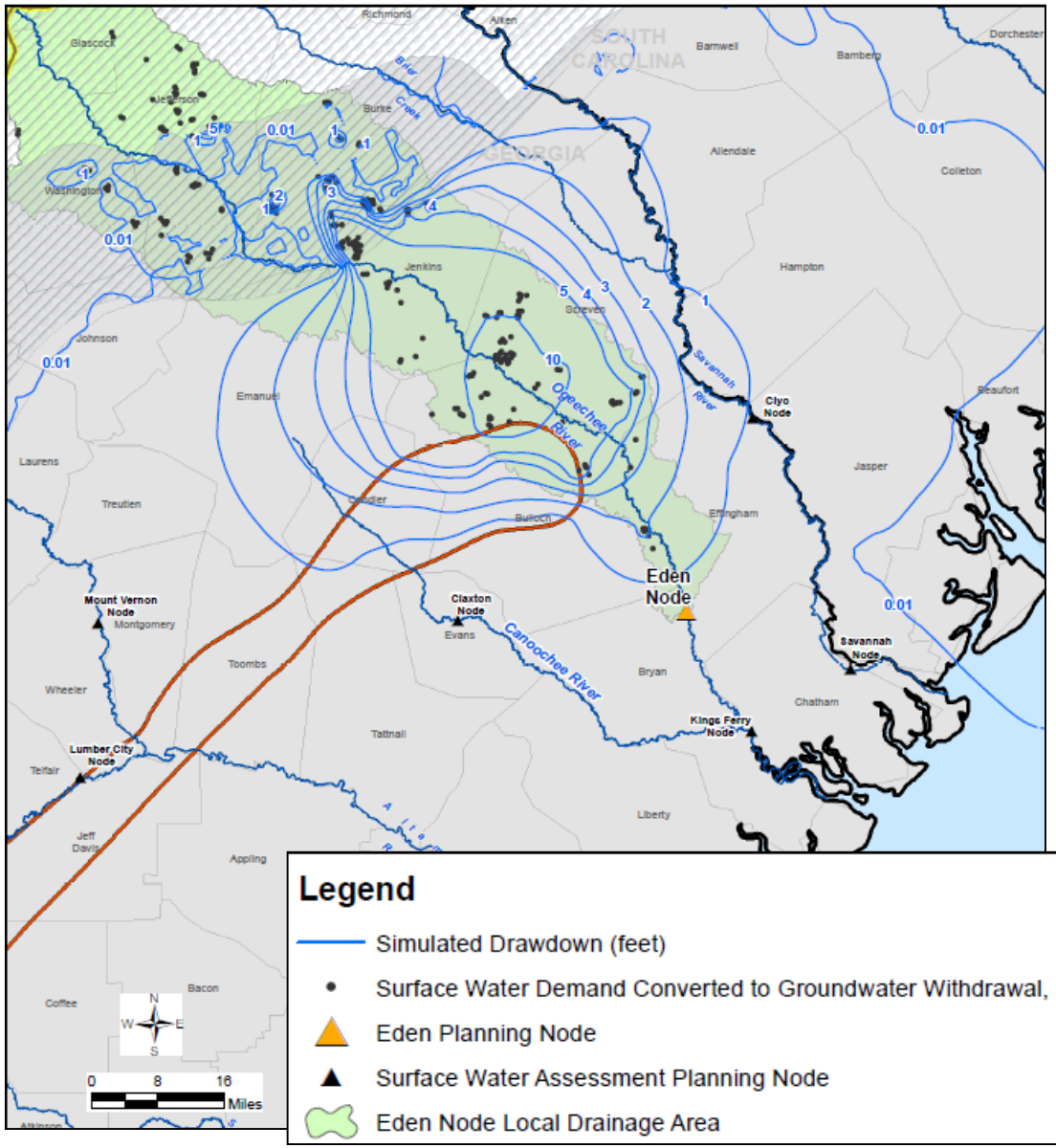


Calculated Irrigation Demand of Surface Water Only Parcels – Eden Node LDA

Excluding Pumping from the Gulf Trough Area

	Number of Parcels	Total Irrigated Area	Mean Irrigation Depth		Total Additional Groundwater Demand	
			(May - August)	(September - April)	(May - August)	(September - April)
Units	-	(acres)	(inches/month)	(inches/month)	(MGD)	(MGD)
Surface Water Only Parcels that will be Replaced by Groundwater from Floridan Aquifer	207	10,910	1.39	0.35	13.34	3.41
Surface Water Only Parcels that will be Replaced by Groundwater from Cretaceous Aquifer	35	1,740	1.39	0.35	2.13	0.54
Total	**242**	**12,650**	**1.39**	**0.35**	**15.47**	**3.95**

