SECTION 4

# Future Conditions

Developing a long-term water resource management plan requires projecting forward from baseline conditions to envision the region's future water resource management needs. This section describes the water demand and wastewater flow forecasts for the District. These forecasts are based on population and employment projections for the region. This section also projects future watershed development conditions that will affect watershed management needs and concerns.

## 4.1 Population and Employment Projections

For the 2017 Plan Update, the District used two sets of population and employment projections, presented in Tables 4-1 and 4-2, to forecast future water and wastewater demands:

**Scenario 1:** ARC Population and Employment Projections (2020 to 2050)

**Scenario 2:** Georgia Office of Planning and Budget (OPB) Population Projections and OPB-Based Employment Projections (2020 to 2050)

ARC population and employment projections were prepared by ARC's Research and Analytics Division (RAD) for use by the District for the purpose of water demand forecasting as part of the 2017 Plan Update. ARC provided county-level population and employment projections that were calculated using a Regional Econometric Models Inc. (REMI) econometric model. County level projections were reviewed by Metro Water District jurisdictions and adjusted to account for factors driving future growth that are not captured by the REMI model.

OPB population projections were prepared in 2015 by the University of Georgia's Carl Vinson Institute of Government using a traditional population cohort-component model. OPB and ARC used different methodologies for their projections, and OPB did not provide future employment forecasts. Therefore, corresponding future employment forecasts for the OPB population projections were developed by ARC's RAD using a simple share allocation method. A ratio of population to employment for each year by county was calculated using the standard REMI projection per county. This ratio was then applied to the OPB population number to create an annual employment projection for each county.

The ARC and OPB forecasts are separate and independent projections of future population for each county in the District. These independent projections were derived using different methodologies, and the District developed projected water demand and wastewater flows using both projection scenarios to improve forecast reliability. The water demand and wastewater flow forecasts are described in Sections 4.2 and 4.3.

Table 4-1. Population Projections by County

| County | ARC Population Projections (Scenario 1) | | | | OPB Population Projections (Scenario 2) | | | |
|---|---|---|---|---|---|---|---|---|
| | 2020 | 2030 | 2040 | 2050 | 2020 | 2030 | 2040 | 2050 |
| Bartow | 130,924 | 160,133 | 178,780 | 189,569 | 108,763 | 118,274 | 125,461 | 131,085 |
| Cherokee | 270,994 | 336,152 | 394,907 | 437,370 | 265,020 | 331,015 | 406,740 | 494,713 |
| Clayton | 283,792 | 304,371 | 327,266 | 350,555 | 282,488 | 302,823 | 315,351 | 321,509 |
| Cobb | 726,369 | 799,383 | 893,279 | 969,932 | 781,311 | 863,236 | 930,414 | 984,089 |
| Coweta | 165,321 | 204,744 | 235,587 | 256,038 | 152,575 | 182,430 | 213,856 | 247,779 |
| DeKalb | 725,746 | 789,454 | 870,176 | 945,468 | 756,138 | 800,302 | 824,638 | 835,063 |
| Douglas | 148,812 | 175,224 | 201,144 | 220,545 | 155,959 | 185,446 | 215,834 | 247,930 |
| Fayette | 109,427 | 124,558 | 140,809 | 148,739 | 114,379 | 122,584 | 127,011 | 129,033 |
| Forsyth | 255,412 | 356,079 | 431,478 | 468,230 | 245,429 | 334,694 | 450,066 | 597,255 |
| Fulton | 1,050,286 | 1,143,594 | 1,235,645 | 1,310,110 | 1,104,788 | 1,278,928 | 1,453,507 | 1,631,265 |
| Gwinnett | 927,056 | 1,073,102 | 1,239,115 | 1,392,162 | 985,396 | 1,176,845 | 1,375,267 | 1,581,299 |
| Hall | 234,487 | 287,486 | 330,425 | 362,697 | 210,468 | 244,958 | 280,791 | 318,828 |
| Henry | 256,188 | 311,014 | 353,232 | 379,989 | 241,568 | 289,270 | 339,799 | 395,121 |
| Paulding | 169,951 | 213,806 | 259,524 | 297,884 | 170,901 | 209,745 | 253,980 | 304,621 |
| Rockdale | 96,909 | 113,320 | 129,993 | 145,344 | 95,285 | 106,944 | 116,872 | 126,086 |
| **Total** | **5,551,674** | **6,392,420** | **7,221,360** | **7,874,632** | **5,670,468** | **6,547,495** | **7,429,586** | **8,345,677** |

Table 4-2. Employment Projections by County

| County | ARC Employment Projections (Scenario 1) | | | | OPB-based Employment Projections (Scenario 2) | | | |
|---|---|---|---|---|---|---|---|---|
| | 2020 | 2030 | 2040 | 2050 | 2020 | 2030 | 2040 | 2050 |
| Bartow | 62,524 | 69,819 | 76,352 | 82,193 | 56,867 | 60,238 | 64,315 | 67,420 |
| Cherokee | 95,421 | 108,787 | 123,123 | 128,021 | 93,318 | 107,124 | 126,812 | 144,806 |
| Clayton | 187,706 | 201,227 | 216,228 | 231,625 | 186,843 | 200,204 | 208,356 | 212,433 |
| Cobb | 526,073 | 581,725 | 641,877 | 699,093 | 565,865 | 628,192 | 668,561 | 709,297 |
| Coweta | 64,037 | 71,972 | 79,668 | 86,453 | 59,100 | 64,128 | 72,319 | 83,664 |
| DeKalb | 524,712 | 573,647 | 625,031 | 679,851 | 546,685 | 581,529 | 592,322 | 600,463 |
| Douglas | 71,786 | 81,812 | 91,924 | 100,510 | 75,234 | 86,585 | 98,637 | 112,990 |
| Fayette | 84,908 | 93,954 | 102,838 | 111,192 | 88,750 | 92,465 | 92,761 | 96,461 |
| Forsyth | 85,801 | 100,872 | 115,834 | 134,805 | 82,447 | 94,814 | 120,824 | 171,952 |
| Fulton | 1,098,358 | 1,182,107 | 1,268,878 | 1,360,794 | 1,155,354 | 1,321,998 | 1,492,600 | 1,694,373 |
| Gwinnett | 488,390 | 549,702 | 611,597 | 671,565 | 519,125 | 602,845 | 678,798 | 762,803 |
| Hall | 118,756 | 133,564 | 147,120 | 160,535 | 106,591 | 113,806 | 125,021 | 141,118 |
| Henry | 96,029 | 107,685 | 118,775 | 127,670 | 90,549 | 100,156 | 114,258 | 132,754 |
| Paulding | 54,898 | 63,544 | 72,732 | 80,089 | 55,205 | 62,337 | 71,178 | 81,900 |
| Rockdale | 54,289 | 61,027 | 67,890 | 74,363 | 53,379 | 57,593 | 61,037 | 64,510 |
| **Total** | **3,613,688** | **3,981,444** | **4,359,867** | **4,728,759** | **3,735,312** | **4,174,014** | **4,587,799** | **5,076,944** |

