REALLOCATION REPORT

JOHN H. KERR RESERVOIR WATER SUPPLY STORAGE REALLOCATION REQUEST FOR THE CITY OF HENDERSON, NORTH CAROLINA

May 2005

U.S. Army Corps of Engineers
Wilmington District

PREFACE

The Hydro-power Analysis Center prepared Power Benefits Foregone in May 2004. Mr. Terry Brown, P.E. and Mr. Allen Piner, Wilmington District performed the yield analysis and period of record modeling. Ms. Jenny Owens, Wilmington District, submitted the Record of Environmental Evaluation. Mr. Russell Davidson, P.E. and Mr. Kamau Sadiki, Northwestern Division, Corps of Engineers developed power values. Southeastern Power Administration (SEPA) provided their current rates for computing the revenue foregone, as well as criteria for the loss of marketable capacity due to the withdrawal. Mr. Duane Bailey, Savannah District, performed a Quality Assurance Review of the document. Primary contacts at the Wilmington District are Mr. Greg Williams and Mr. Allen Piner.

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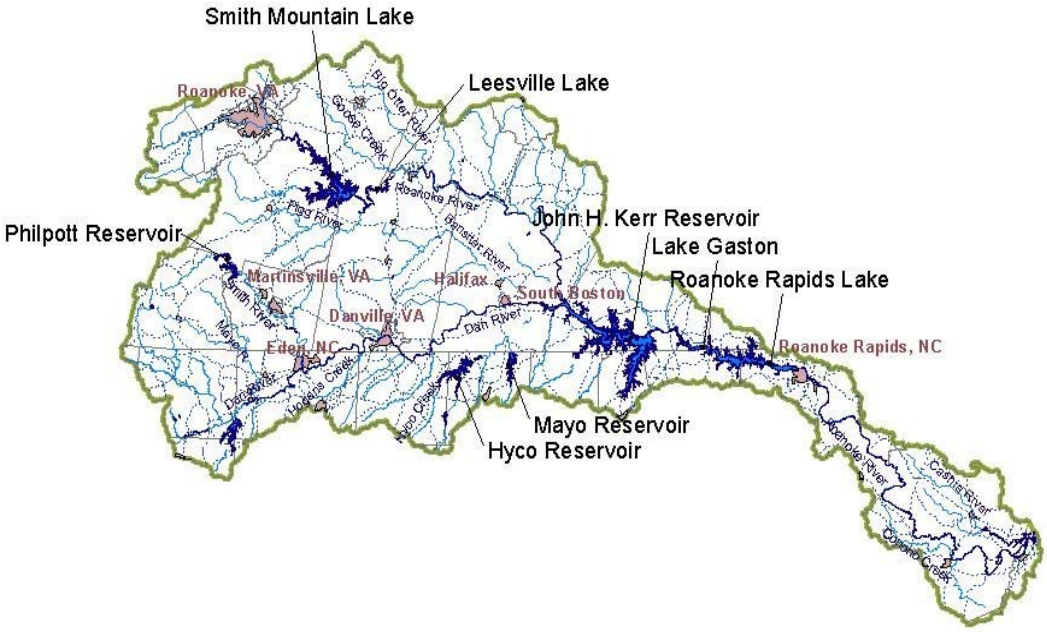
1.0 INTRODUCTION

1.1 Purpose

This reallocation report was prepared to provide information in support of a request by the City of Henderson, North Carolina (sponsor) for a reallocation of 10,292 acre-feet (AF) from the usable conservation pool storage at the John H. Kerr Reservoir (Kerr) for water supply. A map of the area and vicinity is shown in Figure 1. This reallocation will finalize conversion of an original 20 million gallon per day (MGD) 'water use' agreement to a 'storage agreement'. Average annual use for the previous 27 years of operation is approximately 5 MGD with current use at approximately 6 MGD and a projected annual withdrawal of up to 20 MGD for water supply. This water will be used to provide municipal and industrial water supply for the City of Henderson, North Carolina, which operates the Kerr Lake Regional Water System (KLRWS).

Figure 1
Roanoke River Watershed



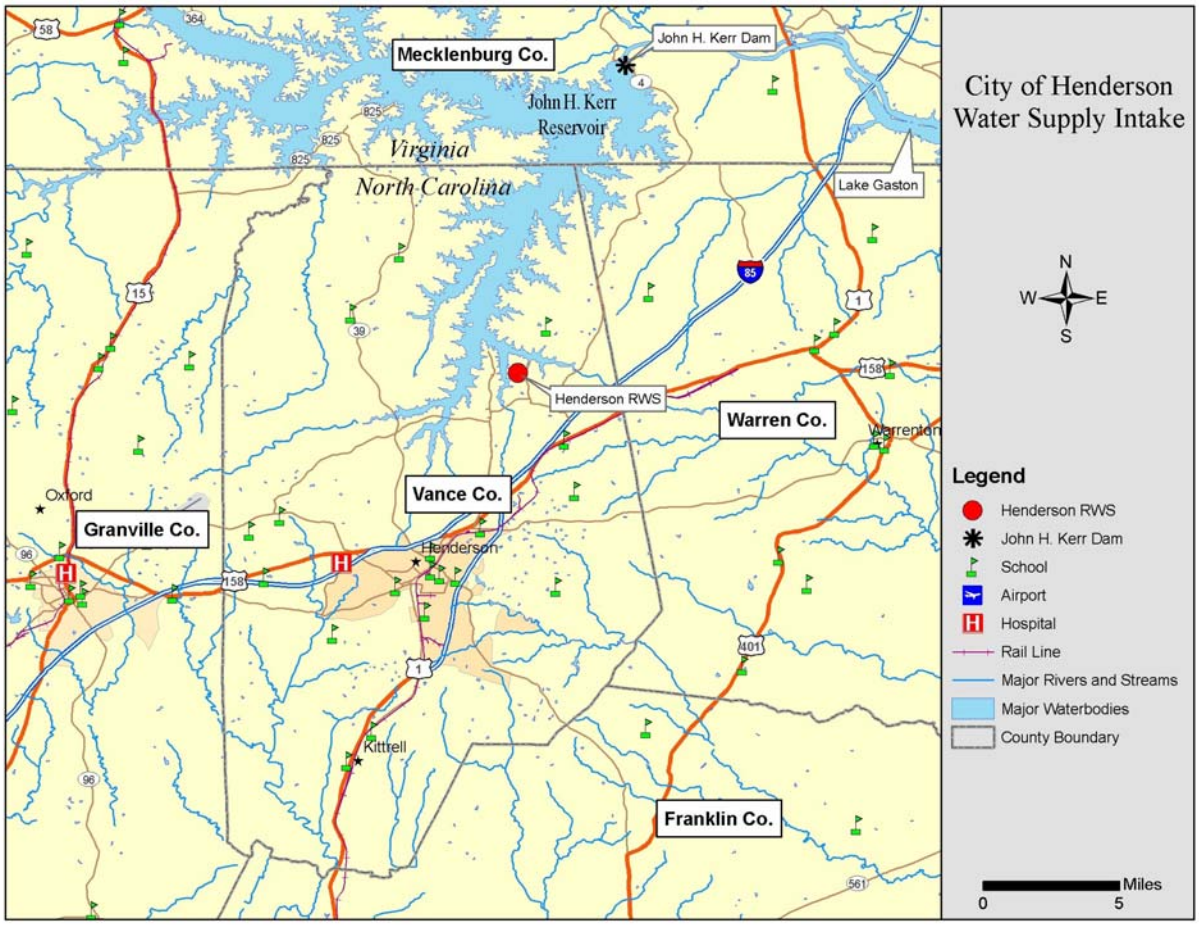
The sponsor began operation and withdrawals from Kerr in 1978. The site is located adjacent to Kerr Reservoir about 7 miles from Henderson, North Carolina, and approximately 20 miles from Kerr Dam (Figure 2).