Simulated Drawdown in Floridan Aquifer Heads – Pumping 13.3 MGD

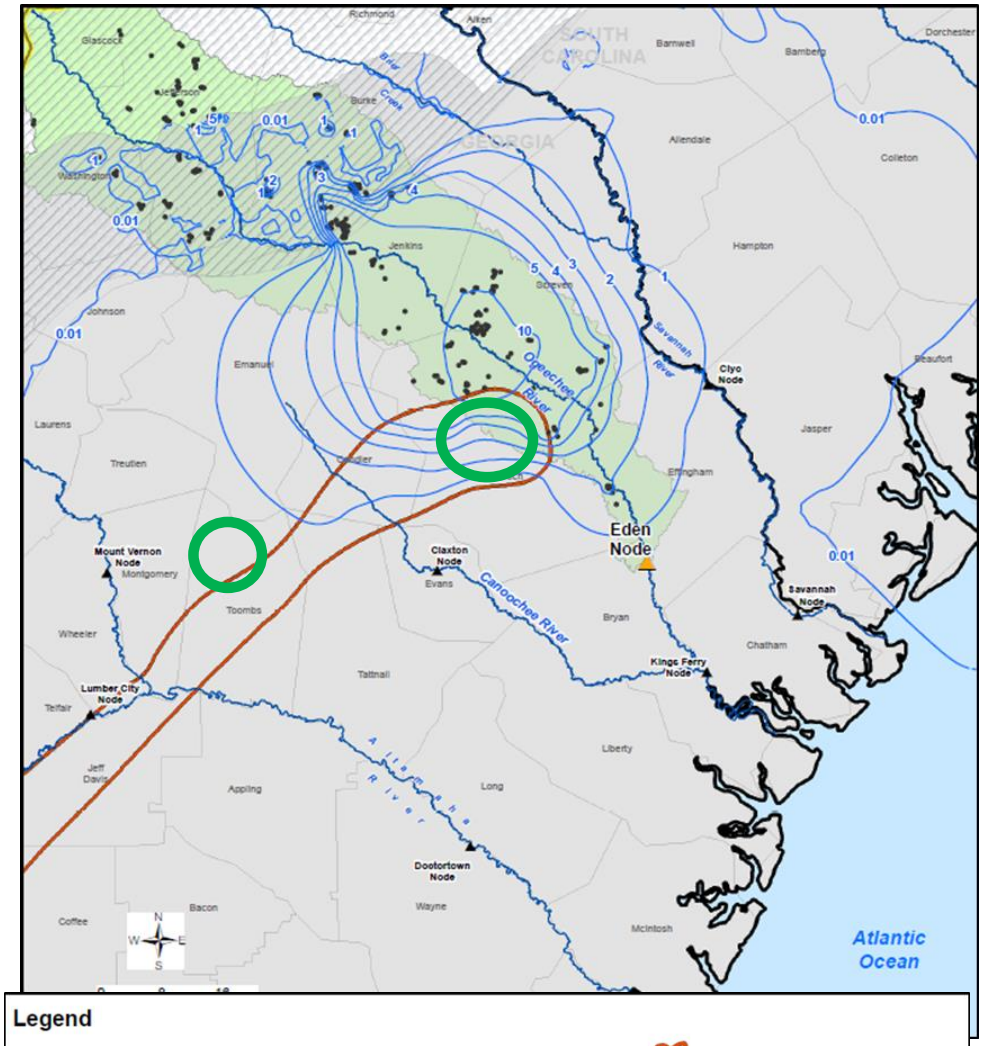


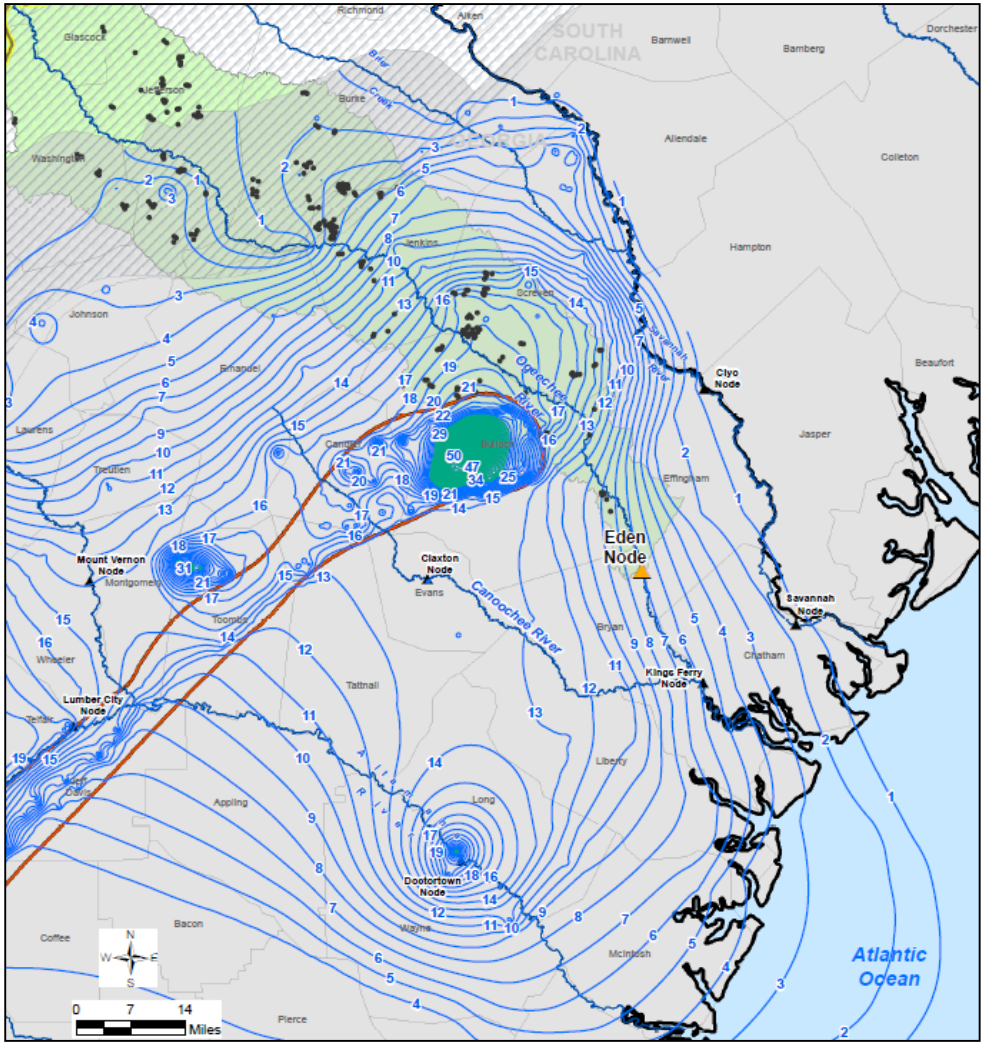
Legend

- Simulated Drawdown (feet)
- Surface Water Demand Converted to Groundwater Withdrawal, Floridan Aquifer
- Eden Planning Node
- Surface Water Assessment Planning Node
- Eden Node Local Drainage Area
- Approximate Extent of Gulf Trough
- Cretaceous Aquifer Area of Use
- Floridan Aquifer Area of Use
- Major Rivers
- Fall Line

Maximum drawdown does not exceed sustainable yield criterion (30 feet), based on 2010 baseline condition

Simulated Drawdown in Floridan Aquifer Heads – Pumping 13.3 MGD



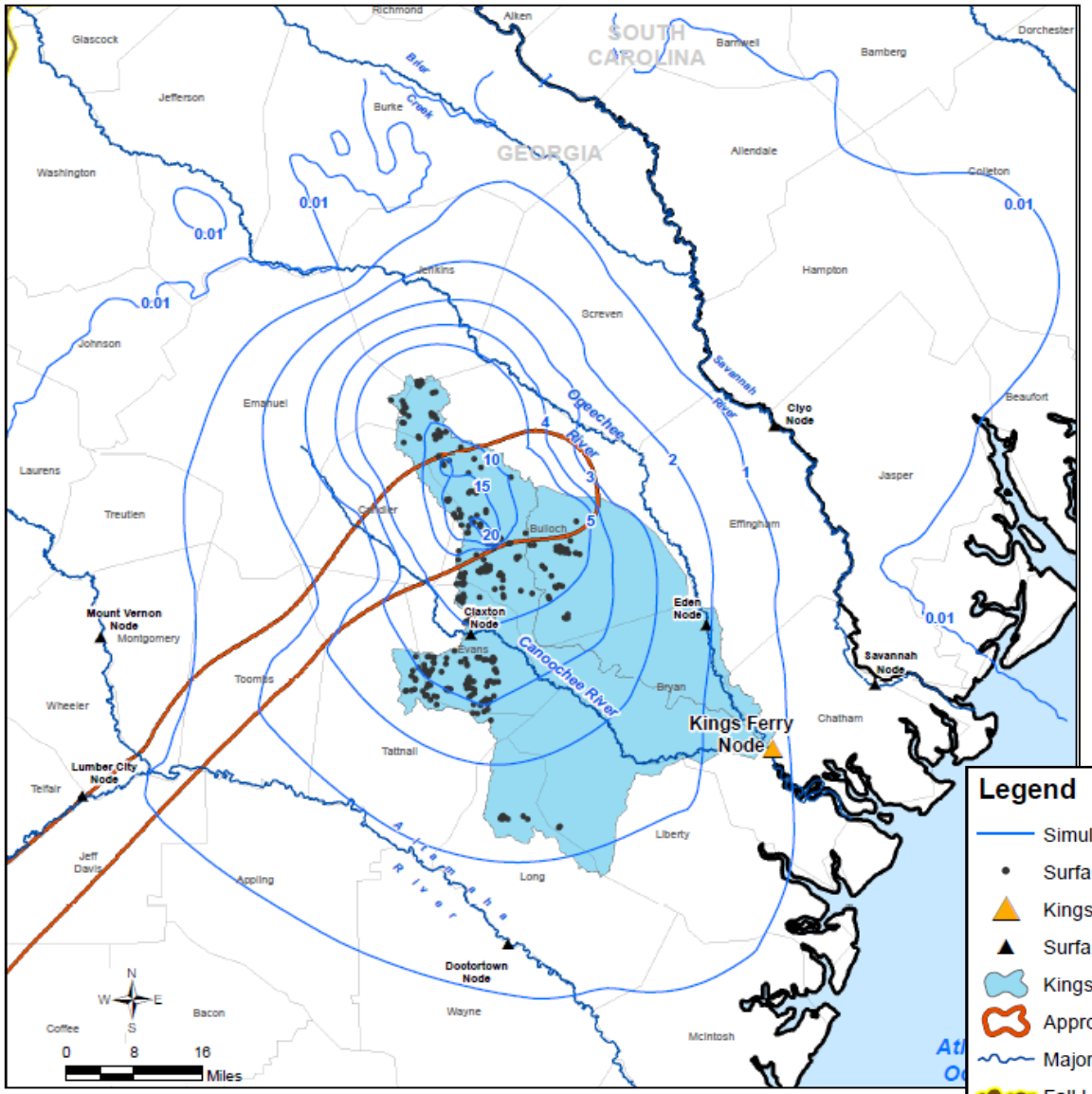


Potential 1 to 10 ft incremental drawdown increase, when added to sustainable yield simulated drawdown

