ES.1 Introduction

In February 2008, the Georgia General Assembly adopted the Georgia Comprehensive State-wide Water Plan. This Plan established a Regional Planning Process and 11 planning regions throughout the state. The purpose of the Plan is to help "guide Georgia in managing water resources in a sustainable manner to support the state's economy, to protect public health and natural systems, and enhance the quality of life for all citizens."

A foundational element of this planning process is the assessment of current water use and forecasted needs. Evaluating and forecasting water demands for power generation is a critical element to consider in planning for future water needs. This executive summary and the corresponding technical memorandum present the methodology and results of the Georgia statewide energy sector water demand forecast. The purpose of this study was to evaluate energy sector water withdrawal and water consumption needs to meet the anticipated power needs of Georgia's citizens through 2050.

For the purposes of this analysis, forecasted water demands are associated with future energy sector utilities' (NAICS 22) power generation[1]. Power generation water demands associated with facilities with other industry codes are captured as part of the municipal and industrial water demand forecasts already completed on a regional basis. The forecast is designed to support statewide water resources planning and is not intended to support future energy planning needs.

The ability to transmit power from the location of generation to the location of demand presents some unique challenges in developing the water forecast. Consequently, this forecast does not focus specifically on regional demands, but rather is meant to forecast energy sector water demands at the state level. It was possible to identify statewide demands at a regional level through the forecast year 2020 based on a set of assumptions applicable to all power generating facilities in the state and according to the location of known and planned power generating facilities confirmed by the Georgia Environmental Protection Division (EPD) and an energy sector ad hoc group. As described in more detail below, statewide forecasted demands beyond 2020 have not been distributed regionally as this effort would be speculative.

An energy sector ad hoc group provided guidance related to assumptions used in this forecast. The energy sector ad hoc group is composed of representatives from three major electric utilities in the state: Georgia Power, Oglethorpe Power Corporation, and MEAG Power and the Georgia Environmental Finance Authority (GEFA).

ES.2 Background and Current Water Use

The majority of thermoelectric power generation water use occurs as part of a facility's cooling process. It is important to note the distinction between requirements for water

[1] NAICS stands for the North American Industrial Classification System. This system uses numeric codes as the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

withdrawal and water consumption during the power generation process. Cooling water withdrawal requirements are proportional to the quantity of steam being condensed. Water consumption refers to the water that is consumed during the power production process and not returned to the stream, mostly as a result of evaporation during the cooling process. Information related to water withdrawals is an important consideration in planning for the water needed for energy production. However, water consumption is the more important element when assessing future resources because a large volume of water is typically returned to the source following the energy production process.

The majority of thermoelectric power plants employ either once-through or recirculated (closed loop) cooling. Power plants with once-through cooling (also known as single pass cooling) require large amounts of water withdrawals while consuming a relatively small amount of water. The cooling water is run through a condenser in a single pass and discharged back into the source water body at slightly higher temperatures without ever coming into contact with the air. These facilities tend to be located near large reliable water sources and require a steady flow of water for cooling. During 2005, facilities with once-through cooling were responsible for about 88 percent of the thermoelectric sector's water withdrawals.

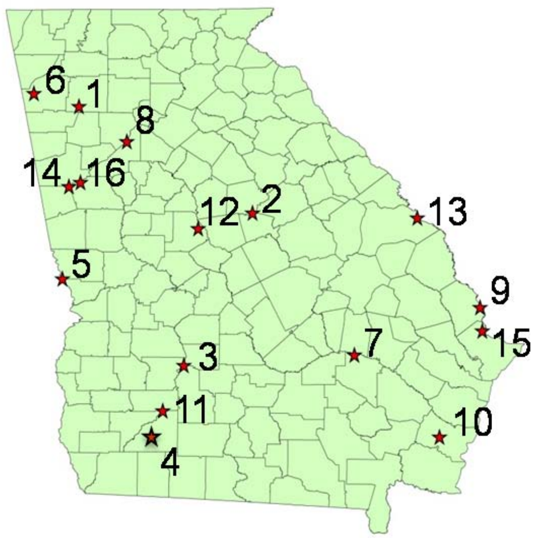
Power plants using recirculated cooling water have much have lower withdrawal rates than once-through facilities because rather than running the cooling water through the condenser in a single pass in a closed system, warmed cooling water is pumped from the steam condenser to a cooling tower or pond. During this process, the warmed cooling water comes into contact with the air, allowing a portion of the water to be evaporated. The cooled water is then recycled back to the condenser. As a result of the recirculation, less water is required for cooling; however, a much greater portion of the cooling water is consumed.

In addition to a facility's cooling type, its method of power generation is a determinant of its water use. The prime mover (e.g., steam turbine, gas combustion turbine, and combined-cycle) is a determining factor because water is only required during processes involving steam turbines. The type of fuel used to produce the power is a factor to a lesser degree. For example, the water requirement of a coal-fired generator powering a steam turbine and using cooling towers is not significantly different than a biomass powered steam turbine using cooling towers. Since water requirements differ based on a facility's cooling type, prime mover, and fuel type, statewide forecasts were developed for each unique power generation combination.

Current (i.e., base year 2005) water use by thermoelectric utility facilities in Georgia is 2,737 million gallons per day withdrawn, with about 187 million gallons per day consumed (7 percent of total water withdrawals). This water use corresponds to 16 facilities possessing water withdrawal permits with EPD. A complete list of these facilities, along with a map showing their location can be found in **Figure ES-1**. Nearly all of the water withdrawals associated with thermoelectric power generation in Georgia is from surface water sources. Groundwater use at thermoelectric power facilities in

Georgia represents about 0.1 percent of all reported utility thermoelectric power generation water withdrawals.

