Hydropower Analysis

BEAVER LAKE WATER SUPPLY REALLOCATION STUDY

Hydropower Analysis Center| Portland District | July 7, 2017

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1. Introduction

1.1. Purpose and Scope

This report, prepared by the Hydropower Analysis Center (HAC) for the Little Rock District (SWL), Corps of Engineers, presents an analysis of the hydropower benefits and costs of reallocating water at Beaver Lake for water supply. This reallocation request is for municipal and industrial (M&I) purposes and is needed to provide for an immediate need estimated at 22.0 MGD, which requires that 41,960.7 acre-feet (AF) of storage be reallocated for water supply (as described by SWL 18 FEB 2016). The study will focus on two reallocation conditions from inactive and conservation pools of 20.75 million gallons per day (MGD) totaling 25,360 AF.

1.2. Reallocation Authority

Authority for the Corps to reallocate existing storage space to M&I water supply is contained in Public Law 85-500, Title III, Water Supply Act of 1958, as amended. The Secretary of the Army is authorized to cooperate with local interests in providing storage space for M&I water supply in U.S. Army Corps of Engineers projects as long as the local interests agree to pay the costs associated with the storage space. The Chief of Engineers has the discretionary authority to reallocate storage capacity in Beaver Lake provided the reallocation has no severe effect on other authorized purposes and will not involve major structural or operational changes. If so, Congressional authorization is required.

1.3. White River Hydropower System Description

The U.S. Army Corps of Engineers (Corps) operates five projects with hydropower capabilities in the White River System: Beaver, Table Rock, Bull Shoals, Norfork, and Greers Ferry. Beaver, Table Rock, and Bull Shoals are located on the main stem White River in sequence (Fig. 1-1). Norfork and Greers Ferry are located on tributaries to the White River

The following paragraphs include brief descriptions of the projects examined in this study.

Beaver Project. Beaver Dam is located on the main stem of the White River at river mile 609.0, about 9 miles northwest of Eureka Springs, Arkansas. The reservoir extends into Benton, Carroll, and Washington Counties, Arkansas. The reservoir has a maximum storage of 1,952,000 acre-feet and drains an area of 1,186 square miles in the White River basin. The project is operated for flood control, water supply, recreation, and hydropower. The dam structure, which is 228 feet high and 2,575 feet long, was completed in 1963, and construction of the powerhouse and appurtenant structures was begun in April of 1963. Commercial hydropower generation began in May of 1965. The project power plant has an installed capacity of 112 megawatts and generates an average of 172,000 megawatt-hours (MWh) annually.

Table Rock Project. Table Rock Dam, which is downstream of the Beaver project, is located on the main stem of the White River at river mile 528.8, about six miles southwest of Branson, Missouri. The reservoir extends into Stone, Taney, and Barry counties, Missouri, and Carroll and Boone counties, Arkansas. The reservoir has a maximum storage of 3,462,000 acre-feet and drains an area of 4,020 square miles in the White River basin. The project is operated for flood control, recreation, and hydropower. The dam structure, which is 252 feet high and 6,423 feet long, was completed in August 1958. The construction of the powerhouse and switchyard was completed in June of 1959, and commercial hydropower generation began in this month. The project power plant has an installed capacity of 200 megawatts and generates an average of 495,000 MWh annually.

Bull Shoals Project. Bull Shoals Dam, which is downstream of the Beaver and Table Rock projects, is located on the main stem of the White River at river mile 418.6, about 7 miles north of Cotter, Arkansas. The reservoir extends into Clark, Ozark, and Taney counties, Missouri, and Baxter, Marion, and Boone counties, Arkansas. The reservoir has a maximum storage of 5,408,000 acre-feet and drains an area of 6,036 square miles in the White River basin. The project is operated for flood control, recreation, and hydropower. The dam structure, which is 256 feet high and 2,256 feet long, was completed in July 1951, and the powerhouse and switchyard were completed in July 1953. Commercial hydropower generation began in 1953. The project power plant has an installed capacity of 340 megawatts and generates an average of 785,000 MWh annually.

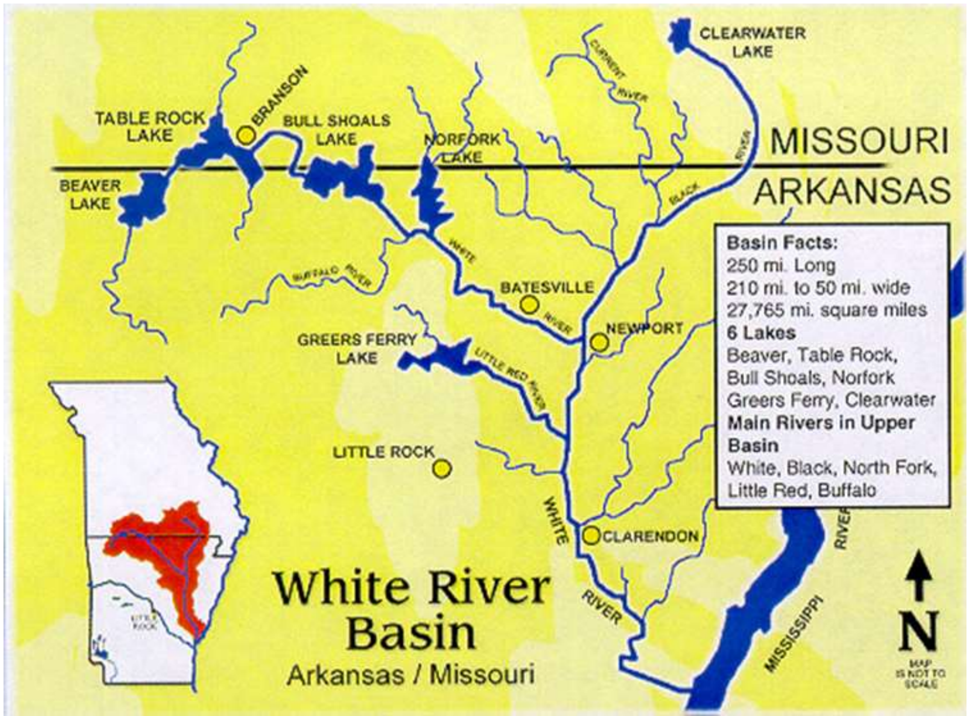
Norfork Project. Norfork Dam is located at river mile 4.8 on the North Fork River, about 4 miles northeast of Norfork, Arkansas. The reservoir extends into Ozark County, Missouri, and Baxter and Fulton Counties, Arkansas, has a maximum storage of 1,983,000 acre-feet, and drains an area of 1,806 square miles in the North Fork River basin. The project is operated for flood control, recreation, and hydropower. The dam structure, which is 216 feet high and 2,624 feet long, was completed in 1944, and the powerhouse and switchyard were completed in October of 1949. Commercial hydropower generation began in 1944. The project power plant has an installed capacity of 81 megawatts and generates an average of 184,000 MWh annually.

Greers Ferry Project. Greers Ferry Dam is located at river mile 79.0 on the Little Red River, about 3 miles northeast of Heber Springs, Arkansas. The reservoir extends into Van Buren and Cleburne counties, Arkansas, and has a maximum storage of 2,844,500 acre-feet and drains an area of 1,146 square miles in the Little Red River basin. The project is operated for flood control, recreation, and hydropower. The dam structure, which is 140 feet high and 1,704 feet long, was completed in December of 1962, and the powerhouse and switchyard were completed in July of 1964. Commercial hydropower generation began in 1964. The project power plant has an installed capacity of 96 megawatts and generates an average of 189,000 MWh annually.

Table 1-1. White River System Hydropower Project Capacities

Project	Installed Capacity (MW)
Beaver	112.0
Bull Shoals	340.0
Greers Ferry	96.0
Norfork	81.0
Table Rock	200.0

Figure 1-1. The White River Basin



2. General

2.1. Period of Analysis

The economic period of analysis is 50 years. The "Period of Analysis" as defined in *Planning Guidance Notebook*, Section 2-4j, for a multiple-purpose reservoir project, is not to exceed 100 years. Section E-63 i(1)(a)(1), "Benefits Foregone", defines the period of analysis for storage reallocations as the greater of (a) the remaining economic life of the project, or (b) 50 years.

2.2. Discount Rate

Both costs and benefits are expressed at an estimated October 2015 (FY2016) price level. Some prices, such as annual wholesale generation prices in the Energy Information Administration (EIA) Annual Energy Outlook forecasts, are based on a calendar year price level rather than fiscal year. Because the fiscal year overlaps three-quarters of the calendar year, these prices are used as if they were fiscal year prices, without adjustment. Costs and benefits occurring at different points in time are converted to an average annual equivalent basis over a 50-year period of analysis using the federal discount rate prescribed for water resources projects. This rate is currently 3.125%.

2.3. Price Level

Capacity unit value and energy costs and prices in this report are reported in FY2016 dollars. Because constant value dollars are used for all calculations, inflation and price escalation are not included in the analysis, as would be the case with nominal dollars.

2.4. Simulation with RiverWare

The RiverWare simulation model was used to simulate the operation of all hydropower projects in the White River System. Daily and hourly generation values were modeled. The simulation period extended from 1940 to 2011.

> NOTE: RiverWare energy output files are identical for both conditions of reallocation from Conservation Pool and Inactive Pool.

2.5. Conditions Description

The Corps modeled and evaluated five (5) alternative water supply allocations in this analysis. These conditions were chosen to represent different assumptions in Beaver Lake water reallocation. Appendix A, Conditions Description provides a detailed description of the conditions and tables of existing and requested reallocation of water supply among local entities.

2.6. Study Assumptions

The following assumption was made and reflected in the RiverWare model data used in this study:

- RiverWare model runs for Beaver Dam includes water management implications of other White River projects.

Water management and allocation decisions have a larger effect on the three main stem plants; therefore, effects of reallocation are not as for the Greers Ferry and Norfork that are located on tributaries.

2.7. Hydropower Effects

The procedures for computing the cost of reallocating water from hydropower to water supply use are outlined in ER 1105-2-100, *Planning Guidance Notebook* (22 April 2000), Appendix E, paragraph E-57, d(2). These procedures require that the reallocation cost charged to water supply customers be the highest of the following:

- Power benefits foregone
- Power revenues foregone
- Replacement costs of power
- Updated cost of storage

Power benefits foregone, power revenue foregone, and the replacement costs of power are impacts to hydropower. Power benefits foregone and power revenue foregone are computed in this report. The replacement costs of power is equal to power benefits foregone and are not computed separately. The updated cost of storage is not power related and will be computed by the Little Rock District based on the storage necessary to yield the requested withdrawals.

Conditions Analyzed

The following water reallocation conditions will be analyzed:

- **Base Case**
  - The Base Case or original condition is the lake with original seasonal/conservation pool elevations and water supply withdrawal rates prior to any reallocations.
- **Congressional**
  - Congressional condition is the lake with original and any subsequent congressional allocations or changes in elevations.
- **Current**
  - The Current Condition is the current conditions (as of 2015) with appropriate conservation/seasonal pool elevations and water supply withdrawal rates. No additional action is implemented beyond the existing condition.
- **Conservation Pool**
  - This reallocation condition is reallocation of 25,360 acre-feet of storage from the conservation pool. This accounts for 20.75 MGD per day.
- **Inactive Pool**
  - This reallocation condition is reallocation of 25,360 acre-feet of storage from the inactive pool. This accounts for 20.75 MGD per day.

    NOTE: Yield/storage for this Inactive Pool Condition of expanding storage into the Inactive Pool should change different when compared to reallocation from Conservation Pool.

Hydropower Generation Seasonality

The value of energy has a seasonal trend following the demand and generating resource availability through the year. This can be captured on a monthly level and is usually highly correlated with extreme temperatures. A first step in comparing conditions is to notice if any changes in a condition's operation strategy results in fundamental changes to the normal seasonal generating pattern. Figure 2-1 shows average monthly generation for all white river projects. Figures 2-2 to 2-6 provide a comparison of the five conditions and the base case for the system and by project.