Calculated Irrigation Demand of Surface Water Only Parcels – Kings Ferry Node LDA

	Number of Parcels	Total Irrigated Area	Mean Irrigation Depth		Total Irrigation Demand	
			(May - August)	(September - April)	(May - August)	(September - April)
Units	-	(acres)	(inches/month)	(inches/month)	(MGD)	(MGD)
Surface Water Only Parcels that will be Replaced by Groundwater from Floridan Aquifer	274	9,790	1.39	0.35	11.97	3.06

Simulated Drawdown in Floridan Aquifer Heads – Pumping 12.0 MGD

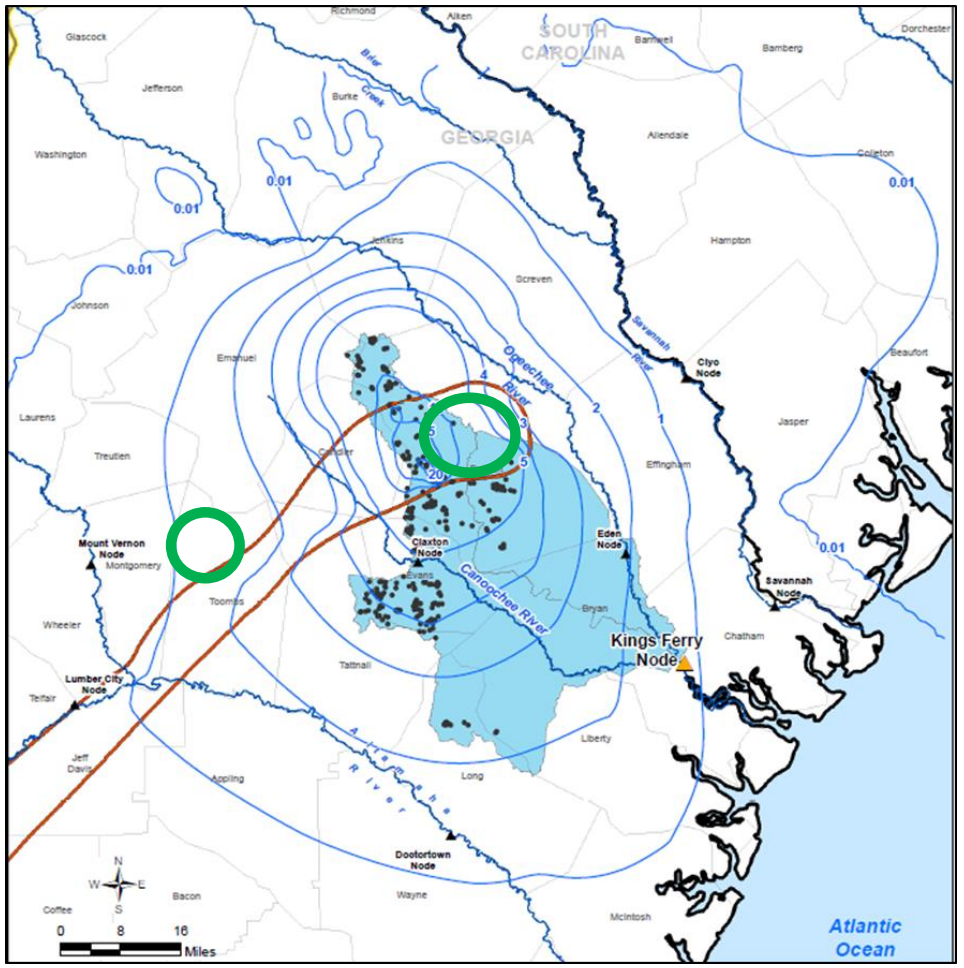


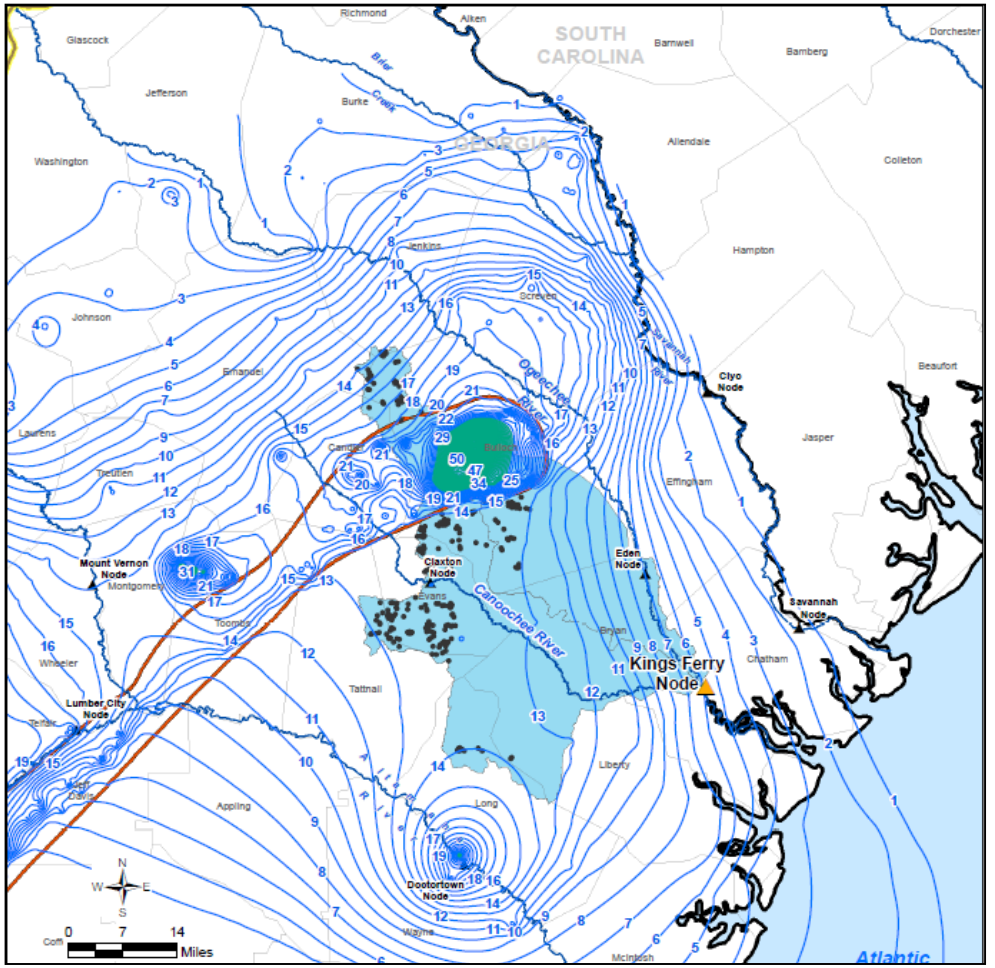
Maximum drawdown does not exceed sustainable yield criterion (30 feet), based on 2010 baseline condition

Legend

- Simulated Drawdown (feet)
- Surface Water Demand Converted to Groundwater Withdrawal, Floridan Aquifer
- Kings Ferry Planning Node
- Surface Water Assessment Planning Node
- Kings Ferry Node Local Drainage Area
- Approximate Extent of Gulf Trough
- Major Rivers
- Fall Line