# 4.2 Water Demand Forecasts

## 4.2.1 Methods

Water demand forecasts for the Plan Update were generated with the same approach used for prior versions of the Plan. The water demand forecasts are mainly a function of two variables: (1) future projections of population and employment, and (2) future water use by residents and employees. The latter category includes assessment of specific projections of future per capita water use, future per employee water use and water conservation impacts and adjustment of the total demand to account for potential uncertainty in projecting the future. The methodology is discussed below.

The District employed the Demand Side Management Least Cost Planning Decision Support System (DSS) Model computer model tool developed by Maddaus Water Management to develop the water demand forecasts. This model, which was developed in 1999 and is continually updated, was also used for the 2003 Plan and 2009 Plan Update. The projections developed for the 2017 Plan Update include an additional element of analysis that was not used in previous projection calculations. To account for the variability of key forecast determinants, an uncertainty factor, which progressively increases to 13 percent in 2050, was applied to the base water demand forecasts for each county. The key forecast determinants used in this uncertainty analysis included population growth rate, employment-to-population ratio, per capita residential water use and per employee commercial water use.

The DSS Model was used to forecast water demand for the 15 District counties for 2015 through 2050. The DSS Model includes a conservation component that quantifies savings from existing efficiency standards (for example, plumbing codes and appliance standards) and active conservation programs over time. Only conservation impacts from existing efficiency standards were assessed for the 2017 Plan Update. Conservation from existing efficiency standards refers to water savings resulting from customer actions and activities that do not depend on direct involvement with utility conservation programs. These activities are required by the current plumbing codes and appliance standards: (1) natural replacement of existing plumbing fixtures and appliances with water-efficient models, and (2) installation of water-efficient fixtures in new buildings and retrofits in existing buildings. The forecasts in this Plan consider potential water savings from existing efficiency standards that are implemented over time.

The steps in the DSS Model process are illustrated on Figure 4-1. Using two distinct approaches, “top-down” and “bottom-up,” the DSS Model calculates anticipated indoor and outdoor water demands for each customer category: single-family residential, multifamily residential, commercial, industrial, institutional and other categories, as established by the local water provider. The “top-down” approach breaks overall water usage by total consumed/billed, by customer category and by indoor and outdoor use. The “bottom-up” approach examines the specific end uses of water (for example, toilets, showers, faucets and irrigation) and the frequency of those end uses. The model aggregates the specific end uses to calculate total water use for each customer category. Each county’s specific conditions were calibrated using this approach. The following sections describe the water demand forecasts methods in more detail.

