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# Beaver Lake Water Supply Reallocation Study

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## Current and Projected Water Demands



*Photograph: Beaver Lake Dam*



**US Army Corps  
of Engineers®**  
Little Rock District

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## 1.0 Introduction

This report describes the methodology and results for estimating current and projected water withdrawals by project sponsors for the Beaver Lake Water Supply Reallocation Study. Study sponsors are the:

- 1) Benton Washington Regional Water Authority (BWRWA) with a service area that comprises much of Washington and Benton counties;
- 2) Carroll Boone Water District (CBWD) that provides water to customers in Carroll and Boone counties; and
- 3) Madison County Regional Water District (MCRWD) that provides water to most of Madison County.

Section 2.0 describes existing economic conditions and current water use for each sponsor. Section 3 outlines the methodology for estimating future water demands, and Section 4 summarizes results of the analysis.

## 2.0 Existing Conditions

Projects sponsors operate water systems in northwestern Arkansas (the “Ozarks” region of the state). Washington, Benton and Madison counties make up the Fayetteville-Springdale-Rogers Metropolitan Statistical Area (Fayetteville MSA). Fayetteville, Springdale, Rogers, and Bentonville, are the third, fourth, eighth and tenth largest cities in Arkansas. According to the U.S. Census, the Fayetteville MSA is the 105th largest metropolitan statistical area in the U.S. (501,653 residents) and the 23rd fastest growing in the nation in terms of population. Benton and Washington counties form the urban core of the MSA. Carroll and Boone counties are on the western periphery of the MSA along the border with Missouri.

According to projections by HIS Global Insight, Northwest Arkansas is the third fastest-growing economy among large metropolitan areas in the nation through 2020.<sup>1</sup> IHS expects the Fayetteville MSA economy (measured in regional gross domestic product) to grow at a rate of 4.2 percent annually through 2020. Only the Austin-Round Rock-San Marcos MSA in Texas (4.4 percent) and Raleigh-Cary, North Carolina (4.3 percent) are expected to grow at a faster rate. Current real annual gross domestic product in the region is about \$26 billion. According to the Northwest Arkansas Council, major businesses in the region include the headquarters of Walmart, J.B. Hunt Transport Services, and Tyson Foods (the nation’s largest chicken, pork, and beef processor). The supplier base includes many Fortune 500 companies that numbers over 1,350 who’ve located here to be close to their customers and because of the region’s great business climate.

From the perspective of water use, poultry production is an important industry given that poultry rearing and meat processing are very water intensive processes. In 1997, poultry producers raised and sold nearly 360 million chickens and turkeys, and by 2012, this amount increased to 435 million (an average growth

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<sup>1</sup> HIS Global Insight, “U.S. Metro Economies GDP and Employment 2013-2015 Including 2020 Economic Forecast.” June 2014.

rate of 1.59 percent per year).<sup>2</sup> As global demand for meat continues to rise, poultry production in the region will likely grow substantially over the planning horizon.

## 2.1 Benton Washington Regional Water Authority

The BWRWA is a wholesale water provider serving customers in Benton and Washington counties. BRWRA operates a treatment plant with a capacity of 24 million gallons per day (mgd), and has four water storage locations: 12.5 million gallons in Decatur, 5 million gallons in Lincoln, just under 0.9 million in Garfield, and an additional 3.5 million in Centerton. Their distribution system includes about 120 miles of pipeline. BRWRA also runs a booster pump station in Lincoln, which produces the pressure required to fill Lincoln water storage tanks.

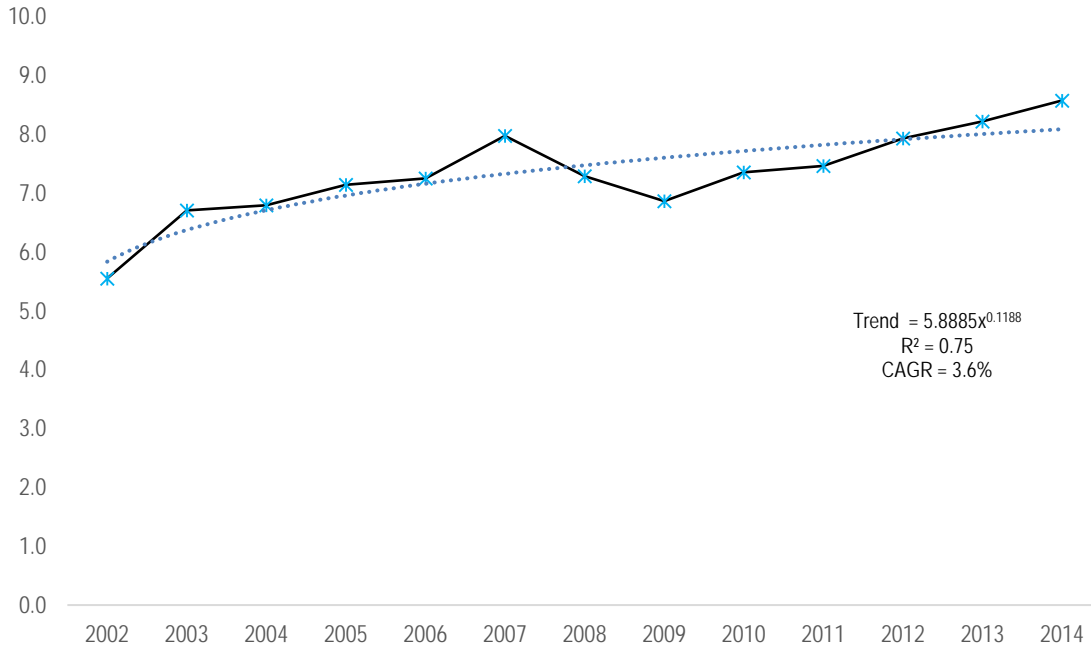
Since 2002, BWRWA withdrawals from Beaver Lake have at annual compound growth rate of 3.6 percent per year (Figure 1). In 2002, water production totaled 5.5 mgd; and by 2014, production was 8.6 mgd.<sup>3</sup> BWRWA currently sells water to 14 communities with a collective population about 93,000 people (Table 1). Most individual systems served by the BWRWA are relatively small and resell water to communities with 25,000 customers or less (average of 6,800 customers). Average per capita use for BWRWA is 104 gallons per capita day (gpcd) with a range of 60 for the Lost Bridge Water and Sewer District (residential use only) to 512 gpcd for Decatur Waterworks, which provides water to several poultry processing plants.

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<sup>2</sup> U.S. Department of Agriculture, Agriculture Census 2002 and 2012.

<sup>3</sup> Water production data for BWRWA is based statistics from the project sponsor, and the Arkansas Natural Resource's Water Use Registration program, which requires consumers of surface and groundwater to report monthly withdrawals.