1.2 Authority for Reallocation

Corps Policy as outlined in paragraph 3-8b(5) of the Planning Guidance Notebook (PGN) is:

"Reallocation or addition of storage that would seriously affect other authorized purposes or that would involve major structural or operational changes requires Congressional approval. Provided these criteria are not violated, 15 percent of the total storage capacity allocated to all authorized project purposes or 50,000 acre feet, whichever, is less, may be allocated from storage authorized for other purposes. Or, this amount may be added to the project to serve as storage for municipal and industrial water supply at the discretion of the Commander, USACE."

Figure 2
City of Henderson Water Supply Intake



All criteria for the Commander's discretionary approval are met as summarized below:

- The 10,292 AF proposed reallocation does not significantly affect other authorized purposes and does not involve major structural or operational changes in the project.

- 15% of the total storage would be 339,363 AF so the 50,000 AF maximum discretionary amount applies. The cumulative amount of reallocation with this reallocation is 21,115 AF, well within the Commander's authority.

Approval levels for the reallocation report and agreement follow:

- **Draft storage agreement—ASA(CW)**
  - Since any agreement with reallocation over 1000 AF requires ASA(CW) approval.
- **Draft reallocation report—HQUSACE—However, report must be submitted to ASA(CW) with draft agreement prior to approval.**
  - Since cumulative amount reallocated of 21,115 AF exceeds the lesser of 4,000 AF or 226,242 AF (10% of available storage of 2,262,421 AF)
  - Since 10,292 AF requested exceeds 1000 AF threshold for HQUSACE approval
- **Final Agreement. –HQUSACE**
  - Since proposed 10,292 AF reallocation amount exceeds the 1000 AF threshold for HQUSACE approval.

Implementation of these criteria for reallocation of storage at Kerr has resulted in three reallocations to municipal and industrial water supply totaling 10,823 AF as shown in Table 1. Therefore, reallocation is a valid potential source for meeting Henderson's need.

Table 1
Kerr ~ Pertinent Data

Drainage Area (square miles)	7800
Elevations (feet, NGVD)	
Top of Dam	332
Base of Dam	188
Spillway crest	288
Top of Conservation Pool	300
Top of Flood Control Pool	320
Storage (AF)*	
Total Usable Pool (Elev 268-320)	2,262,421
Flood Control Pool (Elev 300-320)	1,282,367
Conservation Pool (Elev 268-300)	980,054
Hydropower	969,231
Water Supply	10,823

* Storage remaining after 100 years of sedimentation from July 1953

2.0 BACKGROUND

2.1 Introduction

Kerr storage could normally either be reallocated from the existing conservation storage or it could be reallocated from the flood control storage space. At Kerr the entire flood control storage space is required to satisfy current criteria established for this purpose. In four separate flood events between 1975 and 1996 over ninety per-cent of the controlled flood storage at Kerr was utilized. The April 1987 event pushed the reservoir level to less than six inches away from the point at which releases downstream match eighty-five per-cent of the computed inflow (a volume in excess of 100,000 cfs) while the September 1996 flood event generated the greatest computed inflow on record for this location (second only to the August 1940 event which was used to justify project construction). As a result, all other reallocations of storage at Kerr for water supply have been made from the conservation/power pool. Therefore, this analysis will only concentrate on the volume of conservation/power pool storage that must be reallocated to satisfy water supply requirements. To meet the requirements of Section 4-32d of ER 1105-2-100, the value must be computed in four ways: (1) power benefits forgone, (2) power revenues foregone, (3) replacement cost of power, and (4) updated cost of storage. The highest of the four costs determines the cost to be paid for the storage. The Hydropower Analysis Center (HAC), Portland, Oregon determined the first three methods in a report titled 'Power Benefits Foregone' dated May 2004, attached in its entirety as Appendix A. Results of this effort are summarized in section 4-2 through 4-3 of this report. Water Management, Wilmington District determined the fourth item, 'updated cost of storage' with results summarized in section 4-4.