Figure ES-1. Current Electric Utility Facilities with EPD Withdrawal Permits



Facility Name	County
1. Plant Bowen	Bartow
2. Plant Branch	Putnam
3. Crisp County Power Comm-Steam	Worth
4. Gum Power Plant LLC	Mitchell
5. H Allen Franklin[1]	Lee (Alabama)
6. Plant Hammond	Floyd
7. Plant Hatch	Appling
8. Plant Jack McDonough	Cobb
9. Plant McIntosh	Effingham
10. Plant McManus	Glynn
11. Plant Mitchell	Dougherty
12. Plant Scherer	Monroe
13. Vogtle	Burke
14. Plant Wansley	Heard
15. Plant Wentworth (Kraft)	Chatham
16. Plant Yates	Coweta

[1] Plant is physically located in Alabama; water withdrawal permit from Georgia EPD

ES.3 Future Power Generation

Future statewide power generation needs were derived by examining the relationship between statewide population growth and statewide electric utilities (NAICS 22) power generation from 1990 to 2008. The Georgia Office of Planning and Budget (OPB) prepared statewide population projections with assistance from the Applied Demography Program at the University of Georgia's Carl Vinson Institute of Government. These projections, shown in **Figure ES-2**, are the driver of future statewide power generation need estimates.

Two scenarios of statewide power generation needs were produced for the thermoelectric sector water demand forecast: a baseline scenario and an alternative scenario. The first scenario, referred to as the *baseline scenario,* uses a regression analysis based on population growth and power generation. This scenario represents the mean values for future statewide power needs as determined by the regression analysis results. Under the *baseline scenario,* statewide power generation needs increase at a rate of 1.74 percent annually from 2008 to 2050.

A higher power demand (*alternative*) scenario was also developed to examine future statewide energy sector water demands under a situation where power generation needs grow at a slightly faster rate than the power/population growth relationship that was used in the *baseline scenario*. Including this alternative analysis is important because future power needs could be affected by power and population trends outside the State of Georgia and/or may be different than the current assumptions. Under the *alternative* *scenario,* statewide power generation needs increase at a rate of 2.14 percent annually from 2008 to 2050. **Figure ES-3** compares the baseline and alternative statewide power needs forecasts

Figure ES-2 Georgia Office of Planning and Budget Population Projections, 2010 - 2050

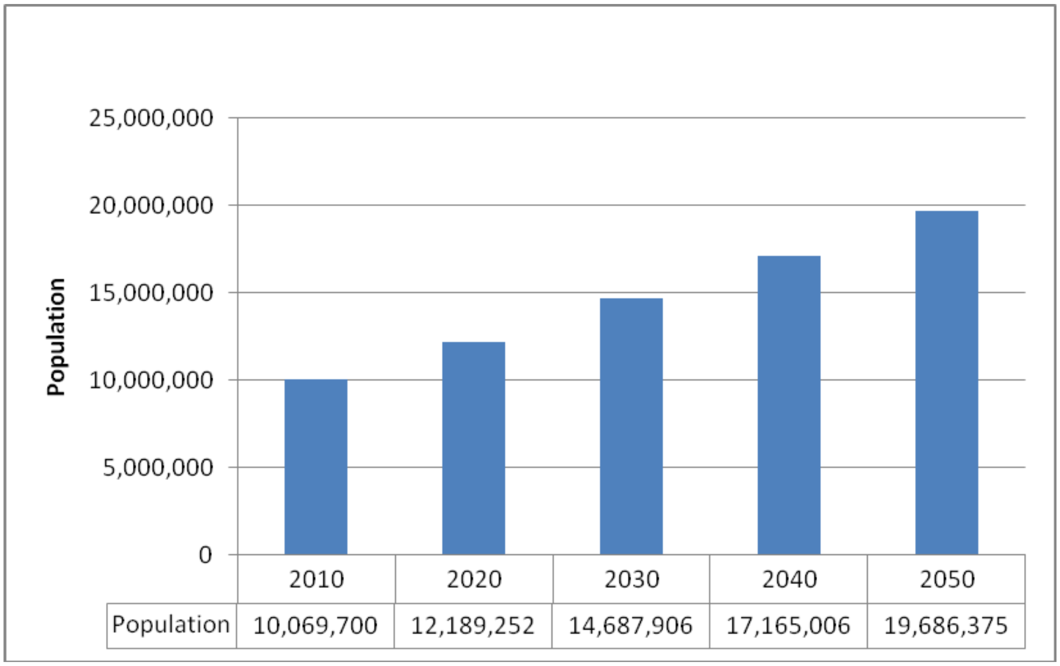
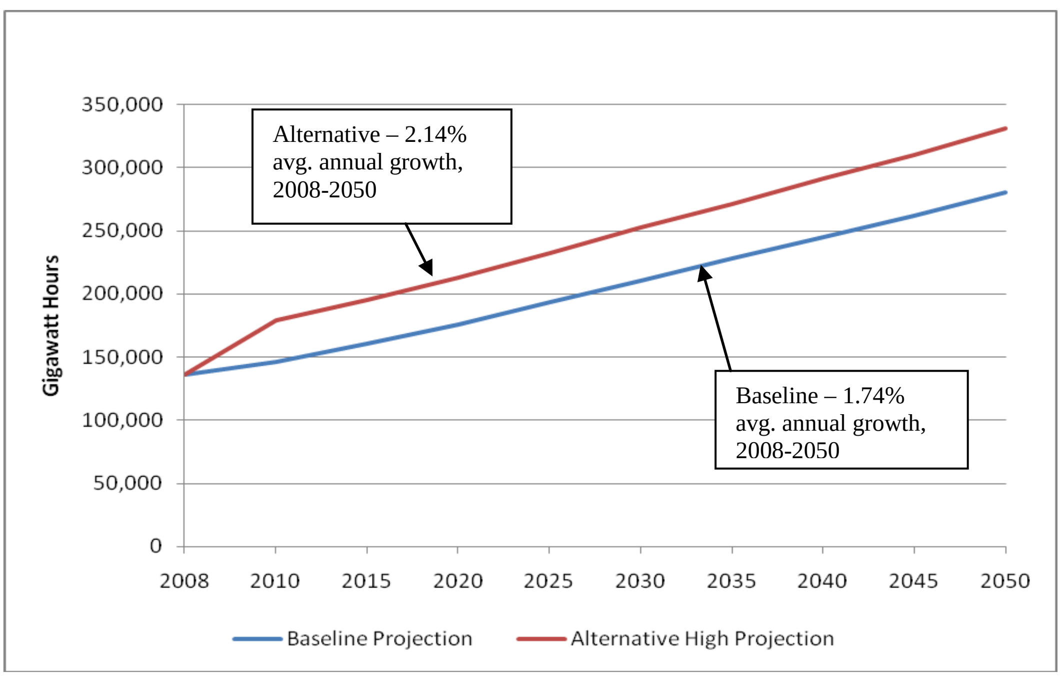