Figure 1  
 Historical Water Production for Benton Washington Regional Water Authority  
 (millions of gallons per day)



\*CAGR= Compound annual growth rate. Source: Arkansas Department of Natural Resources, Water Use Registration Program and Benton County Regional Water Authority.

Table 1  
Benton Washington Regional Water Authority Customers (2014)

| BWRWA customer   | County     | Population served | Average daily water use (mgd) | Per capita water use (gpcd) <sup>b</sup> |
|--|------------|-------------------|-------------------------------|--|
| Benton Co. Water District 1 <sup>a</sup>                           | Benton     | 5,217             | 0.54                          | 104                                      |
| Bella Vista P.O.A  | Benton     | 26,641            | 2.16                          | 81                                       |
| Centerton Waterworks   | Benton     | 11,424            | 0.81                          | 71                                       |
| Decatur Waterworks   | Benton     | 2,851             | 1.46                          | 512                                      |
| Garfield Waterworks  | Benton     | 610               | 0.04                          | 66                                       |
| Gateway Public Water Authority                                     | Benton     | 1,890             | 0.17                          | 90                                       |
| Gentry Waterworks  | Benton     | 5,153             | 0.63                          | 121                                      |
| Gravette Works   | Benton     | 3,445             | 0.31                          | 91                                       |
| Highfill Water Dept.   | Benton     | 1,586             | 0.17                          | 109                                      |
| Lost Bridge Village Water and Sewer Districts                      | Benton     | 995               | 0.06                          | 60                                       |
| Pea Ridge Waterworks   | Benton     | 5,595             | 0.41                          | 73                                       |
| Lincoln Waterworks   | Washington | 6,209             | 0.45                          | 73                                       |
| Prairie Grove Waterworks   | Washington | 5,414             | 0.46                          | 85                                       |
| Washington County Water Authority (Farmington and rural customers) | Washington | 15,734            | 0.43                          | 102 <sup>c</sup>                         |
| Total  |            | 92,764            | 8.10                          | 104                                      |

a: Resells water purchased from BWRWA to the towns of Avoca, Little Flock and rural residents.

b: gpcd = gallons per capita per day.

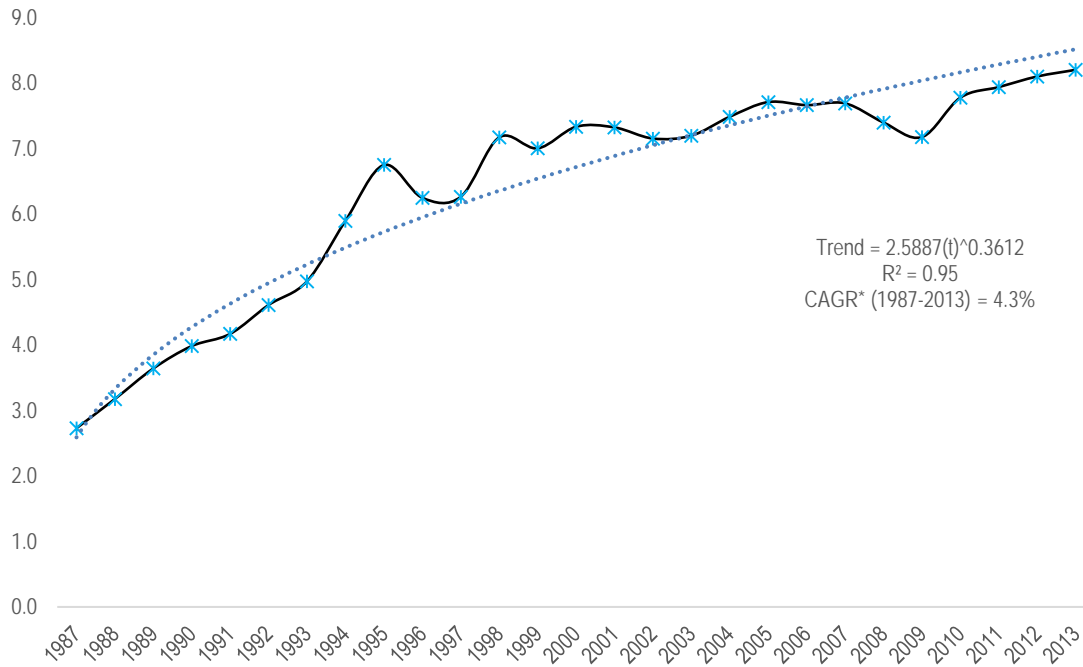
c: GPCD for the Washington County Water Authority is based on total annual water use for the system, which is 1.6 mgd. Water use reported in Table 1 (0.43 mgd) is the portion of total use for the entity water supplied by BWRWA. Washington County purchases water for other entities in addition to BWRWA.

Source Based on data from the Arkansas Department of Health.

## 2.2 Carroll Boone Water District

The CBWD operates a water treatment system with a maximum capacity of 18 mgd. Since its inception in 1987, water withdrawals have increased at annual rate of 4.3 percent. In 1987, CBWD pumped an average of 2.7 mgd from Beaver Lake; and by 2014, this increased to 8.4 mgd (Figure 2). As is the case with the BWRWA, most of CBWDs customers are small in terms of population. The largest is the City of Harrison with 16,905 residential customers, and the smallest is Alpena Waterworks serving 550 residential customers (Table 2). Per capita use also varies considerably from a high of 400 (Berryville) to a low of 67 in Alpena Springs. Again, larger values indicate the presence of water intensive manufacturing customers. The Southwest Boone Water Association is a reseller that provides water to the small towns of Olney, Everton and to rural residents in unincorporated communities.

Figure 2  
 Historical Water Production for the Carroll Boone Water District  
 (1987-2013, millions of gallons per day)



\*CAGR= Compound annual growth rate. Source: Arkansas Department of Natural Resources, Water Use Registration Program and the Carroll Boone Water District.