Simulated Drawdown in Floridan Aquifer Heads – Pumping 12.0 MGD





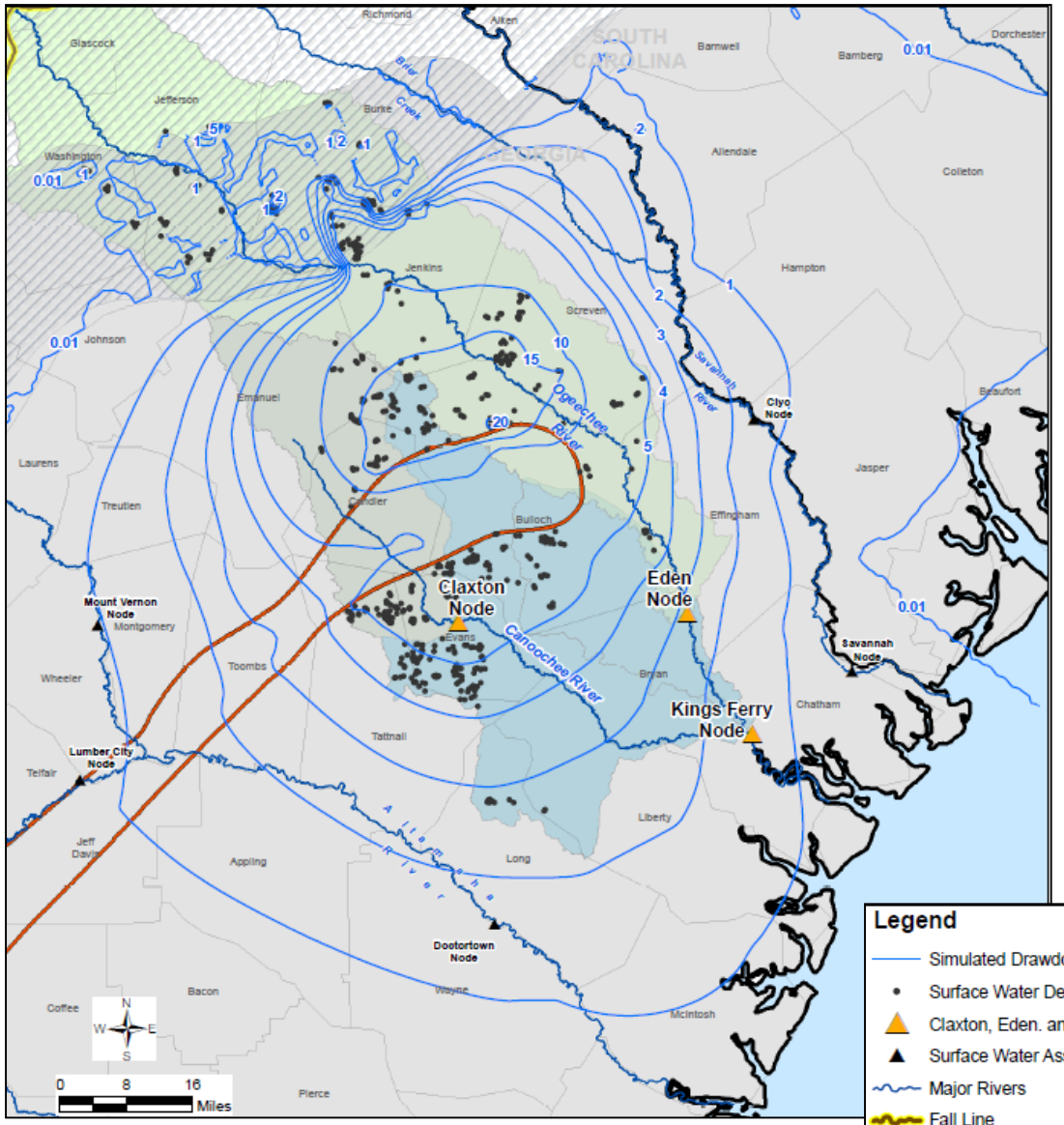
Potential 5 to 10 ft incremental drawdown increase, when added to sustainable yield simulated drawdown

Calculated Irrigation Demand of Surface Water Only Parcels

Claxton, Eden, and Kings Ferry LDAs and Excluding Pumping from the Gulf Trough Area

	LDA	Number of Parcels	Total Irrigated Area	Mean Irrigation Depth (May - August)	Total Additional Groundwater Demand (May - August)
Units	-	-	(acres)	(inches/month)	(MGD)
Surface Water Only Parcels that will be Replaced by Groundwater from Floridan Aquifer	**Eden**	207	10,910	1.39	13.34
	Claxton	121	2,980	1.39	3.65
	Kings Ferry	226	7,960	1.39	9.73
Surface Water Only Parcels that will be Replaced by Groundwater from Cretaceous Aquifer	**Eden**	35	1,740	1.39	2.13
Total	-	**589**	**23,590**	**1.39**	**28.85**

Simulated Drawdown in Floridan Aquifer Heads – Pumping 26.7 MGD



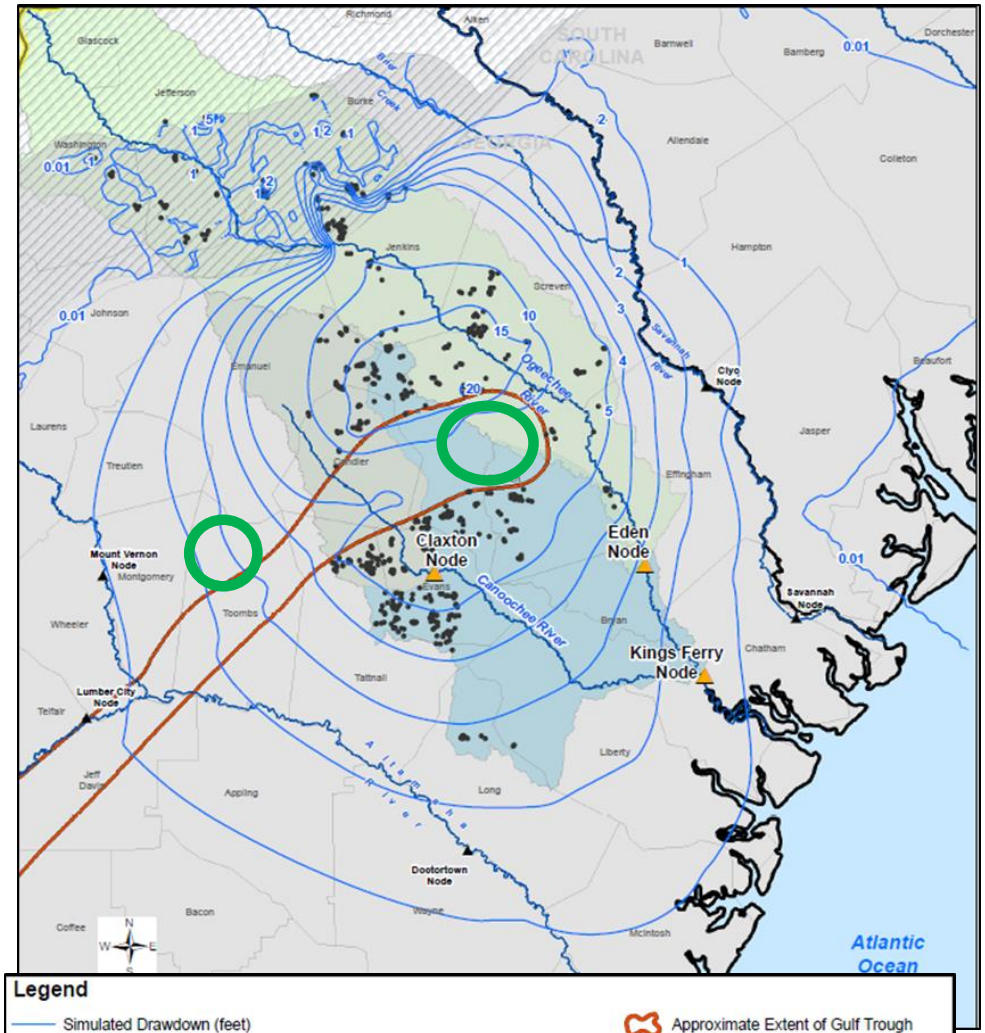
Claxton, Eden, and Kings Ferry Node LDAs – No Withdrawals in Gulf Trough Area