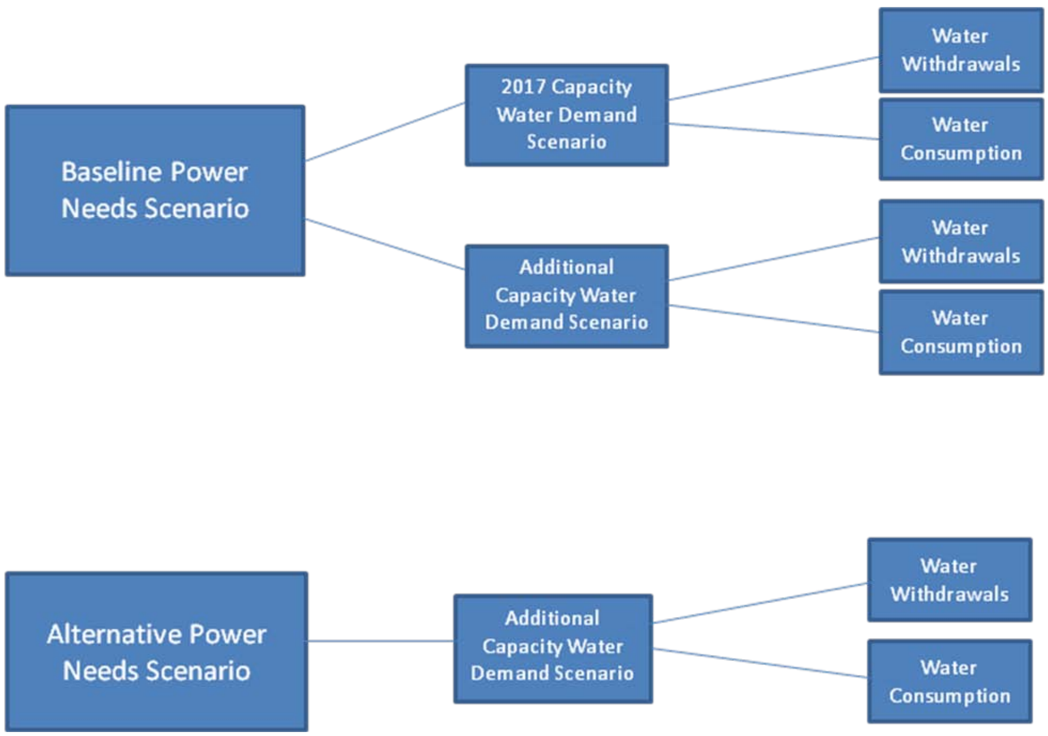
Figure ES-3 Comparison of Baseline and Alternative Statewide Energy Needs Projections, 2010 - 2050



ES.4 Future Water Demand Scenarios

Figure ES-4 is a diagram of the energy sector water demand forecasts developed for each future power generation scenario described in Section ES.3. As the figure shows, three energy sector water withdrawal and three water consumption forecasts have been developed. For the *baseline scenario*, future water demands were developed under two statewide power generation capacity scenarios: the *2017 Capacity Scenario and the Additional Capacity Scenario*. The two water demand scenarios differ by their assumptions regarding how additional generating capacity will be added in the future.

Figure ES-4 Energy Sector Water Demand Forecast Scenarios Diagram



The *2017 capacity scenario* assumes future statewide power needs are met only through:

- the power generating capacity associated with existing facilities, and
- the power generating capacity associated with facilities that have been specifically planned in Georgia through the year 2017.

Under this scenario, statewide power needs are assumed to come from existing and planned facilities until the point at which their capacities are maximized. Planned facilities were identified through a review of existing air quality permit applications for power generating facilities with EPD as well as through guidance from the energy sector ad hoc group. **Table ES-1** lists the planned facilities included in the development of the forecast along with planned capacity, fuel type, prime mover, cooling type, location, and planned year of operation.

Table ES-1 Planned Energy Utility Facilities in Georgia

Plant Name	Capacity (MW) approx.	Fuel Source/Prime Mover	Cooling Type	County	Planned Year of Operation
Plant Mitchell	-59[1]	Biomass/Steam Turbine	OT	Dougherty	2013
McDonough Unit Retirement	-259	Fossil Fuel/Steam Turbine	CT	Cobb	2011
McDonough Units 4&5	1682	Natural Gas/Steam Turbine	CT	Cobb	2012
McDonough Unit Retirement	-258	Fossil Fuel/Steam Turbine	CT	Cobb	2012
McDonough Unit 6	841	Natural Gas/Steam Turbine	CT	Cobb	2013
Vogtle Unit 3	1102	Nuclear/Steam Turbine	CT	Burke	2016
Vogtle Unit 4	1102	Nuclear/Steam Turbine	CT	Burke	2017
Bainbridge Power	170	No. 2 Fuel Oil/Simple Cycle	N/A	Decatur	b/w 2010 and 2015
Paul Creek Energy Center, LLC	225	Natural Gas/Simple Cycle	N/A	Washington	b/w 2015 and 2020
Plant Washington	850	Coal/Steam Turbine	CT	Washington	b/w 2010 and 2015
Longleaf Energy Station	1,200	Coal/Steam Turbine	CT[2]	Early	b/w 2015 and 2020[3]
Oglethorpe Power – Monroe County[4]	1,200	Natural Gas/Combined-Cycle	CT	Monroe	b/w 2015 and 2020
Warren County Biomass Energy Facility	100	Biomass/Steam Turbine	CT	Warren	2015[5]
Total	**7,896**				
Cooling Type Abbreviations					
OT – Once-through (single pass) CT – Cooling Tower (recirculated)					