2.2 Project Description

Kerr Dam is located on the Roanoke River, about 180 river miles above the Albemarle Sound, 20 miles downstream of Clarksville, Virginia 18 miles upstream of the Virginia – North Carolina state line and 80 miles southwest of Richmond, Virginia. The dam is located in Mecklenburg County, Virginia and the reservoir lies within Mecklenburg, Charlotte and Halifax Counties in Virginia and Granville, Vance and Warren Counties in North Carolina. The project was authorized in the Flood Control Act of 1944 (Public Law 534, 78th Congress, 2nd session, December 22, 1944) for reduction of flood damage in the lower Roanoke River, generation of hydroelectric power, mosquito control, pollution abatement and conservation of fish and wildlife, low water control navigation, and for recreation. Initially, all of the conservation storage at Kerr was allocated to hydropower with operational consideration for other purposes as secondary. Operation for navigation never really materialized and was removed from consideration at Kerr once the Roanoke Rapids project was constructed downstream. Reallocation of storage at Kerr for water supply was made possible with passage of Public Law 85-500 also known as the Water Supply Act of 1958. The in-service date for the control of floods is considered to be May 1952. Commercial power generation was initiated in November 1952, and full plant capability was attained in December 1953. The reservoir has 2,262,421 AF of usable storage, which is regulated for power production, flood control, stream flow regulation, recreation, water supply, and fish and wildlife management. The power plant has seven generating units capable of delivering power to customers, with a total installed capacity of 204,000 kilowatts (kw). Kerr Dam is a concrete gravity dam with a gated spillway, flanked by earth dikes, a powerhouse and

switchyard. The top elevation of Kerr Dam is 332 feet, msl and it has an overall length of 22,035 feet. The maximum height above the streambed is 144 feet. The spillway has a crest elevation of 288 feet, msl and a total length of 1,092 feet. It is crested with 22 tainter gates, each 42 feet wide by 32 high. The powerhouse has six vertical shaft Francis turbines rated at 32,000 kw each, one unit at 12,000 kw and two station service units (internal use only) rated at 1,000 kw each for a total plant capacity of 206,000 kw (204,000 kw available on-line). Kerr Reservoir at elevation 300 feet, msl covers an area of 48,900 acres, has a shoreline length of 800 miles and extends into Mecklenburg, Charlotte and Halifax counties in Virginia and Granville, Vance and Warren counties in North Carolina.

2.2.1 Impacts of Sedimentation

Available usable storage at Kerr was determined by adjusting the most current computation of storage capacity for sedimentation impacts as directed by Public Law 88-140, attached as Appendix G. These computations were derived by use of the most recent sedimentation survey data found in a report titled *'REPORT OF SEDIMENTATION RESURVEY' November 1997* located in the Wilmington District office. Sedimentation rates computed for each operational zone or pool over the 21-year period of operation from 1976 to 1997 were projected for the remaining 56 years to determine the usable storage. The 21-year period of operation from 1976 to 1997 was used to most closely represent current conditions. This time period very closely reflects current and expected future conditions by use of the same basic operation and guide curve at Kerr and effectively similar impacts from the operation of Smith Mountain-Leesville combination project, which began filling in 1962, and Philpott project. A breakdown of elevation-storage volume data at Kerr as impacted by sedimentation is shown in Table 2.

Table 2
Kerr ~ Usable Storage Volume Determination

Storage Pool	Elevation Range	Storage* Change 1976-1997	Rate of Sedimentation 1976-1997	Total* Volume 1997	Projected** Sediment 1997-2053	Projected*** Total Volume 2053
	Feet msl	AF	AF/YR	AF	AF	AF
Flood Control	300 to 320	-271	-13	1,281,644	-723	1,282,367
Conservation	268 to 300	12,835	611	1,014,281	34,227	980,054
Total	268 to 320	12,564	598	2,295,925	33,504	2,262,421

* From *'REPORT OF SEDIMENTATION RESURVEY' November 1997*

** Estimated by projection of sedimentation rate observed from1976 to 1997

*** Storage remaining after 100 years of sedimentation from July 1953 the date the project became operational and does not include dead storage and/or storage set aside for hydropower head.

2.3 Current Water Supply Agreements

The City of Clarksville, City of Virginia Beach, Virginia Department of Corrections, Mecklenburg Co-Generation facility, and Burlington Industries, Virginia, and the City of Henderson, North Carolina, are all existing users of water from Kerr for municipal and industrial water supply.

The City of Clarksville and Burlington Industries in Virginia are grandfathered water users at Kerr. Because these entities were users of the affected waters prior to construction of the Kerr project, Clarksville and Burlington are entitled to water at no cost in accordance with pre-project agreements. Currently the City of Clarksville, Virginia, withdraws an average of 0.3 MGD. Burlington Industries at Clarksville, Virginia recently closed and the facilities will be sold, leaving its future impacts questionable. Burlington withdrew an average of 2.2 MGD from Kerr for water supply prior to closing.

The City of Henderson, North Carolina entered into a water use contract on February 12, 1974 and began actual water withdrawals from its current facility in March 1978. This regional water system currently withdraws an annual average of 6 MGD with a monthly range of 5.2 to 6.6 MGD from Kerr. The City currently has a request to purchase storage from Kerr to provide a future projected need of 20 MGD.

The City of Virginia Beach, Virginia, purchased 10,200 AF of storage at Kerr to supplement its withdrawal of up to 60 mgd on January 13, 1984. Withdrawals are made from a pump station on Lake Gaston downstream of Kerr Dam. Required releases from storage at Kerr to supplement this demand are rare.

The Virginia Department of Corrections (VADOC) entered into a contract to utilize an estimated 23 acre-feet of the conservation storage in Kerr for water supply effective April 7, 1989. The specified withdrawal rate is not to exceed 60,000 gallons per day. Water for the Mecklenburg Correctional Center is currently supplied by a regional system, thus delaying construction of a water supply pipeline to Kerr reservoir for an indefinite period of time.

A water supply storage contract with the Mecklenburg Cogeneration Limited Partnership (MCLP) for withdrawals of water from Kerr was signed on June 5, 1991. MCLP constructed a pulverized coal-fired cogeneration plant to supply electric power to Dominion Resources and steam to Burlington Industries, and uses water from Kerr Reservoir for make-up water. MCLP has the right to utilize an estimated 600 acre-feet of conservation storage in John H. Kerr between elevation 268 and 300 feet, m.s.l. During the drought of 2002 MCLP exceeded its 600 acre-feet allocation and will need to increase its storage in the near future. Also, MCLP was recently purchased by Dominion Resources and will need to process a name change.