Figure 2-1. Average Monthly Generation for White River System Hydropower Projects

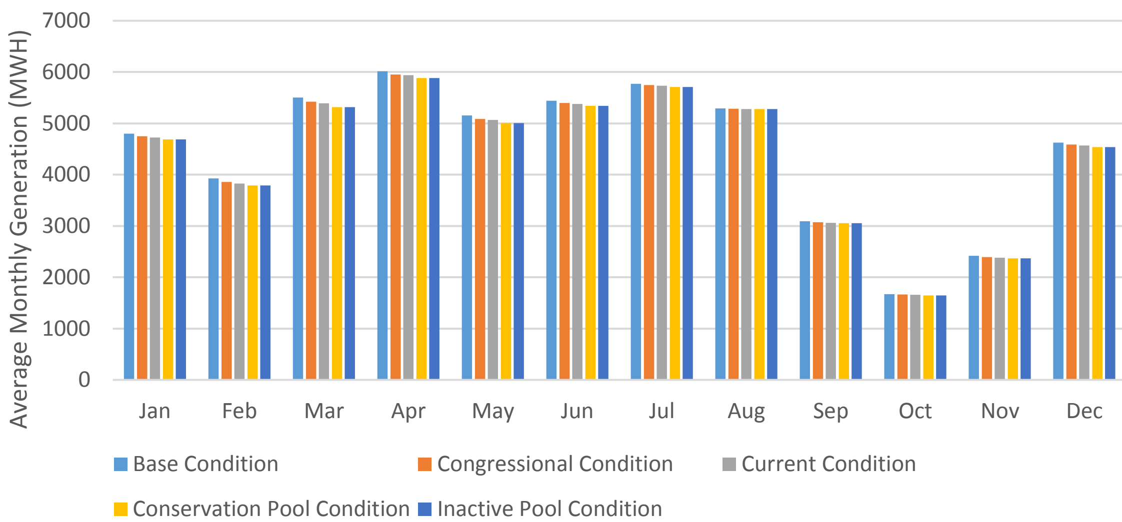


Figure 2-2. Beaver Average Monthly Generation

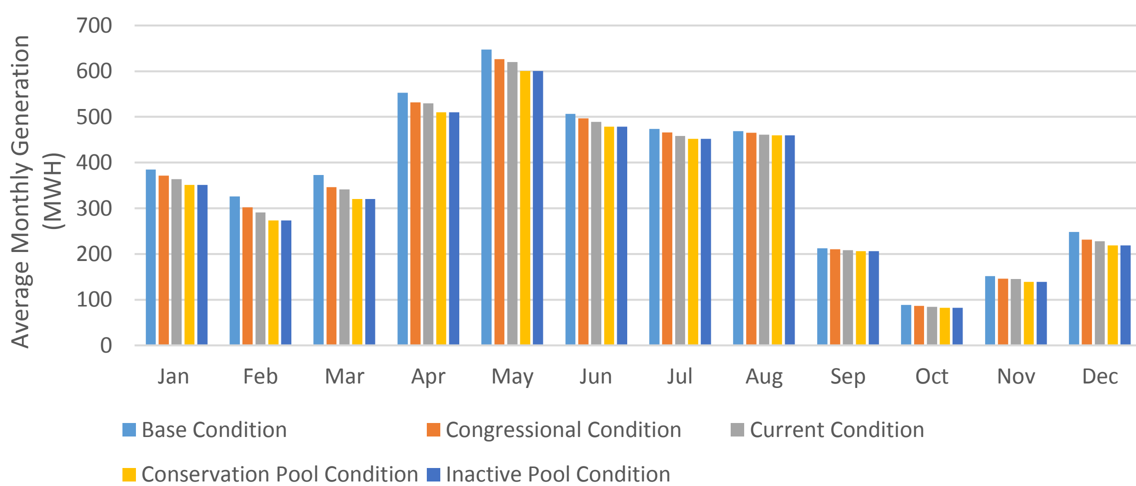


Figure 2-3. Bull Shoals Average Monthly Generation

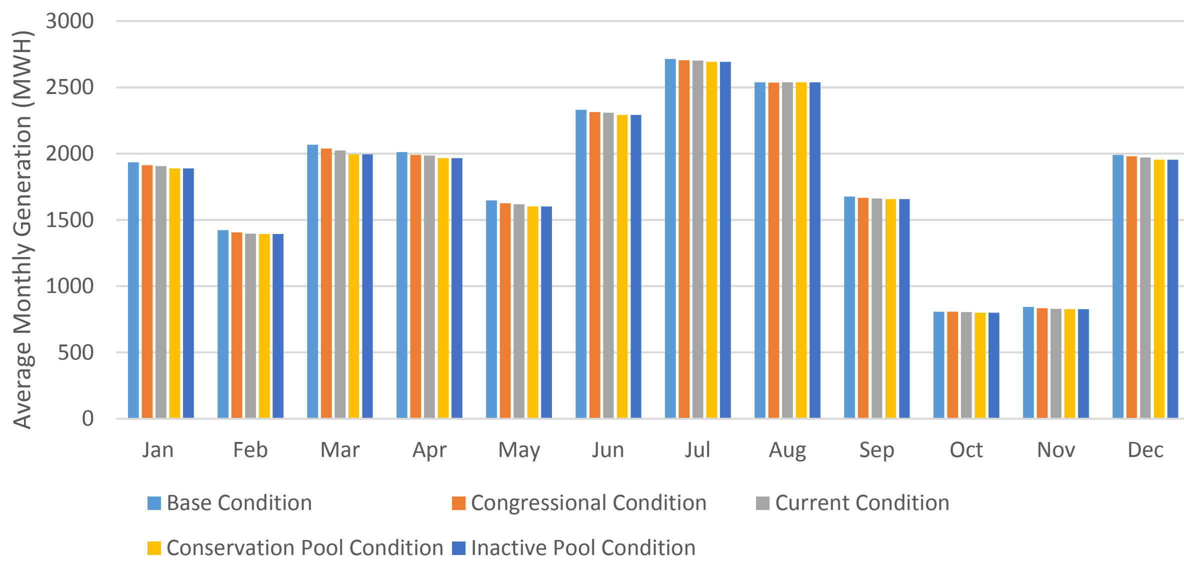


Figure 2-4. Greers Ferry Average Monthly Generation

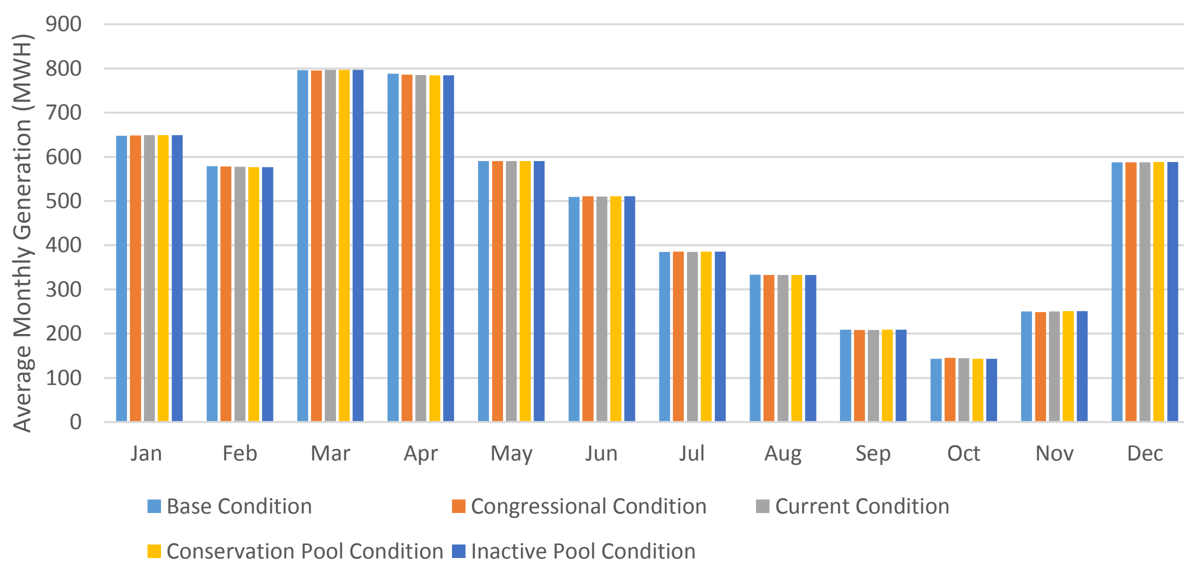


Figure 2-5. Norfork Average Monthly Generation

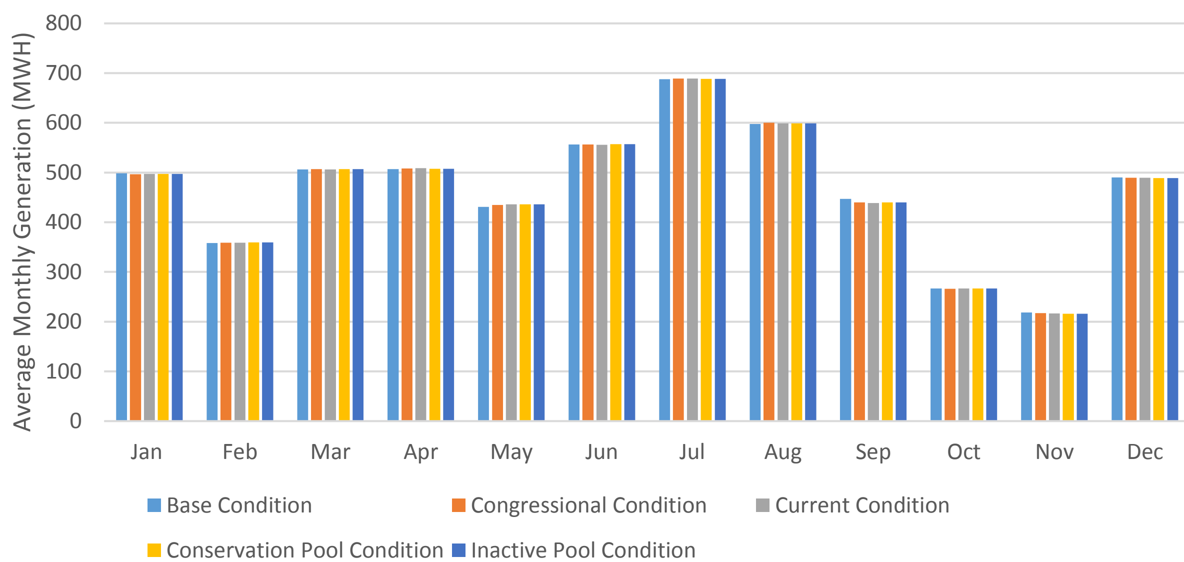
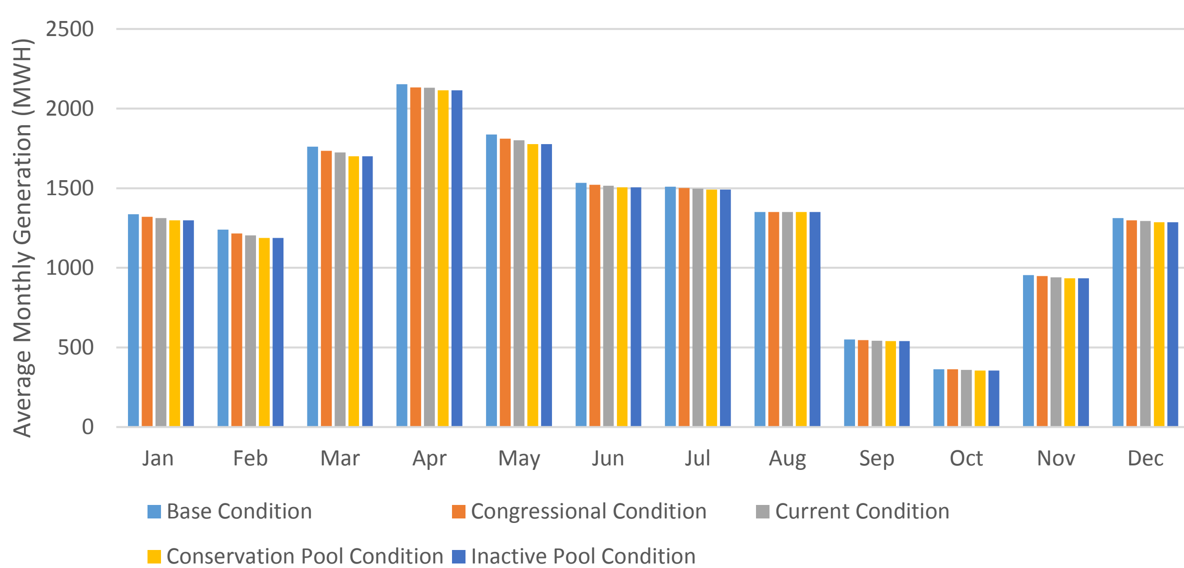


Figure 2-6. Table Rock Average Monthly Generation



3. Overview of Hydropower Benefits Forgone

Hydropower benefits are based on the cost of the most likely alternative source of power. When conservation storage is reallocated for water supply it is assumed that the lost hydropower will be replaced with power generated from thermal sources.

The power benefits foregone can be divided into two components, energy benefits foregone and capacity benefits foregone. Energy benefits foregone are based on the loss in generation (both at-site and downstream) as a result of water being diverted from the reservoir for water supply rather than passing through the hydropower plant. In addition, there could be a loss of capacity benefits as a result of a loss in dependable capacity at the project.