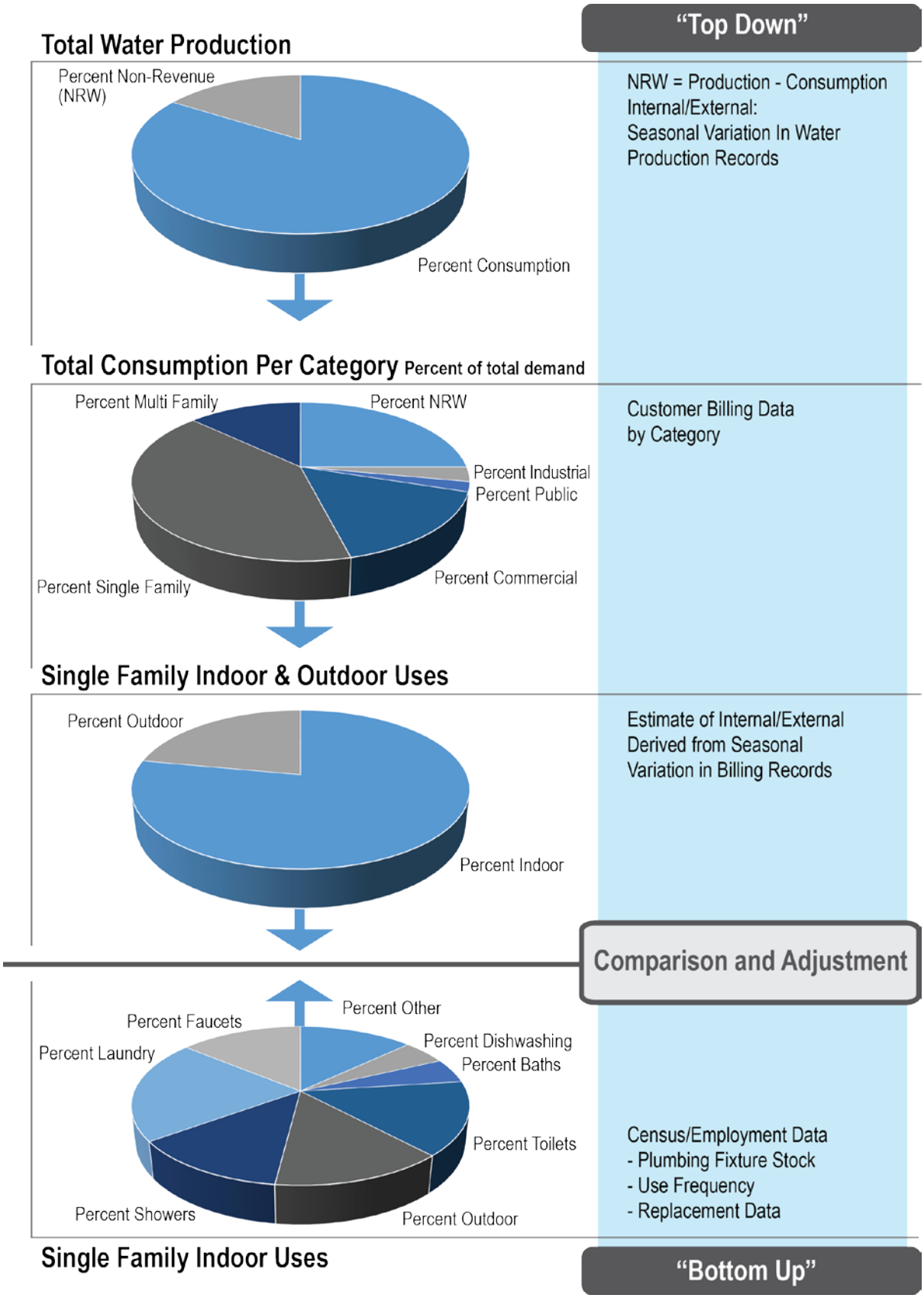


Figure 4-1. DSS Model Overview

## Data Collection

Water demand forecasts for the District were based on three main data inputs:

1. Population and employment forecasts (presented in Section 4.1)
2. Water billing, production and withdrawal data
3. Plumbing fixture and appliance stock (by county)

The second input enables the model to build a water use profile by customer category for existing conditions. The first input is used to project current unit-based demands forward through the planning horizon. The third input is used to quantify the expected reduction in current water use trends based on the conversion of inefficient plumbing fixtures and appliances as a result of the current requirements of the plumbing code and appliance standards (existing efficiency standards). Other demographic data used for the model were obtained from the 2010 decennial U.S. Census and 2013 U.S. Census estimates.

**Water Billing, Production and Withdrawal Data**

Water use data were obtained from local water providers in the District. These data included customer billing (water use data) by customer category, water withdrawals, water production, water loss audits, maximum day demands, records of abnormal years and planning documents, if available. Figure 4-2 shows the process by which water is conveyed from its source to its end use and how the provided billing data were separated into various components for further analysis. Water utility data were collected to take into account water sold between counties. In cases where more than one water utility exists in a county, the billing data from those utilities were combined to support county-level calculations.

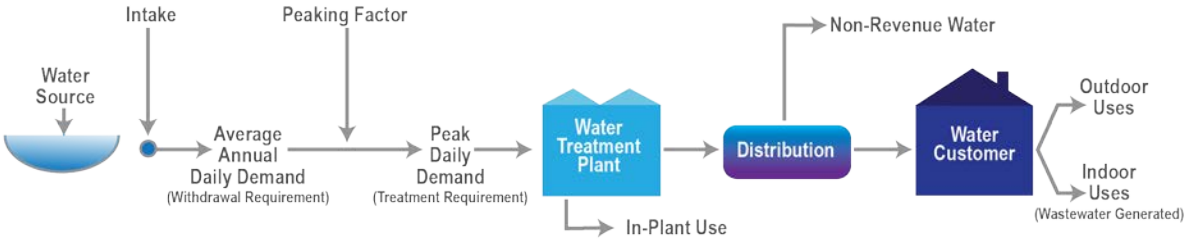


Figure 4-2. Water System Diagram

These data were used to develop estimates of water demand per account for each customer category and to calculate a forecast baseline for county-level water use totals. The forecast baseline of water use for each county in the District is shown in Table 4-3 in AAD-MGD. The baseline use estimates were based on data from 2010, 2011, 2012 and 2014, as available. Rainfall totals in 2013 were much higher than normal, and water demands that summer were lower than normal. In order to create a representative baseline demand, demand data for 2013 were removed from the baseline calculations. Baseline water use in the District incorporates the District's historical and ongoing water conservation program and existing plumbing codes and appliance standards. In order to reflect the enhanced efficiency and conservation effects, only the most recent several years of data were included in the baseline calculation.

Table 4-3. Municipal Water Demand Baseline per County (AAD-MGD)

| County | Baseline Water Demand (AAD-MGD) |
|---|---|
| Bartow | 27.49 |
| Cherokee | 19.89 |
| Clayton | 25.02 |
| Cobb | 71.31 |
| Coweta | 13.65 |
| DeKalb | 72.95 |
| Douglas | 12.83 |
| Fayette | 11.77 |
| Forsyth | 22.65 |
| Fulton | 142.67 |
| Gwinnett | 84.42 |
| Hall | 20.24 |
| Henry | 23.66 |
| Paulding | 12.77 |
| Rockdale | 13.15 |
| **Total** | **574.47** |

Note:
These baseline demands account for all people and jobs in each county, not reflective of water source location, or WTP production. They account for self-supplied, as well as publicly supplied, and include losses due to production and distribution, if applicable.

### Non-revenue Water

The forecast baseline water demands include NRW. Estimates of NRW were compiled using water loss audits from each water provider and compiled withdrawal/production and consumption data. NRW and water loss are indicators of the efficiency of a water distribution system. NRW is defined by the International Water Association (IWA)/American Water Works Association (AWWA) as the total water in the system (including water produced and imported) minus the total billed consumption. It is the water that does not provide revenue to the local water provider.

NRW can be subdivided into three categories: unbilled authorized, apparent losses and real losses. Unbilled authorized uses include fire-fighting, hydrant flushing, street cleaning and public fountains. Apparent losses include meter inaccuracies, data errors and unauthorized consumption (theft or illegal connections). Real losses include physical losses from any type of leakage, breakage or overflow. For this Plan Update, NRW and water loss were determined using the withdrawal/production and consumption data and verified using the system-specific water audits. The IWA/ AWWA methodology that defines NRW and water loss is a new national standard, and as it becomes more widely understood and used by water systems, more complete local data should become available. Although the NRW and water loss information has limitations, it is important to highlight that the integrity and quality of the data provided by the local water providers were more robust and complete compared to that used for previous versions of the Plan. The forecast baseline

for water demands also accounts for production losses during the water treatment process. These losses were accounted as part of the NRW.