Table 2  
 Carroll Boone Water District Customers

| CBWD Customer                                  | County            | Population served | Average daily water use (mgd) | Per capita water use (gpcd) <sup>a</sup> |
|--|-------------------|-------------------|-------------------------------|--|
| Harrison                                       | Boone             | 16,905            | 3.05                          | 180                                      |
| Southwest Boone Water Association <sup>b</sup> | Boone             | 3,953             | 0.34                          | 86                                       |
| Alpena Waterworks                              | Boone and Carroll | 550               | 0.04                          | 67                                       |
| Eureka Springs Waterworks                      | Carroll           | 3,158             | 0.60                          | 190                                      |
| Berryville Waterworks                          | Carroll           | 5,632             | 2.25                          | 400                                      |
| Green Forest Waterworks                        | Carroll           | 5,473             | 2.13                          | 389                                      |
| Total  | -                 | 35,671            | 8.41                          | 236                                      |

<sup>a</sup> gpcd = gallons per capita per day

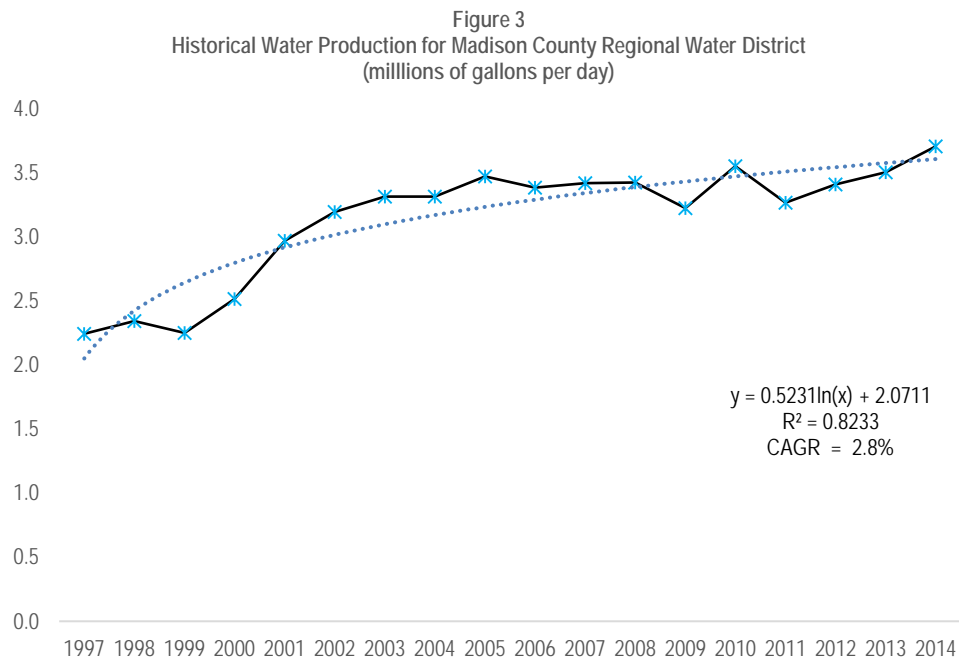
<sup>b</sup> Resells water purchased from CBWD to the towns of Olney, Everton and rural residents.

Source Based on data from the Arkansas Department of Health and the Carroll Boone Water District.

### 2.3 Madison County Regional Water District

MCRWD is water wholesaler that provides water to customers in or near Madison County. It has two main direct customers—the Madison County Water Facilities Board (MCWFB), and the City of Huntsville. MCWFB is also a reseller and provides water to the Mount Olive Water Association, and to the Benton County Water Authority No. 5. As shown in Figure 3, water withdrawals from Beaver Lake by MCRWD have increased at a rate of 2.8 percent per annum. In 1997, the district pumped an average of nearly 2.2 mgd from the lake; and by 2014, they withdrew 3.5 mgd.

With about 8,000 customers, the MCWFB is the largest customer of the MCRWD in terms of population; however, in terms of water demand, the City of Huntsville is the largest with an average daily volume of 1.4 mgd. Population served in Huntsville is only 2,402; and as a result, the city has a very high per capita rate (583 gpcd). Huntsville’s unusually high per capita rate is due to the presence of a Butterball poultry processing facility. Benton County Water Authority No. 5 also has high gpcd (392). Again, this is a result of water consumption by poultry producers in the county. Poultry farmers often rely on groundwater for water supply, but most of the groundwater in Madison County is very high in total dissolved solids, which is unsuitable for poultry consumption. In fact, high dissolved solids can be toxic poultry; thus, some broiler houses in the county are connected to public water supplies. A typical modern boiler house uses about 15,000 gallons per day for feeding, cooling and waste management.<sup>4</sup>



<sup>4</sup> University of Alabama Cooperative Extension Service, “Alabama Poultry Engineering and Economics Bulletin.” No. 7, September, 2005.



\*CAGR= Compound annual growth rate. Source: Arkansas Department of Natural Resources, Water Use Registration Program and Madison County Regional Water District.

**Table 3**  
Madison County Regional Water District Customers

| MCRWD Customer                                | County  | Population served | Average daily water use (mgd) | Per capita use (gpcd) |
|---|---------|-------------------|-------------------------------|-----------------------|
| Huntsville Waterworks                         | Madison | 2402              | 1.40                          | 583                   |
| Mount Olive Water Association                 | Madison | 5,400             | 0.47                          | 87                    |
| Madison County Water Facilities Control Board | Madison | 8,059             | 1.40                          | 174                   |
| Benton Co. Water Authority No. 5              | Madison | 1,530             | 0.07                          | 44                    |
| Total   | -       | 17,391            | 3.34                          | 192                   |

\*Resells water purchased from CBWD to the towns of Olney, Everton and rural residents  
Source Based on data from the Arkansas Department of Health and the Carroll Boone Water District

### 3.0 Projected Water Use

#### 3.1 Methodology

Since project sponsors are primarily water wholesalers, they lack consistent and comprehensive data regarding end uses by sector such as residential, commercial and industrial. Ideally, demands should be disaggregated by water use sector to allow greater precision in estimating future trends. Therefore, the PDT (Project Delivery Team) allocated total water production for each sponsor based on county level water use estimated by the U.S. Geologic Service by sector (e.g., public supply, industrial, self-supplied domestic). Table 4 displays per capita water use data for Arkansas counties that make up the north western tier of the state including counties served by project sponsors.

**Table 4**  
Per Capita Use for Self-Supplied Domestic and Public Supply Water in Northwest Arkansas

| County     | Self-supplied domestic |                | Total public supply    |                       |
|------------|------------------------|----------------|------------------------|-----------------------|
|            | Population (thousands) | Per capita use | Population (thousands) | Per capita use (gpcd) |
| Benton     | -                      | -              | 221.34                 | 100                   |
| Boone      | 4.56                   | 90             | 32.34                  | 100                   |
| Carroll    | 3.36                   | 89             | 24.08                  | 100                   |
| Madison    | 4.39                   | 89             | 11.33                  | 313                   |
| Washington | -                      | -              | 203.07                 | 133                   |
| Crawford   | -                      | -              | 61.95                  | 109                   |
| Franklin   | -                      | -              | 18.12                  | 100                   |
| Johnson    | 0.72                   | 84             | 24.83                  | 100                   |

Table 4  
Per Capita Use for Self-Supplied Domestic and Public Supply Water in Northwest  
Arkansas

| County    | Self-supplied domestic |                | Total public supply    |                       |
|-----------|------------------------|----------------|------------------------|-----------------------|
|           | Population (thousands) | Per capita use | Population (thousands) | Per capita use (gpcd) |
| Logan     | -                      | -              | 22.35                  | 100                   |
| Marion    | 7.47                   | 90             | 9.18                   | 107                   |
| Pope      | 8.17                   | 89             | 53.58                  | 100                   |
| Searcy    | 0.48                   | 84             | 7.72                   | 100                   |
| Sebastian | -                      | -              | 125.74                 | 190                   |
| Total     |                        | 89*            | 815.63                 | 126*                  |

\* Average weighted by population.