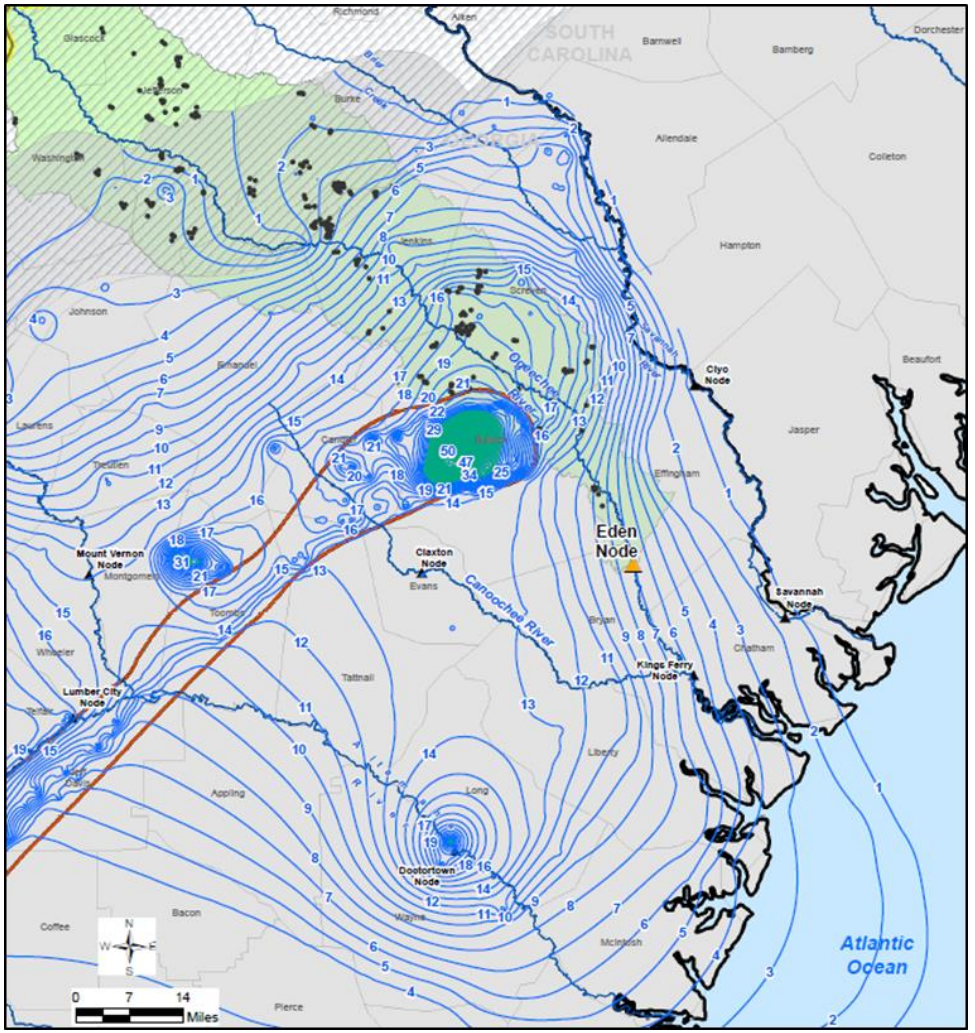
Maximum drawdown does not exceed sustainable yield criterion (30 feet), based on 2010 baseline condition

Legend

- Simulated Drawdown (feet)
- Surface Water Demand Converted to Groundwater Withdrawal, Floridan Aquifer
- Claxton, Eden. and Kings Ferry Planning Nodes
- Surface Water Assessment Planning Node
- Major Rivers
- Fall Line
- Approximate Extent of Gulf Trough
- Cretaceous Aquifer Area of Use
- Floridan Aquifer Area of Use
- Claxton Node Local Drainage Area
- Eden Node Local Drainage Area
- Kings Ferry Node Local Drainage Area