### Consumption by Customer Service Category

The local water provider production data is broken out by customer category (such as single-family residential, commercial and industrial) and used along with NRW and water loss data to create a District water use profile (Figure 4-3). With the demand per account estimate for each customer category, the number of accounts was used to calculate the total baseline demand in each county. In cases where all the major water suppliers within each county provided their complete billing data, the number of accounts was taken directly from the data. In cases where part or all of the billing data were unavailable, the number of accounts was estimated using 2010 and 2013 U.S. Census data or extrapolated from the water demand modeling conducted for previous versions of the Plan, relative to any population or employment increase.

A self-supplied customer category was included for counties with a historically significant population using private wells. Self-supplied populations were calculated from the 2003 Plan water demand modeling efforts and data from the U.S. Census for 2010 and 2013.

Residential water use, including single-family and multifamily residential use, accounts for 54 percent of the District's total water use. Figure 4-4 shows the water use profile for each county in the District. Table 4-4 shows the resulting baseline per capita and per employee uses for residential single-and multi-family, as well as other non-residential uses, including indoor and outdoor use. Baseline per capita water use was calculated using the years 2010, 2011, 2012 and 2014. As such, and because of the declining per capita trend, this number may be higher than the current per capita use. The use of conservative baseline per capita estimates allows for reasonably conservative planning and takes into account the interannual variability in water use. Figure 4-5 summarizes the District's Single Family End Uses, which were applied to calibrate the model as described in the Modeling and Analysis section.