Energy Benefits Forgone

Energy benefits foregone are computed by binning energy generation and values by their value. This is done because energy values can vary significantly based on the time of day and day of the week (e.g. energy in the morning and early evening is more valuable than energy in the middle of the night due to demand). Binning is done in three categories: Super Peak, Peak, Off-peak. Energy benefits are computed by multiplying the binned expected annual generation loss in megawatt-hours (MWh) by the binned average annual energy price in dollars per megawatt-hour ($/MWh) over the period of analysis. These energy prices are based on the marginal cost of energy from a combination of thermal generating plants that would replace the energy lost from hydropower generation.

For each month of the year, the present value of forecast energy prices (values) over the 50-year period of analysis is amortized to produce annualized monthly prices. Energy benefits forgone are computed by condition: for each condition annualized monthly energy price and the energy loss due to water withdrawal are multiplied together.

The calculation of energy benefits foregone is presented in detail in Sections 5.

Capacity Benefits Forgone

Capacity benefits foregone are the product of the composite of fixed cost of the most likely mix of replacement thermal power and the loss of dependable capacity.

Capacity benefits foregone are computed by determining a capacity cost per MW representing the annualized fixed cost of the combination of thermal power plant types lost likely to replace the hydropower lost to the White River system as a result of the reallocation conditions.

Next, the loss of dependable capacity for each condition is calculated using the average availability method.

Loss of dependable capacity can be a result of:

- A loss in head due to lower post-withdrawal reservoir elevations
- Inadequate water to support full capacity during low-flow periods (i.e., low-flow periods that reduce the amount of water that can be passed through the generators)

Calculations of capacity value and dependable capacity are presented in Section 5.

4. Energy Benefits Forgone

4.1 Energy (Generation) for each Condition

The amount of energy generated at each of the five White River projects under existing conditions and under the reallocation of storage conditions at Beaver Lake was simulated by the Little Rock District using stream flows from the historical period of record (1940–2011) in the RiverWare model (a sequential streamflow routing model) run on a daily time-step.

NOTE: RiverWare energy output files are identical for both conditions of reallocation from Conservation Pool and Inactive Pool.

Daily Energy Blocks Defined

The regional definition of peak hours of generation is 6am to 10pm on weekdays and Saturdays. The off-peak hours of generation are the remaining hours on weekdays and all hours on Sunday; however, because generation by plants in the White River system is assumed to be concentrated in a subset of the highest-value weekday peak hours to fulfill power contracts, these blocks of hours were evaluated separately as super-peak (contract peak) and peak (non-contract peak) in order not to understate the their value. Table 4-1 presents the distribution of hours among super-peak and peak, and off-peak hours for each month of the year, and weekends. A schedule of these hours was provided by the Southwestern Power Administration (SWPA).

Table 4-1. Generation Schedule (blocks) for White River Hydropower Plants

Day Type	Month	Super-peak (hours)	Peak (hours)	Off-peak (hours)
Weekdays	January	5	11	8
	February	3	13	8
	March	3	13	8
	April	3	13	8
	May	3	13	8
	June	5	11	8
	July	9	7	8
	August	9	7	8
	September	4	12	8
	October	3	13	8
	November	3	13	8
	December	5	11	8
Weekends (All Year)	Saturday	0	16	8
	Sunday	0	0	24

As an example of how daily energy production is allocated between hours, Table 5-2 below shows the simulated energy production for Beaver for seven days of June 7, 1999 under existing (baseline) conditions. The capability is constant so the maximum on-peak production Monday through Friday would be 16 hours per day of generation at the plant capability of 129 MW (2,064 MWh), of which 3 hours would be contract generation (387 MWh) and the remaining 13 hours would be non-contract generation (1,677 MWh). Generation in excess of 16 hours on weekdays and Saturdays is off-peak energy. All power generated on Sunday is also off-peak energy.

Table 4-2. Super Peak, Peak, and Off-peak Energy (block) Allocation for Beaver Dam (7-13 June 1999)

Date	Day	Capability (Power in DSS) (MW)	Energy Production (MWH)	Super Peak Energy (MWH)	Peak Energy (MWH)	Off-peak Energy (MWH)
06-07-99	Monday	129	3096	645	1419	1032
06-08-99	Tuesday	129	3096	645	1419	1032
06-09-99	Wednesday	129	3096	645	1419	1032
06-10-99	Thursday	129	3096	645	1419	1032
06-11-99	Friday	129	3096	645	1419	1032
06-12-99	Saturday	129	3096	0	2064	1032
06-13-99	Sunday	129	3096	0	0	3096

Average monthly super peak, peak and off-peak energy for each project under existing conditions are shown below in Figures 4-1 through 4-5. Monthly energy generation was also computed for each project and the White River system and is reported in Appendix C.

Figure 4-1. Beaver Average Monthly Block Energy Generation under Existing Conditions

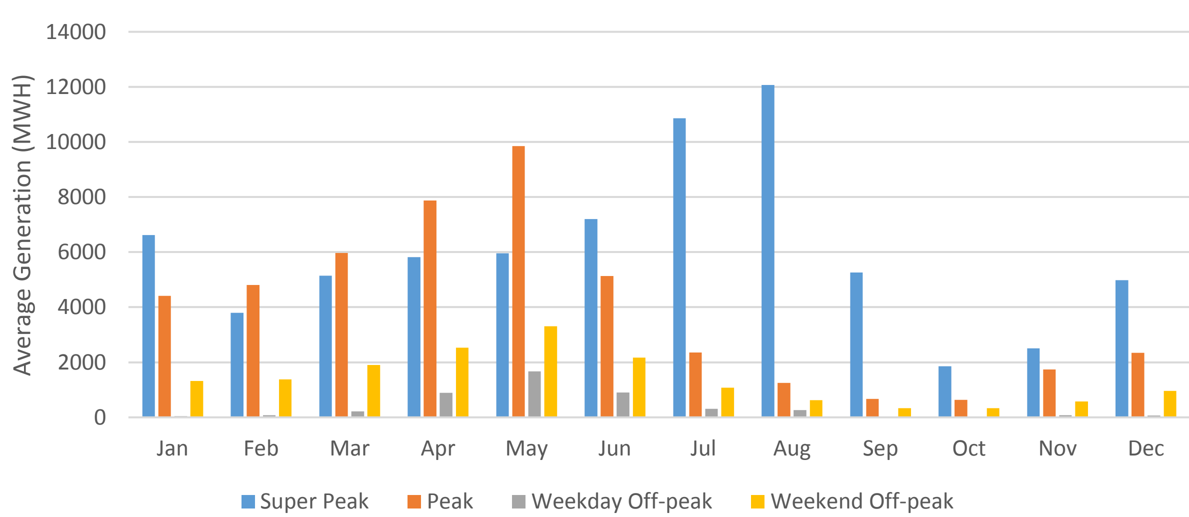


Figure 4-2. Bull Shoals Average Monthly Block Energy Generation under Existing Conditions

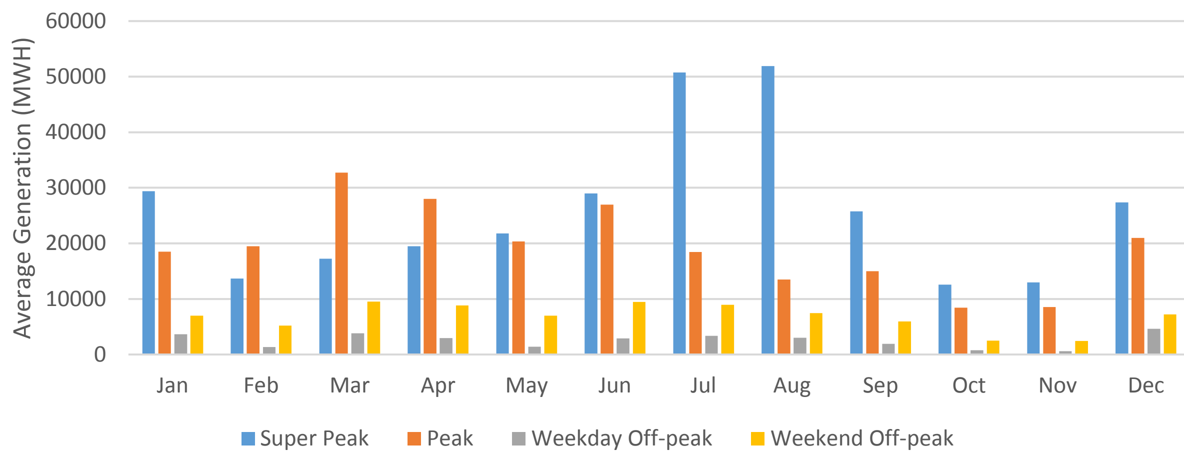


Figure 4-3. Greers Ferry Average Monthly Block Energy Generation under Existing Conditions

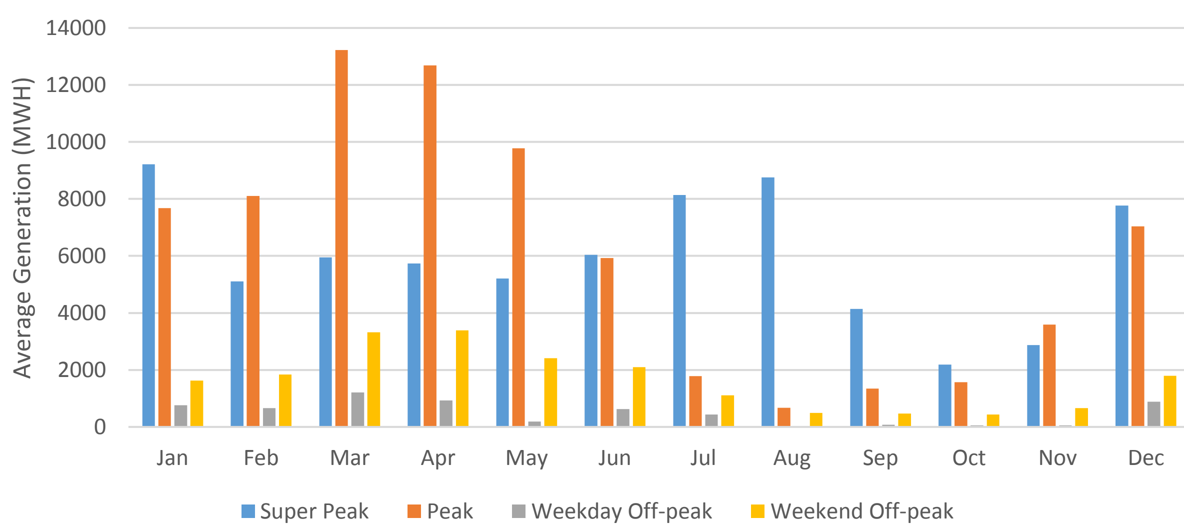


Figure 4-4. Norfork Average Monthly Block Energy Generation under Existing Conditions

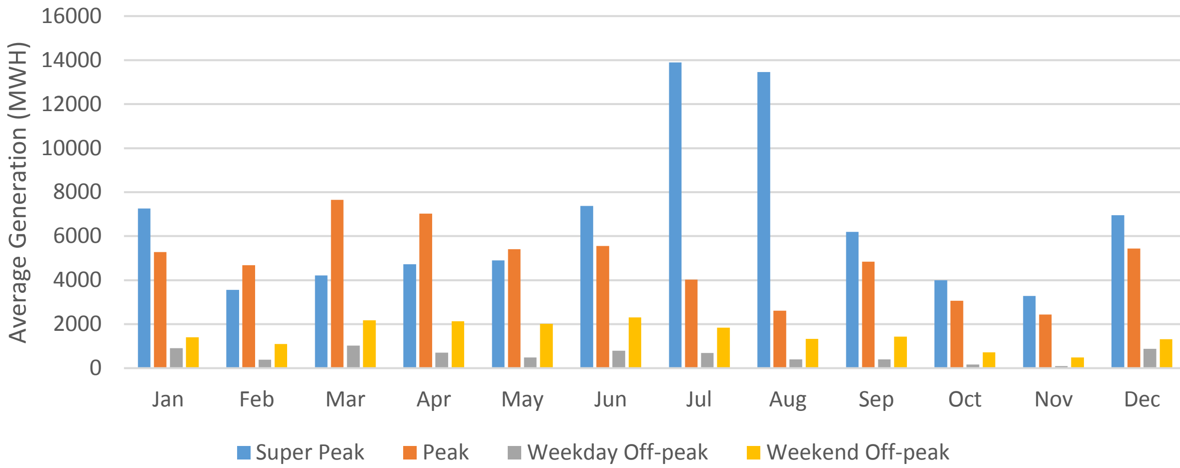
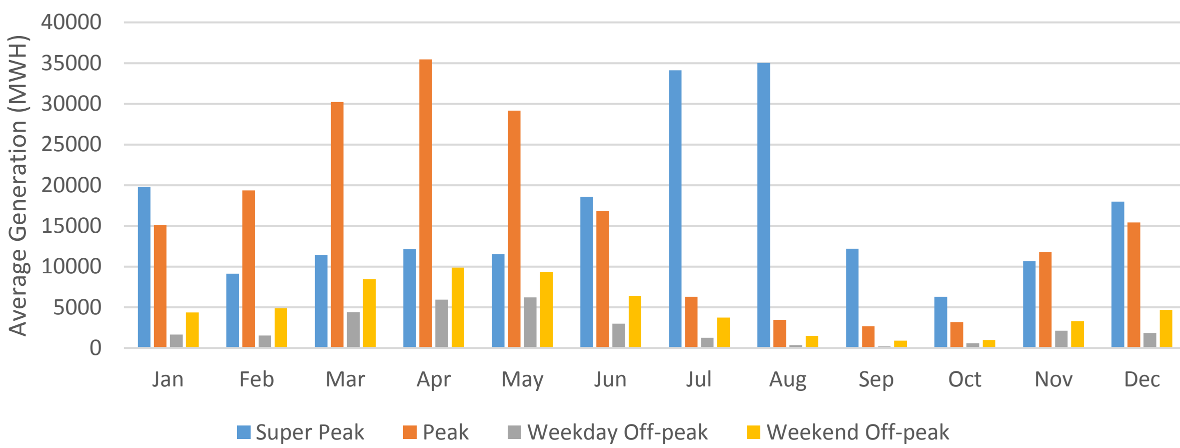


Figure 4-5. Table Rock Average Monthly Block Energy Generation under Existing Conditions



4.2 Energy Unit Values

This analysis uses simulation outputs to estimate the effects of water management decisions and hydropower production. The simulation estimates for this analysis cover 71 years in the past, but a forecast of energy values is also needed to predict energy prices for years to come.