Simulated Drawdown in Floridan Aquifer Heads – Pumping 26.7 MGD





Legend

- Simulated Drawdown (feet)
- Surface Water Demand Converted to Groundwater Withdrawal, Floridan Aquifer
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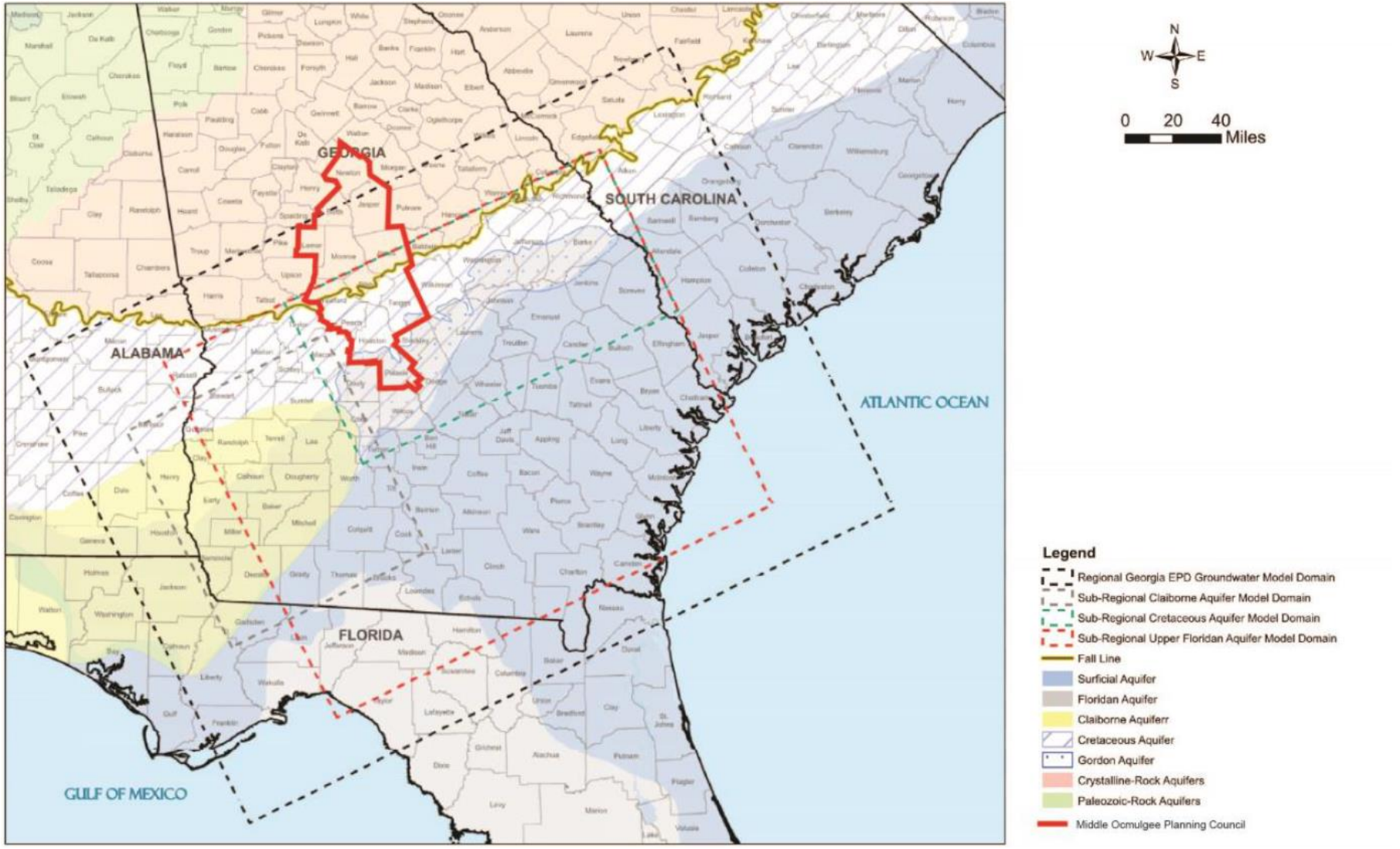
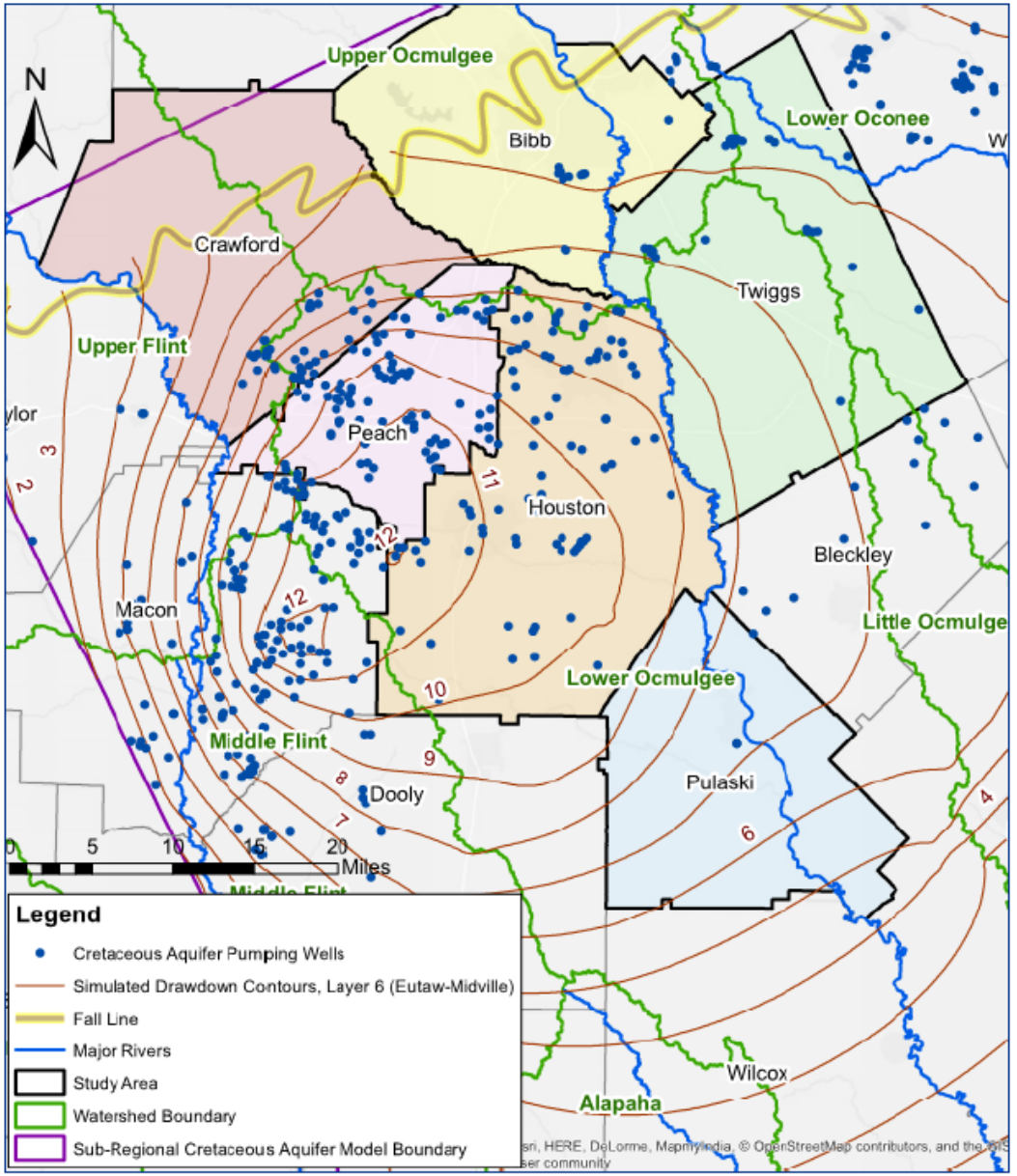
Potential 2 to 10 ft incremental drawdown increase, when added to sustainable yield simulated drawdown

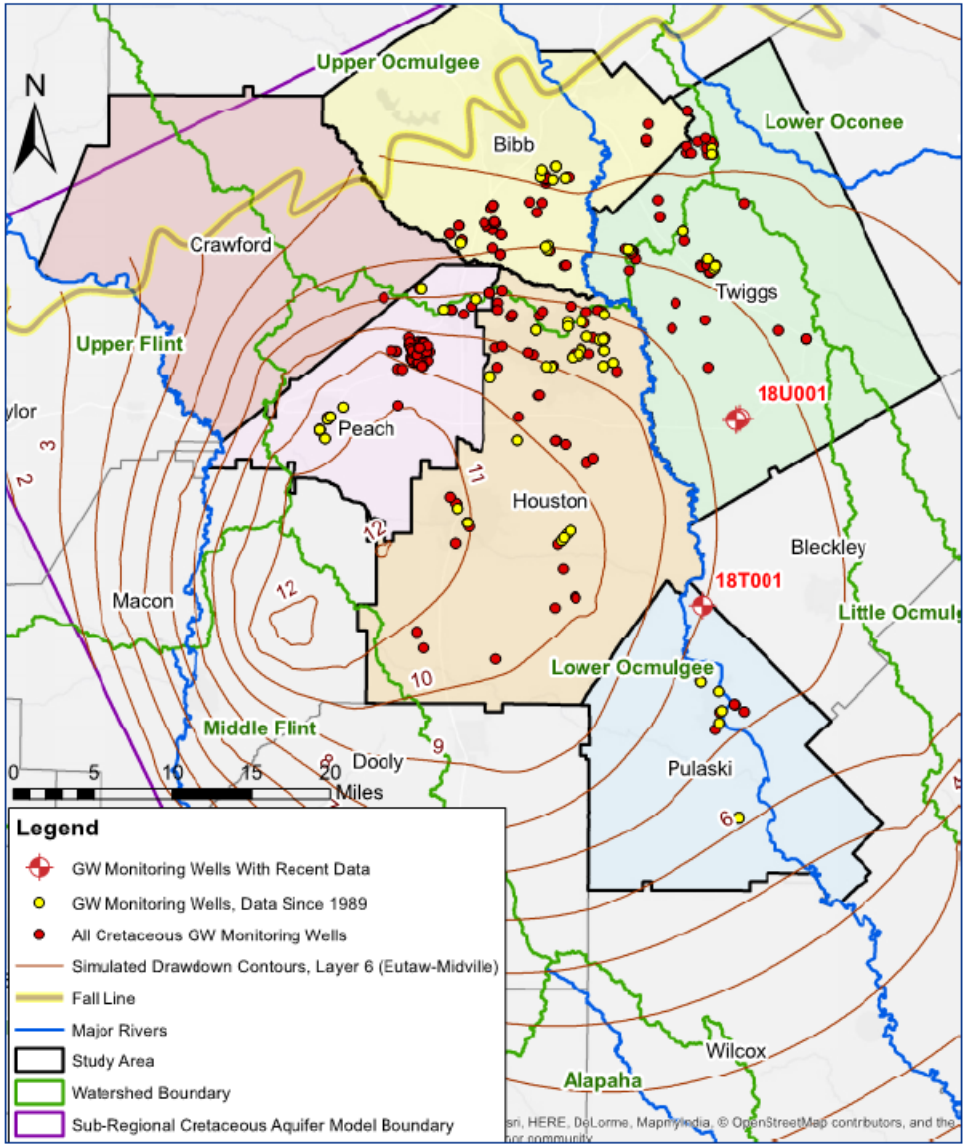
Middle Ocmulgee Water Planning Region in the Existing Cretaceous Aquifer Model