2.4 Projected Need for Existing Water Users

With the exception of MCLP, no user has expressed any plans to increase its existing allocations. KLRWS is a public water system currently owned by three partners, the sponsor, the City of Oxford, and Warren County, each representing 60%, 20%, and 20% of the overall system ownership respectively. KLRWS provides potable water to the sponsor, Warren County

(including all municipalities in Warren County), Franklin County, the City of Oxford, and portions of Vance and Granville Counties. The KLRWS consists of a conventional surface water treatment plant, distribution mains, storage tanks, and water meters. Environmental Engineering & Technology, Inc. (EE&T, Inc.) consulting engineers for the sponsor developed average daily water demand projections over the next thirty years in October 2004. These data are summarized in Table 3 and provided in Appendix B. Counties adjacent to Kerr in North Carolina, which represent the primary service area for KLRWS, are projected to have the greatest cumulative growth rate. Projected water demand based on these data more than justifies the requested 20.0 MGD allocation.

Table 3
KLRWS Average Daily Withdrawals MGD

Year	1992	1997	2002	2010	2020	2030	2035
Withdrawal	4.99	5.07	5.89	10.19	15.88	20.97	24.19

Source: EE&T, Inc. October 6, 2004

3.0 WATER REQUIREMENTS AND ALTERNATIVE SOURCES

3.1 Water Requirements for The City of Henderson

The sponsor will require a gross withdrawal of 20 MGD from Kerr to provide drinking water for its regional water distribution network. The 20 MGD allocation will be sufficient to handle its current and future demands.

While most of the water use will be consumptive, a small portion of the water will be returned to Kerr, with the remaining portion treated and released to the Tar River and Neuse River basins. EE&T, Inc. consulting engineers for the sponsor recorded inter basin transfers of water distributions in 2002 and made projected distributions for 2035. These data were provided in a 2004 Inter Basin Transfer Study prepared by EE&T, Inc. and summarized in Table 4. The storage reallocation and impacts to power generation were based on the 20 MGD gross withdrawal.

Table 4
KLRWS Average Daily IBT

Year	Tar Basin MGD	Roanoke Basin MGD	Neuse Basin MGD
2002	3.35	2.37	0.07
2035	15.35	5.01	0.81

3.2 Alternative Sources

Consulting engineers and internal planners for the sponsor have examined several alternative ground water and surface water sources to identify prospective new sources of water supply.

3.2.1 Southerland Pond Some of this effort simply involved updating similar studies from the mid-sixties. The principle source of water at that time was Southerland Pond on Sandy Creek, six miles east of the city. The A-E firm retained by the city to do this initial analysis performed a thorough study and concluded that the only source capable of meeting the City's forecast water supply demands was Kerr, thus eliminating all other inadequate ground and surface water alternatives. This analysis led to the construction and development of the KLRWS facility adjacent to Kerr Reservoir. An updated review of Southerland Pond as a potential supplemental source of water supply revealed that this pond has since silted in, reducing the safe yield to nearly zero. The original raw water pipeline at Southerland Pond has been abandoned and the original water plant has been demolished. There is no capacity available from this old raw water source.

3.2.2 Groundwater Generally, deep rock wells in the KLRWS service area produce less than 100 gallons per minute (gpm). The Town of Bunn in Franklin County, now receiving water from the KLRWS, had previously relied on wells. The best well in Bunn had a capacity of around 40 gpm. The Town had drilled over 21 wells over a period of 20 years with very little success (Ref: Peirson and Whitman Engineers, consulting Engineers for the Town of Bunn since 1967). The old wells in Warrenton, Norlina, Soul City and other areas of Warren County were similar in capacity to those in Franklin County. The soil and geologic structure in Franklin, Warren, Vance

and Granville Counties is such that high yield wells are not possible. Therefore, it would not be cost effective to utilize large well fields as the water supply source.

3.2.3 Lake Gaston Lake Gaston is down gradient from Kerr and would require new construction of at least 14 miles of raw water pipeline, a new raw water intake and pumping facilities. Based on the cost to upgrade the existing KLRWS facility to 20 MGD capacity it is estimated that the raw water intake and pumping facilities would cost approximately $21 million. Additional costs would be expected for real estate, permits and pipeline construction. Also, since Lake Gaston is operated as a privately owned run-of-river hydropower facility with no storage for water supply, the sponsor would need to purchase storage from Kerr to ensure dependable water supply during a repeat of the critical drought.

3.2.4 Town of Oxford The alternative of re-establishing the old Town of Oxford water plant located in Granville County within the KLRWS service area, was investigated in 1995-1996. At that time, the plant had been off-line for over 15 years. The clearwell was used in 1998 for wastewater storage and there remains mercury in the Simplex gases at the plant. Therefore, re-establishment of the old plant is no longer feasible. Oxford also investigated the feasibility of increasing water storage in Oxford and building a package water plant with raw water withdrawal from Lake Devin. The study indicated that it was more cost effective to build a second finished water line from KLRWS plant to Oxford, which has been done. Funding for the new finished water line was provided by Oxford, Granville County and Vance County.

Warren County also built a second finished water line into Warren County in 2002.

The KLRWS facility and corresponding extensive distribution network which began operation in 1978 represents a capital investment for the sponsor and its taxpayers of approximately $21 million. In addition to serving the sponsor it also serves as a public water system for Warren County, portions of Vance, Granville and Franklin Counties. The sponsor has operated as the majority partner in the KLRWS for the past 27 years with considerable capital investment in planning, facilities, and distribution networks with other regional partners, all based on a continued 20 MGD water supply withdrawal capability. This fact, plus the fact that the “no action” alternative would result in a directive to not only cease and desist any and all future water withdrawals but to also remove all equipment and structures, makes this a most undesirable choice for the sponsor. However, the government always reserves the right to exercise the ‘no action’ alternative for any reallocation of storage at any time. While the “conservation” alternative could potentially provide some minor relief in the short term it is not a viable option for a future long-range solution. This becomes clearly evident considering that the most recent drought of record lasted for a period of 16 months.