Source: U.S. Geologic Survey and Arkansas Natural Resource Commission, Water Use Data Program.

Based on these data, the PDT estimated a baseline per capita water use value broken out by residential, commercial and industrial (Table 5). Residential per capita use is based on the weighted average for the sample of counties for self-supplied domestic uses, which is 89 gpcd, which is slightly lower than the national average of 98 gpcd according to the USGS. This figure is subtracted from total public supply gpcd (184) to yield 94 gpcd, which consists of any water from a public supplier used by non-residential uses including industrial, commercial and institutional. To disaggregate industrial from commercial and institutional, total public “domestic” gpcd (126) is subtracted from total public supply gpcd (184), which equals 58 gpcd. Note that the USGS classified commercial and institutional uses as “domestic.” Thus, the baseline reference gpcd is:

- Total public supply population served = 815,631
- Total public supply withdrawals (gpcd) = 149,760,000
- Total public supply per capita = 184 gpcd
- Total public supply "domestic" (residential, commercial and institutional) = 126 gpcd
- Total residential = 89 gpcd
- Total public supply (commercial and institutional) = 37 gpcd
- Total public supply (industrial) = 58 gpcd
- $89 + 37 + 58 = 184$ .

These metrics provide a reference average per capita use values to distribute total water use according to end use sector for individual customers of each project sponsor; however, for many individual systems, baseline values were adjusted to reflect larger populations and towns that attract a large number of tourists.<sup>5</sup> In both cases, commercial and institutional water use will be higher. In addition, many of the systems purchasing water from project sponsors do not have industrial customers, and some have

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<sup>5</sup> The distribution of commercial water use for different sized cities and high volume tourist towns is based on analysis completed for the 2012 State Water Plan for Texas, see: Norvell, Stuart D., and Shaw Douglass, S. “2012 Water for Texas, Socioeconomic Impacts of Projected Water Shortages.” Texas Water Development Board, December 2012. Available online at: <http://www.twdb.texas.gov/waterplanning/data/analysis/index.asp>.

residential customers only. The PDT determined which systems do not have industrial or commercial water users based on a review of U.S. Census and U.S. Bureau of Economic Analysis (BEA) Zip Code Business Pattern data.

Another important note is that industrial use captured by the assumed baseline distribution does not include water for poultry production including processing. Identifying systems that sell to the poultry industry is also based on a review of BEA and Census data as well as online business directories for poultry producers. These systems have very high total per capita use figures (typically in excess of 200 gpcd). For systems with poultry customers, the PDT estimated the portion that is residential and commercial based on the baseline regional per capita values for residential, commercial water (Table 5), and the remainder is assumed to be water for poultry production.<sup>6</sup> For example, Huntsville Waterworks (MCRWD) with total gpcd of 583 provides water to Butterball for poultry processing. The portion sold to Butterball for 2014 was estimated using the following calculation:  $1,400,000 - [(89 \times 2,402) + (37 \times 2,402)]$  where 2,402 is population served. Tables 6 through 8 show disaggregated water use by system for each project sponsor. Water use by sector for each sponsor is the baselines for water demand projections (i.e., year 2015 estimated demands).

Table 5  
Distribution Used to Disaggregate Total Water Use for Individual Customers of Project Sponsors

| Sector                    | Average per capita use based on county level USGS data (gpcd) | Distribution                               |   |   |  |                  |
|---------------------------|---|--|---|---|--|------------------|
|                           |   | Residential, commercial and industrial use | Residential commercial only (population 5K or less) | Residential and commercial only (population 5K or less) | Residential and commercial (tourist town ) | Residential only |
| Residential               | 89  | 49%  | 90%   | 80%   | 45%  | 100%             |
| Commercial                | 37  | 20%  | 10%   | 20%   | 55%  | -                |
| Industrial (non-poultry)  | 34  | 31%  | -   | -   | -  | -                |
| Public water supply total | 160   | 100%                                       | 100%  | 100%  | 100%                                       | 100%             |

A "-" indicates a value of zero. Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division

<sup>6</sup> The distribution of commercial water use for different sized cities and high volume tourist towns is based on professional judgment and experience. The author of this report (Stuart Norvell, Economist with the Little Rock District) served as the chief economist for the Texas Water Development Board for 8 years, and led the Water Uses and Projections Section (Water Resources Planning) that estimated current and projected water use for all public water supply systems in the state of Texas and for agriculture, self-supplied industrial and mining, and thermoelectric generation. During his tenure, Mr. Norvell conducted extensive analyses of end uses of water for public systems including commercial uses.

**Table 6**  
**Current Estimated Water Use by Sector for the Benton Washington Regional Water Authority (2015)**

| Water system                                  | Population served | Water demand by end use (mgd) |             |                           |             |
|---|-------------------|-------------------------------|-------------|---------------------------|-------------|
|   |                   | Residential                   | Commercial  | Poultry and manufacturing | Total       |
| Benton Co. Water District 1 <sup>a</sup>      | 5,217             | 0.40                          | 0.05        | 0.12                      | 0.57        |
| Bella Vista P.O.A                             | 26,641            | 1.82                          | 0.46        | -                         | 2.28        |
| Centerton Waterworks                          | 11,424            | 0.68                          | 0.17        | -                         | 0.85        |
| Decatur Waterworks                            | 2,851             | 0.24                          | 0.06        | 1.24                      | 1.54        |
| Garfield Waterworks                           | 610               | 0.04                          | 0.00        | -                         | 0.04        |
| Gateway Public Water Authority                | 1,890             | 0.16                          | 0.02        | -                         | 0.18        |
| Gentry Waterworks                             | 5,153             | 0.47                          | 0.06        | 0.13                      | 0.66        |
| Gravette Works                                | 3,445             | 0.23                          | 0.03        | 0.07                      | 0.33        |
| Highfill Water Dept.                          | 1,586             | 0.16                          | 0.02        | -                         | 0.18        |
| Lost Bridge Village Water and Sewer Districts | 995               | 0.06                          | -           | -                         | 0.06        |
| Pea Ridge Waterworks                          | 5,595             | 0.30                          | 0.04        | 0.09                      | 0.43        |
| Lincoln Waterworks                            | 6,209             | 0.38                          | 0.10        | -                         | 0.48        |
| Prairie Grove Waterworks                      | 5,414             | 0.39                          | 0.10        | -                         | 0.49        |
| Washington County Water Authority             | 15,734            | 0.34                          | 0.08        | -                         | 0.42        |
| <b>Total</b>                                  | <b>92,764</b>     | <b>5.69</b>                   | <b>1.18</b> | <b>1.64</b>               | <b>8.52</b> |