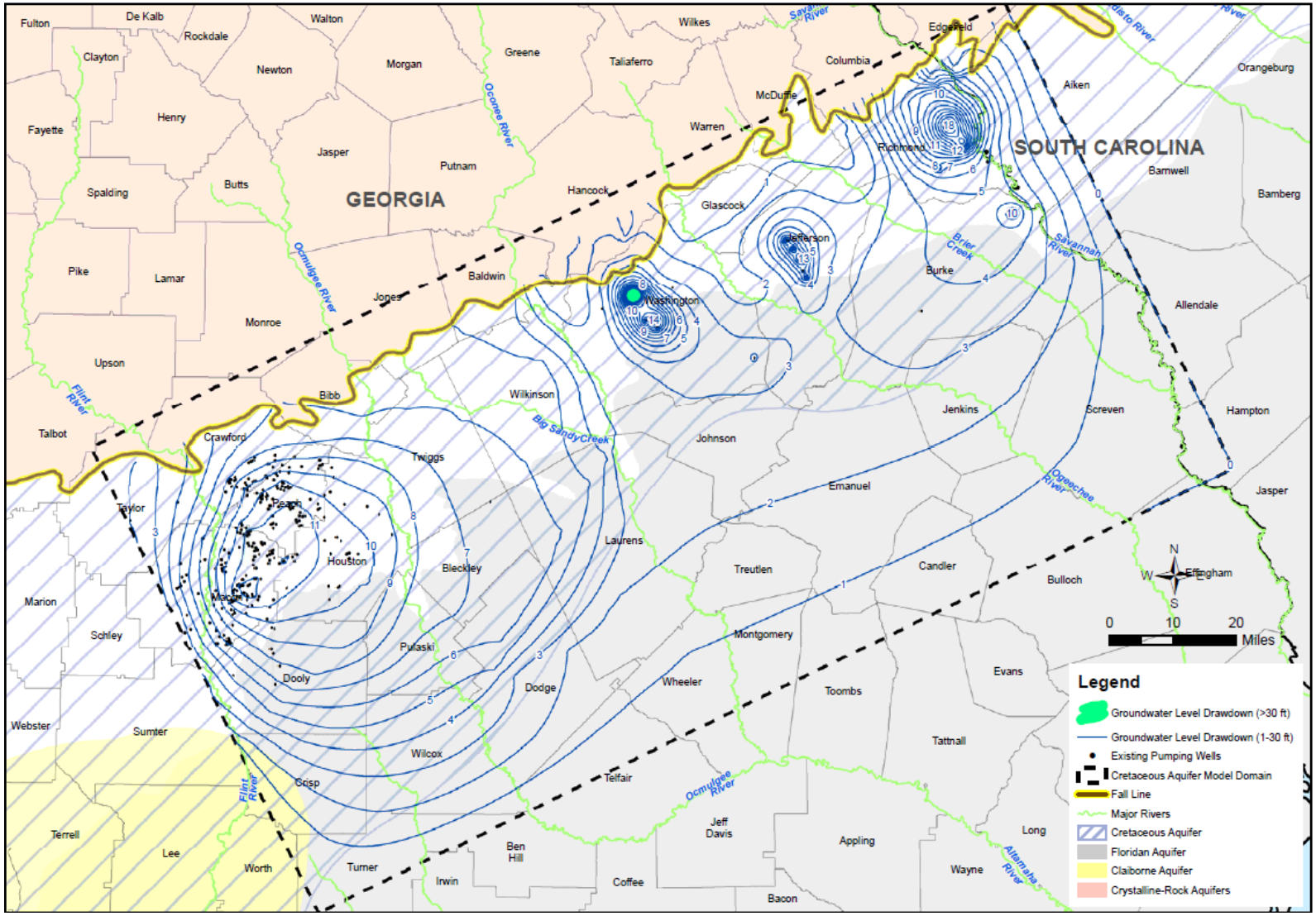
Cretaceous Aquifer Groundwater Pumping Well Locations