3.3 Summary of Alternatives

Table 5 provides a summary of the various alternatives that were considered. While rejecting the first three alternatives for various reasons, this leaves us with two potentially viable ones, a new reallocation of conservation storage from Kerr and the “no action”.

Table 5
Summary of Alternative Sources of Water

ALTERNATIVE	VIABILITY
1. Groundwater/Bulk Finished Water Purchase	Rejected: inadequate supply
2. Alternative Surface Water	Rejected: inadequate supply
3. Conservation	Rejected: not viable for long term
4. No Action	Potentially viable
5.New Reallocation from Conservation Storage (Kerr)	Potentially viable

3.4 Storage Requirements for Kerr Withdrawal

The volume of storage required for the sponsor was based on a withdrawal rate of 20 MGD. Inflow during the historical critical low flow period at the project was used as the basis to determine the required storage. The critical low flow period at the project was June 2001 through October 2002. This critical low flow period exceeded the previous critical low flow period of June through October 1968 by a whole year. The storage-yield analysis was determined by adjusting the computed inflows during the critical low flow period to a base case condition by adding the actual Henderson water supply withdrawals back in. The volume of storage to be reallocated was determined as the volume of withdrawal minus the volume of inflow during the critical period. The percentage of storage reallocated was adjusted by trial until the storage allocated and the volume of water used during the critical period balanced. The storage reallocation determined to yield a flow of 20 MGD is 10,292 AF as shown in Table 6. The sponsor has requested and demonstrated a future need for a total withdrawal of 20 MGD from Kerr to match the volume currently allowed in its water use agreement. Storage volumes provided to the Hydropower Analysis Center to determine impacts on hydropower were made without consideration of sedimentation impacts and were rounded up to the next whole 100 AF. While this procedure gave a slightly greater impact to hydropower by use of a larger volume of storage (10,700 AF verses 10,292 AF) than what was actually required, it did not adversely impact the cost to the sponsor as the cost of storage is greater than the cost of hydropower by a factor of 2.2 (refer to Table 15). Because of this magnitude, it is not deemed necessary to recompute impacts to hydropower and the values determined in Appendix A are accepted as computed.

Table 6
Reservoir Yield

Conservation Pool Storage (AF)	980,054	
Storage Reallocated (AF)	10,292	
Storage Reallocated (per cent)	1.05	
Withdrawal Rate (MGD)	20	
Withdrawal Rate (cfs)	31	
Critical Period (days)	478	
Withdrawal Volume Critical Period (AF)		29,339
Inflow Volume Critical Period (AF)	1,814,030	
Per cent of Inflow allocated to water supply	1.05	
Volume of Inflow used for water supply (AF)		19,047
Volume of storage utilized during critical period (AF)		10,292

3.5 Impact on Reservoir Operation

The overall impact on operation at Kerr will not change with conversion from a 'water use' agreement to a 'water storage' agreement for 20 MGD. Operation of the reservoir with a 20 MGD water withdrawal during the critical low flow period would result in an elevation at Kerr of 0.26 feet lower than what would be expected without any withdrawal.

3.6 Impact of New Storage Reallocation on Other Project Purposes

3.6.1 Hydropower. The main impact of the proposed withdrawal for water supply will be a reduction in power output from Kerr. These impacts are addressed in detail in Appendix A.

3.6.2 Flood Control. Reallocation from the conservation pool will have no impact on flood control.

3.6.3 Recreation. With conversion of an existing 20 MGD 'water use' to a 20 MGD 'water storage' agreement there will be no change in the water control plan to meet water supply requirements and/or downstream minimum flow requirements. The increase in elevation draw down due to 20 MGD water supply will be 0.26 feet lower than if there were no water supply withdrawals during the recent drought of record. Normal reservoir operations and recreation activities (fishing, boating, swimming, etc.) will not be adversely impacted by this change.

3.6.4 Water Supply. The proposed reallocation would have no impact on other water supply users since the reallocation would come from the conservation storage allocated to hydropower. Reallocation of 10,292 AF of storage to satisfy this request would leave 28,885 AF of storage remaining for reallocation at Kerr under the discretionary authority of the Chief of Engineers.

3.6.5 Streamflow Regulation and Water Quality. The proposed action to convert an existing 20 MGD 'water use' to a 20 MGD 'water storage' agreement will not change the impacts on the total volume of water released from Kerr Dam. The maximum water supply withdrawal of 31 cfs (at the 20 MGD rate) is quite small compared to average annual releases of almost 8,000 cfs from Kerr Dam. No adjustment in reservoir operation will be required to accommodate the withdrawal and the supporting storage reallocation. The volume of Kerr Reservoir is too large compared to the volume withdrawn on any given day for the proposed withdrawal to have a noticeable effect. Because the proposed reallocation as made from the conservation pool would merely be a reallocation of the storage presently in the reservoir, no adverse impacts are expected to the surface or ground water quality and quantity.

3.6.6 Fish & Wildlife. As this action only involves conversion from water use to water storage with no change in the total withdrawal the impact on fish and wildlife and other environment-related impacts will not change. Refer to Appendix D for a further statement on environmental impacts associated with this reallocation.

4.0 DERIVATION OF USER COSTS

4.1 Introduction

This chapter describes the derivation of user costs for a storage reallocation from the conservation storage at Kerr.

According to Section 4-32d of ER 1105-2-100, the cost to be paid by the water supply storage user is established as the highest of

Benefits foregone as a result of the storage reallocation, or
Revenues foregone as a result of the storage reallocation, or
Cost of replacing the outputs that were provided by that increment of storage before reallocation, or
Updated cost of storage

In the case of Kerr, the output that must be replaced would be the updated cost of storage. Since the power benefits foregone are specified by economic evaluation criteria to be the cost of replacement power, the benefits foregone and cost of replacement are identical. Thus, a separate calculation of cost of replacement power is not required.