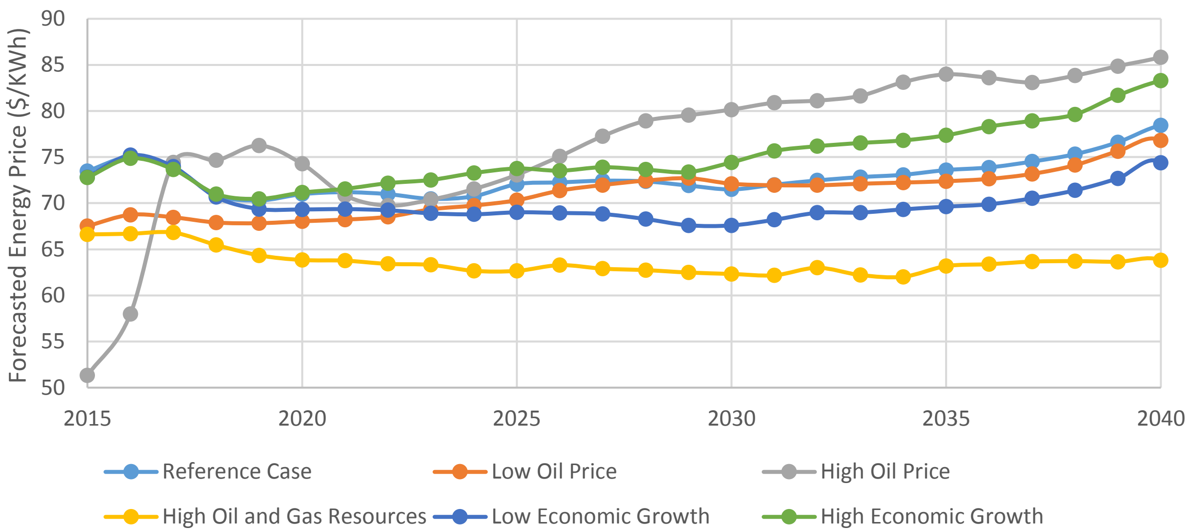
Future energy values in this analysis are based on EIA forecasts from the supplemental tables of "Annual Energy Outlook" (AEO 2015). The EIA forecasts are developed with the Electricity Market Model (EMM) as part of the National Energy Modeling System (NEMS). The following description is from the model documentation report available on the EIA website:

> *The National Energy Modeling System (NEMS) was developed to provide 20-to-25 year forecasts and analyses of energy-related activities. The NEMS uses a central database to store and pass inputs and outputs between the various components. The NEMS Electricity Market Module (EMM) provides a major link in the NEMS framework (Figure 1). In each model year, the EMM receives electricity demand from the NEMS demand modules, fuel prices from the NEMS fuel supply modules, expectations from the NEMS system module, and macroeconomic parameters from the NEMS macroeconomic module. The EMM estimates the actions taken by electricity producers (electric utilities and non-utilities) to meet demand in the most economical manner. The EMM then outputs electricity prices to the demand modules, fuel consumption to the fuel supply modules, emissions to the integrating module, and capital requirements to the macroeconomic module. The model iterates until a solution is reached for each forecast year.*

In addition to providing average annual energy forecasts of electrical generation prices through 2040, AEO 2015 also includes regional forecasts corresponding to North American Electric Reliability Corporation (NERC) regional entity sub-regions for different energy cases. These cases were plotted to demonstrate the variance in EIA forecasts by case (Figure 5-6). The White River system projects are located in the Southwestern Power Pool.

Energy prices can significantly change hourly, daily, and seasonally; therefore, to estimate lost hydropower energy benefits, the energy price forecast must consider when hydropower energy benefits will be lost and the variability of the associated replacement energy price. For this study we assume the energy price forecast for the White River are best estimated using the Reference Case for Southwestern Power Pool southern sub-region (SPP/S).

Figure 4-6. EIA Annual Energy Outlook 2015 Price Forecast by Case (SPP/S)



Note: Forecasted prices are indexed to FY2016 dollars

Locational Marginal Pricing

Location Marginal Pricing (LMP) is a computational technique that determines an hourly shadow price for an additional MWh of demand. The LMP node values for Southwestern Power Administration (SPA) node reported by Midwest Independent System Operator (MISO) were used for this study. Historical LMP values for the SPA node can be downloaded from the MISO website.

LMP provides historical pricing, so the data was utilized in combination with information from the EIA to develop an energy price forecast. Each year the EIA publishes an Annual Energy Outlook (AEO) that includes 30 years of forecasted electricity costs for different electric market modules organized by the three cost categories of generation, transmission and distribution. The forecasted values encompass a wide range of assumptions, including a reference case that is used for calculating benefits. The AEO also lists actual electricity prices for three historical years. The EIA generation forecast for the SERC/Delta Sub-region electric market module was used to forecast future LMP values for this study.

To shape the values the following ratio is assumed:

$$\frac{LMP_{Future}}{LMP_{Past}} = \frac{EIA\_Generation_{Future}}{EIA\_Generation_{Past}}$$

This can be rewritten as:

$$LMP_{Future} = EIA\_Generation_{Future} * \frac{LMP_{Past}}{EIA\_Generation_{Past}}$$

Future LMP values can then be computed by the product of the EIA generation forecast and a shaping ratio defined as:

$$ShapingRatio = \frac{LMP_{Past}}{EIA\_Generation_{Past}}$$

Unique shaping ratios are defined to reflect the daily and seasonal variability of the generation block schedule described in Table 5-1. To replicate this schedule, daily historical LMP values are sorted from high to low and divided into three blocks, with the higher LMP values associated with the on-peak contract hours and the lower LMP values associated with the off-peak hours. Seasonal variability is taken into account by computing shaping ratios for each month. These shaping ratios are computed as averages among dates with like generation block and month using the equation:

$$ShapingRatio(month, generation\_block) = Average\left(\frac{LMP_{Past}(month, generation\_block, year)}{EIA\_Generation_{Past}(year)}\right)$$

This produces the following equation to estimate LMP forecasts for the four blocks (peak classifications) described in Table 5-1 for each month:

$$LMP_{Future}(generation\_block, month) = EIA\_Generation_{Future} * ShapingRatio(generation\_block, month)$$

Table 5-3 tabulates the shaping factors for each block of energy.

Next, prices for EIA average annual prices were downloaded and shaped for each the EIA economic reference case and future energy cases to the year 2040.

Table 4-3. Generation Shaping Factor for Each Generation Block

Month	Super Peak	Peak	Weekday Off-peak	Weekend Off-peak
January	0.67	0.45	0.40	0.42
Feb	0.70	0.44	0.40	0.41
Mar	0.68	0.41	0.41	0.39
Apr	0.56	0.37	0.41	0.33
May	0.65	0.44	0.38	0.36
Jun	0.78	0.43	0.38	0.27
Jul	1.31	0.53	0.46	0.36
Aug	0.86	0.47	0.40	0.34
Sep	0.80	0.41	0.35	0.32
Oct	0.66	0.40	0.40	0.38
Nov	0.50	0.39	0.42	0.39
Dec	0.51	0.39	0.46	0.43

Table 5-4 shows the EIA forecasts of average blocked wholesale energy generation prices for the period 2015 through 2040, indexed to constant FY 2016 dollars. Annualized Super Peak, Peak and Off-peak monthly values were computed using the current federal discount rate of 3.125% for the 50-year period of analysis. Shaped, monthly energy values are the product of the EIA reference case and the generation shaping factors, resulting

Table 4-4. Average Block Energy Prices by Month

Month	Super Peak	Peak	Weekday Off-peak	Weekend Off-peak
Jan	$47.51	$31.81	$28.40	$29.96
Feb	$49.87	$31.49	$28.65	$29.39
Mar	$47.96	$29.36	$28.88	$27.63
Apr	$39.92	$26.07	$29.13	$23.13
May	$45.92	$30.94	$27.23	$25.25
Jun	$55.33	$30.72	$27.25	$19.27
Jul	$92.54	$37.66	$32.26	$25.62
Aug	$60.79	$33.07	$28.48	$24.44
Sep	$56.91	$29.31	$25.01	$22.46
Oct	$46.73	$28.48	$28.19	$27.22
Nov	$35.46	$27.33	$29.87	$27.99
Dec	$35.81	$27.84	$32.74	$30.76

4.3 Energy Benefits

In this Section energy benefits foregone are computed for only two conditions; Reallocation for Conservation Pool and Reallocation from the Inactive Pool by taking differences from the Current Condition (all energy values are reported in Appendix B). The average monthly generation values in Table 4-4 were multiplied by these differences for these two conditions to obtain the energy benefits foregone.

NOTE: RiverWare model output of daily generation for both reallocation from Conservation Pool and Inactive Pool are the same thus the benefits foregone will be identical.

The product of Table 4-4 and these differences is referred to as energy benefits forgone. Energy benefits forgone by condition are reported in Tables 4-5 to 4-6. For clarity, losses are expressed as negative numbers and increases in generation are presented as positive numbers.

Table 4-5. Energy Benefits Foregone Summary for Reallocation from Conservation Pool Condition

Project	Time	Energy Benefits Forgone	Total Forgone Benefits
Beaver	Super Peak	-$55,224.83	**-$130,142.79**
	Peak	-$52,835.06	
	Weekday Off-peak	-$6,394.30	
	Weekend Off-peak	-$15,688.60	
Bull Shoals	Super Peak	-$18,764.75	**-$117,546.32**
	Peak	-$71,103.12	
	Weekday Off-peak	-$1,522.29	
	Weekend Off-peak	-$26,156.16	
Greers Ferry	Super Peak	$2,754.94	**$1,046.56**
	Peak	-$1,070.89	
	Weekday Off-peak	-$504.74	
	Weekend Off-peak	-$132.76	
Norfork	Super Peak	$1,441.45	**-$1,173.20**
	Peak	-$5,536.06	
	Weekday Off-peak	$681.94	
	Weekend Off-peak	$2,239.47	
Table Rock	Super Peak	-$11,217.62	**-$114,649.36**
	Peak	-$75,263.92	
	Weekday Off-peak	-$10,736.90	
	Weekend Off-peak	-$17,430.92	
Total	Super Peak	-$81,010.81	**-$418,559.23**
	Peak	-$203,245.01	
	Weekday Off-peak	-$19,034.38	
	Weekend Off-peak	-$115,269.03	

Table 4-6. Energy Benefits Foregone Summary for Reallocation from Inactive Pool

Project	Time	Energy Benefits Forgone	Total Forgone Benefits
Beaver	Super Peak	-$55,224.83	**-$130,142.79**
	Peak	-$52,835.06	
	Weekday Off-peak	-$6,394.30	
	Weekend Off-peak	-$15,688.60	
Bull Shoals	Super Peak	-$18,764.75	**-$117,546.32**
	Peak	-$71,103.12	
	Weekday Off-peak	-$1,522.29	
	Weekend Off-peak	-$26,156.16	
Greers Ferry	Super Peak	$2,754.94	**$1,046.56**
	Peak	-$1,070.89	
	Weekday Off-peak	-$504.74	
	Weekend Off-peak	-$132.76	
Norfork	Super Peak	$1,441.45	**-$1,173.20**
	Peak	-$5,536.06	
	Weekday Off-peak	$681.94	
	Weekend Off-peak	$2,239.47	
Table Rock	Super Peak	-$11,217.62	**-$114,649.36**
	Peak	-$75,263.92	
	Weekday Off-peak	-$10,736.90	
	Weekend Off-peak	-$17,430.92	
Total	Super Peak	-$81,010.81	**-$418,559.23**
	Peak	-$203,245.01	
	Weekday Off-peak	-$19,034.38	
	Weekend Off-peak	-$115,269.03	

5. Capacity Benefits Forgone

5.1 Dependable Capacity

A hydropower project's dependable capacity is a measure of the amount of capacity that the project can reliably contribute towards meeting system peak power demands. If a hydropower project always maintains approximately the same head, and there is always an adequate supply of stream flow so that there is enough generation for the full capacity to be usable in the system load, the full installed capacity can be considered dependable. In some cases even the overload capacity is dependable.