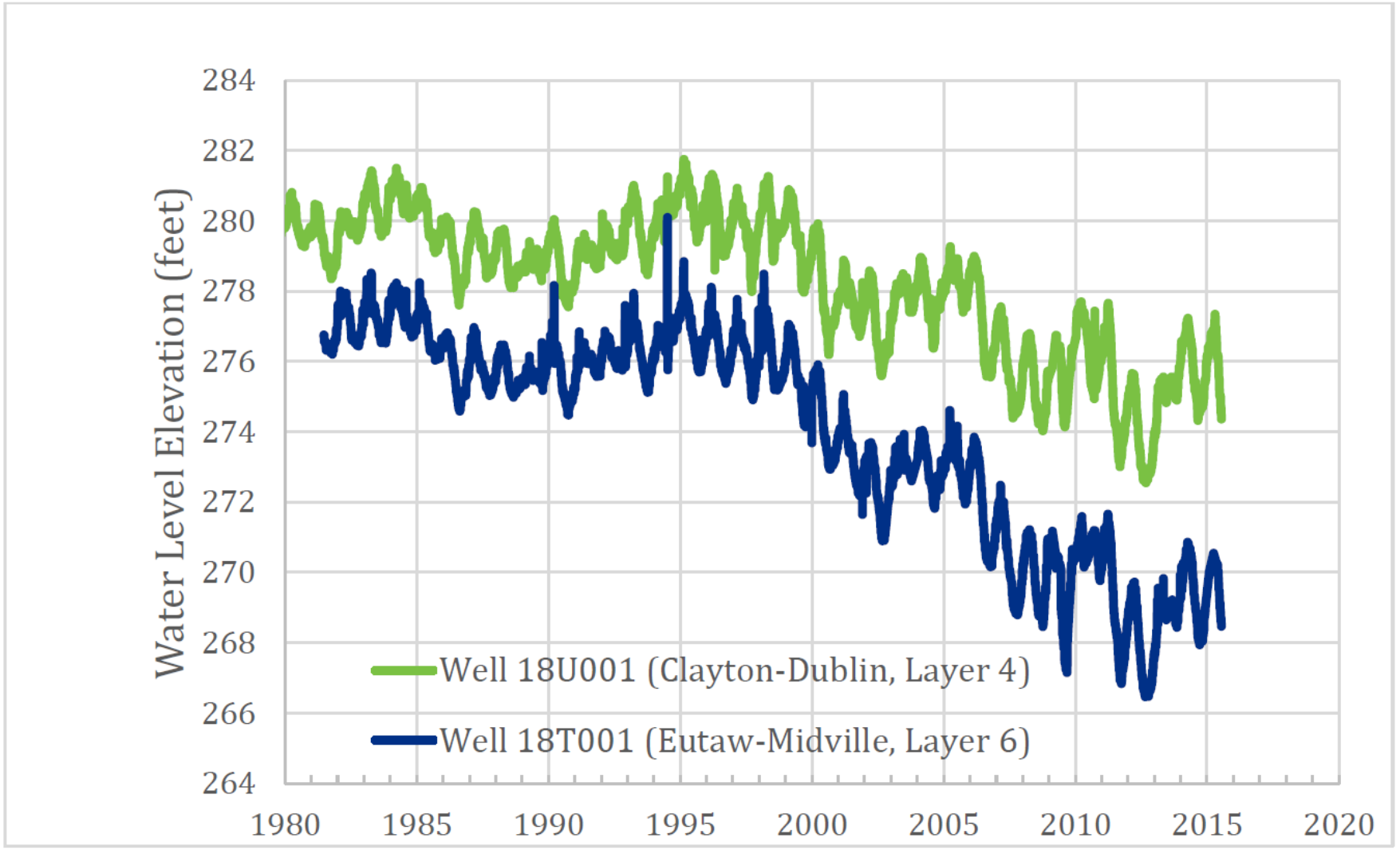
Groundwater Monitoring Well Locations



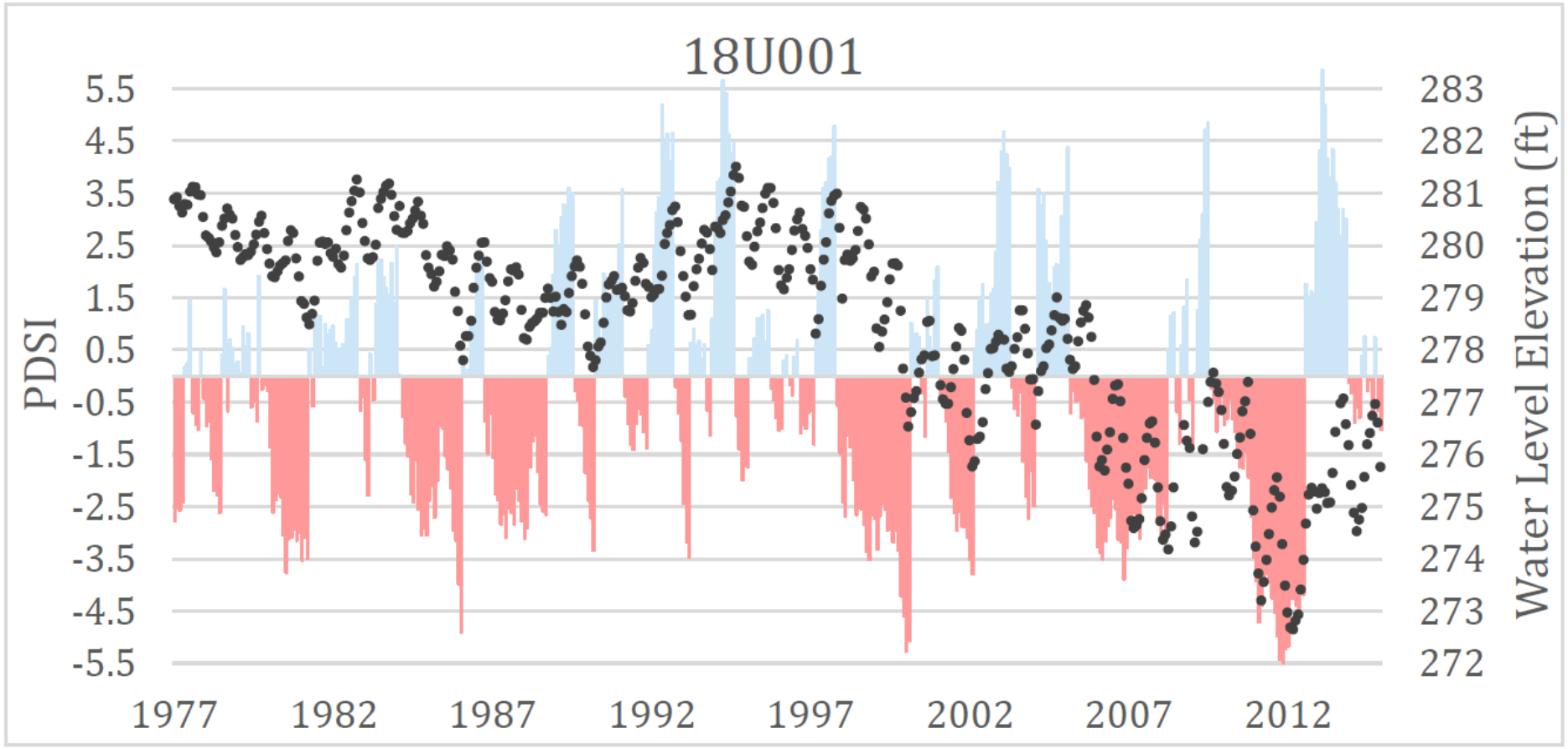
State Water Plan Model of the Cretaceous Aquifer – Layer 6



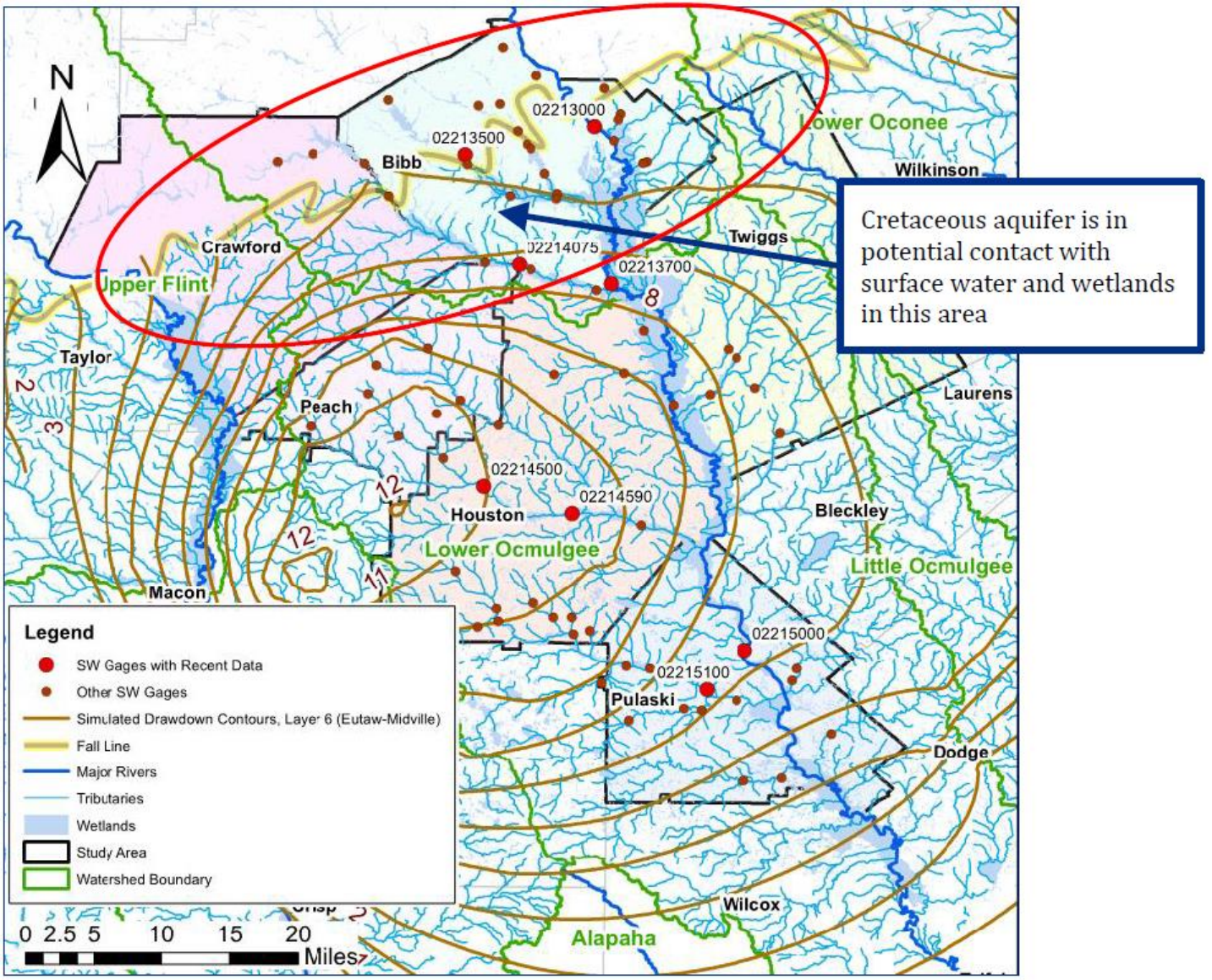
USGS Monitoring Wells



Water Level Relationship to Palmer Drought Severity Index



Surface Water Monitoring Locations



Task 3 Recommendations

- Identified potential areas that may be more sensitive to increased groundwater withdrawals (based on currently available data)
- Recommendations regarding availability and suitability of existing monitoring locations (SW and GW) and other sources of data that may be useful for monitoring groundwater conditions in the Cretaceous aquifer
- Recommendations for long-term monitoring in the study area