Reallocation from both conservation storage and flood control storage must be considered. The choice as to which reallocation will be permitted must be based on the alternative having the least impact on existing project purposes (i.e., the least benefits foregone). At Kerr the entire flood control storage space is required to satisfy current criteria established for this purpose. In four separate flood events between 1975 and 1996 over ninety per-cent of the controlled flood storage was utilized. The April 1987 event pushed the reservoir level to less than six inches away from the point at which releases downstream match eighty-five per-cent of the computed inflow (a volume in excess of 100,000 cfs) while the September 1996 flood event generated the greatest computed inflow on record for this location (second only to the August 1940 event which was used to justify project construction). Therefore, this analysis will only concentrate on the volume of conservation/power pool storage that must be reallocated to satisfy water supply requirements. The actual cost to the sponsor will be based on the value of reallocated conservation pool storage. This equates to determining the greatest impact to hydropower since the entire conservation pool storage at Kerr was authorized for hydropower production.

4.2 Power Benefits Foregone

Power benefits foregone represent the impact the withdrawal will have on the National Economic Development (NED) power benefits of the Roanoke River reservoir system. Power benefits are divided into energy and capacity benefits. The following sections summarize these benefits. Detailed information on how they were developed can be found in Chapters 2, 3, and 4 of Appendix A.

4.2.1 Energy Benefits Foregone. A hydro project's National Economic Development (NED) energy benefit is computed as the product of the project's average annual energy production and a unit energy value. That energy value is intended to measure the cost of producing the same

energy by the regional power system if the hydro project were replaced by the most likely thermal alternative.

Energy values are currently developed by the Corps' Northwestern Division office using PROSYM, an hourly power system production cost model. The applicable regional power system is modeled with and without an increment of hydro generation. The difference in system cost between the two simulations represents the value of hydro energy lost. Dividing that cost by the energy output of that increment of hydro will give the average unit value of the hydro energy, and this is commonly called the "energy value." The average value of hydroelectric energy in the VACAR power system over the life of the water supply contract is estimated to be about $33.51/MW-hour (see Section 3.6.8 and Table 3-3 of Appendix A).

Using the $33.51/MWh energy value and the losses in average annual energy production for each case, as described in Chapter 5 of Appendix A, average annual energy benefits foregone were computed for each case.

Table 7
Annual Energy Benefits Foregone

LOST ENERGY	ENERGY VALUE	BENEFITS FOREGONE
1981 MWh	$33.51/MWh	$66,383

4.2.2 Capacity Benefits Foregone. A hydro project's NED capacity benefit is computed as the product of the project's dependable capacity and a unit capacity value. The capacity value is intended to measure the cost of constructing the increment of equivalent thermal generating capacity that would replace the hydro capacity in the power system.

Using the $84.26/kW-year capacity value and the losses in dependable capacity for each case (see Appendix A, Section 5 and Table 5-1), average annual capacity benefits foregone were computed for each case, as follows:

Table 8
Annual Capacity Benefits Foregone

LOST DEPEND. CAPACITY	CAPACITY VALUE	BENEFITS FOREGONE
327 kW	$84.26/kW-year	$27,553

4.3 Revenues Foregone. Revenues foregone represent the income reduction suffered by the regional Federal Power Marketing Agency (Southeastern Power Administration) as a result of lost power sales. These lost sales are due to the reduced power output caused by the water supply withdrawal and storage reallocation. The revenues foregone are to be based on the current rates of the Federal power-marketing agency, which in the case of the Roanoke River projects is the Southeastern Power Administration (SEPA). The rates that were in effect for 2004 are as follows:

Energy value: 8.25 mills/kWh
Capacity value: $23.52/kW-year

The energy value would be applied to the average annual energy loss calculated as described in Section 3.4 of Appendix A. The capacity value, however, would be applied to the loss in marketable capacity rather than the loss in dependable capacity (see Section 4.5 of Appendix A). Further details concerning marketable capacity and revenues foregone may be found in Section 6 of Appendix A.

4.3.1 Energy Revenues Foregone. The average annual energy revenues foregone for each of the alternatives would be as follows:

Table 9
Energy Revenue Foregone

LOST ENERGY	SEPA ENERGY RATE	REVENUES FOREGONE
1981 MWh	$8.25/MWh	$ 16,343

4.3.2 Capacity Revenues Foregone The average annual capacity revenues foregone for each of the alternatives would be as follows:

Table 10
Capacity Revenue Foregone

LOST MARKETABLE CAPACITY	SEPA CAPACITY CHARGE	REVENUES FOREGONE
325 kW	$23.52/kW-year	$ 7,644

4.4 Updated Cost of Storage

Water supply storage reallocation at Corps of Engineers' reservoir projects is outlined in chapter 4 of IWR Report 96-PS-4 (Revised). This reference discusses in detail the authority, guidance, opportunities and procedures required to accomplish this process. The cost of authorized municipal and industrial (M&I) water supply storage in a new or existing project is to include two components: (a) the direct costs (costs attributed specifically to that purpose, such as the cost of a water supply intake), and (b) the allocated joint costs (an allocated portion of the costs of facilities that are shared by all project purposes). In the case of Kerr, there are no direct costs assigned to water supply. Therefore, the sponsor's share of the project cost will be the product of the project's total joint use cost and the ratio of the sponsor's storage space to the total storage space. Section 4-32d(2d) of ER 1105-2-100 stipulates that these joint costs must be updated to current FY 2005 price levels.

The updated cost of reallocated storage in this study was estimated by updating the cost of the joint use features from the midpoint of construction to the fiscal year in which the reallocation of storage is approved. This method eliminates consideration of interest during construction and costs associated with specific project purposes such as hydropower. The updated cost of storage is then multiplied by the reallocated storage as a percent of the total available storage to determine the current value of the reallocated storage.

From paragraph 5 of the 'Cost Allocation Study' dated February 1956, construction was initiated in February 1946 and by definition on page D-12 of IWR Report 96-PS_4 (Revised), June 1952 is the date construction was complete. Therefore, 1949 was used as the midpoint of construction for baseline cost projections. The Engineering News Record (ENR) and Civil Works Construction Cost Index System (CWCCIS) were used to determine the FY2005 estimated construction cost values as directed in Table 4-4 on page 4-10 of IWR Report 96-PS-4 (Revised).