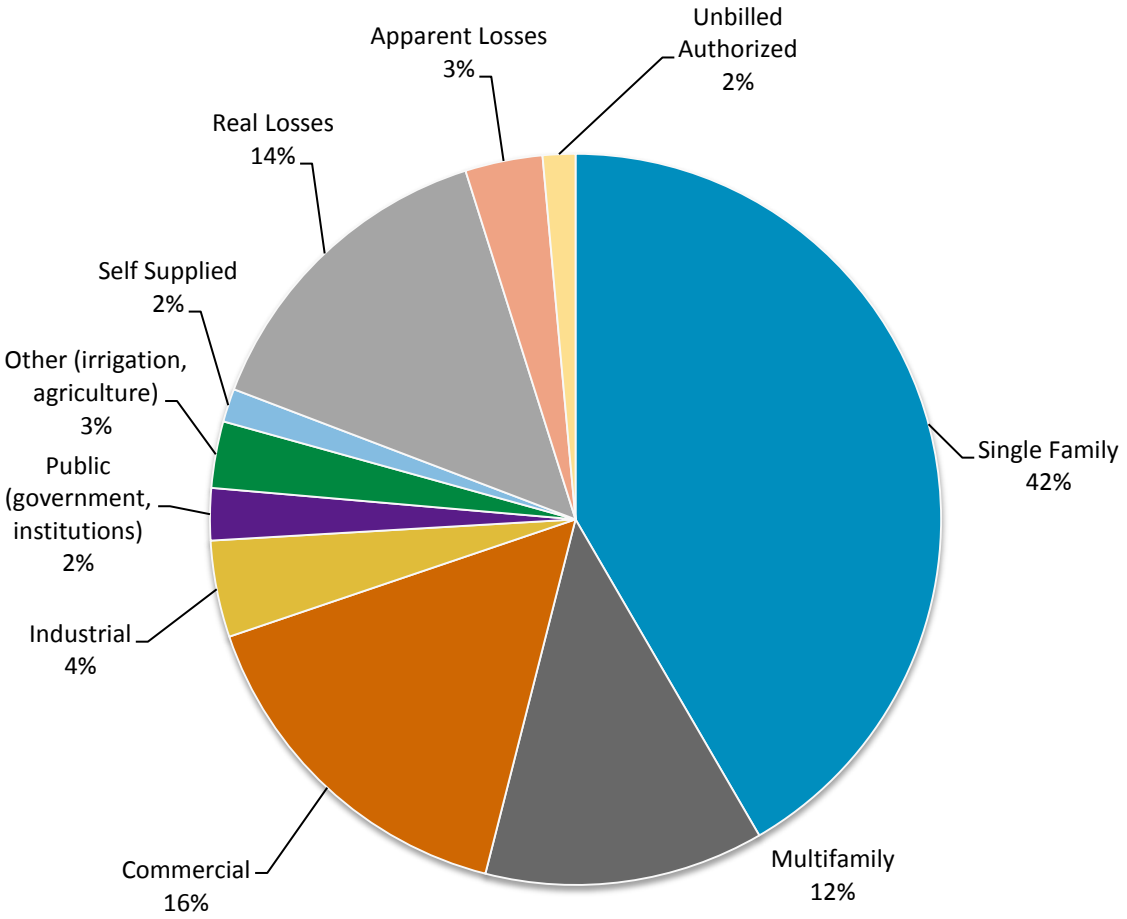


Figure 4-3. Water Use Profile, District Baseline

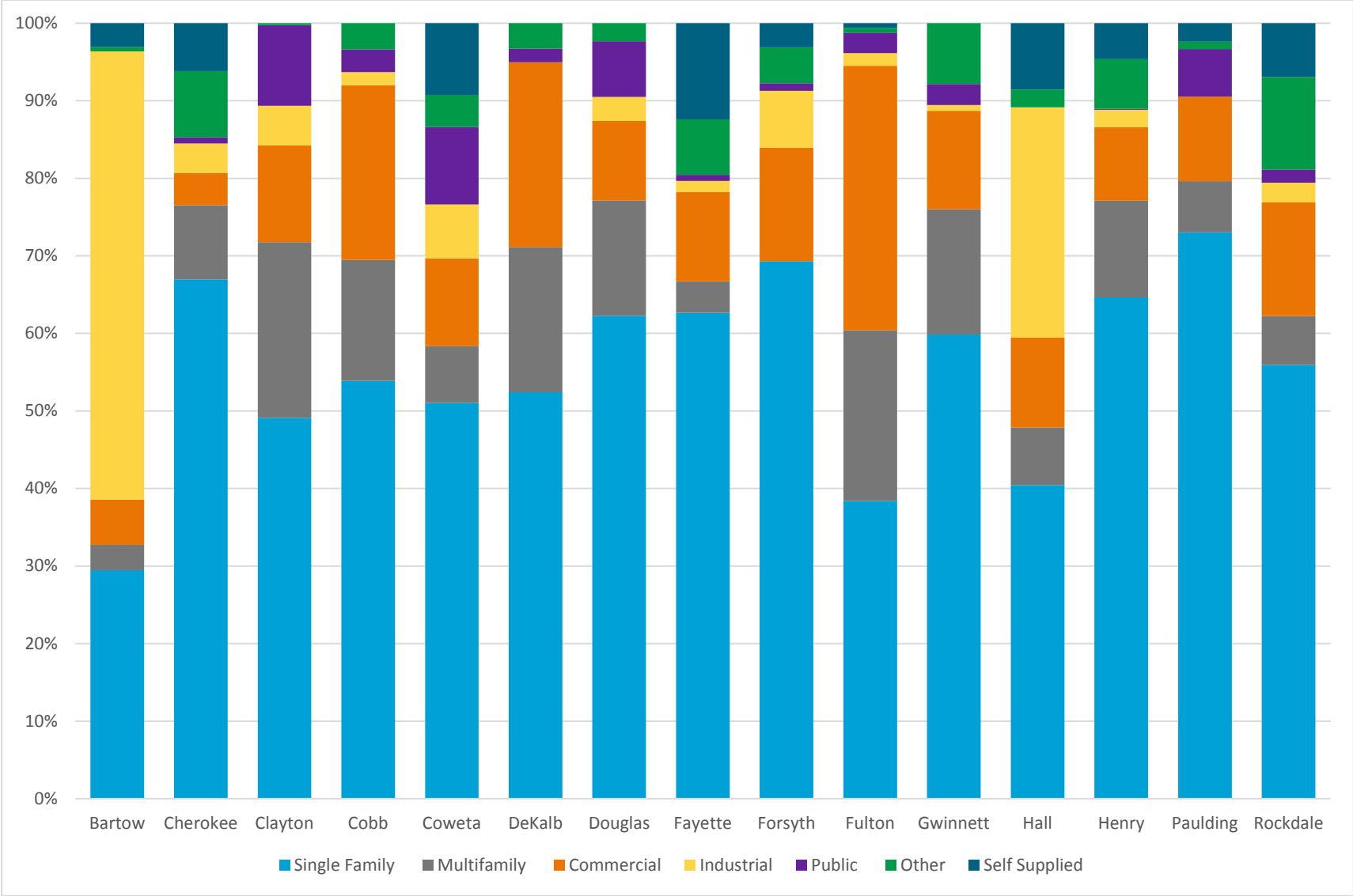


Figure 4-4. County-Level Water Use Profiles, District Baseline

Table 4-4. Baseline Water Use Profile by County (GPCPD)

| County | Baseline Total System Use (gpcpd)[a] | Baseline without NRW (GPCPD)[b] | | | | Single-family Residential (GPCPD)[c] | | | | Multifamily Residential (GPCPD)[c] | | | | Non-Residential (gallons per day per employee)[c] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Baseline Indoor | Baseline Outdoor[e] | Baseline % Outdoor | Baseline Total Use | Baseline Indoor | Baseline Outdoor[e] | Baseline % Outdoor | Baseline Total Use | Baseline Indoor | Baseline Outdoor[e] | Baseline % Outdoor | Baseline Total Use | Baseline Indoor | Baseline Outdoor[e] | Baseline % Outdoor | Baseline Total Use |
| Bartow | 250 | 142 | 31 | 18% | 174 | 54 | 12 | 18% | 67 | 52 | 11 | 17% | 63 | 177 | 38 | 18% | 215 |
| Cherokee | 82 | 52 | 16 | 24% | 68 | 47 | 12 | 20% | 59 | 42 | 4 | 9% | 46 | 17 | 16 | 48% | 33 |
| Clayton | 90 | 71 | 10 | 12% | 81 | 57 | 5 | 8% | 62 | 53 | 4 | 6% | 57 | 27 | 9 | 24% | 36 |
| Cobb | 96 | 71 | 17 | 20% | 88 | 53 | 11 | 18% | 64 | 52 | 7 | 12% | 59 | 29 | 11 | 26% | 40 |
| Coweta | 95 | 69 | 16 | 19% | 85 | 51 | 10 | 16% | 60 | 49 | 5 | 9% | 54 | 50 | 19 | 27% | 69 |
| DeKalb | 99 | 64 | 14 | 18% | 78 | 49 | 12 | 20% | 61 | 44 | 3 | 6% | 47 | 26 | 8 | 23% | 33 |
| Douglas | 90 | 59 | 13 | 17% | 72 | 56 | 9 | 13% | 65 | 42 | 7 | 14% | 49 | 25 | 11 | 31% | 36 |
| Fayette | 106 | 67 | 31 | 32% | 98 | 58 | 24 | 29% | 82 | 51 | 9 | 15% | 59 | 16 | 12 | 42% | 28 |
| Forsyth[d] | 106 | 57 | 25 | 30% | 82 | 43 | 16 | 28% | 60 | NA | NA | NA | NA | 40 | 23 | 36% | 62 |
| Fulton | 138 | 86 | 18 | 17% | 103 | 60 | 10 | 14% | 70 | 50 | 9 | 15% | 58 | 31 | 8 | 21% | 40 |
| Gwinnett | 93 | 64 | 14 | 18% | 78 | 54 | 9 | 15% | 63 | 48 | 5 | 9% | 53 | 25 | 13 | 34% | 37 |
| Hall | 100 | 67 | 18 | 21% | 84 | 44 | 12 | 22% | 56 | 46 | 4 | 8% | 50 | 54 | 15 | 22% | 69 |
| Henry | 104 | 60 | 18 | 23% | 78 | 52 | 14 | 21% | 66 | 51 | 7 | 11% | 58 | 23 | 14 | 39% | 37 |
| Paulding | 82 | 50 | 12 | 19% | 62 | 42 | 10 | 19% | 51 | 40 | 9 | 19% | 49 | 28 | 8 | 21% | 36 |
| Rockdale | 144 | 82 | 20 | 19% | 102 | 60 | 14 | 19% | 75 | 51 | 8 | 14% | 59 | 46 | 12 | 21% | 58 |
| **Weighted Average[f]** | **108** | **70** | **17** | **19%** | **87** | **53** | **11** | **17%** | **64** | **46** | **6** | **11%** | **52** | **32** | **12** | **28%** | **44** |