A "-" indicates a value of zero. Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division

**Table 7**  
**Current Estimated Water Use by Sector for the Carroll Boone Water District (2015)**

| Water system                      | Population served | Water demand by end use (mgd) |             |                           |             |
|-----------------------------------|-------------------|-------------------------------|-------------|---------------------------|-------------|
|                                   |                   | Residential                   | Commercial  | Poultry and manufacturing | Total       |
| Harrison                          | 16,905            | 1.68                          | 0.92        | 0.46                      | 3.06        |
| Southwest Boone Water Association | 3,953             | 0.34                          | -           | -                         | 0.34        |
| Alpena Waterworks                 | 550               | 0.04                          | -           | -                         | 0.04        |
| Eureka Springs Waterworks         | 3,158             | 0.29                          | 0.32        | -                         | 0.60        |
| Berryville Waterworks             | 5,632             | 0.45                          | 0.11        | 1.69                      | 2.26        |
| Green Forest Waterworks           | 5,473             | 0.44                          | 0.11        | 1.59                      | 2.14        |
| <b>Total</b>                      | <b>35,671</b>     | <b>3.24</b>                   | <b>1.46</b> | <b>3.74</b>               | <b>8.44</b> |

A "-" indicates a value of zero. Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division

Table 8  
Estimated Water Use by Sector for the Madison County Regional Water District (2015)

| Water system                                  | Population served | Water demand by end use (mgd) |            |         |       |
|---|-------------------|-------------------------------|------------|---------|-------|
|   |                   | Residential                   | Commercial | Poultry | Total |
| Huntsville Waterworks                         | 2,402             | 0.22                          | 0.09       | 1.15    | 1.46  |
| Mount Olive Water Association                 | 5,400             | 0.44                          | 0.05       | 0.00    | 0.49  |
| Madison County Water Facilities Control Board | 1,530             | 0.07                          | 0.00       | 0.00    | 0.07  |
| Benton Co. Water Authority No. 5              | 8,059             | 1.09                          | 0.29       | 0.08    | 1.46  |
| Total (MCRWD)                                 | 17,391            | 1.83                          | 0.43       | 1.22    | 3.48  |

A "-" indicates a value of zero. Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division

To estimate future water demands, the PDT selected drivers (i.e., growth rates) for residential, commercial and manufacturing and poultry from various secondary sources. Hence, the water demand model is a driver times rate of use approach. For residential water, the drivers are county level population published by the University of Arkansas at Little Rock (UALR); and thus, projections assume a constant growth rate for customers of each project sponsor (Table 9).<sup>7</sup> For manufacturing and poultry production, growth rates are from the U.S. Department of Agriculture's long term projections for poultry supplies, and the U.S. Energy Information Administration's long term forecasts of manufacturing output measured by the real value of shipments.

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<sup>7</sup> Population projections for individual water systems are not available. UALR uses Holt's exponential smoothing method to generate trend extrapolations for of county level Census data. A natural logarithm of Census data was used in the trend extrapolation, and then the data are transformed back into non logarithmic form to eliminate zero change values. UALR generates a 95 percent confidence interval about the mean of the point extrapolations and reports high and low values (5 percent exceedance and 95 percent exceedance).

**Table 9**  
**Growth Rates for Beaver Lake Water Demand Projections**

| <b>Benton Washington Regional Water Authority</b> |                    |  |  |
|---|--------------------|--|--|
| <b>Sector</b>                                     | <b>Growth rate</b> | <b>Data source(s)</b>  | <b>Comment</b>   |
| Residential and commercial (Benton County)        | 2.0%               | County level population projections published by the Institute for Economic Advancement, University of Arkansas at Little Rock.  | None   |
| Residential and commercial (Washington County)    | 2.3%               | County level population projections published by the Institute for Economic Advancement, University of Arkansas at Little Rock.  | None   |
| Manufacturing and poultry                         | 1.8%               | Average of long-term projected rate for:<br><br>1) Real value of manufacturing shipments published by the U.S. Energy Information Administration, Annual Energy Outlook (2015), Value of shipments in constant 2009 dollars for energy intensive manufacturing (2012-2040)<br><br>2) Projected national production of poultry (2014-2024) published by: USDA, Office of the Chief Economist, "USDA Long Term Agricultural Projections," Report: OCE-2015-1Long-term Projections, Feb. 2015 | In Benton County, there is both poultry processing and other industries using process water  |
| <b>Carroll Boone Water District</b>               |                    |  |  |
| Residential and commercial (Boone County)         | 0.2%               | County level population projections published by the Institute for Economic Advancement, University of Arkansas at Little Rock.  | None   |
| Residential and commercial (Carroll County)       | 0.6%               | County level population projections published by the Institute for Economic Advancement, University of Arkansas at Little Rock.  | None   |
| Poultry and manufacturing                         | 1.6%               | Projected national production of poultry (2014-2024) published by the USDA, Office of the Chief Economist, "USDA Long Term Agricultural Projections," Report: OCE-2015-Long-term Projections, Feb. 2015  | There is only a small amount of non- poultry manufacturing in Benton and Carroll counties. These firms do not use significant amounts of process water |
| <b>Madison County Regional Water District</b>     |                    |  |  |
| Residential and commercial (Madison County)       | 0.3%               | County level population projections published by the Institute for Economic Advancement, University of Arkansas at Little Rock.  | None   |
| Poultry   | 1.6%               | Projected national production of poultry (2014-2024) published by the USDA, Office of the Chief Economist, "USDA Long Term Agricultural Projections," Report: OCE-2015-Long-term Projections, Feb. 2015  | There does not appear to be any non-poultry manufacturing in Madison County.   |

Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division

Per the Corps Water Supply Handbook demands for a reallocation study should: “*describe in as much detail as necessary the average daily water demand during drought conditions and how those demands are expected to increase over the period of the study (normally 30-50 years)*”. Generally, demand for water for uses such as landscape irrigation and cooling water increases during drought.<sup>8</sup>

To adjust regional demands in the study area, the PDT compared data from the National Climatic Data Center (historical Palmer Drought Indices) for the five county area to historical water withdrawals from Beaver Lake.<sup>9</sup> Based on the review of the Palmer Index, year 2012 was the only severe drought year over period for which historical water withdrawal data are available. From about June 2012 through January 2013, drought conditions in the region were extreme (Palmer Index of negative 4.0 and below). To determine a drought peaking factor, the PDT calculated the average difference between annual withdrawals calculated using the maximum monthly value, and total annual withdrawals; and compared these values to the value for 2012. For example, in 1997 the MCRWD pumped withdrew 2,514 mgd and the maximum monthly amount was 208 mgd. Thus, based on the maximum month, total annual maximum withdrawals is 2,732 mgd (208 multiplied by 12). The difference between total annual and total maximum annual is 9 percent. This is percent difference was calculated for each year with the exception of 2012. The difference between the 2012 peak and the mean of previous years serves as a drought adjustment metric. For the BWRWA, this value is a positive 21 percent, for the MCRWD a positive 16 percent and for the CBWD a positive 4 percent.