[1] Conversion from 155 MW coal-fired boiler into a 96 MW biomass-fired boiler. Note – work on the conversion of this plant has been suspended pending EPA Industrial Boiler MACT regulations.
[2] Longleaf Air Quality Permit (4911-099-033-P-01-1) dated April 9, 2010 indicates the construction of cooling towers.
[3] Currently under litigation. Air quality permit states that construction shall be completed no later than December 31, 2015. Therefore, additional capacity from the Longleaf facility is assumed to be available between 2015 and 2020.
[4] Additional generating capacity and planned year of operation identified by Oglethorpe Power via the energy sector ad hoc group meeting on 8/3/10.
[5] Planned year of operation identified by Oglethorpe Power via email to author dated 8/11/10.

The purpose of the *2017 capacity scenario* is to allow Regional Water Planning Councils (Councils) to assess future water resource demands associated with power generation at current and planned facilities. This scenario assists in showing whether current and planned facilities can meet future energy needs for the state. For the *2017 capacity scenario,* each facility's capacity factor was increased until the sustainable maximum for the facility was reached. A facility's capacity factor refers to the ratio of power generation output it experiences over a period of time related to its full capacity (also referred to as the nameplate capacity). Each power generation process has its own maximum sustainable capacity factor. These factors were determined based upon guidance from the energy sector ad hoc group.

Under the baseline power generation scenario, 2017 capacity does not meet statewide power needs through 2050, the end of the planning horizon. Using the baseline power generation scenario projection, 2017 capacity is projected to fail to meet statewide power generation needs sometime between 2040 and 2045. Since 2017 capacity does not meet the baseline projected energy needs through 2050, this scenario is not viewed as a reasonable scenario for water resources planning purposes. Therefore, this scenario was not developed for the alternative power generation scenario presented in Section ES.3.

The *additional capacity scenario* involves the assumption that in addition to existing and planned facilities, new capacity will be developed to meet statewide power generation needs. This is new capacity beyond that currently planned through 2017. The *additional capacity scenario* assumes that approximately 1,000 megawatts of additional thermoelectric power generation capacity will be added in the State of Georgia annually from 2021 to 2050. This assumption is based on information produced by a Governor's Energy Policy Council Staff Research Brief indicating projected growth in statewide energy demand of approximately 1,000 MW per year (GEFA). No assumptions were made regarding the geographic distribution of the future capacity.

The purpose of the *additional capacity scenario* is to determine the total statewide energy sector water demands associated with the existing and planned facilities as well as the assumed additional (not yet planned) capacity beyond 2017. For planning purposes, demands associated with existing and planned facilities through 2017 are separated from demands associated with additional capacity assumed to become available after 2020. This will allow Councils to qualitatively consider the implications of a portion of the demand associated with the assumed additional capacity occurring within their respective Water Planning Region and develop resource management practices accordingly.

Under the *additional capacity scenario,* it is assumed that a small portion of Georgia's future energy needs will be met by renewable energy that is not hydroelectric or produced from biomass. Input from the energy sector ad hoc group along with a review of the literature led to the conclusion that in the near term the majority of power generated from renewable sources in Georgia in the future, especially near term, will come from biomass. For the purposes of developing the statewide energy sector water demand forecast it is assumed that 1 percent of Georgia's power needs will be met by non-hydroelectric and non-biomass renewable energy beginning in 2030 and continuing throughout the planning horizon.

ES.5 Future Water Demand

ES.5.1 Forecast Methodology

As noted in section ES.2, water requirements for thermoelectric power generation can vary significantly depending on the specific process of power generation employed at a particular facility. A facility's cooling type, prime mover, and, to a lesser degree, fuel type determines its water needs characteristics. Prior to forecasting statewide energy sector water demands, specific water withdrawal and consumption rates were developed for four fuel type/prime mover/cooling type combinations (herein referred to as power generation combinations) that are most common in the State of Georgia.

Using EPD water withdrawal and consumption permit data and power generation data from the U.S. Department of Energy, Energy Information Administration (EIA) from 2003 to 2007, the average withdrawal and consumption rates (expressed in gallons of water per megawatt hour of power generated) for each of four power generation combinations were calculated. **Table ES-2** shows the withdrawals and consumption rates used to forecast statewide energy sector water demands.

Average water withdrawal and consumption rates were multiplied by the power generation for each power generation combination to arrive at a water withdrawal and consumption value for each combination for each forecast year. Individual power generation combination withdrawal and consumption values were summed for each forecast year to calculate the total statewide withdrawal and consumption.