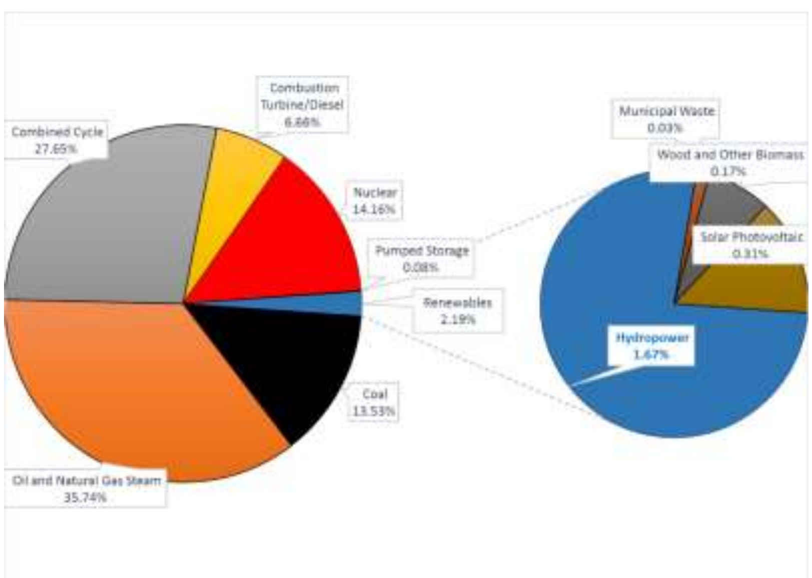
However, at storage project's normal reservoir drawdown can result in a loss of capacity due to a loss in head. At other times, stream flows in low flow periods may result in insufficient generation to support the available capacity in the load. Dependable capacity accounts for these factors by giving a measure of the amount of capacity that can be provided with some degree of reliability during peak demand periods.

5.2 Evaluation Method

The most appropriate method for evaluating a hydropower plant's dependable capacity in a predominantly thermal-based power system is the average availability method, as described in Section 6-7g of EM 1110-2-1701, *Hydropower*, dated 31 December 1985. The occasional unavailability of a portion of hydro project's generating capacity due to hydrologic variations is treated in the same manner as the occasional unavailability of all or part of a thermal plant's generating capacity due to forced outages. The average availability method attempts to measure the average capacity available during the peak demand periods of the year.

The SERC-Delta sub-region is primarily a thermal-based power system, as illustrated in Figure 5-1. Consequently, the average availability method is the most appropriate method for measuring dependable capacity for this analysis.

Figure 5-1. Generation Capacity by Generation Type for SERC-Delta Sub-region, 2016 Forecast



Source: Annual Energy Outlook 2015, Energy Information Administration, U.S Department of Energy

Hydrologic Period of Analysis

In order to evaluate the average dependable capacity of a project during its peak demand season, a long-term record of project operation must be used. Actual project operating records can be used, but the period of operation may not be long enough to give a statistically reliable value. Furthermore, operating changes may have occurred over the life of the project, which would make actual data somewhat inconsistent.

An alternative method is the use of a period-of-record computer simulation of system operation. As described in Section 2.4, the Little Rock District provided a daily simulation of the White River projects over the period 1940 to 2011 (72 years). This simulation, which was performed using the RiverWare streamflow routing model, served as the basis of this study's dependable capacity computations. Because reallocation of water at Beaver Lake changes the amount of water available for power generation at all five of the White River projects, dependable capacity calculations were performed for each project and then summed to estimate changes in dependable capacity for the White River system.

5.3 Dependable Capacity Procedure

The initial step is to calculate each project's contribution (average weekly generating hours) to the system's capacity for the regional critical year. That contribution estimate was determined by first calculating each project's average weekly energy produced (MWh) for the peak demand months of June through September in 1954, the critical period used by SWPA to calculate marketable capacity. That number was then divided by SWPA's defined marketable capacity (MW), giving an estimate of average (expected) weekly generating hours during the peak demand months. Coordination with SWPA confirmed marketable capacity values for the Corps hydropower plants and that the critical water year of 1954. These values, as well as the marketable capacity and machine capability (i.e., the overload capacity) of each project, are presented in Table 6-1.

Table 5-1. Machine Capability, Weekly Energy, Marketable Capacity, and Average Weekly Generation Hours for White River Hydropower Plants

Project	Beaver	Bull Shoals	Greers Ferry	Norfork	Table Rock
Machine Capability (MW) [Eq (5) below]	128.8	391.0	110.4	92.5	230.0
Average Weekly Energy (MW)* [Eq (1) below]	1087.9	6080.9	2358.4	2492.6	4825.3
SWPA Marketable Capacity (MW) [Eq (2) below]	128.8	373.0	109.1	75.6	230.0
Average Weekly Generation Hours * (Eq (3) below]	8.5	16.3	21.6	33.0	21.0

** Value is computed for the critical period (1954)*

Next, each project's average weekly energy (MWh) produced during the peak demand months was calculated for each simulated year. Dividing those values for each project's by the average weekly generating hours from the critical period, as determined in the previous step, yields an array of yearly potential supportable capacity values. However, energy produced is limited by the machine capability of the project. The actual supportable capacity for any given year is consequently the lesser of the potential supportable capacity or the machine capability. With the average availability method, dependable capacity is the average actual supportable capacity over the period of record.

These values are defined in the following equations:

Eq. (1) Average Weekly Energy (MWh)$_{(\text{year = i})}$ =

Total Energy (MWh)$_{(\text{year = i})}$ / 17 weeks

Eq. (2) Marketable Capacity (MW) = Marketable Capacity as provided by SWPA

Eq. (3) Average Weekly Generating Hours$_{(\text{baseline critical period-1954})}$ =

Average Weekly Energy (MWH)$_{(\text{baseline critical period-1954})}$ / Marketable Capacity (MW)

Eq. (4) Potential Supportable Capacity (MW)$_{(\text{year=i})}$ =

Average Weekly Energy$_{(\text{year=i})}$ / Average Weekly Generating Hours$_{(\text{baseline critical period-1954})}$

Eq. (5) Machine Capability (MW) = Overload Capacity of Project (MW)

Eq. (6) Actual Supportable Capacity (MW)$_{(\text{year=i})}$ =

MIN (Potential Supportable Capacity (MW)$_{(\text{year=i})}$, Machine Capability (MW))

Eq. (7) Dependable Capacity = Average Actual Supportable Capacity over the Period of Record

As an example of how dependable capacity is calculated, Table 6-2 shows the values described in the previous paragraphs for the base condition for Beaver Lake for the years 1940-2011 (the years 1960-2006 are not shown for brevity). The average actual supportable capacity for the years 1940-2011 for Beaver Lake is 124.8 MW. For most years, the actual supportable capacity is equal to the machine capability (overload capacity) of the project. The dependable capacity is calculated based on the average number of generating hours per week in a critical year in which water was scarce.

Table 5-2. Dependable Capacity Calculations for Existing Conditions, Beaver Lake and Dam, 1940-2011 Period of Record

Year	Average Weekly Energy (MW)	Potential Supportable Capacity (MW)	Machine Capability (MW)	Actual Supportable Capacity (MW)
		Eq (4) above	Eq (5) above	Eq (6) above
1940	628.03	74.26	128.80	74.26
1941	1425.82	168.60	128.80	128.80
1942	3708.64	438.53	128.80	128.80
1943	3821.98	451.93	128.80	128.80
1944	3516.90	415.85	128.80	128.80
1945	4459.66	527.33	128.80	128.80
1946	4084.85	483.01	128.80	128.80
1947	4975.23	588.29	128.80	128.80
1948	3996.19	472.53	128.80	128.80
1949	2906.76	343.71	128.80	128.80
1950	5071.62	599.69	128.80	128.80
1951	2955.94	349.52	128.80	128.80
1952	3861.81	456.64	128.80	128.80
1953	2829.82	334.61	128.80	128.80
1954	1089.27	128.80	128.80	128.80
-	-	-	-	-
-	-	-	-	-
2007	1501.83	177.58	128.80	128.80
2008	3288.46	388.84	128.80	128.80
2009	3433.12	405.95	128.80	128.80
2010	2684.21	317.39	128.80	128.80
2011	3668.42	433.77	128.80	128.80
		[Eq (7) above]	**Average Availability**	**124.8**

Table 5-3 summarizes the dependable capacity for each of the five White River projects as well as the total dependable capacity under the base, congressional, current, conservation pool, and inactive pool conditions.

NOTE: The effects of both the conservation and inactive pool conditions on dependable capacity are identical because RiverWare model daily energy output is the same under both conditions.

Table 5-3. Dependable Capacity Summary

Project	Beaver	Bulls Shoals	Greers Ferry	Norfork	Table Rock	White River Total
Base Condition (MW)	124.48	388.15	83.11	83.46	227.53	**906.73**
Congressional Condition (MW)	124.43	388.13	83.24	83.43	227.51	**906.74**
Current Condition (MW)	124.40	388.12	83.12	83.50	227.50	**906.64**
Conservation Pool Condition (MW)	124.40	388.12	83.28	83.45	227.52	**906.77**
Inactive Pool Condition (MW)	124.40	388.12	83.28	83.45	227.52	**906.77**

5.4 Capacity Values

Capacity benefits are an estimate of the investment cost of thermal generating plant capacity that would be needed to replace the lost capacity due to the water withdrawals from the reservoir. Capacity benefits are computed as the product of the dependable capacity loss and a capacity unit value, which is based on the unit cost of constructing the most likely thermal generating alternative.

Most Likely Thermal Generation Alternative

A screening curve analysis was conducted to determine the mix of thermal generating types that would be the most likely (least-cost) replacement alternative for each of the White River hydropower plants. The type of thermal generating plants considered were coal-fired steam (base loads displacement), gas-fired combined cycle (intermediate loads displacement), and gas-fired combustion turbine (peak loads displacement).

Values Used in Screening Curve Analysis

Capacity unit values for coal-fired steam, gas-fired combined cycle and combustion turbine plants were computed using procedures developed by the Federal Energy Regulatory Commission (FERC). Capacity values were computed based on a 3.125% discount rate and a FY2016 price level. The adjusted capacity values incorporate adjustments to account for differences in reliability and operating flexibility between hydropower and thermal generating power plants. See EM 1110-2-1701, Hydropower, Section 9-5c for further discussion on the capacity value FERC adjustments.

Operating costs for coal-fired steam, gas-fired combined cycle and gas fired combustion turbine plants were developed using information obtained from the EIA Electric Power Monthly (DOE/EIA-0226) and other sources. The information obtained included fuel costs, heat rates, and variable O&M costs. Since current Corps of Engineers policy does not allow the use of real fuel cost escalation, these values were assumed to apply over the entire period of analysis.

Cost data contained in EIA report "Updated Capital Cost Estimates for Utility Scale Electricity Generating Plants", was used to update the base costs indexed in the FERC spreadsheet models for power generation costs.

Adjusted capacity values and operating costs for the Arkansas and Oklahoma were averaged and are presented in Table 5-4.

Table 5-4. Plant Capacity and Operating Costs

Metric	Coal-fired Steam	Combined Cycle	Combustion Turbine
Adjusted Capacity Value ($/kW-yr)	316.54	173.81	91.75
Operating Costs ($/MWH)	36.11	34.47	60.92

Screening and Generation-Duration Curve Analyses

To determine the most likely and least costly thermal alternative, a generation-duration curve and screening curve are generated (Figure 5-2). The goal of the analysis is to determine the least costly mix of energy generating types to replace the lost hydropower generation.

A generation-duration curve (Figure 5-2, top) plots observed hourly generation and shows how much time each level of generation occurs in a typical year. Observed hourly generation values are compared to total project nameplate capacity for data verification.