[a] The baseline total per capita use was calculated using the baseline water demand estimates and the average population estimates. This column includes NRW.
[b] Includes self-supplied, does not include NRW.
[c] Publically supplied water and population only
[d] Billing data for Forsyth County include multifamily in single-family category.
[e] Outdoor use is defined as all use above the winter minimum level.
[f] Weighted average is based on population.
GPCPD = gallons per capita per day

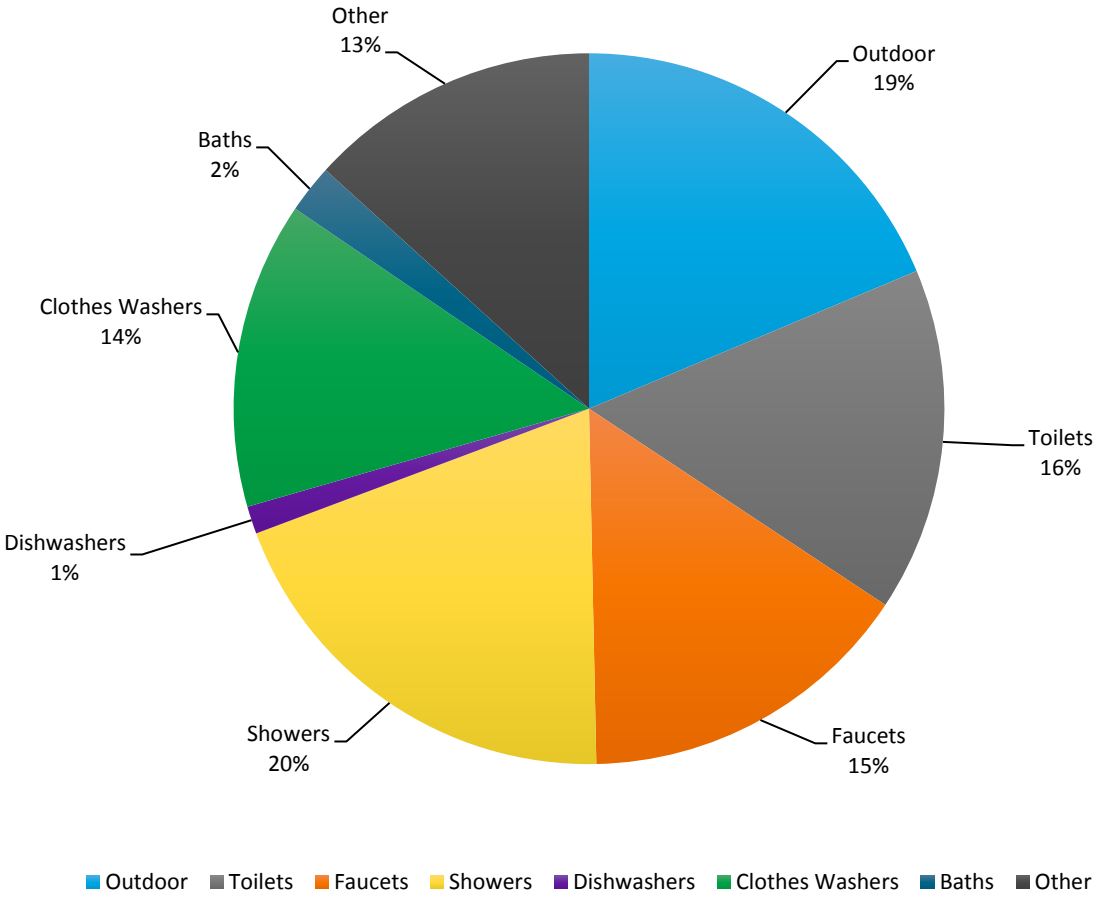


Figure 4-5. Single Family End Uses, District Baseline

**Plumbing Fixture Stock**

Plumbing fixture stock was estimated from housing age data provided by the 2010 decennial U.S. Census, 2013 U.S. Census estimates and the implementation status reports developed by the District with input from its member jurisdictions. It was adjusted based on a projected replacement rate that estimated the rate of installation of more efficient fixtures, as described below.

The types of plumbing fixtures installed in houses and other buildings play a large role in current and forecasted indoor water use. Toilets are historically the largest indoor water use, and therefore, the analysis of plumbing stock is focused on toilet replacement. Counties with more recent development, such as Forsyth and Paulding, are estimated to have low levels of inefficient toilets. Alternatively, counties that developed more heavily in past decades, such as Fulton and DeKalb, have a higher percentage of inefficient toilets. Therefore, counties with large percentages of high flush toilets have a higher water savings potential in the future from the natural replacement of fixtures due to plumbing code. Estimates for existing types of toilet fixtures by county are shown on Figure 4-6. A decrease in use can be attributed to the conservation and efficiency programs implemented across the District. One such example is retrofits on reconnection as implemented by DeKalb County.

The housing stock also allows for estimates of other water using fixtures and appliances to be determined. In addition to toilets, these estimates were developed for urinals, faucets, and washing machines.