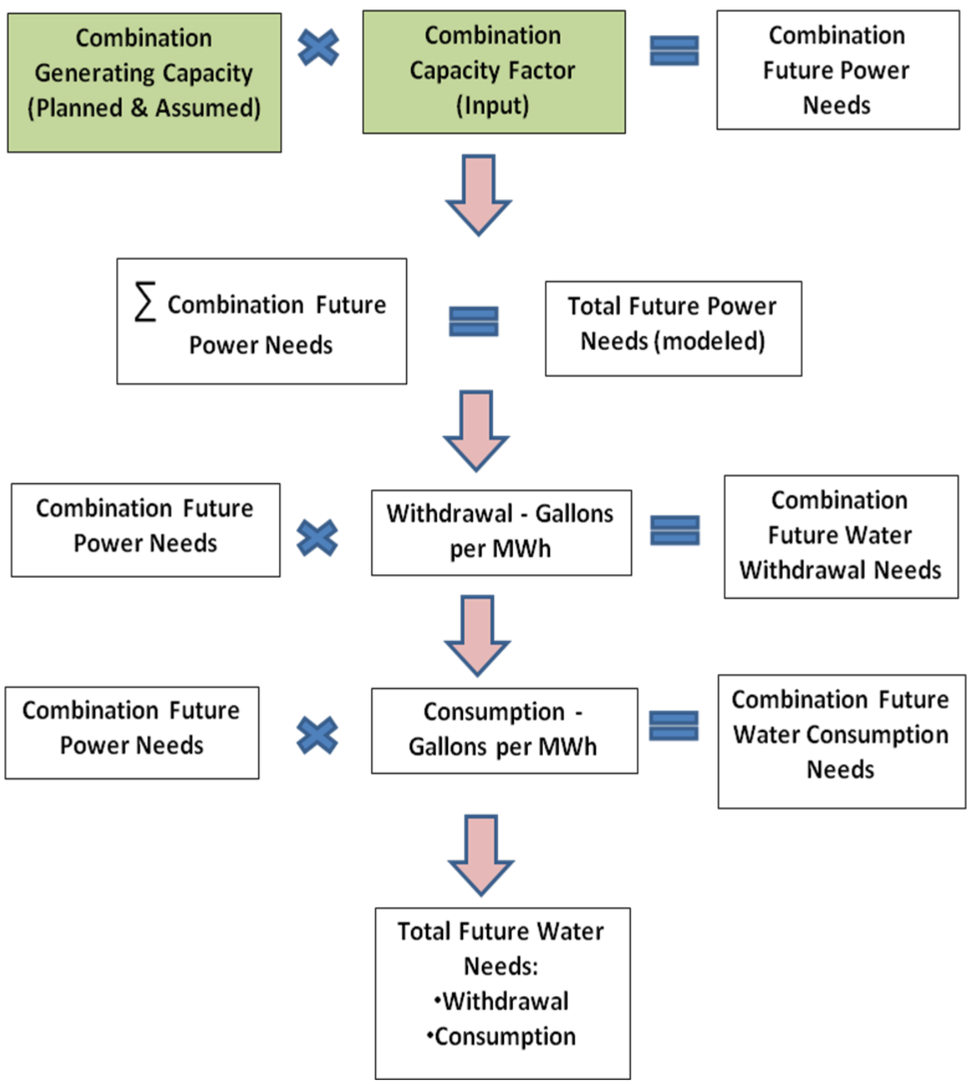
Table ES-2 Withdrawal and Consumption Rates Analysis Results

<table>
<tr><th colspan="3">Water Withdrawals (in gallons) Per Megawatt Hour</th></tr>
<tr><th colspan="2">Power Generation Combination</th><th>5-Year Average</th></tr>
<tr><td colspan="2">FF/Bio, ST, OT</td><td>41,005</td></tr>
<tr><td colspan="2">FF/Bio, ST, CT</td><td>1,153</td></tr>
<tr><td colspan="2">NG, CC, CT</td><td>225</td></tr>
<tr><td colspan="2">Nuc, ST, CT</td><td>1,372</td></tr>
<tr><th colspan="3">Water Consumption (in gallons) Per Megawatt Hour</th></tr>
<tr><td colspan="2">FF/Bio, ST, OT</td><td>0</td></tr>
<tr><td colspan="2">FF/Bio, ST, CT[1]</td><td>567</td></tr>
<tr><td colspan="2">NG, CC, CT</td><td>198</td></tr>
<tr><td colspan="2">Nuc, ST, CT</td><td>880</td></tr>
<tr><th colspan="3">Abbreviations</th></tr>
<tr><td>Fuel Type:
FF – Fossil Fuel (includes coal, fuel oil, and natural gas)
Bio – Biomass
NG – Natural Gas
Nuc – Nuclear</td><td>Prime Mover:
ST – Steam Turbine
CC – Combined-cycle</td><td>Cooling Type:
OT – Once-through
CT – Cooling Tower</td></tr>
</table>

[1] Plant Harlee Branch has a unique cooling system that employs a combination once-through condenser and part-time once-through cooling tower. Consumptive use at Plant Harlee Branch is not incorporated into the water consumption rates for either the fossil fuel/biomass once-through or cooling tower combinations.

The amount of power generated by combination was calculated by taking the combination available capacity times a combination capacity factor – the percent of capacity utilized. It is recognized that multiple factors can influence a combination's capacity factor from year-to-year making future combination capacity factors difficult to predict. Future combination capacity factors were guided by recent historical trends in combination capacity factors and energy sector ad hoc group guidance. **Figure ES-5** provides a diagram of how future energy sector water demands were calculated within the demand forecast model.