Additional assumptions include:

- 1) Demands assume that unit use such a residential per capita use for each sector remains constant over the planning horizon. In other words, improvements in efficiency conservation are not included. For manufacturing, which is primarily poultry production, significant increases in efficiency are not likely, and for high growth communities with considerable commercial development will have water efficient fixtures per the National Energy Policy Act of 1992 and 2005. Residential per capita use (estimated average of 84 gallons per person per day) is already low relative to the national average.<sup>10</sup>
- 2) Other than adjusting demands to account for drought, weather and climate change are not included in the model.<sup>11</sup>

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<sup>8</sup> While demands may increase during droughts, some water suppliers have drought management plans that restrict water use during severe drought. This is particularly true in the more arid portions of the nation. In the study area, drought is relatively infrequent, and project sponsors do not have active drought management plans.

<sup>9</sup> National Climatic Data Center, “Historical Palmer Drought Indices,” accessed online at: <http://www.ncdc.noaa.gov/temp-and-precip/drought/historical-palmers/psi/198411-201510>.

<sup>10</sup> According to the Pacific Institute, analysis of national water use data shows that overall per capita use has declined in the U.S.; however, residential per-capita water use, which ranges from 54 gallons per day in Maine to 190 gallons in Nevada with a national average of 98 gallons, has remained mostly unchanged over the past 10 years or so. Source: The Pacific Institute, “Per Capita Water Use in the U.S. Drops.” October 2009. Accessed online at <http://pacinst.org/news/397/>

<sup>11</sup> Global climate models depict climate using a three dimensional grid over the globe (see below), typically having a horizontal resolution of between 250 and 600 kilometers, 10 to 20 vertical layers in the atmosphere and sometimes as many as 30 layers in the oceans. Thus, their resolution is very coarse relative to the scale of exposure units in most impact assessment including regional and local water demand analyses. Source: Data Distribution Center, Intergovernmental Panel on Climate Change, “What is a GCM.” Accessed on line 23 December, 2015 at: [http://www.ipcc-data.org/guidelines/pages/gcm\\_guide.html](http://www.ipcc-data.org/guidelines/pages/gcm_guide.html)

- 3) Demands include non-revenue water and system losses. The degree of systems losses for individual systems for each project sponsor is unknown.

### 3.2 Results

Tables 11 and 12 and figures 4 through 6 compare projected demands for each project sponsor to both current and requested water supply allocations from Beaver Lake. Demands in Table 11 assume normal weather conditions based on historical withdrawal data for each sponsor; and Table 12 shows demands adjusted for drought. As discussed previously, demographic and economic growth will likely be greatest for areas served by the BWRWA; and thus expected growth in water demands will also be high. From 2015 through 2065 assuming drought conditions, water demands for the BWRWA are projected to grow from 10.5 mgd to 28.4 mgd. BWRWA’s current and requested allocation is 16.0 mgd. Projected demands for BWRWA reach 16 mgd in about 2045. Water demands for the CBWD and MCRWD, are expected to grow at slower rate largely due to smaller increases in projected populations. Total average annual demands for the CBWD rise from 8.9 mgd in 2015 to 14.2 mgd in 2065, and demands for the MCRWD increase from 4.0 mgd in 2015 to 6.1 mgd in 2065. Total current and requested yield allocation for CBWD is 12.0 mgd, and for MCRWD it is 6.5 mgd.

Table 10  
Projected Demands and Yield Allocations for the Beaver Lake Reallocation Study (normal weather conditions)

|   | Current and requested allocation | Projected demands         | 2016 | 2025 | 2035 | 2045 | 2055 | 2065 |
|---|----------------------------------|---------------------------|------|------|------|------|------|------|
| <b>Benton Washington Regional Water Authority</b> |                                  |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake               | 4.0                              | Residential               | 5.7  | 6.9  | 8.4  | 10.4 | 12.8 | 15.7 |
| Requested allocation from Beaver Lake             | 12.0                             | Commercial                | 1.3  | 1.6  | 2.0  | 2.5  | 3.0  | 3.7  |
| Total current and requested allocation            | 16.0                             | Manufacturing and poultry | 1.6  | 1.9  | 2.3  | 2.7  | 3.3  | 3.9  |
|   |                                  | Total BWRA                | 8.7  | 10.4 | 12.7 | 15.6 | 19.1 | 23.4 |
| <b>Carroll Boone Water District</b>               |                                  |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake               | 6.0                              | Residential               | 3.5  | 3.6  | 3.7  | 3.9  | 4.0  | 4.2  |
| Requested allocation from Beaver Lake             | 6.0                              | Commercial                | 1.5  | 1.6  | 1.6  | 1.7  | 1.8  | 1.8  |
| Total current and requested allocation            | 12.0                             | Manufacturing and poultry | 3.5  | 4.0  | 4.7  | 5.5  | 6.5  | 7.6  |
|   |                                  | Total CBWD                | 8.5  | 9.2  | 10.1 | 11.1 | 12.3 | 13.6 |
| <b>Madison County Water District</b>              |                                  |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake               | 2.5                              | Residential               | 1.8  | 1.9  | 1.9  | 2.0  | 2.0  | 2.1  |



|  |     |                           |      |      |      |      |      |      |
|--|-----|---------------------------|------|------|------|------|------|------|
| Requested allocation from Beaver Lake  | 4.0 | Commercial                | 0.4  | 0.4  | 0.4  | 0.4  | 0.4  | 0.4  |
| Total current and requested allocation | 6.5 | Poultry                   | 1.3  | 1.5  | 1.8  | 2.1  | 2.4  | 2.8  |
|  |     | Total MCRWD               | 3.5  | 3.8  | 4.1  | 4.4  | 4.8  | 5.3  |
| <b>Total</b>                           |     |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake    | 2.5 | Residential               | 11.0 | 12.3 | 14.1 | 16.2 | 18.8 | 22.0 |
| Requested allocation from Beaver Lake  | 4.0 | Commercial                | 3.3  | 3.6  | 4.0  | 4.6  | 5.2  | 6.0  |
| Total current and requested allocation | 6.5 | Manufacturing and poultry | 6.4  | 7.5  | 8.8  | 10.3 | 12.2 | 14.3 |
|  |     | Total demands             | 20.7 | 23.4 | 26.9 | 31.2 | 36.2 | 42.3 |

Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division

**Table 11**  
**Projected Drought Demands and Yield Allocations for the Beaver Lake Reallocation Study (drought conditions)**

|   | Current and requested allocation | Projected demands         | 2016 | 2025 | 2035 | 2045 | 2055 | 2065 |
|---|----------------------------------|---------------------------|------|------|------|------|------|------|
| <b>Benton Washington Regional Water Authority</b> |                                  |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake               | 4.0                              | Residential               | 6.9  | 8.3  | 10.3 | 12.6 | 15.5 | 19.1 |
| Requested allocation from Beaver Lake             | 12.0                             | Commercial                | 1.6  | 2.0  | 2.4  | 3.0  | 3.7  | 4.5  |
| Total current and requested allocation            | 16.0                             | Manufacturing and poultry | 2.0  | 2.3  | 2.8  | 3.3  | 4.0  | 4.7  |
|   |                                  | Total BWRA                | 10.5 | 12.6 | 15.5 | 18.9 | 23.2 | 28.4 |
| <b>Carroll Boone Water District</b>               |                                  |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake               | 6.0                              | Residential               | 3.6  | 3.8  | 3.9  | 4.1  | 4.2  | 4.4  |
| Requested allocation from Beaver Lake             | 6.0                              | Commercial                | 1.6  | 1.6  | 1.7  | 1.8  | 1.8  | 1.9  |
| Total current and requested allocation            | 12.0                             | Manufacturing and poultry | 3.7  | 4.2  | 4.9  | 5.8  | 6.8  | 7.9  |
|   |                                  | Total CBWD                | 8.9  | 9.6  | 10.6 | 11.6 | 12.8 | 14.2 |
| <b>Madison County Water District</b>              |                                  |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake               | 2.5                              | Residential               | 2.1  | 2.1  | 2.2  | 2.3  | 2.3  | 2.4  |
| Requested allocation from Beaver Lake             | 4.0                              | Commercial                | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  | 0.5  |
| Total current and requested allocation            | 6.5                              | Poultry                   | 1.5  | 1.7  | 2.0  | 2.4  | 2.8  | 3.3  |
|   |                                  | Total MCRWD               | 4.1  | 4.4  | 4.7  | 5.1  | 5.6  | 6.1  |
| <b>Total</b>                                      |                                  |                           |      |      |      |      |      |      |
| Current allocation from Beaver Lake               | 12.5                             | Residential               | 12.7 | 14.2 | 16.4 | 18.9 | 22.1 | 25.9 |
| Requested allocation from Beaver Lake             | 22.0                             | Commercial                | 3.7  | 4.1  | 4.6  | 5.2  | 6.0  | 7.0  |
| Total current and requested allocation            | 34.5                             | Manufacturing and poultry | 7.2  | 8.3  | 9.8  | 11.5 | 13.5 | 15.9 |
|   |                                  | Total demands             | 23.5 | 26.6 | 30.7 | 35.7 | 41.6 | 48.8 |

Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division

Figure 4  
 Historical and Projected Water Withdrawals from Beaver Lake by Benton Washington Regional Water  
 Authority and Requested and Current Total Yield Allocation  
 (millions of gallons per day, drought conditions)

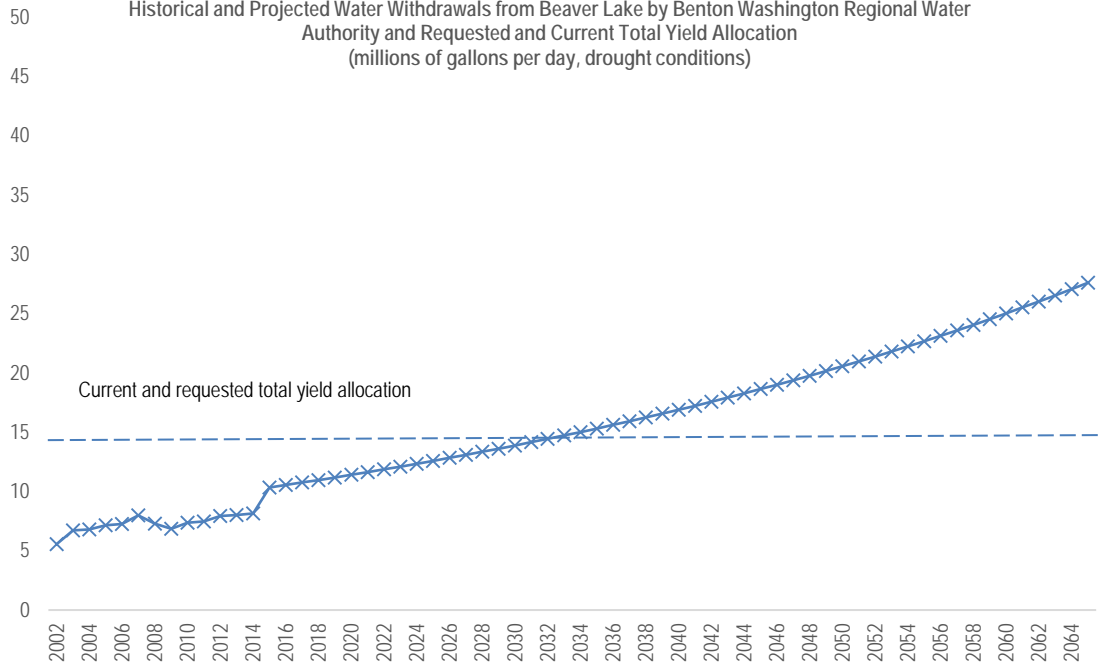


Figure 5  
 Historical and Projected Water Withdrawals from Beaver Lake by the Carroll Boone Water District and Requested and Current Total Yield Allocation (millions of gallons per day, drought conditions)