TABLE 11
ENR and CWCCIS Cost Update Indices

ENR Construction Cost Index

Year	ENR Index	Ratio
1949	477	
1967	1074	2.2516

CWCCIS Update Index

Feature	1967	FY2005	Index Ratio
Relocations	100	600.64	6.0064
Reservoirs	100	633.16	6.3316
Dams	100	578.92	5.7892
Roads, Railroads & Bridges	100	600.64	6.0064
Bldgs, Grounds, and Utilities	100	582.41	5.8241
Permanent Operating Equip	100	582.41	5.8241

Storage Requirements

Total Flood Control Storage	1,282,367	Ac-Ft
Total Conservation Storage	980,054	Ac-Ft
Total Usable Storage	2,262,421	Ac-Ft
Reallocated Storage Required	10,292	Ac-Ft
Total Usable Storage	2,262,421	Ac-Ft
Ratio of Reallocated to Total	0.00454911	

TABLE 12
Updated Cost of Storage

Description	As-Built Joint-Use Costs ($)	ENR Index Ratio	CWCCIS Index Ratio	Land Update Factor	FY 2005 Jo Use Cost ($)
Lands and Damages	10,401,000			13.338 1/	138,728
Relocations	14,810,000	2.2516	6.0064		200,290
Reservoirs	5,140,000	2.2516	6.3316		73,277
Dams	24,601,000	2.2516	5.7892		320,673
Roads, Railroads & Bridges	1,043,000	2.2516	6.0064		14,105
Buildings, Grounds, and Utilities	570,000	2.2516	5.8241		7,474
Permanent Operating Equipment	380,000	2.2516	5.8241		4,983
Total Cost	56,945,000				759,532

Footnote: 1/ Derivation of Factor:

As-built Joint-Use Cost (-) Lands and Damages = $ 46,544,0

FY '05 Cost (-) Lands and Damages = $620,804,1

Ratio 620,804,145/46,544,000 = 13.338

The calculation for the updated cost of storage from John H. Kerr Reservoir for 10,292 acre-feet of sto (out of a total usable storage of 2,262,421 acre-feet) is as follows:

$759,532,683 x 10,292 acre-feet = $3,455,197

2,262,421 acre-feet

Table 12 shows computations used to determine the current cost of storage required for a 20 MGD water supply withdrawal. A reallocation of 10,292 AF from the conservation pool would cost $3,455,197.

4.5 Summary of Storage Values

Table 13 summarizes the annual benefits foregone. Also shown are net present values based on a 5-1/8 percent discount rate and the 50-year remaining life of the Kerr project (2004-2053). The net present value is $1,559,000 for 20 MGD.

Table 13
Benefits Foregone

Capacity Benefits Foregone	$27,385
Energy Benefits Foregone	$66,383
Average Annual Benefits Foregone	$93,768
Present Value of Benefits Foregone	$1,559,000

Table 14 indicates annual and net present value of revenues foregone for both storage options. Revenues foregone are substantially lower than benefits foregone.

Table 14
Revenues Foregone

Capacity Revenues Foregone	$7,644
Energy Revenues Foregone	16,343
Average Annual Revenues Foregone	$23,987
Present Value of Revenues Foregone	$398,800

To summarize, the net present values of the four costs for each alternative are as follows:

Table 15
Summary of Costs

Updated Cost of Storage	$3,455,197
Revenues Foregone	$398,800
Benefits Foregone	$1,559,000
Replacement Cost	$1,559,000

As noted earlier, the price to be charged to the sponsor for the reallocated storage would be the highest of the four values cited above. Therefore, updated cost of storage would control. The cost payable for reallocation of the conservation pool storage is $3,455,197 for 20 MGD.

4.6 O&M and RRR Expense These expenses are described here and utilized in Exhibit B of the draft water supply agreement provided as Appendix H.

4.6.1 Operation and Maintenance Expense Annual operation and maintenance expenses charged to the sponsor are estimated by multiplying the proportion of reallocated storage to total useable storage by the total joint-use operation and maintenance (O&M) expense. The following equation summarizes the calculation:

(Required Storage AF/Total Storage AF)*$Annual Joint-Use O&M = $Cost

The $2,722,255 total joint use O&M expense is an average from fiscal year 1994-2004 as indicated in Table 16. Table 17 indicates the estimated annual cost for 20 MGD as $12,384. Future years should increase slightly with inflation.

TABLE 16
John H Kerr Joint-Use Operation and Maintenance Cost

Year	($)
1994	2,491,478
1995	2,537,131
1996	2,831,041
1997	3,014,254
1998	2,914,601
1999	2,359,534
2000	2,465,247
2001	2,208,906
2002	2,843,171
2003	3,389,934
2004	2,889,508
Total	29,944,805
Average	2,722,255

TABLE 17
Apportioned Joint-Use O&M Cost

Reallocated Storage Required (AF)	10,292
Total Usable Storage (AF)	2,262,421
Ratio of Reallocated Storage to Total	0.00454911
Estimated Annual O&M Cost ($)	2,722,255
Estimated O&M cost ($/yr)	12,384

4.6.2 Major Repair, Replacement and Rehabilitation Major repair, replacement and rehabilitation (RRR) costs charged to the sponsor are determined by multiplying the proportion of reallocated storage to total useable storage by the total joint-use RRR expense. This is similar to the method used to compute annual O&M costs. The $950,906 total joint use RR&R expense

is an average from fiscal year 1995-2004 as indicated in Table 18. Table 19 indicates the estimated annual cost for 20 MGD as $4,326.