Figure ES-5 Energy Sector Water Demand Forecast Model Diagram



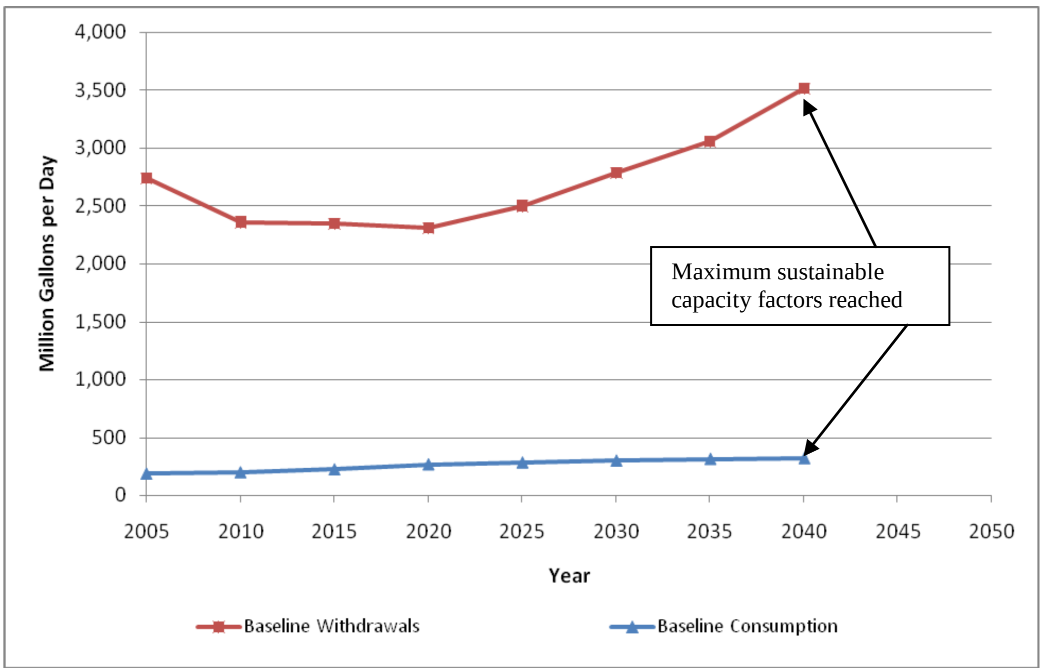
ES.5.2 Forecast Results

As discussed above, water demand forecasts were prepared for three overall scenarios: 2017 capacity scenario with baseline power generation, additional capacity scenario with baseline power generation, and additional capacity scenario with alternative power generation. The results for each of these are presented below.

ES.5.2.1 Forecast Results for the 2017 Capacity Scenario

As noted earlier, under the *2017 capacity scenario with baseline power generation*, existing and planned capacity is insufficient to meet statewide power needs through 2050. The forecasted water withdrawals and consumption steadily increase until the point where maximum sustainable capacity factors are reached. Capacity fails to meet forecasted power needs between 2040 and 2045. **Figure ES-6** shows the *2017 capacity scenario* withdrawal and consumption demands for the baseline power generation needs scenario.

Figure ES-6 Statewide Energy Sector Withdrawal and Consumption Forecasts - 2017 Capacity Scenario, Baseline Power Needs



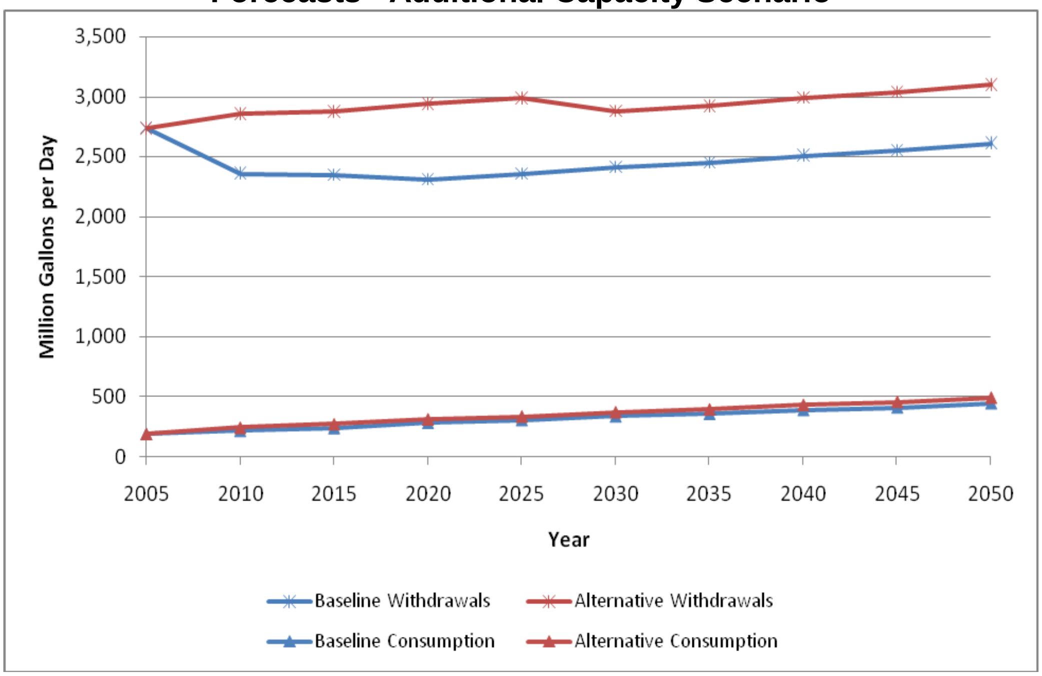
ES.5.2.2 Forecast Results for the Additional Capacity Scenario

Under the *baseline additional capacity scenario*, statewide withdrawals increase by about 251 mgd (10.6 percent) from 2010 to 2050, while under the *alternative additional capacity scenario,* withdrawals increase by about 243 mgd (8.5 percent) from 2010 to 2050. Growth in withdrawal demand is lower under the *alternative scenario* because it is assumed that capacity will be added to less water withdrawal intensive power generation combinations (i.e., those with cooling towers) and no capacity will be added to water withdrawal intensive power generation (facilities with once-through cooling). Therefore, a greater portion of future statewide power needs will be met by facilities requiring relatively small water withdrawals.