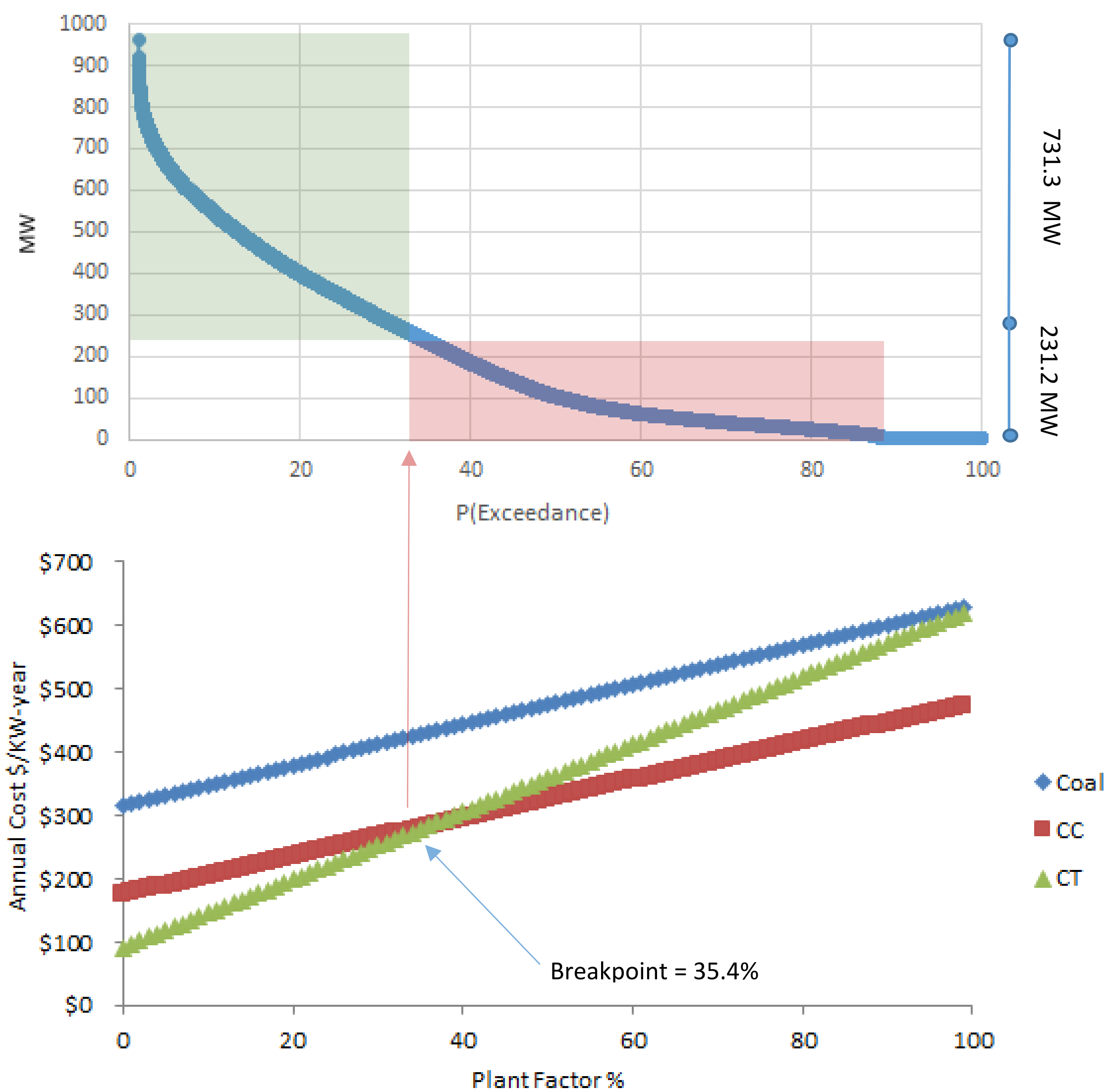
A screening curve (Figure 5-2, Bottom) plots annual total plant costs for a thermal generating plant [fixed (capacity) cost plus variable (operating) cost] versus annual plant factor. When this is applied to multiple types of thermal generation resources, the screening curve provides an algebraic way to show which type of thermal generation is the least cost alternative for each plant factor range.

The screening curve assumes a linear function defined by the following equation:

$$AC = CV + (EV * 0.0876 * PF)$$

Where:
AC = annual thermal generating plant total cost ($/kW-year)
CV = thermal generating plant capacity cost ($/KW-year)
EV = thermal generating plant operating cost ($/MWh)

Figure 5-2. Generation-Duration and Screening Curve for the White River System



The breakpoints of the White River screening curve are the points where the thermal alternative lines cross. Breakpoints show what types of power generation will substitute for hydroelectric generation when compared with the White River system duration curve. For plant factors less than or equal to 35.4%, natural gas turbine (CT) generation is the lowest cost alternative for the first 731.3 MW. In the case of the system generation-duration curve, plant factors can exceed 35.4%, meaning combined cycle (CC) generation would be used as the lowest cost thermal alternative for 231.2 MW. Coal (CO) was not a low cost replacement.

These thermal capacities for the three plant types are used to weight the respective adjusted capacity values from Table 5-4 and summed to produce a composite capacity value.

The calculation for the White River system of projects is:

$$Comp.\ Capacity = \left[ACV_{CT} \cdot \left(\frac{Replacement\ Capcity_{CT}}{Maximum\ Capacity}\right)\right] + \left[ACV_{CC} \cdot \left(\frac{Replacement\ Capcity_{CC}}{Maximum\ Capacity}\right)\right]$$

Where:
ACV=Adjusted Capacity Value
CT=Combustion Turbine
CC=Combined Cycle

Using the formula above, the composite capacity for the White River system was computed:

$$\left[\$91.75 \cdot \left(\frac{731.3\ MW}{962.5\ MW}\right)\right] + \left[\left(\$171.81 \cdot \left(\frac{231.2\ MW}{962.5\ MW}\right)\right)\right] = \$110.98\ per\ kW - year$$

5.4 Capacity Benefits

The capacity value for the White River system projects is then converted to dollars per kW-year and multiplied by the respective changes in dependable capacity to determine capacity benefits foregone.

Changes in dependable capacity in Table 5-3 are summarized in Table 5-5.

Table 5-5. Changes in Dependable Capacity (Conditions-Current Condition)

Project	Beaver	Bull Shoals	**Greers Ferry**	Norfork	Table Rock	White River Total
Current Condition (kW)	-	-	-	-	-	**-**
Conservation Pool Condition (kW)	0.00	0.00	160.00	-50.00	20.00	**130.00***
Inactive Pool Condition (kW)	0.00	0.00	160.00	-50.00	20.00	**130.00***

**Since there is a net gain in total system dependable capacity, system dependable capacity values are positive*

Dependable capacity losses in Table 5-5 were multiplied by the White River System capacity value (110.98 $/kW-yr) to compute the capacity benefits forgone for each project and summarized in Table 5-6.

Table 5-6. Capacity Benefits Foregone by Condition

Project	Greers Ferry	Beaver	Bulls Shoals	Norfork	Table Rock	White River System Total
Current Condition	-	-	-	-	-	-
Conservation Pool Condition	$17,756.80	$0.00	$0.00	-$5,549.00	$2,219.60	**$14,427.40***
Inactive Pool Condition	$17,756.80	$0.00	$0.00	-$5,549.00	$2,219.60	**$14,427.40***

**Since there is a net gain in total system dependable capacity, total benefits are positive*

6. Summary of Hydropower Benefits Forgone

Tables 6-1 to 6-5 summarize annual hydropower (energy + capacity) benefits foregone for the White River hydropower projects by reallocation condition, relative to the current condition. The data in tables 6-1 to 6-5 are derived from prior sections of this report.

Table 6-1. Summary of Average Annual Power Benefits Foregone for Beaver Project

Condition	Energy Loss (MWh)	Energy Benefits Foregone	Capacity Loss (MW)	Capacity Benefits Foregone	Total Hydropower Benefits Foregone
Current Condition	-	-	-	-	-
Conservation Pool	-3,714	-$130,142.79	0	$0	-$130,142.79
Inactive Pool	-3,714	-$130,142.79	0	$0	-$130,142.79

Table 6-2. Summary of Average Annual Power Benefits Foregone for Bull Shoals Project

Condition	Energy Loss (MWh)	Energy Benefits Foregone	Capacity Loss (MW)	Capacity Benefits Foregone	Total Hydropower Benefits Foregone
Current Condition	-	-	-	-	-
Conservation Pool	-3,871	-$117,546.32	0	$0	-$117,546.32
Inactive Pool	-3,871	-$117,546.32	0	$0	-$117,546.32

Table 6-3. Summary of Average Annual Power Benefits Foregone for Greers Ferry Project

Condition	Energy Loss (MWh)	Energy Benefits Foregone	Capacity Loss (MW)	Capacity Benefits Foregone	Total Hydropower Benefits Foregone
Current Condition	-	-	-	-	-
Conservation Pool	-18	$1,046.56	0.16	$17,756.80	$18,803.36
Inactive Pool	-18	$1,046.56	0.16	$17,756.80	$18,803.36

Table 6-4. Summary of Average Annual Power Benefits Foregone for Norfork Project

Condition	Energy Loss (MWh)	Energy Benefits Foregone	Capacity Loss (MW)	Capacity Benefits Foregone	Total Hydropower Benefits Foregone
Current Condition	-	-	-	-	-
Conservation Pool	-42	-$1,173.20	-0.05	$5,549.00	$4,375.80
Inactive Pool	-42	-$1,173.20	-0.05	$5,549.00	$4,375.80

Table 6-5. Summary of Average Annual Power Benefits Foregone for Table Rock Project

Condition	Energy Loss (MWh)	Energy Benefits Foregone	Capacity Loss (MW)	Capacity Benefits Foregone	Total Hydropower Benefits Foregone
Current Condition	-	-	-	-	-
Conservation Pool	-3,812	-$114,649.36	0.02	$2,219.60	-$-112,429.76
Inactive Pool	-3,812	-$114,649.36	0.02	$2,219.60	-$-112,429.76

System power benefits forgone are shown in Table 12-1.

7. Replacement Cost of Power

Because energy benefits foregone are based on the costs of the equivalent costs of thermal generating energy, the replacement costs of power are identical to energy benefits foregone and do not require separate calculation.

8. Revenue Forgone

Revenue foregone is to be based on the current SWPA contract Rates applicable to power generation by the White River plants. The current rates are:

- Energy Rate Total: $15.30/MWh
  - Firm Energy, Supplemental Energy, and Excess Energy Rate: $9.40/MWh
  - Power Purchase Adder: $5.90/MWh
- Monthly Capacity Charge: $4,500/MW
- Ancillary Services:
  - Monthly Regulation and Frequency Response: $70.00/MW
  - Monthly Spinning Operating Reserve: $14.60/MW

❖ Annual Capacity Rate Total: $55,190.40/MW-yr

To compute energy revenues foregone, the contract peaking energy rate is applied to the average annual on-peak contract energy losses, and the supplemental peaking energy rate is applied to on-peak non-contract energy losses and off-peak energy losses. A summary of dependable capacity in the critical year of 1954 is provided in Table 9-1. Differences in critical year dependable capacity between conditions and the current condition are provided in Table 9-2.

Table 8-1.Summary of Critical Year (1954) Supportable Capacity by Condition

Project	Beaver	Bulls Shoals	Greers Ferry	Norfork	Table Rock	White River Total
Current Condition (MW)	128.80	373.00	108.86	75.60	229.27	915.53
Conservation Pool Condition (MW)	128.80	373.00	108.86	75.60	229.21	915.47
Inactive Pool Condition (MW)	128.80	373.00	108.86	75.60	229.21	915.47

Note: Capacity values computed based on SWPA defined critical water year (1954)

Table 8-2. Supportable Capacity Difference from Current Condition

Project	Beaver	Bulls Shoals	Greers Ferry	Norfork	Table Rock	White River Total
Conservation Pool Condition (kW)	0.00	0.00	0.00	0.00	-60.00	-60.00
Inactive Pool Condition (kW)	0.00	0.00	0.00	0.00	-60.00	-60.00

Note: Capacity values computed based on SWPA defined critical year water (1954)

Critical year dependable capacity is used in the revenue foregone calculation. Tables 9-3 and 9-4 show the Energy Revenue Foregone for each of the conditions.

Table 8-3. Conservation Pool Reallocation Power Revenue Forgone by Project

Project	Energy Loss (MWh)	SWPA Current Rates ($/MWh)	Critical Year Capacity Loss (MW)*	Capacity Rate	Total Revenue Forgone
Beaver	-3,714	$15.30	0	$55,190.40	-$56,824.20
Bull Shoals	-3,871	$15.30	0	$55,190.40	-$59,226.30
Greers Ferry	-18	$15.30	0	$55,190.40	-$275.40
Norfork	-42	$15.30	0	$55,190.40	-$642.60
Table Rock	-3,812	$15.30	-0.06	$55,190.40	-$61,635.02
White River Total	-11,457	$15.30	-0.06	$55,190.40	-$178,603.52

**Capacity values are based on SWPA defined critical water year (1954)*

Table 8-4. Inactive Pool Reallocation Power Revenue Forgone by Project

Project	Energy Loss (MWh)	SWPA Current Rates ($/MWh)	Critical Year Capacity Loss (MW)*	Capacity Rate	Total Revenue Forgone
Beaver	-3,714	$15.30	0	$55,190.40	-$56,824.20
Bull Shoals	-3,871	$15.30	0	$55,190.40	-$59,226.30
Greers Ferry	-18	$15.30	0	$55,190.40	-$275.40
Norfork	-42	$15.30	0	$55,190.40	-$642.60
Table Rock	-3,812	$15.30	-0.06	$55,190.40	-$61,635.02
White River Total	-11,457	$15.30	-0.06	$55,190.40	-$178,603.52

**Capacity values are based on SWPA defined critical water year (1954)*

9. Credit to Power Marketing Agency

Project costs originally allocated to hydropower are repaid through power revenues based on rates designed by the federal power marketing agency (PMA) to recover allocated costs, plus interest within 50 years of the date of commercial power operation. If a portion of a project's storage is reallocated from hydropower to water supply, the PMA's repayment obligation may be reduced in proportion to the lost energy and capacity through a system of financial credits.