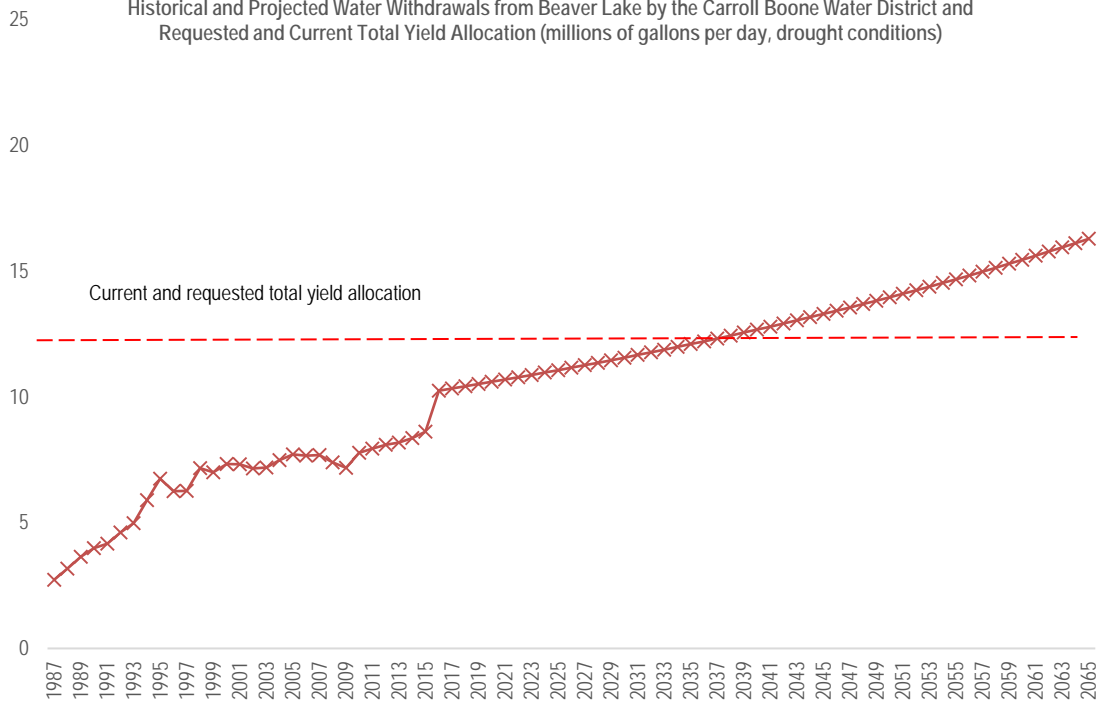
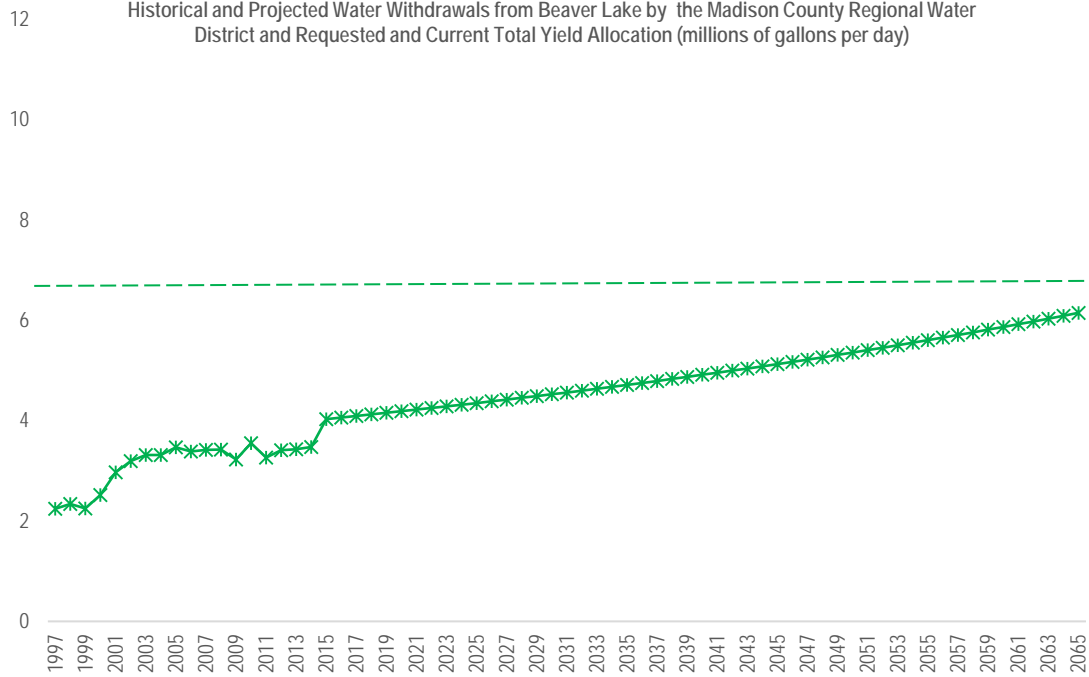


Figure 6  
 Historical and Projected Water Withdrawals from Beaver Lake by the Madison County Regional Water District and Requested and Current Total Yield Allocation (millions of gallons per day)



### 3.3 Risk and Uncertainty

Table 12 shows a range of projections characterized as the mid-point (figures in Table 11), and low and high variations. Low and high projections were generated using the 5<sup>th</sup> and 95<sup>th</sup> percent exceedance values for population projections for residential and commercial water use. Manufacturing high and low projections are 30 percent higher and lower based on professional judgment.

**Table 12**  
**Range of Projected Drought Demands and Yield Allocations for the Beaver Lake Reallocation Study**  
 (millions of gallons per day, drought conditions)

|  | 2016 | 2025 | 2035 | 2045 | 2055 | 2065 |
|--|------|------|------|------|------|------|
| Benton Washington Regional Water Authority |      |      |      |      |      |      |
| High                                       | 10.6 | 13.2 | 16.8 | 21.4 | 27.2 | 34.7 |
| Mid-point                                  | 10.5 | 12.6 | 15.5 | 18.9 | 23.2 | 28.4 |
| Low  | 10.5 | 12.1 | 14.3 | 16.8 | 19.7 | 23.2 |
| Carroll Boone Water District               |      |      |      |      |      |      |
| High                                       | 8.9  | 10.1 | 11.6 | 13.4 | 15.5 | 18.0 |
| Mid-point                                  | 8.9  | 9.6  | 10.6 | 11.6 | 12.8 | 14.2 |
| Low  | 8.8  | 9.0  | 9.2  | 9.4  | 10.6 | 11.2 |
| Madison County Regional Water Authority    |      |      |      |      |      |      |
| High                                       | 4.1  | 4.6  | 5.2  | 6.0  | 6.9  | 8.0  |
| Mid-point                                  | 4.1  | 4.4  | 4.7  | 5.1  | 5.6  | 6.1  |
| Low  | 4.0  | 4.1  | 4.2  | 4.4  | 4.6  | 4.8  |
| Total                                      |      |      |      |      |      |      |
| High                                       | 23.6 | 27.8 | 33.6 | 40.7 | 49.6 | 60.6 |
| Mid-point                                  | 23.5 | 26.6 | 30.7 | 35.7 | 41.6 | 48.8 |
| Low  | 23.4 | 25.3 | 27.7 | 30.6 | 34.9 | 39.2 |

Source: U.S. Army Corps of Engineers, Little Rock District, Planning and Environmental Division