Statewide consumption increases by about 232 mgd (117 percent) from 2010 to 2050 under the *baseline additional capacity scenario*. Under the *alternative additional capacity scenario*, statewide consumption increases by about 251 mgd (114 percent). The volume of growth in consumption is higher under the *alternative scenario* because statewide power needs are higher and a greater portion of those needs are met by facilities that consume relatively large quantities of water (i.e., facilities with cooling towers) than under the *baseline additional capacity scenario*.

Figure ES-7 shows the trend in statewide energy sector water withdrawals and consumption from 2005 to 2050 for both power generation needs scenarios for the *additional capacity scenario*.

Figure ES-7 Statewide Energy Sector Withdrawal and Consumption Forecasts - Additional Capacity Scenario



Statewide energy sector water demands were geographically disaggregated by region through 2020 using the location of existing and planned facilities. In order to geographically disaggregate demands, it was assumed that all facilities of a particular power generation combination operate at an identical capacity factor and have identical water withdrawal and consumption rates. The portion of a power generation combination's demand assigned to a particular region was determined by the capacity available in that region. For example, currently 43 percent of the available nuclear power generating capacity in the state is located at Plant Hatch in the Altamaha region. Therefore, 43 percent of the nuclear/steam turbine/cooling tower withdrawal and consumption demands are assigned to the Altamaha region in 2010.

The percent of available capacity by region changes when new capacity from planned facilities is added. For example, the Vogtle nuclear power plant, located in the Savannah Upper Ogeechee region, is scheduled to add 2,204 MW of capacity between 2015 and

2020. As a result, the percent of available nuclear capacity (and subsequently water demands) changes to reflect the addition. In 2015 the Savannah Upper Ogeechee region will contain 57 percent of nuclear generating capacity, however, with the additional planned capacity becoming available between 2015 and 2020, it will contain 72 percent of the nuclear power generating capacity in 2020.

Withdrawals are highest in those regions with facilities with once-through cooling. Consumption is highest in those regions with facilities with the greatest generating capacity for facilities with cooling towers.

ES.6 Conclusions

The energy sector represents a significant portion of statewide water demands in Georgia. As the state's population grows, so will its need for electricity. This analysis has shown that current statewide energy needs are expected to more than double by 2050[2]. Similarly, statewide water consumption demands are forecasted to more than double by 2050. Consumptive demands represent water that is consumed during the power production process and not returned to the stream and thus have implications for potential water supply gaps in the state.

This analysis showed that the capacity of existing facilities and those planned through the year 2017 will not meet future statewide power generation needs through the planning horizon of 2050. By assuming that additional generating capacity will be added in a similar fashion as observed in recent history, statewide energy sector water demands were forecasted through 2050.

Figures ES-8 and **ES-9** show statewide withdrawal demands through 2050 under the *baseline additional capacity scenario* and the *alternative additional capacity scenario* forecasts respectively. **Figures ES-10** and **ES-11** show statewide consumption demands through 2050 under the *baseline additional capacity scenario* and the *alternative additional capacity scenario* forecasts respectively. The area in blue represents the demands associated with all existing and planned facilities. The area in red represents the demands associated with the additional thermoelectric generating capacity added after 2020. It is the red portion of the chart that represents the demand not associated with a particular water planning region.

Forecasted demands through the year 2020 have been disaggregated by region because the location of these facilities is known. The location of the facilities responsible for the assumed additional capacity is unknown and no assumptions were made regarding potential locations. Thus, statewide energy sector water demands are not disaggregated regionally beyond the year 2020.

Planning for additional power needs beyond 2020 at a regional level would be a speculative exercise, as the location and types of generating facilities that may be built is

[2] Current statewide energy needs refer to the year 2008. This is the most recent year of electric utilities' power generation data available from the EIA.

not well known. If a regional Council has credible information that would provide information on where and what type(s) of facilities might be planned and implemented, then this information could be used to distribute some of the forecasted needs to a more regional level. If a Council is concerned about including more information on regional power demands beyond 2020, it may be more prudent at this time to qualitatively assess if future power generation is plausible for the region and why. Councils could then undertake a general assessment of whether or not there appears to be available supplies to address some or all of that need. As necessary, relevant management practices could then be crafted based upon that information and assessment.

Figure ES-8 Statewide Energy Sector Water Withdrawals Forecast – Baseline Power Generation Needs, Additional Capacity Scenario

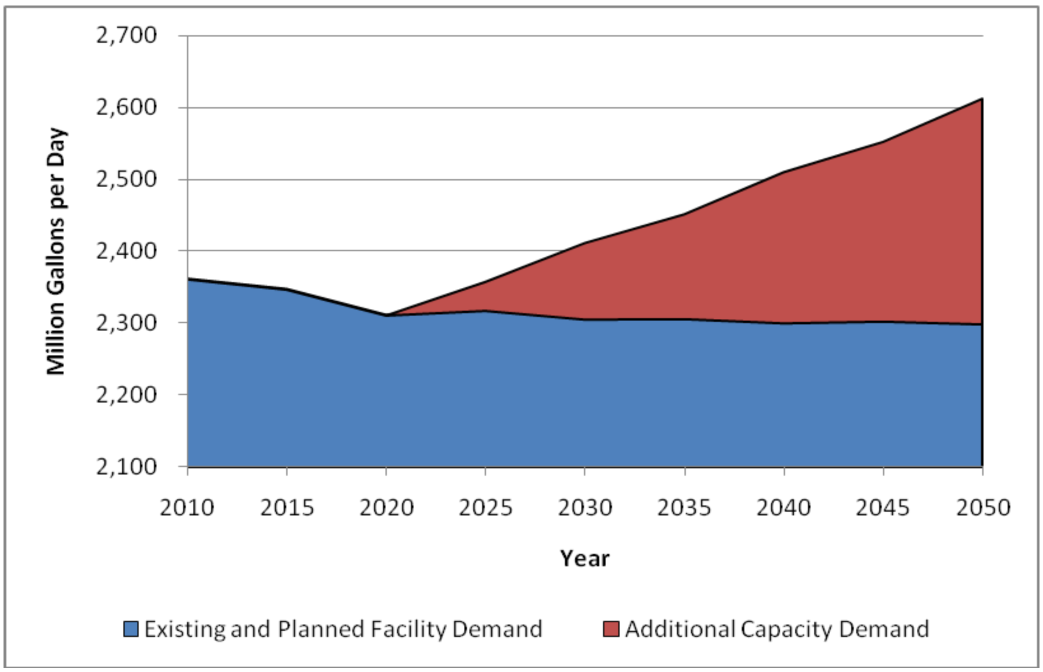


Figure ES-9 Statewide Energy Sector Water Withdrawals Forecast – Alternative Power Generation Needs, Additional Capacity Scenario