TABLE 18
Joint-Use Repair, Replacement and Rehabilitation Cost

Year	($)
1995	- 320,112
1996	31,365
1997	31,810
1998	3,517,824
1999	- 400,924
2000	402,461
2001	- 27,050
2002	629,125
2003	5,648,107
2004	- 3,545
Total	9,509,061
Average	950,906

TABLE 19
Apportioned Joint-Use Repair, Replacement and Rehabilitation Cost

Reallocated Storage Required (AF)	10,292
Total Usable Storage (AF)	2,262,421
Ratio of Reallocated to Total	0.00454911
Estimated Annual RR&R Cost ($)	950,906
Estimated RR&R cost ($/yr)	4,326

Given the uncertain nature of major RR&R costs plus the fact that they are payable only when incurred, it is suggested that the sponsor place the resultant amount in an annual reserve or sinking fund for future contingency.

5.0 OTHER CONSIDERATIONS

5.1 Financial Feasibility

As a test of financial feasibility, the annual cost of storage should be compared to the cost of the most likely, least costly alternative that the applicant would undertake in the absence of utilizing the Federal project. This should be an alternative that would provide water of equivalent quality and quantity. The following decision process was analyzed.

As wells and local surface water options are inadequate, the most likely alternative to the Federal project is the purchase of water from another entity. No other industrial or municipal system within a reasonable distance is known to possess a surplus supply of water adequate to meet the sponsor's needs. A possible alternative would be to obtain water from another lake or reservoir source. This would require the construction of a pipeline at a minimum and possible relocation of the water treatment facility adjacent to the water source. The closest water source other than Kerr is Lake Gaston, which is a private hydropower lake owned by Dominion Resources. This option would require construction of at least a 14-mile pipeline depending on the location and construction of a new intake structure and pump facility. Based on the sponsor's cost to upgrade its existing facility to 20 MGD the cost of a new facility would be approximately $21 million, not counting the cost for a pipeline, pumping plant, real estate, and necessary access and environmental permits. Since Lake Gaston has no storage to supply a dependable yield for water supply and since this lake is downstream of Kerr, the sponsor would need to purchase storage at Kerr, the same result we are addressing here. This exercise has taken on a circuitous nature without an adequate alternative.

The reallocation of storage has a significant advantage over the alternative purchase of water from private sources. The annual water purchase with an initial five-year interest rate at 5-1/8 percent (the lowest rate offered to date by guidelines for reallocated storage) represents a major cost savings over potential alternatives. Construction of a pipeline to allow purchase of water from private sources would be very expensive, and likely to result in much greater environmental impact that the proposed reallocation of storage. The existing raw water facility is already in place and operational.

5.2 Cost Account Adjustments

According to Section 4-33d(3) of ER 1105-2-100,

> *When there is a loss of revenue of existing purposes, or additional operation and/or maintenance expense to existing purposes are incurred because of the new water supply addition, such charges shall be shown as a direct charge against the water supply function. This will effect the appropriate cost reductions in the existing project purposes and all revenues from the new addition will be credited to the new purpose. 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. In instances where existing contracts between the power marketing agency and their 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.

In the case of the proposed sponsor reallocation, there would be a loss of revenue due to the reduction in the power-generating capabilities of Kerr. During the early years of the reallocation (2005-2018), there would also be the possibility of the marketing agency (SEPA) having to purchase replacement power.

The estimated credit to the power-marketing agency for each of the four cases is as follows. The back-up calculations and further details on credit to the power marketing agency can be found in Chapter 7 of Appendix A.

Table 20
Credit to Marketing Agency

Withdrawal Alternative	5 MGD	20 MGD
Energy credit	$11,896	$47,511
Capacity credit	$5,066	$20,088
Annual credit to PMA	**$16,962**	**$67,599**

5.3 Environmental Considerations

The environmental impact of the withdrawal and discharge will not be significant. As all facilities are already constructed and in operation there is no additional risk to the environment. No archeological/cultural or threatened and endangered species will be impacted.

Operation of the water intake facility will not change as a result of converting from a water use agreement to a water storage agreement. The discharge from the wastewater pipeline is designed to meet all applicable water quality criteria for a NPDES permit.

These factors minimize and limit environmental impact and are addressed in a Record of Environmental Evaluation provided in Appendix D.

5.4 Structural Changes

No structural modifications will need to be made to Corps of Engineers facilities to accommodate either the storage reallocation or the water supply withdrawal.

5.5 Test for Low Income Community Discount

Public Law (PL) 101-640 specifically defines a “low income community” as a community with a population less than 20,000 that is located in a county with a per capita income less than the per capita income of two-thirds of the counties in the United States. The maximum amount of water supply storage space, that may be provided to a community under this authority, may not exceed an amount of water supply storage space sufficient to yield 2,000,000 gallons of water per day. The sponsor currently exceeds the requirement for maximum daily water supply use of 2 MGD thus rendering it ineligible for this discount.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Findings

There are no viable alternatives available to the sponsor as a source of water verses their proposed conversion of the water use agreement to a water storage agreement at Kerr.

Reallocation of storage at Kerr from the conservation pool will satisfy the sponsor's need.

In order to support the sponsor's firm withdrawal of 20 MGD, a reallocation of 10,292 AF of storage will be required from the conservation pool.

There would be a reduction in the power capability of Kerr as a result of the withdrawal.

The net present values of the four cost parameters specified by Section 4-32d of ER 1105-2-100 are as follows:

Updated Cost of Storage	$3,455,197
Revenues Foregone	$398,800
Benefits Foregone	$1,559,000
Replacement Cost	$1,559,000

Updated cost of storage is the highest cost, and this would establish the cost to be paid by the sponsor for the storage allocation.

There would be slightly greater pool fluctuations at Kerr during periods of low flow. However, these small changes in pool elevation would not have a perceptible impact on reservoir recreation. Likewise, it is not anticipated that the reallocation would have any significant impact water quality, or fish and wildlife.

6.2 Recommendations

The reallocation of storage discussed in this report is economically justified and will not significantly impact the authorized purposes of Kerr. The reallocation will not require any structural or operational change.

Therefore, pursuant to the authority provided in the Water Supply Act of 1958, as amended, it is recommended that the reallocation of 10,292 acre-feet of conservation storage be approved. Approval is subject to the execution of a water storage contract between the U.S. Army Corps of Engineers and The City of Henderson, North Carolina and is subject to the successful fulfillment of all requirements of said contract.