Planning Guidance Notebook, Appendix E-57.d.(3)(a) of ER 1105-2-100 (22 April 2002) states;

> "When hydropower is adversely impacted by reallocation of the flood pool to satisfy additional water supply needs, hydropower losses can be mitigated through the provision of financial credit. In this case, credits will be provided to the hydropower account from a portion of the water supply storage proceeds. This credit is based on revenues foregone to the United States Treasury for repayment of the hydropower costs assigned to the project. Revenues foregone reflect the allocated costs to power upon which the rates are based. When reallocation is accomplished through this credit approach, in essence, the allocation of costs is adjusted without performing a laborious new cost allocation. …" *(credit #1)*
>
> *(credit #2)* "Additionally, where existing Federal power delivery contracts require market purchases of power as a result of storage reallocations and withdrawals, the power marketing agency may obtain an additional credit for the funds expended for those purchases upon demonstration that they were made as a direct result of the reallocation."

Planning Guidance Notebook, ER 1105-2-100 (22 April 2002), Appendix E, SECTION VIII - Water Supply, Para. E-57.d.(3). states;

> "If hydropower revenues are being reduced as a result of the reallocation, the power marketing agency will be credited for the amount of revenues to the Treasury foregone as a result of the reallocation assuming uniform annual repayment. In instances where existing contracts between the power marketing agency and its customer would result in a cost to the Federal Government to acquire replacement power to fulfill the obligations of contracts, an additional credit to the power marketing agency can be made for such costs incurred during the remaining period of the contracts. Such credits should not actually be made for replacement costs until the costs are incurred and documented by the power marketing agency."

Thus, there may be an annual credit due to the PMA resulting from the proposed water supply reallocation that reduces revenues.

For the purposes of providing an estimate, the annual credit will be based on the revenue foregone as calculated in Section 10 because the power sales contracts are "evergreen" with the rate adjusted periodically to cover the cost of O&M for providing hydropower from the Federal projects and to repay the Treasury for the hydropower portion of the Federal investment in the project. In either case, the annual credit is based on revenue lost or costs actually incurred (and documented by the PMA).

10. Summary of Results

Power benefits foregone are described in Sections 5, 6, and 7. Total average annual power benefits foregone for each condition, annualized over the 50-year period and the discount rate of 3.125% are shown below.

Table 10-1. Total Average Annual Power Benefits Foregone by Project and Condition

Project	Condition	Annual Energy Loss	Annual Energy Benefit Forgone	Annual Capacity Loss (MW)	Annual Capacity Benefit Forgone	Total Benefit Forgone
Beaver	Conservation Pool Reallocation	-3,714.06	-$130,142.79	-0.35	-$38,843.00	-$168,985.79
	Inactive Pool Reallocation	-3,714.06	-$130,142.79	-0.35	-$38,843.00	-$168,985.79
Bull Shoals	Conservation Pool Reallocation	-3,871.46	-$117,546.32	-0.35	-$38,843.00	-$156,389.32
	Inactive Pool Reallocation	-3,871.46	-$117,546.32	-0.35	-$38,843.00	-$156,389.32
Greers Ferry	Conservation Pool Reallocation	-17.59	$1,046.56	-0.35	-$38,843.00	-$37,796.44
	Inactive Pool Reallocation	-17.59	$1,046.56	-0.35	-$38,843.00	-$37,796.44
Norfork	Conservation Pool Reallocation	-41.97	-$1,173.20	-0.35	-$38,843.00	-$40,016.20
	Inactive Pool Reallocation	-41.97	-$1,173.20	-0.35	-$38,843.00	-$40,016.20
Table Rock	Conservation Pool Reallocation	-3,812.09	-$114,649.36	-0.35	-$38,843.00	-$153,492.36
	Inactive Pool Reallocation	-3,812.09	-$114,649.36	-0.35	-$38,843.00	-$153,492.36
Total	Conservation Pool Reallocation	-11,457.18	-$418,559.23	-0.35	-$38,843.00	-$457,402.23
	Inactive Pool Reallocation	-11,457.18	-$418,559.23	-0.35	-$38,843.00	-$457,402.23

The average annual credit due the PMA under the water supply reallocation from each condition is described in Section 10 and is the same as Revenue Foregone.

Table 10-2. Total Average Annual Revenue Foregone and PMA Credit by Condition

Condition	Annual Energy Loss	Annual Energy Revenue Forgone	Annual Capacity Loss (MW)	Annual Capacity Revenue Forgone	Total Revenue Forgone
Conservation Pool Condition	-11,457	-$175,292.10	-0.06	-$3,311.42	**-$178,603.52**
Inactive Pool Condition	-11,457	-$175,292.10	-0.06	-$3,311.42	**-$178,603.52**

Appendix A. Conditions Description

Beaver Dam is on the White River approximately 18 miles northeast of Rogers, AR. The lake is one of five multiple-purpose projects constructed in the White River Basin for flood control, power generation and other purposes. The first water supply available for M&I purposes from Beaver Lake was the part of the original project condition and provided 108,000 acre-feet of storage for the Beaver Water District. Current storage capacity on the lake is 287,302 acre-feet of flood control storage and 937,398 acre-feet of conservation storage (SWL, 18 FEB 2016).

This reallocation request is for municipal and industrial (M&I) purposes and is needed to provide for an immediate need estimated at 22.0 MGD, which requires that 41,960.7 acre-feet (AF) of storage be reallocated to water supply.

Project Physical Features

Feature	Elevation[1]	Surface Area (acres)	Storage Volume (AF)	Equiv. Runoff[2] (inches)
Top of dam	1142	-	-	-
Top of flood control pool	1130	31,700	1,951,500	-
Top of conservation pool	1120.43	28,370	1,664,200	-
Top of inactive pool	1077	15,540	726,800	-
Usable Storage	-	-	1,951,500	-
Flood control storage	-	-	287,300	4.54
Conservation Storage	-	-	937,400	14.82
Inactive storage	Below elev.1077	-	726,800	11.49

[1] All elevations are referenced to feet, National Geodetic Vertical Datum (NGVD)
[2] From 1,146 square miles of drainage area upstream from dam.

Existing Water Supply Allocations

(Includes Original Authorizations and Reallocations)Entity	Acre Feet	MGD	Date
Beaver Water District	108,000	56.92	1960 – Original
Beaver Water District	28,757	15.08	2006 – Congressional (Conservation pool)
Carroll Boone	9,000	4.74	1977 – Conservation Pool
Carroll Boone	2,396	1.26	2006 – Congressional (Conservation pool)
Beaver Trout Hatchery (No Agreement)*1	21,972	11.52	2013 – Congressional (Conservation pool)
Madison County	3,882	2.04	1992 – Flood Pool
Benton Washington County	7,643	4.0	1996 – Flood Pool
Beaver Total Agreements	181,650	95.56	-
			-
Flood Reallocation Total	11,525	6.50	-
Conservation Reallocation Total	9,000	4.74	-

Reallocation Requests for Beaver Lake
Water Supply Storage Reallocation Study

User	Request Date	MGD	Acre-feet
Benton Washington	2000	12.0	22,887.11
Carroll Boone	2001	6.0	11,443.55
Madison County	2006	4.0	7,629.04
Subtotals for this Reallocation		22.0	41,959.70
Total current water supply storage at Beaver Lake:			20,525.00
Cumulative Total:			62,484.70

The final array of alternatives is as follows:

NO ACTION-FUTURE WITHOUT PROJECT

The existing condition represents that there is no action implemented and the water demand through 2065 is unmet. There would be no reallocation at Beaver Lake and the least cost alternative to reallocation would not be implemented. NEPA requires this alternative to be considered and evaluated against all other alternatives.

The water supply needs, for about a twenty-five year period, could be met by constructing a new reservoir. This project would consist of constructing a reservoir which would have had an approximate yield of 60 MGD.

REALLOCATION OF CONSERVATION POOL AT BEAVER LAKE

This request is for reallocation of the conservation pool at Beaver Lake for 41,959.70 acre-feet of storage. (Riverware model run)

REALLOCATION OF INACTIVE POOL AT BEAVER LAKE

This request is for reallocation of the inactive pool at Beaver Lake for 41,959.70 acre-feet of storage. (Riverware model run)

Appendix B. Measures of Hydropower Impact

Energy Impact is a measure of how much energy difference each condition makes that was studied.

Table B-1. Annual Energy (MW) by Condition

Condition	Beaver	Bull Shoals	Greers Ferry	Norfork	Table Rock	White River Basin
Base Condition	129913	643799	169954	162959	465024	1571649
Congressional Condition	125292	638921	169962	162983	460394	1557549
Current Condition	123497	636909	169958	162965	458252	1551583
Conservation Pool Condition	119784	633044	169941	162925	454438	1540128
Inactive Pool Condition	119784	633044	169941	162925	454438	1540128

Table B-2. Percent Difference in Annual Energy (MW) from Current Condition

Condition	Beaver	Bull Shoals	Greers Ferry	Norfork	Table Rock	White River Basin
Base Condition	4.94%	1.07%	0.00%	0.00%	1.46%	1.28%
Congressional Condition	1.43%	0.31%	0.00%	0.01%	0.47%	0.38%
Current Condition	-	-	-	-	-	-
Conservation Pool Condition	-3.10%	-0.61%	-0.01%	-0.02%	-0.84%	-0.74%
Inactive Pool Condition	-3.10%	-0.61%	-0.01%	-0.02%	-0.84%	-0.74%

Capacity Impact is a measure of how much difference in dependable capacity (MW) each condition makes that was studied.

Table B-3. Dependable Capacity (MW) by Condition

Condition	Beaver	Bulls Shoals	Greers Ferry	Norfork	Table Rock	White River Total
Base Condition	124.48	388.15	83.11	83.46	227.53	**906.73**
Congressional Condition	124.43	388.13	83.24	83.43	227.51	**906.74**
Current Condition	124.4	388.12	83.12	83.5	227.5	**906.64**
Conservation Pool Condition	124.4	388.12	83.28	83.45	227.52	**906.77**
Inactive Pool Condition	124.4	388.12	83.28	83.45	227.52	**906.77**

Table B-4. Percent Difference in Dependable Capacity (MW) from Current Condition

Condition	Beaver	Bulls Shoals	Greers Ferry	Norfork	Table Rock	White River Total
Base Condition	0.06%	0.01%	-0.01%	-0.05%	0.01%	**0.01%**
Congressional Condition	0.02%	0.00%	0.14%	-0.08%	0.00%	**0.01%**
Current Condition	-	-	-	-	-	**-**
Conservation Pool Condition	0.00%	0.00%	0.19%	-0.06%	0.01%	**0.01%**
Inactive Pool Condition	0.00%	0.00%	0.19%	-0.06%	0.01%	**0.01%**

Value Impact is a measure of how much difference in the monetary value each condition makes that was studied.