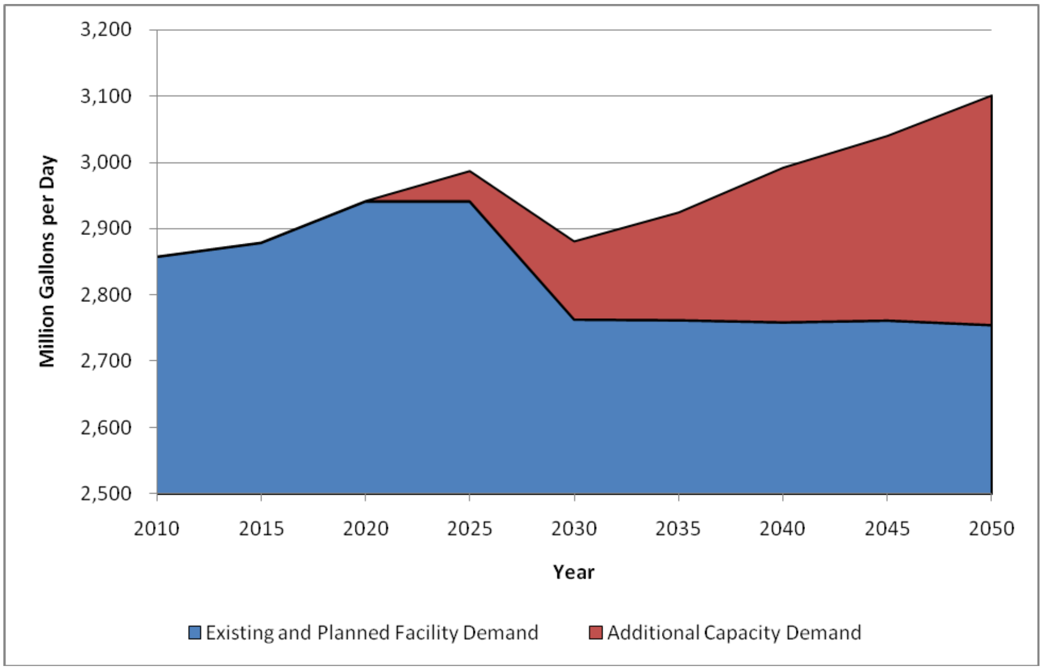


Figure ES-10 Statewide Energy Sector Water Consumption Forecast – Baseline Power Generation Needs, Additional Capacity Scenario

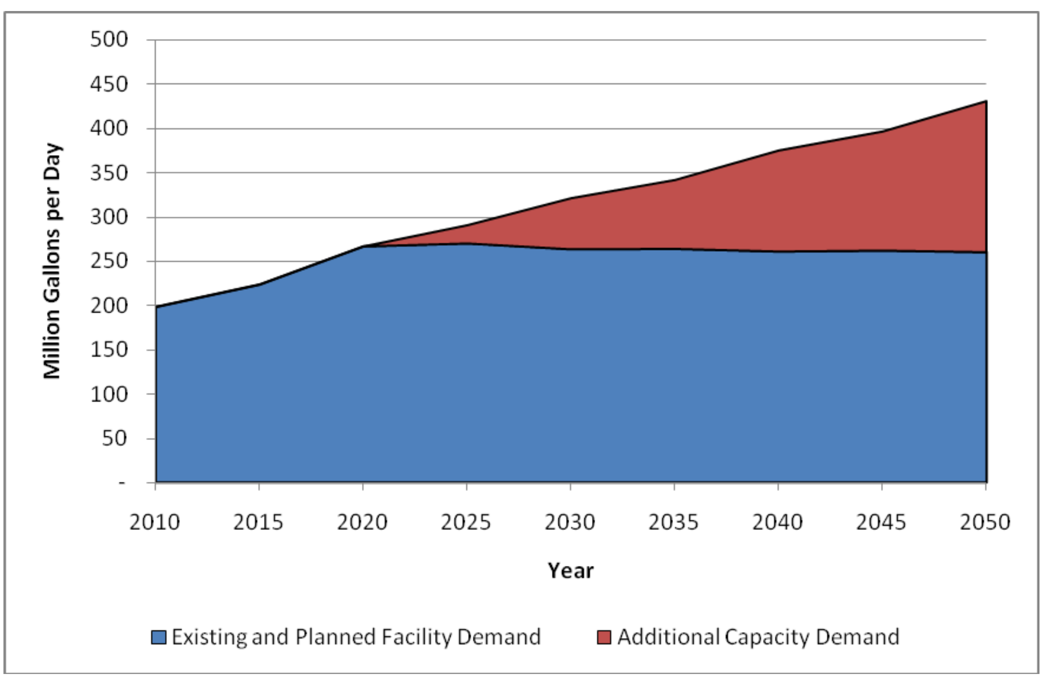


Figure ES-11 Statewide Energy Sector Water Consumption Forecast – Alternative Power Generation Needs, Additional Capacity Scenario