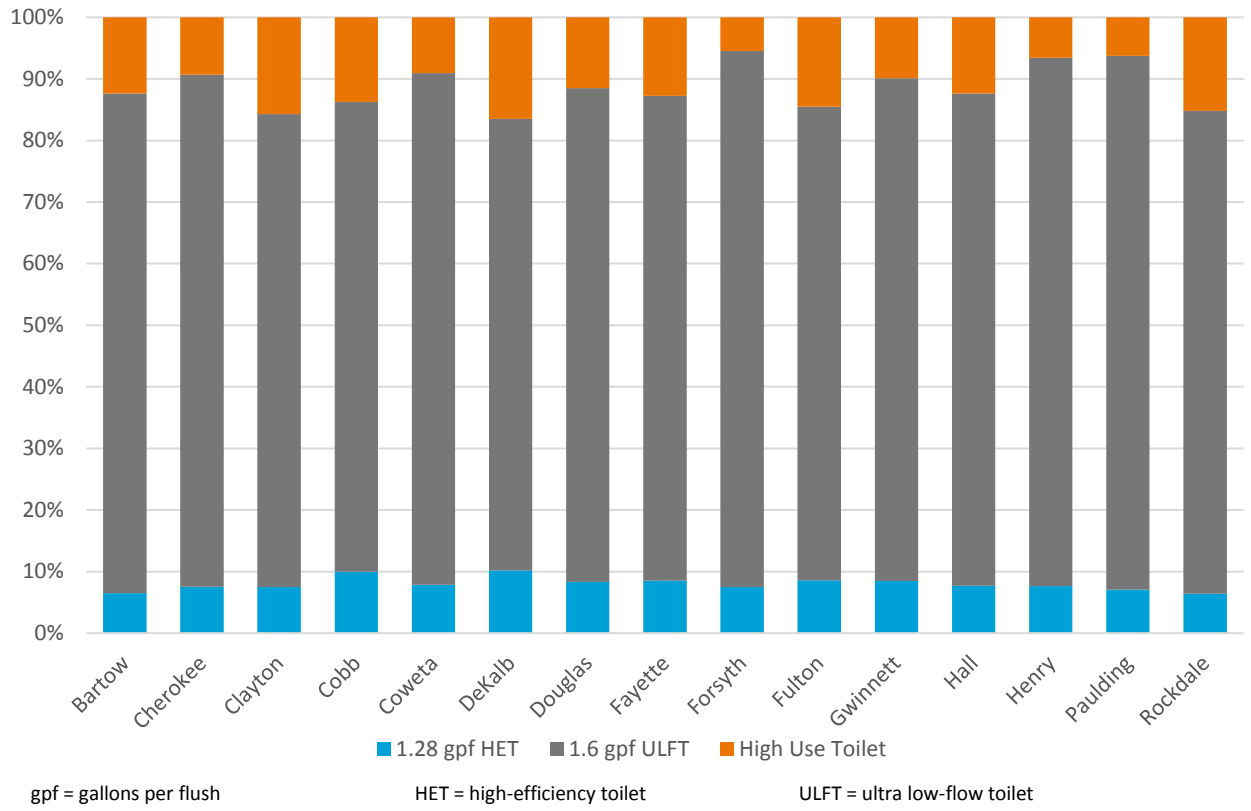


Figure 4-6. Toilet Fixture Estimates by County, District Baseline

## Analysis

The total demand for each county was estimated based on gallons-per-day per-account unit-based demands for each customer category and the number of customer accounts. In most cases, the numbers of accounts were taken directly from the data provided by the water utilities. Since there is no standard billing category system in place in the District, common categories were used across the District for comparative purposes. The main categories were:

- Single-Family Residential
- Multifamily Residential
- Commercial
- Industrial
- Institutional

Other categories were included based on the billing data submitted by the water utilities. These included categories for separately metered irrigation use and individual industries (for example, food processing and beverage production). These categories were aggregated under the non-residential category in Table 4-4.

To forecast self-supplied, a one percent annual conversion from self-supplied water to water utility service was assumed through the forecasting horizon. In some cases, this annual conversion rate was lowered to 0.5 percent based on feedback from the water utilities.

The bottom-up analysis considered end uses of water and was conducted to confirm and adjust the top-down water use estimates. For this analysis, the initial estimates for fixture use (frequency and volume) were obtained from the Water Research Foundation study, “Residential End Uses of Water” (Version 2, 2016, #4309). Table 4-5 lists end uses, share of total use, frequency of use factors and average volume per

use for a single-family account, based on the Water Resources Foundation study. These initial end use estimates were compared to the existing stock of plumbing fixtures in each of the counties from the top-down analysis. For instance, counties with a larger percentage of older homes have a larger portion of indoor use attributed to toilet flushing than counties with a higher percentage of new development.

Table 4-5. National Average Single Family Indoor Water End Uses – Water Research Foundation

| End Use | Share of Total Indoor Water Use[a] | GPCPD | Average Number of Uses per Capita per Day[a] |
|---|---|---|---|
| Toilets | 24% | 14.2 | 5.05 flushes |
| Washing Machines | 16% | 9.6 | 0.37 loads |
| Shower | 19% | 11.1 | 0.75 showers and baths |
| Faucet | 19% | 11.1 | 8.1 minutes |
| Leaks | 13% | 7.9 | -- |
| Other Domestic | 4% | 2.5 | -- |
| Bath | 3% | 1.5 | -- |
| Dishwasher | 1% | 0.7 | 0.1 loads |
| **Indoor Total** | **100%** | **58.6** | -- |

[a] Data Source: Water Research Foundation, 2016

Forecasted demands for the planning period (2015 to 2050) account for the effects of the existing state and federal plumbing codes and appliance standards. These include the National Energy Policy Act of 1992, Georgia Water Stewardship Act of 2010 and the EPA ENERGY STAR program. These codes and standards apply to a broad range of plumbing fixtures and appliances, but those considered in the DSS Model analysis for the 2017 Plan Update were toilets, urinals, showerheads and washing machines.

The bottom-up end use analysis supports adjustment of water demand forecasts to account for the effect of existing efficiency standards due to the implementation of the Georgia Water Stewardship Act and the plumbing and building codes. Over time, the code and standards gradually have and will continue to reduce indoor per capita water use because they will result in a growing percentage of homes and buildings with high-efficiency fixtures. The forecast demands that include water savings due to existing efficiency standards are referred to as the "with enhanced efficiency" demand.