Table B-5. Monetary Value (x $1,000) by Condition

Condition	Beaver	Bull Shoals	Greers Ferry	Norfork	Table Rock	White River Total
Base Condition	$5,675.18	$27,285.86	$6,644.44	$6,972.52	$18,926.77	**$65,504.56**
Congressional Condition	$5,518.96	$27,130.84	$6,645.61	$6,973.14	$18,784.94	**$65,053.30**
Current Condition	$5,449.30	$27,067.49	$6,644.03	$6,973.18	$18,712.35	**$64,846.46**
Conservation Pool Condition	$5,319.18	$26,950.16	$6,645.08	$6,972.71	$18,597.64	**$64,484.73**
Inactive Pool Condition	$5,319.18	$26,950.16	$6,645.08	$6,972.71	$18,597.64	**$64,484.73**

*Note values are in $1000's

Table B-6. Percent Difference in Monetary Value from Current Condition

Condition	Beaver	Bull Shoals	Greers Ferry	Norfork	Table Rock	White River Total
Base Condition	3.98%	0.80%	0.01%	-0.01%	1.13%	**1.00%**
Congressional Condition	1.26%	0.23%	0.02%	0.00%	0.39%	**0.32%**
Current Condition	-	-	-	-	-	**-**
Conservation Pool Condition	-2.45%	-0.44%	0.02%	-0.01%	-0.62%	**-0.56%**
Inactive Pool Condition	-2.45%	-0.44%	0.02%	-0.01%	-0.62%	**-0.56%**

Appendix C. Monthly Generation of White River System and Projects Under Study Conditions

Table C-1. Base Condition Average Monthly Energy at USACE White River Hydropower Plants

	Beaver				Bull Shoals				Greers Ferry			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	6348	3859	59	1188	29225	17823	3713	6784	9220	7677	750	1629
Feb	3533	4191	69	1202	13544	18810	1283	4940	5114	8108	653	1823
Mar	4621	4731	199	1548	16928	31633	3614	9331	5954	13215	1200	3316
Apr	5538	7202	838	2349	19238	27072	2791	8821	5733	12692	883	3387
May	5776	8920	1533	3032	21689	19426	1272	6626	5207	9774	185	2418
Jun	6927	4681	899	2089	28715	26325	2807	9295	6025	5926	615	2100
Jul	10716	2166	274	947	50636	17876	3228	9054	8144	1782	423	1113
Aug	11985	1160	218	586	51818	13168	3042	7502	8755	645	37	486
Sep	5207	593	35	294	25689	14897	1828	5837	4140	1339	71	464
Oct	1767	572	0	301	12577	8070	792	2609	2189	1582	60	436
Nov	2307	1513	71	481	12814	8418	585	2457	2875	3595	61	670
Dec	4673	1856	53	806	27249	20524	4444	6980	7771	7030	877	1805

Table C-1 (cont'd). Base Condition Average Monthly Energy at USACE White River Hydropower Plants

	Norfork				Table Rock				Total			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
	7252	5247	890	1417	19699	14302	1606	4180	71744	48907	7019	15198
	3566	4664	405	1103	9042	18416	1432	4737	34800	54190	3840	13804
	4220	7637	1035	2213	11254	28914	4281	7969	42977	86130	10329	24378
	4722	7019	716	2166	12077	34529	5670	9730	47307	88514	10898	26452
	4900	5447	510	2052	11362	28235	6031	9027	48934	71802	9532	23155
	7344	5544	794	2351	18470	16461	2886	6367	67480	58937	8002	22201
	13901	3996	716	1895	34060	5970	1268	3632	117456	31789	5909	16641
	13436	2572	432	1313	35006	3419	318	1472	121000	20965	4048	11359
	6182	4770	390	1376	12136	2628	182	898	53353	24226	2506	8869
	3997	3029	159	752	6248	3067	593	897	26778	16320	1603	4994
	3276	2392	69	517	10681	11537	2125	3144	31954	27456	2911	7270
	6945	5411	862	1357	17931	14927	1754	4454	64569	49748	7989	15402

Table C-2. Congressional Condition Average Monthly Energy at USACE White River Hydropower Plants

	Beaver				Bull Shoals				Greers Ferry			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	6210	3663	36	1150	29078	17577	3616	6630	9220	7685	750	1652
Feb	3383	3678	62	1063	13492	18487	1272	4873	5114	8112	647	1819
Mar	4423	4267	192	1432	16705	31152	3629	9200	5954	13209	1201	3319
Apr	5430	6843	798	2247	19152	26634	2705	8821	5729	12665	874	3377
May	5701	8499	1466	2974	21647	18909	1183	6646	5193	9781	183	2410
Jun	6832	4571	845	2052	28628	25870	2806	9324	6028	5942	629	2113
Jul	10660	2080	254	882	50695	17625	3220	8925	8159	1768	437	1110
Aug	11970	1110	205	569	51769	13106	3167	7411	8756	652	22	482
Sep	5198	546	39	287	25665	14932	1862	5549	4140	1334	63	466
Oct	1736	555	0	291	12570	8090	763	2590	2189	1623	59	444
Nov	2251	1425	62	475	12754	8288	577	2374	2875	3567	60	671
Dec	4434	1688	51	707	27172	20420	4347	7014	7771	7024	876	1808

Table C-2 (cont'd). Congressional Condition Average Monthly Energy at USACE White River Hydropower Plants

	Norfork				Table Rock				Total			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	7250	5224	903	1398	19649	13943	1553	4125	71407	48092	6858	14955
Feb	3566	4664	407	1097	9035	17959	1409	4574	34590	52901	3796	13426
Mar	4202	7634	1031	2221	11207	28399	4210	7828	42490	84661	10263	24000
Apr	4716	7031	708	2171	12062	34095	5623	9663	47089	87268	10709	26279
May	4898	5475	511	2061	11304	27775	5923	8870	48743	70439	9267	22961
Jun	7336	5515	788	2390	18414	16223	2854	6345	67238	58121	7922	22225
Jul	13913	3980	732	1882	34054	5873	1223	3541	117480	31326	5866	16340
Aug	13449	2607	435	1368	35003	3457	295	1425	120947	20931	4123	11255
Sep	6180	4755	427	1317	12119	2553	175	871	53301	24120	2564	8489
Oct	3996	3011	170	736	6208	3065	571	939	26699	16344	1563	4999
Nov	3272	2410	78	491	10674	11483	2091	3079	31826	27174	2868	7091
Dec	6944	5408	861	1364	17894	14715	1687	4357	64215	49255	7822	15251

Table C-3. Current Condition Average Monthly Energy at USACE White River Hydropower Plants

	Beaver				Bull Shoals				Greers Ferry			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	6139	3542	43	1109	29003	17478	3558	6649	9220	7700	752	1650
Feb	3277	3553	55	1000	13441	18351	1274	4820	5118	8097	634	1818
Mar	4317	4224	193	1423	16589	30894	3668	9064	5954	13232	1211	3323
Apr	5355	6829	813	2252	19128	26599	2683	8743	5726	12668	854	3378
May	5655	8420	1429	2955	21605	18773	1185	6576	5193	9784	182	2422
Jun	6799	4469	810	2019	28586	25806	2799	9278	6010	5931	642	2104
Jul	10589	1943	239	869	50641	17831	3300	8662	8142	1748	470	1100
Aug	11897	1062	200	564	51819	13300	3103	7319	8759	652	14	475
Sep	5183	498	32	276	25677	14669	1719	5811	4140	1333	63	466
Oct	1715	498	0	295	12559	8049	789	2567	2189	1607	59	436
Nov	2232	1431	54	466	12748	8283	576	2287	2875	3610	59	670
Dec	4414	1618	51	691	27167	20274	4403	6806	7771	7031	882	1804

Table C-3 (cont'd). Current Condition Average Monthly Energy at USACE White River Hydropower Plants

	Norfork				Table Rock				Total			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	7250	5242	903	1395	19591	13814	1545	4080	71203	47775	6801	14883
Feb	3565	4668	406	1097	9007	17702	1407	4515	34409	52371	3776	13250
Mar	4198	7631	1032	2198	11163	28137	4218	7807	42221	84118	10321	23816
Apr	4716	7044	734	2165	12069	34030	5619	9636	46994	87170	10702	26174
May	4893	5476	521	2095	11218	27598	5929	8883	48564	70050	9247	22931
Jun	7336	5492	800	2371	18380	16123	2846	6303	67111	57821	7897	22075
Jul	13913	4015	737	1840	34010	5876	1221	3448	117295	31414	5968	15919
Aug	13454	2620	435	1322	34988	3407	324	1442	120916	21041	4075	11122
Sep	6179	4720	400	1341	12090	2495	175	842	53270	23716	2389	8736
Oct	3993	3036	186	731	6140	3043	576	917	26597	16233	1609	4946
Nov	3270	2410	79	483	10655	11342	2064	3034	31780	27077	2831	6939
Dec	6943	5421	856	1353	17906	14633	1697	4307	64202	48977	7890	14961

Table C-4. Conservation Pool Condition Average Monthly Energy at USACE White River Hydropower Plants

	Beaver				Bull Shoals				Greers Ferry			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	6046	3319	28	1057	28882	17291	3491	6539	9224	7700	742	1646
Feb	3131	3302	62	923	13508	18192	1277	4829	5118	8076	637	1808
Mar	4103	3956	163	1300	16488	30394	3711	8766	5954	13233	1206	3319
Apr	5264	6537	772	2119	19066	26372	2677	8534	5729	12652	842	3377
May	5486	8132	1381	2877	21541	18452	1174	6534	5191	9784	181	2415
Jun	6690	4373	726	2000	28475	25569	2677	9312	6025	5951	627	2111
Jul	10527	1867	222	844	50671	17770	3283	8390	8159	1761	454	1095
Aug	11865	1046	207	559	51880	13185	3258	7250	8760	640	23	491
Sep	5166	478	38	258	25671	14467	1749	5850	4140	1325	79	468
Oct	1698	462	0	283	12539	7941	782	2573	2189	1579	59	436
Nov	2180	1327	45	451	12699	8256	574	2319	2875	3611	59	678
Dec	4286	1523	51	654	27074	20043	4357	6712	7771	7041	897	1803

Table C-4 (cont'd). Conservation Pool Condition Average Monthly Energy at USACE White River Hydropower Plants

	Norfork				Table Rock				Total			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	7250	5243	909	1394	19568	13544	1504	4024	70970	47096	6674	14660
Feb	3565	4666	413	1104	9013	17321	1390	4456	34336	51556	3779	13121
Mar	4197	7651	1048	2181	11115	27641	4171	7705	41858	82875	10300	23270
Apr	4715	7024	716	2158	12050	33716	5586	9525	46825	86301	10593	25712
May	4888	5484	514	2088	11154	27159	5798	8786	48261	69011	9047	22700
Jun	7329	5524	798	2384	18324	15902	2806	6319	66843	57318	7633	22126
Jul	13936	3994	738	1821	34019	5812	1197	3328	117312	31204	5894	15478
Aug	13459	2573	461	1337	35032	3416	325	1390	120997	20861	4273	11027
Sep	6179	4691	394	1399	12056	2490	182	825	53211	23450	2442	8799
Oct	3995	3042	169	733	6128	2982	588	872	26549	16007	1597	4897
Nov	3260	2392	66	497	10636	11223	2040	3029	31650	26810	2783	6973
Dec	6943	5397	865	1341	17859	14477	1662	4293	63933	48481	7832	14803

Table C-5. Inactive Pool Condition Average Monthly Energy at USACE White River Hydropower Plants

	Beaver				Bull Shoals				Greers Ferry			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	6046	3319	28	1057	28882	17291	3491	6539	9224	7700	742	1646
Feb	3131	3302	62	923	13508	18192	1277	4829	5118	8076	637	1808
Mar	4103	3956	163	1300	16488	30394	3711	8766	5954	13233	1206	3319
Apr	5264	6537	772	2119	19066	26372	2677	8534	5729	12652	842	3377
May	5486	8132	1381	2877	21541	18452	1174	6534	5191	9784	181	2415
Jun	6690	4373	726	2000	28475	25569	2677	9312	6025	5951	627	2111
Jul	10527	1867	222	844	50671	17770	3283	8390	8159	1761	454	1095
Aug	11865	1046	207	559	51880	13185	3258	7250	8760	640	23	491
Sep	5166	478	38	258	25671	14467	1749	5850	4140	1325	79	468
Oct	1698	462	0	283	12539	7941	782	2573	2189	1579	59	436
Nov	2180	1327	45	451	12699	8256	574	2319	2875	3611	59	678
Dec	4286	1523	51	654	27074	20043	4357	6712	7771	7041	897	1803

Table C-5 (cont'd). Inactive Pool Condition Average Monthly Energy at USACE White River Hydropower Plants

	Norfork				Table Rock				Total			
Month	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)	Super Peak (MWH)	Peak (MWH)	Weekday Off-peak (MWH)	Weekend Off-peak (MWH)
Jan	7250	5243	909	1394	19568	13544	1504	4024	70970	47096	6674	14660
Feb	3565	4666	413	1104	9013	17321	1390	4456	34336	51556	3779	13121
Mar	4197	7651	1048	2181	11115	27641	4171	7705	41858	82875	10300	23270
Apr	4715	7024	716	2158	12050	33716	5586	9525	46825	86301	10593	25712
May	4888	5484	514	2088	11154	27159	5798	8786	48261	69011	9047	22700
Jun	7329	5524	798	2384	18324	15902	2806	6319	66843	57318	7633	22126
Jul	13936	3994	738	1821	34019	5812	1197	3328	117312	31204	5894	15478
Aug	13459	2573	461	1337	35032	3416	325	1390	120997	20861	4273	11027
Sep	6179	4691	394	1399	12056	2490	182	825	53211	23450	2442	8799
Oct	3995	3042	169	733	6128	2982	588	872	26549	16007	1597	4897
Nov	3260	2392	66	497	10636	11223	2040	3029	31650	26810	2783	6973
Dec	6943	5397	865	1341	17859	14477	1662	4293	63933	48481	7832	14803