The savings from enhanced efficiency standards reduce the baseline water demand forecast for each county through 2050. The savings per county vary between 9 and 11 percent depending on the existing age of housing stock and population growth. Overall, the District-wide savings from enhanced efficiency standards amount to a 10 percent reduction over baseline by 2050. The estimated rates for natural replacement due to enhanced efficiency standards (that is, plumbing codes and appliance standards) that were used in the demand forecast model are presented in Table 4-6. Specific water savings resulting from enhanced efficiency standards vary by county depending upon the demographics of each county and its current share of various flow fixtures in existing dwellings and businesses. The calibration of the top-down and bottom-up analyses in the model generated estimates of typical single-family residential end uses.

Table 4-6. Current Plumbing and Appliance Standards and Estimates of Natural Rate of Plumbing Fixture and Appliance Conversion

| End Use | Current Plumbing Code | Natural Replacement Rate[a] |
|---|---|---|
| Toilets | ≤ 1.28 gpf[b] | 2% per year |
| Urinals | ≤ 0.5 gpf[b] | 2% per year |
| Showerheads | ≤ 2.5 gpm[c] | 4% per year |
| Washing Machines | 19 gallons per load or less | 10% per year[d] |

[a] Source: Water Research Foundation, 2015

[b] Georgia Water Stewardship Act of 2010 applies to toilets and urinal standards of 1.28 and 0.5 gallons per flush (gpf)

[c] National Energy Policy Act of 1992 applies to showerhead standard of 2.5 gallons per minute (gpm).

[d] EPA, 2012

## Uncertainty Analysis

Water demand forecasts that will be used for water resource planning purposes must be reasonably conservative, because it takes many years to plan, develop, and construct the infrastructure necessary to meet future water needs. Any projection of future water demand, however, is subject to some uncertainty because the drivers of water use vary over time.

For the 2017 Plan Update, the DSS Model provided forecasts of future water demands by county for each of the population scenarios analyzed. Actual future water use over the long-term (35-year) planning horizon could be lower or higher than these forecasts as a result of variability in the key drivers of water demand, including population growth, employment growth and water use rates. For example, two key water demand drivers include potential shifts in employment sectors and job growth across the region.

Because the District needs to provide reasonably conservative projections of water demands, an "uncertainty factor" was used to adjust water demand projections to account for potential variability. This uncertainty factor was derived by analyzing historical variability relative to four water demand drivers:

1. Population growth rate
2. Employment/population ratio
3. Per capita residential water use
4. Per employee commercial water use

Probability distributions based on historical data were created for each demand driver and truncated to remove unrealistic extremes. Then, a Monte Carlo analysis (50,000 simulations) was conducted to determine future water demand probabilities based on the observed historical variability in demand drivers. The results of this Monte Carlo analysis were used to estimate the range of probabilities around the median water demand forecasts.

It is industry best practice to select a level of uncertainty above the median probability for water demand and supply planning. Many large local and regional planning entities, such as Seattle, Tacoma and Tampa Bay, use somewhere between the 60th and 75th percentile for water demand forecasting. The 65th percentile of the water demand forecast was used to calculate the uncertainty factor that was applied to each individual county. For each county, this resulted in an increase in water demands of approximately three percent at the start of the projections that grew to approximately 13 percent for the 2050 projections.

### 4.2.2 Water Demand Forecasts with Enhanced Efficiency Standards and Uncertainty Analysis

Using the methods described above, the model generated water demand forecasts for the District for the baseline through 2050. Table 4-7 presents the county-level water demand forecasts. As noted above, the baseline was calculated based on data from 2010, 2011, 2012 and 2014. The forecasts are adjusted to reflect the effects of efficiency standards and the uncertainty factor. The forecasts are reported in terms of AAD-MGD basis.

Figure 4-7 summarizes the District population projections and water demand forecasts. It demonstrates how the water demand forecasts have decreased from the previous versions of the Plan. The availability of better data for the 2017 Plan Update produced a more reliable set of water demand forecasts. As discussed in Section 4.1, the water demand forecast scenarios are based on two different population projections by ARC (Scenario 1) and Georgia OPB (Scenario 2). Figure 4-7 shows the effect of enhanced efficiency standards by providing two lines for each 2017 Plan Update Scenario: one with the effect of the enhanced efficiency standards (lower line) and one without this effect (upper line).

Table 4-7. Water Demand Forecasts for the District with Enhanced Efficiency Standards and Uncertainty through 2050

| County | Baseline Water Demand (AAD-MGD) | 2025 Water Demand (AAD-MGD) | | 2050 Water Demand (AAD-MGD) | |
|---|---|---|---|---|---|
| | | Scenario 1 | Scenario 2 | Scenario 1 | Scenario 2 |
| Bartow | 27.5 | 36.4 | 31.4 | 52.0 | 40.4 |
| Cherokee | 19.9 | 25.0 | 24.4 | 35.2 | 39.5 |
| Clayton | 25.0 | 28.9 | 29.1 | 37.6 | 33.6 |
| Cobb | 71.3 | 77.1 | 80.6 | 98.1 | 96.0 |
| Coweta | 13.7 | 17.4 | 16.0 | 23.7 | 23.5 |
| DeKalb | 73.0 | 77.5 | 78.7 | 95.4 | 83.2 |
| Douglas | 12.8 | 14.9 | 15.2 | 20.0 | 21.7 |
| Fayette | 11.8 | 12.9 | 12.8 | 16.7 | 14.0 |
| Forsyth | 22.7 | 31.5 | 29.5 | 47.9 | 59.6 |
| Fulton | 142.7 | 155.3 | 166.4 | 186.4 | 227.4 |
| Gwinnett | 84.4 | 96.2 | 101.2 | 132.1 | 145.2 |
| Hall | 20.2 | 25.0 | 22.7 | 33.9 | 31.0 |
| Henry | 23.7 | 29.6 | 28.1 | 39.4 | 41.5 |
| Paulding | 12.8 | 15.6 | 15.5 | 23.0 | 24.0 |
| Rockdale | 13.2 | 15.4 | 14.8 | 21.1 | 18.3 |
| **District Total** | **574.5** | **658.6** | **666.5** | **862.5** | **899.0** |

Note: The Metro Water District provided information comparing water use projections in the Plan with the State of Georgia's 2015 Water Supply Request in a memorandum to the Georgia EPD Director dated May 2, 2017. There is no substantive difference between the projections.